# HISTORY OF BIOLOGY

#### Alberto M. Simonetta

Dipartimento di Biologia Animale e Genetica, "L. Pardi," University of Firenze, Italy

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# **Summary**

A short account is given of the development of biological sciences from their Greek origins to recent times. Biology as a pure science was the creation of Aristotle, but was abandoned shortly after his death. However, considerable advances relevant for medicine continued to be made until the end of classical times, in such fields as anatomy and botany. These developments are reviewed.

After a long pause, both pure and applied research began anew in the thirteenth century, and developed at an increasing pace thereafter. However, unlike astronomy and physics, which experienced a startling resurgence as soon as adequate mathematical methods and instruments became available, the development of biology was steady but slow until the appearance of Darwin's revolutionary ideas about evolution brought about a fundamental shift in the subject's outlook. The efflorescence of biological sciences in the post-Darwinian period is outlined briefly.

## 1. Introduction

To outline more than 2000 years of biology in a few pages is an extremely difficult endeavor as, quite apart from the complexities of both the subject itself and of the technical and theoretical approaches of various scholars, the development of scholars' views, ideas, and researches forms an intricate network that cannot be fully disentangled in such a brief account.

Until well into the eighteenth century, biology was so closely bound up with medicine that "pure" biologists were extremely rare. Some biologists, like Aristotle, who apparently never practiced medicine and was basically interested in philosophy and science generally, were trained as physicians. Others, including Descartes and Leibniz, were interested in biology as a sort of side-show to their broader philosophical interests. Links between pure biology and agriculture and husbandry are also of ancient origin. Roman writers on agriculture included in their treatises a fair amount of description and theory that clearly belongs to biology in the broad sense. In spite of this, however, we shall here endeavor to sketch an outline of the history of biology with as little reference as possible to the development of medical practice and other aspects of applied biology.

# 2. Antiquity

The science of biology was invented by Aristotle (384–322 BC). Before Aristotle, many Greek philosophers had speculated about the origins of the Earth and of Life, but their theorizing was unsupported by empirical investigation. Aristotle's work on plants is lost, but his research on animals produced outstanding results. Some of these, such as his observations on the viviparity of some species of shark or the parental behavior of catfish, were finally confirmed only in the nineteenth century. Although Aristotle may not have produced a formal classification of animals, he did discuss the principles of such a classification. Their implementation results in an excellent systematics, granted his relative lack of knowledge and the fact that, as he himself notes, no one had touched such subject before. Indeed, it has been argued by some scholars of the history of philosophy and of science that some, later much criticized, faults of Aristotle's physics and metaphysics are just the consequence of his excellence as a zoologist, which led him to build his philosophy around a core of biological insights that were amply supported by his empirical observations.

Aristotle's pupil Theophrastus (380–286 BC) produced, among many other things, the first treatise on plants. Apart from this, antiquity was content with listing the external and behavioral features of animals such as were, sometimes uncritically, related by local tradition. Of this kind were, for instance, Pliny's (23?–79 AD) accounts in his general encyclopedia *Naturalis Historia*. Botanists fared better. Reliable practical guides for the identification of useful plants were much required, given that most medical recipes were based on plants. These works culminated in the treatise by Dioscorides (or Dioscurides) (around 100 AD), which was usually copied with figures. Some early Byzantine copies survive and show that not only the text but also the figures of the good copies were remarkably accurate.

Advances in biology during Greek and Roman times were a by-product of medical research. Surgery was very advanced by the time of the Roman Empire, and good surgery requires a sound knowledge of anatomy. Before that human anatomy made considerable progress in Egypt under the Ptolemees, Erasistratus and Herophilus, both living around 300 BC, being the foremost anatomists of this age. The greatest of these physicians and surgeons was Galen (129–199 AD). As he lived mainly in Rome, where dissection of human bodies was forbidden (in contrast to Egypt where it had been practiced and probably still was in his time), Galen studied the anatomy of a number of different animals, mainly mammals. Galen was also an extremely able surgeon. He

employed his skills in a number of rather advanced experiments aimed at improving the understanding of physiology. His studies on the nervous system were unsurpassed until the eighteenth century. His authority became so great that it impeded further progress for centuries. Nevertheless, some advances continued to be made until the end of classical times, especially in the field of parasitology.

#### 3. The Medieval and Renaissance Periods

Practically no advances were made during the long span of time from the sixth to the thirteenth century. Arab and Byzantine scholars were instrumental in the preservation of much ancient knowledge in the different branches of science, including biology, but the actual contributions of such celebrated scholars as Avicenna (980–1037) and Averroes (1126–1198) are significant only for medical practice and for the great stimulus they gave to the lively debates in the early European universities.

During the twelfth to thirteenth centuries there was an intense revival in Western interest in philosophy and sciences, and it appears that some 5000 Greek philosophical and scientific texts were translated into Latin, either from the original Greek or from Arabic translations.

In parallel with this surge of interest in the sciences, updated summaries of all available knowledge were produced. Yet only two notable personalities emerged: the emperor Frederic II (1194–1250), whose book on falconry includes a number of original descriptions of birds and some notable investigations in bird anatomy and behavior; and his contemporary St. Albert the Great (1193?–1280), who produced a fresh and original discussion of various problems, including reproduction, and made both anatomical and experimental investigations, chiefly on arthropods.

