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HE is the Healer

One thing stands out clearly, that the physician, the patient and the medicine are all under the will and control of God. He alone is the Creator of the physician and the patient and also the medicine and it is He, who has bestowed the gift of healing on the physician. If we as His creation keep this basic fact before us, there would be no hesitation in admitting that cure of disease really comes from Allah and that He is the Healer.

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PRELIMINARY REMARKS ON THE PHILOSOPHY OF BIOLOGY

TEOMAN DURALI

Attempts at Defining the Philosophy of Biology

As may be readily understood, the designation Philosophy of Biology covers, broadly stated, a melting pot where primary and secondary results of *biosciences* are evaluated with the help of *philosophical methods*. Philosophy of biology is in general a highly abstract 'language' and some of its 'dialects', which I shall deal with shortly under the subheading "parabiology", even tend to be speculative.

The data of experimental biology are expressed in what I call the 'basic language' (or a first order). They are appraised in a 'higher level' (or a second order). Then, their account of an 'uppermost level' is the 'uppermost language'. The basic language describes straightforward facts observed by the experimentalist in the laboratory or by the researcher in the field. The second tries to explain (either with the help of a formal notational system or by means of an ordinary daily language) the experimental or 'purely' observational data. Already the second step furnishes some of the life sciences with certain explanations, which can be accepted as laws, even highly fluctuating theories, but surely not principles, since biology, in general, still lacks a rather well-established axiomatic system. The third one is a sort of replication over those statements expressed in the second order. This, however, does not yet mean that the uppermost language represents an altogether speculative domain. As already Immanuel Kant specifies in his *First Critique*, not every theoretical statement is necessarily speculative. To be speculative it must be entirely deprived of any kind of factual basis.[1]

Working within the frame of the higher and uppermost levels, the philosopher of biology is usually exempted from experimental occupations. Unlike the experimental scientist, he is not in a position to affirm his arguments *demonstratively*; they need to be *founded*. It is this very point which identifies him as a philosopher of biology. Simply because, contrary to experimental methods, philosophical method consists of founding that which is asserted. Moreover, "to philosophize means to ground concepts and their association on the basis of the very question: 'What is . . .?' The philosophical foundation of a question yields an answer which furthers other answers."[2] Thereby it gets clear how philosophical investigation differs from the experimental enterprise: almost no philosophical answer can ever be considered final, whereas basic scientific answers, satisfying the necessary experimental conditions, do usually not require to be tackled on any longer.

So, philosophy of biology designates:

1. the attempt to satisfy the most urgent need of biology in general, to construct an adequate axiomatic system, enabling similar experimental data to harmonize with one another. Consequently systematized knowledge — like laws, theories and finally principles — concerning biotic phenomena will be produced;
2. clarification of the meaning of terms and uncovering sets of terms, used in various descriptive or explanatory statements, belonging to different biological sciences (biosciences) and disciplines;
3. the appraisal of doctrines — usually cited under the label 'natural philosophies', which try to grasp the living being and its diverse qualities either previous to or beyond life sciences, without loosing contact with factual data;
4. to glance at the outgrowths of some of the natural philosophies, which transgress the phenomenal world altogether and sometimes appear as ideologies to be called 'parabiology';
5. working out purely experimental data and theoretical results yielded by life sciences for moral purposes.

Consequently it may be possible to name every particular branch, brought under the general title of 'philosophy of biology', as follows:

1. Theoretical Biology, which in turn can be functionally divided into two main sections:
    a. Epistemology of Biology;
    b. Biomathematics.

2. History of Biology in General:
    a. History of Biosciences;
    b. History of Biophilosophy:
        i. History of Metabiology,
        ii. History of Parabiology.

3. Bioethics:
    a. Impact of biosciences upon living things in general and human life in particular;
    b. Deontology-ethics of medicine.

The denotation and detailed classification of the herein treated field are certainly not accepted all over. At first glance this field seems rather heterogenous. This however, is not the case. Among the seemingly unrelated parts or domains there exist in fact intrinsic ties. As long as a firmly set-up theoretical biology is existent it will hardly be possible to cover experimental data by unambiguous conceptual frameworks and to establish well-founded laws and theories. This state of affairs means that no efficient results should be expected from bioethics. Since ethics itself has an extremely slippery basis, we need clearly defined concepts for bioethics to arrive at something meaningful. This indeed is exceedingly important, not only for biology, but for our morally tormented world as well.

Metabiology still has a significant function: it is a reliable source from where, whenever necessary, relevant concepts may be extracted for facts newly discovered by experimentation. Important hints can also be obtained from history for coining fresh assumptions, even hypotheses, which in turn may result in new experiments.

The only use of parabiology within the whole field of what we here call philosophy of biology, may be qualified as 'negative'. It may indicate the limits of meaningful and sound reasoning. Just at this point, no doubt, we owe a lot to Kant's ingenious distinction between the *transcendental* and *transcendent* spheres of intellectual activity.[3] Inspired by this distinction I venture to draw a demarcation line between *theoretization* — extending from theoretical biology up to metabiology — and pure *speculation* — like parabiology. Indeed metaphysics and pure speculation are no longer considered as synonymous terms, as it used to be during the Scholastic period. While the first is seen today, more or less, as an inquiry concerning the coming into being and passing away of situations, positions, relations of real being, the latter is regarded rather as doing the same within the context of fictitious entities. The principle subject-matter of parabiology consists, thus, of entities produced solely by the thinking self.

Now let us have a closer look at those specific domains, which make up the whole philosophy of biology. The arrangement of the specific domains will take place in the above-mentioned order of Theoretical Biology, Biophilosophy and Bioethics — see also "Table I" in the "Appendix".

Theoretical Biology

As mentioned above, the aim of this treatise is to show how biosciences can *theoretically* handle questions concerning organisms, and also those questions escaping the scope of biological research. Therefore it should not cause any astonishment, in case no first-hand information about organisms and problems related to them will be presented. The present account is about statements concerning descriptions of experimental data.

A. Epistemology of Biology

The first branch of theoretical biology has to do with biological mechanisms and methodology of biosciences. "It establishes the foundations of biological knowledge and thus forms a branch of general logic and *epistemology*, whilst it may also be important for biological investigation, for example, that of teleology, or relation between fact and theory, of the significance of experiment in biology . . . it may be of the greatest importance for the whole direction in biology. Critical methodological clarification may constitute protection against the fallacies of hurried hypotheses."[4]

The epistemologist of biology starts his enterprise by analyzing statements formulated mainly by the biomathematician. This means that he undertakes a logical investigation. Thus an epistemological account is a twofold theoretization: between experimental biology and epistemology of biology, there lies an intermediary step with which we shall deal hereafter. Accordingly, the epistemologist of biology is unable to ascertain by himself whether a given experimental datum *really* corresponds to its factual basis. To find out such *material fallacies*, he has to cooperate with the biomathematician and especially with the experimental biologist. The main duty of the epistemologist of biology, therefore, is to search whether a given theoretical argumentation contains certain paradoxes, contradictions, contrarieties between premises and conclusion, in short, any *formal fallacy*.

Starting from conceptual analyses, the epistemologist of biology, together with the biomathematician, tries to match certain concepts with the aim to designate similar phenomena or processes. In this way he makes a statement trying to explain a definite process or fact, which, when sufficiently confirmed, may be transformed into a scientific law and eventually into a theory.

I shall now give a suitable example, which displays the chief characteristics of a description of experimental data.

"Avena seedlings were imbibed and germinated in the presence of inhibitors of caretenoid biosynthesis. After excision and defoliation, the coleoptiles were cultured in the presence of these basally supplied inhibitors and their growth, phototropic behaviour and pigment content were subsequently measured. Total carotenoids could be reduced to ca. 20 per cent of the control value without marked influence on the dose-response curve for the first positive curvature. Chromatographic analysis of extracted carotenoids on alumina columns revealed that the inhibitors produced both qualitative and quantitative changes, reducing one fraction and virtually eliminating two others . . ."[5]

If a report such as this one, enumerating and describing isolated processes, is not connected or compared to similar reports, no generalization can ever be achieved. *Generalization*, however, is the *indispensable condition for establishing law and thenceforward theory*. Furthermore, *unless there are laws and theories, we cannot assume to possess a reliable* and *systematic knowledge about a special field of facts*. Thus experimental data do not yield us knowledge in general, but furnish us with the necessary means of either building up a fresh system of knowledge or of testing whether existing knowledge is trustworthy enough.

When we turn our attention from descriptions to explanations, which could be considered also as stepping stones for devising laws and then theories, things get more complicated.

Moreover, information obtained in the course of ordinary experience about the material realm is frequently accurate, but it seldom provides any explanation why the facts are as alleged. It is one of the distinctive attributes of theoretical science, namely, philosophy in its non-speculative sense, that it strives to provide explanations of why the observed events do in fact occur. Theoretical science attempts to discover and to formulate the conditions under which the observed facts and their mutual relationships exist.[6] Now let us recapitulate this exceedingly important point: unlike *experimental science* which enumerates and then *describes certain* facts, *theoretical science* seeks to construct conceptual *definitions* within whose limits it can render explicit the already described facts.

