A BIO-ETHICAL ASSESSMENT OF BIOTECHNOLOGY

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The term Biotechnology is used to describe all those scientific methodologies which utilise living organisms, or their components, in industrial processes, under carefully designed conditions. In a sense, Biotechnology is almost as old as human civilisation itself, since for thousands of years humans, have in practice, been using microbes in order to produce bread, cheese, wine, beer and other bio-products. Nevertheless, in the past two decades, the extremely rapid advance of biological sciences (especially molecular biology and genetics) has led to a remarkable improvement in the efficiency, speed and productivity of the biological systems, as a result of the manipulation and genetic programming of micro-organisms. When I was asked to present the point of view of a concerned biologist on Bioethics and Biotechnology (because of my position as elected President of the Panhellenic Association of Biologists), I found the opportunity quite challenging.

Biotechnology is considered the third major technological advance of humanity after the agricultural and industrial revolutions and, like them, it is expected to alter drastically the attitudes and values of human civilisation. Biotechnological achievements promise to solve most of the major problems of mankind, such as the quantity and quality of food, energy sources, protection of the environment, improvement of public health, etc. Usually based on brilliant scientific ideas, biotech solutions, to the previously mentioned problems, may be quite economical, as a result of reduced energy consumption and human effort. Indeed the greater effort occurs at the stage of basic research and the manipulation of microbial genetic material. After the scientific problem has been solved, the next stages, i.e. the proliferation of the genetically programmed microbe in large fermentation reactors and massive production of the desired bio-product, can be performed routinely and economically, in terms of energy and labour costs.

A few examples of biotechnological applications include:

- the production of large amounts of medicinal drugs such as insulin from microbial cultures
- the production of fuel chemicals, such as ethanol in bio-reactors
- the use of specialised mutant bacteria for the bio-treatment of toxic organic waste
- animal fertilisation technologies for use in animal improvement
- the production of genetically engineered plants with selected characteristics
- the application of molecular genetic techniques to the prevention of inherited disorders, by prenatal diagnosis and the potential development of routine gene therapy in the future

Despite all this, people's attitudes toward the technological applications of basic biological sciences, vary considerably. While there is a tendency toward excitement and euphoria among scientists, businessmen and economists, there is a prevalence of ignorance, or even phobia, among a large proportion of the general public. In many cases, fears are expressed about potential catastrophes: "if we continue to manage forces that are unknown to us, powers that, even if we could control them, we should not tamper with, we are playing God."

Questions, such as "should we play God and create new organisms?" or "should we introduce genes in humans, by gene therapy?" are about as relevant as arguments such as "aeroplanes are unnatural because humans were not meant to fly," or "we should not practise blood transfusions and organ transplants, introducing into a human body the cells of another person." Behind this superficial hysteria about all new scientific discoveries and advances, there are indeed substantial concerns, expressed by people who know a great deal about the potential hazards: the scientists themselves. It is worth noting that, unlike religion or politics, science is probably the only human discipline whose members question, or even criticise systematically, principles, ideas or practices almost immediately after they have been introduced.

The undeniable truth is that some biotechnological achievements, although promising, might be irreversible in their effects, and therefore they should be considered, in light of our responsibility toward bios. An example would be the creation of a microbe which, upon its release into the field, would be potentially harmful to the environment and/or public health. In many countries there are already restrictions on the release of genetically-programmed organisms into the field but, even after a number of safeguarding experiments, the long term effects are often difficult to predict.

In fact, we are now beginning to realise that human intervention, on biological systems, might be even less predictable than was thought a few years earlier, because of the lack of sufficient data. A well-documented example of a conditionally either fatal, or favourable, inherited characteristic is provided by the mutant gene which causes the devastating human disease, sickle-cell anaemia. This pathological mutation has helped entire populations of carriers in the Mediterranean region to survive malaria. Who then, has the right to determine what is right and

wrong, good genes and bad genes? We cannot pretend to know the answer to this question, and we might tend to be very sceptical about people who claim to have all the answers.

At this point, I will merely express my opinion as a concerned scientist and biologist. Ethical theories based on irrational values, such as doctrine, philosophy, faith or revelation, because they are divorced from reality, have always failed consistently to modify human behaviour. On the other hand, bioethics seems to provide a solution based on realistic values for the survival of bios and mankind, interdependence among living organisms and respect for the bio-environment.

Along with these principles, it would seem best to adopt internationally-accepted guidelines for biotechnology. The guidelines already in existence in the European Union and Japan, and to a lesser extent in the USA, could provide the basis for forming international guidelines under the auspices of the UN. The complexity and interdependence of modern technologies is so great, as is also the rapidity of change in science and technology, creating entirely new issues, that only a realistic and scientifically-sound bioethical approach can be applied.

Bureaucracy, "public consensus" policies, or short-term economic gains, should not be as important criteria as a potential, real or imagined, threat to human health and the bio-environment. Regardless of the socio-economic benefits of a biotechnological application, biotechnology should be judged on a step-by-step basis, mainly by experts, in addition, of course, to other representatives of society. Scientists too, should act with responsibility, avoiding experiments which pose an increased risk of hazardous results.

Of course, scientists are as human as other people but, as a rule, they tend to be more knowledgeable than the average person about scientific facts and more reluctant to jump to conclusions, without examining solid data. Nevertheless, it should be stressed that no expert could really predict the future with reasonable accuracy. For example, Professor Monod, a famous geneticist and Nobel Prize winner, in his inspired book Chance and Necessity (1971) predicted that "man would never be able to recombine DNA molecules from different organisms." This statement was written only two years before the advent of recombinant DNA technology, illustrating the fact that even the imagination of a brilliant expert cannot always accurately predict the future.

In conclusion, on one hand there are the vast possibilities that biotechnology has to offer, in order to assist us in solving the major survival problems of humankind and the biosphere, and on the other, we face potential risks and hazards which might accompany some new technological advances. Specialised scientists, combining knowledge and respect for bios, may help, by considering each biotechnological advance with as much prudence and foresight as possible.

I would like to believe that in the years to come Homo sapiens will justify their wise name and act with the necessary responsibility by using, and not abusing, the natural resources of bios.

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