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Short Communication

THE BIOTECH CENTURY: EXPLORING THE FRONTIERS OF BIOTECHNOLOGY

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ABSTRACT
Biotechnology that combines the ideas and needs of biology and medicine with engineering has emerged as one of the most successful technology of the twenty-first century. For both scientists and the general public, one of the most winning aspects of biotechnology lies in the prospect of treating human diseases. Thanks to its successes so far in making possible, for instance, the cheap and plentiful production of such disease fighting agents as insulin and interferon, numerous people have been able to live longer and healthier lives. Its promise in improved agricultural production is exciting. The moral dilemmas now enveloping biotechnology would not be so hotly debated if the technology itself were not so remarkable and effective. And even without considering the practical consequences, we have the prospect of a new world of knowledge about life itself and the essential components of our own humanity, our own individuality, as revealed in our distinctive genetic codes. The authors survey the field of genetic engineering, describe some recent developments in the field, and conclude by discussing some of the social, legal and ethical questions regarding its benefits and risks.

KEY WORDS: Biotechnology,Applications of Biotechnology, Bioethics

INTRODUCTION

While the twentieth century was shaped largely by the spectacular breakthroughs in the fields of physics and chemistry, the twenty-first century will belong to the biological sciences (Rifkin, 1995).Scientists around the world are quickly deciphering the genetic code of life, unlocking the mystery of millions of years of biological evolution on Earth. Global life sciences companies, in turn, are beginning to exploit the new advances in biology in a myriad of ways, laying the economic framework for the Biotech Century. For more than three billion years, nature has been conducting uncountable numbers of genetic experiments, through mutation, crossing over, and other events that introduce changes in genetic message. This is the source of life's diversity. For many thousands of years, we humans have been changing numerous based traits of species. By artificial selection practices, we produced new crop plants and breeds of cattle, birds, dogs, and cats from wild ancestral stocks. We developed meatier turkeys and sweeter oranges, larger corn, seedlesswatermelons, flamboyant ornamental roses, and other useful plants. We produced splendid hybrids, including the tangelo (tangerine x grapefruit) and mule (horse x donkey) (Starr & Taggart, 1998).

Genetics, the science of inherited characteristics, has figured in human history in a rough and ready way for thousands of years, in the breeding of domesticated plants and animals to obtain desired types. Formal scientific studies in genetics, however, date only from the experiments of the Austrian botanist Gregor Mendel (1822-1884). Mendel established some of the basic laws of inheritance by crossbreeding plants with certain characteristics and noting how those characteristics were distributed in subsequent generations. But the means for understanding the molecular basis of those laws was not developed until 1953, when James Watson, an American, and Francis Crick, a Briton, published a landmark article in the scientific journal *Nature* that first elucidated the molecular structure of DNA (deoxyribonucleic acid) (Behrens & Rosen, 2000)..

A Brief Look at DNA

It had been known for some time that DNA is the chemical compound forming the genetic material (chromosomes and genes) of all organisms, but understanding how DNA functions in the process of inheritance required knowledge of DNA's molecular structure. Watson and Crick showed the DNA has the structure of a double helix, that is, two interconnected helical strands. Each of the two strands of the DNA molecule consists of a sugar-phosphate "backbone" and sequence of nucleotides, or bases, attached to the backbone. The base pair up in specific ways to connect the two strands. In most organisms, DNA is present in all cells in the form of chromosomes gathered in the cell's nucleus. Genes are part of chromosomes–that is, they are segments of DNA. Each gene is a sequence of bases that governs the production of a certain protein, so the sequence of bases that forms a gene can be viewed as a "code" for producing a protein; hence, the term *genetic code.* Acting separately and together, the proteins produced by the genes determine many of the organism's physical and behavioral characteristics, including the way in which the organism progresses through its life cycle (Behrens & Rosen, 2000). And because genes are passed along from one generation to the next, they are the basis for heredity.

