

PART I

Organic or Vegetative Life

CHAPTER I

IDEA OF LIFE

3. As *acts* proceed from the subject which puts them forth, we may logically infer from them the *nature* of their subject. The Scholastic axiom '*operari sequitur esse*' expresses the intimate connexion that exists between the activity of a substance and its nature. Before taking up the study of the inner nature of the vital principle, we must therefore first investigate vital activities, the functions which manifest and characterize life.

I. POPULAR IDEA OF LIFE

4. According to popular ideas the ordinary sign of life is *movement without any apparent external cause*. A bird on the wing, a creeping insect, a fish darting up stream, all awaken in us the idea of life. The untrained mind of the savage and the child fondly imagines that even any piece of automatic mechanism is gifted with life; the child, for instance, wants to see the little animal that makes the ticking inside the watch. On the other hand, as soon as an object that was once seen to live has ceased to move, we consider its life to have departed and immediately declare it dead.

II. SCIENTIFIC CONCEPTION OF LIFE

5. For the scientist, living being is a synonym for organic substance: by life he means the sum-total of the functions peculiar to organized beings, namely nutrition, growth, reproduction, etc. An *organized being* consists either of a single cell or of a compound of several cells. As a matter of fact every living being, however complicated its organized structure, is derived from a single primitive cell, and all its organs and

tissues are made up of cells. The cell is therefore the primordial element of living beings, and must accordingly be the first object to engage our attention.

6. *Morphology of the Cell.*—A section of living tissue, when viewed under the microscope, is seen to resemble a piece of honey-comb. This is the reason why the name *cell* has been given to each of the elements composing the tissue. The cell itself may best be compared to a microscopic egg. It has in its composition two fundamental parts, the *protoplasm* or *cytoplasm* and the *nucleus* or kernel (Plate I, Fig. 1A).

The protoplasm has the appearance of a firm meshwork, very irregular and floating in a more or less fluid ground-substance. This protoplasm is the fundamental living substance and fills the whole cell. At the exterior it is generally thickened into a permeable membrane or cell-wall that serves to regulate the endosmosis and exosmosis², that is the entrance into the cell of nutritive liquids and the rejection of matter that has become useless. In the middle of the cell lives the *nucleus* sheathed in a thin membrane (nuclear membrane) and containing its own protoplasmic reticulum (*hariooplasm*). It contains moreover another peculiar substance rich in phosphorus and readily receptive of colouring matter, and is called *chromatin* or *nuclein*.

Although it is enclosed in a membrane, the nucleus is not a body separate from the cell; it does not form an independent element, a new individual. Between the protoplasm and the nucleus there exists such a close relationship that the cell is one complete undivided whole, a single unit.

7. *Physiology of the Cell.*—The cell is not only the ultimate anatomical element of the organized substance, but it is also the fundamental seat of the vital activities, which may be reduced to the following: *nutrition, growth and development, multiplication, and irritability.*

Nutrition or metabolism is the name given to the double process of assimilation and dissimulation, or as they are otherwise called, anabolism and catabolism.³ From the substances

² The word *osmosis* is used to signify the diffusion of liquids through a porous wall. If the liquid enters into the porous recipient, we speak of there being *endosmosis*; the opposite process, liquid issuing from the porous vessel, is called *exosmosis*.

³ Cf. J. T. Mearns, *Evolutionary Thought in the Nineteenth Century*, Vol. II, p. 421 (Painbridge, 1904).—T.M.S.

by which it is surrounded the cell draws certain materials which it combines into organic molecules of ever increasing complexity and eventually incorporates them into its own substance, by *assimilating* them either wholly or in part. Anabolism is accompanied by the alternating process of *catabolism*, that is the destruction of certain parts of the living substance, the breaking up of the complex organic molecules into simpler bodies, some of which are ejected (e.g. carbonic acid) whilst others provide matter for new combinations and thus re-enter in the course of assimilation.

Growth and development. As the result of the double process of nutrition, the cell is subjected to continual modifications in form and structure, to alternate growth and decay which biologists call the *evolution* of the living organism.

Multiplication: When it has reached a certain stage in its evolution, the cell has the power of dividing itself and of generating another cell (Plate I, Fig. 3).

Lastly, *irritability* is a generic property of living protoplasm by virtue of which the protoplasm reacts with intensity to the slightest excitation. This reaction often consists in a displacement or a contraction: it then takes the special name of *motility*; at other times it manifests itself by a secretion or by a certain definite vital activity according to the nature of the element irritated.

