SCIENCE AND SOCIETY
WITH SPECIAL REFERENCE TO GENETICS

Dissertation submitted to Jawaharlal Nehru University
in partial fulfillment of the requirements for
the award of the Degree of

MASTER OF PHILOSOPHY

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2003

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21st July, 2003

CERTIFICATE

Certified that the dissertation entitled "**Science and Society – with special reference to Genetics**" submitted by **Ms. Lavanya Mehra**, in partial fulfillment of the requirements for the award of the Degree of Master of Philosophy, has not been previously submitted for any other degree of this or any other university. To the best of our knowledge this is an original work.

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ACKNOWLEDGEMENTS

I wish to express my heartfelt gratitude to my supervisor, Prof. Dipankar Gupta, for his great support and guidance during the course of this research. Prof. Gupta patiently answered all my queries and was readily forthcoming with his suggestions and criticisms. I would also like to thank Prof. Gupta for encouraging me in my desire to pursue this topic of research.

I am grateful to the library staff of the Centre for Science Policy, Jawaharlal Nehru University and of Teen Murti Library, from where I collected valuable material for this study.

I am indebted to the Parkinson's Information Exchange Network, because of which I have kept in touch with the latest scientific advances.

LAVANYA MEHRA

21st July, 2003.

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Glossary of Scientific Terms

Biologics- Medical products derived from living sources. They include vaccines, blood and blood derivatives, allergenic patch tests and extracts, tests to detect HIV and hepatitis, gene therapy products, cells and tissues for transplantation, and new treatments for cancers, arthritis, and other serious diseases.

Biotechnology- is using living or dead components of living organisms, in contrast to purely chemical processes, to make products.

BT (Bacillus thuringiensis): A naturally occuring bacteria that produces a protein toxic to certain types of insects. The gene for this toxin-protein has been cloned and used to transform crop plants, thereby making them more resistant to the corresponding insect.

Chimera- Any organism derived from the mixture of human and animal cells.

Cloning - The intentional creation of one or more genetically identical individuals. The process usually refers to a form of asexual reproduction in which the genome from a cell of an individual is used to generate one or more genetically identical individuals. At the moment, there are two possible methods of cloning: Somatic Cell Nuclear Transfer and Embryo Splitting. Cloning can either be done for reproductive or therapeutic purposes.

DNA (deoxyribonucleic acid): the substance of heredity; a long linear molecule composed of deoxyribose (a sugar), phosphate, and one of four bases, adenine (A), thymine (T), guanine (G) and cytosine (C). DNA contains the genetic information necessary for the duplication of cells and for the production of proteins. In its native state, DNA is a double helix composed of two complementary strands.

Embryo (for purposes of this draft legislation)- Refers to a human organism during the first fifty-six days of its development following fertilization or creation, excluding any time in which its development has been suspended (eg. frozen).

Embryo Splitting- An early stage embryo can be split into two or more embryos with identical genetic makeup.

Foetus - In humans, this is an organism during the period of its development beginning on the fifty-seventh day following fertilization or creation and ending at birth.

Gene: the fundamental unit of heredity; a bundle of information for a specific biological structure or function.

Gene Patenting- The act of assigning a patent for a gene such that the patent holder has ownership but can license the use of the patent to others.

Gene Therapies- The process of inserting new genetic material into an organism for the purpose of treating or controlling a genetic disease. The therapy only affects the person being treated and not the germ-line cells so no alterations can be passed on to future children. Gene therapy is also sometimes referred to as somatic cell therapy.

Genetic Engineering: the manipulation of genes, composed of DNA, to create heritable changes in biological organisms and products that are useful to people, living things, or the environment.

Genetic Modification is a special set of technologies that alter the genetic makeup of such living organisms as animals, plants, or bacteria.

Genetics- The study of heredity and the variation of inherited characteristics.

Genome- The complete DNA sequence in a full set of chromosomes for a given organism.

Genomics- The systematic study of the structure of the genome of an organism, including mapping and sequencing.

Germ-line Alteration- The modification of a human genome such that the modification is passed on to descendants. This alteration or replacement of a gene is usually done in the very initial stages of development. This could lead to the abuse of such procedures to create "designer babies".

Informed Consent- written consent, which has been given after information has been received and understood by a person.

In Vitro Fertilization (IVF)- Mature eggs are removed from a woman's ovaries and placed with sperm in a laboratory dish in order to achieve fertilization. Often the resulting embryo(s) is then transplanted into the woman's uterus.

Multipotent stem cells can give rise to multiple different cell types.

Neuropharmacology- Discovery of drugs for the treatment of Neurological disorders.

Pharmacogenomics - Custom drugs or individualized medicine.

Pluripotent stem cells can give rise to any type of cell in the body except those needed to develop a fetus.

Pre-existing embryo- An embryo that was destined for, but not used in, reproduction. In IVF treatment, there are usually more embryos produced than are transferred to a woman.

Pre-implantation Genetic Diagnosis- Techniques by which in vitro embryos are tested for specific genetic disorders (e.g. cystic fibrosis) or other characteristics such as sex before being transplanted to the uterus.

Recombinant DNA- Combining genes from different organisms is known as recombinant DNA technology, and the resulting organism is said to be "genetically modified," "genetically engineered," or "transgenic."

Somatic cell: cells in the body that are not involved in sexual reproduction (that is, not germ cells).

Somatic Cell Nuclear Transfer (SCNT) This refers to the technique of inserting the nucleus of a cell from one of the body's tissues into an egg which has had its nucleus removed.

Stem cells – Those cells that have the remarkable potential to develop into many different cell types in the body

Therapeutic cloning- sometimes used to refer to cloning of an embryo for the purpose of deriving stem cells for therapeutic uses.

Totipotent - A fertilized egg is considered totipotent, meaning that its potential is total; it gives rise to all the different types of cells in the body.

CHAPTER ONE INTRODUCTION

There are in fact two things, science and opinion; the former begets knowledge, the latter ignorance

- Hippocrates

There is hardly any aspect of life that is not permeated by a scientific knowledge of it. Sociological fascination with science is not recent. Auguste Comte, the father of Sociology was deeply interested in the degrees of accuracy that science seemed to produce and wanted to create a similar science of society. Comte argued that mankind's intellectual development passed through three stages. The first stage was Theological and saw all events being attributed to supernatural forces or the divine power. The second stage or Metaphysical saw the source of all power lying in a formal authority like the King or State, and the last stage, Positivistic, saw phenomena explained through observation, hypotheses, and experimentation. This last stage was where science emerged and society could be reorganized on scientific and rational grounds. For Comte, Sociology was to be the queen of all sciences. It was the most complex as well as the most general among all sciences and would be capable of interpreting other sciences like mathematics, astronomy, physics, chemistry, biology, etc.

Since Comte, generations of sociologists have dealt with various facets of science. Thinkers have analyzed how science manages to stay disinterested and isolated from society (Merton, 1968) and the nature of science- society relationship (Nowotny et al, 2001). Furthermore, sociologists have studied why science seems a cumulative and long history of one achievement after another (Kuhn, 1970) and how are scientists more successful than sociologists (Latour, 1988)? If it is as research based as the rest of the knowledge systems, then why does science get the level of funding that other disciplines can not dream of (Etzkowitz & Webster, 1995)? How is it that often the best minds in every society go into scientific pursuits? Why is it that in spite of being in a language that is largely unintelligible to most non-scientists, the public has trust and faith in its ability to solve most problems irrespective of the fact that science may have created them in the first place (Wynne, 1995)?

While defining science is often a slippery task, it is widely acknowledged that science exists in almost every aspect of society. Edgar Zilsel criticized the notion of a linear evolution of human beings and their ideological growth. It is often our belief that human beings as a species and especially those closest to the civilized and industrialized world form the 'natural peak of human evolution'. Due to this belief, we suppose that man 'simply became more and more intelligent until one day a few great investigators and pioneers appeared and produced science as the last stage of a one- line intellectual ascent' (Zilsel, 2000: 936). The danger with such thinking is not just that humans are presumptuous of their superior intellectual capabilities, but also that science becomes associated with increasing progress. The more scientific a society is, the more developed it is assumed to be. The stress on science and subsequently on technology is often so paramount that questioning any technological innovation borders on questioning the entire rationale behind economic, political, social planning and development.

Science and Technology

For most members of my generation, science and technology have come to signify great possibilities along with great threats. On the one hand, technology is a means of bringing a distant world together through the Internet or a means of eradicating diseases like small pox and polio. On the other, technology is a reminder of the horrors of the nuclear bomb, of oil spills and green house effect. It is this often very familiar and real dichotomy that faces us in our daily life and challenges our attitude towards the notion of science.

There are several reasons for studying science sociologically. To begin with, science is an integral part of society. Scientific pursuits are often deemed beneficial for the welfare of the entire nation.[1] All countries of the world lay stress on science and technology and allocate a significant amount of their revenues on scientific research.[2] Technological advance is crucial in these days of military and economic competition. No nation that desires to remain independent and have a strong position in international relations can hope to remain out of the race for increasing scientization of society.[3] Secondly, it is essential to analyze science because scientific advances often run ahead of our full understanding or appreciation of them. Perhaps in no other knowledge system is the product of research so instantly appropriated as it is in the case of science. Irrespective of whether the product is a microchip for computers or an automatic toaster, the utility of science often does not even get questioned.

Throughout the world, recent advances in science have been if not unthinkable, then most certainly of the nature that were once deemed impossible. Writers like H.G. Wells or Jules Verne could envision a world of space travel and journeys to the moon and Mary Shelly could describe the creation of a human being in the laboratory, but these remained works of fiction. The fact that present technology can claim to turn science fiction into science fact does deserve some attention. This is especially true of biotechnology. Biotechnology and Information technology are the two largest technological revolutions to take place in the past few decades. They have significantly altered the field of health and communication. With the stress on interdependence between nations through the programme of globalization, changes in one part of the world have consequences for the entire world. The power of technologies lies in their being the impetus for standardization in the contemporary world. It is a tribute to man's endeavour and determined will that the world seems to be interconnected in ways unforeseen in the past. Advances in the medical arena have been remarkable and have shifted attention from prolonging life to an improvement in the quality of life.

Biotechnology and the case of Genetics

There is perhaps no better way to understand science than to attempt to do so through the study of biotechnology and genetics. Biotechnology is one area of contemporary science and technology, which has been able to arouse the curiosity, support and criticism of people across the world. Biotechnology involves the use of biological organisms- animals, plants, living beings, in order to create something further. Molecular genetics is the central foundation of the expanding biotech industry. Genetics like no other scientific pursuit is central to various aspects of human existence (Griffiths et al, 1999: 2). The interest in genetics is usually traced to the 1860's when an Augustinian monk Gregor Mendel performed a series of experiments that led to the discovery of genes. Genes are the basic functional unit of heredity. Mendel derived certain basic laws of heredity through his experiments in pea plants

(Griffiths et al, 1999: 32). He demonstrated that hereditary factors do not combine, but are passed through generations intact. Every member of the parent generation transmits only half of its hereditary factors to each offspring and lastly, different offspring of the same parents receive different sets of hereditary factors. Mendel's work became the foundation for modern genetics.

Biotechnology is a large area of research and has many applications for the present times and the future.[4] It is already being used in **Agriculture and Livestock rearing** to produce pest resistant crops and hardier animals. It will be of benefit to the **Environment** because of the attempts to sequence the genomes of bacteria useful in energy production, environmental diagnostics, toxic waste reduction, and industrial processing. It will affect the **Industrial processes** by being able to generate cleaner and more efficient manufacturing in sectors like chemicals, pulp and paper, textiles, food, fuels, etc. The fact that the entire DNA sequence of humans will be recorded and known will enable scientists to conduct **DNA fingerprinting** or forensic testing, the use of which will help as much in solving crime and warfare as in anthropological studies. The most celebrated use of this technology comes from its application in **Medicine.** It aims to improve diagnoses, biomedical therapy, drug therapy, and identification of genetic predisposition to disease.

Thus, while Biotechnology is a very vast field, the Human Genome Project is considered to be its biggest and also its most controversial project. This project was started in 1990, with the joint coordination of the U.S. Department of Energy (D.O.E.) and the National Institute of Health (N.I.H.) with the aim to map the entire DNA sequence of the human body, which includes more than 30,000 genes. This project was unusual also because it was successfully completed two years ahead of schedule in 2003.[6] As part of the goal of this project, all the information that is collected must be stored in databases and subsequently shared with the private sector for use in industry.

The life and times of 'Dolly' are important not just because she was the first cloned sheep and the cynosure of all eyes, but because she reminds us that we belong to a society where science can move out of the laboratories into the public domain. Genetics has come to symbolize the entire gamut of possibilities that technology and the modern era epitomizes. What Information technology accomplished for gadgets, we accept that biotech will do for living beings. It will revolutionize our life, our society and reorient our ideas and experiences.

Exactly to what extent genetics may come to alter our lives is yet unclear but what has become apparent is that it will effect every aspect of our existence in some way. What emerges as the key question is whether we want this change to take place. In his book *Our Posthuman Future: Consequences of the Biotechnology Revolution*, Francis Fukuyama argues that some technologies come with obvious dangers, such as nuclear technology. Society does not need prompting to be wary of the possible threats from nuclear experiments thus has stringent regulations for its development and use. But the threat from Biotechnology is more latent and subtle. The changes ushered in by biotechnology may be permanent and relate to basic social needs. Humankind stands to lose much more from genetics primarily because it changes whatever we have come to know as natural (Fukuyama, 2002: 7).

Sarah Franklin similarly argues that over the past decade, there has been a flood of information related to biotechnology and genetics. "In the year 2000, it has become clearer than ever before, that these changes affect the human condition in its every aspect, from the food we eat, to the way we define health, to our national economies, to our understandings of the human, the future, and ourselves" (Franklin, 2001). Thus, the study of biotechnology and genetics is essential not only because it is a rapidly advancing technology but more so because it is threatening to intrude into every part of our life. To ignore this technology would be a mistake.

Sociological study of genetics

According to Peter Conrad and Jonathan Gabe (1999), while sociological study of the new genetics did start in the late 1980's, majority of the work on genetics is a product of the nineties. Sociologists in the past have focussed on the growth of genetics as a profession to research for instance, the relationships that are formed in the health- care sector. Work has been done on the role of media in creating genes as a cultural icon and forming public images and discourse around genetics. Research has been conducted on the public understanding of science, the growing complexity of science-society relationship and the increasing geneticization of society. Feminists have been keenly watching this technology from thc point of view of changes in reproductive technology and its consequences for women. Thus, three prominent themes emerge in the study of genetics- the structure and production of genetic knowledge, the social meaning of genetics and the impact of such a technology on society.

The aim of this research is to argue that the reason science or technology dominates us is not only due of the product of its creation, but because of the social conditions that appropriate its production and usage. Reality is not constructed by science but society determines what notions to back as reality. By society here, I mean the complex of institutions, agencies and relationships that exist in our life and govern us. My aim is to show that three main factors determine the success of any scientific enterprise and these are evident in the case of biotechnology and genetics as well. These three factors are- first, a link that deems the project **indispensable** to mankind's progress and the subsequent strength of such a link. Secondly, the ability of the project to **involve** as many sections of society as possible and thirdly, the ability of the project to show its rootedness in **previous knowledge**. These three factors are social in nature.

For instance, the big computer boom of the 1980's and 1990's saw just how many facets of our lives could be altered, ordered, simplified, or even be made complex by technology. From how we store data in college libraries, process records in government offices, perform complex calculations in banks or dissolve distances in being able to communicate with acquaintances around the world- computers did revolutionize our lives. Information Technology's' link with society was its being the source of solving man's secondary needs of communicating and organizing. The link that Biotechnology has found has a much deeper impact on our existence- that of the human body. By linking itself to the food we consume, the air we breathe, to the methods of reproduction and the ideas of health– biotechnology becomes more basic, more indispensable, and more crucial to our lives. It has also been able to involve various sections of industry, academia and government to its cause. And although, genetics is sufficiently path breaking in its technological procedures, it has its roots in the knowledge system of western medicine.

In order to understand the processes underlying scientific progress I will begin with a sociological understanding and interpretation of science. The aim is not to give a social context to the study of science but to effectively argue that the criterion of success is sociologically determined and hence requires sociological investigation. My argument further is that we have reified genetics- we have made genetics indisputable, not because fighting technology is a lost battle. It is because we have made it a science of the body, of diseases, and of health. Technology can be controlled; but to control science is difficult, as it carries along with it the concepts of progress, development, rationality and liberation.

The arguments in the study are divided into the next three chapters.

The **second chapter** comes with the objective of studying how sociologists have dealt with the notion of science. Edgar Zilsel argued in 1942 that the 'spirit of science is worldly and not military.' "It could not develop among clergymen and knights but only among townspeople" (Zilsel, 2000: 936).[6] Thus, science carries along with it the tag of being factual, unbiased, objective and uncompromising in its outlook.

To understand this status of science better, I begin with an analysis of Karl Mannheim's *Ideology and Utopia.* I discuss the growth of rationality and the breakdown of a formal objective authority that had shaped our daily experiences and had allowed the existence of only certain thoughts and ideas. When the power of the Church or State lessened, its rigid control over individuals' lives and experiences also diminished. The subsequent intense social mobility made it impossible for everything in society to change and yet for thought to remain static. Thought underwent a transformation as well. The direct consequence of such a breakdown, Mannheim argues, has been the notion that science can alleviate human suffering because it is independent of traditional constraints. The more scientific we are, the more we will be in control of our situations, and the better our lives will be. Science is related to the spirit of rationality and individualism and flows freely in an atmosphere unhampered by conservatism. When man was left with little or no support from a higher authority, he had to develop his own faculties, his own sense of exploration and his own sense of right and wrong. The most crucial factor became his ability to interrogate and question. Thus, science arose when the spirit of free enterprise and competition arose.

It is a privileged position that science finds itself in, of being linked to the growth of rational thinking, free inquiry and individualism. Zilsel argues that fully developed science or modern science as we know it today seems to be a direct result of all the other forces working alongside it. That science takes such a preemptive place in our lives seems to be the ultimate tribute to the project of rationality (Zilsel, 2000:938). The trust that we have come to place on science and its agencies comes in part from this legacy of rationality. Science, having delivered us from the world of ignorance, would now continue to take us towards greater realms of knowledge and towards a better understanding of the universe.

Where does science as a university based knowledge system get the image? How have we continued to pin all our hopes on science? Robert K. Merton (1968) gives a clue. For Merton science is primarily fraud free and that is because science does not involve itself with activities other than those purely scientific. Scientific enterprise is successful because scientists are people of moral standing. Science uses its knowledge for the benefit of humanity and has a spirit of inquiry and exploration ingrained in its culture. The only reason science gets politicized is when it comes in contact with society.

Are we then to assume that science exists in isolation from society? Thomas S. Kuhn in *The Structure of Scientific Revolutions* describes science as a living, moving discipline. Kuhn argues against interpreting science as a cumulative record of its achievements. Science does not progress from a state of simple to complex knowledge, from old to new or from the state of inertia to a state of Eureka. Science sees changes in paradigms instead, which envelop the nature of the scientists' work and areas of research and problems. The current state of science is due to the constant endeavour to solve conflicts, which arise in daily scientific enterprise. The success of paradigms depend on their problem-solving ability — on what problems it can solve and whether it can hope to find a solution for problems deemed crucial at that stage. No paradigm is ever completely successful but even then it should not re-open those problems, which an earlier paradigm had satisfactorily solved.

