**Habitat and biome**

Habitat is a place where an organism or a community of organisms lives, including all living and nonliving factors or conditions of the surrounding environment. A host organism inhabited by parasites is as much a habitat as a terrestrial place such as a grove of trees or an aquatic locality such as a small pond. Microhabitat is a term for the conditions and organisms in the immediate vicinity of a plant or animal.

Open habitat is a part of a landscape that is not enclosed by trees. Open habitat may include plains, tundra, polar barrens, forest clear-cuts, and other areas free of tree cover. It may be limited to certain portions of ecosystems, or it may encompass whole ecosystems or biomes, such as grasslands or deserts. In open habitats the ground is more exposed to wind, rain, and light.

Plants in open habitats tend to be short in stature, because water in these areas is a limiting resource because of increased evaporation by wind. Animals in open habitats have adaptations for dealing with exposure to wind, rain, and sun. Such adaptations often include thick, waterproof, or windproof fur or feathers, but they may also include claws or other appendages that allow the animal to excavate burrows.

In contrast, woodlands are considered “closed” habitat. In those habitats trees form a barrier to the wind that limits evaporation. As a result, forests retain moisture, and so they tend to be more humid than open habitats. In addition, the crowns of trees in dense woodlands often touch one another to form a canopy that significantly reduces the amount of light that strikes the ground.

Biome, also called major life zone is the largest geographic biotic unit, a major community of plants and animals with similar life forms and environmental conditions. It includes various communities and is named for the dominant type of vegetation, such as grassland or coniferous forest. Several similar biomes constitute a biome type – for example, the temperate deciduous forest biome type includes the deciduous forest biomes of Asia, Europe, and North America. “Major life zone” is the European phrase for the North American biome concept.

**Biology**

Biology is the study of living things and their vital processes. The field deals with all the physicochemical aspects of life. The modern tendency toward cross-disciplinary research and the unification of scientific knowledge and investigation from different fields has resulted in significant overlap of the field of biology with other scientific disciplines. Modern principles of other fields – chemistry, medicine, and physics, for example – are integrated with those of biology in areas such as biochemistry, biomedicine, and biophysics.

Biology is subdivided into separate branches for convenience of study, though all the subdivisions are interrelated by basic principles. Thus, while it is custom to separate the study of plants (botany) from that of animals (zoology), and the study of the structure of organisms (morphology) from that of function (physiology), all living things share in common certain biological phenomena – for example, various means of reproduction, cell division, and the transmission of genetic material.

Biology is often approached on the basis of levels that deal with fundamental units of life. At the level of molecular biology, for example, life is regarded as a manifestation of chemical and energy transformations that occur among the many chemical constituents that compose an organism. As a result of the development of increasingly powerful and precise laboratory instruments and techniques, it is possible to understand and define with high precision and accuracy not only the ultimate physiochemical organization (ultrastructure) of the molecules in living matter but also the way living matter reproduces at the molecular level. Especially crucial to those advances was the rise of genomics in the late 20th and early 21st centuries.

Cell biology is the study of cells – the fundamental units of structure and function in living organisms. Cells were first observed in the 17th century, when the compound microscope was invented. Before that time, the individual organism was studied as a whole in a field known as organismic biology; that area of research remains an important component of the biological sciences.

**Population biology and taxonomy**

Population biology deals with groups or populations of organisms that inhabit a given area or region. Included at that level are studies of the roles that specific kinds of plants and animals play in the complex and self-perpetuating interrelationships that exist between the living and the nonliving world, as well as studies of the built-in controls that maintain those relationships naturally. Those broadly based levels – molecules, cells, whole organisms, and populations – may be further subdivided for study, giving rise to specializations such as morphology, taxonomy, biophysics, biochemistry, genetics, epigenetics, and ecology.

*Taxonomy*, in a broad sense the science of classification, but more strictly the classification of living and extinct organisms – i.e., biological classification. The term is derived from the Greek taxis (“arrangement”) and nomos (“law”). Taxonomy is, therefore, the methodology and principles of systematic botany and zoology and sets up arrangements of the kinds of plants and animals in hierarchies of superior and subordinate groups.

Popularly, classifications of living organisms arise according to need and are often superficial. Anglo-Saxon terms such as worm and fish have been used to refer, respectively, to any creeping thing – snake, earthworm, intestinal parasite, or dragon – and to any swimming or aquatic thing. Although the term fish is common to the names shellfish, crayfish, and starfish, there are more anatomical differences between a shellfish and a starfish than there are between a bony fish and a man. Vernacular names vary widely. The American robin (Turdus migratorius), for example, is not the English robin (Erithacus rubecula), and the mountain ash (Sorbus) has only a superficial resemblance to a true ash.

