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Medical Biotechnology – Its Impact on Society¹⁾

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INTISARI

T. Jacob — *Bioteknologi kedokteran: Dampaknya terhadap masyarakat*

Karangan ini memberi pandangan bioanthropologis tentang dampak sosial bioteknologi medis. Dimulai dengan definisi bioteknologi dalam arti luas dan sempit, lalu diteruskan dengan tinjauan tentang cara, baik yang modern maupun yang tradisional, kemudian diakhiri dengan uraian tentang dampak biososial, ekologis, evolusioner, demografis, ekonomis, politis, militer, hukum, sosiokultural dan agama, yang dapat menimbulkan perubahan-perubahan mendasar dalam masyarakat dunia.

Di antara cara-cara bioteknologi yang disinggung adalah eufenetika, eugenetika, transplantasi dan substitusi organ, genoteknologi dan teknologi reproduksi. Ke dalam yang terakhir termasuk perjodohan terpimpin, pengendalian pembuahan, pembuahan anumerta, dan *in vitro*, fusi embryo dan pencangkakan nukleus, hybridisasi sel dan klonasi. Di antara cara-cara tradisional dikemukakan system kasta, pengebirian, pengguguran, infantisida, perjodohan terpimpin dan manipulasi lingkungan.

Diingatkan tentang dampak negatif yang merugikan manusia dan ekosistemnya, karena akhirnya aspek teknologis kehidupan tidak dapat dipisahkan dari aspek-aspek politis, sosial dan etnis.

Key Words: biotechnology – euphenics – eugenics – reproductive technology – guided mating

INTRODUCTION

On this special occasion I shall discuss the impact of biotechnology, particularly medical biotechnology, on society. I have no pretention to present a technical exposé, but rather a bioanthropological view on the facts and potentialities of biotechnology, and its consequences.

1) Presented at the Regional Islamic Science Conference on Feb. 13, 1989 in Jakarta.

Biotechnology *in sensu lato* is the application, by utilizing scientific and engineering principles, of biological sciences to produce goods and services for the welfare of mankind. Scientific disciplines involved are mainly biochemistry, microbiology and genetics. The goods produced are novel organisms, organisms with new traits, hormones, enzymes, immunity components and other chemical compounds. Services produced are improvement of function and structural changes in the body. Because the results are in the form of goods and services obtained by means of technology, hence human intervention, they are patentable despite of being living matter.

Included into biotechnology in the wide sense, which is also called the new biology, is hi-tech medicine such as the technology of transplantation and artificial organs and of reproduction. The new biology differs from the old because it involves synthesis, not only description and analysis. In this sense biotechnology may not cover genetics.

Biotechnology *in sensu stricto*, also named genetic technology, engineering or surgery, always involves genetics. This is what is usually meant by biotechnology. In this case the products could be organisms with wholly or partially new genome, modified genes, individuals with more than two parents, etc.

The aims of biotechnology are to create individuals with good qualities and prevent the birth of individuals with bad qualities, to manage and cure genetic and congenital diseases, and manufacture biologicals.

The creation of better individuals is achieved by selecting good characteristics with known responsible genes or choosing individuals considered to have good qualities and reproduce them in large quantities. This is at present more wish and fantasy rather than fact, but we know that many fantasies of yesterday are plain facts today. Scientific history consists of dreams that come true. Still the difficulty lies in determining which characteristics are good, since what is good for someone is not necessarily good for another. Likewise, what is good today is not necessarily so in the distant future. In fact, to determine what is good is harder than to determine what is bad.

The next problem is to mark the gene responsible. If the trait concerned is a behavioural one, it is usually polygenically inherited, and thus, difficult to determine. It is estimated that every individual has on the average eight bad genes, so that if the whole genome is cloned the bad mutants will remain hidden in the population. Many have the opinion that Nobel prize laureates and millionaires have good genomes. This is not necessarily true if the total aspects of life are taken into consideration. Even if it were true, question arises whether a community of solely Nobel laureates is socially and evolutionarily desirable. Most likely such a community cannot function or survive. It takes all kinds to make the world.

