Philosophy Study, January 2022, Vol. 12, No. 1, 18-25
doi: 10.17265/2159-5313/2022.01.002

The Biomathematics Is a Borderland Science

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In the latter decades, biomathematics played an important role in life sciences. Today, a great variety of biomathematical methods are applied in biology and medicine. Practically every mathematical procedure that is useful in physics, chemistry, engineering, and economics has also found an important application in the life sciences. At present, many life scientists are really interested in going deeply into biomathematics. Any attempt to apply biomathematics to the life systems involves three stages. Firstly, we observe the phenomena and formulate a biomathematical description in the form of a differential equation, algebraic equation, statistic comparison or whatever. We then temporarily forget the real life system and use biomathematical reasoning to solve the equation. This stage may involve inventing new biomathematics or extending what exists. Finally, we return to the real life system and interpret this solution in terms of reality; this interpretation may require experimental testing. Commonly, the most difficult stage is the first one; this is certainly so in biology and medicine at present we hardly know enough about the "laws" governing the components of life systems to write down their appropriate relationships with confidence.

Keywords: borderland science, axiomatisation, mathematics, biplogy, biomathematical modeling

Introduction

In the world of the scholars of the non-satisfactorily mathematical sciences, it is a wide-spread view that mathematics has reached much farther, incomparably, on the way of thinking than biology why mathematical formulae do not depict Nature as such but they reflect our knowledge on Nature in a particular way. Our biological experiences, however, qualify us to make the assumption that Nature realizes the mathematically thinkable simplest solutions (Bertalanffy, 1968).

Biomathematics is not else than an endeavour to sum up the quantitative correlations during studying life in the possible strictest interrelation system. To do this, there is a need for introducing suitably closed, exhaustively apprehend able, abstract, and apt for mathematisation concepts which result in the substitution of life during the investigation of the features of different organisms (Boulding, 1956). Obviously, that attractive intention guides us that evolution of the Universe is observable at each given point and time in its relationships, and that the development is grasped not outwardly and as a succession of static scenes but inwardly, in its ever-changing tendency. In brief, we wish to make the dynamic and continuous character of the motion of structure and function visible in the biological phenomena (Goldsmith & Lewis, 2000). However, this implies that life becomes a fundamental idea in modern biomathematics which has no definition at all.

Twenty-five centuries ago, the development of sciences shows that human has purported that they tended to describe the phenomena, the processes, and the structures in the most exact and realistic way. We may state

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that Nature is coming to understand itself in its “human-like face”.

In a word, the tendency to progress toward the exactness has prevailed; although very frequently, this trend foundered from time to time in the labyrinth of amateurishness of naive morphological way of looking and concealed simplification (Morton, 1966). Evolutionary, inductive tendencies of the natural sciences exited their polarizing effects in direct proportion with the increase of the volume of the lexical knowledge against the superficial definitions.

Inflexibility was driven by the narrow-mindedness and specialist-political structure or system and, so to speak, the crystal-stiffened attitudes came into antagonism with the fruitful evaluation contemplating bearings at large as well.

Axiomatisation

Obviously, circumscription of exactness is not really a simple thing, but it became a more rational concept depending on the fashion and the time-spirit as well as the changing common opinion. According to the *Hungarian Hand-Dictionary of Definitions*, a concept is exact if it is accurate and it can be defined exactly and unequivocally. However, according to the *Oxford Dictionary of Definitions*, a field of science is exact if one may suppose that it is absolutely precise. An exact science is such that based on the exact laws, it is able to, e.g., describe the later statement of its examined system the now and here assessed parameters. The following ascertainment is absolutely exact: Across two points, one and only one strait line can be drawn. Relatively exact is a two-dimensional snap-shot taken on a three-dimensional object (Gánti, 1974).

If we think it over well, our statements are seldom absolutely exact ones. Our thoughts reflect the structure of relatively exact stories. To the relative exact statements, their development is characteristic (Bianchi, 1981). However, development is a typically historical concept. In this relation, it covers determination by the mental- and technical- level of the investigations for the characteristic graspable data of the system under investigation regarding the availability either of its concept or the exactness of the measurement of the defined characteristics (Guyton, 1971). This is the reason why we speak about approaches defined according to geocentric (Earth-bound), anthropormorphic (anthropocentric), evolutionostic or scientific level of developments or views.

