# EUGENICS: PAST, PRESENT, AND FUTURE

By

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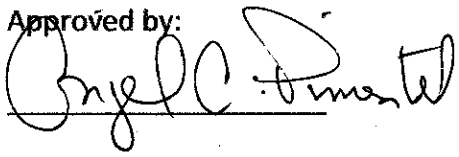

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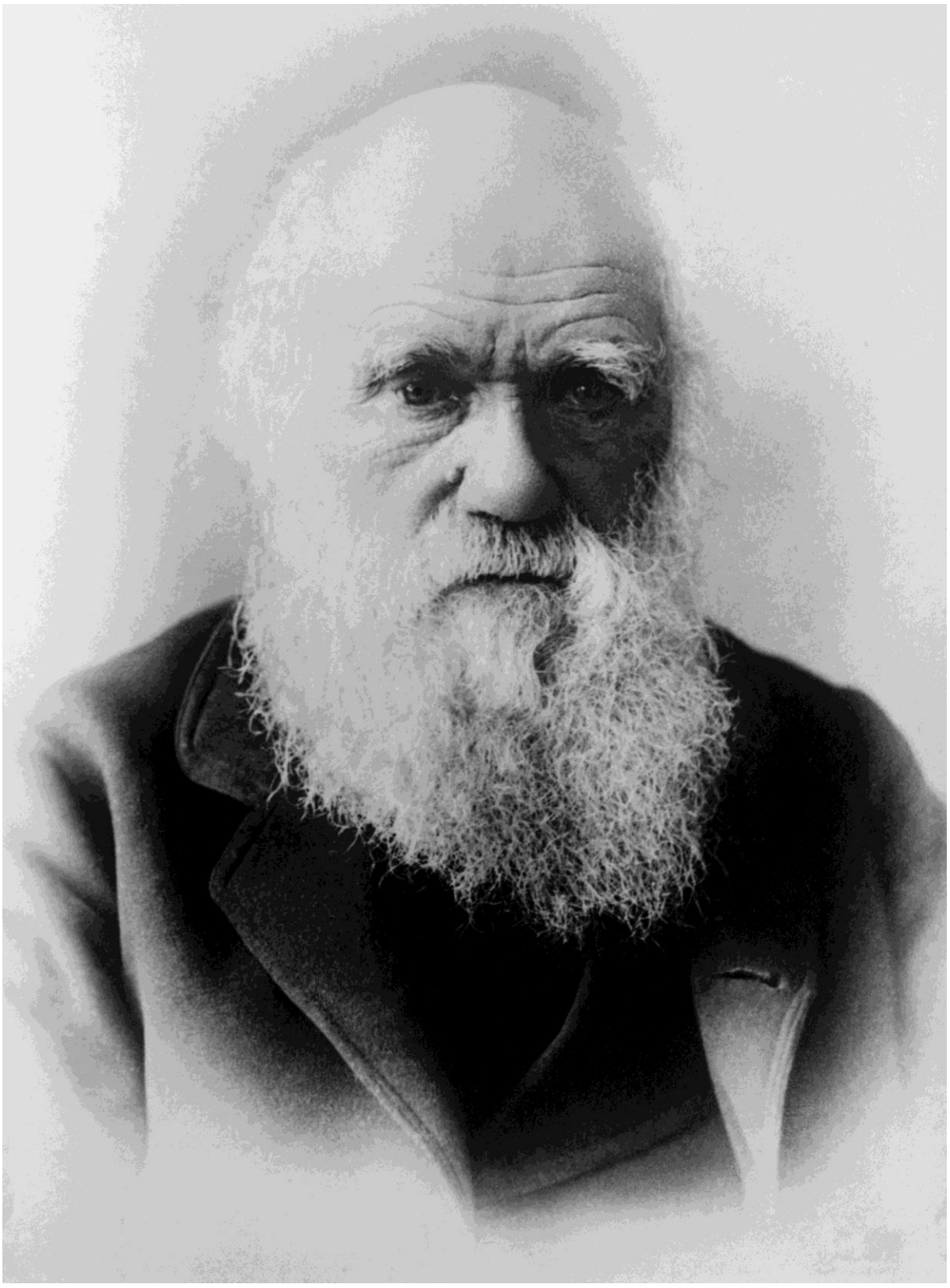
# Eugenics: Past, Present, and Future

Author: Nathaniel May

Abstract:

Eugenics has been an ever present idea since the time of Darwin. While the practices and methods have changed over the years to represent a shift from public to private considerations, eugenics still persists. Advances in scientific technology have led to progressively more finely tuned eugenic techniques in the form of cellular and molecular eugenics. Accompanied with molecular eugenics, the transhumanist movement is pushing the human condition to new boundaries. The ethical dilemmas created by such practices are staggering and barely yet considered.