To prevent bad genes or individuals from being reproduced is also not an easy matter. A bad gene at a certain time and in a certain space will turn out to be a good one at another time and in another space. The sicklecell gene for example, is deleterious in a normal environment, but in a malaria-ridden environment it is beneficial. Many a bad gene are recessive, and thus, can never be eradicated by any method, since they are hidden in the heterozygote. To eliminate them by recombinant DNA technique, we have to mark first their loci in the

chromosome. Human gene mapping is still in its infancy, especially for genes determining behavioural traits which are likely to be polygenic in inheritance and strongly influenced by the environment.

The cure of a genetic disease can be accomplished by eugenics besides reproductive intervention. Drugs, hormones and enzymes can be administered to patients and surgery can be performed. Moreover, intervention can be mediated through transfusion of blood or blood fractions, environmental change or substitution, and diet. Intervention in reproduction can be done by castration, contraception, abortion and feticide.

The production of hormones, enzymes and vaccines can be achieved by using recombinant DNA technique on bacteria. Examples of these are the production of insulin, interferon and immunoglobulins which are important in healing genetic and infectious diseases, and cancer.

Biotechnology opens up new venues for further application with still unpredictable consequences. Many aspects will run against existing rules of law, religion and ethics, for example abortion, compulsory castration and creation of life which can be regarded as paternalism intervening with privacy. To oppose biotechnology entirely is on the other hand, not the right attitude, because it promises many beneficial rewards to mankind.

THE METHODS

The methods employed by biotechnology in the wide sense are eugenics, transplantation of organs and substitution by artificial organs, gene therapy and reproductive technology. The latter includes guided mating, conception control, posthumous fertilization, in vitro fertilization, embryo fusion and nucleus transplantation, cell hybridization, and cloning.

Eugenics concern management of the phenotype and environmental manipulation. By the latter is meant improvement of micro-, meso- and macroenvironment to achieve individual and social, physical and mental health. Biotechnology in this case contributes through the improvement of food production by means of hi-tech agriculture and animal husbandry, and the elimination of pollution by using for example microorganisms such as oil-digesting microbes.

Examples of managing the phenotype are the management of PKU (phenylketonurea), hemophilia and diabetes mellitus. Eugenics results in the protection of bad genes and consequently, the increase of genetic load in a population which finally ends up in the increase of social load, because the carriers are enabled to reach reproductive age.

Eugenics is either positive or negative. Positive eugenics increase the good genes, while negative eugenics decrease or wipe out the bad genes. The difficulty of reproducing good genes has been described. The eradication of bad genes is theoretically possible if they are dominant. In one generation it is possible to eliminate unwanted dominant genes by prohibiting procreation or by abortion. The problem arises if the genes are recessive, or if they are polygenes. In this case we have to be able to mark the loci of the genes to be replaced by recombinant DNA technique.

Transplantation of certain organs has become commonplace, but many problems will reveal themselves if and when brain transplantation will be possible and necessary. Then we have to deal with a new individual composed of the body from one individual and the brain from another. The person will recognize himself as the brain owner, but others will identify him as the body owner. If disharmony occurs between these two parts, there will certainly be conflict in the identity of the self.

Transplantation may also involve parts of an organ of another species with close affinity to man. Or those parts can be man-made such as blood vessels, bone and possibly the heart etc. The result of all these is the lengthening of human lifespan, and consequently, there will be more non-productive old people in the population, while equally non-productive children decrease in number. Transplantation is known to present social, legal and ethical problems.

Gene therapy is treatment by alteration of the genome employing DNA recombination technology. Guidelines for experimentation with this technique have been issued by the U. S. National Institute of Health during 1976-78 which are considered too restrictive by some and too lenient by others.

Reproductive technology varies from guided mating to gene technology. Examples of guided mating have a long history, e. g. the caste system, hypergamy, monogyny, mating arranged by the extended family, prohibition of miscegenation and consanguinous marriage.

Conception control is used to limit the population. Differential reproduction among populations might change the population composition of the world. If for example, two populations of the same number (50:50) have a difference in birth overshoot of 1%, then in one century the proportion would be 88.7:11.3. Because of this, population of the First and Second World will change proportionally *vis-à-vis* the Third World which will exert a global, biopolitical impact. Moslems are expected to increase in the next century.