In recent sense, axioms are regarded as absolute exact matters. The axiom is such a basic ascertainment from which we may start out to deduce all the statements of a certain scientific theory, but they are not verified by the theory itself and they cannot be ascribed to any of the known natural laws (Hull, 1988). From the axioms or axiom-systems, a theory can deduce each or all the laws of a branch of science. The axioms are not perpetual or “a priori” facts or they are not statements to be proven, but they are generalisations which come into being on the basis of substantial abstraction of the practical experiences of wide generalisations, therefore essentially they are results of observations and logical inductions (Deamer & Fleischaker, 1994).

The correctness of axioms is justified subsequently by the practise in that way that the conclusions deduced from them agree with the experiences according to the corresponding degree of precision of the development of science and technology. But the correctness of the axioms is also relative as all scientific observations are and they reflect reality with the accuracy corresponding to the degree of a given historical development (Eigen & Schuster, 1979). Therefore, in this, there is the particular historical change of the absolute exactness. The axioms are absolute exact things because they are abstracted from Nature, they are conceptual constructions, and as such they are unchangeable by definition. But in another period or in another connection-system, the accepted axioms are already examples of another, e.g., more correct, more embracing, therefore they are better reflecting reality by the former remarks/theoretical construction and they are again stiffened ones (Clark, 1981).

Certain branches of mathematics are built upon a few axioms and other statements; theses are deduced from these ones. It is customary to say that thermodynamics can be built upon the basis of three axioms. In chemistry, there are only attempts, e.g., Thermodynamics and Quantumdynamic Heuristic Concept of the True Driving Force and Uniformity of the Rate of Bond Rearrangements in Chemical Reactions (catalyzed or non-catalyzed) but already rather analytical, inductive character is dominating. Unfortunately, in biology, we do not know any axiom-system either (Matthews & Meck, 2016).

An axiom-system has to fulfil three conditions according to the laws of logics: lack of contradiction, independency, and fullness. An axiom-system lacks contradiction if an axiom is not suitable for ascertaining a statement and for the opposite of it as well.

In working out an axiom-system, we must tend to keep the axioms independent of each other, i.e., in the particular axiom-system, there should be no superfluous axioms which could be derived from each other/representing each other's combinations (Cleri, 2016).

However, such axiom-systems which are strong enough to carry on meaningful methodological investigations in them cannot be complete; this is the famous Gödel-thesis. The same Gödel-thesis points out the natural limit of a given axiomatic method that all the axioms of a given science cannot be fixed once for all but to solve certain problems newer axioms must be abstracted. This latter circumstance refers to the fact that a given axiom-system is a historical category, as it was viewed above, and it would be a boldness to state that even a very thin group of phenomena could ever be discussed exhaustively with finite number connections (Harvell, 2015).

Mathematics is not else just the science of accurate way of thinking. The mathematical declarations should be fully precise. If they are not precise, then they have no meanings. Nevertheless, mathematics wishes to eliminate ambiguity. It can achieve elimination—but against it, the easiness of communication will be lost. This explains that for the outsiders, the mathematical language barrier shows up immediately as the most frightening character. Mathematics is the most exact science, therefore, such an approach is the most idealistic. In this respect, biology stands farther from mathematics than physics or chemistry. For this reason, the position of biomathematics is also more disadvantageous (Sarson & Cobelli, 2014). This, however, has its own partly historical and partly objective characteristic causes.

In physics (and in astronomy), the situation had developed first to concept-formatting of those few factors which made possible description of the systems at a desired accuracy and by these recognitions, the mathematical formal-language was worked out (Vincze & Vincze-Tiszay, 2021a). The characteristics of the chemical processes are also numerous even in the case of the simplest system as well and on the top of this, the transformations (reactions) are fast and many directional. These are the reasons why it should be waiting for the mathematisation till the 18th and 19th centuries. As to the topic of biology, not even in the case of the simplest system as well and on the top of this, the transformations (reactions) are fast and many directional. These are the reasons why it should be waiting for the topic of biology, not even the entire biosphere is complex but already the most primitive living being is more complicated than the Solar System itself or the oxygen atom. This is the reason why mathematisation of the biological special branches are making their first steps in spite of the most developed mathematical arsenal at hand in the 20th century (Vincze, 2007).

It was worth to investigate the relations with the collision of the possibilities of mathematical axiomatisation and biological mathematisation, obviously using definite axiomatisation (Gánti, 2003).