In a sense then, science is one way among others of thinking and emerges in the same society in which all other knowledge systems also exist. Bruno Latour questions the artificial separation of science and society. In *Laboratory life- The Social Construction of Scientific Facts*, Latour argues that scientists work with the same data and concepts as do non-scientists and any separation between them is reductionist in nature. In *The Pasteurization of France*, Latour argues that the success of science depends on its networking ability. If Louis Pasteur succeeded in his war on the microbes it was only partially due to the fact that he could control microbes and cure ailments. Pasteur succeeded because he could make allies and become involved in a social movement led by the hygienists and eventually redirect its course. Pasteur could take his laboratory everywhere and bring newer areas under his command.

In the **third chapter**, I aim to use genetics as the empirical data against which I will examine these various interpretations of science. This chapter is divided into three sections with the idea of studying the increasing **scientization** of society. I will begin with a technical description of genetics and the processes involved in its research. Second, I aim to state my case that although the misapprehension regarding technology is not due to a lack of public understanding of science, even then, technology can not be understood as being value free. For this reason, an analysis of the controversies surrounding genetics becomes important. ELSI or **Ethical Legal Social Implications** have become so fundamental that most biotechnology laboratories spend a portion of their research funds on tackling and understanding these concerns. From the ELSI debate, emerges an important sociological concern. The significance of biotechnology as a project also comes from its ability to alter our a-priori notions of what is meant by being human, by life, disease, health, reproduction, family and human nature. The changes that this technology may usher will not only alter our medical conditions but also stand to change all that is normal with humans as well.

In the third section, I will try to show that the success of biotechnology depends mainly on the issue of disease and health. It is the **medicalization** of society, which gives a stronghold to genetics.[7] Over the past century or more, medicine has convinced humans of their inability to deal with disease, pain and suffering. Increasingly, the notion of health has been changing from a mere prolongation of life to an emphasis on the improved quality of life. Medicine had already established itself in our daily experience with the doctor occupying a central place in our life. By linking genes to pathology, human suffering and illness, an opening is created from where scientists and science can enter and stay in our lives. I will show that genetics has become indispensable not because of some inherent attribute of genes but because in order to be healthy we need to have control over our genes. I will attempt to study if under the guise of freedom of choice and human volition we are instead becoming geneticized in our thinking and actions. Thus, through a study of genetics and health, I aim to show how our understanding of science, of experts, of truth and reality, of the end-goals of scientific pursuits and our experiences with trust in social institutions — all underline our interpretations and responses to any growing technology.

After discussing the process of medicalization, in the **fourth chapter**, I will study the impact of genetics on society and on social relationships. Several questions will be addressed. For instance, what is the process by which knowledge passes from the scientist's laboratory to the economic and political sphere? What is the role of various institutions like laboratories, biotechnology companies and pharmaceutical firms in promoting the idea of genes-equals-health? The changing nature of health-care services, the widening gap between doctors and patients and the dichotomy between increased visibility of disease and decreased visibility of the individual patient will be discussed. I will try to analyze how technological change can alter preexisting social relationships.

Having said this, it is necessary to understand how the various nations and government agencies are affected by the spread of genetics. How is it that within 50 years of the identification of double helix by James Watson and Francis Crick, most nations at present are trying hard to catch up with the rapid transformation of their fundamental ideas? The seriousness of the issue of genetics comes out most plainly from the laws that have been formulated regarding not just the use of the technology but also the production of the knowledge on which this technology rests. Most nations face the challenge of accepting intellectual capital as the unit of exchange through which trade exchange and business will be carried out, even between nations. Laws to protect this capital, sharing of resources and privacy of information, etc., are all being drawn up even as progress in this technology is still in its infancy. David Dickson argues that an assessment of potential risks and benefits of science is not of relevance, but what is important is to ask why the government thinks it is appropriate to enter into this debate now (Dickson, 2000: 918).

Thus, the crucial factor that needs to be discussed is the commercialization of knowledge. The entire biotechnology industry depends on some very serious funding by different agencies. The funding may explain how the human genome project is the industrial revolution of biotechnology. "A survey of 77 local and 36 state economic development agencies (in the U.S.) reported that 83% have listed biotechnology as one of their top two targets for industrial development" (Grudkova in Cortright & Mayer, 2002: 6). With such information we hope to understand how genetics is being marketed and what sections of community are going to be potentially benefited later. The other benefit of studying regulations is that we get to see actual changes taking place. If one thinks that a futuristic debate on science and on genetics is interesting, the insight into what is already happening with genetics is even more so.

In the **concluding chapter**, I try to assess what a study of science, and more so, genetics gives to our understanding of sociology and the underlying social processes at work. I take up the question as to how certain technologies, in spite of being enmeshed in controversy, continue to be developed. I try to understand what lacks in our understanding of the issues of science, progress, genetics and revolution, that makes science seem at the same time both full of doom and hope.
Several questions emerge regarding whether science can be limited. Should science have any boundary where its control would end and society would begin? I discuss the Libertarian, Conservative and Social Democratic models for scientific progress and try to study which model may eventually emerge as the definitive one for future international laws.

The aim of this research is twofold. On the one hand I will try to gain a better insight into current scientific advances through an understanding of sociology. On the other hand, I will try to study how a study of genetics can assist in our understanding of society and even sociology.

As Mark Twain said, "There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

NOTES

1. See for instance Paul Feyerabend, *Science in a Free Society*, NLB London, 1978.

2. For budgetary allocation in India, see Sachin Chaturvedi, "Developments in Biotechnology: International initiatives, Status in India and Agenda before Developing Countries", *Science, Technology and Society*. Sage Publications, pp. 72-100, Vol. 8, No. 1 Jan- June 2003.

3. For a comprehensive argument see Francis Fukuyama, *The End of History and the Last Man,* New York, Free Press, 1992

4. For a description of the areas covered under biotechnology, visit the web site of Oak Ridge National Library http://www.ornl.gov/TechResources/Human_Genome/project/benefits.html

5. See for instance D. P. Burma, "Whither Medical Sciences", *Science and Culture*, pp. 90-98, Vol. 69, March- April ,2003

6. The date of completion is often conflictingly quoted as 2000, 2001 or 2003. While the Human Genome Project was completed in April 2003, a "working draft" was ready by June 26, 2000, and was published in February 2001. For the project timeline, visit Oak Ridge National Library web site (April 2003) http://www.ornl.gov/TechResources/Human_Genome/project/timeline.html

7. Edgar Zilsel's article was originally published in *The American Journal of Sociology* (Vol. 47, pp. 544-562) in 1942. In December 2000, it was reprinted in its original form in the *Social Studies of Science* (Vol. 30, No. 6).

8. For medicalization, see for example, Steve Taylor, "Health, Illness and Medicine", *Sociology- Issues and Debates*. pp. 253-276, London. Macmillan, 1999.

CHAPTER TWO SCIENCE AS REVOLUTION

In an Age of Universal Deceit, Telling the Truth is a Revolutionary Act
- George Orwell.

In *Ideology and Utopia*, Karl Mannheim argues that the rise and fall of phenomena can be understood only in their social context (Mannheim, 1936: 97). If science has come to occupy a central place in our life or has been the focus of several studies, it is because of its rootedness in the ideas of rationality and enlightenment. This is not to say that humans did not possess any analytical thinking in the pre-enlightenment era. But the growth of science as a spirit of critical inquiry arose only when freethinking and rationalism were allowed to develop. "The critical scientific spirit (which is entirely unknown to all societies without economic competition) is the most powerful explosive, human society has ever produced" (Zilsel, 1942: 937). What has come to signify our intellectual life is multiplicity of thought. It is this factor more than any other, which distinguishes our society from that of our feudal ancestors. There is decentralization of power not just in political or economic spheres but also in our cognition of forces around us.

The Rise of Rationality

Mannheim argued that the authoritative position that the Church occupied in people's life, the centrality of God and religion, what Comte had termed the Theological Stage – was non-conducive to the spirit of exploration that scientific thought required. When this authoritative hold over people's lives was broken and was first replaced by a less divine and more worldly power of the kings and subsequently when even this was further broken apart, individuals realized that the only possible source of authority was their own analytical ability.

It was this decreased dependence on a formal objective authority that enabled humankind to bring under questioning, all objects and phenomena from the material world and even subject their own thought processes to scrutiny. Thus, the disintegration of the notion that truth was what was established by God or His holy men, gave rise to the belief that there was not just one but several ways of thinking.

With the increased capability to question their own thought processes, human beings realized that each one of them could interpret the same data and reach different conclusions. Could it be possible, people wondered, for different individuals to have different and equally valid ideas? This process according to Mannheim culminated when people recognized differences in thought processes, each equally legitimate and with equal claim to authority- existing not just between different members of the society, but that often such antagonistic processes could exist in the same mind. Such thinking is possible only in times when disagreement is more prevalent than agreement (Mannheim 1936: 5).

In a sense then, the mere fact that there existed different thought processes was not a problem so long as at the end of the day there was an authority, which enforced any one interpretation. When social stability underlies and guarantees the internal unity of a worldview, then different ways of thinking do not become pressing issues. When this authority was broken up, the blind faith in its truth was dissolved and the validity of a single socially held position fell, other ways of interpreting the world emerged. This is what fuelled the spirit of exploration and inquiry. It became clear that only by thinking through the various contradictions could one arrive at the solutions. Since the illusion of absolute thought dissolved, it became clear that authority rests within each one of us. Therefore, only that is true, which I can think of or verify by my actions or experience (Mannheim 1936: 13).

Mannheim talks about the development of the rational scientific and mechanical world. Having recourse to no single line of reference, human beings developed an epistemology that was increasingly precise in its exclusion of phenomena and its development as a formal body. The more formal and mechanical one's language and emotions became the greater were the chances of agreement with others. The need to create agreement was best served by asserting that one's own theories and ideas were more rational, more scientific and thus freer of emotional bearings in comparison with the rest. In a sense then, what arose from the project of enlightenment was this desire to mask all that lay within us that was not likely to attract allies. Thus, the existence of these unconscious hidden motivations led to the necessity of mechanizing and scientizing everything from emotions to politics. An artificial separation of thought from its social process became crucial to give the illusion of a thought process free from the rigid bonds of the past. Being scientific came to imply being accurate. "The result of the amalgamation of politics and scientific thought was that gradually every type of politics, at least in the forms in which it gave itself for acceptance, was given a scientific tinge and every type of scientific attitude in its turn came to bear a political colouration" (Mannheim 1936: 33).

Mannheim described the concept of Ideology, which is unreal thought. What started out as an enterprise to develop critical analytical thinking, had led to the process where individualism was the key. Disagreement with other members was important as a route to self-promotion. All thinking is social in nature and carries along with it the associations of social thought. By unmasking the opponents' hidden motivations and exposing the social rootedness of their thoughts, their claim to truth could be demolished. This unmasking in academic discussions was with the aim of destroying the opponents' intellectual basis and in politics with the purpose of annihilating their entire existence (Mannheim 1936: 34).

The Ethos of Science

Robert K. Merton also discussed the impact of social thought on science. There is often a reluctance to explore the bearings of the social environment upon science. The pure science sentiment, if eliminated, would place science under the direct control of other institutional agencies. There exists a notion that 'science remains pure and unsullied as if it is implicitly conceived as developing in a social vacuum' (Merton, 1968: 586). The stress laid on objectivity in science would be undermined by an open admission that science is an organized social activity. This is partly because 'to admit the sociological fact would be to jeopardize the autonomy of science' (Merton, ibid.). The process of unmasking is applicable even to science as it exists in universities. Unmasking became even more prominent ever since the contact between science and politics became visible during the Nazi rule. What social scientists had been unable to achieve, the events in history did by leading 'scientists to recognize the interplay between their science and social structure' (Merton 1968: 587).

The institutional goal of science is the extension of certified knowledge (Merton 1968:606). Merton talks of four institutional imperatives which comprise the ethos of 'modern science'- Universalism, Communism, Disinterestedness and Organized Scepticism. While science is not unique to any one particular stage in history, its development is fuller in times that harbour a certain ethos. **Universalism** adds to the impersonal character of science, when all conceptions of truth are judged by uniform standards irrespective of who it is that promotes them. Truth is not subject to who it is that speaks it. Facts remain facts irrespective of the social situation. **Communism** asserts that scientific knowledge is the property of all people and is to be used for people's benefit. Science draws inspiration from and develops knowledge from a common heritage. Mannheim had also argued that while thought can be individual, knowledge is always social or community based (Mannheim, 1936: 2). Human beings participate in thinking further what other members of their society have thought before them. They find themselves in an inherited situation where through a largely predefined set of options they sets out to meet new challenges. Science is **disinterested** in terms of institutional involvement. That science seems virtually free of fraud is because the nature of science is such that it involves very close scrutiny by its peers. In order for science to be treated as unbiased and progressive, science needs to be disinterested. It does not have to be completely altruistic; but merely self-interested or self-promoting behaviour is abhorred in scientists. **Organized scepticism** states that the scientific observer does not preserve the cleavage between the sacred and the profane, between what requires uncritical respect and that which can be objectively analyzed. Science is the one discipline that nurtures scepticism. Science progresses because scepticism is ingrained in its project. Conflicts lead to the progress of science.

Viewed in such a way, science's exclusion from society seems possible. The trend towards scientization leads to a separation between the social and the scientific. Science becomes a noble and grand discipline, which can be even if only for analytical purposes, physically separated from society. Science is glorified and put on a pedestal. The social seems to be at the opposite end of the spectrum. To be scientific appears to be infinitely more desirable.

Scientific Achievements

In *The Structure of Scientific Revolutions*, Thomas S. Kuhn argues that science and scientists often project an illusionary image of their content and work. Science classics and textbooks are pedagogical and persuasive and since our understanding of science begins with them, we get an account of science, which is far removed from what scientific enterprise is actually about. The reason why we are tempted to place science on a pedestal is because science seems to have progressed in a linear cumulative fashion to the present stage, with an older science giving way to a newer and more complex one. The history of science seems to read like a long list of one achievement after another, cataloging the process by which facts, theories and processes were added to the basket of science. Instead, Kuhn asserts that 'science does not progress by an accumulation of individual discoveries and inventions' (Kuhn 1970: 2). On the other hand it progresses due to 'anomalies that subvert the existing tradition of scientific practice' which leads to the investigation of a new basis for scientific inquiry.

Not all scientific work is groundbreaking. Most of the time scientists are occupied in routine work. Normal science research is based on past scientific achievements. Further pursuits can be based on these achievements because they are unprecedented and also because they are open ended and allow various researches to develop. These achievements are called **Paradigms**. Each paradigm defines what is accepted as a research area and brings along with it a method of solving problems and tools with which to solve them. Thus, it brings a different Weltanschauung. Sharing of a paradigm is a fundamental necessity for scientists as it implies sharing the same scientific rules and standards. Every paradigm faces anomalies- some that are solvable and others that resist the onslaught of the ablest minds working on it (Kuhn 1970: 5). Work in a paradigm continues till such time as there arise several unsolvable problems or when some key anomaly is unresolved. The conflict period leads to the adoption of a new paradigm and the adoption of a new basis of study. During the crisis period, one or the other paradigm rises to prominence. The new paradigm will not leave exactly the same anomaly unresolved even though it can not be expected to solve all questions.

Paradigms change and redefine what classifies as a problem and what could be a legitimate solution. Since no paradigm solves all anomalies, a paradigm shift often reflects which questions were considered worth solving at the time. Success in a paradigm refers to the promise of success; a promise that subsequent scientific activity tries to actualize (Kuhn 1970: 24). It is on such a promise that most adherents to the paradigm base their life's work.

By asserting that 'normal science does not aim at novelties of fact or theory and, when successful finds none' (Kuhn 1970: 52), Kuhn is in a sense describing the mundane, everyday quality of scientific work. When a discovery is made, it is usually not groundbreaking work but is in fact very routine. Since each paradigm assures defining of the problem and existence of a stable solution, when a seemingly unsolvable puzzle is solved or when an old phenomenon is visible in a new light, it is not the work of individual genius but instead it is made possible precisely because the shift in ideas makes the task obvious. "Assimilating a new sort of fact demands a more than additive adjustment of theory, and until that adjustment is completed- until the scientists have learned to see nature in a different way- the new fact is not quite a scientific fact at all" (Kuhn 1970: 53). Discovery thus, is not a single act based on seeing something new but it is also recognizing what one has seen. The scientists begin to see things differently because a different set of relationships is established around the same phenomena. For Kuhn then normal scientific work is oriented towards puzzle solving, knowing full well that it is in finding the solutions to the puzzles that paradigms are tested and science moves forward.

For Kuhn, any new interpretation of nature emerges first in the minds of a few people. While working within normal science, these individuals are not concerned with the problems of the paradigm- their main focus is still on puzzle solving. Paradigm testing occurs only when a puzzle repeatedly fails to be solved. In such cases the paradigm is pitted against other competing ones. That these individuals learn to see science differently is aided by the fact that their attention is focussed on the anomaly and that they are either too young themselves or too new to the paradigm to have been completely institutionalized into its ways.

So how does one paradigm succeed over the others during periods of scientific revolution? Kuhn argues that by raising standards through which criterion for success is determined or by proving to others that the problems that one's paradigm can solve are more prescient in nature. A new paradigm is never instantly accepted and may not be accepted completely by everyone. While a new paradigm could be adopted for purely aesthetic reasons, its success also depends on its claim to solve the contentious and much elaborated anomaly that led the earlier paradigm to crisis (Kuhn 1970: 153). Since no scientific theory is ever an absolute, the criterion for selection becomes its probability of success. The claims are more valid if the new paradigm is quantitatively more precise. Kuhn argues that when such a claim can not be satisfactorily made, then success depends on the act of convincing scientists of its ability to solve grave future problems.

Science and Networks

While Kuhn described the progress of science in terms of paradigm changes and revolutions, for Bruno Latour the seeds of present science are sown in its preexisting science (Latour 1988: 19). Latour argues that the act of convincing occurs in a slightly different situation. In society to 'convince someone that an experiment has succeeded, that a technique is effective, that a proof is truly decisive, there must be more than one actor' (Latour 1988: 15). The other actors are as important for having understood the new phenomena and applying it further, as is the actor who tries to convince them. Knowledge is not developed in isolation and it certainly is not developed by one individual.

Latour argues that we wish science to remain non- political because we hope that some just and objective order exists somewhere in the world. It is the desire to want rational, impartial relations that makes us overestimate the importance of science and its seemingly uncompromising and non-chaotic nature (Latour, 1988:5). The project of enlightenment is to sweep the world with rational relations and in our desire to extend this, we often neglect to see the complex activities, which constitute science. Any sort of separation between science and society is reductionist in nature and to attempt to do so is an error.

In *The Pasteurization of France*, Latour describes the rise of Louis Pasteur both as a scientist and as the initiator of a movement that culminated in the transformation of the field of medicine. Latour begins by asking why some scientists or some movements are successful at changing the whole course of history, or at least are accredited for doing so. Latour argues that the reason why science seems elusive is not because it is isolated but because it succeeds where sociology fails. Scientists revolutionize the very conception of society and what society comprises. What the case of Louis Pasteur shows very simply is that while sociologists remain focussed on the interplay of power relations between different agents, scientists by inducing a new agent, manage to revolutionize the society and transform its relationships (Latour, 1988: 38).