Source: Charles Darwin, *Darwin Restored*, Wikimedia Commons.

*"Yearning for the seemingly impossible is the path to human progress." – Bryant H. McGill*

Progress has been a defining theme throughout human history. The continual drive towards improvement dictates human actions on a broad scale. Individuals seek to enhance their immediate and long-term prospects, just as nations care for the safety and welfare of their citizens. It appears natural, and very human for that matter, to desire the betterment of the species. And it is the elusive nature of the end goal of progress that provides continuous and uncompromising motivation. Progress is defined by the measures taken, not the product produced. Advances in medicine and education are on-going in modern societies. More effective and more efficient practices and methods are continually being developed. Healthier bodies and higher intelligence are sought, but never fully satisfied. While humans may have succeeded in progressing in these areas, it remains relative, as there is always more progress to be made. Medical genetics and related fields are beginning to offer a new type of progress—progress with unknown consequences.

That which is being spoken about is the manipulation of the human genome to improve the human race. Such an endeavor is the product of recent scientific advancements and something not encountered before in human history. The question can be raised that if humans strive to improve themselves with education, healthcare, and any other beneficial actions, is an alteration to the genome different in any sense? Questioning the morality of such improvements is indeed a justified follow-up. Perhaps just as important is determining who decides what an improvement is and who should receive it. Advances in scientific research are forthcoming at a rate faster than ethical thought, leaving behind a considerable chasm as a result. Recent history offers examples into how previous scholars have dealt with a rapidly rising scientific field. Of

particular interest is the history of eugenics, which is central to answering, or at least understanding, the questions at hand.

*"Support for eugenics has waxed and waned over the succeeding years, but the concerns that inspired it have never disappeared." – Diane B. Paul*

In 1883 an Englishman, Francis Galton, coined the term *eugenics*, giving a name to what would become one of the most divisive and misunderstood issues in science. Despite being coined, eugenics has eluded definition beyond that of the Greek roots "good-in-birth" (Paul 3). In continuous flux, eugenics exists in a variety of forms. Disagreements over the direction and scope of eugenics have and continue to mark its history. As it will be seen, presumed scientific facts regarding the hereditary nature of traits laid the foundation for early eugenics. The supposed veracity of these arguments convinced many to attribute social ills to inheritance and to call for a powerful solution: eugenics (Paul 4). Although Galton was the first to delve into eugenics, he was heavily influenced by his cousin, Charles Darwin.

In 1859, Darwin published his landmark *On the Origin of Species*, a proposal for the theory of natural selection as a mechanism for evolution. Darwin postulated that in the harsh competition for survival those organisms that survived did so as a result of small advantages. The small advantages could be perceived as manifestations of variations in the genetic code of the surviving members. Genes, units of heredity, can have multiple forms or versions that code for diverse, but related products. Each form of a gene is termed an allele; thus, the surviving members would pass on these small advantages, allelic differences, to their offspring. In time, these advantages would shape a population via shifting allelic ratios. This "survival of the fittest" assured that the best members of a species propagated. In terms of Darwin's theory "best" means

those organisms that are best suited to survive the current conditions. In general this usually related to those most physically and mentally gifted (Paul 6, 23).

Darwin's theory had important implications for all living things, especially humans. What Darwin was proposing threatened the established beliefs about man's higher status in the world of nature. His work represented a seismic shift in thinking. Western science had long been influenced by Western theology and its lofty view of man in the tree of life. Darwin not only placed man on equal footing with animals, but suggested that evolution, rather than divine intervention, was to credit for the diversity of the biosphere. If true, Darwin's theories placed man in the savage animal world, fighting for survival along with the other species present on Earth. Human characteristics, according to Darwin were products of millennia of evolutionary factors, dependent on environmental interactions. What Darwin was presenting was a non-moralistic rationale for human behavior, though he shied away from saying so. Although he himself was loath to enter the debate on human inheritance, Darwin's cousin, Galton, was not.