The chief function of cellular life is *nutrition*; growth and multiplication are the consequences of it, whilst irritability is its indication or expression.

8. *The Human Organism and its Functions.*—The human organism, like any other organism, is characterized by the harmonious *co-ordination* of its anatomical elements together with the subordination of their functions to a single end, which is the well-being and preservation of the individual and of the species.

In an organism so complicated as that of man, the structure of the cells deviates considerably from the type described above. Owing to the economic law of nature known as the *division of labour*, the primitive cells during their multiplication become differentiated so as to constitute different organs and systems.⁴

⁴ Any part of the living body that is composed of cells of the same nature is called a *tissue*, e.g. muscular tissue, cartilaginous tissue, adipose tissue.

The more complicated the organs of a living being, the more complex are its vital functions. Every tissue has to be fed; the food-stuffs to be assimilated by our tissues are not provided by nature already prepared; a number of nutritive substances are solid, and consequently have first to be rendered liquid before they can be absorbed; it is the work of *digestion* to dissolve them by means of ferments secreted for the purpose by the glands of the digestive system (saliva, gastric juice, bile, etc.). Once made soluble these substances may pass by osmosis through the intestine and in this way their *absorption* takes place (Plate IV, Fig. 3). The food material that has been received has next to be distributed to the various parts of the organism; this is effected by the *double circulation* of lymph and blood (Plate IV, Fig. 4). For the blood to be of avail, however, its oxidation is first required, and for this purpose the organism provides *respiration*.

In a word all these functions—digestion, absorption, circulation and respiration—are subsidiary to the *assimilation* of food on the part of the cells forming the tissues. On the other hand *dissimilation* takes place by the various *secretions*, some of which (those of the saliva glands, stomach, pancreas, etc.) aid the work of digestion, and others (from the kidneys, liver, and sweat glands) serve to get rid of the waste-matters that are superfluous or harmful to the economy of the organism (Plate IV, Fig. 2).

In the higher organisms no less than in unicellular beings, functions that appear the most diversified may be reduced to nutrition, which is the primordial function of vegetative life. Accordingly, to this subject of nutrition our attention must first be devoted if we intend to make a philosophic investigation of the distinctive functions of the living being. Previously, however, it would be well to notice what are the conditions under which these functions can be carried out and what are the laws to which they are subject.

9. Conditions of Vital Activity.—A superficial observation would lead us to consider the activity of living beings as entirely etc. Many tissues combine to form an *organ*, i.e. a part of the body having a particular function, such as the stomach, the tongue, etc. A *system* or *apparatus* is a combination of organs adapted for the performance of some special functions; thus the organs of the mouth, œsophagus, stomach, and intestines together form the *digestive system*.

automatic and independent of external agents; to regard the living being as living by its own inherent power and as creating, so to speak, its own activity. But a closer insight dispels any such illusion: vital activity, just like every natural activity of inorganic beings, is subject to fixed conditions. If some of these are so necessary that in their absence it is *absolutely impossible* to live and life, should it be present, ceases, others are only necessary for the normal functioning of life; if they are absent, life is difficult or becomes sluggish and *latent*—as it is in seeds, microbes, or in the dried-up spores of certain plants. As long as they remain in this state such beings are only potentially alive, they are but machines ready for action. For them to become actually alive certain material conditions are needed, such as damp, certain degrees of heat, etc.

Furthermore, vital activity seems subject, exactly as in the case of inorganic nature, to the great laws of the *conservation of matter* and the *conservation of energy*. 'Nothing is ever lost, nothing is ever created'. Man may make use of matter, but he cannot create or annihilate a single particle of it. He may make use of energy in one form to reproduce it in another, but the new form is always exactly proportionate to the old, so that he no more creates or annihilates it than he creates or annihilates matter. Now, the chemical transformations that occur in living bodies are of the very same nature as those which take place in the laboratory; and the physical and mechanical properties manifested by living bodies are the same as those displayed by inorganic bodies. Hence there is no reason for thinking that living bodies do not come under the above general law of matter. Moreover the application of this double law has been verified at least approximately by experiment.

III. PHILOSOPHIC DEFINITION OF LIFE

10. Vital Movement is Continuous and Immanent.—By the light of facts disclosed to us by scientific observation we have to find what is the peculiar character of vital activity. How is it differentiated from the activity of lifeless matter? We discover that it has two distinguishing features, viz. that it is, by its nature, *continuous* and *immanent*.

