Genetic engineering: a leap in to the future or a

leap towards destruction? IntroductionScience is a creature that continues to evolve at a much higher rate than the beings that gave it birth. The transformation time from tree-shrew, to ape, to human far exceeds the time from an analytical engine, to a calculator, to a computer. However, science, in the past, has always remained distant. It has allowed for advances in production, transportation, and even entertainment, but never in history has science be able to so deeply affect our lives as genetic engineering will undoubtedly do. With the birth of this new technology, scientific extremists and anti-technologists have risen in arms to block its budding future. Spreading fear by misinterpretation of facts, they promote their hidden agendas in the halls of the United States congress. They fear that it is unsafe; however, genetic engineering is a safe and powerful tool that will yield unprecedented results, specifically in the field of medicine. It will usher in a world where gene defects, bacterial disease, and even aging are a thing of the past. By understanding genetic engineering and its history, discovering its possibilities, and answering the moral and safety questions it brings forth, the blanket of fear covering this remarkable technical miracle can be lifted. The first step to understanding genetic engineering and embracing its possibilities for society is to obtain a rough knowledge base of its history and method. The basis for altering the evolutionary process is dependant on the understanding of how individuals pass on characteristics to their offspring. Genetics achieved its first foothold on the secrets of nature’s evolutionary process when an Austrian monk named Gregor Mendel developed the first “ laws of heredity.” Using these laws, scientists studied the characteristics of organisms for most of the next one hundred years following Mendel’s discovery. These early studies concluded that each

organism has two sets of character determinants, or genes (Stableford 16). For instance, in regards to eye color, a child could receive one set of genes from his or her father that were encoded one blue, and the other brown. The same child could also receive two brown genes from his or her mother. The conclusion for this inheritance would be the child has a three in four chance of having brown eyes, and a one in three chance of having blue eyes (Stableford 16). Genes are transmitted through chromosomes which reside in the nucleus of every living organism's cells. Each chromosome is made up of fine strands of deoxyribonucleic acids, or DNA. The information carried on the DNA determines the cells function within the organism. Sex cells are the only cells that contain a complete DNA map of the organism, therefore, " the structure of a DNA molecule or combination of DNA molecules determines the shape, form, and function of the organism's offspring " (Lewin 1). DNA discovery is attributed to the research of three scientists, Francis Crick, Maurice Wilkins, and James Dewey Watson in 1951. They were all later accredited with the Nobel Prize in physiology and medicine in 1962 (Lewin 1)." The new science of genetic engineering aims to take a dramatic short cut in the slow process of evolution" (Stableford 25). In essence, scientists aim to remove one gene from an organism's DNA, and place it into the DNA of another organism. This would create a new DNA strand, full of new encoded instructions; a strand that would have taken Mother Nature millions of years of natural selection to develop. Isolating and removing a desired gene from a DNA strand involves many different tools. DNA can be broken up by exposing it to ultra-highfrequency sound waves, but this is an extremely inaccurate way of isolating a desirable DNA section (Stableford 26). A more accurate way of DNA splicing is the use of " restriction enzymes, which are

produced by various species of bacteria” (Clarke 1). The restriction enzymes cut the DNA strand at a particular location called a nucleotide base, which makes up a DNA molecule. Now that the desired portion of the DNA is cut out, it can be joined to anothe strand of DNA by using enzymes called ligases. The final important step in the creation of a new DNA strand is giving it the ability to self-replicate. This can be accomplished by using special pieces of DNA, called vectors, that permit the generation of multiple copies of a total DNA strand and fusing it to the newly created DNA structure. Another newly developed method, called polymerase chain reaction, allows for faster replication of DNA strands and does not require the use of vectors (Clarke 1). Viewpoint 1The possibilities of genetic engineering are endless. Once the power to control the instructions, given to a single cell, are mastered anything can be accomplished. For example, insulin can be created and grown in large quantities by using an inexpensive gene manipulation method of growing a certain bacteria. This supply of insulin is also not dependant on the supply of pancreatic tissue from animals. Recombinant factor VIII, the blood clotting agent missing in people suffering from hemophilia, can also be created by genetic engineering. Virtually all people who were treated with factor VIII before 1985 acquired HIV, and later AIDS. Being completely pure, the bioengineered version of factor VIII eliminates any possibility of viral infection. Other uses of genetic engineering include creating disease resistant crops, formulating milk from cows already containing pharmaceutical compounds, generating vaccines, and altering livestock traits (Clarke 1). In the not so distant future, genetic engineering will become a principal player in fighting genetic, bacterial, and viral disease, along with controlling aging, and providing replaceable parts for humans.