Galton quickly incorporated his cousin's ideas into his application of the determination of human inheritance. A long time supporter of direct heredity, Galton saw the only way to alter human traits was via breeding. He conducted studies that implied that men of noble birth gave rise to successful, noble offspring, which must be due to the passage of good traits. Galton was far from an outcast in his own time, but he did experience resistance to his work from among members of the scientific community (Paul 30-31). Like a surprising majority of scientists and professionals at the time, Galton feared the unbalanced birth rates between the "best" and "lowest" classes of society. The "best" class generally included the educated, wealthy, and the hard-working middle class, while the "lowest" class consisted of the illiterate and poor (Paul 6-7). Different notable proponents of eugenics debated the scope of the classes based on their

political ideals. However, despite differences in determining who the "lowest" class was, the majority of prominent scientists and intellectuals agreed that the "lowest" class was out-breeding the "best" class (Paul 7). The degeneration of the human condition was a frightening proposition, one propagated by the most ardent supporters of the fledgling eugenics movement.

Galton and others saw the application of eugenics in the form of breeding techniques. Just as humans oversaw and manipulated the breeding of animals, they argued, humans should control the fecundity of their species in order to produce the best and brightest offspring. According to their rationale, it seemed odd that man would control the breeding of cattle but not of itself (Paul 5). Many thought that modern society protected those members who would once have died off due to selection pressures and as a result natural selection, and thus evolution, was effectively halted (Paul 6). Without allowing natural evolutionary forces to operate, many feared that the progress of the human race would be irreparably damaged. Even Darwin agreed with contemporaries who hypothesized that stagnation or potentially even evolutionary degeneration was a very real possibility (Paul 6). Such fears led to the merger of science and social policy that would define the nature of eugenics for the better part of the early 20$^{th}$ century. Eugenics came to be associated with two forms of breeding controls: Positive and Negative. Positive eugenics favored increased birth rates among the "best" class while negative eugenics focused on reducing the fertility among the "lowest" class. Negative eugenics took a more prominent role and was characterized by efforts such as family planning, segregation, and sterilization. To better understand the application of positive and negative eugenics the concepts of "hard" and "soft" heredity need be introduced.

*"The genes are the atoms of heredity." – Seymour Benzer*

The characterization of the social patterns of the hereditary nature of human physical and psychological traits preceded attempts and the ability to discern their mode of transmission. As mentioned, Galton hypothesized that eminence and other traits were heritable from his studies of successful British families, but he lacked the necessary data to substantiate such a claim (Paul 40). Before Galton, in the early 19th century, a French scientist Jean Baptiste de Lamarck proposed a theory of heredity known as Lamarckism. Lamarckism stated that animals were influenced by the environment and their surroundings, and as such, underwent physiological changes in response. These changes manifested themselves, according to Lamarck, in bodily organ responses and these acquired traits were passed on to offspring (Paul 40). As such, a parent could alter their hereditary material via changes in attitude and behavior, much in contrast to the Darwinian theory of natural selection which acted over long periods of time. Such a theory had enormous consequences in terms of eugenic social policy. Also termed "soft" heredity, Lamarckism came to dominate the 19th century scientific scene as a likely explanation for the transmission of traits from parent to offspring.

While readily accepted by most, Galton and others challenged Lamarckism with the competing view of "hard" heredity. The case for "hard" heredity was championed by the research of August Weismann, a German scientist who discovered the two distinct cell types found in humans: somatic and germ. The entirety of cells within the body, with the exception of those cells responsible for gamete production, are deemed somatic cells, with the sex cells termed germ cells. Weismann's findings provided evidence that somatic cells were capable of undergoing change in response to the environment, but germ cells, controllers of hereditary

material, were immutable (Paul 41). Thus, "hard" heredity claimed that parents had no ability to alter the traits they would propagate.