UNDERSTANDING BIOTECHNOLOGY

Broadly speaking, biotechnology encompasses “all the studies and techniques that combine the ideas and needs of biology and medicine with engineering” (Grolier’s *Academic American Encyclopedia*). In the public mind, however, biotechnology has mainly come to be associated with a range of applications in the area of genetic engineering, medicine, human genetics, and the forensic use of DNA. Watson and Crick’s discovery and the subsequent advances in genetics provided the foundation for genetic engineering, and the techniques developed for genetic engineering made possible the unlimited applications in medicine, human genetics, and law. Genetic engineering, a branch of biotechnology is “the application of the knowledge obtained from genetic investigations to the solution of such problems as infertility, diseases, food production, waste disposal, and improvement of a species” (Grolier’s *Academic American Encyclopedia*). Genetic engineering is also known as “gene splicing” and as “recombinant DNA technology” because it involves combining the DNA that is, splicing together the genes of different organisms. The new technology also is the basis of genetic engineering, by which genes are isolated, modified, and inserted back into the same organism or into a different one (Starr & Taggart, 1998). For example, a gene with a certain desired function, e.g. that of generating a particular antibody, could be taken from the cells of one person and inserted into the cells of a person lacking that gene, thus enabling the second person to produce the desired antibody (Behrens & Rosen, 2000).
Biotechnology enables us to get chemical explanation for life, explanation of why we are human beings and not monkeys. The reason of course, is our DNA. Watson (1992) proposes: “If you can study life from the level of DNA, you have a real explanation for its processes.”

THE APPLICATIONS OF BIOTECHNOLOGY

Breakthroughs in genetic technology are bringing us to the edge of a new *eugenics* era. The idea of selecting desirable human traits is called *eugenic engineering.* Genes are the raw resource of the new economic epoch and are already being used in a variety of business fields including agriculture, animal husbandry, energy, bioremediation, building and packaging materials, pharmaceuticals, and food and drink to fashion a bio-industrial world.
This astonishing technology originated with the innards of bacteria. Bacterial cells have a single chromosome, a circular DNA molecule that has all the genes they require to grow and reproduce. But many species also have plasmids, or small, circular molecules of “extra” DNA that contain a few genes. In nature, many bacteria are able to transfer plasmid genes to a bacterial neighbor of the same species or a different one. Replication enzymes may even integrate a transferred plasmid into the bacterial chromosomes of a recipient cell. A recombinant DNA molecule is the result. Researchers now use recombinant DNA technology to analyze genetic changes. With this technology, they cut and splice DNA from different species, then insert the modified molecules into bacteria or other types of cells that engage in rapid replication and cell division. The cells copy the foreign DNA right along with their own. In short order, huge populations produce useful quantities of recombinant DNA molecules (Starr & Taggart, 1998). In another kind of application, genes that generate desired products can be inserted into the DNA of bacteria or other types of cells that replicate rapidly. When the “engineered” cells replicate, they copy the foreign genes along with their own and generate the products specified by those genes. Population of such cells can function as “factories” to produce large quantities of useful products (Behrens & Rosen, 2000).

Applying the New Technology to Humans

About 99.9 percent of the nucleotide sequence is the same in all humans on Earth. The remaining 0.1 percent, about 3,200,000 base pairs are mutations and other sequence variations sprinkled throughout the genome. They account for *all* genetic differences in the human population. Researchers around the world are working their way through the 3.2 billion pairs of the twenty-three pairs of human chromosomes. The ultimate objective of the human genome program is to learn the nucleotide sequence of human DNA (Watson, 1992). These phenomenal researches are opening doors to gene therapy, the transfer of one or more normal or modified genes into the body cells of an individual to correct a genetic defect or boost resistance to disease. Human gene screening and therapy raise the very real possibility of engineering the genetic blueprints of our species and redirect the future course of human biological evolution. The new gene splicing techniques will make it potentially possible to transform individuals and future generations into “works of art,” continually updating and editing DNA codes to enhance physical and mental health (Rifkin, 1995).
While genetic screening is already here, human genetic engineering, in other words, gene therapy is making its presence felt. Genetic manipulation is of two kinds. In somatic therapy, intervention takes place only within non-sex (somatic) cells and the genetic changes do not transfer into the offspring. In germ line therapy, genetic changes are made in the sperm, egg or embryonic cells, and are passed along to future generations (Rifkin, 1995). Somatic gene surgery has been carried out in limited clinical trials for many years. Germ line experiments have been successfully carried out on mammals for more than two decades and researchers expect that if all goes well, the first human trials to be conducted within the next several years.
In the coming decades, scientists will learn more about how genes function. They will become increasingly adept at turning genes “on” and “off.” They will become more sophisticated in the techniques of recombining genes and altering genetic codes. Over the next few years, molecular biologists say they will locate specific genes associated with several thousand genetic diseases. In this context (Rifkin, 1995) comments: “In the past, a parent’s genetic history provided some clues to genetic inheritance, but there was still no way to know for sure whether specific genetic traits would be passed on. In the future, the guesswork will be increasingly eliminated, posing a moral dilemma for prospective parents. Parents will have at their disposal an increasingly accurate readout of their

