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Chapter 1 : Dictionary of Biology - Oxford Reference

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Biology deals with every aspect of life in a living organism. Biology examines the structure, function, growth, origin, evolution, and distribution of living things. It classifies and describes organism s, their functions, how species come into existence, and the interactions they have with each other and with the natural environment. Four unifying principles form the foundation of modern biology: Biology as a separate science was developed in the nineteenth century as scientists discovered that organisms shared fundamental characteristics. Biology is now a standard subject of instruction at schools and universities around the world, and over a million papers are published annually in a wide array of biology and medicine journals. Most biological sciences are specialized disciplines. Traditionally, they are grouped by the type of organism being studied: The fields within biology are further divided based on the scale at which organisms are studied and the methods used to study them: Foundations of modern biology There are five unifying principles of biology: Cell Theory is the study of everything that involves cells. All living organisms are made of at least one cell, the basic unit of function in all organisms. In addition, the core mechanisms and chemistry of all cells in all organisms are similar, and cells emerge only from preexisting cells that multiply through cell division. Cell theory studies how cells are made, how they reproduce, how they interact with their environment, what they are composed of, and how the materials that make up a cell work and interact with other cell sections. In addition, traits are passed on from one generation to the next by way of these genes. All information flows from the genotype to the phenotype , the observable physical or biochemical characteristics of the organism. Although the phenotype expressed by the gene may adapt to the environment of the organism, that information is not transferred back to the genes. Only through the process of evolution do genes change in response to the environment. The physiological processes that allow an organism to maintain its internal environment notwithstanding its external environment. All living organisms exhibit a stimulus-response behavior. Cell Theory The cell is the fundamental unit of life. Cell theory states that all living things are composed of one or more cells, or the secreted products of those cells, for example, shell and bone. Furthermore, the cell is considered to be the basic part of the pathological processes of an organism. Evolution A central organizing concept in biology is that life changes and develops through evolution and that all lifeforms known have a common origin see Common descent. This has led to the striking similarity of units and processes discussed in the previous section. Introduced into the scientific lexicon by Jean-Baptiste de Lamarck in , Charles Darwin established evolution fifty years later as a viable theory by articulating its driving force, natural selection Alfred Russel Wallace is recognized as the co-discoverer of this concept as he helped research and experiment with the concept of evolution. Darwin theorized that species and breeds developed through the processes of natural selection as well as by artificial selection or selective breeding. Genetic drift was embraced as an additional mechanism of evolutionary development in the modern synthesis of the theory. The evolutionary history of the species â€” which describes the characteristics of the various species from which it descendedâ€” together with its genealogical relationship to every other species is called its phylogeny. Widely varied approaches to biology generate information about phylogeny. These include the comparisons of DNA sequence s conducted within molecular biology or genomics , and comparisons of fossil s or other records of ancient organisms in paleontology. Biologists organize and analyze evolutionary relationships through various methods, including phylogenetics , phenetics , and cladistics. For a summary of major events in the evolution of life as currently understood by biologists, see evolutionary timeline. Up into the 19th century , it was commonly believed that life forms could appear spontaneously under certain conditions see spontaneous generation. It simply means that there is an unbroken continuity of life from its initial origin to the present time. A group of organisms share a common descent if they share a common ancestor. All organism s on the