It is crucial to note that although the two theories of "soft" and "hard" heredity differed on the influence parental units had on altering their hereditary traits, they converged on the supposition that behavioral characteristics and other traits were passed to the next generation. A rough form of early genetic determinism, the assumed causative nature of genes on behavioral, mental and physical traits was accepted. For example, both schools of thought saw violent and criminal actions as having hereditary roots (Paul 42). In terms of mitigating the social consequences of having such defective traits circulating within the population, proponents of "soft" and "hard" heredity took drastically different stances. Lamarckians proposed social policies to combat criminality and other public ills, as "soft" heredity saw changes to heritable traits as dependent on environmental conditions. Welfare programs and education were seen as the instruments for facilitating continual genetic improvement throughout each generation (Paul 42). Weismann and other supporters of "hard" heredity saw such social programs as wasteful, as for them the only means to prevent passage of "degenerative" traits was through breeding controls (Paul 44).

Studies of American criminal families reflected initial support for Lamarckism and its following social policy interventions, though hard heredity gained ground in the early 1900's. The work of the American Richard Dugdale on the "Jukes", a family beset by degenerative behavioral tendencies, is a prime example of the eugenic studies of the time. Upon completion of his study, Dugdale suggested that environmental factors could effectively counter the heredity of such criminal traits. Through education, the social delinquents could be spurred to change their ways, and thus the ways of their potential offspring (Paul 43-44). While Dugdale submitted to a

Lamarckian view of heredity, subsequent studies took on a harder view of heredity. As such, these studies suggested segregation and sterilization as effective eugenic controls, in contrast to the more benevolent social welfare programs of Lamarckian social policy.

Source: Austrian biologist Gregor Mendel, *Gregor Mendel*, Wikimedia Commons.

The work of Gregor Mendel on pea plants was partly responsible for the rising support of hard heredity. In 1865, Gregor Mendel conducted his famous genetics experiments with pea plants. Mendel observed the faithful transfer of hereditary units, genes, from parent to offspring. Though not appreciated at the time, his work provided staunch evidence in support of heredity as based on immutable factors. In the early 1900's, scientists rediscovered his work and quickly adopted his research to bolster the position of hard heredity. With increasing scientific support, as well as fading enthusiasm for Lamarckism, hard heredity gained ground in the United States, Britain, and Germany. Because mental and physical traits were no longer seen as mutable hereditary characteristics, proponents of hard heredity deplored the use of social welfare programs as ineffective. As a result, social policies and programs took on a more negative and drastic tone in respect to the actions taken to improve the human genetic stock (Paul 44-49). Segregation and sterilization rose to influence predominately in American and German social policy.

*"Eugenics is … the most adequate and thorough avenue to the solution of racial, political and social problems." – Margaret Sanger (1921), Activist*

From studies of American families to Nazi concentration camps, eugenics and Darwin heavily influenced political ideology in the 20th century. An American scientist by the name of Henry Goddard studied the divergence of two lines of an American family that displayed two drastically different behavioral patterns. Stemming back to one common ancestor, one line was shown by Goddard to have an extraordinarily high percentage of "feeble-minded" offspring, while the other line was characterized by well-to-do persons. Goddard and his associates used unscientific and rash visual judgments to lambast the "degenerate" line. He extrapolated his data to suggest that the state of the entire nation's populace was being overrun by the "morons" (Paul

51). “Feeble-mindedness” was touted as a national emergency and proponents of eugenics called on stricter social controls such as sterilization to quell the rising tide (Paul 62). American Army psychologists released reports of the mental capacities of soldiers based on data captured during and after World War I from scientifically dubious tests, with the results supporting the notion that “feeble-mindedness” afflicted near 47% of white army recruits (Paul 65-67). Accompanied with a hard view of heredity, Goddard’s study and the Army’s psychological test results pushed American social planners to adopt sterilization laws in numerous states.

Of the most prominent sterilization programs implemented in the United States was the program found in California. In 1909, California enacted a sterilization law intended to prevent “feeble-minded” persons and prisoners from propagating and spreading “degenerative” traits (Abate 1). Public support was fueled by alarming statistics of growing numbers of “feeble-mindedness”. Financial considerations were also a significant push-factor towards sterilization, as the cost of maintaining institutions designed to house the infirm and delinquents was steep. As the years progressed in California, the law was amended to encompass those deemed insane. Around 19,000 men and women were sterilized under these California laws, which were seen as models throughout the United States, and in particular, in Germany (Abate 1).