Biologists, however, have attempted to view all living organisms with equal thoroughness and thus have devised a formal classification. A formal classification provides the basis for a relatively uniform and internationally understood nomenclature, thereby simplifying cross-referencing and retrieval of information.

The usage of the terms taxonomy and systematics with regard to biological classification varies greatly. American evolutionist Ernst Mayr has stated that “taxonomy is the theory and practice of classifying organisms” and “systematics is the science of the diversity of organisms”; the latter in such a sense, therefore, has considerable interrelations with evolution, ecology, genetics, behaviour, and comparative physiology that taxonomy need not have.

**Life (in biology)**

Life in biology is living matter and, as such, matter that shows certain attributes that include responsiveness, growth, metabolism, energy transformation, and reproduction. Although a noun, as with other defined entities, the word life might be better cast as a verb to reflect its essential status as a process. Life comprises individuals, living beings, assignable to groups (taxa). Each individual is composed of one or more minimal living units, called cells, and is capable of transformation of carbon-based and other compounds (metabolism), growth, and participation in reproductive acts. Life-forms present on Earth today have evolved from ancient common ancestors through the generation of hereditary variation and natural selection. Although some studies state that life may have begun as early as 4.1 billion years ago, it can be traced to fossils dated to 3.5–3.7 billion years ago, which is still only slightly younger than Earth, which gravitationally accreted into a planet about 4.5 billion years ago. But this is life as a whole. More than 99.9 percent of species that have ever lived are extinct. The several branches of science that reveal the common historical, functional, and chemical basis of the evolution of all life include electron microscopy, genetics, paleobiology (including paleontology), and molecular biology.

Much is known about life from points of view reflected in the various biological, or “life,” sciences. These include anatomy (the study of form at the visible level), ultrastructure (the study of form at the microscopic level), physiology (the study of function), molecular biology and biochemistry (the study of form and function at chemical levels), ecology (the study of the relations of organisms with their environments), taxonomy (the naming, identifying, and classifying of organisms), ethology (the study of animal behaviour), and sociobiology (the study of social behaviour). Specific sciences that participate in the study of life focus more narrowly on certain taxa or levels of observation—e.g., botany (the study of plants), lichenology (the study of lichens, leafy or crusty individuals composed of permanent associations between algae or photosynthetic bacteria and fungi), herpetology (the study of amphibians and reptiles), microbiology (the study of bacteria, yeast, and other unicellular fungi, archaea, protists, viruses), zoology (the study of marine and land animals), and cytology (the study of cells). Although the scientists, technicians, and others who participate in studies of life easily distinguish living matter from inert or dead matter, none can give a completely inclusive, concise definition of life itself.

**Unicellular and multicellular organisms**

*A multicellular organism* is an organism composed of many cells, which are to varying degrees integrated and independent. The development of multicellular organisms is accompanied by cellular specialization and division of labour; cells become efficient in one process and are dependent upon other cells for the necessities of life.

Specialization in single-celled organisms exists at the subcellular level; i.e., the basic functions that are divided among the cells, tissues, and organs of the multicellular organism are collected within one cell. Unicellular organisms are sometimes grouped together and classified as the kingdom Protista.

*A protest* is any member of a group of diverse eukaryotic, predominantly unicellular microscopic organisms. They may share certain morphological and physiological characteristics with animals or plants or both. The term protist typically is used in reference to a eukaryote that is not a true animal, plant, or fungus or in reference to a eukaryote that lacks a multicellular stage.

From the time of Aristotle, near the end of the 4th century BCE, until well after the middle of the 20th century, the entire biotic world was generally considered divisible into just two great kingdoms, the plants and the animals.

During the 1970s and ’80s, attention was redirected to the problem of possible high-level systematic subdivisions within the eukaryotes. American biologists Robert H. Whittaker and Lynn Margulis, as well as others, became involved in such challenging questions. A major outcome was widespread support among botanists and zoologists for considering living organisms as constituting five separate kingdoms, four of which were placed in what was conceived of as the superkingdom Eukaryota (Protista, Plantae, Animalia, and Fungi); the fifth kingdom, Monera, constituted the superkingdom Prokaryota.

In the late 1970s, realizing distinctions between certain prokaryotes, American microbiologist Carl R. Woese proposed a system whereby life was divided into three domains: Eukarya for all eukaryotes, Bacteria for the true bacteria, and Archaea for primitive prokaryotes that are distinct from true bacteria. Woese’s scheme was unique for its focus on molecular characteristics, particularly certain RNA sequences. Although imperfect, RNA analyses have provided great insight into the evolutionary relatedness of organisms, which in turn has led to extensive reassessment of protist taxonomy such that many scientists no longer consider kingdom Protista to be a valid grouping.