Up to the fourteenth century, Italian medical students learnt anatomy and surgical practice on swine (in Italy no distinction was made between physicians and surgeons). However, by 1275 Guglielmo da Saliceto recommended autopsies for forensic reasons and these were practiced from at least 1302. Human dissection for medical training was revived in Italy by Mondino dei Luzzi (1275–1326), and immediately became a standard requirement in the Italian medical faculties, though it was generally practiced publicly only two to four times a year, usually on the corpses of criminals supplied by the local authorities. Students and teachers had, for the rest, to provide for themselves, with the result that the theft of corpses became so common that graveyards had to be provided with watchdogs. In 1410 the body of even a Pope (Alexander V), whose sudden death appeared suspicious, was dissected, and we have several records of wills providing for the dissection of the deceased "in order to gain knowledge useful for my children and relatives."

In spite of these practices, we have to wait well into the fifteenth century before we find any new advances in human anatomy. It was during the transition between late medieval times and the renaissance proper that advances began to be made.

Not only Leonardo da Vinci (1452–1519), as it is often thought, but all the great artists of the age practiced dissection. We know, for instance, that Michelangelo was supplied

with corpses by the monks of St. Spirito in Florence, who ran a hospital. Leonardo planned an immense treatise on anatomy, for which he prepared hundreds of drawings. However it never materialized. Leonardo had had no formal education and his Latin was poor. He had therefore arranged to write the book jointly with a young and brilliant anatomist, Marcantonio della Torre, then professor in Pavia, but Della Torre died young (1511) and the project was abandoned. Something like thre book that would have been produced by Leonardo and Della Torre was published a few years later by Berengario da Carpi (1460?–1530) in one of the early illustrated books on medicine. The book included several new discoveries.

The invention of printing was almost immediately followed by the issue of a number of editions both of classical authors and of new ones, the first illustrated herbal being printed in 1483. By the middle of the sixteenth century, the facilities for the study of anatomy and botany available in Italy were such that students from all over Europe flocked to Italian Universities, especially to Padua and Bologna. Not a few of them, including Vesalius (1514–1564), actually became professors in these universities themselves. The first botanical garden was established in Pisa in 1543, followed in 1545 by those of Padua and Florence.

Biology as we think of it today had but a small place in the curricula of the Arts, which aimed to provide an all round cultural education from which the student was expected to pass into the curriculum for the doctorate in Medicine. However various influxes were instrumental in prompting a renewal of interest in the vegetable and animal worlds. As far as botany was concerned, Arab authors had introduced into medical practice a number of drugs prepared from plants unknown to Greek and Roman authors. Such preparations were in great demand, and both genuine and spurious vegetables were imported from the East. In the Northern regions there were useful plants that local lore knew and used and that were also unknown to classical authors. Moreover, from the middle of the fifteenth century European sailors began a systematic exploration of the sea routes to the East (incidentally discovering the Americas) and new and rich sources of unknown plants were disclosed. With this, classical authors like Dioscorides came to seem obsolete. Indeed, new herbals appeared slightly earlier than new books on zoology. As far as zoology is concerned, the revival of interest for investigations first took the characters of descriptions of particular faunas and of animals not recorded in the ancient sources.

The Swiss Conrad Gesner (1516–1565), by trade a professor of classical languages and of medicine but in practice a polymath, made the first attempt to update such encyclopedic medieval treatises as those of Vincent of Beauvais (c.1264) and Thomas of Cantimpré (active between 1233 and 1248). Publication began in 1551 and, as far as animals were concerned, was completed several years after the death of Gesner himself, the botanical treatise being published only in the eighteenth century.

Human anatomy was soon advancing by leaps and bounds. Vesalius published his epoch-making treatise (*De humani corporis fabrica*) in 1543 and he was soon followed by a number of first class anatomists (e.g., Fallopio, 1523–62; Fabrizio, 1537–1619; Coiter, 1524–76). However, while the advances in descriptive anatomy were of immediate practical use to surgeons, they placed physicians in a quandary. They made

classical—in practice, Galenic—anatomy obsolete, but all physiology was based on Galenic anatomy! If the new anatomy was the true one—and this was obvious to all but a few die-hards, such as Vesalius' teacher Sylvius—then a new physiology was also required, one based on a consistent set of theories about pathology. But to be accepted a new physiology not only required a new anatomy, but also the understanding of vital processes, something for which neither an adequate chemistry nor suitable instruments were available. This explains why for a while most physicians, including Vesalius himself, were strangely "schizophrenic," appearing unaware of the need to build a new physiology, and simply trying to graft the old physiology on the new anatomy. The first steps towards the renovation of physiology were taken by William Harvey (1578–1657) in his momentous publication in 1628 of the description of blood circulation.

Rather than following a strict chronological order, the development of the biological sciences since the Renaissance can be most conveniently related by providing separate accounts of the evolution of knowledge in the main subdivisions of biology. It must, however be stated immediately that there very frequently a close connection between advances in biology and the development of new instruments, such as the first microscope (built by Galileo Galilei), or some substantial improvement on them such as, again concerning microscopes, the development of achromatic lenses, or the air pump of von Guericke and Boyle, or developments in chemistry and physics (such as Lavoisier's discoveries on oxydation).

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# **Biographical Sketch**

**Alberto M. Simonetta,** born 1930, is full professor of zoology at the University of Florence (Italy). He has studied in Florence, where he had his first appointments as assistant and was appointed as full professor of Comparative Anatomy at the University of Camerino in 1969. His major research interests are the comparative anatomy and evolution of Vertebrates and of Arthropods, including fossils, theoretic aspects of evolutionary taxonomy and history of biology.