Medicine has seen many new innovations in its history. The discovery of anesthetics permitted the birth of modern surgery, while the production of antibiotics in the 1920s minimized the threat from diseases such as pneumonia, tuberculosis and cholera. The creation of serums which build up the bodies immune system to specific infections, before being laid low with them, has also enhanced modern medicine greatly (Stableford 59). All of these discoveries will fall under the broad shadow of genetic engineering when it reaches its apex in the medical community. Many people suffer from genetic diseases ranging from thousands of types of cancers, to blood, liver, and lung disorders. Amazingly, all of these will be able to be treated by genetic engineering, specifically, gene therapy. The basis of gene therapy is to supply a functional gene to cells lacking that particular function, thus correcting the genetic disorder or disease. There are two main categories of gene therapy: germ line therapy, or altering of sperm and egg cells, and somatic cell therapy, which is much like an organ transplant. Germ line therapy results in a permanent change for the entire organism, and its future offspring. Unfortunately, germ line therapy, is not readily in use on humans for ethical reasons. However, this genetic method could, in the future, solve many genetic birth defects such as downs syndrome. Somatic cell therapy deals with the direct treatment of living tissues. Scientists, in a lab, inject the tissues with the correct, functioning gene and then re-administer them to the patient, correcting the problem (Clarke 1). Along with altering the cells of living tissues, genetic engineering has also proven extremely helpful in the alteration of bacterial genes. “ Transforming bacterial cells is easier than transforming the cells of complex organisms” (Stableford 34). Two reasons are evident for this ease of manipulation: DNA enters, and functions easily in

bacteria, and the transformed bacteria cells can be easily selected out from the untransformed ones. Bacterial bioengineering has many uses in our society, it can produce synthetic insulins, a growth hormone for the treatment of dwarfism and interferons for treatment of cancers and viral diseases (Stableford 34). Throughout the centuries disease has plagued the world, forcing everyone to take part in a virtual " lottery with the agents of death" (Stableford 59). Whether viral or bacterial in nature, such disease are currently combated with the application of vaccines and antibiotics. These treatments, however, contain many unsolved problems. The difficulty with applying antibiotics to destroy bacteria is that natural selection allows for the mutation of bacteria cells, sometimes resulting in mutant bacterium which is resistant to a particular antibiotic. This indestructible bacterial pestilence wages havoc on the human body. Genetic engineering is conquering this medical dilemma by utilizing diseases that target bacterial organisms. These diseases are viruses, named bacteriophages, " which can be produced to attack specific disease-causing bacteria" (Stableford 61). Much success has already been obtained by treating animals with a " phage" designed to attack the E. coli bacteria (Stableford 60). Diseases caused by viruses are much more difficult to control than those caused by bacteria. Viruses are not whole organisms, as bacteria are, and reproduce by hijacking the mechanisms of other cells. Therefore, any treatment designed to stop the virus itself, will also stop the functioning of its host cell. A virus invades a host cell by piercing it at a site called a " receptor". Upon attachment, the virus injects its DNA into the cell, coding it to reproduce more of the virus. After the virus is replicated millions of times over, the cell bursts and the new viruses are released to continue the cycle. The body's natural defense