Zero population growth (ZPG) by the two-child-system will decrease the population size significantly in the long run. For example, a starting population of 1000 will remain 120 in one century or only 8 after three centuries, because of the two children born in each family less than two will reach reproductive age, some will be sterile (genetic death), and others will not have children or remain celibate. This last attitude will be more frequent with technological and industrial progress, so that the next generation does not replace their parents.

Particularly important is the single-child-system which would drastically alter the population number. A big nation consisting of solely spoiled single children poses another problem nationally as well as internationally.

Diseases prevalent in the first born, such as ductus arteriosus Botalli, will be common, since ZPG results in a high proportion of them. Geniuses will decrease, because historically we know that many geniuses are not the first or second child of family. Koch was the third child, Cervantes the fourth, Kant and Rembrandt the fifth, Mozart the seventh, Bach the eighth, Richard Wagner the ninth, Lamarck the eleventh, Schubert, Boyle and Mendeleev the fourteenth, and Franklin the eighteenth. More rituals for having single and two children only must be performed by parents in certain traditional societies in order to avoid

harrassment by evil spirits. Uncles and aunts will be rare and this could change some of the traditional customs, for example in matriarchal societies. Incest will also be infrequent owing to the decrease of siblings in every generation.

ZPG will cause repercussion in the social and economic realms if implemented too rapidly, since suddenly children below 15 years decrease in number while adults above 55 years increase, so that socioeconomic activities have to be shifted from the earlier to the later part of life. Many schools have to be closed due to lack of students and more facilities have to be provided for old people. Politically, parties and campaign issues will change accordingly. Women's leisure time will be plentiful which could be filled by positive activities to improve the quality of life or by consumptive activities. There will be a need for a ministry of senior citizens and recreation in lieu of the ministry of youth and sports.

Posthumous fertilization can be carried out to multiply the genome of an individual considered to have desirable qualities, by establishing sperm banks. Many such banks have been created to store frozen semen of Nobel laureates and millionaires. It could also be possible to erect an egg bank or an embryo bank. By so doing, fertilization can be accomplished long after the demise of the biological parents. The children will be raised by a single parent, surrogate parents or a rearing agency. Question arises whether the educational environment will not compensate the qualities inherited by the selected genes.

In vitro fertilized eggs need implantation in a uterus of a conceiving mother. The problem emerges when the sperm donor is not the husband of the ovum mother as in the case of posthumous fertilization. There is also a problem if the uterus mother and the ovum mother are not the same person. The child will have three mothers if he has another nursing mother. If two embryos are fused or nucleus transplantation from somatic cells is performed the resulting child could have four to six mothers.

Fathers can be multiple too if a chromosome of one father's spermatozoon is modified by recombinant DNA from another father. Consequently, there will be problems of kinship, laws, religion, ethics and economics. Incest rules could expand and the uterus is commercializable. And after a uterus mother conceived a child of another woman, she can claim him to be her child.

Cloning is replicating DNA or genotypes preferred. It has not been tried in higher animals and man, but theoretically it is a possibility. The result is simply Xeroxing human beings and the decreased diversity in the gene pool which is detrimental for successful evolution. Major ecological changes act adversely on uniform populations and probability of extinction is thus higher due to the absence of variants which could adapt rapidly to entirely new environments.

DNA recombination is incorporation of fragments of foreign DNA into the genome of an individual. The technique, developed in the 1970s, has excited the scientific and business world, because it promises unprecedented possibilities for the creation of life. On one hand, it shocked the stock market by the rapid and successful establishment of biobusinesses, and on the other, it casts shadows of fear against unwanted consequences, such as the appearance of novel, unfriendly species, the release of new strains of microorganisms outside the laboratory environment, and their probably adverse effects on the ecosystem. It is also feared about the ability of man to create life with unpredictable impact, such as the

transmission of diseases and the influence of the gene environment on transferred DNA and *vice versa*. However, the advantages cannot be discounted, for example the improvement of the genome, treatment of genetic disease and the advancement of biological research.

Another hazard of biotechnology is the development of biological weapons. Highly virulent microorganisms can be synthesized which cannot be counteracted by available medicines. Biological weapons are relatively cheap and can be used by a state or a terrorist group.

TRADITIONAL METHODS

As a matter of fact, biotechnology in the wide sense has been practiced for a long time, *e. g.* the caste system, castration, abortion, infanticide, guided mating and environmental manipulation.