1. Vital activity is continuous.—Inanimate nature tends to stability: a body left to itself tends to a state of equilibrium

of the many possible combinations when chemical bodies are united, invariably that one results which is the most stable. A living being, on the other hand, *tends to keep in continual motion*: nutrition in particular is an incessant movement of alternate assimilation and dissimilation. The albuminoid molecules that compose protoplasm, being extremely complex and highly unstable, are incessantly becoming dissociated or decomposed and as quickly re-combined. This movement, it is true, may become so slight as to be almost imperceptible in the state of latent life, but it never ceases altogether; once it stops, death ensues, or rather has already taken place. This continuousness of vital movement is not however the chief feature of life: its essential characteristic is immanence.

2. Vital activity is *immanent*.—The activity of material bodies is generally *transitive*, that is, it modifies a patient distinct from the agent, it has an object or term other than the subject acting. Vital activity, on the contrary, is not transitive but *immanent*. The patient here is, sooner or later, the agent itself: the organized subject is the object affected by vital activity, it is nourished and developed and the activity, having its effect remaining in it, is immanent (manere in) ¹.

We do not mean to say, however, that all physical and chemical phenomena displayed by a living being are immanent; it is obvious that a great many of these phenomena are not so; for instance, all the changes in food-matter, right up to and including the building up of the organic molecule, are transitive; but all these are only so many preparatory stages leading up to assimilation properly so called, and it is this intussusception of the organic molecule into the substantial unit of the cell that really constitutes immanent movement in the strict sense. As assimilation is the essential end or purpose of the nutritive process it remains true to say generally that nutrition is an *immanent movement*.

Likewise the growth and evolution of the living being are unmistakably seen to possess the character of *immanence*.

11. Definition of Living Being.—These two characteristic

¹ 'Duplex est actio, Una quae transit in exteriorem materiam: ut calefacere et secare. Alia quae manet in agente: ut intelligere, sentire et velle. Quarum haec est differentia: quia prima actio non est perfectio agentis quod movet, sed ipsius moti: secunda autem actio est perfectio agentis.' *Sum. Theol.*, I, q. 18, a. 3, ad 1.

notes of life, *continuous and immanent movement*, furnish the materials for a strict definition of living substance. The first element, continuous movement, will represent the proximate *genus* in the definition; the second, immanence, is the *specific difference*.

St. Thomas describes life as the distinctive property of beings which move themselves: a living being is one which possesses by its nature the power of self-movement ¹.

Movement, *motus*, in the language of the Schoolmen does not signify merely local movement or change of place, but any action involving change. Hence when the living being is said to move itself, *movet seipsum*, the meaning is that it so acts as to be both the principle of the action and the subject receptive of the change that is at once the completion and the purpose of the action; in other words, the action of the living being is immanent. This is really the idea the ordinary man endeavours to express when he considers any manifestation of movement without an apparent external cause to be a sign of life. This definition is too the conclusion from our scientific analysis of the functions of organized being.

According to the definition of St. Thomas, self-movement is natural to a living being, '*cui convenit secundum suam naturam movere seipsum*'; indeed a living being, as we have seen, possesses a natural tendency to move itself, though for the effective realization of this self-movement the presence of certain conditions is required.

In fine, by the words '*secundum aliquam speciem motus seipsam movens*', Aquinas alludes to the particular evolution of life, to the special character peculiar to each different type of living being.

¹ 'Tria proprie sunt viventia quae seipsa secundum aliquam speciem motus movent.' And again: '*Eius virtus est substantia cui convenit secundum suam naturam movere seipsum*.' *Sum. Theol.*, I, q. 18, a. 2.

CHAPTER II

NATURE OF LIVING BEING

12. *Statement of the Question.*—For the marvellous structure and the harmoniously co-ordinated functions of the living organism a sufficient reason is clearly demanded: there must be a cause alike for this order and for its maintenance. Three hypotheses have been, and continue to be, put forward to solve this problem.

The first, which we may designate by the name of *Exaggerated Vitalism* or Vitalism of the School of Montpellier, posits in the living being vital forces distinct from the chemico-physical forces of inanimate nature.

The second, *Organicism*, is at bottom only a particular application of the mechanical conception of the universe. According to this theory the whole of nature in general, and beings endowed with life in particular, are only aggregations of atoms plus efficient causes which are always reducible to mechanical forces.

Midway between these two opposite systems, comes the theory of Aristotle adopted by Aquinas, viz., *Moderate Vitalism* or Vitalistic Naturalism. A living being, like every other substantial being, is not a mere accidental aggregation of atoms and forces, but is a nature tending towards a definite end, for the realization of which it directs, as so many means, the inherent powers with which it is endowed. This nature which is the foundation and first principle of the being's tendencies and activities finds its explanation in what we call the *substantial form*, which, in the case of a living being, is the *soul* or *vital principle*. The statement of the extreme vitalists, that this principle is immaterial and simple, the source of the forces not to be found in the mineral kingdom, stands as a gratuitous assertion.