Thus furthermore, for explaining a certain case (or fact) we need two conditions: *facts* and *scientific laws*. Facts can be represented by basic propositions. Laws are expressed either by universal conditional propositions — in this case it is a question of *universal* as well as *deterministic* laws — or general expressions which render us probabilistic relations -- and in such cases we speak about *probabilistic* as well as *indeterministic* laws. An explanation can be considered as an argumentation. Its conclusion is a statement which describes the fact to be explained. The premises are statements describing us laws and (other) related facts. Whenever the argument is deductive, we speak of a *deductive-nomological* explanation.[7]

"A deductive-nomological explanation" says Hempel, "is based on laws which express unexceptional uniformities; such laws are strictly universal form, of which the following is a simple example: 'In every case x, without exception, when the — more or less complex — conditions A are satisfied, an event or state of affairs of kind B comes about', or, symbolically, '(x) (Ax ⊃ Bx)'. Generally, the deductive-nomological model construes an explanation by means of strictly universal laws as a deductive argument of the form:

$$\frac{\begin{array}{c} L_1, L_2, \ldots, L_m \\ C_1, C_2, \ldots, C_n \end{array}}{E}$$

"The premises are said to form the explanans: the conclusion, in other words, the statement E describing the phenomenon to be explained, is called the explanandum-statement or briefly the explanandum . . . especially in the case of causal explanation, which is one variety of deductive-nomological explanation, the particular circumstances specified in the sentences $C_1, C_2, \ldots, C_n$ will be such that their occurrence is prior to, or at most simultaneous with, that of the event to be explained."[8]

The classical explanations of physico-chemical sciences commonly fit the above-stated pattern. They are couched in terms of universal law, as is clearly seen in Sir Isaac Newton's famous formula,

$F = g\frac{m_1 \cdot m_2}{r^2}$, which represents the law of gravitation.

On the contrary, explanations pertaining to biosciences usually display *inductive-probabilistic* properties. Again according to

Hempel's statement, in an inductive-nomological explanation, at least some of the relevant laws are not of strictly universal, but of *statistical* character. "The simplest statements of this kind have the form: 'the statistical probability — that is, roughly, the long-run relative frequency — for the occurrence of an event of kind B under conditions of kind A is r' or in symbols, 'Ps(B,A)=r'. If the probability r is close to 1 then a law of this type may serve to explain the occurrence of B in a particular case i by reference to the information, together with the statistical law invoked, does not, of course, deductively imply the explanandum-statement 'Bi', which asserts the occurrence of B in the individual case i; rather, it lends to this statement strong inductive support; or, to use Carnap's terminology, it confers upon the explanandum-statement a high logical, or inductive, probability. The simplest kind of inductive-probabilistic explanation, then, may be schematized as follows:

A_i		confers
Ps (B,A) 1-ϵ (where ϵ is small)		high inductive
B_i		probability on."[9]

At present, even those assumptions, considered as the most basic ones in biology can at best be rendered by inductive-probabilistic (or better said, inductive-statistical) laws. In connexion with this fact the subsequent passage may serve as a striking example:

"Virus diseases can be transmitted by the crystalline virus material as well as by infected sap, and again the amount of recoverable virus increases as the disease develops. Here, therefore, we have something that has some of the properties of living material; like many bacteria, the viruses can transmit disease from one organism to another and again like bacteria, they can multiply in tissues of their hosts. Yet, at the same time and unlike bacteria, they seem to have no metabolism of their own and unlike any other kind of living stuff whatsoever, they are crystallizable . . . These substances thus bridge the gap between the living and non-living worlds, a discovery that has had profound effects upon biological thought. It has been necessary, for example, to revise our ideas about nature and the origin of life; indeed it seems that *we can no longer use the word Life as a precise term*, because *we know less than ever exactly what we mean by it.*"[10]

'*What is life?*' is indeed one of the oldest unsolved riddles, keeping busy the most illustrious minds from Aristotle up to Erwin Schrödinger. Herewith, of course, we suddenly pass from theoretical biology to metabiology in particular or to biophilosophy in general. Here again we can apprehend how the various branches of the philosophy of biology are intermingled.

There is no doubt that the definition of '*life*' or '*living being*' poses itself as the main problem of general biology and especially of the philosophy of biology. Being directly or indirectly the basis for every biological explanation, 'life' must be clearly and unambiguously defined. Otherwise we cannot expect that *deductive-nomological explanations* and *universal-deterministic laws* will ever be produced by biological researches. Moreover, as long as biology remains inapt to define its *basic concept*, the strong appeal for reduction of biological facts through physico-chemical explanations by mechanists, will remain convincing. Consequently, the time-old quarrel between *animists* (or *vitalists* or *organicists* or *panpsychists*) and *mechanists* (or *physicalists* or *reductionists*) is bound to go on.

Those supporting the mechanistic (or physicalist or reductionist) point of view assert that biotic phenomena are an amalgamation of inorganic matter, different only in apparition from the inanimate ones or that the living being is nothing but a well running engine. They accordingly claim that *every* life process can be explained in terms of physical sciences.

Against those former *physicalists* or *mechanists* and the present-day *reductionists*, other thinkers hold that the origin and prevalent unfolding of life are due to or brought about by a vital principle, apart from a purely physico-chemical force. Thus they affirm that life processes can solely be explained contradistinctively to organic ones. It gets clear that while *mechanism* may be considered as an offshoot of *materialism*, its adversary, *vitalism*, can be regarded as a scion of *idealism*.

Actually, those following the first trend can be recognized by their thesis that any strict natural science only works with the Causal explanations characteristic of the physico-chemical sciences. On the other hand the adherents of the second trend assert that although biology is a natural science, it is *irreducible* to physico-chemical principles. According to them biotic phenomena are the effect of a non-material principle, which is variously called vital force, entelechy, vital impetus, radial energy, or the like. Hence biology is, they maintain, obliged to use a distinct category of explanation, that is, Teleology.

Although the term *teleology* was coined by Christian Wolff in the XVIIth century, we inherit the conception from Aristotle, who distinguished four causes, the foremost of which was the *purposive:*

"... we see that there are more causes than one concerned in the formation (genesis) of natural things (tēn physikēn): there is the *cause* (aitia) *for the sake of which* (heneka) the thing is formed (gignesthai), and the *cause* to which *the beginning of the motion* (hē archē tēs kinēseōs) is due. Therefore another point for us to decide is which of these two *causes* stands first and which comes second. Clearly the first is that which we call the *final cause* — that for the sake of which the thing is formed —, since that is the *logos* of the thing — its rational ground, and the *logos* is always the beginning for products of *nature* as well as for those of art. The physician or the builder sets before himself something quite definite — the one, health, apprehensible by the mind, the other, a house, apprehensible by the senses; and once he has got this, each of them can tell you the causes and the rational grounds for everything he does, and why it must be done as he does it. Yet the *Final Cause* (heneka: *purpose*) and the Good (to kalon: the *Beautiful*) *is more fully present in the works of Nature than in the works of Arts.* Moreover the factor of *Necessity* (hē anagkē) is not present in all the works of Nature in a similar sense. Almost all philosophers endeavour to carry back their explanations to Necessity; but they omit to distinguish the various meanings of Necessity. There is absolute (haplous) Necessity, which belongs to the eternal things; and there is *conditional* hypotheseōs) Necessity, which has to do with everything that is formed by the processes of Nature, as well as with the products of Arts, such as houses and so forth. If a house, or any other End, is to be realized, it is necessary that such and such material shall be available; one thing **must** first be formed, and set in motion, and then another thing; and so on continually in the same manner up to the End, which is the Final Cause, for the sake of which every one of those things is formed and for which it exists. The things which are formed in Nature are in like case. Howbeit, the method of reasoning in *Natural Sciences* (physikēs) and also the mode of Necessity itself is not the same as in the *Theoretical Sciences* (theōrētikōn epistēmōn) . . . They differ in the following way: In the *Theoretical Sciences*, we begin with what already Is; but in *Natural Sciences* with what Is Going To Be."[11]

Herewith a grave misconception usually attributed to Aristotle must be corrected: As the preceding passage excerpted from Aristotle's "Parts of Animals" clearly shows, Purposiveness in the study of nature does generally mean an over-all 'heavenly end or plan'. In spite of his unshakeable belief in the *stability of the universe* and the *orderly processes of its components*, worded in his passages about the 'teleological' causality of the *unmoved mover*, he does pay attention to ends in the sense of determinate end-points, of particular processes in the natural world. Consequently, for Aristotle 'telos' is especially significant in explaining '*ontogeny*' and not *phylogeny*'. To suppose otherwise is, as Marjorie Grene very rightly suggests, to introduce a Medieval theological confusion not due to Aristotle.[12]