against such cell invasion is to release certain proteins, called antigens, which “ plug up” the receptor sites on healthy cells. This causes the foreign virus to not have a docking point on the cell. This process, however, is slow and not effective against a new viral attack. Genetic engineering is improving the body’s defenses by creating pure antigens, or antibodies, in the lab for injection upon infection with a viral disease. This pure, concentrated antibody halts the symptoms of such a disease until the bodies natural defenses catch up. Future procedures may alter the very DNA of human cells, causing them to produce interferons. These interferons would allow the cell to be able determine if a foreign body bonding with it is healthy or a virus. In effect, every cell would be able to recognize every type of virus and be immune to them all (Stableford 61). Current medical capabilities allow for the transplant of human organs, and even mechanical portions of some, such as the battery powered pacemaker. Current science can even re-apply fingers after they have been cut off in accidents, or attach synthetic arms and legs to allow patients to function normally in society. But would not it be incredibly convenient if the human body could simply regrow what it needed, such as a new kidney or arm? Genetic engineering can make this a reality. Currently in the world, a single plant cell can differentiate into all the components of an original, complex organism. Certain types of salamanders can re-grow lost limbs, and some lizards can shed their tails when attacked and later grow them again. Evidence of regeneration is all around and the science of genetic engineering is slowly mastering its techniques. Regeneration in mammals is essentially a kind of “ controlled cancer”, called a blastema. The cancer is deliberately formed at the regeneration site and then converted into a structure of functional tissues. But before controlling

the blastema is possible, “ a detailed knowledge of the switching process by means of which the genes in the cell nucleus are selectively activated and deactivated” is needed (Stableford 90). To obtain proof that such a procedure is possible one only needs to examine an early embryo and realize that it knows whether to turn itself into an ostrich or a human. After learning the procedure to control and activate regeneration, genetic engineering will be able to conquer such ailments as Parkinson’s, Alzheimer’s, and other crippling diseases without grafting in new tissues. The broader scope of this technique would allow the re-growth of lost limbs, repairing any damaged organs internally, and the production of spare organs by growing them externally (Stableford 90). Viewpoint 2Ever since biblical times the lifespan of a human being has been pegged at roughly 70 years. But is this number truly finite? In order to uncover the answer, knowledge of the process of aging is needed. A common conception is that the human body contains an internal biological clock which continues to tick for about 70 years, then stops. An alternate “ watch” analogy could be that the human body contains a certain type of alarm clock, and after so many years, the alarm sounds and deterioration beings. With that frame of thinking, the human body does not begin to age until a particular switch is tripped. In essence, stopping this process would simply involve a means of never allowing the switch to be tripped. W. Donner Denckla, of the RocheInstitute of Molecular Biology, proposes that the alarm clock theory is true. He provides evidencefor this statement by examining the similarities between normal aging and the symptoms of ahormonal deficiency disease associated with the thyroid gland. Denckla proposes that as we get older the pituitary gland begins to produce a hormone which blocks the actions of the thyroid hormone, thus

causing the body to age and eventually die. If Denckla’s theory is correct, conquering aging would simply be a process of altering the pituitary’s DNA so it would never be allowed to release the aging hormone. In the years to come, genetic engineering may finally defeat the most unbeatable enemy in the world, time (Stableford 94). The morale and safety questions surrounding genetic engineering currently cause this new science to be cast in a false light. Anti-technologists and political extremists spread incorrect interpretation of facts coupled with statements that genetic engineering is not natural and defies the order of things. The morale question of biotechnology can be answered by studying where the evolution of man is, and where it is leading our society. The safety question can be answered by examining current safety precautions in industry, and past safety records of many bioengineering projects already in place. The evolution of man can be broken up into three basic stages. The first, lasting millions of years, slowly shaped human nature from Homo erectus to Home sapiens. Natural selection provided the means for countless random mutations resulting in the appearance of such human characteristics as hands and feet. The second stage, after the full development of the human body and mind, saw humans moving from wild foragers to an agriculture based society. Natural selection received a helping hand as man took advantage of random mutations in nature and bred more productive species of plants and animals. The most bountiful wheats were collected and re-planted, and the fastest horses were bred with equally faster horses. Even in our recent history the strongest black male slaves were mated with the hardest working female slaves. The third stage, still developing today, will not require the chance acquisition of super-mutations in nature. Man will be able to create such super-species