Louis Pasteur, in the early decades of 1880's and 1890's, managed to convince his opponents, defeat them and redefine the way medicine and disease was understood. He first established that microbes lay at the cause of diseases. It was these tiny invisible microbes, which in moving from agent to agent spread any illness further (Latour, 1988: 44). This new knowledge was accepted and even appreciated because in making the enemy visible, he provided to the hygienists (scientists at the time of Pasteur who were already engaged in fighting diseases), a tool with which they could practice their science with better accuracy (Latour 1988: 34). Henceforth all that the Pasteurians needed to do was to establish important links between their work and diseases and subsequently larger areas of medical life. The Pasteurians were the only scientists who could see germs in their laboratories, they could see in diseases the work of agents where other doctors could see nothing. By being able to study germs they were able to invoke or quell diseases at their will. Pasteurians became the link to health, just as the microbes became the link to diseases. With this transformation in the idea of disease, a subtle yet potent change took place. Since the microbes were visible only to the Pasteurians, society on the whole had to 'make room' for them in order for its members to lead a healthy life (Latour, 1988: 38).

This was the network of Pasteur, wherein one by one he either convinced different section of the society, or by associating himself with the notion of a disease- free nation, made it impossible for others to find any objections to his method. Since convincing work depends equally on the work done by the person convincing and the ones who are convinced, the success of Pasteur's project depended on finding allies who would apply his method. The network in science gets stronger, according to Latour, when more areas are brought under scientific purview. Apart from convincing people that in his laboratory diseases could be interpreted and cured, Pasteur demonstrated that every aspect of health was microbe related. He could take his apparatus and his methods to distant areas and establish new fortresses (Latour, 1988: 89).

Science and Society

The purpose of outlining various facets of science was to understand how science arose as a spirit of inquiry and later became inseparable from social life. The point for the moment is not whether Merton is more accurate in placing his faith on scientists or whether Latour's analysis of the importance of a networking is closer to the truth. The fact is that science has come to occupy a privileged position in our life, without which we can not hope to advance our knowledge of the universe, the environment, material phenomena, etc.

In the work of various sociologists three themes assume primary importance. These three elements that define the nature of the complex relationship between science and society are- Authority, Isolation and Truth. These three lead to a fourth one, which is important for our study- Hostility or Opposition.

Authority

Science seems to be in a constant position of authority from where it dictates terms to society. Although contemporary thinkers argue that this authority is passe, and a greater colloquy between the two is emerging, that this concept needs to be addressed is also acknowledged.* Merton states that the reciprocity of relations between science and society have received unequal attention with more importance being given to the

* This notion of authority has given way to discussions of bridging the gap between science and society, in ways like increasing the dialogue between the two, demystifying scientific literature or increasing the public understanding of science. I will take up this concept more in detail in the next chapter.

impact of science on society rather than the opposite. Relatively less work has been done that tries to study the effect of the social structure and social environment on the 'very content of science' (Merton 1968: 585).[1]

Form where does science derive its position of authority? To begin with, this authority comes from textbooks, the language of which is uniquely polarizing. The language and the concepts entailed in the texts only attain meaning while belonging to the world of a particular paradigm. The texts address a definite section of the community in a language that is particular to them, the community being the scientific community. The texts are constraining in nature. There is no sense of historicity, no sense of science as a living and worker- oriented enterprise. Whatever little history is contained in them is usually confined to descriptions of the earliest scholars. Viewed thus, science seems to be only a long list of one great achievement after another (Kuhn 1968: 136). Latour takes this a step further and argues that this authority is not just due to texts but also the fear of not complying with what is written in them. 'The paralysis of those who do not dare transgress what they believe to lie potentially in its scriptures' gives science its sense of power (Latour 1988:204). The strength of laws comes not from anything intrinsic to them but from words, phrases, and other symbolic accompaniments.

This concept of authority does not remain limited to science; it inadvertently extends to the scientists. With the growth of science, we see the emergence of the scientists as experts. The myth of the scientific authority lies also in the acceptance that only the scientific community is able to correctly understand the workings of science. "The modern scientist has necessarily subscribed to a cult of unintelligibility" (Merton 1968: 601). Latour demonstrates that the inclusion of scientists as experts in our life takes place out of our willingness to place trust in their abilities. Scientists are the people who are specially bred to solve problems in ways that the lay masses can not. Kuhn also argues that much of normal science is predicated on the assumption that the scientific community knows what the world is like and to defend this it is willing to go to considerable lengths (Kuhn, 1970: 5). "A passion for knowledge, idle curiosity, altruistic concern with the benefit of humanity and a host of other special motives have been attributed to the scientist" (Merton 1968: 613).

Isolation

The concept of isolation plays a major role in the power dynamics of science. Isolation adds to the authority of science. A major sentiment is that science remains purer and more truthful if it develops in a social vacuum without the intrusion of concerns alien to science proper.

In *Laboratory life- The Social Construction of Scientific Facts*, Latour elaborates on the fact that scientists themselves work with a very definite distinction between 'social' and 'technical' (Latour 1979: 26). Social reports on science are often seen with suspicion. The relative exclusion of science from society is a myth that is easily upheld because scientists assume that sociologists can and are interested only in the non-scientific aspects of pure science. Similarly, Sociological concern with science is also inferred to be limited to those peripheral aspects of science, which exist only because scientists themselves live in society and are human too. Latour demonstrates that the intrusion of anything social into the scientific has for long been seen as inducing bias and removing objectivity (Latour 1979: 21). Social factors give rise to wrong science. Often, the dominant view is that science should maintain its exclusion from society or somehow manage in spite of it. It is of little significance that this isolation is an illusion and has never been completely achieved.

The lay public enters far more quickly in most other fields be they art or archaeology than it does into science. For it is among scientists as in 'no other professional communities in which individual creative work is so exclusively addressed to and evaluated by other members of the profession' (Kuhn, 1970: 164). And since science is more insulated from the public, scientists often do not need to go too deeply into explanations of facts, most of which will be self explanatory within the privileged group of peers. Due to this scientists end up managing to direct all their attention to the problems that they think need a solution, instead of having to explain or defend concepts in front of the wider public. 'The most esoteric of poets or the most abstract of theologians is far more concerned than the scientist with lay approbation of his creative work, though he may be even less concerned with approbation in general' (Kuhn, ibid.).

Kuhn argues that ever since paradigms were created, books ceased to be understood by lay people. Science became specialized because with the creation of paradigms, researchers drew from that foundation all they needed for their work. No longer was the prior justification of concepts required at the beginning of each study. The community of scientists understood the precise language and coherent research could follow even while ideas became increasingly exclusive. Work became specialized in terms of where it drew its inspiration as well as whom it addressed. What Kuhn is thus suggesting is that as sciences grew and as paradigms developed, a situation was created whereby those who did not adhere to the paradigm were often left out or rendered incapable of understanding the theories.* Kuhn develops a theory of the growing esotericism of sciences, from dynamics and electricity to the other physical sciences. This perhaps more than anything else is the main obstacle in the path of sociologists and social theorists in their inquiry of science. Science has for long escaped without too much sociological inquiry because it could claim to be beyond non- scientific explanations. Apparently only a scientist could understand science.

Let us for a moment go back to Merton's concept of Communism according to which, entrenched in science is the notion of spreading knowledge. A sense of community is embedded in science. There is in a sense a duality in the relationship between science and society. On the one hand it seems as if science is restrictive and its theorems and concepts are incomprehensible to the lay masses. The social is involved only at the very last stage of knowledge production when the outcome or social consequences of the project are to be tested. On the other hand, it seems rather naïve to argue that science or any other activity can exist in any sort of social isolation. To begin with, the scientist just as 'all other professional workers, has a large emotional investment in his way of life' (Merton 1968: 596). In a recent article by Cunningham-Burley and Kerr (1999: 149), it was argued that the cognitive authority of science rests not on an essentialist distinction between objective science and other knowledge and practice, but rather on the outcome of complex negotiations and interplay of a range of professional interests. Science is thus as entrenched in the social world as other knowledge systems are.

* The exact phrases that Kuhn uses to describe sciences are as illuminating in themselves- Ceased to be intelligible, ceased to be generally accessible (Kuhn, 1970: 20).

Truth

The notion of truth has also been of concern to sociologists in their study of science and society. The scientific enterprise often seems to be channelized towards exposing the hidden facets of nature. With the temptation of viewing science as cumulative, there is also the temptation of assuming that it all adds up somewhere. We think the universe is a great big puzzle and the current state of scientific knowledge is assumed to be the best available approximation to that truth' (Martin & Richards, 1995: 510). Thus, it is often assumed that all work is somehow going to aid humanity. When we glance at some of the scientific projects of the past it also looks like science is predominantly explorative. Be it the discovery of Oxygen or that of the Microbes- these and other objects in the world are made evident to us by science. Kuhn describes how science seems to discover the real nature of phenomena. It separates Oxygen from the rest of the gases (Kuhn 1970: 54).

Is it the aim of the science to take us towards a certain goal? Is there such a thing as an ultimate truth, which exists out there somewhere and is it the objective of scientific enterprise to reach us closer to that? If so, then science does seem intimidating, for indeed it seems to be taking us nearer that truth as compared to any other knowledge system. But if on the other hand, science is not a quest for truth, and instead is a pursuit for progress on a much smaller scale- even remaining limited to solving mundane questions in the laboratory, then science is not very different from other fields. It stops being intimidating. Most social theorists, including Kuhn and Latour, assert that science does not work with such potent concepts. Routine scientific work proceeds further in several directions, some of which later we say led to developments in the field. But for the moment science can not entirely work with the main purpose of betterment of the human race.

Mannheim was among the first to effectively argue that there is no such thing as the absolute truth. The world is not something that exists out there; its basis is very subjective. It is not as though this subjectivity leads to a fragmented universe through different people claiming different things. The unity of the world is not external, nor personal, it is the unity of the consciousness. Two factors constitute reliable knowledge- Relativism and Relationism. Relativism was the traditional notion, which stressed that all thinking is relative to one's social situation. Relationism stresses that all things in nature, all elements of meaning have reference to one another. There is a system of interdependence (Mannheim, 1936: 70).

For Mannheim, all positions, ideas, thoughts, definitions are never that of an individual but are necessarily the part of a group. Thought is inseparable from the thinker and his social situation. Since there is nothing like absolute truth, all thought is likely to be unreal. In a sense then, we have to give up all notions of an a-historical and a-social absolute truth. Instead, we have the notion of Optimum Truth. Instead of arguing that science leads us towards some truth, we can serve ourselves better by asking, which position, which standpoint, which theory vis-a-vis history, offers the best chance for reaching an optimum of truth? Thus, the focus shifts from finding solutions to working on problems more effectively.

For Latour, reality was the consequence of the settlement of a dispute rather than its cause. A scientist's activity is directed not towards reality but towards these operations on statements (Latour 1979: 236). When the stress on truth and reality is removed, then scientific activity seems more grounded and it is possible to accept its indulgence in social and political matters. Because the issue at stake in scientific enterprise is problem solving, hence all forms of disputes, debates, competitions and outmaneuvering seem normal.

Linked to the notion of truth is the idea that science is **factual and indisputable**. Being indisputable is in a sense the high point of the endeavor. Claiming to be indisputable is what other disciplines can not hope to achieve. For Latour, this is achieved by reorienting the society around one's argument. Latour argues that in order to get any of their statements accepted, scientists first need to work out how many alternative statements are equally probable. It is only then that they build a case to eliminate these options one by one. The operation of information construction transforms any set of equally probable statements into a set of unequally probable statements. This inequality is introduced between equal alternatives by increasing the cost for others to prove their statements (Latour 1979: 241). This is done by many ways, for instance by imposing new standards. Another way in which science becomes indisputable is by linking two or more issues. By adding a very potent and unquestionable statement, to argue against the original statement would require challenging the unquestionable one. Thus, the inability to change the potent statement induces the inability to question the former one.[2]

Latour also argues that part of the trick lies in keeping the illusion of certainty alive. Whether the text is made genuine by the style of the article or the data contained in the pages, the point is that finding objections is almost made impossible. Different methods are used by which conviction is added and the aura of truth is presented. And more often than not, debates are concluded not by critical discussions but by closing all areas of possible refutations. Thus any 'set of statements considered too costly to modify constitutes what is referred to as reality. Scientific activity is not about nature, it is a fierce fight to construct reality' (Latour 1979: 243).[3]

Hostility

If science and society seem to be irrcconcilable with each other the reason lies primarily in a combination of the three facets of authority, isolation and ability to produce real facts. The aura of science is such that it is presumed that there is no need for the social. There is no need to question why scientists believe what they believe because there is nothing between them and their quest for the truth. "There are no social factors intervening between nature and scientific truth" (Martin & Richards, 1995: 510).

For Merton, whenever science expands its realms and appropriates more of the so called social territory, or 'extends its research to new areas towards which there are institutionalized attitudes', there is a conflict between science and society (Merton 1968: 614). Similarly, Nowotny et al argue that the opposition to science exists because 'science has determined technical processes, economic systems and social structures' and have also 'shaped our everyday experiences of the world, our conscious thoughts and even our unconscious feelings' (Nowotny et al, 2001: 1).

This idea that a certain intolerance or separation exists between science and society is an important feature of most sociological works on science. This separation can be attributed to several reasons. To begin with, it is as much to do with sciences' supposedly incomprehensible- to– non-scientists character, as it is to do with the mere acceptance of science as superior. Latour agues that the uncritical acceptance of the various concepts and terminology used by scientists and those entailed in the subject, has had the effect of enhancing rather than reducing the mystery which surrounds the doings of science. If in our societies men are confused or undecided about science, it is not because we have a lack of information. Often we have too much information. And that leads to inertia. If the increasing scientization leads to increasing confusion it is because there are at times conflicting reports about phenomena, each one claiming to be absolutely genuine and true. This sort of problem is unresolvable if we insist on treating science as a system that will take us near truth. The fact that the public is often deceiver by scientific reports is because we have not as yet learnt to separate science from truth

Secondly, on a broader level, the intolerance is also due to the social agencies and institutions that science and rationality seem to give rise to. The opposition to science comes as much from the notion of trust that is placed in scientific enterprise and its various institutions. Therefore, public attitude towards science is often traced to the experiences in dealing with the artefacts of science, i.e. the institutions, which grow out of and are supported by the rise of science. What the lay masses objects to or forms their opinion from, are not real experiences with laboratory science, but 'the perception of the relevant institutions or social actors' (Wynne, 1995: 377).

Conclusion

For Martin and Richards (1995), there are in essence four ways to study science. Firstly the **Positivist Method**, whereby sociologists study the conflicts within science but do not actually see science as problematic. Second, the **Group Politics Approach**, where sociologists study the various groups involved in and around science- government, citizen's organizations, laboratories, economic agencies etc. Resource mobilization becomes the key factor in this approach. This view also presupposes that much of science can remain neutral till it is tainted by the network of agencies around it. Third, the **Constructivist Approach**, which does not attribute to science any great gift of knowing the absolute truth. The constructivists study the basis of scientific knowledge and also its social dynamics. Controversies are great learning grounds because we can see science in the making and can judge how some information is accepted as true or false. Lastly, the **Social Structural Approach,** whereby science is studied through its social structures and relations that it forms as in the case of studying professional rivalry, male dominance, exploitation etc (Martin & Richards, 1995: 507). All these four approaches have been employed by sociologists in their study of science.

Thomas F. Gieryn argues that it is difficult to build a case for the relations between science and society, without having to define science first. And definitions of science can not be attempted without a formal demarcation between the two and subsequently end in science attaining a superior status. Both Kuhn and Merton were interpreters of science. For them the strength of science lay in its constant striving for increased reliability and validity. Kuhn's notion of a paradigm based science describes the adoption or rejection of one paradigm over another, which is accomplished by different methods of convincing scientists and by testing the probability of the new paradigm. Gieryn argues that Kuhn does not see the very existence of such unity under a paradigm as a case for analysis. "The degree of consensus in science itself might be a matter of interpretation, negotiation and settlement— by scientists and sometimes other involved parties" (Gieryn 1995: 403).

For Merton, science was in essence problem free. Scientists were individuals of high moral standing and the enterprise saw little corruption- 'virtual absence of fraud' even though it saw competition (Merton 1968: 613). Science could be trusted because it believes in the 'suspension of judgement until facts were at hand' (Merton 1968: 614). Gieryn states that Merton's normative interpretation of science remains superficial and develops 'surface rules which do not translate into behaviour patterns in an immediate and direct way' (Gieryn, 1995: 400). The norms of disinterestedness and communism of knowledge are especially controversial and have come under attack especially at present when universities, research laboratories and scientists collaborate with industry for economic gain.

In this light Latour's argument that a 'science freed from the politics of doing away with politics' seems slightly more relevant (Latour in Nowotny et al, 2001: 2). For quite some time now sociologists have argued fairly effectively that objectivity is attained not by blocking but by exposing the subject and by including, controlling and studying it as well. For Latour, it was not a question then of science and society being different or science being exclusive of society. Latour talks of the Inversion of Relationships in the creation of knowledge. Facts are constructed in such a way that they seem untouched by human agents, financial aspects are so subtle and ingrained that material considerations do not seem to arise at all. The point being that scientific enterprise is actualized in such a way that it enables a systematic filtering-out of social circumstances (Latour 1979: 240).

What becomes important from the point of view of this study is that the spread of science does not imply a direct movement of laboratory science to various parts of the society. Science does not get transported alone; it also gets transformed during the very process by which it transforms society. The form of science and its presentation to us are socially determined and an analysis of genetics is the best way to study this.

NOTES

1. Similar arguments can be found in several works. See e.g., Nowotny et al eds, *Rethinking Science: Knowledge and the Public in an Age of Uncertainty.* Polity Press with Blackwell Publishers Inc., U.K. 2001.

2. The same problem forms the basis of a law generally known as the Ockham's Razor. Occam's (or Ockham's) Razor was formulated William of Ockham in the 14th century. The principle is generally quoted as "Pluralitas non est ponenda sine neccesitate" or that "Entities should not be multiplied unnecessarily." Or in its most basic form- "Keep it Simple". The Razor is used to cut away the unnecessary part of a theory. For instance, if two theories are in contention to explain the same phenomena, then we can decide which of the two is better by using the razor. Let's take the example of two theories- Theory 'A' states that an apple from a tree fell to the ground because of gravity; and Theory 'B' states that an apple from a tree fell to the ground because of gravity and because it was God's will. though both the theories satisfy the sufficient condition, that of gravity's role, theory 'B' by adding an extra element (God's will), weakens the statement. Another problem with accepting theory B is that although Gravity is the necessary requirement, by adding God's will to the process, in effect, we end up proving that God's will does exist.

3. Latour is often criticized for his ideas on reality, especially because he seems to argue that reality does not exist but is constructed. He appears to deny the existence of real phenomena and suggests that whatever comes to be believed in, becomes known as real. I will take up this point in the last chapter, and also Latour's defense.

CHAPTER THREE ADVANCE OF GENETICS

Any sufficiently advanced technology is indistinguishable from Magic.
- Arthur C. Clarke.