As a matter of fact, from the beginning of the Middle Ages until recent times, teleological explanations in biophilosophy used to be supplanted with theological considerations. Especially for explaining organic evolution, usually recourse was taken to a creator or planning agent external to the organisms themselves, as we can see in Teilhard de Chardin's works, to name one of the more recent thinkers following this trend. Such attempts to explain and define life processes in terms of teleology, imbued with theological thoughts, were not infrequently confronted with severe criticism. Even that kind of teleological conception which refrains from theological reflexions is generally in disrepute in modern science. "More frequently than not it is considered to be a mark of superstition, or at least a vestige of the non-empirical, a prioristic approach to natural phenomena characteristic of the pre-scientific era" says Carl G. Hempel. "Biology", he carries on, "has been said to require teleological concepts and hypotheses in order to be able to account for regeneration, reproduction, homeostasis, and various other phenomena typically found in living organisms; and the resulting explanations have been held to be fundamentally different from the kinds of explanation offered by physics and chemistry . . . Now indeed, some kinds of teleological explanation which have been suggested for biological phenomena fit neither of the covering-law models. This is true, for example, of vitalistic and neo-vitalistic accounts couched in terms of vital forces, entelechies, or similar agents, which are assumed to safeguard or restore the normal functioning of a biological system as far as this is possible without violation of physical or chemical laws. The trouble with explanations of this type — in sharp contrast, for example, to explanations invoking gravitational or electromagnetic forces — is that they include no general statements under what conditions, and in what specific manner, an entelechy will go into action, and within what range of possible interferences with a biological system it will succeed in safeguarding or restoring the system's normal way of functioning. Consequently, these explanations do not tell us — not even in terms of probabilistic laws — what to expect in any given case, and thus they give us no insight into biological phenomena, no understanding of them — even though they may have a certain intuitive appeal —; and precisely for this reason, they are worthless for scientific purposes and have, in fact, been abandoned by biologists. The reason for their failure does not lie, of course, in the assumption that entelechies are invisible and indeed non-corporeal entities; for neither are gravitational or electromagnetic fields of classical theory visible or corporeal, and yet they provide the basis for important scientific explanations . . . It is precisely the lack of corresponding laws or theoretical principles for entelechies which deprives the latter concept of all explanatory force."[13]

Beside such total renunciations of teleology with the contention that any biological statement must be formulated right from the start in physico-chemical terms, it has been maintained that propositions containing teleological concepts can be converted to ones constituted by causal concepts. Hence it has been tried to demonstrate that prositions based on teleological concepts do not have any non-Causal substance. One of the most outstanding supporters of this opinion is Ernest Nagel, who claims that teleological — in the sense of functional — explanations are equivalent to non-teleological ones, so that the former can be replaced by the latter without loss in asserted content. To document this, Ernest Nagel presents the following example: " 'The function of chlorophyll in plants is to enable plants to perform photosynthesis.' " This statement, according to Nagel, appears to assert nothing which is not said by " 'plants perform photosynthesis only if they contain chlorophyll', or alternatively by 'a necessary condition for the occurrence of photosynthesis in plants is the presence of chlorophyll.' These latter statements, however, do not explicitly ascribe a function to chlorophyll, and in that sense are therefore not teleological formulations . . . On this assumption, therefore, a *teleological explanation* states *consequences* for a given biological system . . . the equivalent *non-teleological explanation* states some of the *conditions* — though not necessarily in physico-chemical terms — under which the system persists in its characteristic organization and activities. The difference between teleological and non-teleological explanations is thus comparable to the difference between saying that B is an effect of A, and saying that A is a cause or condition of B."[14]

Nevertheless, no one can assert that the stage is only open to those who wage a fierce war against teleological explanations. In this connexion we may lend an ear, among others, to Francisco J. Ayala, who maintains that "generally, the experimental laws formulated in a certain branch of science will contain terms which are specific to that area of inquiry. If the laws of the secondary science contain some terms that do not occur in the primary science, logical derivation of its laws from the primary science will not be prima facie possible. *No term can appear in the conclusion of a formal demonstration unless the term appears also in the premises.* To make reduction possible it is then necessary to establish suitable connections between the terms of the secondary science and those used in the primary science. This may be called the *condition of connectability*.[15] It can be satisfied by redefinition of the term of the secondary science using terms of the primary science. For example, to effect the reduction of genetics to physical science such concepts as gene, chromosome, and so forth, must be redefined in physico-chemical terms such as atom, molecule, electrical charge, hydrogen bond, deoxyribonucleic acid, length, and so on . . . Scientific laws and theories consist of propositions about the material world, and the question of reduction can only be settled by the concrete investigation of the logical consequences of such propositions, and not by discussion of the properties or the natures of things."[16]

In case we once conceive wholeheartedly the fact that science, on its unswerving itinerary heading towards an ever increasing acquisition of cognitive wealth about the world, gets changed not only in its general outlook, but eventually in its very structure and constitution too, then, we must give up at last that habit of observing phenomena and processes from behind spectacles of classical mechanics, which was considered for such a long while as the ultimate step of scientific advancement. As a matter of fact, "in the biological, behavioural and sociological fields, there exist predominant problems which were neglected in classical science or rather which did not enter its considerations. If we look at a living organism, we observe an amazing order, organization, maintenance in continuous change, regulation and apparent teleology. Similarly, in human behaviour goal-seeking and purposive directiveness cannot be overlooked, even if we accept a strictly behaviouristic standpoint. However, concepts like organization, directiveness, teleology, and so on, just do not appear in the classic system of science. As a matter of fact, in the so-called mechanistic world view based upon classical physics, they were considered as illusory or metaphysical . . . The appearance of models — conceptual and in some cases even material — representing such aspects of multivariable interaction, organization, self-maintenance, directiveness, and so on, implies *introduction of new categories* in scientific thought and research."[17]

No doubt, a teleological explanation, as it has already been revealed thanks to Ernest Nagel, can be reformulated in a non-teleological one; yet, the above arguments unmistakably indicate that teleological explanation connotes something more than the equivalent non-teleological one: the former includes all the basic assumptions of the latter, but says more than that.

This state of affairs reveals another point very crucial for comprehending theoretical investigations on living nature: Although we do not venture to erect a barrier between inorganic and organic matter which would obviously be inappropriate in view of intermediates such as viruses, nucleoproteins and self-duplicating units, we do not thereby maintain that the difference between the organic and the inorganic is simply a matter of mathematically measurable degree. Consequently, to deny that biology is partially explained by physics would be out of place in view of the tremendous advances of physico-chemical explanation of life processes; but it would appear equally nonsensical to assert that biology does not need any explanatory form surpassing those used by physico-chemical sciences.

For distinguishing *scientific teleology* — which has been shown as indispensable for biology — from the *speculative* one, Jacques Monod preferred to employ a newly coined term, *Teleonomy*. This, he defined as follows: "The concept of teleonomy implies the idea of an *oriented*, *coherent* and *constructive* activity. By means of these criteria, we can maintain that proteins must be considered as the essential molecular agents for the teleonomical performances of living beings . . . The organism is an engine which builds up itself. Its macroscopic structure is not imposed upon it by the intervention of exterior forces. Thanks to its inner constructive interactions, it makes up itself autonomously . . .Even though our understanding concerning the mechanism of development might be more lacking, we can nevertheless affirm henceforth that the constructive interactions are microscopic, molecular and furthermore the molecules are essentially, if not uniquely, proteins . . . Consequently proteins build up, assure the coherence and canalize the chemical machinery. All these teleonomic performances of proteins rest, in the final analysis, upon properties called as 'stereospecific'; in other words, proteins possess capacities of 'recognizing' other molecules — among which are proteins too — according to their *shape*, which in turn is determined by the structure of those to be 'recognized'. Literally this can be designated as a microscopic discriminating and even 'cognitive' property."[18]

Hence we can gather together all that has been indicated in respect to biological explanatory forms in the following manner:

1. On the basic levels of biology, like biochemistry, biophysics . . . a *causal* explanatory form is commonly used.

2. But where already cells and then especially organisms and their various parts are taken into consideration as open systems,[19] as in embryology, genetics, paleontology, evolution, physiology of particular organs or organelles, ethology and sociobiology, we come across '*functional-purposive*' explanations — in the sense depicted hitherto.

3. Another form, found either implicitly or explicitly in almost all biological — especially evolutionary and paleontological — statements, is the *chronological* explanation. In fact every teleological statement bears certain chronological elements. *Teleology* in a way relates, according to Nicholas Rescher "solely to the role played by the time factor in explanation, as evidenced in the temporal scope of the data requisite for explanatory purposes."[20]

4. Besides causal, teleonomic ('functional-purposive') and chronological explanatory forms there is a fourth one called *structural* (or, *morphological*), encountered in anatomy, morphology, and comparative physiology.

5. One of the most common explanatory forms in biosciences

is the *statistical* one.