**Evolution**

Evolution is the theory in biology postulating that the various types of plants, animals, and other living things on Earth have their origin in other preexisting types and that the distinguishable differences are due to modifications in successive generations. The theory of evolution is one of the fundamental keystones of modern biological theory.

The diversity of the living world is staggering. More than 2 million existing species of organisms have been named and described; many more remain to be discovered – from 10 million to 30 million, according to some estimates. What is impressive is not just the numbers but also the incredible heterogeneity in size, shape, and way of life – from lowly bacteria, measuring less than a thousandth of a millimetre in diameter, to stately sequoias, rising 100 metres (300 feet) above the ground and weighing several thousand tons; from bacteria living in hot springs at temperatures near the boiling point of water to fungi and algae thriving on the ice masses of Antarctica and in saline pools at −23 °C (−9 °F); and from giant tube worms discovered living near hydrothermal vents on the dark ocean floor to spiders and larkspur plants existing on the slopes of Mount Everest more than 6,000 metres (19,700 feet) above sea level.

The virtually infinite variations on life are the fruit of the evolutionary process. All living creatures are related by descent from common ancestors. Biological evolution is a process of descent with modification. Lineages of organisms change through generations; diversity arises because the lineages that descend from common ancestors diverge through time.

The 19th-century English naturalist Charles Darwin argued that organisms come about by evolution, and he provided a scientific explanation, essentially correct but incomplete, of how evolution occurs and why it is that organisms have features – such as wings, eyes, and kidneys – clearly structured to serve specific functions. Natural selection was the fundamental concept in his explanation. Natural selection occurs because individuals having more-useful traits, such as more-acute vision or swifter legs, survive better and produce more progeny than individuals with less-favourable traits. Genetics, a science born in the 20th century, reveals in detail how natural selection works and led to the development of the modern theory of evolution.

**Speciation**

Subspecies are groups at the first stage of speciation; individuals of different subspecies sometimes interbreed, but they produce many sterile male offspring. At the second stage are incipient species, or semispecies; individuals of these groups rarely interbreed, and all their male offspring are sterile. Natural selection separates incipient species into sibling species, which do not mate at all but which in morphology, or structure and form, are nearly indistinguishable. Sibling species then evolve into morphologically (and taxonomically) different species. Because it is often difficult to distinguish between subspecies and stable species, another criterion has been developed that involves a historical, or phylogenetic, dimension. In this form, a species is separated from another when there is a parental pattern of ancestry and descent.

Speciation may occur in many ways. A population may become geographically separated from the rest of its species and never be rejoined. Through the process of adaptive radiation, this population might evolve independently into a new species, changing to fit particular ecological niches in the new environment and never requiring natural selection to complete its reproductive isolation from the parent species. Within the new environment, populations of the new species might then radiate into species themselves. A famous example of adaptive radiation is that of the Galapagos finches.

The evidence for speciation formerly was found in the fossil record by tracing successive changes in the morphology of organisms. Genetic studies now show that morphological change does not always accompany speciation, as many apparently identical groups are, in fact, reproductively isolated.

The identification of lineages in species developed tremendously following the advent of molecular biology. Certain kinds of molecular information, especially DNA sequences, can provide clearer support than morphological data ever could for species identification, particularly when species clusters are similar in appearance. Molecular characters can often be identified less ambiguously than morphological characters. Species identification is extremely important for the conservation of biodiversity. About 1.9 million species have been named, yet it is estimated that the total number of species may be anywhere from 3 to 100 million. Large numbers of animals and plants have not been studied.

**Biodiversity**

Biodiversity, also called biological diversity is the variety of life found in a place on Earth or, often, the total variety of life on Earth. A common measure of this variety, called species richness, is the count of species in an area. Colombia and Kenya, for example, each have more than 1,000 breeding species of birds, whereas the forests of Great Britain and of eastern North America are home to fewer than 200. A coral reef off northern Australia may have 500 species of fish, while the rocky shoreline of Japan may be home to only 100 species. Such numbers capture some of the differences between places – the tropics, for example, have more biodiversity than temperate regions – but raw species count is not the only measure of diversity. Furthermore, biodiversity encompasses the genetic variety within each species and the variety of ecosystems that species create.

Although examining counts of species is perhaps the most common method used to compare the biodiversity of various places, in practice biodiversity is weighted differently for different species, the reason being that some species are deemed more valuable or more interesting than others. One way this “value” or “interest” is assessed is by examining the diversity that exists above the species level, in the genera, families, orders, classes, and phyla to which species belong (see taxonomy). For example, the count of animal species that live on land is much higher than the count of those that live in the oceans because there are huge numbers of terrestrial insect species; insects comprise many orders and families, and they constitute the largest class of arthropods, which themselves constitute the largest animal phylum. In contrast, there are fewer animal phyla in terrestrial environments than in the oceans. No animal phylum is restricted to the land, but brachiopods (see lamp shell), pogonophorans (see beardworm), and other animal phyla occur exclusively or predominantly in marine habitats.