without the strict limitations imposed by natural selection. By examining the natural slope of this evolution, the third stage is a natural and inevitable plateau that man will achieve (Stableford 8). This omniscient control of our world may seem completely foreign, but the thought of the Egyptians erecting vast pyramids would have seem strange to Homo erectus as well. ConclusionMany claim genetic engineering will cause unseen disasters spiraling our world into chaotic darkness. However, few realize that many safety nets regarding bioengineering are already in effect. The Recombinant DNA Advisory Committee (RAC) was formed under the National Institute of Health to provide guidelines for research on engineered bacteria for industrial use. The RAC has also set very restrictive guidelines requiring Federal approval if research involves pathogenicity (the rare ability of a microbe to cause disease) (Davis, Roche 69).” It is well established that most natural bacteria do not cause disease. After many years of experimentation, microbiologists have demonstrated that they can engineer bacteria that are just as safe as their natural counterparts” (Davis and Rouche 70). In fact the RAC reports that “ there has not been a single case of illness or harm caused by recombinant engineered bacteria, and they now are used safely in high school experiments” (Davis and Rouche 69). Scientists have also devised other methods of preventing bacteria from escaping their labs, such as modifying the bacteria so that it will die if it is removed from the laboratory environment. This creates a shield of complete safety for the outside world. It is also thought that if such bacteria were to escape it would act like smallpox or anthrax and ravage the land. However, laboratory-created organisms are not as competitive as pathogens. Davis and Roche sum it up in extremely laymen’s terms, “ no matter how much Frostban you dump on a

field, it’s not going to spread” (70). In fact Frostbran, developed by Steven Lindow at the University of California, Berkeley, was sprayed on a test field in 1987 and was proven by a RAC committee to be completely harmless (Thompson 104). Fear of the unknown has slowed the progress of many scientific discoveries in the past. The thought of man flying or stepping on the moon did not come easy to the average citizens of the world. But the fact remains, they were accepted and are now an everyday occurrence in our lives. Genetic engineering is in its period of fear and misunderstandifng, but like every great discovery in history, it will enjoy its time of realization and come into full use in society. The world is on the brink of the most exciting step into human evolution ever, and through knowledge and exploration, should welcome it and its possibilities with open arms. Works Cited” Bioethics: an Introduction.” N. d. Online posting. Internet. 2 Dec. 1997. Clarke, Bryan C. Genetic Engineering. Microsoft (r) Encarta. Microsoft Corporation, Funk ; Wagnalls Corporation, 1994. Davis, Bernard, and Lissa Roche. “ Sorcerer’s Apprentice or Handmaiden to Humanity.” USA TODAY: The Magazine of the American Scene GUSA 118 Nov 1989: 68-70. Lewin, Seymour Z. Nucleic Acids. Microsoft (r) Encarta. Microsoft Corporation, Funk ; Wagnalls CorporationShapiro, Harold T. “ Ethical and Policy Issues of Human Cloning” Journal Group: Sci/tech 11 Jul. 1997. 195-196. CD-ROM. UMI-Proquest. Snell, Marilyn Berlin “ Bioprospecting or Biopiracy?” Utne Reader March/April 1996. 82-93. UTNE READER 1996. SIRS, 1996. Stableford, Brian. Future Man. New York: Crown Publishers, Inc., 1984. Thompson, Dick. “ The Most Hated Man in Science.” Time 23 Dec 4 1989: 102-104