Biotechnology refers to the use of physical or chemical components of living organisms to create products, instead of simply using chemicals. It is a unique programme as far as its research aims and procedures go and offers a great opportunity for study and analysis. More importantly, it is an example of a technological achievement having spurred a great social debate. It would be safe to say that Biotechnology is one of the biggest technologies of the moment and will continue to harbour changes for a long time to come. Different theorists have given importance to different revolutions in the past, be they automobiles, computers, Internet or space travel. And Biotechnology shares one thing in common with them. It is accredited with pushing back the frontiers of knowledge more than ever before. It has led to a fundamental restructuring of ideas of what human enterprise can achieve and an evaluation of humankind's capability of altering their position in the nature of things. It is not often that we get a chance to challenge all that we take for granted.

Use of Biotechnology

In a field that is still so new and regarding a technology that is still in its infancy, any discussion or writing on Biotechnology involves building a case from the foundation. When in 1953, James Watson and Francis Crick discovered the structure of the DNA molecule, few people had anticipated that in less than half a century, our society would be so dependent on this discovery that we could stand in danger of being geneticized. [1]

The reason why biotechnology is seeing this sort of frenzied activity is because it has a wide range of applicability. There are five major target areas where biotechnology is already or may be put to use. These are Agriculture and Livestock; Industry; Environment; DNA testing; and Medical purposes. What this technology may eventually be used for later is of course not clear, but we can get a rough idea by understanding what is already happening in the five areas.[2]

Some of the most basic changes are taking place in **livestock and agriculture.** Genetic modification, is a special set of technologies that alter the genetic makeup of such living organisms as animals, plants, or bacteria and is accomplished by combining genes from different organisms which is known as recombinant DNA technology. GM products, also called transgenic products, include medicines and vaccines, foods and food ingredients, feeds, and fibers. GM crops are grown commercially or in field trials in over 40 countries and on 6 continents. In the year 2000, about 44 million hectares of land was planted with transgenic crops, in over 14 countries, the principal ones being herbicide and insecticide-resistant soyabeans, corn and cotton (AEBC, 2001: 12). Other crops grown commercially or field-tested are a sweet potato resistant to a virus that could decimate most of the African harvest, rice with increased iron and vitamins that may alleviate chronic malnutrition in Asian countries, and a variety of plants able to survive weather extremes. On the horizon are bananas that produce human vaccines against infectious diseases such as hepatitis B; fish that mature more quickly; fruit and nut trees that yield years earlier, and plants that produce new plastics with unique properties.[3] Similarly animals have been modified to be hardier, yield more milk, lay more eggs etc.

The application of biotechnology in a wide range of **industrial sectors** (chemicals, plastics, food processing, natural fiber processing, mining and energy) has invariably led to both economic and environmental benefits via processes that are less costly and more environmentally friendly than the conventional processes they replace. Microorganisms are being developed to transform raw agricultural materials (starch, proteins, oils) to commercially valuable products such as food additives, fuels, cosmetics, and industrial lubricants.

The use of biotechnology for **environment** comes from two main changes. First, due to the changes in agriculture patterns like the use of pest resistant crops, less chemical sprays are used and dispersed in the soil and air. Secondly, it is developing products especially for the benefit of the environment, like bio-degradable green plastics instead of the non-combustible plastic products.

The application of biotechnology to **anthropology and forensics** comes from the fact that DNA samples can be isolated, separated and studied. No two people have the identical DNA sequencing: samples of hair, bodily fluids or skin can lead to the identification of humans, species, races etc. Scientists are using DNA to determine the degree of relatedness among human fossils from different geographic locations and geologic eras. The results shed light on the history of human evolution and the manner in which our human ancestors left Africa.

DNA typing was first used in Great Britain for law enforcement purposes in the mid-1980s and was first employed in the United States in 1987. Today, the Federal Bureau of Investigation performs most DNA typing for local and state law enforcement agencies, and private biotechnology companies also perform DNA fingerprinting tests.

Even though this technology has the potential to be applied in a lot of different areas, **medicine** is emerging as the key area of its future use. It is often said that when all the human genes are truly known, scientists will have produced a Periodic Table of Life, containing the complete list and structure of all genes and providing us with a collection of high-precision tools with which to study the details of human development and disease (Peltonen & McKusick, 2001:1224). Noel Horner writing for the *Good News Magazine* states that if the discovery of the DNA molecule were the birth of modern genetics, many scientists believe the Human Genome Project (HGP) is its industrial revolution.[4] The Human genome project is an international research effort initiated by the U.S. Department of Energy and the National Institute of Health. It is often called the most important scientific project mankind has ever mounted. The goal of the project was to determine the location of the estimated 30,000 genes which exist on the 23 pairs of chromosomes in the human body and to sequence the entire human DNA. The project began in 1990 and was completed prior to schedule in 2003, which is usually attributed to the rapid advances in computing and the subsequent efficacy in maintaining and storing data. [5]

Stem Cell Research

Medically, genetics may be useful in two ways. First, in the development of improved biomedicine and pharmaceutical drugs which have greater chances of treating the malaise. As causes and spread of diseases are made clearer through the study of genes, drugs can be developed on the basis of the new knowledge. The rise of Neuropharmacology and Pharmacogenomics is indicative of this very trend. Neuropharmacology refers to the development of drugs for neurological disorders. Pharmacogenomics refers to the development of customized drugs, even individualized drugs. The second use of genetics comes through the use of gene therapy and stem cell research through which existing medical practices may be substantially altered.

Biologically, all organisms are made up of tiny cells. Stem cells are those specific cells in the body of every living being, which have three characteristics- they renew themselves indefinitely through cell division, they have no predetermined function in the body and lastly, have the potential to develop into different cell types. They can divide without limit to replenish and take over from other cells in the body if they are damaged. The important fact is that they can be induced to become cells with special functions, such as the beating cells of the heart muscle or the insulin-producing cells of the pancreas or red blood cells, etc. [6]

Stem cells once extracted from the body can be made into or cultured into stem lines, which can be grown indefinitely in the laboratory and do not need to be recreated again and again. Stem cells can potentially be derived from several sources. First, from embryos while they are still microscopic clusters of cells; second, from foetal tissue obtained usually from aborted foetuses; and third, with greater technical difficulty, from adult organs, for example from bone marrow during transplantation. For most researches, stem cells are derived from the embryo. Embryonic stem cells are considered better for research because until recently, it was believed that stem cells from adults were not as flexible as the various procedures and treatments would require. Secondly, adult stem cells are not as easy to isolate and obtain due to the general belief that they get more impure as time goes by. There is also evidence that they may not have the same capacity to multiply as embryonic stem cells do. Adult stem cells may also contain more DNA abnormalities, mostly caused by sunlight, toxins and errors in making more DNA copies during the course of a lifetime. [7]

Studying stem cell has received this importance for several reasons. For one, it is common knowledge that out of all the diseases in the world, medical science has a cure for only a fraction of them. It is argued that a study of genes will provide an opportunity to expand our knowledge considerably by making visible the very genesis of diseases in the body. It will help us understand the workings of diseases like cancers and tumors, which are all, related to cells in the body. Secondly, stem cells will be used for therapeutic purposes. National Institute of Health's *Backgrounder on Stem Cells*, states that current medical therapies use the process of transplantation to replace damaged or diseased organs and tissues. "Unfortunately, the number of people suffering from these disorders far outstrips the number of organs available for transplantation".[8] Stem cells by being able to replace the non- functional cells of the body will be used to treat myriad diseases and disabilities like Parkinson's and Alzheimer's diseases and cancers, spinal cord injury, etc. Almost all aspects of medical life will be altered by stem cell research. Why genetics becomes of relevance to all of us is because in the future even those diseases that have a cure may be treated genetically.

Kervasdoué et al argue that it is a commonly held belief that health is the most precious thing human beings possess. In Western society everyone wants to live 'normally' as long as possible and for that reason they constantly ask their physicians to do whatever they can to prolong their life (Kervasdoué, 1985: xvii). Increasingly, the focus of health is not merely the prolongation of life but also a radical improvement in the quality of life. And as biotechnology emerges on the horizon, one of the most compelling question is, what can this technology do to fulfill this need. The answer that is often received seems to open more debates that it solves.

Genetic Disorders

Eve K. Nichols in her study of *Human Gene Therapy* states that a genetic disease is a mix of genetic factors and environmental factors. Some genetic diseases are apparent at birth but others may not appear until early childhood or later. Huntington disease does not become apparent until after age 30 (Nichols, 1988: 4). Nichols divides genetic disorders into groups to show how genetic therapy will affect them (Nichols, 1988: 6).

Multifactorial Disorders as the name suggests are those diseases which are due to the complex interaction between the environment and one or more gene because of which they can not be interpreted solely in scientific terms. Some of the most common chronic disorders are multifactorial disorders. Examples include heart disease, high blood pressure, Alzheimer's disease, arthritis, diabetes, cancer, etc. In such disorders social factors often play an important role and thus the concept of O-GOD, or One Gene, One Disease does not work. These diseases are for the moment unlikely candidates for Gene Therapy.

Second, are the **Chromosome Disorders** that are caused by either an increase or a decrease in the chromosomal material in the cell, or from an abnormal arrangement of chromosomes. Although gene therapy may be able to help some symptoms of some of the chromosomal disorders, it may never be capable of curing them.

Lastly, the **Single Gene Disorders**, which are the primary focus of research in gene therapy. They make up more than 4000 known diseases including Sickle Cell Disease, which affects 1 in 625 live- born infants (among blacks in the U.S.) and Cystic Fibrosis, which affects 1 in 2,000 live- born infants (among whites in the U.S.) (Nichols, 1988: 8). These disorders are caused by a defect in a single gene. More that half of all known monogenic disorders or single gene disorders lead to early deaths. Most of those diseases in which patients survive beyond infancy lead to restrictions in gaining education, in ability to work, or both. Two thirds impair the reproductive capability of affected individuals.

Quoting a study undertaken by Canadian and American researchers, Nichols argues that modern medicine and surgery have relatively little to offer to most patients with single gene disorders. "In the 351 single- gene diseases they examined, the researchers found that treatment increased life-span to normal in only 15 percent of the disorders, increased reproductive capability in 11 percent and increased social adaptation in 6 percent" (Nichols, 1988: 9). This is also true of diseases where the absence or presence of an enzyme or chemical produces a defect. Parkinson's Disease is caused by a deficiency of dopamine in the brain. Current treatments can help reduce the symptoms of some patients, but most benefit very little. Not surprising then, most of the literature on genetic therapy also gives substantial evidence of what existing medical practices leave to be desired. But what is it that genetics can achieve instead? This is crucial for any understanding of the controversial nature of this technology.

Genetic Engineering

There are two core issues of genetics, which in a sense define the whole programme of biology as well (Griffiths, et al, 1999: 2). Firstly, what makes us a distinct species? Why is it that humans have some properties that are common to all of us by virtue of being human? Secondly, why do variations occur in what we are? Why do all women in a family have black hair and brown eyes or why do men start balding before women? What causes family inheritance patterns, like curly hair, thin lips, large foreheads, etc? The study of present day genetics is bombarding both these issues from all fronts. The former question enables a detailed research into our evolvement and continuance as a species. The latter is the area that allows numerous studies into types, forms and degrees of variations that exist between us and which can be further manipulated. The fact that variations exist at the DNA level and can be produced artificially forms the backbone of genetic engineering.

Genetic engineering as it relates to the insertion of genes into human cells can be divided into four distinct categories: Somatic Cell Gene Therapy, Germ Line Therapy, Enhancement Genetic Engineering and Eugenic Genetic Engineering. (Nichols, 1988: 10)

Somatic cell gene therapy is the main object of interest in medicine. In this form of gene therapy a single gene is inserted into the somatic cells (all cells except reproductive cells) of an individual with a life threatening disease for the purpose of curing the illness. The inserted gene is not passed onto future generations.

Germ line gene therapy is a research that has been performed successfully in several animals. A healthy gene is inserted into the fertilized egg of an animal that has a genetic defect. Because of this, every cell in the body, including the reproductive cells will therefore acquire the new gene. Thus the alterations done in one person affect his or her offspring. This therapy understandably comes with a series of problems. To begin with, there is a high degree of failure as it involves very complex technical procedures. Since a gene is inserted into the egg, slight errors result in the destruction of the egg itself. Secondly, in the case of human beings, genetic defects are not necessarily going to be passed down. Statistically at least there is a 50% chance that the embryo produced by such unions will be a healthy one. So do we then subject all embryos to this experimental procedure when it would be useless for the 50% healthy ones? This is not a case of preventive vaccination as in the case of chicken pox shots or polio shots. Logistically, the procedure should be avoided at present.

Enhancement genetic engineering is the cause of serious ethical and social concerns along with the eugenics engineering. The purpose of this procedure is not the curing of diseases, but as the name suggests- enhancement towards a preferred end. It may be employed to alter genetic traits in "normal" individuals and it could lead to the generation of 'designer babies', or children modeled according to the wants of the parents. Needless to say, the mere mention of this form of genetic engineering arouses great criticism. It seems to do away with whatever may be uniquely individual in all of us. For the moment though, it appears as if current and future technologies may not even be able to come anywhere close to producing such results. And indeed these results are not desired even by the staunchest supporters of genetics.

Eugenic genetic engineering refers to the use of Recombinant DNA technology to modify traits like intelligence, behaviour, personality, aggression etc. These traits are a mix of several factors working upon the individual. They can not be pinned down to single genes which cause a part of the problem because the major work is done by genes interacting differentially with social and environmental factors. Nichols argues that the fear of this technology arises more from society's past experience with Eugenics than from any real assessment of this technology. Scientifically, we are not at that stage where we can even attempt such modifications (Nichols, 1988: 13).

What can be deduced from the above discussion of the technology involved in the debate, is that as of now, research work in laboratories across the world is concentrated on applying somatic gene therapy to the cure of monogenic disorders. The extent to which somatic gene therapy will be able to reduce the burden of these diseases is unclear. What is clear however is that as work progresses in this direction, genetics may become part of standard medical practice (Nichols, 1988: 9).

As mentioned earlier the current medical treatments, like pharmacological, surgery or dietary, etc., work very well in most diseases yet they can not cure everything that ails human beings.[9] It is indubitable and one must assert it, that the progress made by medicine is fantastic. Yet there are diseases, common diseases, for which medicine does not yet have an answer, for instance, numerous cardiovascular and cerebrovascular illnesses. (Kervasdoué et al, 1985: 87) Purely on the basis of biological data on genetics, somatic gene therapy seems to be the perfect answer for all the shortcomings of medicine and will benefit society. If genetic therapy can hope to cure diseases like cystic fibrosis or depression, then why do we need to go into philosophical debates?

We need to get into philosophical debates for several reasons, which mostly arise out of the Ethical, Legal and Social Implications (ELSI) of this technology.

Ethical Implications

The issue of ethics crops up instantly as one reads any commentary on genetics. To say that ethical constraints are raised in genetics only because of its predecessor Eugenics, implies that at present genetics is problem free. Eugenics, a movement, which gained momentum during Nazi rule, saw systematic experiments being done to produce a smarter Aryan race and create stronger humans. Proponents of present day genetics argue that Eugenics and genetics are poles apart and that may be the case. But Geneticists often find themselves having to answer this question and the quickest way out is often stating the critical distinction between social coercion and free choice.

Genetics is controversial for other reasons as well, which usually deal with three problematic issues. First, is that category of concerns that is related to **humanitarian ideas**. This form the backbone to the ethical issue in genetics. Embryonic stem cells can only be extracted from a 5-day-old embryo by a process, which necessarily involves the destruction of the embryo. Two important questions are raised. Is the 5-day-old foetus a human life and if not what comprises a morally significant human life? Secondly, if it is a human life, then what is the ethics of destroying one life in order to save another? [10] Interestingly, U.S. President George W. Bush in his address to the nation in August 2001, stated these reasons as the primary cause behind banning all forms of cloning. [11] Society has to make serious moral decisions about the meaning of life. The problem lies in deciding who 'deserves' a greater chance at life- the embryo, which if allowed to survive would grow into a human being or a sick patient whose life could be rejuvenated by the therapy.

Another aspect of the humanitarian concerns is the apprehension against the mechanical, factory-like production of spare body parts for transplantation as opposed to the current practices of transplants carried out through donated organs. Is the artificial creation of organs, or cells for the convenience of those who are living? The keyword being 'convenience' with supporters of stem cell research arguing that curing a disease can not be termed convenience and others arguing that therapies as drastic as stem cell research should not even be an option.

The second category of ethical concerns relates to the idea of **Playing God**. This often-used cliché assumes all the more importance when it comes to genetics. Are we indeed trying to play god in an attempt to eliminate diseases? Are we trying to manipulate our own evolution? Supporters of this research on the other hand stress that humans are known for their ability to transform and adapt to their conditions and if change is the only thing constant in life, then why are we suspicious about genetics? If change is the order of the day, then why have a rigid outlook?

The last category of concerns deals with the concept of our unique **human identity** and stresses that stem cell research will destroy our essential human characteristics. To argue that genetic therapy will reduce our humanness is to presuppose firstly, that there is something like humanness that we all possess and which only we as humans possess and no other life form does. Thus, there is something sacred about being human, which starts from before our birth and lasts for our entire life span. For Francis Fukuyama, the biggest danger in accepting gene therapy is that we stand to lose out on the one main factor that should be incontrovertible i.e. our unique human nature. Human nature is what separates man from all other creations. Animals may show signs of culture, of language, of emotional attachment and even creativity, but below it all lies something that they can not claim to have – that's a common nature.

Fukuyama argues against using religion as the primary line of attack against genetics as "it leads many to believe that the only reason one might object to certain advances in biotechnology is out of religious beliefs" (Fukuyama 2002: 12). Instead, the problem lies in our growth as a species, which has made us believe that humans are at the apex of natural evolution. Our ability to constantly modify ourselves seems to have given us the idea that we can continue to do so infinitely. Humans can constantly adapt to their surroundings and change the environment to suit their needs. The current technological advances in various fields also corroborate our ability to triumph over life's mysteries. But what emerges as a major problem with such egocentric thinking, is that we have assumed that humans are infinitely plastic and can be 'shaped by their environment to behave in open ended ways' (Fukuyama, 2002: 13).

What is important then, is to distinguish between the natural and the conventional. Changing the conventional is not the problem. But changing the natural should not be taken lightly. Giving the example of the 'two opposite horrors of the twentieth century', Fukuyama talks about Nazism and Socialism, both of which had diametrically opposite views on biology. Nazism argued that biology and race was everything and was reason enough for making a separate nation. Socialism stated that Biology was nothing, and governance could be carried ahead in spite of it. Both programmes failed, and they failed because they were not in touch with human nature and natural patterns of behaviour (Fukuyama, 2002: 14). Fukuyama objects to cloning based on the logic that cloning is unnatural. Disease, suffering, pain and death are a part of what it means to be human. To be deserving of one's sorrows, to heroically face up to one's problems are qualities we cherish in ourselves and in our fellow humans. It is natural for human beings to go through different life experiences and that includes pain, sorrow disease etc. Will we lose that part of our lives, that feeling of nobleness when we let go of diseases?