6. Among biosciences particularly taxonomy, systematics, comparative physiology and morphology take frequently recourse to *comparative* explanations — see "Table II" in the "Appendix".

This amazing wealth of explanatory categories in biology springs from its place at an intersection of natural and non-natural sciences. While for instance its biochemical and biophysical regions border on physico-chemical sciences, paleontology and biogeography possess a common frontier with earth sciences and geography in general. Evolution is closely connected with historical sciences. Systematics and taxonomy extensively use categories and concepts of the science of logic.[21] Ecology has got some ties with economics, climatology, oceanography and with all other biosciences; socio-biology, as its name indicates, is intermingled with sociology; whereas ethology can hardly be seperated from psychology — see "Table III" in the "Appendix".

The tremendous variety which we encounter in the research field of experimental biology, we also encounter in the theoretical biology. Therefore, most of the methodological aspects of adjacent biosciences and those of domains beyond the realm of biology must be considered in theoretical biology. Consequently, statements appearing in theoretical biology are usually neither totally causal nor purely teleonomic in form. They contain both of the explanatory ingredients. To pass, accordingly, from one of these explanatory forms to another with an almost automatic ease is not the unusual practice in biological arguments. Here we see that premises of an explanatory argument can, either totally or partially, be explained by another argument, which in turn might also be explained by a subsequent one; and the new one may give a fresh impulse for further explanations. Hence a 'chain' of arguments comes into being, which is called *genetical*[22] explanation.

Under appropriate epistemological conditions from such 'ultra-synthetic' arguments as 'genetical' explanations are, it is possible to arrive at 'ultra-synthetic' theories — like the modern theory of evolution. No doubt that the evolutionary and synthetic — better said, 'systematic' — trends, proper to contemporaneous biology, owe a lot to Charles Darwin's integrating influence upon all kinds of biosciences.[23]

Today having won a much deeper insight into biology's own subject matter than Darwin could ever dream of, we perceive more clearly that all biological events, like all inorganic processes, are based ultimately on a relatively small number of irreducible components, the alterations of which are determined by a limited sum of basic laws.[24] Bernhard Rensch denominates these complicated biological laws, embracing a vast variety of such causally determined 'basic laws', as well as of probability and logic as *polynomistic.*[25]

Like explanations and laws — other than biochemical and biophysical all biological definitions are also built from extremely heterogenous elements. The fact that biology proceeds with explanations whose constituting parts are not, so to say, tightly packed together and that definitions become devoid of evidence, deprive most of the biological laws and the theories of their power for liable prediction. In this case we can speak in biology only about potential predictions.

Besides this heterogeneity of the constituting elements of biological explanations, caused by the fact that biology mainly treats *open systems* that are exposed to an extraordinary amount of external influences, there is another factor playing a decisive role in weakening the predictive value of biological statements: the ambiguity of terms used in them. This is the reason, why it is so urgent to develop a *formalized language.*

B. Biomathematics

Theoretical biology in the second sense should be related to descriptive and experimental biology in just the same way theoretical physics is related to experimental physics. "That is the task of a theory of the various single branches of the vital phenomena, of development, metabolism, behaviour, reproduction, inheritance . . . and in the last resort, of a 'theory of life', in just the same sense in which there is a 'theory of heat', a 'theory of light', and so forth."[26]

Theoretical biology in its second sense is precisely as much a branch of natural science as theoretical physics: it deals exclusively with the exact theoretical systematization of facts; in other words, it is a systematized evaluation of facts expressed through a formalized language. So it has no room for speculations. This point, as Ludwig von Bertalanffy puts forth so clearly, requires emphasis, because voices are often raised to reject theoretical biology as 'merely speculative' and 'superfluous'.[27]

This misunderstanding of theoretical biology is the result of a current confusion of the various domains pertaining to the philosophy of biology. The biomathematical field of theoretical biology is certainly the least related to the other, let us say, more speculative domains. Nevertheless, if we are to overcome the state of crisis in biology, which has been reiterated hitherto several times, we require theoretical biology in both the 'first' and in the 'second' senses as well as all the other domains belonging to the philosophy of biology.

In fact the most important point is that the groundwork for a 'theory of life' has been prepared as a result of researches undertaken on the molecular level since the 1950's. The modern theory of evolution, which has been bolstered by experimental data of these molecular investigations, assumes, more often than not explicitly, that there is a fundamental uniformity among living beings, that the basic machinery is the same in all. The best illustration of this assumption is the fact that the genetic code itself, that is to say the chemical mechanism of inheritance, works according to the same basic principles and the same code in every known living being from bacteria to man.[28]

What remains to be achieved, according to some theoretical biologists, is the reformulation of the above-mentioned data within the frame of an integrated set of deductively related ('deductive-nomological') with the logical of $(x)(Ax \supset Bx)$. Even in such a situation however, we could not regard 'the law' or 'theory of life' as possessing such an all-embracing validity as, for instance, Newton's law of gravitation. But this, of course, is an ontological rather than epistemological question.[29]

Besides such high-flying laws or theories like the 'law' or 'theory of life', biology as natural science possesses of course a lot of simpler laws and theories which await their share of a formalized language. Surely it will be much easier to formalize them than the 'theory of life'. The latter is subject to an immense aggregate of boundary conditions, which render it extremely difficult, if not completely impossible to arrive finally at a more or less reliable theory.

It has been endeavoured to construct some minor biological laws and theories in a formalized language. To a great extent this formalized language is mathematical. There are also some attempts to formalize biological statements with logical notations other than the pure mathematical ones. We can include within the logico-mathematical notation system cybernetics too.

One of the most outstanding pioneers of biomathematics is Nicholas Rashevsky, whose "Mathematical Biophysics" emerged eventually as one of the classical reference works written on this subject. In the preface to his book Rashevsky reasons on the meaning and necessity of biomathematics. Thus: ". . . as no theoretical science can be developed without an experimental foundation, so can no experimental science be really meaningful without some theoretical insight. This requires a certain autonomy of the mathematical natural science, which must develop in agreement with the results of experimental research, but should not be made mere handmaidens of the experimentalist. A theoretical problem may have an interest of its own and should not be tabooed only because *at present* it does not appear applicable to a definite experiment. The history of physics shows how frequently such 'purely theoretical' developments led, few decades later, to the most astonishing results."[30]

Like many other contemporary theoreticians, Rashevsky maintains that as a *natural positive science* biology should also depart from those basic principles, which have proven themselves useful in promoting physics to the rank of a model for all other sciences. One of the most basic principles is, no doubt, the fundamental belief in the *uniformity of nature*, without which no science can exist.[31]

The other is the formal language, namely mathematics. It is obvious, however, that although every biological phenomenon can be explained in terms of a physical model, *it does not follow that the existence of biological phenomena can straightaway be deduced from the sets of postulates on which physics is based.*[32]

Rashevsky asks whether it is not more appropriate to represent an *organism* in a rather abstract form, namely by a class of relations. Then we could study, according to him, mappings of such classes of relations. However, there is a point we have to add to the foregoing proposition: transformations need something more than mere geometric rules so that we can express the time component besides the spatial one; that is, *qualitative* values in addition to *quantitative* ones; because the concept of biological time reveals something more than a causal-quantitative sense.[33]

If the time factor is left out of consideration, the transformations from primordial simpler organisms into more complicated multicellular organisms will remain incomprehensible to us. While horizontal transformation stipulates the space component, the lateral one asks for the component of time. Consequently, each of them will require a mathematical, or at least another logical expression proper to its own subject matter.

The subsequent example may serve to shed light on both notions of horizontal and lateral transitions:

"During a very long geological period — so about 1000 to 500 million years ago — organisms were living in the sea, while on land life was still inexistent. The CO_2 content of the atmosphere altered between 0.01 and 0.1 present atmospheric level (P.A.L.). The atmosphere was composed in such a way that ultraviolet light could reach the Earth and inflict mortal injuries to the organisms. After this period the CO_2 content exceeded 0.01. Thanks to this increase of CO_2 content, an ozone layer was formed, which absorbed ultraviolet light, and so a varied life found the chance to emerge and evolve on Earth. The above-stated data are sufficient to explain adequately that 500 million years ago no life could come about on land."[34]

The foregoing argument also presents an appropriate illustration of genetic explanation, because the causal, functional-purposive (namely, teleonomic), chronological and statistical statements are derived from one another. The facts contained in it can be formulated in the following manner:

1. $(x)(d)[(\exists i)\ (G^2 iI)_{(x,d)} \supset \sim (\exists y)\ (Qy_{(x,t)})]$
2. $G^2 i_o I_{(a,b)}$
3. $\sim(\exists y)\ (Qy_{(a,b)})$

d: duration: $(t_2 - t_1)$

x: place.

i: intensity. I: a constant value, $G^2 iI = i > I$.

Qy: y is an organism.

