AN INTRODUCTION TO
BIOLOGY

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LONGMAN

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by

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CHAPTER 1

ANIMALS AND PLANTS

BEFORE we begin to study animals and plants, we must understand that we cannot hope to learn much about them unless we are ready to use our eyes and to think about what we observe. So let us look at Figs. 1 and 2. Fig. 1 shows us some of the features of a well-known animal—the cat, while Fig. 2 pictures an equally well-known plant—the buttercup. The first thing we notice is that they are not a bit alike! Suppose we write down a number of ways in which they differ. We can, for example, note that a cat has a body with a head, legs and a tail, eyes, ears and nostrils, a mouth and digestive organs, and a heart and lungs, while a buttercup has an entirely different kind of 'body' made up of roots, stems, leaves and flowers. It is hardly possible to imagine two things more unlike—and yet they share one feature in common: they are both alive. What do we mean when we say that the cat and the buttercup are alive? In fact, how do we know whether anything is living or non-living? Why do we say that a cat is a living creature but that a brick is not alive? To answer such questions, we must turn our attention from the picture of the cat, and study the actual live cat which lives in our house—or in our neighbour's. What does it do which a brick cannot? Quite simply we can say:

1. It moves about of its own free will—a brick cannot move unless it is pushed or lifted by someone.
2. It feeds.
3. It breathes (or respires).
4. It grows when young.

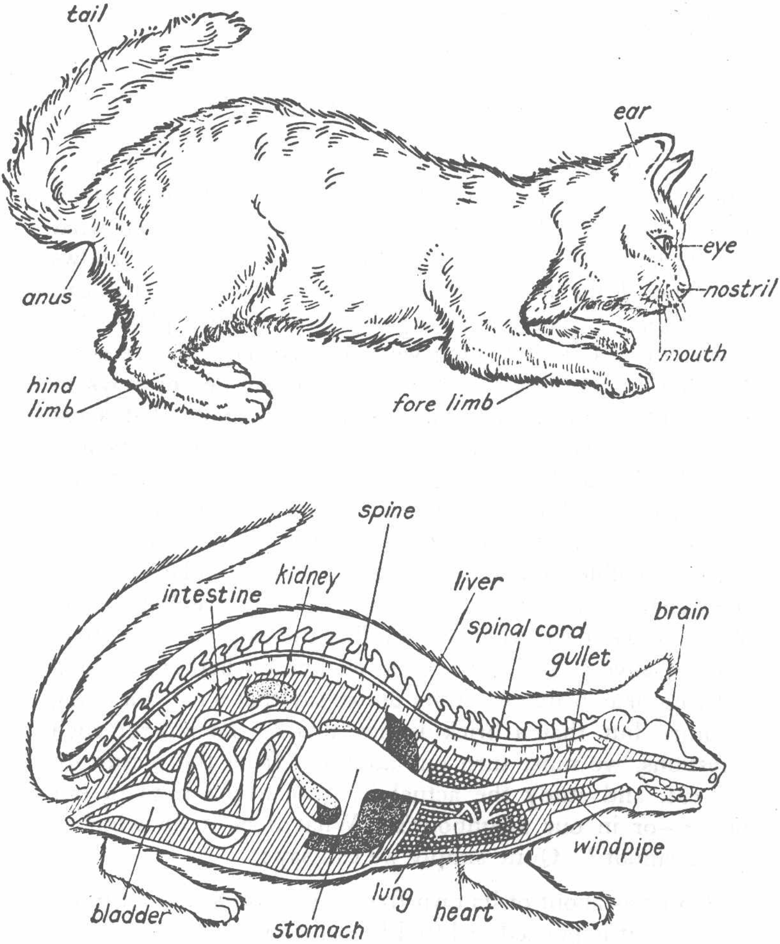
tail
ear
eye
nostril
anus
mouth
hind limb
fore limb
spine
kidney
liver
intestine
brain
spinal cord
gullet
windpipe
lung
heart
bladder
stomach

FIG. 1

5. It repairs itself—when hurt in a fight, its flesh can heal.
6. It excretes (gets rid of) waste matter.
7. It is sensitive and responds to various influences (stimuli), *e.g.* when stroked, it purrs.
8. It shows rhythm, *i.e.* alternating periods of rest and activity.
9. It can reproduce, *i.e.* have kittens which grow into new cats.

A brick does none of these things, and so we recognize a living creature, such as a cat, by the above features.

It is not so easy to recognize that a buttercup is a living thing, especially since it does not move, yet we know that it grows, reproduces by producing seeds which can grow into new plants, and shows rhythm with the passing of the seasons; in winter it lies dormant and in summer grows up, flowers and produces seeds. Later we shall learn that it feeds itself—not like an animal on *solid* food but by making its food from simple substances—that it respires, and finally that it is sensitive to certain outside influences, such as light and gravity, to which it responds by changing the direction of growth of its stems, roots and leaves.