Criticism and Self-criticism

By comparing the Euclidian geometry with the Aristotelian living world concept, which latter is only a culture-historical curiosity according to the modern scientific criticism, therefore a heap of unscientific observations show that a gap has separated mathematics and biology as a large unpenetrable trench between them throughout centuries. In fact, sorry to say, but the way of viewing the phenomena also mutually excluded each other and we may be seldom meeting a specialist even now who purposefully keeps trying to fight for connecting them together (Eigen, 1971).

In this direction, isolated experimentations have been made already in the 19th century. One of the greatest representatives of this field of science was the Belgian Quetelet who applied statistics in anthropology, besides this in meteorology and in plant physiology. Cavarrets works remarked the summit who, following Poisson, worked out the theory of distribution of discrete probabilities (Levin, 1974). It was a notable use of it when investigating the probability of birth rates of boys and girls born in or out of wedlock and he found significant differences. Biological application of mathematical statistics was first used by Galton in 1901.

We may observe that the development of the theory of statistics was relatively fast followed by its use in the fields of more exact sciences (astrology, geodesy, and physics), but its development was much slower in biology in the medicinal and agro sciences where only seldom could be found accessible representative materials (Crick, 1981). The most important cause of this resides in the fact that it was incomparably easier to establish identity of the circumstances in physics (astronomy) or in chemistry than in the biosciences dealing with the living beings (Cartwright, 1983).

Below we list the ordinary arguments attacking mathematics and biology.

Attacking Arguments

Mathematics

1. The famous Cambridge toast says: “I raise my glass to the pure mathematics and to it never being useful for anyone for anything”. Sorry to say that most of the vast majority of the special mathematical articles cannot be useful elsewhere than in mathematics itself, till our days.

2. Mathematics abstracts from the nature of elements. What is the meaning of the following statements? Two hearts + two hearts are equal to four hearts? What does it mean: living organism to the power? In other words, the simplest mathematical operations lose their meanings.

3. In mathematics, those methods are lacking which could make possible elucidation of the data gained from the observations and the related experiments.

4. Mathematicians engender their newer theses of their peculiar logical systems by cutting themselves from the world, but they never raise such questions like: Why? Where? When? How?

5. We must agree with Tibor Gánti (1974): “the day-to-day experience from curing to environmental protection, from animal- and plant- breeding and fighting pests, one faces everywhere the fact that it is impossible to predict the response of a given biological system as such either qualitatively or quantitatively” (p. 28). To this problem, neither mathematics nor the biological sciences are able to give correct answers unequivocally at the level of the living organisms.

6. In applied mathematics, models are set up but those cannot be used for the concrete living systems for the investigations of the processes taking place in them.

7. The great setback of the mathematical methods is that the changing and developing phenomena are stiffened in static formulae and perhaps they are able to reflect certain grasped momentary situation by isolating them from their dynamic and dialectic entireness (Vincze, 1984).

Biology

1. Even nowadays, we may read from foolish biologists similar statements that follow: Up till now, the mathematical methods did not bring essential results for biology, it could not happen to be simply just because, by using the common sense, these are "foreign bodies regarding their relations to the mobility and complexity of the biological systems". Unfortunately, this opinion suggests equivalency with the negation of quantitative interrelationships at the level of the organism of the living matter.

2. In biology, observation dominates this however, subject dependent, therefore, it is possible to raise to law levels the Aristotelian nonsenses.

3. In biology, reduction to a common basis two identical types of experiments is impossible because the deviations are so large that the basis of lawfulness itself is being lost.

4. The biologists and physicians describe certain phenomena, but the score of the individual values is so large that lawfulness relations cannot be discovered.

5. Scientists studying living organisms reduce quantitative relationships to statistical evaluation. They use equivalence that marks between elementary statistics and mathematical sciences (Ganti, 2003).

6. By turning over the pages of the biological periodicals, we may experience that biology has not been able to clarify such basic concepts like life, death, species heredity, etc. From all, these difficult contradictions will be derived.

It is probable that both mathematicians and biologists will grow angry with me by reading the above rows. But the relative truth is this: They accuse each other in their papers and only very seldom take up polemics, just because they mutually do not read their articles, published by the specialists of the other branch of sciences (Vincze & Vincze-Tiszay, 2019).

Necessity and Usefulness

It would not be unprincipled or acceptable standpoint to raise only critical remarks, but we deem it necessary to list by the double slip system to draw in outline arguments to supporting both branches of sciences (Vincze & Vincze-Tiszay, 2021a). The slips are reversed purposefully.

Biology

1. Biology as a theme of research is in exceedingly close contact with Nature as being a kind of natural science; it studies the living world itself.