1. In any place 'x' and any duration d, if there is an intensity 'i' such that $i > I$, then at place 'x' and during duration 'd', there is no living organism 'y'.
2. At place 'a' and during 'b', '$i_o > I$'.
3. Therefore at place 'a' and during 'b', there is no living organism 'y'.

Obviously enough, formalization of biological statements, beside bearing immeasurable advantages, as already mentioned on various occasions, carries with it some dangers too. The most perceptible one is, as David L. Hull suggests, the failure of communication between theoretical biologists — especially bio-mathematicians — and experimental biologists, caused by the formal reconstruction of biological statements in the logico-mathematical notation.[35]

This method of doing philosophy of biology according to Hull, has two drawbacks. The obvious one is that few experimental biologists are familiar with the notation. But is this not the fault of experimental biologists? Is it not up to them to learn set theory or symbolic logic, so that they can reap the benefits of this large body of literature? The straightforward answer Hull gives to this question is "no". Formalists such as Joseph Henry Woodger and

Gregg have made some biologically significant points in their work, but few that could not have been made just as clearly without extensive use of these notations. Perhaps the discovery of certain logical distinctions was aided by the use of these techniques, but the results need not have been communicated in these same terms. Too often the application of logico-mathematics to problems in biology gives the impression that more or less commonplace ideas have been expressed in tiresome exactitude when they could have been conveyed more easily and more directly in a few plain sentences of an ordinary vernacular tongue.[36]

The second drawback of the formalist method is that more often than not the method becomes the message; in other words, formalistic analyses are made for the sake of formalistic analyses.[37] The principal aim, however, should be to attain a sound *synthesis* as the conclusion of a well-founded network of analyses.

III. History of Biology in General

A. The History of Biosciences

It is often overlooked how much a historical survey can contribute to the understanding of the present level of a specific problem and to the furthering of its development. Technically minded scientists in particular do not pay attention to such surveys or accounts, politely dismissing the idea by saying they do not have enough spare time for useless 'hobbies'. It is in fact open to discussion whether an experimental scientist or even a technician needs any insight into the historical background of his specific discipline for getting a better comprehension of his subject matter. Contrariwise, besides his main occupation, the necessity of disclosing, at least briefly, the historical contours of his discipline presents itself to every theoretician as a matter beyond discussion. In this way the theoretician's comprehension concerning his research field is intensified. No progress can ever be achieved unless the previously attained progress is sufficiently appreciated. Historical apperception supplies us with a broadening view over our field and prevents us from becoming stagnant. Specialization in itself, that is, the state of being deprived of the consciousness of the particular historical process which has necessitated that specialization, inevitably succumbs to one-sidedness. Of course there is no question that the enormous wealth of experimental data, the sophisticated techniques and complicated concepts of modern science require specialization. Nevertheless, a theoretician is expected, after all, to detect the thread binding certain previous conclusions to their premises, since some of these conclusions will serve him in turn as his own set of premises. The condition for finding out this very thread is a historical appraisal of the discipline in which the theoretician carries out his research work.

Every theoretical (philosophical) approach is expected to avoid one-sidedness by adopting both the historical and the logical points of view. Now, as far as the cognitive sphere of biology is concerned, *history*, together with *experimental science*, 'nourishes' the theoretical domain with the necessary 'materials' — information about past and present achievements — originating from different research fields in connexion with biotic phenomena. Indeed to work up these necessary 'materials' — informations, ideas . . . — supplied by history into a rational, coherent system we require the substantial help of formal logic or dialectics.[38]

Moreover, "the logical approach, as we find it in innumerable philosophical writings, is, in broad outline and oversimplification, something like this: we are confronted by observation with facts, pointer readings, protocol sentences . . . From these we derive generalizations, which, when properly formulated, are called laws of nature. These are fitted into conceptual schemes called theories, which on hypothetico-deductive view, allow for the explanation, prediction and control of nature. The logical operations involved could be carried through even better and neater with sufficiently capable computers . . . The history of science, however, shows that the actual development of science is nothing of this sort. Psychology has shown that cognition is an active process, not a passive mirroring of reality. For this reason, there are no facts as ultimate data; what we call facts has meaning only within a preexisting conceptual system. The famous pointer readings which positivist philosophers were so fond to speak of as being the basis of scientific knowledge simply make no sense without a conceptual scheme . . . In consequence, history of science does not appear as an approximation to truth, a progressively improved mirroring of an ultimate reality. Rather, it is a sequence of conceptual constructs which map, with more or less success, certain aspects of an unknown reality. For example, one of the first models was that of myth and magic, seeing nature animated by gods and demons who may be directed by appropriate practices. Another one was Aristotle's seeing the universe guided by purposeful agents or entelechies. Then there was the Newtonian universe of solid atoms and blind natural forces . . . Nowadays we seem to be dedicated to still another model, epitomized by the term 'system' . . . Neither were the previous models and world views simply superstitious nonsense, nor were they completely eradicated by subsequent ones. The mythical world view served mankind admirably well through many millenia, and produced unique achievements, such as the array of domesticated plants and animals which modern science did not essentially increase. And there is still far too much demonology around, in science and particularly in the pseudo-science of politics. Aristotle's physics was a bad model, as was shown by Galileo; but problems posed by him, such as that of teleology, are still alive in the theory of evolution — see Teilhard de Chardin — and in the considerations of cybernetics. That our thinking is still much too Newtonian is the common complaint of physicists, biologists and psychologists."[39]

For getting a better comprehension of biosciences, rapidly advancing since the 1750's, we have to possess an incisive insight into the historical development of their recent as well as remoter sources, or even, resources.

B. *History of Biophilosophy*

Unlike *theoretical biology*, philosophy about the living being, hence *biophilosophy*,[40] does not solely treat the *conceptual* framework of biosciences as such to a certain extent, but has something to say quite apart from what science generally asserts.

Today, even those philosophical trends which are not directly linked to the biotic sphere are amply pervaded by biological considerations. This means also a deviation from orthodox materialism, mainly nourished by classical mechanism. The mid XIXth century Romantic movement, which chiefly grew as a reaction against the materialistic-mechanistic conception of the world could partly account for the thriving interest philosophers showed toward the living being and its realm. However, the principal cause of the aforesaid change sprang from the steadily increasing store of tough problems mankind has been facing and was unable to solve by using conventional tools only.

Physics, particularly its Galilean-Newtonian version, may easily be regarded as the embodiment of an optimistic-progressive world conception, basically hostile to nature, which it considers more or less as an object good to be exploited. It can be said that the adherents of such a world conception would aspire to the erection of almost an artificial environment. The more we approach the end of the present century — and with it the final stages of the First Millennium A.D.—, the more we get alienated from our natural surrounding. This situation has not failed to bring about results of its own sort, calamitous for the human species. To get out of this entanglement we need something in addition to the mentality shaped by the physico-chemical sciences, which may be counted among the chief responsibles of the present state of affairs. The key to undo this deadlock is a new manner of evaluating facts and problems. Accordingly the inquiring mind is not any more expected to look upon the '*dead*' matter as its sole object of study. *Life* stands now in the middle of all experimental and theoretical investigations as well as speculative debates.

i. History of Metabiology

While René Descartes considered the living being as a '*perfect engine*',[41] Henri Bergson, who took life processes as the basis of his doctrine, proclaimed that even the *'thing'* was a living being, 'solidified' by our 'physicalist' mode of thinking, which obstructs the flow of events and takes out any one of them at random from its 'natural' circumstances.[42]

In its essentials Bergson's mode of thinking reminds us of the Aristotelian reflections, which are later to be found in both Muslim — like Avicenna, one of the most outstanding among them — and Christian philosophers.

According to Avicenna (Abu Ali Ibn Sina) even the seemingly inanimate 'spherical' ("kurewî") 'bodies' ("edjsâm") make their way to each other because of a certain 'love' ("a'shq") existing between them — finalism—. But ultimately they get a 'beloved' ("mua'shûq") in common, namely the 'Necessary Existent' (Wâdjib al-Wudjûd") towards Whom they all strive — theological finalism.[43]

In spite of the similarities between vitalistic ideas in contemporaneous and ancient philosophy, still a deep gap separates them. Contemporaneous biophilosophies, just like modern bio-sciences, are inconceivable without the influences from Jean Baptiste de Lamarck's and Charles Darwin's epoch-making theories about Evolution.