How we study animals and plants

When we study animals and plants, we first observe their appearance and by making labelled drawings we learn to name the various parts (see Fig. 2 as an example). By using a simple lens, such as a watchmaker's eyeglass, we can see more clearly the smaller features of animals or plants. If we wish to study the internal structure (anatomy) of an animal such as a rabbit, it is necessary to explore the inside of the animal by a method called dissection, but you can learn a great deal of anatomy by paying a visit to a butcher's shop. While waiting to be served, you can study the carcases and joints, hearts, lungs and livers exposed for sale. By watching the butcher cutting up a

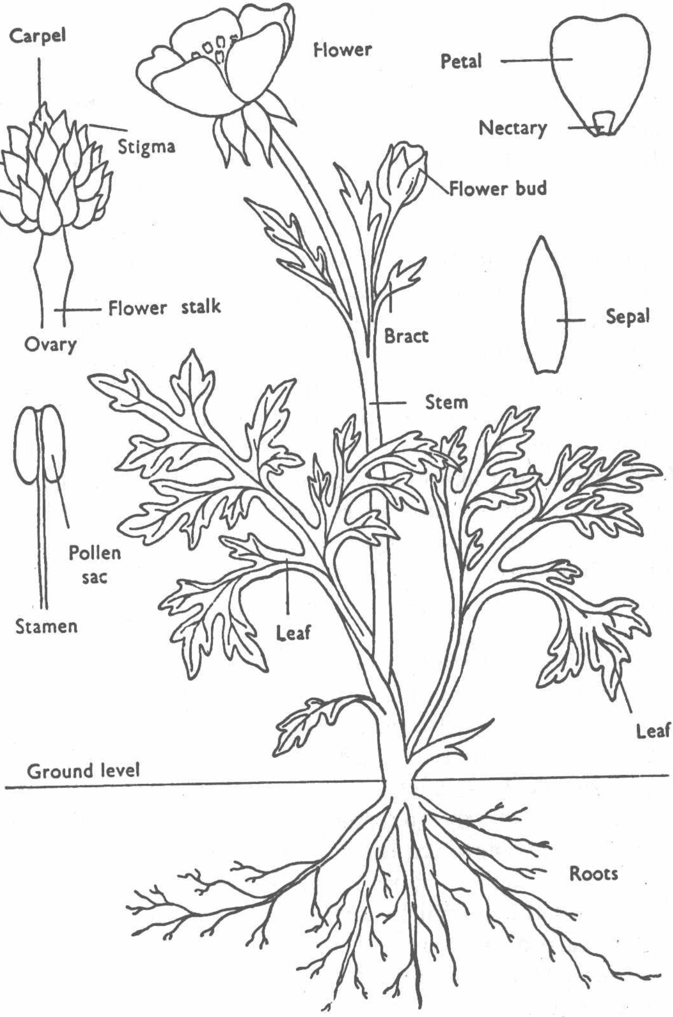

FIG. 2.—A typical plant—a buttercup

carcase of a sheep you can learn how the body of an animal such as a sheep is constructed, though you will not see the blood vessels and the food canal (digestive organs) since the latter will have been removed and the blood vessels torn away before the carcase reaches the shop. These your teacher will show you by dissecting a dead rabbit or rat so as to show these structures. But in order to see the finest details of the anatomy of animals and plants, it is necessary to use a microscope (Fig. 3, Pl. II). Plate I shows one of the earliest microscopes constructed in the 17th century. Using a microscope of this type, an Englishman named Hooke examined thin slices of cork. He drew what he saw and Fig. 4, Plate I is a reproduction of his drawings. He considered that cork was constructed like a miniature honeycomb and he named the compartments 'cells', since those of a honeycomb are also called 'cells'. The cells of cork are empty, but much later, in 1846, a German named von Mohl made thin sections of the stem of a *living* plant and by using a more powerful microscope discovered that the cells contained a slimy living substance, which he named 'protoplasm'. In each cell there is a round or oval body embedded in the protoplasm called the *nucleus*. This is really a special part of the protoplasm and, in a manner not yet completely understood, 'governs' the life of the rest of the protoplasm (called the *cytoplasm*). Protoplasm is a living substance since it displays all the features which we have learnt to recognize as those which distinguish living things from non-living (p. 1). It consists mainly of protein (p. 45).

All[1] animals and plants have bodies made up of cells. Animal cells consist of nothing more than cytoplasm and nucleus, though varying in shape. Plant cells have in addition: (1) a firm non-living *cell wall* which surrounds the cytoplasm and which is usually made of *cellulose*; (2) one or more spaces in the cytoplasm known as *vacuoles* which

[1] Except a few, *e.g.* bacteria, p. 223.

are filled with a watery solution of sugar and other substances (*cell sap*); and, usually, (3) *chloroplasts.* Chloroplasts are special parts of the cytoplasm and are generally oval in shape. On exposure to light, they develop a green colour known as *chlorophyll.* Chloroplasts are, however, absent from the cells of the roots and of certain other parts of a plant, such as the petals of the flowers.