The caste system has been implemented for more than 3,000 years. The main castes (*varna*) coincide with the skin colour. Of the mating system homogamy or hypergamy is preferred among the more than 2,000 subcastes, meaning that women have to marry with men of similar or higher subcaste. For the *gotra* (subdivision of the subcaste) exogamy is the rule. Higher castes are considered to have higher qualities which are protected from mixture with the lower castes. Men are regarded to be dominant in determining the genotypes of the offspring.

Castration or gonadectomy is performed on criminals or "worthless lives" as in Nazi Germany on Jews and "non-Aryans". Castration interferes with reproduction and privacy, and is irreversible.

Abortion is intervention after fertilization and is done with the purpose of limiting the number of individuals and populations, and in preventing unwanted children, *i. e.* children with genetic defects and illegitimate children.

Infanticide is carried out after the birth of the child with the same purpose, sometimes including the elimination of a member of a twin pair. It is resorted to when abortion is not successful.

Environmental manipulation is achieved by dietary regimens, improvement of living environment, changing of habitat and by taking medicines.

Guided mating could be in the form of internecine mating and prohibiting or prescribing incest. The prohibition covers down to the seventh grade. Exogamy and endogamy are other forms of guided mating. Exogamy prevents homozygosity of bad recessive genes and may result in heterosis. Brother-sister marriage is to preserve the royal blood and spirit, but it may cause genetic diseases.

THE SOCIAL IMPACT

Consequences of biotechnology are among others: the increase in the expectation of life, change in the population composition and in the concept of the family, hybrid vigour, increase in the human biomass and in the genetic load,

change in the ecosystem and in gene frequencies, extinction and growth of bioindustry.

The worst impact of biotechnology has been exposed in negative utopia, such as *We*, *The Animal Farm, 1984*, and *The Brave New World*. The authors envisioned a totalitarian society which controls everything for its members, including the life style, information, nutrition and reproduction.

The increase in life expectancy results in more numerous senile and senescent people who are not productive. Another consequence is longer contact between successive generations and the increase in generation length. Social regeneration will be slower followed by social, political and economic consequences. Along with the increase in number and influence of old people, the influence of children and adolescents decreases.

Change in the population composition in the result of the increase of life expectancy and the decreased birth rate. The number of women also increases, since they survive longer than men. Divorce rate goes up due to the prolonged marital period.

Change in the concept of the family effected by the various kinds of parents that are possible. We have the uterus mother, genetic mother, nursing mother, and rearing mother, and we have the genetic father, social or formal father and recombinant father, besides stepparents and adopted parents. Sex of the offspring can be predetermined, so that it is possible to have the preferred sex, and this might change the population sex composition. It might be possible to order sperms and egg with certain traits for the offspring. Since many mothers are working, child rearing is left to the government or private agencies.

Heterosis will be more frequently encountered due to not only the increase of mixed mating and miscegenation, but also to DNA recombination through the change in gene environment and the elimination of bad genes, especially if the donor comes from another gene pool.

The human biomass increases because of the drop in the death rate, but this is decompensated by the lower birth rate. The biomass of elderly people and women increases. The general increase of the biomass is due to the improvement of nutrition and this in turn demands an increase in food supply. The animal biomass will concentrate in domesticated mammals while many non-patented wildlife become extinct.

Change in the ecosystem is brought forth by the advance of man-made ecosystem and pollution, the extinction of animal and plant species, and the increase in members of selected species, speeded up by patenting laws. Particularly important is the introduction of novel species and variants. The impact of this is difficult to predict, most likely it is both positive and negative. The negative one is *e. g.* the creation of organisms that are pathogenic or that interfere with the food chain.

Change in gene frequencies takes place if bad genes are eliminated by recombinant DNA and cloning. Gene frequency change, of course, means evolution. Therefore, by biotechnology man can influence his own evolution by accelerating it whilst it has been decelerating as result of the small number of offspring, the increased generation length and the manipulated environment.

Extinction may be the fate of mankind if unintended global mass mutation occurs owing to radiation in a nuclear war. In that particular case those who do not die immediately by heat or blast will suffer the effects of massive and continuous radiation. Probably we do not have to ponder over this catastrophe, since post-war survival is impossible due to the global ecological change. The only alternative is to prevent such a foolish and tragic man-made holocaust.