As in almost all domains of modern philosophy, it was again Immanuel Kant who paved the way towards the philosophy of biology which is at work of our time. In the last of his three Critiques, namely "The Critique of Judgement", Kant discusses, for the first time in the history of ideas, consciously and seriously the philosophical foundations of biology. In his First Critique he even does something more as he attempts to explore *the biological basis of the human intellectual powers.*[44]

Kant, throughout his painstaking investigation, is amazingly aware of the crucial difficulty biology faced and which it still faces today, when it wants to express its research data: the dichotomy between *causality* and *finality*. However, far from being that sort of thinker who at first uncovers and exposes the question, retiring afterwards to his den, Kant had something of his own to propose. Moreover, his proposition is the consequence of a meticulously worked-out argumentation. Therefore, it still keeps its validity in present philosophical discussions on life in general and biology in particular. For elucidating organic processes, we need, according to Kant, two models of explanation: Mechanistic and Teleological.[45] In case one of them is missing we shall not be able to grasp the phenomena of life, since it is the *mechanistic cause* which expounds *how* a living being is a natural product and it is the *teleological principle* which sets forth *why* it exists.[46]. Kant warns that if these two principles are applied in wrong instances, then the results we acquire may be misleading. If for example we ask why a living being is a natural product, we can easily be dragged to the point of answering this question in terms of either *occasionalism* or the *pre-establishment of the cause.* On the other hand if we merely ask how it exists, we may tend to reason in a brute *mechanistic* manner.[47]

Kant, above all, revolutionized philosophical inquiry in particular, and our representation about the world in general. The majority of the most influential thinkers and researchers before him took it for granted that the perceived phenomena corresponded adequately to the *reality* of them. Kant removed the second pole of this bilateral relationship. "Laws" he says, "limit our freedom in relation to conditions . . . How objects are themselves", that is, how their real entity looks like, "how things, standing beneath a principle are constituted and how they should be determined according to pure concepts, is, at least, a claim which does not make any sense."[48] Accordingly it is understood that our representation concerning nature does not adequately mirror the natural order. We interpret every single happening, process and fact in accordance with our *intellectual faculties*, namely understanding and reason. Therefore, it is Kant's conviction that we must turn our attention from the things, which can become objects to our cognitive faculties, toward the faculties themselves. This shift of interest paved the way towards contemporaneous gnoseology as well as epistemology. It might therefore, be regarded as a turning point in the evolution of philosophy as a whole.

As shown before, epistemology of biology is part of theoretical biology and thus some sort of natural science. 'To philosophize', however, means for certain philosophical circles an investigation into man's cognitive possibilities, and into the conceptual structure of individual sciences and their various disciplines, to uncover those common logical elements underlying them. Furthermore, 'to philosophize' has come to denote the study of ethical problems arising from scientific research.

In this context, different manners of philosophical inquiry add to mankind's common intellectual treasure. But is there still a place for philosophies allegedly concerned with factual investigations, when natural sciences are already busy with the factual world, surely with much more competence than philosophy could ever dream of?

Thus two pitfalls should be avoided by all means: extreme specialization resulting in insulation; and immoderate generalization overrunning the limits of competence with regard to facts. We often witness oversimplified specializations in biosciences and particularly in biotechnologies. On the other hand, the wholesale transgression of competence and of facts forms a subject matter by itself, called *parabiology*.

ii. History of Parabiology

Why do we then call this transgression, 'parabiology', instead of including it under the subheading of 'metabiology'? What criterion do we possess to distinguish the former term from the latter?

Indeed, at first glance, both terms indicate the same sense: 'The overstepping of facts pertaining to the biosphere.' However, as described in the foregoing section, 'metabiology' oversteps the factual world guided by reason, without loosing a firm sight of facts;[49] whereas speculative tendencies gathered together under the subheading 'parabiology', surpass above all the assignments of reason and do not care to keep up even the necessary minimum of contacts with reality.[50] This designation is not intended to convey a derogatory sense, but only to indicate that these tendencies stand 'alongside' other domains of philosophy as well as the science of biology. "For the progress of biological science, however, they seem to be useless, or even harmful in so far as they mislead non-biologists about the real character of scientific biology and divert the expert from a correct formulation of his problem."[51]

Since contemporaneous thought is so much affected by biological considerations, and since it gets nowadays thanks to mass-media easily within the reach of everybody interested in material as well as intellectual problems of his time, biology becomes more and more fashionable. As an outcome of this fashion we have *ideologies* and *world views* peculiar to our century. Almost all of them try to live on fragmentary ideas taken over mainly from biology. If at least these ideologies and world conceptions stayed silently 'alongside' scientific investigations, as Felix Mainx wishes to see them, no one could raise any serious objection against them. They could in such a case be a harmless ingredient of the treasury known as culture. However, it is just contrary to their essence to remain modest.

Every philosophy of life (Lebensanschauung), just as Felix Mainx points out appropriately,[52] rests on a faith, on a decision to trust, which can only be reached from an *inner human experience*. But on the basis of empirical science a philosophy of life can hardly ever be built. Biology as an empirical science therefore cannot answer those 'great questions of life', which move men from within. Yet, this does not mean that a person occupying himself with biology or any other empirical science is not at all supposed to believe in or adhere to a certain philosophy of life. A happy synthesis of both of these seemingly contrary domains is always possible as long as they are not confused. No doubt such confusions are the breeders of ideologies; and wherever these loom large — just as it has happened throughout the modern European spiritual history — we can be sure to find the symptoms of weakness of faith and uncertainty. *Ideological systems clearly bear the stamp of religious substitutes.* They seek to fill the substance of faith, hollowed out by the Enlightenment and liberalism, with pseudo-scientific content.

IV. Bioethics

The purpose of this treatise is not only to *analyse* what the term 'philosophy of biology' may denote, since our problem-loaden age expects the fulfillment of a special duty from the philosophy of biology.

As alluded to before, man rediscovered his origin in the biotic sphere. In order to prevent a tendency towards extremes, namely towards a new '-ism', as it has been the case so often throughout history, solutions have to be sought in the first place in man's biotic realm. However, unique as he is, man transcends life in its organic aspect, thanks to reason, which must fundamentally be biotic too.[53] Herewith, it becomes clear enough that for attaining a sound notion about man, both aspects should be taken into consideration. In case the stress falls solely on life in the sense of a pure organic process, *savagery* will be the result; and if reason, together with its derivative, culture, is merely accentuated, then the outcome will be an inclination towards *degeneracy*.[54] So what we urgently need is a happy *combination* of both components. This new and ingeneous synthesis has been epitomized into a single term by one of the most prominent thinkers of the XXth century, José Ortega y Gasset: '*Biotic Reason*' ("razon vital").

Thanks to this assignment of reason to its right place — within the frame of life —, those timeworn opponents, mechanism and vitalism — in other words realism and subjective idealism — have been obliterated from the agenda of the philosophy of biology. Consequently there should be no sense to debate anymore 'which of them is valid: realism or subjective idealism'. Ortega y Gasset warns us to refrain from giving priority to *things*, as realism does, or to *me* over them, as subjective idealism does. Reality is an indivisible whole of me and things around me.[55]

Herewith the principal function of the philosophy of biology appears clearly before us: to expose the causes of certain human actions within individual as well as social frames, after having studied the entire living nature thoroughly; and then to evaluate these actions inside an integrated structure. To achieve this end, general biology and particularly the philosophy of biology pursues a path, which may be called evolutionary and integrative. "The new lawfulness arising out of new structures", as a matter of fact, "never abolishes the laws of nature prevailing within the living system previous to the new event of integration. Even the systemic properties of the newly united subsystems need not be entirely lost. This is true of every step taken by evolution, even of its greatest and initial step from the inorganic to the organic . . . The processes of life are still physical and chemical processes, though, by virtue of the complicated structure of chain molecules, they are something very particular besides. It would be plain nonsense to assert that they are 'nothing else but' chemical and physical processes. An analogous relationship exists between man and his pre-human ancestors: man certainly is an animal, but it is simply not true that he is nothing but an animal".[56]

Philosophy of biology, as now becomes evident, strives to integrate various basic biological facts and processes inside a coherent system considering at the same time all domains of human achievements: religion, science and arts. Moreover, the main aim of this system is to attain a position where an adequate explanation of human activities can be presented. Here, no doubt, we enter the realm of *ethics*, seen from the biological standpoint.

Conrad Hal Waddington argues that the particular character of ethical values is indeed defined by their developmental involvement with the proceedings by which the *human individual becomes a functioning part of a new type of evolutionary process, based on the cultural or socio-genetic transmission of information from one generation to the next.* This, in fact, is the major line of demarcation, separating man from other animals. "The developing human individual becomes an 'Ethical Animal'[57] by the operation of the same processes as those by which he becomes a member of a species with a socio-genetically transmitted system of evolution."[58]

In addition to this philosophical kernel, topics like *Medical Deontology*, *Sociobiology* (or biosociology), *Ecology*, *Ethology* form either wholly or partly the constituent elements of *Bioethics.*

Beside their necessary interdependence, each of them leans for its own part on other sections of biology; like the dependence of medical deontology mainly on biochemistry and genetics.

The vital importance of almost all the themes treated within the frame of bioethics go much beyond the limits of this field, and even as a whole, of biology. They concern the entire sphere of human activities. Let us not forget above all that one of the most deep-going revolutions in history has been brought about by a biological hypothesis, namely Charles Darwin's assumption concerning evolution. With it the physicalist world conception arrived at its zenith; and consequently man abdicated his throne, which, till then, stood in the centre of a created and purposively evolving universe.