2. Agro sciences—as special branches of biology—essentially contribute to the support of the human society regarding its results.

3. Medicine—as a sector of biology—during its development—became a powerful tool of increasing human well-being and life span.

4. Researches in biological sciences require international collaboration (organ transplantations, AIDS program, epidemics); therefore, they may have become firm pledge of these international relations.

5. The biological special publications are unambiguous; therefore, serious, substantial financial supports can be got for the researches from state and private shares.

6. Biological researches open up miracles of Nature brought about in billions of years and these are profitably used by humanity within a few decades (or they can be wasted quickly).

7. Biological view of development and variability of life forecasts symbiosis of biological and technical development in the epoch of scientific-technological revolution (Vincze & Vincze-Tiszay, 2021b).

The reason is that the laws of other studied disciplines which define life in a decisive manner can be distinguished, collated and integrated with those of biology (social energy demand and ecological relations).

Mathematics

1. The character of the mathematical methods is the absolute precisely and the exactness is achieved by abstracting from the eventuality of the concrete substantial quality (out of one apple or one horse, it abstracts the unit, while biology will study the apple and the horse).

2. The nature of operations and the results of the solutions of equations are independent of space, time and the human subjectivity. In this way, it develops—with some exaggeration—a “super-human” or rather an “independent of human eventualities” science (passion, emotion-charged argumentation), therefore an objective method of thinking.

3. By describing the quantitative interrelationships, mathematics becomes the common language of sciences. In this connection, we refer not only the services done for the natural sciences but also for those of the social sciences as well.

4. Mathematical symbolics is used internationally and this interdependence is an excellent example, although it is only a formal sign of internationalism and general humanism residing in the nature of mathematics.

5. The mathematical special publications do not grow absolutely, but their subjects are incorporated into newer results as particular cases of the general themes.

6. Maturation of the results of mathematical researches resulted in such possibilities like appearance of computer machines and by this qualitative burst a revolutionary development came about in the human society. This sets free human mind from the working of long calculations. At the same time, the calculation robots can work out scientific models in a large scale manner and in a long run with suitable programs (Human data recording with computers threatens with social dangers besides its advantages).

7. Mathematisation of physics and astronomy makes recognizable natural definiteness of the living matter, even that mathematics is a manifestation of the highest organisational and developmental substance, the function of the brain, that of the intelligence (Vincze & Vincze-Tiszay, 2020).

Alpha-, Beta- and Gamma Categories to Arrange Biologists?

We have been investigating the two branches of sciences, mathematics and biology, because these developed self-reliantly of each other on the whole. It is important to clearly record the fact: Biology is one of the natural sciences. Mathematics is not kept as natural science but the science of logical, quantitative science of thinking that as such deals not only with the approximation pictures of mathematical models of the existing world but also with its own “world of imagination”, with its constructions at will, although it is a regular ones that not necessarily correspond somehow predestinate to the elements of the existing world.

Nevertheless, mathematics serves excellently as “the language of Nature” (G. Galilei) and for the service rendered the natural science problems to be served generate dynamic developments. Hereinafter we are watching at biomathematics as a border-science.

The initial, relatively fast development (it already has an independent periodical since the 30s) was followed by a coming to a sudden stillstand and opposing an expectation, a great stagnation could be observed. This can be attributed to many different facts:

1. The biological systems are extremely complex and the corresponding mathematical models and methods did not develop;

2. There is no self-reliant international biomathematical society and such symposia are held only very seldom; biomathematics is thought in university level education in almost every country only facultative; both mathematicians and biologists observe the initial failures, because they norm down biomathematics to biometry; there are very few biomathematical specialists who are actively working, their number is less by two orders of magnitudes than those researching in other border-sciences.

The question I wish to pose is this: Is there evidence that decision systems are physically realized in actual cases of biological interest? Can we find biological systems in which arbitrariness is not due to the particular epistemological approach of the observer, but is generated by the system itself?

In order to begin to explore such a query, we must first consider the hierarchical nature of biological (more generally, complex) systems. Clearly the sequence: molecule — macromolecule — organelle — cell — tissue — organ — organism — population — etc., is a hierarchy in the usual sense of the word. We can choose to describe a biological system at any of these levels and, if we believe that such an observational and descriptive choice is entirely ours, the only task left is to establish ways of relating such descriptions to each other. To put it in other words, the existence and nature of levels is entirely arbitrary from the point of view of the system and depends exclusively on the observer.

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