While Fukuyama's call for preserving human nature makes an interesting read, the problem with such an argument is that though it finds several allies, it can not keep them united. Human nature is a marshy terrain. It is open to various definitions. In an article in the *Economist*, we find a similar argument. "Interfering with our nature is wrong...but humans, typically, behave badly. Ought it not then be our duty to try and alter genes so as to behave better? (Economist, 2002)" Similarly, Noel Horner (1999) states that the desire to rid society of sickness and to foster a suffering-free society may be due to our good intentions, but this sort of view completely overlooks why disease exists in the first place. The reason why there is disease in the world is because we abuse our bodies with alcohol, drugs, improper diet etc. "The problem that man most needs to address—but that we frequently ignore—is the need to change our nature rather than trying to improve on the physical design of mankind." [12]

Another implicit presumption in arguing that stem cell research will reduce our human qualities is that genetics is sufficiently different from current medical practices and can thus have negative effects that no other system could before it. Nichols argues that somatic cell gene therapy represents a logical extension of existing approaches. Quoting from the Presidents Commission for the Study of Ethical Problems in Medicine and Biomedical Research, Nichols states, "gene therapy carried out on somatic cells, such as bone marrow cells, would resemble standard medical therapies in that they all involve changes limited to the person being treated. They differ, however, in that gene therapy involves an inherent and probably permanent change in the body rather than requiring repeated applications of an outside force or substance (Nichols, 1988: 163)."

The hype about genetics often takes the form of an argument where we expect genetics to be foolproof. The problems in cloning animals, rats developing neurosis and Dolly being arthritic, seem to imply that technology has gone awry. If Dolly has failed then so have experiments in other therapies. It would be illogical to argue that current medical procedures followed in most hospitals are completely accurate. Chemotherapy used to treat a childhood malignancy is often known to lead to possible malignancy many years later (Nichols, 1988: 154).

The Legal Implications

These are the second category of concerns in the genetics debate and are related to those institutional problems, which may arise if this technology is allowed to develop. Any discussion of technology is risk-laden. There are enough examples of misleading predictions in the past, be it in computers, Internet or space travel to make most theorists shy away from future guessing. It is in our interest both as a society and as a responsible international community to lay out a few 'scenarios for possible futures that suggest a range of outcomes, some of which are very likely and even emerging today, and others which may never see the light of day' (Fukuyama, 2002: 19). The possibilities of science must be addressed now, whether or not genetics will deliver what it claims.

Legal interest in genetics stems primarily from the potential for **Genetic Discrimination**. Given the rapid development of genetic technologies, discrimination is a problem that threatens to grow over the next few years. The issue of genetics has two main components. First the discrimination that arises out of increased knowledge through testing; and secondly the social ostracism that arises out of any attempt to resist this technology. There will be a period of years when we are able to identify which individuals will be at increased risk to contract certain diseases but we will not have any cures for these. Currently, tests are available for approximately 700 genes, most of which are associated with relatively rare conditions.[13] That small number will soon grow to the thousands, but we will be unable to prevent or cure these diseases. Since each individual carries a number of mutated genes, genetic discrimination and issues of privacy should be important to each of us.

Secondly, our desire to resist or not avail of this technology may create a different hierarchy of "haves" and "have-nots". To be a dwarf, nicotine addict or homosexual in an era when these 'diseases' are medically curable may lead to social ostracism. Does it give us a better society in terms of the availability of technology that can cure a disease, or does this give us a social stigma, a sort of shallow understanding of disease. Do we thus become more intolerant of the disease and of the persons who continue to have it?

Thus, the legal concerns that crop up, relate to the potential for both biological and social discrimination in offices, employment sector, insurance agencies and other areas of professional or personal life. It is not so much a question of whether there should be regulations to prevent such matters, but more a question of what shape such laws may take, keeping in mind socio- cultural diversities.

The Social Implications

Social concerns, while not completely divorced from ethical or legal considerations, stem from the possible effects of cloning on society. Sociologically, these are the most important concerns because they enable us to focus on the main issues that genetics has raised. By keeping ourselves involved with issues of eugenics or ethics of stem cell research the debate remains mired at a relatively abstract level (Fukuyama, 2002: 10).

Polarization

It is often argued that genetics will be highly exclusive in its language and will lead to increasing departure between its information and the rest of our concepts. Peter Conrad and Jonathan Gabe (1999) point out the differences in the social understanding of descent in terms of heredity versus genetics. Will we have to change other common sense traditional notions of descent, childbirth, procreation, reproduction, etc? Similarly, Jackie Leach Scully argues that genetics is changing our definition of diseases as well. Scully describes the changes in the interpretations of Achondroplasia – a form of dwarfism or restricted growth. In the 1950's in U.K. the standard medical textbook *Dunlop, Davidson and McNee's Textbook of Medical Treatment* defined the disease rather simply in purely pathological terms. By 1997, in contrast, *Harrison's Principles of Internal Medicine* describe the same disease with 'vast increase in factual content, and especially the emphasis on molecular and genetic mechanisms' (Scully, 2002: 2). Such changes in the basic understanding of diseases will be of concern especially if this therapy is slated to become a part of the standardized medical practice.

Medicalization

Let me refer back to Kervasdoue et al and the notion of health increasingly being an improvement in the quality of life. A large part of the emphasis on being healthy implicitly results in the inclusion of medicine in our lives. Healthcare services point to the ever intensifying medicalization of our lives. The success of medicine in society is dependent on its ability to bring under its purview new areas of life. Thus various experiences in life, 'once seen as normal, such as pregnancy, childbirth, misbehaviour, feeling unhappy, growing old and dying, became seen as illnesses requiring medical supervision and control' (Taylor, 1999: 271).

This trend of medicalizing all aspects of our being was given a new boost by the desire to view our existence as genetically determined. It is a cause for serious social concern that all areas of our life are suseptible to a genetic makeover. From crime investigation with DNA testing, to planting transgenic crops and breeding genetically engineered livestock, to prenatal screening for genetic defects, there will be no area of life where we can resist genetics. We are being increasingly convinced of our inability to deal with life's problems- biological, emotional, psychological- because the cure of the disease may no longer be a behavioural, attitudinal or environmental one, but a genetic 'invisible- to- naked- eye' one. Our dependency on medical treatment and expertise is in a sense what is aiding the rapid growth of this technology.

Feministic Concern

Another concern with the data emerging on genetics has been the consequences of this technology for women. Several feminists have raised concern over the use of this technology on grounds of medical and social reasons. "The medicalization of the birth process, the usurpation of the role of midwives, and the place of birth (both in the sense of its physical location - in hospital, home or clinic- and in the sense of its more general function in our society) are now recognized as genuine social and moral issues" (Overall, 1987: 10). Reproduction in society does not simply mean procreation. It requires a social understanding of the construction of child rearing practices, sexual interactions and relationships. Overall also argues that the feminist analysis is demonstrating that women's sexual, procreative, and child care abilities are being manipulated, exploited and appropriated to accommodate patriarchal interests. Feminists argue against clubbing the women's issues in genetics along with the rest of the Ethical Legal Social Implications (ELSI). To not give women's health issues a separate hearing is to make women in genetics a non- issue. This technology affects women first of all (Overall, 1987: 1). This will affect women in two ways- firstly women are the carriers of the unborn child whose genes may be altered in gene therapy. Secondly to control or monitor reproductive capacity of women, to trade in foetuses, and to genetically alter embryos appear to several thinkers as the latest form of perpetuation of women's slavery and the latest tool in the hands of a patriarchal society.

Sociologically, a study of the feminist perspective in genetics becomes important to gain a clear insight into the construction of technology as a positive, user friendly system. Feminists have argued that genetics is the newest form of 'reproductive prostitution of women' where their reproductive capability is turned into a commodity. There is a social creation of the utility and efficacy of this technology, which is diametrically opposite to women's experiences. "In contrast to the glorification of this technology...feminists for the most part are not blinded by rosy visions of an approaching technological paradise" (Overall, 1987: 10).

Abby Lippman also warns of the trend to further this technology by marketing it as a woman oriented technology. The key to Genetics lies in its being marketed as a promoter of women's choices. But these choices in medical services which are seen by feminists as a requisite for womens' health are being 'appropriated by politicians and industry and turned into an array of biomedical options for us to use or undergo' (Lippman, 2000:3). Healthcare is no longer seen in isolation, it has become a source of economic development and has to play a part in stimulating the economy. Lippman argues that instead of choices in drugs, women's health stands to gain by improvements in work conditions and social environment. Thus, choices in genetics are only contrived 'as a tool to commercialize and further privatize health' (Lippman, 2000: 3.)

Genetic Determinism

Genetic determinism in a sense is the culmination of all ethical, legal and social fears regarding developments in biotechnology. It refers to a change in outlook, which is compelling us to view all our issues as being governed by genes and thus, providing us with a genetic approach towards solving problems. Nichols argues that it is too early to talk about the impending doom of genetic determinism because genetic treatments would be limited to those diseases that do not have a cure (Nichols, 1988: 69). Other thinkers see a real danger in our dependency on genetics. By viewing genes as carriers of diseases or as determinants of human characteristics we reduce the importance of social and environmental factors in causing illness as well as in the evolution of human beings. This genetic determinism gives rise to a growing sense of Genetic Fatalism, which leads to a sense of disillusionment in tackling issues that are perceived to be beyond our day to day control. Thus our inability to deal with issues of genetics is translated into an inability to deal with issues of health and illness.

Public Understanding of Science

Is there anything in this debate for sociology, if let's say, we ultimately discover that most of the scientific projects do not take off and if not even one more animal or a human is cloned further? Even if the creation of chimeras is taken as an exaggeration, the rest of the technology brings with it more issues than it solves. This is not to question the efficacy of gene therapy as a method of treatment. Gene therapy may work just fine, but the important issue becomes the reorientation of society due to a genetic determinism.

Studying the ELSI is crucial for this research, first of all to recognize that the only opposition to genetic engineering is not through fears related to creation of chimeras and of Frankenstein's monsters. Secondly, it is to realize that there is a very large area of objection to genetics in spite of which further research has been continuing. Proponents of biotechnology often argue that the reason there is so much controversy in genetics is not because the technology itself is problematic but because of a lack of public understanding of science. Science has for long ignored its audience, remained isolated and has been unable to communicate with the lay masses. The lay masses in turn have not given science its due and taken the lack of communication as an indication of secrecy and disputable motives. The problem lies in the faulty communication process between science and society. This argument springs from the same sentiment that suggests that science is good, fraud- free, disinterested and works for the benefit of humankind. "There is a tendency among scientists to assume that the social effects of science must be beneficial in the long run" (Merton 1968: 600). This view assumes that the lay masses are naïve or misinformed and their education in the ways of science is the bridge that is needed to convince them of the utility of science.

The *Science and Society Report* brought out by the U.K. House of Lords also recognizes that the hostility is 'due to a lack of awareness and understanding of the essentially beneficial nature of scientific progress or a lack of awareness by both scientists and politicians of the full nature of public concern' (Dickson, 2000: 918). The Report further states that by listening to public values and concerns, scientists will be able to give the public some assurance that their views are taken into account, increasing the chance that decisions will find acceptance. It locates as a source of serious problem the fact that most people interact with science first in their schools, which employ teachers unqualified to teach science. Most primary school teachers have few science qualifications, and are therefore likely to lack confidence in teaching science. It recommends all schools to prepare 'the most interested and talented pupils for science courses at the university'. Schools must also equip all students for scientific literacy (Science Report, 2000: 6.12).

In India similarly, the *Preface to the Ethical Guidelines for Biomedical Research on Human Subjects (ICMR Code)* states that the recent advances in medicine and technology 'promise unquestionable and hitherto undreamed of benefits to mankind and at the same time they raise many questions of law and ethics, stimulating public interest and concern' (ICMR 2000: 4). The ICMR Code in fact goes so far as to say that public concern should be requited so that there is no undue deterrence to scientific innovations.

The hidden assumption remains the fact that essentially technologies are problem free. New technologies promise unquestionable benefits. The public's interest is aroused only when science is controversial, otherwise people are willing to accept its role in daily life. And if we accept this argument that the hostility is reflective of a lack of correct information about the real workings of science, then, the solutions seem rather obvious. The *Science and Society Report* suggests a need for greater dialogue and openness and an increased role for mass media. Political thinkers often argue for a democratization of science and technology production. Dickson himself argues that none of these methods will be completely successful without empowering people and giving society the capabilities of challenging science. Challenging science does not in any way mean dishonouring the progress made by science in its own evolution and in the development of the wider society. Yet it does enable us to critically examine the ways scientific knowledge is 'produced and applied so that we can make or endorse properly informed decisions about both processes' (Dickson, 2000: 921).

Issue of Trust

It has been argued by sociologists that the reasons for controversy are not a lack of awareness but a deeper mistrust of the so-called modern institutions. According to Brian Wynne, the concept of trust that is associated with science does not come without the notion of dependency. The layman's association with science comes in the form of the agencies that science supports or leads to the establishment of. Once people are dependent on a particular institution or organization, this dependency is often coercive, constraining and leads to a breakdown of trust (Wynne, 1995: 381). Thus, the issue of trust also revolves around the control over technology and information. Fukuyama argues that at this stage in our political evolution, ideas of increased governmental regulation, state- controlled technology, privacy and secrecy of information, become disputable concepts. When we talk of regulation in matters such as genetics, it often comes down to one factor- how much state interference do we want in our private lives. Fukuyama states that in present times, ideas of regulation receive knee- jerk aversion (Fukuyama, 2002: 10).

Myopic Vision of Diseases

In the recent past, sociologists have begun taking an even greater interest in genetics because in a very short span of time, we see around us very familiar concepts becoming very unfamiliar. Genetics is fast changing the meaning of terms like disease, disability, healthcare, individual volition, rights, etc. It is changing the concept and patterns of visibility. Sociologists have raised concern over the resultant myopic vision of diseases. In the biomedical concept of health, disease can be defined objectively in terms of recognized symptoms and health is simply the absence of those symptoms (Taylor, 1999: 254). Geneticists have argued that the patients stand to gain by gene therapy, as diseases will be better addressed and more likely to be cured. Because of genetic intervention, human health will improve and suffering due to diseases will decrease. Even if genetic engineering is not routinely conducted for some more time, increase in knowledge about the body will lead to a greater understanding of the onslaught of diseases, on the basis of which, better medication can be attempted. Neuropharmacology (drugs to treat neurological disorders) and

Pharmacogenomics (custom-made drugs or personalized medicine) will improve current medical practices and drug therapies.

But social thinkers have argued that humans are more that a sum total of their genes. The problem with genetic determinism is that it forces us to find cures only through radical changes in the genetic makeup of individuals, instead of focussing on wider social catalysts for diseases.

For instance, a majority of cancer cases are caused by exposure to environmental carcinogens, not by inherited genetic mutations. Similarly Jackie Leach Scully also argues against the very idea of associating genes with diseases. 'The science of molecular and developmental genetics is straightforwardly concerned with the role of genes in the production, maintenance and transmission of human characteristics, irrespective of whether these characteristics have anything to do with health' (Scully, 2002: 1). The point is that genetics and medicine can not be conflated and the genetic approach to curing diseases solves only part of the problem.

Thus, apart from the fact that genes are not synonymous with illness, is the more basic issue that there can not be a separation of diseases from their social context. Disease may be a medical condition but all its ramifications are social. Steve Taylor distinguishes between impairment and disability. "Impairment means abnormality in the structure or function of the body while disability means restriction of activities of daily living which may also be social, such as negative reactions from others, lack of resources and restricted opportunities in work and leisure"(Taylor, 1999: 263).

Sociology has defined diseases in many ways. Talcott Parsons in *The Social System* (1951) defined disease as a form of deviant behaviour because illness prevents the patient from performing his socially prescribed set of duties. After adopting the sick role the patient must go to a competent professional, seek treatment, abide by the advice and then he shall be exempted from any guilt associated with being sick. Being sick therefore, came in the same parcel as the moral obligation to get cured. Sickness becomes a label, identification and a dominant status, in the case of chronic illnesses. The disease comes to provide an identity to the individual. The label can work both ways- by becoming a means of discrimination or alternatively a legitimation of the patients' symptoms and experiences. Parsons' model of the sick role was criticized mainly for giving a very passive status to the patient as a person who obeys all the orders.

The concept of illness has changed from that of crisis to that of a gradual transformation of identity and experience. "Disease is perceived as a series of status transitions. New ways of life and changes of self- concept have to be negotiated and re- negotiated as the disease progresses and sufferers reorient their relationship to things like work, leisure and personal commitments" (Taylor, 1999: 268). Illness in such cases can not be the Parsonian adoption of the sick role but the adaptation to the sick role. Later sociologists like Marie R. Haug and Bebe Lavin in their book '*Consumerism in Medicine: Challenging Physician Authority*', argue that the patient is not passive but is a consumer of health care. Being a consumer he has the authority to disagree, disobey and challenge the doctor's authority. In a sense then what emerges as an important concern in genetics is that this challenging capability of the patient may seriously be undermined. Scully's example of the difference in the interpretations of Achondroplasia disease (Dwarfism) is bound to increase the gap between the patient and the practitioner. As definitions of diseases change from the living experience to the internal genetic mechanism, the doctors will necessarily subscribe to a more formal language. This increased polarization between the lived disease and the explanation of it will only make the symptoms more invisible.

Therefore genetics manages to obliterate the fact that disease is a way of life. The issue is not value-laden, it is not a question of illness making us noble, the fact is that the visibility induced by genetics is the sort that makes cells and atoms more visible but the issues of the disabled less so. Tom Shakespeare argues that in any study of genetics the message is subtle but clear- disability is a problem and it should be avoided at all costs. Shakespeare further argues that the medical discourse is losing the plot of genetics, because the scientists have lost sight of the disabled people's real issues and problems. The point that needs to be understood in case of the disabled is that the social conditions are as impairing as the biological ones. The biological conditions are individual and varied but the societal conditions are such that need further thinking.

Conclusion

The deeper concern that emerges from this debate must be voiced now. How is it that a technology that is so heavily mired in controversy can ever be brought to use?

Is it the idea of medicine as a bias-free and an a-political knowledge system and the notion of science as a disinterested, universal body of truth that makes us place our trust in the ability of a technology to solve all our problems? Are we facing a situation of increasing intervention of genes in our society, not because all organisms are made up of genes, but because we associate technology with rationality and with the goal of taking us closer to understanding nature? The question is not entirely illogical. The fact is that all other use of biotechnology, from environmental to industrial has become secondary to its application in the field of medicine. This can of course be attributed to medicine being a universal requirement. But there is also a strategic creation of the idea of genes equals health. The call to democratize technology also falls in line with the construction of industrialized nations as health societies. Technology is marketed as being for the people and of the people. Hence, the spread of genetics appears in some ways to be a continuation of the process that began with the breakdown of formal authority of the Church and State and culminated in the growth of rationality, individualism and freedom. Genetics is most certainly being promoted as the highpoint of human achievements – both scientific and ideological.

In the previous chapter we discussed Kuhn's argument that normal science proceeds with the assumption that scientists know what the world is like (Kuhn, 1968: 5). Scientists are the experts without whom we can not uncover the reality of the universe. This belief has in the past paved the way for the inclusion of scientists in our daily understanding of society and in our interpretation of life's processes. In a similar way medicine has eroded our faith in our own ability to deal with the processes of our body. Medicalization brought almost every part of our life under the doctor's supervision. And increasingly as 'badness, sadness and madness' are viewed in genetic terms, they become pathologies that need to be cured (Scully, 2002: 1).