13. *Proof of Scholastic Vitalism.*—I. *The first principle of life is a subject composed of matter.*—The nature of a being is revealed by its acts, '*operari sequitur esse*'. In order to

be able to predicate an immaterial vital force of a being belonging to the vegetable kingdom, we must first have observed, during some part of its life-history, at least one phenomenon that positively cannot be reduced to the general laws of matter. Now it does not appear that there is a single phenomenon of this kind: the living being is superior to the non-living not on account of the particular nature of the forces it displays, but simply and solely in virtue of that constant harmonious employment of all its forces towards the realization of the intrinsic end of the living being, its own well-being and the preservation of the species.

2. *The first principle of life is a substance possessing a natural tendency.*—Even the most elementary organization, such as that of the unicellular being, presents an amazingly complex yet withal harmonious combination of elements and forces that continually combine together for the formation and preservation of what is termed the *organism*. The existence and especially the stability of this combination must have its sufficient reason. Now this sufficient reason is not found in the *actual organization*: this is the very fact requiring explanation. This immense number of elements and forces now mutually related are by their nature independent of one another: there is needed therefore something more than their mere union to account for the permanent and harmonious character of their combination. Nor is this sufficient reason to be found in external conditions or *environment*: for the very same types can live in entirely different environments, and types of entirely different species in one and the same exterior environment. Further, the incessant struggle that has to be made by the organism against a host of different external disintegrating forces forbids us to assign the *immediate intervention of God* as the reason of the persistence of this orderly combination. For if God's intervention were sought as an explanation, it would be necessary to admit that such immediate and direct intervention takes place without intermission and this would deny the action of secondary causes. There is left then only one plausible explanation of the harmonious and stable combination of elements and forces in the organism: viz., the theory that there exists *within* the organism itself some *principle* making them necessarily tend towards an end that is *intrinsic* to the organism, namely its well-

being; a principle that makes all the forces of the organism converge towards the realization of this end and makes a ceaseless opposition against everything that may hinder it.

Hence we may conclude that the organism is not a simple collection of atoms and forces, but a *substance* endowed with a *natural tendency* to realize and maintain the conditions of its organization; it is a *single substance, one nature*, composed of matter and of a specific substantial principle which we call the *soul* or principle of life.

14. Unity of the Living Substance.—As every organism is composed of cells and every cell performs vital functions, there is the inclination to look upon every cell as a separate organism and to say, as some have actually said, that the larger organism is a mere collection or 'colony' of independent cells. Such a conception, however, is radically false; the living being has always two distinctive features that clearly evince its *substantial unity*, namely, the *co-ordination of its organs* and the *subordination of their functions*.

Every organism is a *continuous whole*. Whether surveyed with the naked eye or scrutinized through the microscope, the elements of which it is made never appear disconnected nor do they suggest that they have been brought together by chance; on the contrary, they are united according to an orderly and regular arrangement, are mutually dependent on one another, and by their different structures help to constitute a single harmonious *whole* of which severally they form so many *parts*.

The unity of *subordination* is not less remarkable. We have already noticed above (§) the close interdependence of all the various functions in the more complex organisms. It is true the various tissues are to some extent independent; but whilst each performs its special function, its activity is always regulated by and subordinated to the needs of the organism. The welfare of the whole organism is always the rule of action for each organ as well as for each single tissue. This unity, or subordination, in structure and function clearly demonstrates a more profound unity, the *unity of nature, substantial unity*.

15. Divisibility of Living Beings.—An objection is sometimes raised against the substantial unity of the living being on the score that it can be divided up into more than one

such being. Plants may be reproduced by slips; a sufficient portion detached from a hydra becomes another complete animal; earth-worms can be cut up into sections each of which will continue to live.

The explanation of these facts is to be found in Aristotle's axiom: 'The vegetative soul is *one actually* but *potentially many*'. Unity is not simplicity; what in point of fact is *undivided* is not necessarily *indivisible*. The existence of simple or immaterial forces is in no way disclosed in the development of organic life. There is nothing therefore to prevent the living substance from being divisible, provided every separate portion has whatever is necessary to continue the life lived in the whole. In the lower organisms this condition is easily realized. But in the case of the higher animals such division is impossible owing to the separate functions devolving upon specialized organs which occupy distinct places in the organism.