Earth both living and extinct have been or are descended from a common ancestor or an ancestral gene pool. This last universal common ancestor of all organisms is believed to have appeared about 3. Biologists generally regard the universality of the genetic code as definitive evidence in favor of the theory of universal common descent UCD for all bacteria , archaea , and eukaryote s see: Evolution does not always give rise to progressively more complex organisms. For example, the process of dysgenic s has been observed among the human population. Gene theory Biological form and function are created from and passed on to the next generation by genes, which are the primary units of inheritance. Remarkably, widely different organisms, including bacteria, plants, animals, and fungi, all share the same basic machinery that copies and transcribes DNA into proteins. For example, bacteria with inserted human DNA will correctly yield the corresponding human protein. The total complement of genes in an organism or cell is known as its genome , which is stored on one or more chromosomes. A chromosome is a single, long DNA strand on which thousands of genes, depending on the organism, are encoded. A ribosome then translates the RNA into a structural protein or catalytic protein. Homeostasis Homeostasis is the ability of an open system to regulate its internal environment to maintain a stable condition by means of multiple dynamic equilibrium adjustments controlled by interrelated regulation mechanisms. All living organism s, whether unicellular or multicellular , exhibit homeostasis. Homeostasis exists at the cellular level, for example cells maintain a stable internal acidity pH ; and at the level of the organism, for example warm-blooded animals maintain a constant internal body temperature. Homeostasis is a term that is also used in association with ecosystems , for example, the atmospheric concentration of carbon dioxide on Earth has been regulated by the concentration of plant life on Earth because plants remove more carbon dioxide from the atmosphere during the daylight hours than they emit to the atmosphere at night. Tissues and organs can also maintain homeostasis. Punnent Square made by Reginald Punnet in which is the shorthand way to show the expressed trait Research Structural Molecular biology is the study of biology at a molecular level. This field overlaps with other areas of biology, particularly with genetics and biochemistry. Molecular biology chiefly concerns itself with understanding the interactions between the various systems of a cell, including the interrelationship of DNA, RNA, and protein synthesis and learning how these interactions are regulated. Cell biology studies the physiological properties of cells , as well as their behavior s, interactions, and environment. This is done both on a microscopic and molecular level. Cell biology researches both single-celled organisms like bacteria and specialized cells in multicellular organisms like human s. Understanding cell composition and how they function is fundamental to all of the biological sciences. Appreciating the similarities and differences between cell types is particularly important in the fields of cell and molecular biology. These fundamental similarities and differences provide a unifying theme, allowing the principles learned from studying one cell type to be extrapolated and generalized to other cell types. Genetics is the science of gene s, heredity , and the variation of organism s. Gene s encode the information necessary for synthesizing proteins, which in turn play a large role in influencing though, in many instances, not completely determining the final phenotype of the organism. In modern research, genetics provides important tools in the investigation of the function of a particular gene, or the analysis of genetic interaction s. Within organism s, genetic information generally is carried in chromosome s, where it is represented in the chemical structure of particular DNA molecule s. Developmental biology studies the process by which organisms grow and develop. Originating in embryology , modern developmental biology studies the genetic control of cell growth , differentiation , and " morphogenesis ," which is the process that gives rise to tissues , organs , and anatomy. Model organism s for developmental biology include the round worm Caenorhabditis elegans , the fruit fly Drosophila melanogaster , the zebrafish Brachydanio rerio , the mouse Mus musculus , and the weed Arabidopsis thaliana. Physiological Physiology studies the mechanical, physical, and biochemical processes of living organisms by attempting to understand how all of the structures function as a whole. The theme of "structure to function" is central to biology. Physiological studies have traditionally been divided into plant physiology and animal physiology , but the principles of physiology are universal, no matter what particular organism is being studied. For example, what is learned about the

physiology of yeast cells can also apply to human cells. The field of animal physiology extends the tools and methods of human physiology to non-human species. Plant physiology also borrows techniques from both fields. Anatomy is an important branch of physiology and considers how organ systems in animals, such as the nervous , immune , endocrine , respiratory , and circulatory systems, function and interact. The study of these systems is shared with medically oriented disciplines such as neurology and immunology. Evolution Evolution is concerned with the origin and descent of species , as well as their change over time, and includes scientists from many taxonomically -oriented disciplines. For example, it generally involves scientists who have special training in particular organism s such as mammalogy , ornithology , botany , or herpetology , but use those organisms as systems to answer general questions about evolution. Evolutionary biology is mainly based on paleontology , which uses the fossil record to answer questions about the mode and tempo of evolution, as well as the developments in areas such as population genetics and evolutionary theory. In the s , developmental biology re-entered evolutionary biology from its initial exclusion from the modern synthesis through the study of evolutionary developmental biology. Related fields which are often considered part of evolutionary biology are phylogenetics , systematics , and taxonomy. Up into the 19th century , it was believed that life forms were being continuously created under certain conditions see spontaneous generation. A group of organisms shares a common descent if they share a common ancestor. All organism s on the Earth have been and are descended from a common ancestor or an ancestral gene pool. The two major traditional taxonomically-oriented disciplines are botany and zoology. Botany is the scientific study of plant s. Botany covers a wide range of scientific disciplines that study the growth , reproduction , metabolism , development , diseases , and evolution of plant life. Zoology involves the study of animal s, including the study of their physiology within the fields of anatomy and embryology. The common genetic and developmental mechanisms of animals and plants is studied in molecular biology , molecular genetics , and developmental biology. The ecology of animals is covered under behavioral ecology and other fields.

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