This is not to say that the human race is at a loss because of medicine. But the fact that genetics has brought genes to the forefront and has made the inner body more visible, also does not imply an elimination of diseases. That there is an overemphasis on genes is most easily observable from the fact that a gene is often named after the disease it produces, like the gene associated with Hereditary Hemochromatosis is called the "Hemochromatosis gene." This has two implications- First, that the gene exists for the sole purpose of causing the disease, which of course is not the case as the normal function of a gene is to encode a protein, not cause illness. Disease occurs when genes are unable to work properly. Secondly, and more importantly, it minimizes, if not completely eliminates the role of the social factors in ill health.

The issue of genetics is crucial in understanding how different dots on the paper are joined by a single unbroken line. What concerns us is not an overarching devotion to technology but the socio- politico- economic system. Technology, medicine and the benefit of humanity may be the outer periphery of the debate but right in the middle lies the social structure which appropriates this technology. We could argue that genetics in essence provides a different set of analytical tools by which to view the human body and diseases. To prevent ourselves from falling into the geneticization trap we must sever all links between increasing genetic knowledge and our progress towards any universal truth. The aim of genetics as of most scientific enterprises is not an attempt to save humankind but an increase in knowledge or a testing of its methods.

Latour had argued that the success of any scientific enterprise depends on its ability to convince its opponents. It depends on demonstrating that all problems are solvable but with only one's own methods. "It is not a matter of science. If arguments were sovereign, they would have all the potency of a gouty monarch immured in a crumbling castle. If science grows it is because it manages to convince dozens of actants of doubtful breeding to lend it their strength..."(Latour 1988:205). In the next chapter I will study how biotechnology, in spite of all the controversies, has managed to remain very persuasive and how it has convinced its public.

NOTES

1. For a brief article on Watson and Crick, see for instance Gunther Stent, "DNA's stroke of genius: Crick and Watson will forever be associated with the discovery of the double helix", *New Scientist*, vol. 138 issue 1870 - 24 April 93.

2. For information on the applications of biotechnology see http://www.ornl.gov/TechResources/Human_Genome/project/benefits.html

3. A good source for information on human biology and genetics is *An Introduction to Genetic Analysis,* Griffiths et al ed, , 1999.

4. Noel Horner, "Where will the Genetics Revolution lead?" *Good News Magazine* (July- August 1999).

5. The number of genes estimated earlier was around 100,000. Now this figure has been revised to 30,000.

6. For a brief outline see for instance, *Human Stem Cell Research: Opportunities for Health and Ethical Perspectives*, Canadian Institute of Health Research, Ottawa, 2001.

7. http://www.ornl.gov/TechResources/Human_Genome/medicine/
   Some of the most up to date and relevant information on biotechnology, especially statistics, are only available on the Internet, primarily because the latest findings are reported in newspapers, government web sites and science web sites. Especially useful are sites that give detailed explanations of biological and scientific terms and procedures.

8. NIH Backgrounder on Stem Cells, October 24, 2002.

9. For problems with current treatment of common diseases, see D. P. Burma, "Whither Medical Sciences", *Science and Culture*, pp. 90-98, Vol. 69, March-April ,2003

10. For a brief but relevant discussion, see for instance David A. Lee, "Embryonic stem cells: scientific possibilities, ethical considerations, and regulation in the U.K.", *Interdisciplinary Science Reviews*, (Maney Publishing, Leeds, Vol. 26, No. 2, pp. 112-124, 2001)

11. The full text of the speech is available on the White House Web site http://www.whitehouse.gov/news/releases/2001/08/2001 as well as several others.

12. Noel Horner, July- August 1999

13. This data is from the web site < http://www.workrights.org/issue_genetic.html >

CHAPTER FOUR RESTRUCTURING OF SOCIETY

The march of science and technology does not imply growing intellectual complexity in the lives of most people. It often means the opposite.
– Thomas Sowell

In the previous chapters I discussed the course by which science came to occupy a central place in society and the process by which medicine and lately genetics have entered our lives. Kervasdoué et al argue that since health and health policy revolve around questions of life, death and suffering, societies have responded to these issues through science, technology, bureaucratic organizations, health insurance, biomedical industries, etc. (Kervasdoue et al, 1999: xviii). In this section, I attempt to study how genetics becomes part of socio-political institutions.

I have divided the remainder of this analysis into two parts. In the first part I will discuss the trend of growing geneticization in order to gain an insight into how a largely undeveloped technology becomes a source of contention and how it can be marketed as the basis of further economic and industrial growth. How is the study of genes translating into a social phenomenon? In the second part, I will discuss the regulations formulated by several countries revolving around this issue.

Merton argues that the fact any technology is good is not due to any intrinsic quality it has but because it is deemed beneficial by the people who use it. So widespread and deep-rooted is the belief that technological advance is a self-evident good that men have largely failed to look into the conditions of society under which this is indeed the case. "It is probable that the reputability of science and its lofty ethical status in the estimate of the layman is in no small measure due to technological achievements. Every new technology bears witness to the integrity of science" (Merton, 1968: 614). Similarly Fukuyama also asserts that technology is relevant only in its application in society. Industrialization does not simply mean an elevated technical or mechanical structure of society. It also means the 'bringing to bear of human reason to the problem of social organization and the creation of a rational division of labour' (Fukuyama, 1992: 76).

It is hence necessary to investigate the ways in which genetics is changing the structure of social institutions and the ways in which it is reshaping our relationships. Its impact on the nature of patient- practitioner relationship, organization of health care and availability of funding to medicine become core issues. The funding may explain why the human genome project is the central focus in this biotechnology revolution. It is with this purpose that we study biotechnology firms, laboratories, hospital services, etc.

Another issue to be tackled relates to the notion of restructuring of society. If genetics is in any way challenging the social structure, then how are the various nations and their political machinery dealing with it? We need to look at current regulations in different countries to understand the impact of this technology. The purpose of laws is that they make some movements irreversible (Latour 1988: 57). Regulations give an idea of the urgency and potency of the issue. To have a law regarding genetic research is the best way to ensure that the biotechnology era has dawned. It's a stamp of permanence, even if the law itself is temporary.

If one thinks that the debate on science and on genetics is interesting, the insight into what has already been happening with genetics is even more so.

Geneticization and Society

The study of genes is not a recent phenomenon. Our tracing of genes to Watson and Crick's laboratory is restricted to the analysis of present-day genetics. But for more than a hundred years, cells and genes have been a subject of analysis. Yet the reason why only half a century after Watson and Cricks' experiments, we commonly refer to geneticization, genetic fatalism and genetic determinism, is only minutely due to the nature of genes themselves.

There are two ways to approach the issue of geneticization. The first is a casual approach, which argues that society is under no threat of geneticization because technologically it is not and may never be possible to actualize the scientific claims. The creation of a society on the basis of genetic knowledge is not likely to happen. The grip of genetics over our lives is highly exaggerated and is an illusion held in place by our herd mentality. It is more to do with the overly optimistic reporting of scientific advances by the media, and has little to do with any concrete assessment of progress. Scully argues that the idea of genetic revolution is overly used. The application of modern genetics to society is relatively recent and it is too soon to predict what its social implications may be (Scully, 2002: 1). Dickson states that there is little novelty in the fact that science seems at the same time exciting and full of opportunities as well as full of dangers. Every scientific progress or technological advancement is always accompanied by public qualms (Dickson, 2000: 917). Instead of treating science as problematic, we should treat our own lack of empowered communication between science and society as the real problem. Geneticization has been inflated into a phenomenon by that section of society, which stands to gain directly from it. The lay public does not see itself as genetically constructed, instead promoting genes as health has been 'doubtless productive for molecular geneticists, pharmaceutical companies, manufacturers of laboratory equipment, insurance companies, police forces, genetic engineers and health ministers, among others' (Lippman, 2000: 6).

The second way is to study the various actors and institutions involved in the process of geneticization and argue that there are enough changes taking place already in society for us not to take this revolution seriously. The annual meeting of BIO 2002, the Biotechnology Industry Organization in USA, saw officials from more than a hundred states, cities, regions and countries participating in an attempt to lure biotechnology businesses. An article in the Wall Street Journal Stated, "These officials want to stimulate their economies with a knowledge– based industry to help replace fading jobs in care, corn and computer chips. It can be a risky bet. Biotechnology is not a proven moneymaker; in aggregate, the industry posted $5.8 billion in net losses in 2000, according to BIO" (Hamilton & Gepfert, 2002).

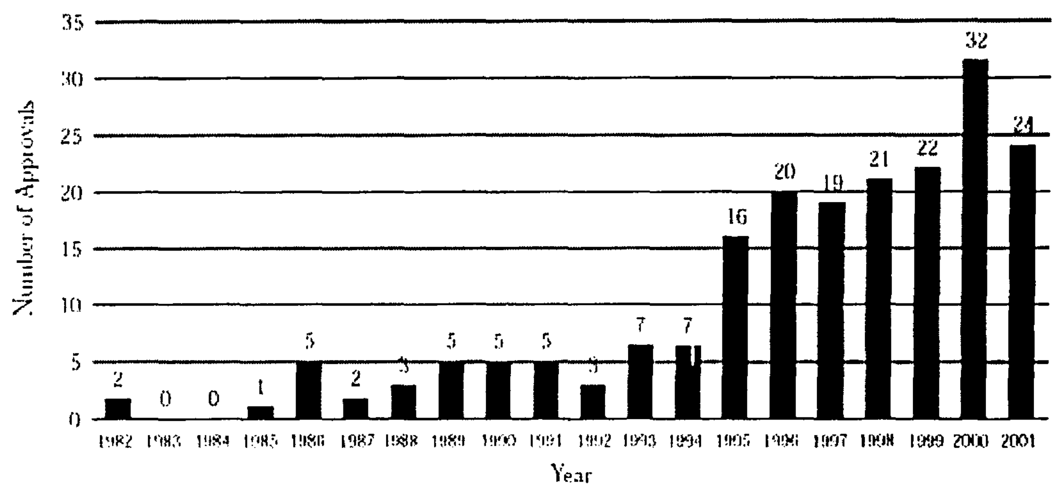
In their report on biotechnology centres in the U.S., Joseph Cortright and Heike Mayer argue that biotechnology is at the centre of a new US economy and has become the focal point of local, regional and economic development strategies. This report covering more than 50 metros in the US showed that growth in biotechnology was most prominent in 9 areas. These nine areas stand up against the rest because they posses two main factors- strong research, and the ability to convert that research into commercial activity. These areas are Boston, Los Angeles, San Francisco, New York, Philadelphia, Raleigh- Durham, San Diego, Seattle and Washington Baltimore (Cortright & Mayer, 2002: 3).

Converting research into commercial activity is at the root of geneticization. The basic point in geneticization is that knowledge is tradable. It is now widely accepted that research is not a unilinear and parallel activity. The boundaries of different organizations have blurred and we see a spiral pattern of research emerging. Innovations see boundary crossing and interconnectedness. If genetics sweeps over our lives, it is because it is linked to different institutions and agencies. This link is impossible in practical terms without some sort of monetary or other transaction. Xin Mao argues that the working draft of the Human Genome Project was completed three years before the expected time, which was also due to the competition between publicly and privately funded teams for the ownership of the completed human genome databases.[1] The ownership of these are thought to have a huge commercial potential. [2]

Biotechnology and Society

Biotechnology Industry Organization statistics show that there are more than 350 biotech drug products and vaccines currently in clinical trials targeting more than 200 diseases. These include various cancers, Alzheimer's disease, heart disease, diabetes, multiple sclerosis, AIDS and arthritis. Biotechnology is responsible for hundreds of medical diagnostic tests that keep the blood supply safe from the AIDS virus and detect other conditions early enough to be successfully treated. If we turn to Chart 1 on the next page, we can see that there is almost an increase of 400% from the mid 1980's to 2001.

**New Biotech Drug and Vaccine Approvals/
New Indication Approvals by Year**



Source: BIO

Chart 1-This chart is indicative of the increase in biotechnological drug and vaccine approvals from early 1980's to 2001. Source BIO

In the area of agriculture, consumers are already enjoying biotechnology foods such as papaya, soybeans and corn. Hundreds of biopesticides and other agricultural products also are being used to improve our food supply and to reduce our dependence on conventional chemical pesticides. DNA fingerprinting, a biotech process, has dramatically improved criminal investigation and forensic medicine, as well as afforded significant advances in anthropology and wildlife management. There are 1,457 biotechnology companies in the United States, of which 342 are publicly held. Market capitalization, the total value of publicly traded biotech companies at market prices, was $224 billion as of early May 2002. In the U.S. the biotechnology industry has more than tripled in size since 1992, with revenues increasing from $8 billion in 1992 to $27.6 billion in 2001. Biotechnology is also one of the most research-intensive industries in the world. The U.S. biotech industry spent $15.6 billion on research and development in 2001. [3]

The same excitement is evident in the rapid changes occurring within the broader society. Health counseling, insurance laws, employee rights, nature of doctor patient relationship, choice of treatments in hospitals, etc. are just some of the key areas that are undergoing transformation due to the introduction of genetics. As with other movements, the ripples are strongest in those areas, which are more deeply connected with advances in science and technology.

Genetic counseling has already become a consequential part of any therapy involving genes. Laws in most countries, including India, Canada and U.K., stress the importance of genetic counseling prior to and after any genetic testing, analysis or treatment. Counseling is seen as a means of providing information and support to families who have members with birth defects and to families who may be at risk for a variety of inherited conditions. Counseling is provided for interpreting the information about the disorder, analyzing inheritance patterns, risks of recurrence, and also providing solutions. Counseling thus involves a mix of medicine and genetics as well as psychotherapy and social work.[4]

Genetic information is a potential source of discrimination and there are growing numbers of individuals who are confronting such problems in employment and health insurance because of diagnosis or predisposition to a genetic condition. Different countries have had to deal with the reality of this issue. In the U.S. for instance, the "Genetic Nondiscrimination in Health Insurance and Employment Act" was passed in 1999. This Act prohibits health plans or health insurance issuers from restricting enrollment on the basis of genetic information. It also prohibits them from adjusting premium or contribution rates based on predictive genetic information. Most importantly it prohibits employers from requiring an individual to undergo genetic testing.

With the changes in the definition of diseases, the doctor-patient relationship is undergoing a transformation as well. Knowledge about disease does not revolve around the patient's symptoms but is increasingly being interpreted in genetic terms. According to Scully, the increase in genetic knowledge and the subsequent increase in complexity of medical language lead to a decrease in the area shared between the doctor and patient and a 'divorce of medical knowledge from the embodied reality in which the experience is lived' (Scully, 2002: 2).

To what can we credit the phenomenal growth of biotechnology? The April, 2002 issue of *Businessworld* proclaimed, "without any warning, in a matter of months, the Indian Biotechnology industry has begun to do what no other Indian industry has done so far: collaborate for research... The collaborations have led to the emergence of a network that can be described as the bio-pharma-informatics network." Even if biotechnology does not hold us too tightly, it does seem to have a horizontal spread and that is in part because genetic treatments are so research intensive that working in isolation is impractical.

Networks

The controversy over genetics has had one major role to play. It has brought out the interconnectedness of different institutions. Science policy is the outcome of the 'dynamic interplay among actors representing what we call different policy cultures' (Dickson in Elzinga & Jamison, 1995: 573). There are four main 'policy cultures', that exist simultaneously in society and are 'competing for resources and influence, and seeking to steer science and technology in particular directions' (Elzinga & Jamison, 1995: 575). The bureaucratic policy culture or the state structure of different countries wants 'science for policy and to make public policy scientific'. The academia, comprising the scientific practitioners, wants to have control over funding and organization of science and to be able to comply with the norms of autonomy and objectivity. The business culture or the industry focuses on the technological use of science and the conversion of knowledge into successful technological products. Lastly the civic culture is concerned with the social consequences of the application of this technology.

If half a century back, science was working in close alliance with the military, what becomes evident now is that science is increasingly working in congruence with society. This is further true as government backing for academic research can be obtained and retained 'only so long as the research plays a key role in the new economy' (Etzkowitz & Webster, 1995: 502). With the acceptance that normal science is seldom esoteric and its research is often commercially driven, science is being looked upon to play a greater role in the building of economies. This regional economic development is not restricted to long term projects like railways or power plants but instead, science is expected to step in place of state-led development programmes of the past. Thus the basic scientific research that propels economic development has increased the importance of the university to the economy. Knowledge economy, a term very much in use refers to this status of science where the markers of economic growth are not just natural resources or land but also intellectual capital (Etzkowitz &Webster, 1995: 481). Hence, to say that knowledge is changing from potent knowledge with indisputable facts to knowledge that is exploitable, implies that knowledge is an investment because it is a commodity.

The Concept of Patents

The economic trade in ideas is most easily visible in the case of biotechnology. Cortright and Mayer argue that intellectual property is the defining feature of the biotechnology industry. The entire industry is research based. 'It involves the creation of new ideas through research, the development of new products and processes embodying these ideas, the testing of the efficacy of these products, and the communication of this information to the physicians and the patients' (Cortright & Mayer, 2002: 8). And most importantly it depends on the safeguarding of these ideas, which is achieved through the process of patenting.

American Medical Association reports that after it was announced in June 2000 that the human genome was almost completely mapped, private and public entities unleashed a flood of patent requests for genes and small pieces of gene sequences (known as expressed sequence tags, or EST's). The patent system is based on the contribution of a single individual or a group of people to the formation of something new or different. It tries to reward inventions or creativity by giving the inventor temporary monopoly over the economic rewards of their invention in exchange for making their designs public. Etzkowitz and Webster (1995), also show that claims which were earlier credited to a scientist after the discovery, as in Haley's comet, or 'Einstein's theory of relativity-are now recognized as belonging to a certain scientist, or a team of scientists, because of the patent they hold on it— such as the Cohen-Boyer patent on DNA cloning techniques' (Etzkowitz & Webster, 1995: 487). The fact that Patenting has become an acceptable part of the research ethic is also apparent if we consider Chart 2 below. While there is roughly an increase of 9 times in the number of patents granted between 1985 to 2000, the increase between 1999 to 2000 alone is around 50% .