The natural outcome of this chaotic moral state, into which man has been thrown, is very strikingly summed up by Jacques Monod: "Thus the appearance of life itself and, within the biosphere, the emergence of Man, can only be conceived as the result of a huge Monte-Carlo game, where our number eventually did come out, when it might as well not have appeared and, in any case, the unfathomable cosmos around us could not have cared less."[59]

Let us leave aside for a moment whether this relentless surmise can ever gain pure scientific validity through experimental work. Its impact, at any rate, upon the sphere of human values is already sufficiently devastating that it should be reconsidered if it could by any chance be accepted as it is. Here of course the dilemma arises whether human life and those values upholding its dignity should, when necessary, be submitted to science and technology or any other considerations but life itself; or, should science simply serve life and its aureola of values.

It was certainly not in vain that Plato chose the latter of the above alternatives. He, no doubt, foresaw clearly enough all the destructive consequences of the former assumption. Mainly this highly *ethical* consideration might have moved him to meditate upon the realm of ideas, which appear today to us, 'men of the pure scientific era', quite ambiguous or even unintelligible, nay nonsensical.

Again, it was not by accident that Plato built up his complicated doctrine of ideas: to find, and then to establish such a firm and unquestionable basic criterion, so that man will never again see himself in a turmoil, caused by futile hesitations about what is true and what is false. Everything could and even should be made a matter of question, except this very Criterion, the supreme measure of all other minor criteria, which are more or less liable to alteration. In this context therefore it has to be understood why Plato rejected resolutely Protagoras' assertion: "Man is the measure of everything."[60]

Now, since this 'Supreme Criterion' is declared to be 'dead', and consequently everything is left over to wild haphazard contingency, all the age-old essential values, like the Hippocratic Oath (Orkos),[61] which as a lifesaving agent comes long before the physician himself and the drugs prescribed by him, lose totally their significance.

If we accept values — as we should — as the lasting products of the human being as a whole, for 'regulating' his 'field of activity', then in the light of the foregoing argumentations we can conclude that contemporary man has fallen into a 'valueless sphere'. Herewith the human being stands now in a total contradiction to the living nature, where every organism finds itself surrounded by certain, at least physico-chemical 'boundary conditions'.

As Biology becomes more and more an autonomous field of research, there arises a glimpse of hope that we will get closer towards some reasonable solutions to this crisis.

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Appendix

PHILOSOPHY OF BIOLOGY

THEORETICAL BIOLOGY

EPISTEMOLOGY OF BIOLOGY

— Description,
— Explanation,
— Definition,
— Hypothesis,
— Law,
— Model,
— Theory,
— Principle.

in Biosciences as

— Biochemistry,
— Biophysics,
— Morphology,
— General physiology,
— Systematics,
— Taxonomy,
— Genetics,
— Embryology,
— Evolution,
— Ecology,
— Ethology,
— Sociobiology,

BIOMATHEMATICS

HISTORY OF BIOLOGY IN GENERAL

HISTORY OF BIOSCIENCES

— Biology in general,
— Botanics,
— Zoology,
— Systematics,
— Medicine,
— Physiology,
— Morphology,
— Biochemistry,
— Cytology,
— Embryology,
— Genetics.

HISTORY OF BIOPHILOSOPHY

HISTORY OF METABIOLOGY

— Animism,
— Mechanism,
(physicalism
and reductionism),
— Vitalism,
— Panpsychism,
— Finalism,
—Evolutionism,
—System theory,
— Organicism,
— Holism.

HISTORY OF PARABIOLOGY

World views and ideologies influenced by metabiological theories or doctrines.

BIOETHICS

MEDICAL DEONTOLOGY
SOCIOBIOLOGY
ETHOLOGY
ECOLOGY

Table 1: Various Branches of the Main Disciplines belonging to the Philosophy of Biology.

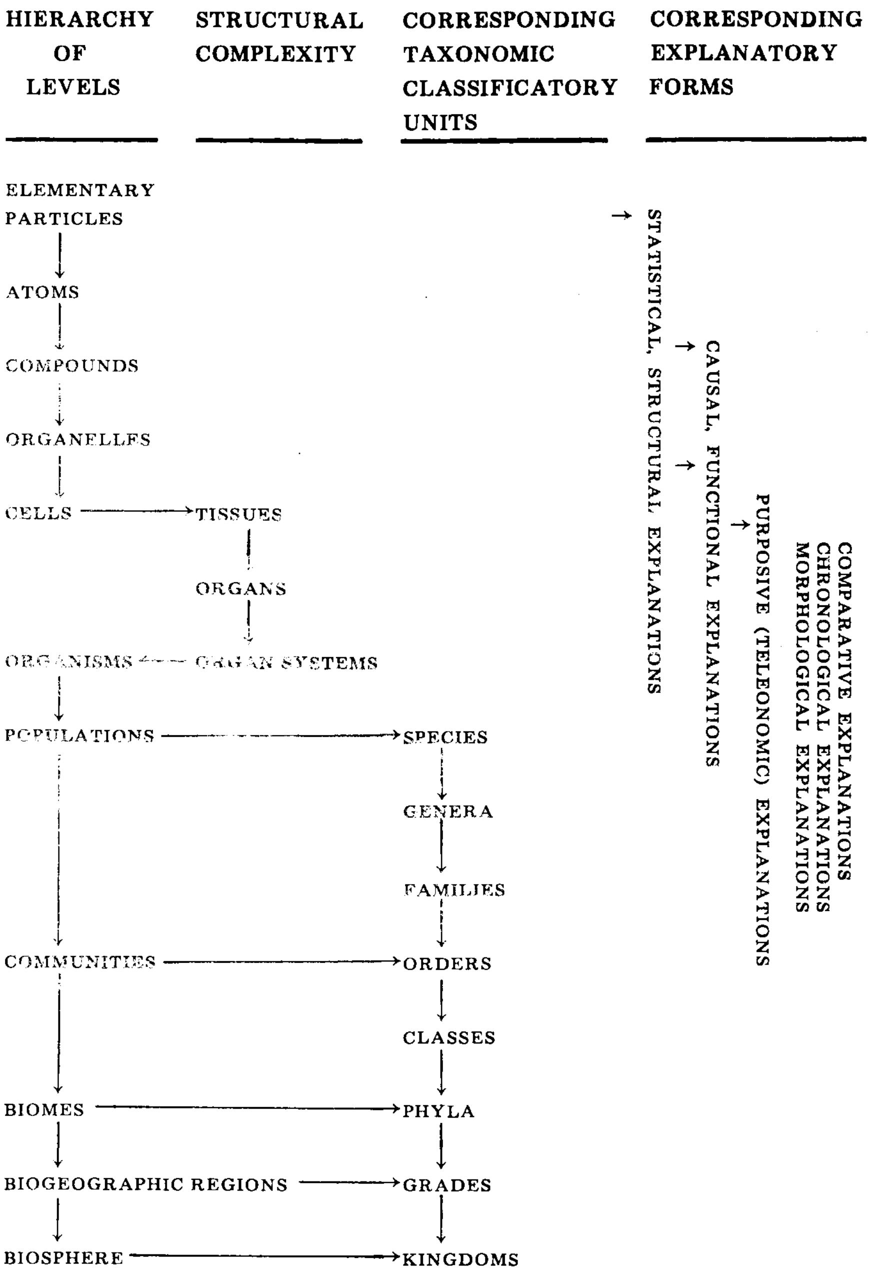

Table 2: The Hierarchy of Entities and their Corresponding Explanatory Forms

		HUMANITIES		
		SOCIOBIOLOGY		
	GEOGRAPHY		PSYCHOLOGY	
	BIOGEOGRAPHY	PHYSIOLOGY, MORPHOLOGY	ETHOLOGY	
PALEONTOLOGY	EVOLUTION	EMBRYOLOGY, GENETICS, BIOPHYSICS BIOCHEMISTRY	SYSTEMATICS, TAXONOMY	ECOLOGY
Earth Sciences	History	Physico-chemical Sciences	Logic	Climatology, Meteorology, Oceanography.

Table 3: Biosciences and the ones adjacent to them.