Tissues, organs and systems

In both animals and plants, different types of cells (Fig. 5) are found, such as the cells in the muscles, cells in the brain

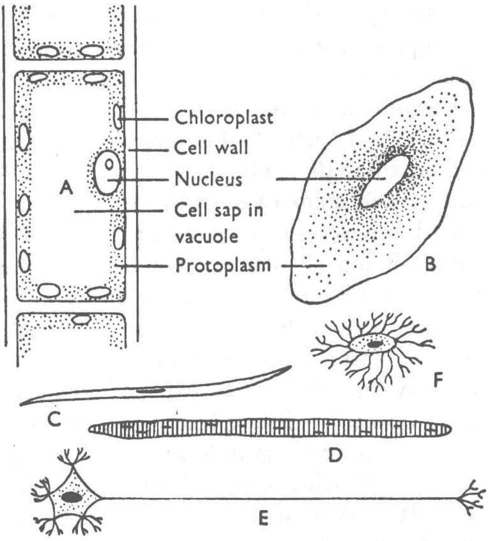

FIG. 5.—Cells

A—A typical plant cell in leaf of pondweed. B—A typical animal cell from the inside of the cheek. C—A muscle cell in the wall of the stomach. D—A muscle 'cell' in the biceps muscle. E—A nerve cell. F—A bone cell

or cells in the bones. As the young animal or plant grows and develops by the multiplication of its cells, the new cells formed undergo changes in their shape and structure to fit them for the different tasks they have to perform in different parts of the body. All cells of the same type are known collectively (*i.e.* in bulk) as a **tissue.** We refer to the cells forming the brain as **nervous tissue,** those of the muscles as **muscular tissue** and so on. We also find that whole parts of the body are devoted to performing certain functions, *e.g.* the limbs for locomotion or the stomach for digestion. These parts are referred to as **organs.** In any one organ are to be found, as a rule, several types of tissue. Thus in the arm occur bone tissue, muscle tissue, connective tissue (binding bones and muscles together and forming the dermis) and nerve tissue (nerves supplying the skin and muscles). Finally we find a number of organs frequently working together to serve one particular task, and such a set of organs is known as a **System.** An outstanding example is the **Digestive System** (Fig. 78), consisting of a number of organs: the mouth, the stomach, the liver, the pancreas and the intestines, all acting together for the digestion and absorption of food.

Examples of Plant tissues will be found in the Chapter on Transport (p. 121), while everyone is familiar with such plant **organs** as roots (for absorbing water and salts from the soil and for anchoring the plant to the ground) and flowers (for producing seeds). The whole of the roots of a plant form its **Root System,** while the parts above the ground—stems, leaves and flowers—form the **Shoot System.**

Practical work

1. Examine in a drop of water some cells scraped from the inside of your cheek with the *back* of a blunt penknife, using the low power of the microscope. Cover the drop with a cover-slip and examine under high power. Draw a single cell much enlarged and label the parts. Run a little iodine under the cover-slip and record the result.
2. Repeat the above, using the thin leaf of a moss or of the

Canadian pondweed. In the latter case observe the long narrow cells in the centre of the leaf *before* running in the iodine. Notice the chloroplasts streaming round inside the cell walls like strings of barges on a canal, carried along by the circulation of the protoplasm in the cell. Draw a few cells.

3. Repeat with (*a*) cells from the pulp of an apple or holly berry; (*b*) thin slices of potato. Notice the grains of starch in the cells of the potato and the effect of the iodine on them. Make drawings.

Questions on Chapter 1

1. Write a short essay on living things.
2. Explain why a motor-car is not alive.
3. Make a list of the *differences* shown in Figs. 1 and 2 so as to bring out how animals may differ from plants.
4. Compare (*a*) animals and plants; (*b*) animal cells and plant cells.

CHAPTER 2

LIVING THINGS AND ENERGY

IN Chapter 1 it was stated that one of the most obvious features of a living animal is that of movement of its own account. Nothing, whether living or non-living, can move or be moved without the use of *energy*. Machines such as steam locomotives or motor-cars need a supply of energy to make them 'run'. We know very little about the nature of energy. We do, however, know that it takes on a number of disguises which we call Light, Heat, Electricity, Kinetic Energy (*i.e.* motion) or Sound. Also we know that it is possible to change one form of energy into another as, for example, when a revolving dynamo converts Kinetic Energy into Electricity. When energy is applied to a resisting body, the latter either moves or gets hot. Usually both things happen. The energy needed by steam engines or motor-cars is supplied to them in a form called Potential Energy stored up in a fuel, *e.g.* coal or petrol. To release the energy and to enable the steam engine or motor-car to move, the fuel must be burnt (oxidized). The burning of the fuel needs a supply of oxygen from the air. At the same time the products formed by the burning of the fuel—usually carbon dioxide and water—escape either up the chimney or through the exhaust pipe. All man-made engines are wasteful of energy since much of that released from the fuel escapes as heat and is not converted to the useful kinetic energy needed to 'run' the engine.