Some species have no close relatives and exist alone in their genus, whereas others occur in genera made up of hundreds of species. Given this, one can ask whether it is a species belonging to the former or latter category that is more important. On one hand, a taxonomically distinct species – the only one in its genus or family, for example – may be more likely to be distinct biochemically and so be a valuable source for medicines simply because there is nothing else quite like it. On the other hand, although the only species in a genus carries more genetic novelty, a species belonging to a large genus might possess something of the evolutionary vitality that has led its genus to be so diverse.

**Cell**

Cell, in biology, is the basic membrane-bound unit that contains the fundamental molecules of life and of which all living things are composed. A single cell is often a complete organism in itself, such as a bacterium or yeast. Other cells acquire specialized functions as they mature. These cells cooperate with other specialized cells and become the building blocks of large multicellular organisms, such as animals and humans. Although cells are much larger than atoms, they are still very small. The smallest known cells are a group of tiny bacteria called mycoplasmas; some of these single-celled organisms are spheres about 0.3 micrometre in diameter, with a total mass of 10−14 gram – equal to that of 8,000,000,000 hydrogen atoms. Cells of humans typically have a mass 400,000 times larger than the mass of a single mycoplasma bacterium, but even human cells are only about 20 micrometres across. It would require a sheet of about 10,000 human cells to cover the head of a pin, and each human organism is composed of more than 75,000,000,000,000 cells.

As an individual unit, the cell is capable of metabolizing its own nutrients, synthesizing many types of molecules, providing its own energy, and replicating itself in order to produce succeeding generations. It can be viewed as an enclosed vessel, within which innumerable chemical reactions take place simultaneously. These reactions are under very precise control so that they contribute to the life and procreation of the cell. In a multicellular organism, cells become specialized to perform different functions through the process of differentiation. In order to do this, each cell keeps in constant communication with its neighbours. As it receives nutrients from and expels wastes into its surroundings, it adheres to and cooperates with other cells. Cooperative assemblies of similar cells form tissues, and a cooperation between tissues in turn forms organs, which carry out the functions necessary to sustain the life of an organism.

Cells contain a special collection of molecules that are enclosed by a membrane. These molecules give cells the ability to grow and reproduce. The overall process of cellular reproduction occurs in two steps: cell growth and cell division. During cell growth, the cell ingests certain molecules from its surroundings by selectively carrying them through its cell membrane. Once inside the cell, these molecules are subjected to the action of highly specialized, large, elaborately folded molecules called enzymes.

**The nature and functions of cells**

A cell is enclosed by a plasma membrane, which forms a selective barrier that allows nutrients to enter and waste products to leave. The interior of the cell is organized into many specialized compartments, or organelles, each surrounded by a separate membrane. One major organelle, the nucleus, contains the genetic information necessary for cell growth and reproduction. Each cell contains only one nucleus, whereas other types of organelles are present in multiple copies in the cellular contents, or cytoplasm. Organelles include mitochondria, which are responsible for the energy transactions necessary for cell survival; lysosomes, which digest unwanted materials within the cell; and the endoplasmic reticulum and the Golgi apparatus, which play important roles in the internal organization of the cell by synthesizing selected molecules and then processing, sorting, and directing them to their proper locations. In addition, plant cells contain chloroplasts, which are responsible for photosynthesis, whereby the energy of sunlight is used to convert molecules of carbon dioxide (CO2) and water (H2O) into carbohydrates. Between all these organelles is the space in the cytoplasm called the cytosol. The cytosol contains an organized framework of fibrous molecules that constitute the cytoskeleton, which gives a cell its shape, enables organelles to move within the cell, and provides a mechanism by which the cell itself can move. The cytosol also contains more than 10,000 different kinds of molecules that are involved in cellular biosynthesis, the process of making large biological molecules from small ones.

Specialized organelles are a characteristic of cells of organisms known as eukaryotes. In contrast, cells of organisms known as prokaryotes do not contain organelles and are generally smaller than eukaryotic cells. However, all cells share strong similarities in biochemical function.

*The molecules of cells*

Cells contain a special collection of molecules that are enclosed by a membrane. These molecules give cells the ability to grow and reproduce. The overall process of cellular reproduction occurs in two steps: cell growth and cell division. During cell growth, the cell ingests certain molecules from its surroundings by selectively carrying them through its cell membrane. Once inside the cell, these molecules are subjected to the action of highly specialized, large, elaborately folded molecules called enzymes. Enzymes act as catalysts by binding to ingested molecules and regulating the rate at which they are chemically altered.