REFERENCES

1. See: Immanuel Kant: "Critique of Pure Reason" (B663).
2. Nermi Uygur, "Das Problem der 'Ergründung' in der Philosophie" in "Zeitschrift für philosophische Forschung", p. 286.
3. See: Immanuel Kant, "Critique of Pure Reason" (B352).
4. Ludwig von Bertalanffy, "An Introduction to Theoretical Biology," p. 5.
5. Metin Bara and Arthur W. Galston, "Experimental Modification of Pigment Content and Phototropic Sensitivity in Excised Avena Coleoptiles" in "Physiologia Plantarum", p. 109.
6. Cf: Francisco J. Ayala, "The Autonomy of Biology as a Natural Science" in "Biology, History and Natural Philosophy", p. 1.
7. See: W.J. van der Steen, "Inleiding tot de Wijsbegeerte van Biologie," p. 84.
8. Carl G. Hempel, "Explanation and Prediction by Covering Law" in 'Philosophy of Science", vol. I, pp. 108 and 109.
9. Carl G. Hempel, *Loc. cit.,* p. 110.
10. Ernest Baldwin, "The Nature of Biochemistry", p. 96, the italics have been inserted by me.
11. Aristotle, "Parts of Animals" (639b/15—25) — throughout the passage, excerpted from Aristotle's work, I have used capital letters and italics whereever I thought it was necessary to emphasize.
12. See: Marjorie Grene, "The Understanding of Nature", p. 77.
13. Carl G. Hempel, *Loc. cit.*, pp. 113 and 114.
14. Ernest Nagel, "Teleological Explanations and Teleological Systems" in "Readings in the Philosophy of Science", pp. 107 and 108.
15. Cf: Ernest Nagel's term, "Condition of derivability".
16. Francisco J. Ayala, "The Autonomy of Biology as a Natural Science" pp. 3 and 4.
17. Ludwig von Bertalanffy, "General System Theory", p. 98.
18. Jacques Monod, "Le Hasard et la Nécessité", pp. 59 and 60 — the term Teleonomy was coined in opposition to *teleology* analogously with the contrary pair of astronomy — astrology.
19. Every living being, according to Ludwig von Bertalanffy, is essentially an *open system.* "It maintains itself in a continuous inflow and outflow, a building up and breaking down of components, never being, so

long as it is alive, in a state of chemical and thermodynamic equilibrium but maintained in a so-called steady state which is distinct from the latter. This is the very essence of that fundamental phenomenon of life which is called metabolism, the chemical processes within living cells" — Ludwig von Bertalanffy, "General System Theory", p. 38.

20. Nicholas Rescher, "Scientific Explanation", p. 67.
21. According to the local category on which a systematic or taxonomic theory depends, five main classificatory trends can be distinguished:

    (1) Essentialism: from Aristotle up to Carl von Linnaeus; (2) Nominalism: Middle Ages; (3) Empiricism: mainly from the XVth century onwards; (4) Cladism: modern; (5) Evolutionary classification: modern; Cf: Ernst Mayr, "Principles of Systematic Zoology", p. 65.
22. Genetical explanation has nothing to do in particular with genetics. Refer for further details, W.J. van der Steen, "Inleiding tot de Wijsbegeerte van Biologie", p. 94.
23. See: J. Lever, "Geintegreerde Biologie", p. 162.
24. See: Bernhard Rensch: "Polynomistic Determination of Biological Processes in "Studies in the Philosophy of Biology", p. 251.
25. See: Bernhard Rensch, *Loc. cit.*, p. 245.
26. Ludwig von Bertalanffy, "An Introduction to Theoretical Biology", p. 5.
27. See: Ludwig von Bertalanffy, *Ibidem.*
28. Cf: Jacques Monod, *Loc. cit.*, p. 7.
29. We presume that mass is found all-over the universe. Thus our law of gravitation works everywhere; whereas it does not seem so likely that another planet exists where there is life. Consequently, a 'formal law concerning life' has, at least for the time being, to content itself with a worldwide validity instead of a universal one.
30. Nicholas Rashevsky, "Mathematical Biophysics", vol. I, p. 10.
31. See: Nicholas Rashevsky, *op. cit.*, vol. II, p. 326.
32. See: Nicholas Rashevsky, "A Unified Approach to Physics, Biology and Sociology", in "Foundations of Mathematical Biology", vol. III, p. 178.
33. Cf: p. 13 of the present treatise.
34. W.J. van der Steen, *op. cit.*, p. 87.
35. See: David L. Hull, "What Philosophy of Biology is not?" in "Synthese" p. 173.
36. See: David L. Hull, *Ibidem.*

37. See: David L. Hull, *Ibidem.*
38. Cf: H.J. Vleeschauwer, "Di Alcune Anomalie Nella Storia della Filosofia Greca", p. 29.
39. Ludwig von Bertalanffy, "The Model of Open Systems: Beyond Molecular Biology" in "Biology, History and Natural History", pp. 17 and 18.
40. The term 'biophilosophy' has been taken from the title of Bernhard Rensch's book, "Biophilosophie".
41. Cf: ". . . let us consider that God created us as an engine, which has been constituted by a huge amount of bones, muscles, nerves, arteries and all other parts. Every animal body is incomparably better arranged and possesses a capacity of self-movement much more admirable than man made automats and mobile machines. . .", René Descartes, "Discours de la Methode" (V), p. 64.
42. Cf: "God. . . has nothing of the already made; He is unceasing life, activity, freedom. Creation, so conceived, is not a mystery. . . That new things can join things already existing is absurd, no doubt, since the *thing* results from a solidifiaction performed by our understanding. . . (262) . . . So that all life, animal and vegetable, seems in its essence like an effort to accumulate energy and then to let it flow into flexible channels, changeable in shape, at the end of which it will accomplish infinitely varied kinds of work. That is what the *vital impetus* (élan vital), passing through matter, would fain do all at once", p. 267, Henri Bergson, "Creative Evolution".
43. See: Abu Ali Ibn Sina (Avicenna), "Metaphysics" (54), p. 100.
44. Cf: Immanuel Kant, "Critique of Pure Reason" (B578).
45. Cf: "For the purpose of keeping strictly within its own bounds physics entirely ignores the question whether physical ends are ends *designedly* or *undesignedly*. To deal with that question would be to meddle in the affairs of others — namely, in what is the business of metaphysics. Suffice it that there are objects whose one and only *explanation* (erklärbar) is on natural laws that we are unable to conceive otherwise than by adopting the idea of ends as principle, objects which, in their intrinsic form, and with nothing more in view than their internal relations, are *cognizable* (erkennbar) in this way alone. It is true that in teleology we speak of nature as if its finality were a thing of design (absichtlich). But to avoid all suspicion of presuming in the slightest to mix up with sources of knowledge something that has no place in physics at all, namely a supernatural cause, we refer to design in such a way that, in the same breath, we attribute this design to nature that is to matter. Here no room is left

for misinterpretation, since, obviously, no one would ascribe design, in the proper sense of the term, to a lifeless material. Hence our real intention is to indicate that the word design, as here used, only signifies a principle of the reflective, and not of the determinant, judgement, and consequently is not meant to introduce any special ground of causality, but only to assist the employment of reason by supplementing investigation on mechanistical laws by the addition of another method of investigation, so as to make up for the inadequacy of the former even as a method of empirical research that has for its object all particular laws of nature. . ." (68/383—384), Immanuel Kant, "Critique of Judgement".

46. Cf: ". . .the mechanism of nature is not sufficient to enable us to conceive the possibility of an organized being, but that in its root origin it must be subordinated to a cause acting by design — or, at least, that the type of our cognitive faculty is such that we must conceive it to be so subordinated. But just as little can the mere teleological source of a being of this kind enable us to consider and to estimate it as at once an end and a product of nature. . . The possibility of such a union of two completely different types of causality, namely that of nature in its universal conformity to law and that of an idea which restricts nature to a particular form of which nature, as nature is in no way the source, is something which our reason does not comprehend" (81/422), Immanuel Kant, "Critique of Judgement".
47. See: Immanuel Kant, "Critique of Judgement" (81/422).
48. Immanuel Kant, "Critique of Pure Reason" (B358).
49. Max Hartmann emphasizes the point, already mentioned by Immanuel Kant in his First Critique (B198), that "natural science is the rationalization of the world of phenomena. Were there nothing rationalizable in nature, natural science could not be formed", Max Hartmann, "Gesammelte Vorträge und Aufsätze" vol. II, p. 122.
50. Cf: Immanuel Kant, "Critique of Pure Reason" (B663).
51. Felix Mainx, "Foundations of Biology" in "International Encyclopedia of Unified Science", vol. I, part 2, p. 627.
52. See: Felix Mainx, *Loc. cit.*, p. 651.
53. Cf: p. 27 of this treatise in connexion with Kant's assumption about the biological basis of the human intellectual powers.
54. Cf: Eusebio Castro, "José Ortega y Gasset; su Influencia. . ." in "Revista Mexicana de Filosofía", p. 62.

55. Cf: Julián Marías, "Ortega y su Filosofía de la Razon Vital" in "Historia de la Filosofía", p. 435.
56. Konrad Lorenz, "The Enmity Between Generations" in "The Place of Value in a World of Facts", p. 388.
57. Cf: Aristotle's term describing the human being as a "zōon politikon", ref: "Historia Animalium" (488a/10).
58. Conrad Hal Waddington, "The Importance of Biological Ways of Thought" in "The Place of Value in a World of Facts", p. 99.
59. Jacques Monod, "On Values in the Age of Science" in "The Place of Value in a World of Facts", p. 24.
60. Platon, "Théétète" (170c).
61. See: "Hippocratic Collection", p. 298.

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