Science of life. Biology includes all the life sciences – for example, anatomy and physiology (the study of the structure of living things), cytology (the study of cells), zoology (the study of animals), botany (the study of plants), ecology (the study of habitats and the interaction of living species), animal behaviour, embryology, and taxonomy (classification), and plant breeding. Increasingly biologists have concentrated on molecular structures: biochemistry, biophysics, and genetics (the study of inheritance and variation).

Biological research has come a long way towards understanding the nature of life. From the late 1990s our knowledge was greatly extended by the Human Genome Project (see human genome), which led to the analysis of entire genome sequences of many species, including human and chimpanzee. In the ‘postgenomic’ era, interpretation of this vast body of information in terms of protein function and metabolism (known as proteomics and metabolomics respectively) has become an important challenge, as is the understanding of organisms on the systems level (systems biology).

Origins The word was first used in 1802 by the German physician Gottfried Reinhold Treviranus (1776–1837), and was popularized by Jean Lamarck. Although medical students such as Hippocrates in the 5th century BC made the first accurate biological observations, describing medicinally useful plants and their properties, attempts at a scientific physiology were bound to fail in the absence of scientific instruments, without a tradition of experiment, or a body of organized knowledge with its own terminology.

Developments Only with the Renaissance did free enquiry come into its own. The 16th century saw the production of encyclopedias of natural history, such as that of Konrad Gesner (1516–1565), and the beginnings of modern anatomy, notably at Padua under Vesalius, who was succeeded by Fabricius. William Harvey laid the foundation of modern physiology by his work on the circulation of the blood – the first time any basic function of the body had been scientifically explained. Linnaeus introduced a binomial system of classification.

Evolution and genetics During the 19th century, attempts to understand the origins of the great diversity of life forms gave rise to several theories of biological evolution, culminating in Darwin's theory of evolution by natural selection. The ensuing debates over the processes of evolution, together with the rules of inheritance found by Gregor Mendel, provided the basis of genetics. After the elucidation of the structure of DNA by Watson and Crick in 1953, genetics could be studied at a molecular level, which led to the new science of molecular biology.

Applying chemical principles The application of the principles of chemistry to organic substances led to developments in biochemistry and molecular biology. Throughout the 20th century, these disciplines followed a reductionist approach, dissecting living systems down to the molecular components. The overwhelming success of this approach made molecular biology the defining scientific discipline of the second half of the 20th century and culminated in the decoding of the complete human genome at the end of the century.

Putting the cell together again With the ‘postgenomic’ era, biology at the beginning of the 21st century saw a new trend pointing in the opposite direction. Thanks to the data compiled by genome
and subsequent proteome, metabolome, and other ‘omics’ analysis, combined with the unprecedented computer power that became available, reassembling the molecules of life became a realistic goal. The new discipline, known as systems biology, emerged around the year 2000. It feeds available data from biochemistry and molecular biology into computer simulations of entire cells or metabolic networks, in order to understand living systems in their entirety and make predictions about their responses.

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Biology

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