In the early 1930’s German eugenicists began to implement social sterilization programs, based largely on the California model (Paul 85-87). American scientists maintained good relations with their German counterparts, even into the early years of Hitler’s Nazi Regime (Paul 85). The Germans too were concerned with the financial resources required to care for “useless eaters”, but more importantly they were strongly motivated by racial stereotypes. With an aggressive plan and the support of the ruling socialist party, Germany instituted negative eugenics programs. Mentally handicapped persons were sterilized, as were people with a range

of circumstances from physical deformities to alcoholism (Paul 86-87). In time, other "inferior" social groups, such as Jews and Gypsies, were deemed not fit and "useless eaters". These "degenerates" were sent for sterilization, a program which morphed into euthanasia. The horrors of this escalation of eugenic practices are evident with the Holocaust (Paul 90-91). In total, 320,000 to 400,000 individuals were sterilized under Nazi rule (Paul 89).

Not all early eugenics programs took on such a drastic, negative tone. Positive eugenics, though not as widely implemented as negative eugenics, played a role in the early 20th century. Among the first positive eugenics programs was the "fitter families" movement, a tribute to the ideal American family. Much like valuing livestock, American families were graded at state fairs on the grounds of fitness and intelligence. Prize-winning families received recognition and awards for their idyllic nature. Such competitions were intended to inspire commitment to good family stock. Much like Galton, those involved in the American family contests perceived no difference in the breeding of animals and humans (Selden 210-212). A similar program, the Lebensborn program, was founded in Nazi Germany with the intent of breeding the future of the regime. Led by Hitler's infamous right-hand man, Heinrich Himmler, the Nazi SS set up a breeding program between pure, Aryan women and SS officers. Regardless of marital status, women deemed fit to participate were encouraged. Emphasis on state service, much like in the American "fitter families" movement, was a motivating factor behind participation (Landler).

Motivating factors behind positive and negative eugenics policies in the 20th century ranged from social to financial to racial concerns. The variety of motives stems from the broad application of genetic understanding of the time to disparate political ideologies. It is apparent that these practices were misguided and sometimes malicious, but it is important to take note of the fact that at that time these policies received strong support. Public opinion and social policy

is determined by the information at hand. While it is easy to decry these past tragedies and their implementers, it may be more constructive to apply the lessons learned to current understanding of science and social policy. The 21st century is a radically different world in terms of scientific understanding and public perception of human enhancement. Individual reproductive rights are the norm and governmental intrusion varies by society. Before looking to where the new form of pre-modern eugenics got its start, the science that brought about the resurgence of eugenics is detailed.

## Chapter 2: Biology

*"A cell is regarded as the true biological atom." – George Henry Lewes*

Before the story of eugenics can continue, it should be noted that the period between social eugenics and pre-modern, or cellular, eugenics, was a time of significant advancement in biology. From the 1600's to the 1970's, the field of biology saw its level of understanding drastically increase. Development in techniques and tools used for understanding biology led the way to a wealth of information hidden in the elementary unit of life: the cell. The discovery of cells by Robert Hooke in 1665 was an important breakthrough that provided a stepping stone for future discoveries (Mazzarello 1). A multitude of other scientists paved the way in characterizing these functional units. Thus, it was not until 1838-1839 that the "cell theory" was accepted, a theory that stated "that all living things are composed of cells or their products" (Mazzarello 1). In addition, cells were shown to form from other cells (Mazzarello 2). With this information in hand, the field of cellular biology was born. Scientists sought to understand these functional units of life, a drive to acquire and apply knowledge. The physical properties of cells and their

constituent components were detailed over the next hundred years, so much so that the inner workings of cells became well known.

While the information regarding cells is seemingly endless, a brief summary of the inner workings of the cell will attempt to be detailed. As the smallest unit of life, cells are deemed the 'building blocks' of all life on Earth. In fact, to qualify as life according to the 'cell theory' the organism in question must be constructed from cells (Mazzarello 2). What was surprising to many scientists early on was how cells vary drastically in size and shape, in addition to being able to 'differentiate'. To differentiate is the biological term for the specialization of a cell. Despite the fact that cells can specialize, they all have similar machinery, or organelles. Organelles are small compartments within a cell that have unique functions. Some act to generate power for the cell, others to dispose of waste, and others to manufacture proteins. A critical organelle of eukaryotic cells, or cells that are found in multi-cellular organisms such as plants and animals, is the nucleus. The nucleus contains deoxyribonucleic acid (DNA), or the key to life.

