BIOS AND THE PHYSICS OF LIGHT

Professor Andrei Rubin
Head, Department of Biophysics
Faculty of Biology, Moscow State University
Russia

This paper will touch upon the question of the interaction between physico-chemical biology and biopolicy. As with other experimental sciences, the problem is that our applied discipline, biophysics, has to find its own place in biopolicy. I hope to show what the correlation is between the separate branches of biopolicy and biology.

What is bios? Bios is every living thing surrounding us. It is life itself. The subject of biology concerns the various forms of life - Biology is bios. As a science, biology developed into different biological areas to be studied, but their variety is naturally greater than the areas themselves. As a result of such interactions, a logical, biopolitics theory was formed. This interaction also includes other natural sciences, as well as the humanities.

Biopolicy exists on two levels. The first, an elementary one, is biopolicy carried out through education. Let us take an analogy from driving. To drive a car, we need to know and observe traffic regulations. Roughly speaking, we must observe the same rules, as far as environmental protection is concerned: do not pollute the environment, do not pollute the atmosphere, take care of your health, etc. These rules are supplied with certain instructions and we generally observe them, however, without always understanding the possible negative effects if we fail to do so. These are the rules of good social conduct in ecology; a well-bred person would behave in a similar fashion.

The second level consists of an already formed ideology. Someone once asked whether the thought had ever occurred to me that by killing a fly we not only kill a harmful insect, but destroy an individual, a highly-organised system, which lives according to its own laws. This is obviously superficial, but there is a grain of truth in it, as well. In fact, by asking this question we are forming an ideology. We should distinguish between forming an ideology and merely observing the rules of good social conduct regarding ecology. After an ideology has been formed, one proceeds from certain postulates, without discussing the questions of rationality or irrationality of this behaviour.

To compare this with religion: religion is a route to human perfection, but there are no specific paths to get there. The Ten Commandments ought to be observed but nothing is said about how to observe them. "Seek and you shall find." Seek self-perfection and you will find the way. There are no instructions on how to fulfil this. Why? Because this is a question of ideology and ideology is a most fragile thing. There are no algorithms here because, this is a question of forming a creative approach. If we knew the answer, it would be the end of creation; the whole concept would be reduced to a set of instructions and algorithms. The only thing we can be sure of is that, if our thoughts are busy looking for ways to form a new biocentric approach and, only if we take this task seriously, shall we find the way, shall we find the methods, shall we find the route to self-perfection.

First and foremost come the goal and the way of forming an ideology. These elements are already very important, because of the simple, utilitarian reason that during the thinking process, the cells of the brain, its grey matter, are involved in useful activity and will not be distracted with anything else. On one the hand, stimulation for a specific aim is carried on. On the other hand, the brain is busy and thinking of nothing else. Critical thinking is important when forming a biological policy.

As a result, we reach the second level. This level involves a complex understanding of what happens from the viewpoint of biological policy. When a biological theory originates, a concrete solution can be found and the elements used in this process include advanced technology, as well as various systems of environmental protection and natural science development. This is to be expected, since biology is not the only field for the application of formulae. This fact is well known in biophysics, since biophysics is a field which developed with the aid and interaction of other sciences, such as physics and mathematics. Literacy in these sciences is essential, in order to comprehend the functional organisation of biological systems.

Forming an ideology to work out the theory of bios, requires addressing the main point of biological science and asking ourselves the following question; are we ready to seek an integrated view of biosystems in conjunction with the theory of bios? If there was no biopolicy and no theory of bios, biology would still continue to develop. What new factor does biopolicy offer? What does it demand that we do? The answer lies in the creation of an integrated perspective, that includes elements of biology, but also extends beyond the limits of our narrow field and encompasses those of other sciences, as well. Are we ready? Have we achieved such an integrated view in biology, meaning, not only for biopolicy, but also for our specific biological problems? Unfortunately there is no such view, thus far. This reflects, not only our individual shortcomings, but also the problems associated with the growth of any science. I would like to illustrate this point by an example of a harmless and widely understood biological factor; the role of light in the vital activity of an organism. This will not be discussed in detail, but will be confined to the construction of a general scheme: Bios and Light.

The role of light in the origin of life is well known. Light is an energy source essential for creating the initial "bricks" of life: aminoacids, nucleotides and sugars. Light also creates the conditions for heterotrophic life in vitro, without the participation of biological systems. At this evolutionary stage, the role of light is most important. The second stage involves the emergence of photosynthesis when, with the aid of light, organic compounds are synthesised. Thus, from the moment of its origin, life exists under the conditions of a permanent interaction between light and biological systems. The set of photo-biological processes includes vision, phototaxis, photosynthesis, phototropism, UV-lesion, photo-morphogenesis and many others. However, are these processes studied by the biological sciences? Although highlights are included in biological curricula, there is still no individual course on the general theory of the effects of light upon bios. This is not because we do not understand that it is necessary; it is simply because, to this date, it has not been our goal.

