CHAPTER I

THE BIOLOGICAL SCIENCES

Biology (from Greek = " life discourse ") is the science of living things. It includes the study of plants and animals; and in a broad sense, it embraces all knowledge concerning phenomena in any way related to life. However, it is usually restricted to narrower limits. Botany (fr. Gr. = " plant ") is that branch of biology that deals with plants, and Zoology (fr. Gr. = " animal discourse ") deals with animals.

Morphology (fr. Gr. = " form discourse ") is a branch of biological science that treats of the form, parts and structure of plants and animals. The field is so large that it would be very difficult to be an expert in both Plant Morphology and Animal Morphology.

Physiology (fr. Gr. = " nature discourse ") has to do with the study of the living processes that constitute life. It investigates functions of living things, the operations of the parts and the totality of activities which constitute life.

As biological sciences progressed, the investigation field widened to such an extent that gradually researchers confined their work to problems of more limited scope, and subsidiary sciences were formed. Many of these are chiefly morphological in character. Examples follow.

Anatomy (fr. Gr. = " to cut up "). Biologists call living things organisms. The word literally means that which is composed of organs. An organ is a part having a particular function. The heart pumps blood, and lungs are concerned in carrying oxygen to the blood. The heart and lungs are organs. Many living things, however, are small and simple and are able to perform all the functions of life without such organs as liver, heart, lungs or intestines. Even such small forms are considered organisms.

We obtain a knowledge of the organ composition of animals by dissecting with scalpel, scissors, needles and forceps. Dissection is a process of analysis. There is a *Plant Anatomy* as well as

Animal Anatomy. To write a book on the anatomy of any animal, one would dissect a great many specimens, make exact drawings of the entire animal and all the organs, determine the structural and functional relations of all the parts, and write accurate descriptions. The individual animals are by no means identical in structure, so that such an account would be an average picture. *Human Anatomy* is the science of the structure of the organs of the human body. The veterinarian must be familiar with the *Anatomy* of *Domestic Animals.* The anatomist may extend his studies to representatives of all kinds of animals and compare their organs and systems of organs. He discovers that all the forms possess a few general characteristics in common; that they may be subdivided into groups, each of which possesses the general characteristics common to all, and that each differs from the other in more specific peculiarities. Thus fishes, reptiles and birds have characteristics in common, and although there are many kinds of fishes yet *they* have common characteristics which distinguish them from reptiles or birds. The study of such resemblances of structure constitutes the science of *Comparative Anatomy.*

Histology (fr. Gr. = " tissue discourse "). One might dissect all of the organs of an animal and thus find that they are built up of a few different kinds of materials or tissues. They possess membranes covering the body, or lining cavities or tubes in the body. These membranes constitute a tissue called *epithelium.* Movements are brought about by the action of a tissue called *muscle;* parts are held together by *connective* tissues such as tendons; *nerve* tissues convey impulses from one part to another, integrating the activities of the organs; the parts are nourished by a tissue called *blood.* The science of the tissue construction of organs is called *Histology.*

Cytology (fr. Gr. = " hollow vessel-discourse "). A further analysis of tissues, by special technical methods, reveals the fact that all are made up of microscopic elementary units called cells, which vary greatly in form and function, and yet agree in fundamental respects. The study of cell morphology and physiology is *Cytology.*

Embryology (fr. Gr. = " embryo-discourse "). Most animals begin life as an individual cell. This divides and subdivides, forming more cells, at first similar in form but later different; then

tissues are laid down and organs appear, until at last the adult stage develops. The science of the development of the individual is *Embryology*.

Pathology (fr. Gr. = "disease-discourse"). Organisms become diseased; organs and tissues are no longer normal, as in health. The study of the morphology and physiology of diseased tissues or organs, and comparison of these with the normal condition, constitutes the science of *Pathology*.

Palaeontology (fr. Gr. = "old existing things-discourse"). The earth has existed for thousands of centuries but life has not always been present on it. Many plants and animals existed in past geologic ages and perished. But some parts of their bodies have persisted as *fossils*, and from these certain scientists can reconstruct the morphology and physiology of the organisms of long ago. The science of organic life of past geologic ages is called *Palaeontology*.

Taxonomy (fr. Gr. = "arrangement-law"). The orderly arrangement of phenomena is a fundamental characteristic of science. Some biologists find that, due to natural relationships, plants and animals can be *classified* or arranged in groups and subdivisions. They have also ascertained a group of principles according to which this can be most satisfactorily accomplished. This is the science of *Taxonomy*.

Ecology (fr. Gr. = "house-discourse"). Plants and animals live in a world of constantly changing physical and chemical conditions. They are adjusted also to an organic environment made up of the plants and animals about them. Every organism must make successful adjustments in order to live. A study of the relation of living things to their organic and inorganic environment is called *Ecology*.

Genetics (fr. Gr. = "to be born"). A child is said to resemble in some respects its father, mother or other ancestors. He is said *to inherit* the blue eyes of his mother, for example. Phenomena of *heredity* are true not only of men but of plants and animals generally. The science which investigates the phenomena of heredity and endeavors to find the laws according to which similarities and differences appear in *closely related* organisms is called *Genetics*. It is one of the more recent biologic sciences.

