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Senior Project- (very partial)
Dr.Koontz, mentor

Dr. Broadhead- I should have this ready to turn in by next Tuesday or Wednesday.
Thanks for your grace--

Intro

As part of the University of Tennessee Honors Program, I am required to submit a senior project, consisting of research and creative analysis supervised by a faculty mentor. Although these project topics may cover any subject, most students choose a topic that falls within their undergraduate course of study. I have chosen to do this as well. As a Biology major, I have undergone ample preparation to enter a highly advanced field of modern science and medicine. One of the "hot topics" of science today is the international collaboration of scientists working to map the human genome, known as the Human Genome Project. Throughout the last five months I have chosen to explore the project and examine the implications it holds for the United States. The results of my research have led me to realize the importance of education at the high school level concerning this subject. This manual was created with the secondary school teacher in mind, to facilitate a broad understanding of the Human Genome Project and to encourage presentation of the Project to high school students.

During the course of my research I have found that the HGP's influence does not remain constricted to the scientific community. During the course of the next twenty years (and beyond), the HGP will open new doors in pharmaceuticals, medical diagnoses and genetic therapy, agriculture, and disease prevention. Its research will be applied in anthropology, sociology, philosophy, religion, and economics. Its insight into the genetics of the human race has already provoked, and will continue to instigate, ethical debate. Because of the dramatic effect it will have upon American life in the future, a basic understanding of the project is crucial for educators.

What is the Human Genome Project?

In 1990 an international effort was launched among scientists to map the human genome. At sixteen laboratories in Japan, France, Germany, Great Britain, and the United States, scientists are carrying out the work of determining the base sequence of human DNA in an effort to better understand humanity. (www.sanger.ac.uk) As a result, new doors to medicine, science, and anthropology are being opened. On the other hand, new ethical questions are being raised as new technology makes more and more advancements possible. The effect that the Project is having on the United States is monumental. The extremely volatile biotech stocks have grabbed enough attention to finally warrant some level of interest in the Human Genome Project.

The Human Genome Project is being primarily funded by the National Institute of Health and the Department of Energy in the United States and the Wellcome Trust of the United Kingdom.

(www.sanger.ac.uk) The U.S. Department of Energy defines the project's goals as the following:

i) to *identify* all the more than 100,000 genes in human DNA, ii) to *determine* the sequences of the 3 billion chemical base pairs that make up human DNA, iii) to *store* this information in databases, iv) to *develop* tools for data analysis, and to v) to *address* the ethical, legal, and social issues (ELSI) that may arise from the project. (www.ornl.gov/hgmis)

To best understand the magnitude of the project, one should consider how far science has come in the field of genetics in just one hundred and fifty years. The following timeline presents the sequence of events that has led us from a very rudimentary knowledge of the laws of heredity to a vast understanding of human genetics:

History of Genetics (<http://library.thinkquest.org/28920/eng/genehist.html>)

1866 Gregor Mendel, Austrian botanist and monk, proposes basic laws of heredity, based on cross-breeding experiments with pea plants.

1882 German embryologist Walter Fleming spots tiny threads within the cells' nuclei that appear to be dividing, while examining a salamander larvae under a microscope. The threads were chromosomes.

- 1910 U.S. biologist Thomas Hunt Morgan reveals that some genetically determined traits are sex linked by experiments with fruit flies. His work also confirms that the genes determining these traits reside on chromosomes.
- 1926 Hermann Muller, an American biologist discovers that X rays can cause genetic mutations in fruit flies.
- 1944 Oswald Avery and Maclyn McCarty prove that DNA, not protein, is the hereditary material in most living organisms by experiments using pneumococcus bacteria.
- 1950 Douglas Bevis, British physician describes how amniocentesis can be used to test fetuses for Rh-factor incompatibility. The prenatal test later becomes used to screen for various genetic disorders.
- 1953 American James Watson and British biophysicist Francis Crick propose the discovery of the double-helix structure of DNA, the molecule that carries the genetic code.
- 1964 Stanford geneticist Charles Yanofsky and his colleagues prove that the sequence of nucleotides in DNA corresponds exactly to the sequence of amino acids in proteins.
- 1969 The first gene is isolated by a Harvard Medical School team.
- 1973 American biochemists Stanley Cohen and Herbert Boyer insert a gene from an African clawed toad into bacterial DNA, in which its functions appeared. This began genetic engineering.
- 1976 Scientists call for guidelines for recombinant-DNA research at an international meeting in Asilomar, California.
- 1980 Martin Cline and his co-workers create a transgenic mouse, transferring the functional genes of one animal to another.
- 1982 The Food and Drug Administration approves the first genetically engineered drug, a form of human insulin produced by bacteria.
- 1983 Researchers locate a genetic marker for Huntington's disease on chromosome 4. Their achievement leads to a screening test, but the disorder remains incurable.
- 1984 Alec Jeffreys of Britain develops "genetic fingerprinting", a technique used to identify individuals from one's unique sequences of DNA.
- 1986 The FDA approves the first genetically engineered vaccine for humans, hepatitis B.

- 1988 Harvard University receives the first patent for a genetically altered animal, a mouse highly susceptible to breast cancer.
- 1989 The National Center for Human Genome Research is founded, headed by James Watson. It presently oversees the \$3 billion U.S. effort to map and sequence all human DNA.
- 1990 Formal launch of HGP; first gene therapy is performed by W. French Anderson on a four-year old girl with ADA deficiency.
- 1991 Mary-Claire King of the University of California, Berkeley, finds evidence that a gene on chromosome 17 causes the inherited form of breast cancer and increases the risk of ovarian cancer.
- 1992 American and British scientist unveil a technique for testing embryos in vitro for genetic disorders such as cystic fibrosis and hemophilia.
- 1993 George Washington University researchers clone human embryos and nurture them in Petri dishes for several days, provoking protest from critics of genetic engineering.
- 1997 Researchers at Scotland's Roslin Institute, led by embryologist Ian Wilmut, report that they have cloned a sheep named Dolly from the cell of an adult ewe.
- 1998 Craig Venter of Celera Genomics announces his ambition to have the genome mapped by 2001, two years earlier than the plans of the federal government.
- 2003 Expected date of completion of mapping, as predicted by scientists.

The magnitude of the project warrants consequences in many fields of study. Anthropology, medicine, botany, and ethics are just some of the fields that will be greatly affected by results of the mapping. The government has allotted a certain percentage of its budget and has assigned an advisory committee to oversee the ethical, social, and legal issues that may arise within the scope of the Human Genome Project.

Shapiro, the president of Princeton University.

One of the major issues to be confronted that has arisen as a result of the Human Genome Project is the question of informed consent. The project acknowledges the necessity of sampling DNA from only

those individuals who have given personal and informed consent, although this seems to at times be impossible. Truly informed consent may not be possible in some scenarios, and so the question of whether to allow community consent in its place is considered. Also, the question of informed consent for vulnerable subjects, such as the mentally retarded, is raised.

(www.stanford.edu/group/morrinst/Protocol.html) According to the protocol, informed consent exists when the information is taught by someone who understands the purpose and nature of the study, what participation in the study requires a person to do and to risk, and what benefits are intended to result from the study