The Chair of Biophysics at Moscow State University is, step by step, approaching this goal. In essence, a new concept of the "biological" role of light, in all its processes, is being developed. Will this lead to any new theoretical or practical results? The significance of forming an integrated approach to studying the interactions between light and biological systems is currently reflected in biotechnology: obtaining new food products, specific diagnoses of the effects of different perturbation factors, with reference to environmental pollution; new sources of energy, biosensors; bioelectronics, nanoelectronics; phototherapy in medicine; new informational processes; and the effects of electromagnetic waves in small doses, including ionising radiation.

How is it possible, however, from our view-point as specialists, to make use of such an integrated approach? It is possible, since all the photobiological processes are based on the interaction of light with macromolecules, as is the case in the mechanics of vision. In fact, this principle applies to all biological processes involving macromolecules, such as gated channels opening and closing, ADP function, and enzyme-substrate interactions through enzyme-substrate complexes. What can this approach offer? It can help elucidate the problem of recording phytoplankton states. The nature of fluorescent light, recorded with the aid of a special instrument developed by our department, allows us to assess the state of an object under specific conditions. On the one hand, we obtain numerical results. On the other hand, we obtain important information about the interaction of light with biological systems. Are we ready to implement such an integrated approach in all fields of biology? Perhaps not. It is not because we fail to understand the importance of this approach but, because we find ourselves facing the enormous task of having all organisms, at every level of organisation, be the object of this investigation.

Bios, as a definition of diversity, is the object of applied biology. Biology studies the diversity of the bio-organic world and the variety of living nature. There is no need to prove how true this is. The concept of bios is synonymous with diversity. This concept is added to the biochemical concept, or the concept of the molecular-biological unity of all living things. Diversity is based on different variations of these united, fundamental principles, which underlie biological organisation. Nature takes finished "bricks," puts them together, and the result is all the diversity which we see. Basically, nature does not take its own course to invent new ways nor new fundamental laws. As yet, the significance of this principle has not been realised. Elementary biological processes are much more similar to inanimate nature than it might seem. Naturally, there is a scientific basis which allows the formation of a general theory of bios. Is the interaction of a living system with the environment assessed? Precedence is given to an influence which finds a biological target.

A typical example is radiation. From the viewpoint of strength of influence, radiation is small, but its effect is huge. The mechanism lies in changes which arise as chain reactions in the system. The system does not respond to the specific character of the influence but rather to its own inner organisation. Bio-informational processes are another example of this kind of biological information sense and their importance lies in the changes within the system that result from the reception of this information. This is the semantic sense of biological information. The effect of low doses of electromagnetic radiation is based on this definition. All applications are based on general principles, which should be the object of study of experimental physico-chemical biology in order to understand the different levels of the organisation of living things,. To have these processes, as an objective, would create the basis for natural-scientific unity and help formulate the bios theory. Moreover, what we hope to achieve is a clear ideology, stemming from biological processes which we can already measure, which enables us to plan our methodology without questioning the basic, underlying ideology.

In conclusion, I would like to cite a half-comic example which illustrates the difference between the first and the second levels of cognition. An educational level is merely an instruction act on how to protect the environment and avert the destruction of humanity, according to pragmatic criteria. The second level, that we act on instinctively, is ideology. For example, a gentleman mistakes his hotel room and finds himself in a bathroom where a lady is taking a shower. What is the reaction to this by someone who is a gentleman only by upbringing? He says: "Oh, I beg your pardon, Madam," closes the door and leaves. And what is the reaction of a gentleman by birth? According to our second definition of formed ideology, he says: "Oh, I beg your pardon, Sir." And he also closes the door. That is the difference. Although our task is to form gentlemen by birth, a gentleman by upbringing is a necessary first stage in the process.

Professor Andrei Rubin has been Head of the Chair of Biophysics at Moscow State University, since 1976. Before that he was Head of the

Space Biology Laboratory in the same faculty. He is Head of the Scientific Council on Biophysics of the Russian Academy of Science, and a member of the RAS Council on Space Biology and Biological membranes, and Chairman of the Special Commission on the higher Biophysical Education and Biophysics Development at IUPAB. He received the USSR State Award for notable achievements in photosynthetic research (1980) and the Lomonosov Award for his biophysics textbook (1992).