Geographical Distribution. The animal life of a region constitutes its fauna, and the plant life its flora. The fauna and flora of

a region are quite distinctive. Deserts have their own peculiar fauna and flora, very different from those of more productive regions. Tropical and temperate zones each have their characteristic plant and animal life. Moreover, similar regions, separated from each other by barriers, differ in respect to some of the animal and plant inhabitants on the two sides of the barrier. The study of the distribution of organisms in space is known as *Geographical Distribution.*

Evolution. There is a multiplicity of facts to prove that many contemporary varieties of plants and animals were not represented in the ancient life of the past. Seed plants appear to be of more recent origin than ferns, and dogs and cats are not as old as reptiles; fishes appeared before frogs, and reptiles before birds. The evidences gathered from various sources indicate that there has been a gradual *evolving* of living forms during geological history; that from primitive, simply organized plants and animals there have developed, along many lines, beings that are more specialized; from the apparently simple has been derived the relatively complex, but all are fundamentally related. This concept is known as the *Theory* of *Organic Evolution.* It is a scientific generalization, not based on guess or surmise, but is the work of many thoughtful and critical seekers after truth. If, at any time, new discoveries in biologic science discredit it, the theory will no longer form part of the body of biologic law.

The word *evolution* is from the Latin meaning "an unrolling," which does not literally express the biologist's conception. Someone has suggested that the word *phylogeny*, meaning "the development of races," be substituted for the word *evolution.*

Physiological Aspects. The above sciences are more or less morphological, but structures cannot be interpreted without considering their functional activity. Indeed, the conclusion that *function determines structure* is well founded. The anatomist does not completely understand an organ until he knows how it works. The most important things to know about cells are their physiological activities. How does a diseased organ function? Compare it with the working of a healthy organ. What is the effect on the activity of the organism as a whole? Lifeless organisms cannot adapt themselves to external changes. One might conclude that the palaeontologist is interested in morphology alone. But fossilized jaws and teeth indicate the kind of food eaten and suggest

the fauna and flora, and therefore the climate of bygone ages. The palaeontologist endeavors to recreate the *living* world of long ago.

There is a great multitude of plant and animal species, all differing more or less widely from each other and yet all are organisms manifesting the phenomena of life. In spite of the many variations in morphological organization, all plants and animals must perform certain similar functions in order to live. The variety of these functions is limited and most of them are common to all living things. This is one of the reasons why it is possible to establish the general science of Biology. Morphological characteristics common to all living things play a part also in the construction of this general science.

In recent years the idea has steadily gained ground that to *understand* biological processes, *i.e., life,* it is necessary to use the technic of physics and chemistry in the investigation of living things. There is an ever increasing extension of the concepts of physics and chemistry to cell phenomena. *Biophysics* and *Biochemistry* are important biologic sciences today.

Special Branches. The field of investigation is so great that investigators confine their researches to limited portions of the whole science and are thus enabled to master the particular part in which they are most interested. Some of these special fields of inquiry have been given special names. Thus, the Ornithologist studies birds; the Entomologist, insects; the Herpetologist, reptiles; the Ichthyologist, fishes; the Protozoologist, single-celled animals; the Bacteriologist, bacteria; the Neurologist, the nervous system. In medicine alone there are many special branches.

Related Branches. Many sciences are to a great extent biological in nature. Human and Animal Psychology, the study of mental phenomena, involve physiology. Anthropology is the biological study of man. It includes Ethnology, which deals more particularly with the origin, distribution and physical, mental and cultural differences between the *races* of *men.* Sociology, another anthropological science, is concerned with a study of the problems arising from the endeavor of men to *live in groups.* These problems are created by the struggle men must make to satisfy individual physiological needs. Economics has as its aim the discovery of the laws governing the origin, distribution and use of

things needed to satisfy human desires which exist only because of human physiological activities. Language plays an important rôle in the existence of social organizations of men. The biologic nature of language is evident when one realizes that language is connected with commercial transactions, so necessary for the continued life of the members of the community.

Importance of the Study. Constant reference is made in the following pages to the relation between biology and human affairs. Biologic science illuminates so many problems of life, that a cultural education is incomplete without the experience of training in this field. Indeed, every man is aided in the *conquest* of *his world* by that understanding of nature which biology alone develops.

Selected References

1. Calkins, G. N. *Biology.* Henry Holt & Co., N. Y.
2. Cunningham, J. T. *Modern Biology.* E. P. Dutton, N. Y.
3. Dorland. *American Illustrated Medical Dictionary.* W. B. Saunders Co., Phil.
4. Garrison, F. H. *History of Medicine.* W. B. Saunders Co., Phil.
5. Gregory, R. A. *Discovery. The Spirit and Service of Science.* The Macmillan Co., N. Y.
6. Haldane & Huxley. *Animal Biology.* Oxford University Press.
7. Holmes, S. J. *General Biology.* Harcourt, Brace & Co., N. Y.
8. Huxley, T. H. *Science and Education.* D. Appleton & Co., N. Y.
9. Libby, Wm. *History of Science.* Houghton Mifflin Co., Boston.
10. Locy, W. A. *Biology and Its Makers.* Henry Holt & Co., N. Y.
11. Moore, Benj. *Origin and Nature of Life.* Henry Holt & Co., N. Y.
12. Nordenskiöld, Erik. *The History of Biology.* Alfred A. Knopf, N. Y.
13. Thomson, J. A. *The Bible of Nature.* Scribners, N. Y.