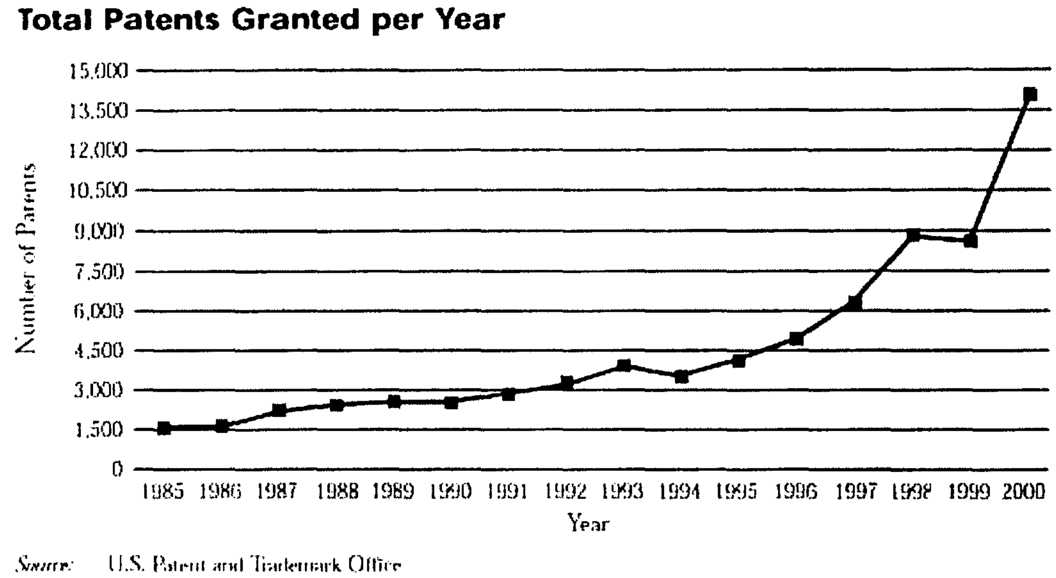


Chart 2- This chart shows the total number of Patents granted in USA, over a period of 16 years. Source- Biotechnology Industry Organization web site http://www.bio.org/er/statistics.asp

Similarly, if we focus only on biotechnology, (Chart 3 below), the number of patents granted between 1989 and 2002 have more than tripled.

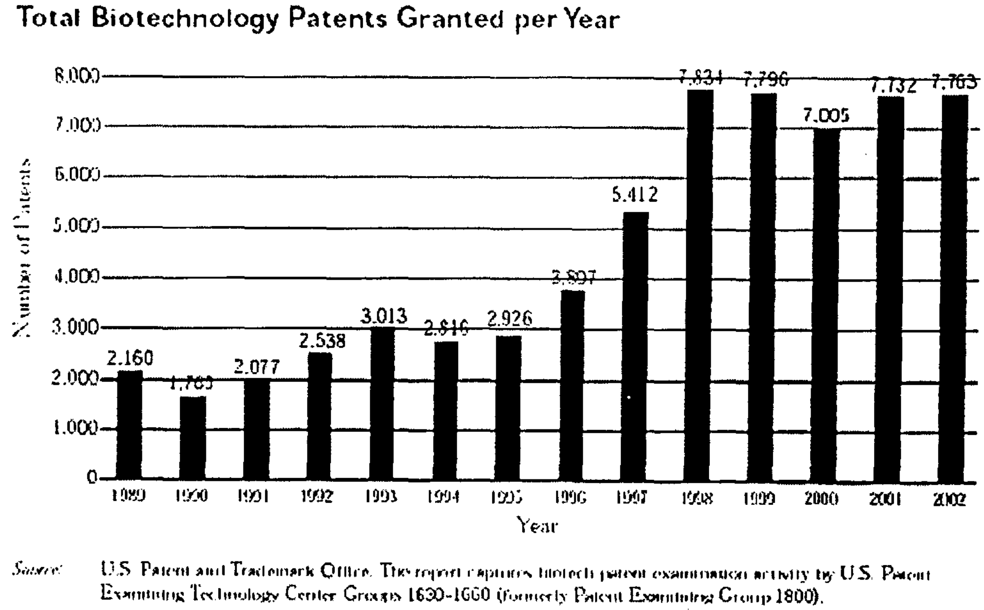


Chart 3- This chart shows the total number of Biotechnology Patents granted in USA, over a period of 14 years. Source: Biotechnology Industry Organization web site. http://www.bio.org/er/statistics.asp

It is no hidden fact that scientists need three things to succeed- Products, Publications and Patents. And all three of these have a cyclical relationship with money. The more funding they receive the more resources they can divert on developing products, authoring publications and acquiring patents and then the more money these stand to generate in turn. Latour and Woolgar (1979), also talk about the accumulation of credit as being important to a scientist for generating returns on his capital. "By its nature, knowledge is evanescent and temporary, because it is always in principle and practice replaceable by new knowledge" (Etzkowitz & Webster, 1995: 483). Since the biotech industry is based on the transfer of ideas, this trading in intellectual property has to be instant. The intellectual property rights have been formed keeping in mind that such ideas are highly contested assets for their academic and monetary value. Intellectual property is not only owned but also enters into property relations just as other ownership does and can be invested, exchanged, its value increased or decreased.

But in the case of biotechnology, what gene patent is achieving is slightly more complex. While the total number of working human genes is expected to be somewhere around 30,000, it represents only about four percent of the total human genome. The remainder of the genetic information is made up of sequences whose functions are currently unknown but may have future uses. In short, ownership of them now may benefit the patent holder later, when their function is determined. But for now it is an investment, done primarily to gain an entry into the economy, which may lead to nothing or turn to gold. A worthy gene will get the owner monetary gain as well as attention from academia, medical institutions and the international community. Thus the research laboratories or research firms acquiring patents know it is a gamble but that the odds are heavily stacked with them especially if work continues to progress in this direction. Patenting is just the first step in the commercialization of knowledge and by itself it does very little for future growth. To get dividends from the patent, the scientists and laboratories need to make sure that the interest remains in the genes. The industrial sector fills this gap.

Industry

The role of the industry is crucial in the marketing of genetics. The Human Genome Project is sometimes reported to have cost in excess of $3 billion. This figure refers to the total projected funding over a 13-year period (1990–2003), for a wide range of scientific activities related to genomics. These include studies of human diseases, experimental organisms (such as bacteria, yeast, worms, flies, and mice); development of new technologies for biological and medical research; computational methods to analyze genomes; ethical, legal, and social issues related to genetics.*

Cortright and Mayer state that apart from the transfer of research, the crucial factor in the development of biotech industries is 'the availability of continuing private sector investment in product development' (Cortright & Mayer, 2002: 5). Biotechnology firms tend to be small and fairly recently established and spend most of their time and resources on research and development. Because research in genes may take a substantial period of time, the funding to run the research, must be made available through some means other than a dependence on the success of the project. "The typical biotech firm spent $8.4 million on research and development and earned revenues of $2.5 million in 1998. In contrast the pharmaceutical firm Merck and Company had net income of $4.6 billion that same year, an amount greater than the collective $3.4 billion losses of all the biotech research firms combined" (Cortright & Mayer, 2002: 8).

The industry in fact stands to gain substantially from research into biotechnology products. There is a realization that intellectual property is a source of future innovation and progress rather than just what it is at the present stage. Research companies can extend their bases over several geopolitical regions. Collaborations with pharmaceutical companies across the world and across national development of research programmes further the profits of industry. For instance, the largest number of biotechnology research firms is in the US while most of the biggest names in pharmaceutical companies are in other countries. Global leaders in pharmaceuticals include Novartis (Switzerland), Hoffman LaRoche (Switzerland), Glaxo- Wellcome

* some details of the genetic budget can be found at
http://www.ornl.gov/TechResources/Human_Genome/project/budget.html

(Great Britain) and Bayer (Germany). These firms sell their products in the United States and most of them have collaborations or joint ventures with U.S. firms (Cortright & Mayer, 2002: 10).

In a sense then, for any enterprise like biotechnology to exist, there are twin processes at work. First, the marketing of the product and for this it needs a strong base in industry and a grasp of commercial trends. And secondly, a justification of the funding involved in the product. Any explanation in contemporary world economies needs to be more valid than a mere assertion that science is useful and indispensable. Justifications are made stronger if more and more sectors of the economy are involved in its products. Thus, joint ventures and bio-pharma-informatics networks are more effective also because it is practically impossible for one firm to invest in so many different areas. This collaborative work benefits all. It makes the research process stronger, impermeable and in a sense makes it difficult to isolate any one sector and put it under scrutiny.

Elzinga and Jamison (1995), argue that if knowledge becomes a contestable, controversial intellectual property, it is because contemporary science sees division of labour in its production sphere itself, leading to an increased interaction between different sectors of the society. That is why guarding this intellectual property has gained as much significance as guarding other scientific resources and material. And this process is paramount when universities, laboratories and research firms try to keep researches private and confidential. The conflict over property rights runs parallel in several areas- between scientists, universities, corporations and also nations. By engaging different sections of the society on a long-term basis in the production, isolation and discovery of genes, the market interest in genes remains intact. And more importantly, it gives the pursuit of science an iron shield that protects against any attack on science.

Increasing scientization in a sense then leads to a world, which on the one hand is formed by intensive networking and alliances and on the other is engaged in an embittered conflict over patents and over larger shares in the state economy and more control over resources.

"As the number of interested parties involved directly or indirectly in the production of scientific information and research flows continues to grow, determinations of proper and rightful ownership become even more uncertain" (Zuckerman 1988a in Etzkowitz & Webster, 1995: 504).

Merton's norms of a disinterested, communal ethos of science seem a bit shaky here especially since legal battles are fought on intellectual property rights. The University of California's human growth hormone research ensnarled the school in high-priced litigation. In 1990, the school sued Genentech Inc. of South San Francisco, California, alleging that the biotech company took the technology and raw material used to make human growth hormones. When the case was settled in 1999, the university came home with a $200 million settlement (Slind-Flor, 2002).

Role of the State

As mentioned thus far, the academia and the scientific laboratory focus on the study of the gene, the research companies work in close alliance with the laboratory and the industry keenly observes all new opportunities. Equally important is the government machinery of different countries. The emergence of the bio-pharma-informatics network is just the tip of the iceberg, with actors from insurance or government agencies, political pressure groups and international bodies keeping a keen eye on scientific advance. The role of the state emerges as a key determinant in health care policies. Kervasdoué et al argue that as the illusion of monetary abundance disappears, both health and technology sectors will come under increasing governmental scrutiny. " The state is likely to extend its power. It will no longer merely finance and regulate the provision of goods and services in the health system; rather, it will be an arbiter in a debate about what is good, equitable, and right in the business of life and death" (Kervasdoué et al, 1985: xix). Apart from the economic forces that would challenge every nation's policies towards genetics, there are also socio- cultural and historical reasons due to which the debate on health care will produce different results in different countries.

To quell some of the conflicts arising out of this debate, elaborate guidelines have been taken out by most countries. The issue being the form that the regulations may take and not whether there should be any regulations or not. These regulations deal with three important dimensions. The international exploitation of nationally generated knowledge and technology, secondly, international technological and scientific cooperation and exchange and lastly, the international generation of knowledge of knowledge and innovation (Edler & Boekholt, 2001: 314). The guidelines can therefore be divided into two main categories- guidelines for research and guidelines for cloning or genetic engineering.

Guidelines for Research

Historically, developed and technologically advanced countries favoured increased protection of intellectual property whereas the underdeveloped nations wanted fewer restrictions. Thus, it is also presumed that any underdeveloped country that reaches the level of the advanced countries would also inadvertently favour increased protection (Etzkowitz & Webster, 1995: 491). For instance, in USA, there is significant importance attached to science and research in 'national rhetoric' (Edler & Boekholt, 2001: 314). Yet the budget for international activities related with science research has not been increased. This is because US being the world leader in technology, stands to gain very little by the exchange of information. It would much rather have more stringent control over ideas so that other countries are not 'free riders' (Edler & Boekholt, 2001: 315).
In the case of developing countries, biotechnology programmes must be evolved in such a way that the potential benefits assist in the national development strategy (Chaturvedi, 2003: 74.

National Institute of Health- USA

National Institutes of Health (NIH) brought out the "Principles and Guidelines for Recipients of NIH Research Grants and Contracts on Obtaining and Disseminating Biomedical Research Resources." This policy is in two parts. It consists of **Principles**, which set forth the fundamental concepts and **Guidelines** providing specific information to patent and license professionals and sponsored research administrators for implementation.

The first principle requires *ensuring academic freedom and publication.* The policy states that academic freedom based on collaboration and peer review of work is at the heart of the scientific enterprise. The second principle requires the ensuring of *appropriate implementation of the Bayh-Dole Act.* The Bayh-Dole Act was passed in 1980. The purpose of the Act is to encourage the utilization of inventions produced under federal funding through encouragement of patenting.[5] Similarly, the Guidelines require *timely publication* so that there is no undue delay in the dissemination of research results. They also require that unmodified and true *materials* be passed on for further research.

Department of Biotechnology- India

The Department of Biotechnology, recognizes that protection of intellectual property is a significant factor in determining strength in the competition for economic growth. In a report on Health Ethics in Six SEAR Countries (South East Asian Region), it was illustrated that India enjoys a large asset of research and development personnel and infrastructural facilities. Yet scientists and policy makers need more information and facilities for protecting the products of Indian scientists. As a step in this direction, a single window **Biotechnology Patent Facilitation Cell** was created by the Department of Biotechnology (DBT) at the Bioinformatics Division of the Department, in 1999. This cell functions to create *awareness* and understanding among biologists and biotechnologists, relating to patents and the challenges and opportunities in this area. It recognizes *patent information* as a key factor in the research and development of biotechnology. All information about developments in the sector of Intellectual property rights should be disseminated to policy makers, bio-scientists, biotech industry, etc.

Guidelines for Cloning

Control of technology is often termed useless because until a consensus is reached on an international level, regulations do not remain effective. In the case of biotechnology as well, some concerned activists argue that unless most nations follow similar policy guidelines, technologies will continue to develop, albeit in different regions. Fukuyama argues that it is naïve to harbour a defeatist attitude in front of technology. In the past we have been able to bring more serious issues under control. Nuclear technology is one example of an international commitment towards control and proper use of scientific advance. The same is possible in the case of genetics.

Governments of various countries are grappling with the problem of scientific advances running ahead of the legislative process and the problem of reaching a consensus on ethical principles based on which legislation could be formulated. As one technological milestone is announced after the other, governments of different nations have reacted differently to the issue. "Many countries have drawn up legislation or codes, or signed Conventions, regulating the creation and use of embryonic stem cells. The response of many governments to reproductive cloning is a complete ban" (Britton & Murton, 2002).

David Lee states that three political philosophies have formed the crux of regulations, based on different interpretations of what lies in the interests of the community. The **Libertarian philosophy** argues for the right of the individual person in deciding his own interests. It tries to limit the use of constraint by a formal authority. Research in biotechnology, from the libertarian perspective, would remain largely unregulated within the private sector. Public funding is of course prohibited keeping in mind that there would hardly be a consensus on such issues. "The Libertarian model, as adopted in the USA, places great emphasis on the source of funding for the research rather than on the moral status of the embryo or of the potential for benefit" (Lee, 2001:118).

The Conservative model stresses the status of the embryo as its main concern. This approach seeks to ban all research in the area. In the ever increasing Right vs. right debates, the conservatives argue that gene research is not a matter of individual rights but instead of what is the right thing for the whole community to do. Lastly, the **Social Democratic model**, stresses the benefit of the research. Research should be allowed if the potential benefit is greater that the potential risk. UK and India's policies fall under this last category.

The Case of India

The **Indian Council of Medical Research (ICMR)** is the national body that monitors supports and provides financial aid for a large number of research projects. In addition, the **Department of Biotechnology (DBT)**, the **Department of Science and Technology (DST)**, the **Council for Scientific and Industrial Research (CSIR)** and the departments of Science and Technology in the various states are other funding agencies.

Pharmaceutical companies are also financing large numbers of drug trials. The ICMR constituted a Central Ethics Committee of the Council. The Committee issued a policy statement in 1980 on "Ethical Considerations involved in Research on Human Subjects". The Committee stated that research involving human subjects was essential for continued progress in providing individuals with better health care options. But at the same time strict guidelines needed to be enforced to protect subjects participating in clinical research. The guidelines state that the rights and welfare of human subjects on whom experiments are carried out should be *adequately protected*. Similarly *Informed consent* should be obtained from the individual by methods that are appropriate and adequate. The clinical investigation on human subjects should be carried out by an investigator who has *the requisite background* and competence to carry out such research and the investigator should have a *framework for obtaining advice*, support and assistance from his peers before embarking on a particular clinical research programme (Kasturiaratchi et al, 1999: 39).

After 20 years, in the light of dramatic changes in science and technology, these considerations were revised. In its place were formulated the "Ethical Guidelines for Biomedical Research on Human Subjects", called **ICMR Code** in the year 2000. While the Preface to ICMR Code states that in light of the recent developments in biotechnology, the universal need for uniform ethical guidelines has acquired a new sense of urgency. It is recognized that genetic data is a likely source of *physical and psychosocial trauma* for a patient and can be a cause of *stigmatization and discrimination* in schooling, employment and general insurance. Since genetic therapy involves *making choices* such as in the case of reproductive therapies, genetic counseling is necessary (ICMR Code, 2000: 40). The guidelines further state that though the technologies provide great benefits, we have to be careful of our own ability to deal with such information. *Informed consent, confidentiality* of the information unless of pressing nature to the general public or required by the court to be disclosed, discussion of potential risks and benefits with the human subject, are stressed as being necessary.

The ICMR code permits somatic cell gene therapy only in cases where patients have a life threatening disease and not for the purposes of changing normal human traits. Germ line therapy, enhancement gene therapy and eugenics therapies are all banned (ICMR Code, 2000: 45).

The Case of USA

The biotechnology industry is regulated jointly by the **Food and Drug Administration** (FDA), the **Environmental Protection Agency** (EPA) and the **Department of Agriculture** (USDA). USA has a more stringent approach to the whole debate. Following an announcement by President George Bush on 9 August 2001, United States federal funds became available for stem cell research on embryonic cell lines already in existence.[6] Before that, more liberal National Institutes of Health Guidelines had recommended that funds were to be available for the creation and use of stem cells from spare IVF embryos. Bush argued that the 60 or so stem lines reportedly in existence were enough for continuing research as cells were self- renewing. Since then there have been reports that only 15 such lines existed, sparking off debates to get this rule revised.

The Human Cloning Prohibition Act 2003 was passed on 27th February 2003 and states that the US administration is unequivocally opposed to the cloning of human beings either for reproduction or for research. The creation of *cloned embryos* or development of human embryos for research is also banned. [7] At the same time, the Administration supports the development of *cell and tissue-based therapies* based on research involving the use of nuclear transfer or other cloning techniques to produce molecules, DNA, cells other than human embryos, tissues, organs, plants, or animals other than humans.

United Kingdom

The creation of embryos for certain limited research purposes was made legal under the **Human Fertilization and Embryology Act 1990** (the 'HFEA'). The subsequent Human Fertilization and Embryology (Research Purposes) Regulations 2001 extended the permitted use of the embryo to include research to improve the understanding of treatment of serious noncongenital diseases. Although legal, such activities are tightly regulated by the Human Fertilization and Embryology Authority set up under the HFEA.[8] A license is required for each project, and there are criminal sanctions for failure in complying. The HFEA must be satisfied that the research project is necessary and desirable.

The **Human Reproductive Cloning Act 2001** makes it an offence to place in a woman a human embryo which has been created by a method other than by fertilization. *Somatic Cell gene therapy is allowed* as well as extracting stem cells from in vitro fertilization process. Cloning using a fertilized egg is banned completely.

Conclusion

The question that is raised at the end of this discussion is how do we understand science, when it moves out of the research laboratory and when by different measures it becomes involved in our lives. The purpose of studying genetics at the empirical level was to understand how alliances form in science and how this networking gives to science its aura of truth. This massive networking also helps in inventing and shaping our needs.