individual genetic make-ups, and will able to predict the statistical probability of a specific genetic disorder being passed on to their children as a result of their biological union." Though there are unlimited avenues for the applications of biotechnology, genetic mapping can lead to emotional anguish to persons with genetic disorders. Some ethicists argue that genotype techniques can place a "genetic stigma" not only on individuals but whole communities. Hence there is growing concern on the ethical implications of biotechnology.

FOCUS ON BIOETHICS

The domain of biotechnology gives rise to serious social and ethical issues,especially related to the application of recombinant DNA technology to our rapidly advancing knowledge of the human genome.To most of us, human gene therapy to correct genetic abnormalities seems like a socially accepted goal. The concern is, is it also socially desirable or acceptable to change certain genes or sperm or egg of a normal human individual to alter or enhance traits.

These days, the rich and the famous have the wonderful luxury of rejecting even relatively minor ailments from menstrual cramps to migraines, as unnecessary and treatable. Treating chronic conditions is, if anything, more nature-defiant than attacking infectious diseases. In large part, this attitude stems from a naïve notion of health as the natural state of the body. "In fact," says Postrel (1997), "disease and death are natural; the cures are artificial. And as we rocket toward the biological century, we will increasingly realize that a bodily state may not be a "disease," but just something we wish to change." There are those who say that the DNA of any organism must never be altered. But the fact is that nature itself alters DNA much of the time, and has done so for nearly all of life's history. The concern is that *we* do not have the wisdom to bring about beneficial changes without causing great harm to ourselves or to the environment. As Starr & Taggart (1998) advises: "When it comes to manipulating human genes, one is reminded of our human tendency to leap before we look." Brownlee *et al* (1994) also warns: "For all its promise, the ability to glimpse the future will not come without costs." Researchers mapping the human genome, both to assure the continuity of public financing for their long-term, costly project and to counter the negative images of genetics are pushing forward the idea to gullible public that identity lies in the genes as a set of "genetic instructions," a "program" transmitted from one generation to another.To locate complex human behavior in a molecular entity is to ignore that behavior's social context. There are not genes for behavior, only genes for proteins that influence physiological processes. Indeed, to explain human beings in biological terms, to jump from the molecular level of genetic systems to the behavior of human beings, requires a profound leap of faith (Nelkin, 1993). Even in the courts, due to the limitations of forensic technology, biotechnology applications in pinning down criminals are being hotly debated. Tucker (1994) citing the problems of DNA profiling in the USA says that the technique is finding it hard to stand the scrutiny of the American justice system. Neufield & Colman (1990) adds: "The power of forensic DNA typing arises from its ability not only to demonstrate that two samples exhibit the same pattern but also to suggest that the pattern is extremely rare. The validity of the data and assumptions on which forensic laboratories have been relying to estimate the rarity are currently being debated within the scientific community."Media interpretations are consequential, affecting both individual decisions and social policies. To journalists looking for certainty, genetic explanations that can be mapped and catalogued or deciphered from nature's text seem more objective and less ambiguous, than environmental or social explanation. Defining people as "predisposed" to immutable traits could justify discriminatory social practices. If we believe that there are "criminal genes," for example, this could sanction the use of tests to predict dangerousness, overriding issues of justice or fairness. And if the concept of genetic determinism is extended to groups, this could compromise the rights or obligations of classes of people.

