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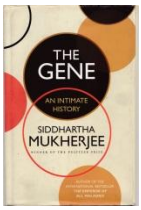

THE GENE: AN INTIMATE STORY Authored by SIDDHARTHA MUKHERJEE
Published by PENGUIN ALLEN LANE, Gurgaon, India; 2016; pages 592, Rs:699

"the largest negative eugenics project in human history was not the systemic extermination of Jews in Nazi Germany or Austria in 1930s.That ghastly distinction falls on Indian and China, where more than 10 million female children are missing from adulthood because of infanticide, abortion, and neglect of female children. Depraved dictators and predatory states are not an absolute requirement for eugenics. In case of India, perfectly free citizens left to their own devices, are capable of enacting grotesque eugenics programs-against females, in this case- without any state mandate" (page 457)

Darwin's theory of evolution and Mendel's laws of inheritance are the revolutionary ideas proposed in the nineteenth century. In the twentieth century, the discoveries such as the chemical nature of genes, the double helix structure of DNA and the genetic code could explain the ideas of evolution and inheritance proposed earlier. As the understanding of life at the molecular level increased, which not only reaffirms our faith on the role of DNA in shaping our life, it also contributed significantly towards the development of science and technology, human health, safety, food security, environment protection, etc. It is beyond doubt that our intimacy with gene has increased at present and we are trying to connect every action of human with gene. Having said this, our surroundings and life style also have a lot to do with the way our genes function to make us a healthy human being. Along with several positive contributions, our understanding of gene has resulted in the development of certain social ethical issues including the latest controversy regarding the human genome editing. The recently published book "THE GENE, AN INTIMATE STORY" written by Dr. Siddhartha Mukherjee tells us the story starting from Darwin's theory of evolution to the human genome editing. Apart from its content and style, what keeps one wondering is the memory,

analytical, imaginative and poetic power of the author, who was born in 1970, after the discovery of the genetic code.

The beginning of the book covers the discovery by Mendel, evolution theory by Darwin, and Eugenics movement from the late 19th Century till the mid part of the 20th century. The story of the eugenics movement in Germany is well known to many and so also the story of Lysenkoism in Russia. In contrast to the excessive belief and stress in the role of gene that resulted in the ruthless killing of millions of Jews in the name of eugenics in Germany, biological research almost came to a halt for several decades in Russia due to the lack of faith in gene. The author has beautifully compared both the contrasting phenomena. Both nature and nurture are important for human growth. However, the excess of anything is dangerous. The merciless experiments done by Mengle on Jew twins described by the authors suggest that with given power how dangerous and cruel can be the human mind sometimes while pursuing behind knowledge.

The next part of the book talks about various aspects leading to the discovery of the DNA structure which includes genetic linkage in Morgan's laboratory, Griffith's experiment and Avery's conclusion of DNA as the genetic material, gene for gene hypothesis by Beadle and Tatum, and finally the discovery of the DNA double helix structure by Watson and Crick. Discovery of the regulation of gene expression by Jacob and Mondo in France, the role of homeotic gene in development of *Drosophila* initiated by Ed Lewis in Germany, and the role of cell death genes in *C. elegans* by Sydney Brenner in UK have been introduced in a systematic manner. Genetic code was discovered after the invention of polynucleotide synthesis method. Finally we could read gene by the sequencing method invented by Sanger in UK and Gilbert in USA. While developmental genetics work was going on in Europe, in America the discovery of DNA polymerase, RNA polymerase, DNA manipulating enzymes happened. These all resulted in the development of recombinant DNA technology. As the author is a student of Paul Berg, the Nobel winner for the recombinant technology, the book describes the various incidences happened soon after

the discovery of recombinant DNA technology in detail. Scientists' concern on biosafety arising from rDNA work, the exact initiation of Asilomar conference to draw the biosafety guidelines for recombinant DNA work, unwanted controversies among scientists relating to biosafety guidelines have been described vividly by the author. In spite of it, S. Cohen in Stanford University pioneered in recombinant techniques joined with H. Boyer from UCSF to start rDNA work in bacteria. Their collaborative research was catalysed by young businessman Swanson to start up the first biotech company, Genentech resulting the production of first recombinant drug molecules Somatostatin and Humulin (human insulin). The biotech company opened up the service of gene to mankind and gene into business.

The author remained focussed on genetic diseases in human, the role of nature *versus* nurture in human development, how gene can be targeted to cure incurable genetic diseases, human genome sequence, human evolution and the role of gene in human future. The discovery of heritance of diseases (alkaptonurea) in human was done by Garrod in 1905. By 1998, McKusick had documented a total of 12,000 genetic disorders in human, of which 3700 diseases are linked to single gene disorder. Because genetic diseases are incurable, in 1968 the first therapeutic abortion of a potential down-syndrome foetus was done under the law in USA. As many parents adopted this strategy to avoid genetically weak children that reduced the case of down-syndrome in USA. After the invention of *in vitro* fertilization, parents could go for pre-implantation genetic diagnosis (PGT) of embryos. In 1989, an English couple having family history of an X-linked immunological syndrome that only manifests in male children, selected only female embryos for implantation and two female twins were born that were disease free. Abortion of the genetically weak foetus or avoiding implantation of genetically weak embryos were seen under negative eugenics (selection against certain genetic disorders), which is different from the positive eugenics (selection of human with certain traits) in Germany. While children with genetically inherited diseases were avoided by using abortion or PGT techniques, these

techniques were misused in a large scale in China and India to have children of particular sex. The negative eugenics in these two countries has cost the life of more than 10 million female children, which is bigger than the number of Jews exterminated by Nazi Germany.

Not all potential genetic disease carrying foetuses could be detected during pregnancy. To further understand the human better, the project to sequence the whole human genome was initiated in late 1980s. The book gives a detail account of all the discoveries leading to development of molecular markers in human by Botstein, cloning of cystic fibrosis as well as huntington genes, human genome sequence, the impact of human genome sequence to study human evolution. The book discusses about gene therapy and scientists' interest to target genetic diseases such as sickle cell anaemia, Tay-Sachs disease and severe combined immune deficiencies (SCID) that are monogenic in nature (due to defect in a single gene). The failure of an attempt of gene therapy in case of Jesse Gelsinger leading to his death resulted into the abandonment of the gene therapy research. Abandonment of the scientific research does not solve the genetic problems in human. The author discusses about complex disorders such as Scizophrenia, bipolar disorders, Autism and homosexuality in human, genetic predisposition to these diseases and the role of environments. This book also gives a detail account of sex determination gene in human and Swyer syndrome where a female is with XY genotype, typically of a male, but with a defect in SRY gene in the Y chromosome, and different efforts made by scientists for sex reversal. Towards the last part, the book discusses about the discovery of the gene modification method CRISPER-Cas9 to do precise changes in genome and its possible implementation to change in human embryo to produce transgenic human, to which many scientists are expressing their concern. Amidst all the protests, in 2015, Junjiu Huang, a Chinese scientist reported genome editing in human embryo. At the end, the book leaves the reader to imagine the future of human genome editing research.

Overall this is an extraordinary read for biologists, teachers, social

scientists interested to learn the fascinating story about the discovery of gene, the role of gene in human development and diseases, and to understand the endless efforts made by scientists to understand the role of environment on human. So many different facts have been told, such a nice way these have been put forward, whatever amount you say about the book, will be lesser to describe it fully. Different readers will perceive it in their unique way and will enjoy reading it.

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