From a sociological point of view it is worth asking why the medical aspect of biotechnology is what receives most attention. Medicine is a primary concern but it is just one area among other areas like environment, forensic testing, industrial process etc. It makes a fair argument to say that we need medicine more as it is both an individual and social concern. For this very reason, it is also true that commercial interests are best served by promoting medicine. Yet it is insufficient to leave the argument here. The answer lies in part on what we discussed in the previous chapters. Medicine is the only area where scientists and technical staff have complete access to our lives, attitudes, and ways of thinking and behaving. Whether we are consumers of health care or adopting the sick role, we have been fed on a staple diet of learning that our body and its processes are not in our control without the doctors' involvement. The problem with geneticization and genetic determination is not that it makes us turn increasingly towards genes for answers but that we interpret previously unproblematic areas as sources of serious problems.

What emerges as the most important part of this flourishing industry, the one factor on which its entire campaign depends, is that the value of genes must be increased. Genetics can not succeed if its research is carried on for the sake of knowledge alone. By engaging different sections of the society, different organizations and different institutions on a long-term basis to the production, isolation and discovery of genes, the market interest in genes remains intact. And by promoting the medical aspect of biotechnology as its primary objective, biotechnology has not only acquired an entry into the health sectors of various countries, but more importantly, it has received a social legitimacy and sanction to continue towards the quest for a disease-free society.

There is no denying that benefit to humanity is a strong motivator for this technology. Yet if the public is appropriating all the details that are coming on genetics then genetics is also appropriating our inability to deal with pain and suffering and replacing it with a detailed map of how the suffering can be eliminated by an inclusion of scientists into our lives. The process has been simple. The medical experts over the past century having proven to us that mankind can not bear too much pain are now convincing us that there is a cure available. The cure can be reached by more state and private funding, more involvement of scientists in our lives and increasingly letting science envelop our daily habits. "It is the transnational pharmaceutical companies, the manufacturers of medical equipment and private hospital complexes that have most to gain from persuading doctors that medical treatments can be applied to an ever widening area of social life" (Taylor, 1999: 271).

Cunningham-Burley and Kerr argue that by advising on the social implications of genetics, scientists are becoming not just experts on science but also on society. The monopolistic control of science over society is reflected in the fact that to address the social issues in genetics, N.I.H and Department of Energy have allocated 3-5% of their budgetary allowance to ELSI departments. By advising on social issues now scientists have become experts on not just science but also society. Similarly the UK House of Lords report stresses that public dialogue should be initiated between the two, while no where addressing why science has the position it has (Conrad & Gabe ed, 1999).

If genetics has become a movement it is in spite of the fact that health does not mean the elimination of disease alone. Alternate forms of medicine have also not disappeared. Volition in systems of therapy exists and it is going to be a long road ahead for genetics to see somatic gene therapy having any success. What is disappearing is the faith in a body of knowledge, which is not corroborated with genetic data. The impact of scientization is such that the more precise or professional a technique is, the more accurate it is presumed to be. It becomes important at this stage to again go back to growth of science and understand the construction of genetics as an intrinsic part of science.

NOTES

1. Xin Mao. 'Economics Issues of *Genetics' Bioethics and the Impact of Human Genome Research in the 21st Century.* Norio Fujiki eds: (pp. 95-101. Eubios Ethics Institute, 2001)

2. See for instance, Andy Coghlan, "The Revolution has Begun", *New Scientist*. Vol 169 issue 2278 - 17 February 2001

3. Statistics are from Biotechnology Industry Organization web site http://www.bio.org/er/statistics.asp

4. Information can be obtained from the US National Society of Genetic Counselors Inc.

5. Bayh Dole Act created in 1980, created a uniform patent policy due to which small or big businesses, universities and other institutions can retain title to their inventions but they are encouraged to cooperate with other sectors so that their work can be commercially utilized.

6. The full text of the speech is available on the White House Web site http://www.whitehouse.gov/news/releases/2001/08/2001

7. http://www.theorator.com/bills108/s245.html

8. Lee, David A. 'Embryonic Stem Cells; scientific possibilities, ethical considerations, and regulations in the UK', *Interdisciplinary Science Reviews*, 2001, Vol 26,No. 2

CHAPTER FIVE CONCLUSION

We should take care not to make the intellect our God. It has, of course, powerful muscles but no personality.

- Albert Einstein.

Through the past chapters, I have taken up various concepts, ideas, and relationships and tried to integrate them in a debate about science and society. Notions of authority, truth, isolation, reality, progress, institutional and structural transformations, regulations, trust, information, knowledge, etc, are some of the key factors that emerged in this study. The purpose of this research was not to portray in any way that somatic cell gene therapy or biomedical therapies are indeed a superior alternative to the existing medical practices or alternately that they will not work and are in reality hyped. They may work very well and may indeed become a major part of the choices available in health care. As work continues on cloning and genetics, scientists are bound to be startled both by their limitations as well as their ability to make great pathways.

The purpose of the research was to highlight four main problems in attempting a sociological study of genetic revolution and its impact on science and society. These four main problems are- Sociological Study; Genetic Revolution; Impact; and Science and Society. The purpose was to critically analyze these very familiar concepts and portray that all put together, they seem to create a potency that is unsurpassable and yet is ephemeral.

Sociological Study

At the beginning of this text, I discussed the fact that since its birth, sociology has had to deal with the question of science, with positivism and with making its own theories and methods more objective. The importance of Comte does not just come from the fact that he delineated three distinct stages in human ideological development. Instead Comte, by associating the nature of science with the notion of liberation, declared science as supreme. The sociological study of science is made more difficult because science is often treated as a reference group for sociology. We keep addressing the scientific community, either to snub them or to make ourselves more objective and more accurate.

Alan Sokal, physicist at the New York University wrote an article, "Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity," in a culture studies journal, *Social Text.* In the article one of Sokal's assertions was that postmodern science has abolished the concept of objective reality. After the publication of the article, Sokal himself revealed in the journal *Lingua Franca*, that his essay was liberally and deliberately salted with nonsense and was written as a test to see whether a paradoxical article would get published if it sounded good and flattered the ideological preconceptions of the editors. Sokal claimed that his purpose was a rebuttal to those untrained in science, that they have no business deconstructing it, analyzing its environment and much else uncovering hidden meanings from its conclusions. [1]

And Sokal is probably justified, for sociologists have used scientific theories and findings to show several times that even scientific knowledge is transitory. Science can not be satisfactorily understood only through its facts. A very definite lacuna is created by the exclusion of sociologists from any scientific study. Kuhn's own study reads like a who's who of scientific names- from Lavoisier to Einstein, from Lord Kelvin to Wolfgang Pauli - all woven in an argument centering around the fact that scientific facts do not exist in themselves. The history of science reveals that more than the fact, what has determined the course of science is how one is able to identify and interpret those facts. The interpretations gain meaning only in the social context. Facts do not have sanctity of their own, it is their meaning that gives to them their potent character.

At this stage we need to ask whether removing error is the burden of science alone or is error minimizing a neutral territory. Sociologists like Latour would probably assert that such hoaxes defeat the entire purpose of both sociology and science. Not giving the outside world its sacred status does not mean that we think the world does not exist or that gravity and global warming are not real issues. It only means that the outside world and its reality are not ahistorical and asocial. Reality is also more than the sum total of its parts. Reality is usually a hypothesis both in science and in society.

Latour's study on Pasteur is an important part of sociological work on science for two main reasons. Latour did not shy away from dealing with the scientific part of science, nor from critiquing sociologists' narrow reductionist interpretations of science. Latour is influential because he is among the few sociologists who talk not of the social relationships formed between different agents in the society but of associations existing everywhere, including those between man and microbes. The external factor, microbes or genes, is no longer external when sociology becomes a study of associations and not just a study of relationships (Latour, 1988: 38).

The problem with sociological studies of science seems to be that they are often at two extremes. Either science is revered and consequently only its social surroundings are studied. Or science is so thoroughly assimilated into other knowledge systems that its identity and concepts are completely dissolved in lay terms.

Genetic Revolution

The story of genetics is largely constructed along the lines of a Greek tragedy, where the noble heroes suffer not because they are wicked but because of their best intentions. It is often argued that genetics stems from a noble cause and conflicts arise not from the fact that medicine fails but because it may succeed all too well. It is this desire to bring improvements that has caused the entire debate. Thus, western medicine, including genetics is still on the quest for truth. But till this truth can be made evident, genetics will continue to face controversies.

The idea of a Genetic Revolution is problematic because it carries several presumptions. For one, it presumes that genetics will sweep over our lives. A part of this has to do with the reception given to computers and Internet. Their success seems to suggest that technologies will homogenize the world. Interestingly, it is often argued that the biggest problem due to Information technology is that it has created the haves and have-nots of technical know-how. Since Biotechnology will help not just on the individual level but will also solve various crises of developing nations, like pollution, lack of food resources, etc., it will eventually aid humanity. Everyone will benefit in some way or the other.

More importantly, although technological advance in the contemporary world is the basis for future development of societies, technology itself can not be interpreted as inherently progressive. Genetics demonstrates how science is fraught with issues-technical, social, political, economic, legal and so on, which give to it both its sense of importance as well as its very profane character.

Another implicit assumption that arises due to the ELSI debate is that society appears to be under the threat of being geneticized. Therefore it is important to ask what the reality of genes is. Can we become geneticized in the first place, if genes can not be conflated to diseases and more importantly if diseases are as much caused by social factors, natural environment and mental trauma? The problem then is not so much to do with our acceptance of genetics, but more to do with our negation of other alternatives. Genetic knowledge will not be used in combination with other forms of existing knowledge and will be exclusive in its approach. Thus, by emphasizing genetics, the focus will be removed from social and environmental causes of diseases.

The concept of revolution also implies that genetics is sufficiently different from existing medical procedures and its therapies are unprecedented. But medicine and medical science has challenged the concept of natural right from the beginning. Organ transplants, blood transfusions, and even skin grafting are treatments whose naturalness can be debated. So what makes genetics any different? The biggest problem with arguing like Fukuyama does along the lines of a pervasive and unique human nature is that we result in declaring that human beings are a product of their genes. If it is so unnatural to tamper with our genetic makeup and if it threatens our identity as human beings, the only reason could be that genes are what make us human. We thus end up proving exactly what we wanted to negate. Furthermore, we make it impossible not to enter into a race to control our genes. If genes do not give us our distinct identity, then there is no harm in tampering with them. On the other hand, if they are at the core of our existence, it would be best to understand and control them as much as we possibly can.

Impact

The question of impact is twofold- the impact by accepting genetics as a form of therapy and secondly, the impact of science on society. Is the reality of genes a question of what controls us more- our heredity or our surrounding? The nature-nurture conflict is often invoked in the case of genetics. John Locke argued that social environment shaped us more than heredity. Francis Galton thought it was the other way round. Similarly, geneticists can argue that finally there is proof of how much we can control our lives once we gain control over our genes. And that after careful scientific study, the pendulum has swung in favour of nature. [2]

Feyerabend argues that in a free society there is room for several strange beliefs. It does not matter if people want to believe in the superiority of science, as long as the myths of science affect limited numbers of people. But in contemporary world, the assumed superiority of science is so prevalent that it is no longer confined to a field of inquiry, and has become the base on which social institutions rest (Feyerabend, 1978: 74). The issue of science as reality is essentially that it is a lived in reality. The historical presentation of science is not sufficient. We never say that some people believe that the earth moves around the sun, we just say that the 'earth moves around the sun' (Feyerabend, ibid). The point is that it is not genetics that is impacting us, the deeper issue is that genes are just one more addition to the long history of science's domination over society.

The concept of impact needs to be studied more thoroughly because it accepts the authority of science. Genetics can impact us, force change upon us and will be constraining. The network around technology involving healthcare sector, government, research firms, laboratories, etc., forms a web around us. Scientists will continue to hold their status because genetics seems to open up a new set of possibilities for other-worldly asceticism, where the other world is the very distant and inaccessible internal human body. We are forced to trust scientists on the question of science.

Science...

The relation between science and society is the most definitive aspect of any study on science. It is assumed that science encourages open debate. While most religions indoctrinate their followers, science develops the spirit of exploration and encourages criticisms of its ideas. Most importantly, science is a-political. It has no hidden agenda, it does not belong to a particular ideology and thus, is a single-minded quest for truth. The construction of science seems to suggest that there exists a spectrum of reality and science is closest to it. Feyerabend argues that a pro- science attitude is acceptable till the state policy starts supporting science. Science may have stood for a force of liberation when the theological stage determined our existence, but now it is more coercive than freeing. Science has become a dogmatic religion precisely because it has become the dominant ideology, stifling away all alternative courses of action (Feyerabend, 1978: 75).

It is often stated that the hostility between science and society can be reduced through better dialogues between the two and by democratizing the use and creation of technology. The problem with democratizing science is that we democratize processes like choice of research topics, flow of finances, etc. But the very construction of what is science and what are facts is completely totalitarian. Every thing else is subjected to democratic scrutiny except the judgement of scientists, who are everything from laboratory technicians, to ethicists, to policy makers. The entire point of having democracy is that there needs to be equal representation, not equal access to one single representation. Thus, the democratization process that is often encouraged, becomes in fact the democratic means to choose science. Everyone has equal opportunity to pursue a scientific career and have access to western medicine in hospital and have free primary education based on the curriculum prescribed by science (Feyerabend, 1978: 74). Democratization thus, leads to a strange sort of assimilation. Everyone is assimilated into the main ideology.

But the entire purpose of having rights is that we want the development of informed, 'mature citizens' (Feyerabend, 1978: 87) that have been bred on the culture of knowledge. The active participation of lay masses in science can not be achieved till the autonomy of scientists is left unquestioned. Whether this is achieved through treating science and society as irreducible to each other (Latour, 1988: 158) or by arguing that the laymen should be able to catch mistakes made by scientists (Feyerabend, 1978: 97); society must not be seen as antagonistic to science.

...And Society

The problem with the notion of society in studies related to science comes simply from its being viewed as the passive soil where all action takes place. Society is the paradox of science; it is the 'in spite of' in science's association with the social. The old understanding of science assumed that science produced truth and because of that science must have a place in all those areas of society where high moral standing, clarity of vision and honesty are desired.

There has to be some central thought, along which the policy and governance of nations is based. Health care systems are organized keeping in mind the prevailing values of the society. Every country has a unique blend of history, culture, religion, etc. Various social and ethnic groups of every nation need to be represented and a balance needs to be found in order for those policies to be formulated which benefit maximum people. As societies differ in shared values, the health-care systems in various countries must be to some extent different also. Three main philosophies that have determined the course of policy, which I discussed in the previous chapter, are Libertarian, Conservative and Social Democratic.

Both Libertarian and Social democratic ideologies stress their democratic basis. They have the greatest benefit of the citizens as the main focus. Yet the main point of emphasis differs in both. Libertarian philosophy defends the rights of an individual in a democracy. These rights are common to all members of the society. Fukuyama states that the basis of rights is not a moral or political order but human nature (Fukuyama, 2002: 111). Rights deal with what is considered natural for humans e.g. since freedom is natural, freedom is a right, etc.

Libertarian philosophy forms the backbone of the US policy on science in general and cloning in particular. It assumes that big governance does not work, not in state control, neither in health care. It is fiercely pro- democracy in what is allowed. Everyone gets to choose and volition is accompanied with intense debates. Since individual choice of action is stressed, this method tries to appease every section of the society and often finds no consensus. The Libertarian method works best in developed countries where private individuals or firms have the amount of capital needed for conducting their own research or for entering into collaborations with other groups. The US has several such cases, e.g. Michael J. Fox Foundation supports stem cell research and has an aggressive funding campaign aimed at finding a cure for Parkinson's within this decade.

But in poorer, developing or underdeveloped countries, it makes little sense to leave scientific research in the hands of private businesses, research universities and laboratories. The role of the Government will have to be key in these countries. But the point even here is that the democratic choice available is between how best to appropriate science. It is often not a choice between alternate forms of medicine, but simply between different options among technologies.

Social democratic philosophy on the other hand is a mix between welfare principles and democratic ideals. The individual has rights, which need to be protected. But equally important is the benefit of the entire society. With the illusion of abundance quickly disappearing, it is realized that health care can not be subsidized in most nations (Kervasdoue et al, 1985: xix). With limited resources at government disposal, choices have to be quickly made regarding which area to promote for development. Progress in one direction can not be made till it is stopped in another (Feyerabend, 1988: 89), therefore, supporting genetics as a method of treatment becomes a huge decision. The involvement of taxpayer money makes this decision more subject to criticism. In the case of privately funded research, as in MJF Foundation, the answerability is limited to the few people who make donations or the media if the research is hyped. But with the social democratic model, the role of the government is central as is the role of committees that make decisions about important matters.

David Lee argues that Conservatism stresses the maintenance of the present order. This approach defends the status of embryo, and seeks to ban cloning because it brings forth unprecedented changes (Lee, 2001: 118). On a personal level, taking the Conservative approach seems the least suitable. Being so far ahead in the era of technology, it does not make sense to stop progress all together especially when progress touches areas like medicine, crops, environment, etc. When the future of the whole world literally can be altered by the safe, regulated use of technology, then it would be a mistake to give the opportunity up.

Fukuyama states that controlling technology is possible. Till far we have done a great job controlling nuclear technology. The same can be done with biotechnology, provided that international laws are found and strictly enforced. The conservative approach reads more like a doomsday forecast rather than a serious analysis of technological risks, capabilities of scientists and lack of societal and governmental interest in regulating it.

Unfortunately for lawmakers, whether or not we need to regulate this technology and how much we desire to legislate it, is not decided inherently by our genes. This is a decision that we all must take, keeping in mind various socio-political, cultural, economic historical and even geographical reasons in mind.

Sociology studies the functioning of human societies and the cultural and social transmission of data through socialization of values, attitudes, norms, etc. Can we apply something so inherently non-genetic to the study of genetics? The problem with genetic engineering is not only its attempt at eradicating diseases but that it may inadvertently devalue the social skills and social groupings that are part of the network of diseases. Genetics offers a lot by way of change but very little by way of understanding ourselves. Apart from genetics not turning out to be as miraculous as we want it to be, the concern is the fact that it will turn all other forms of medicine and subsequently all other forms of thinking into an "alternative." If western allopathic medicine resulted in homeopathy, and Ayurveda being called alternative, then genetics is likely to compound the problem.

There must be some way to challenge the authority of science without making it superior first. The purpose of this study was an experiment to analyze how sociology could help in the interpretation of genetics and also, what could a study of genetics explain about the construction of both sociology and science.

"Ever since the beginning of modern science, the best minds have recognized that the range of acknowledged ignorance will grow with the advance of science. Unfortunately, the popular effect of this scientific advance has been a belief, seemingly shared by many scientists, that the range of our ignorance is steadily diminishing and that we can therefore aim at more comprehensive and deliberate control of all human activities".

-Friedrich. A. Hayek

NOTES

1. All information regarding Prof. Sokal and the hoax may be obtained at New York University web site (22 June 2003) http://www.physics.nyu.edu/faculty/sokal/

2. See for instance, "What Makes You Who You Are", *Time Magazine,* June 2, 2003, Vol. 161, No. 21

3. Information can be obtained from the Michael J. Fox Foundation for Parkinson's Research (2001- 2002)at http://www.michaeljfox.org/

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