Another, perhaps bigger, ethical dilemma is how patients will react to the idea of genetic testing. If drugs are developed, say, to screen people thought to be at risk, for early heart disease, these still-healthy people will have to be genotyped. People will, essentially, need to have barcodes. But they may not want to submit to the testing. They may prefer not to know or have others know exactly what risk categories they fit into. Many fear that a centralization of such knowledge could lead to genetic discrimination (Marshall, 1998). Biotechnologists often dismiss the way in which their work is appropriated by the media, calling it oversimplified and distorted. But much of the popular rhetoric about genes draws support from the promises generated by biotechnologists and the language they use to describe their research. In the interest of public understanding, then, biotechnologists should restrain their tendencies to oversell their work and consider the biases and beliefs that will ultimately shape the uses of a powerful science, one that offers prospects for promising applications, but that also opens possibilities for pernicious abuse.

CONCLUSION

While the twenty-first century will be the Age of Biology, the technological application of the knowledge we gain can take a variety of forms. The biotech revolution will affect every aspect of our lives. The way we eat; the way we date and marry; the way we have our babies; the way our children are raised and educated; the way we work; the way we engage in politics; the way we express our faith; the way we perceive the world around us and our place in it all of our individual and shared realities will be deeply touched by the new technologies of the Biotech Century (Rifkin, 1998).

Surely, these very "personal" technologies deserve to be widely discussed and debated by the public at large before they become an omnipresent part of our daily lives The mapping and sequencing of the human genome is providing researchers with vital new information on recessive gene traits and genetic predispositions for a range of illnesses. The new holistic approach to human medicine views that genetic engineering taking into consideration social and ethical concerns might prove more effective in addressing the needs and fulfilling the dreams of current and future generations.

RECOMMENDATIONS

1. Biotechnology is a very important addition to life sciences. Hence, its study should be introduced at an early stage of basic education.
2. The academic institutions both in the private and public sectors should collaborate in research and teaching keeping pace with the speed of change inherent in the subject matter. They should avoid redundancy.
3. There should be an honest public debate both between the adherents of this science and those who oppose some of its applications. The competing biotech visions should be respected and discussed with integrity, clarity and objectivity.
4. The problem of scientific illiteracy so rampant in our society should be addressed by the biotechnology community. They should organize a sustained literacy campaign through the media to make people aware of the reality and nature of this life science.
5. Accreditation and proficiency testing will work only if implemented with care. National standards for forensic testing must serve the interests of justice, not of parties who have vested interests in the technology.
6. In the use of biotechnology in the field of human medicine, the rights of persons and patients undergoing the tests should be respected.
7. Private industry involved in research and product manufacturing in this field should not only focus on profits but on the ethical and social implications.
8. There should be accountability and transparency adhered by pharmaceutical companies from the developed countries when they conduct clinical trials on citizens of the developing countries.
9. Genetic engineering community should respect the society's concern when some technologies are accepted and others are rejected due to genuine reasons.

REFERENCES

Rifkin, J. (1998) *The Ultimate Therapy: Commercial Eugenics on the Eve of the Biotech Century*. Tikkun Magazine.San Francisco: Tikkun.

Starr, C. and R. Taggart (1998) *Recombinant DNA and Genetic Engineering* from *Biology: The Unity and Diversity of Life,* 8e, Wadsworth Publishing.

Brownlee, S., G. Cook and V. Hardigg (1994) *Tinkering With Destiny.*U.S. News & World Report.

Nelkin, D. (1993) *The Grandiose Claims of Geneticists* from Chronicle of Higher Education, B3-4, Dorothy Nelkin.

Watson, J. D. (1992) *The Human Genome Project: A Personal View* from *The Code of Codes,* Daniel Kevles and Leroy Hood. Harvard: Harvard University Press.

Marshall, E. (1998) *Iceland's Blond Ambition.*Mother Jones Magazine. Foundation for National Progress

Postrel, V. (1997) *Fatalist Attraction: The Dubious Case Against Fooling Mother Nature.*Reason Magazine Los Angeles: Reason Foundation

Neufeld, P. J. and N. Colman (1990) *When Science Takes the Witness Stand*. Scientific American, Scientific American, Inc.

Tucker, W. (1994) *O.J.'s DNA in Court* from *The American Spectator.* The American Spectator.

Behrens, L. and L. J. Rosen (2000) *The Brave New World of Biotechnology*. In *Writing and Reading Across Curriculum* 7e, New York: Addison Wesley Longman, Inc.