In this connection I should mention the new vistas of biological weapons introduced by biotechnology. Virulent microorganisms can be created which can paralyze the enemy. Military experts, however, seem not to be too enthusiastic about this unpredictable weapon.

The advance of biotechnology will finally result in a strong bioindustry, and this will eventually be controlled by a few giant multinational corporations, usually chemical and drug firms. The products will be patented and as result miracle genotypes needed by many will fall in the hands of the few, whereas wild genotypes vanish due to ecosystem exploitation or are stored in seed banks in a few centers controlled by the developed world. Thus, living species can be owned. However, we have to face the fact that bioindustry will play a very important role in the next century.

FUNDAMENTAL CHANGES

Among many fundamental changes that will occur, brought about by biotechnology, the following will be mentioned: the management of mutation and selection, and the guidance of evolution; photocopying human beings; the obsolescence of the family, sex and traditional reproduction; differential reproduction; and the creation of novel species.

These changes are sure to influence religious, political, economic and sociocultural life.

The management of mutation, which increases with the increase of radiation, is done by DNA recombination. By so doing man can guide his own evolution with the assistance of eugenics and gene therapy. Selection is restricted by hi-tech medicine and gene therapy. Cloning results in more or less uniform human beings which are considered of standard quality. Hence, biotechnology is a new factor influencing the tempo and mode of evolution.

The obsolescence of the family has already taken place owing to industrialization, and biotechnology will accelerate it further. The concepts of mother and father become blurred. Uncles and aunts and siblings decrease in number. It is questionable whether mother-child-father bonding will survive the onslaught of bioindustry. Women become more independent and the education of the young will be totally formal. More and more women refuse to conceive and nurse babies while still wanting children. Sex and reproduction will be separated and independent from marriage. Traditional reproduction involving love, sex and mating will be obsolete.

Differential reproduction between the rich and the poor will influence the world population. It is feared that the poor are forced to provide uteri for implantation of fertilized eggs with financial compensation. Intervention with

reproduction will be more frequent in developed countries so that their populations will proportionally diminish, but they control biotechnology and bioindustry.

For the first time man has the ability to create life and novel species. Because there is no precedent, we do not really know whether it is detrimental to man and his ecosystem.

The impact of these changes on religion is certain in the case of the family and reproduction which are traditionally considered sacred. How far can man interfere with nature and to what extent can he act as creator? Can we manufacture persons?

The impact on economy will be apparent in the monopoly or oligopoly of modified genotypes needed by mankind with the consequence that the weak again will suffer. Transplantation presents the same drawback. This fact certainly has social and political implications. The genetic load is another economic impact, and likewise the increase of human biomass distributed more in the old age group.

The political impact besides the patenting of the genotypes is again the increase of senior citizens, of similar or identical people, and of single children. The role of the biocrats and bioindustrialists influences policy decisions. Preferred qualities for Xeroxing could be tinted by ideologies.

The social impact is the decreased number of geniuses which might be counteracted by cloning geniuses who usually have no or a small number of children. The medical impact is the increase of genetic load and the control of genetic and congenital diseases.

The legal impact could be noted in the changes in the family and reproduction, patenting of the genotypes, distributive justice in resource allocation, and transplantation. The military impact is affected by cloning individuals with totalitarian dictatorial traits and reproducing people who are servile for soldiers and manual workers. It is not too foolish to imagine of creating hybrids between man and infrahuman primates for this purpose. Biological weapons are another military application of biotechnology which might change the nature of war and terrorism.

With the advance of biotechnology the role of biocrats and biotechnicians become of utmost importance in the next century. Biocrats can generate rules according to traits which is subject to recombinant DNA technique and for patenting life. Biotechnicians can think up new means in the technology of reproduction and genetic surgery.

As is the case with other technologies, biotechnology also has two faces, because man himself has two faces, the good and the bad. The nature of biotechnology depends on in which hand it happens to fall, and thus, on the ethics, morality and religiosity of the biobusinessmen and biotechnologists, the bioindustrialists and the biocrats, and in the presence and effectiveness of the control exerted by the society. We must not be apprehensive to the marching on of biotechnology just as we must courageously prepare precautions against the biohazards it causes. We should have the conviction that the technological aspects of life cannot be separated from its political, social and ethical dimensions.

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