PROGRESS OF BIOLOGICAL SCIENCES AND THE FUTURE OF BIOS

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All living organisms are the result of the interaction between theirgenetic material and the particular environment in which they live. Attemptsby man to alter living organisms to his benefit started very early - farmingand breeding, for example, but efforts to change an organism could, intheory, be directed towards either the genetic materials or the environment.

Up to now we could intervene only in the environment. Genetic materialwas beyond our reach. The advances of biology in the last 40 years give us,for the first time, the possibility to intervene directly in geneticmaterial. This newly-acquired power has created many questions andanxieties. People are afraid that knowledge exceeds wisdom, and that thiscurrent knowledge may be a threat to our survival.

What are the consequences of this knowledge regarding the nature ofgenetic material and the ability to intervene directly?

PHILOSOPHICAL CONSEQUENCES

As a result of the progress in molecular biology, our thinking aboutthe place of man in nature has changed significantly. We realize that weare part of a continuum and not something unique in terms of livingmaterial. We are the product of a long evolution together with all theother living organisms. Our uniqueness, which is real, is the result of theparticular organization of the living material. As a result of the progressin biology, we now have a better insight into human nature. Until recently,we were under the influence of the ancient Greek philosophers' thinking thatthere is a perfect prototype of man, and every deviation from it is adefect. We now realize that there is no "typical" living organism, everyorganism is unique and the success of life on Earth is based on thispolymorphism. For example, there is no typical representative member of arace. The definition of "race" is only statistical with a large over-lappingbetween the races. So the term "race" has no meaningful application toindividuals. This realization has profound social implications.

TECHNOLOGICAL CONSEQUENCES

The technological applications of modern biology are usually includedin what is called biotechnology. Although it is not a recent invention,biotechnology is probably the most ancient technological endeavor of man; Iuse this term in referring to applications of modern biological knowledge.The following is a list of areas in which biotechnology has foundsignificant applications:

Medicine

The ability to "read" genetic material and detect the presence ofabnormal genes responsible for genetic diseases has already made possiblethe prenatal diagnosis of many severe genetic disorders like thalassemia,hemophilia, sickle cell anemia etc.. However, we have also begun obtaininginformation about genes giving predisposition to certain common diseaseslike atherosclerosis, diabetes, and some forms of cancer. Thesepossibilities have led to the establishment of a new field of medicinecalled Predictive Medicine, which requires a new ethical framework.

The replacement of abnormal genes with corresponding normal ones hasnot yet been attempted in a clinical setting, but it is only a matter oftime. This genetic therapy has created much discussion andcontroversy. If gene replacement concerns somatic cells, the procedurefalls within the frame of traditional medicine and is not different, from anethical point of view, from organ transplantation. On the other hand,replacement of genes in the germ cells (egg and sperm) creates so manymoral and biological problems that no one supports its use.

As with any new procedure, even therapeutic gene replacement in somaticcells may have unknown risks. The risk-benefit analysis has many unknowns.Even the meaning of risk and benefit cannot be clearly defined. Forexample, the risk-benefit ratio is very different for the patient than formembers of the ethical committee which must approve a new procedure. Forthe members of this committee there is only risk to their reputation in caseof failure; while there is no benefit in the case of success. Therefore,they usually turn down any proposal for clinical application of genetictherapy.

Pharmaceutical Industry

There are almost unlimited possibilities for easy and inexpensiveproduction of biologically active substances like hormones and growthfactors which would be unavailable without new technology. It is also nowpossible to "design" drugs based on the detailed knowledge of thestructure

of the target cell component. Another area is the production ofsafe vaccines which will be composed of the immunogenic part of the moleculewithout the toxic component.

An altogether new approach to the production of biological substancesof medical importance is the use of transgenic animals as bio-factories.For example, sheep in which the human genes for clotting factors have beentransplanted will excrete these factors in their milk.

Agriculture

The applications here include the creation of frost, pest and disease-resistant plants. The creation of animals and plants with enhancednutritional value, the transfer of machinery for nitrogen fixation to commoncrops or their symbiotic parasites, will thus eliminate the need forfertilizers and chemicals.

Waste Treatment

There already exists patented micro-organisms created by the technologyof recombinant DNA, which are able to decompose waste products and oilspills.

Chemical Industry

The use of biological processes for the production of ethanol fromcellulose, or to enhance recovery of minerals.

Imitation of Biological Structures in Engineering

Although this is not a direct application of biotechnology, it is avery promising new area of engineering based directly on recent advances inbiology. The knowledge of the molecular structure of living matter isinfluencing engineers in designing new electronic devices.

The progress of biology in the last few decades is beginning to haveserious consequences in our society. Until now the discussions have focusedmainly on the biological effects of our interventions into the geneticmaterial. What is going to happen when we cross species barriers by mixingthe genetic material of different organisms? The biological problems due tobiotechnology are minor, or often, non-existent. Much more serious are thesocial consequences of biotechnological applications. The spreading ofpredictive medicine may lead to a form of biological determinism restrictingour freedom. Also, the economic consequences of biotechnology are difficultto predict, but will be significant.

I believe our newly-acquired knowledge and potential can be used toimprove our lives, but we must make wise use, and establish the appropriatemoral framework to balance the rights of individuals with those of society,so that society will not benefit at the cost of the individual.

Professor **George M. Maniatis** obtained his M.D. and Med.Sci. from the University of Athens Medical School, and a Ph.D. in biochemistry from M.I.T. A former Rector of the University of Patras and visiting Professor to M.I.T., he is presently the President of the Hellenic Society for Human Genetics, and Professor and Director of Biology at the University of Patras Medical School. He is a recipient of the "Medical Foundation Fellow", and the "J.T. Hirschl Career Scientist" awards.