

Introduction

The first page in the history of biology was undoubtedly “written” when our preliterate forebears became consciously aware of the distinction between living and nonliving objects. Later they recognized, at least at a superficial level, the similarities among, and differences between, living organisms encountered in their local environment while hunting for game and gathering food. During the course of preparing animals for a meal, their internal structures were revealed, but there is little reason to suspect that the differences between and among such animals aroused their intellectual hunters’ curiosity. Of far greater importance in the lives of our ancestors were the supernatural forces that were responsible for their existence and who rewarded them with good fortune and children, while punishing them by withholding food sources and inflicting them with disease. They hoped those decisions could be influenced by human and animal sacrifices. Some 12,000 years ago, humans began assuming greater control of their living environment by cultivating plants to provide food and domesticating animals, notably dogs, to assist and accompany them.

The earliest students of biology were healers—variously referred to as witch doctors, medicine men/women, or shamans, who were the resident experts in treating disease. Their “therapy” combined plant-based medicines and prayers and supplications to supernatural forces with healing practices they acquired by experience—not systematic study. Among the greatest and earliest scholars of living organisms was Aristotle (384–322 BCE), who systematically examined animals and plants and their characteristics, and categorized them based on meticulous observation, reasoning, and interpretation, devoid of supernatural explanations, sharing this knowledge in no fewer than four books.

In the late seventeenth century, Leeuwenhoek—trained as a linen merchant and functioning as a self-taught amateur lens grinder, and whose letters to European scientific societies were limited to his native Dutch—uncovered a previously unknown microscopic world that was inhabited by living beings that were neither plants nor animals. Using a microscope, it was possible for Schneider and Schwann in the 1830s to identify the cell as the basic structural and functional unit of life—all life, both plant and animal—just as the atom is the basic unit in chemistry.

Prior to the nineteenth century, the study of living things, then called *natural history*, focused primarily on the diversity and classification of plants and animals as well as on the anatomy and physiology of animals. These naturalists employed observational rather than experimental methods of study. This dramatically changed in the nineteenth century, which hosted the explosive emergence of the systematic study of living things

and descriptions of how living organisms functioned. *Natural science* was replaced by the newly coined designation *biology*. Advances in organic chemistry were applied to studying the chemistry of living organisms by such biochemical pioneers as Claude Bernard; those studies have continued to this present day with increasing sophistication.

Perhaps some of the most momentous findings in biology occurred in the decade between 1859 and 1868. In 1859, Charles Darwin advanced his theory of natural selection, the basis for evolution. Evolution, now the central theme of biology, has been used to explain both the unity and diversity of *all* living organisms. The scientific world reverberated in response to the appearance of Darwin's *On the Origin of Species by Means of Natural Selection* but barely took notice when Gregor Mendel, an obscure Czech priest, published the results of his studies on the height of garden peas conducted in a monastery garden. Over three decades later, Mendel's paper was rediscovered and served as the foundation for the new science of genetics. It also provided the basis for explaining mutations that lead to natural selection, an explanation that perplexed Darwin and his acolytes and that had challenged his theory of evolution. Since ancient times, living beings were believed to have arisen from nonliving sources, namely, by spontaneous generation. In a simple but elegant experiment, Louis Pasteur provided convincing evidence that living beings arose from earlier life forms. But the question still remains, what was the original source of life?

Among the most significant studies in the twentieth century, and continuing to the present, are those that have sought to understand the role of the individual cell components and their unique contributions to cell function. James Watson and Frances Crick's 1953 determination of the structure of DNA generated a revolution in biological research and a popular interest in science that continues to excite. Subsequent research focused upon explaining how genes, working through DNA, serve as the molecular basis for inheritance, direct the synthesis of proteins, and influence our health. Manipulation of DNA and biotechnology have been valuable contemporary tools in the development and modification of innovative medicines and the plants and animals we consume.

Unlike Aristotle, who was interested in and attempted to understand *all* knowledge of his day, the study of biology became increasingly detailed, diversified, and specialized in the late nineteenth century, giving rise to subdisciplines and professionally trained specialists who placed an increasing emphasis on active experimentation. General biology or zoology/botany courses and departments have fragmented into departments of biochemistry, molecular and cellular biology, anatomy and physiology, microbiology, evolutionary biology, genetics, and ecology. The milestones in each of these specialty disciplines will be found in *The Biology Book*.

The Biology Book

Our goal in writing *The Biology Book* is to provide insights into the 250 most significant events in biology in a readable and enjoyable manner. Each entry is intended to be readily comprehensible to all readers, while providing new information and insights for the scientifically well-prepared. In the available space of several paragraphs, we will set the stage for the milestone by providing essential background information, without subjecting the reader to the task of slogging through highly technical discussions and explanations. In short, each entry, arranged chronologically, is intended to be scientifically sound, yet accessible and engaging, and each can stand alone and be read in any order. We have provided cross-references to other entries related to the topic, as well as to sources of more detailed information. As we are sure you will appreciate, the dates assigned to some entries vary in precision: experts are not always of a single mind regarding a date or, for that matter, even which researcher should be most credited with the milestone.

Since most leading college-level biology textbooks are over 1,000 pages long, what was our rationale for selecting only 250 milestones? First and foremost, each milestone must have represented a significant scientific advance in its day, for hundreds of years, and perhaps even today. Some of these milestones incrementally built upon and extended earlier discoveries, and were readily accepted by their contemporaries. Others, particularly those that were revolutionary in nature—a paradigm shift as described by the philosopher of science Thomas Kuhn—and that significantly departed from the then-accepted “truth,” were all too often greeted by naysayers with a firestorm of derision, criticism, and even outright hostility. Although contrary to the self-image of scientists as being rational and objective, over time, some scholars have resisted and rejected new and novel ideas for political, philosophical, economic, or religious reasons, because such ideas ran counter to traditional time-honored, venerated beliefs they embraced, or because of simple, unvarnished ignorance. However, as irrefutable evidence was presented, the scientific community embraced Andreas Vesalius’s correction of Galen’s erroneous description of the human body, which had been taught without question to medical students for almost 1,500 years. Robert Koch’s demonstration that germs—and not supernatural forces or “bad air”—were the causes of infectious diseases was another victory for the scientific method that revolutionized medicine.

Some of the greatest of all scientists, regardless of discipline, made monumental discoveries in the biological sciences. *The Biology Book* highlights their particular discovery and, when appropriate and interesting, profiles these scientists. Consider the internationally acclaimed physiologist Nobel laureate Ivan Pavlov, who linked psychic stimulation and digestive function, and who was tolerated by the Soviet regime during

the 1920s and 1930s, notwithstanding his outspoken negative views of Communism; or Otto Loewi, who provided convincing proof of chemical neurotransmission and used his Nobel Prize money to buy his way out of Austria after the Nazi invasion. Finally, we must confess that a few milestone entries are included mainly because they provide an interesting story and, we suspect, all of us like a good story.

The milestones described in *The Biology Book* illustrate Isaac Newton's saying, "If I have seen further it is by standing on the shoulders of giants." We shall attempt to explain the importance of the discovery or concept in biology from a historical perspective, and underline the influence the finding has had on subsequent researchers and on our contemporary thinking. It is our hope that readers of *The Biology Book* will come away with a vastly enriched appreciation of the living world around them.

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