*"We wish to suggest a structure for the salt of deoxyribose nucleic acid (DNA). This structure has novel features which are of considerable biological interest."*-

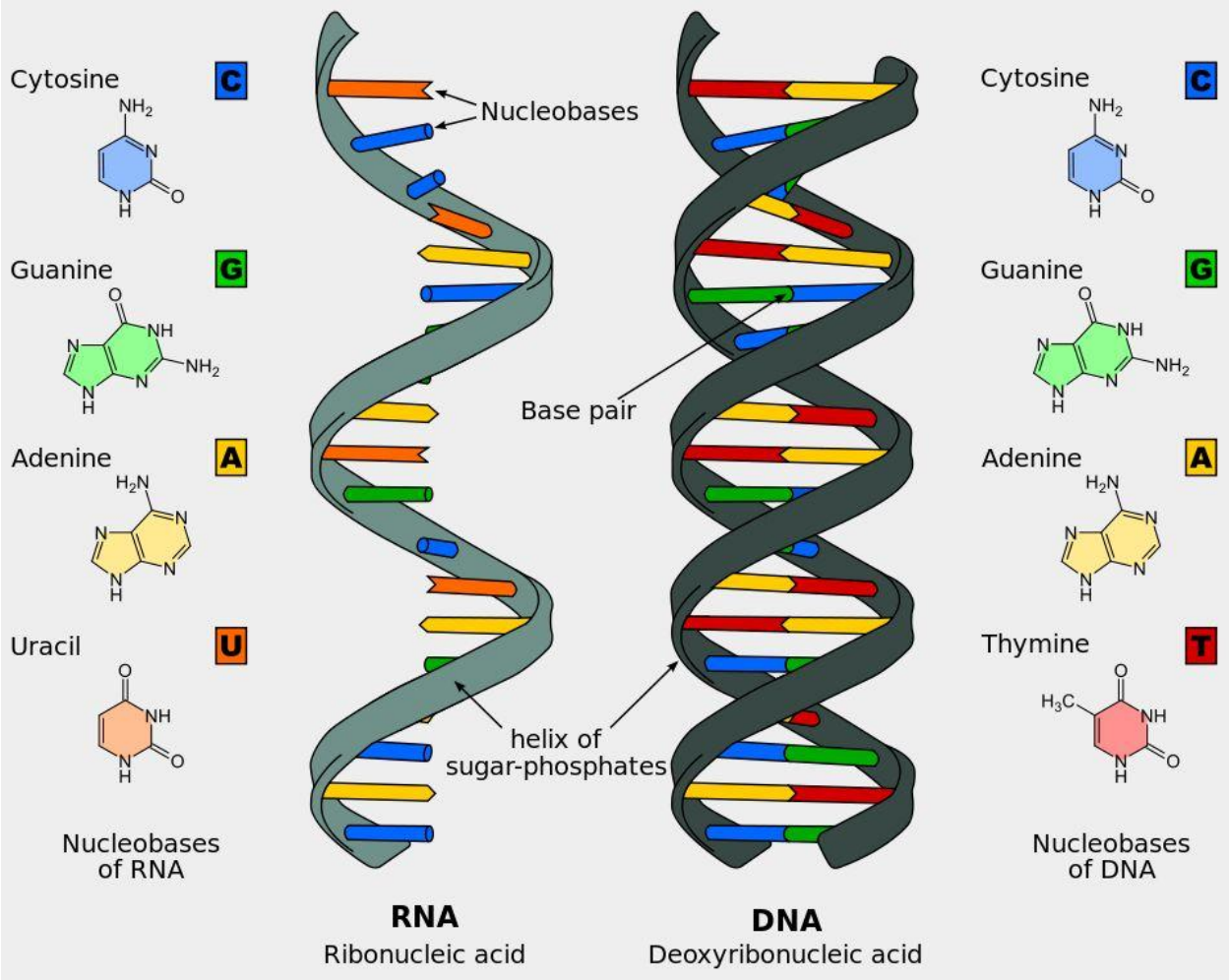
*James Watson and Francis Crick*

DNA is composed of two long strands of nucleotide subunits that encode the information required to organize and run a cell, and therefore an organism. DNA was discovered in 1868, though its function remained unknown. In fact, proteins were at one point considered to be the key-holders of heredity due to the variety of proteins available, while DNA was long thought to be unimportant to the functioning of the cell (Fredholm). As it turns out, DNA *is* responsible for

the metabolic activities of each cell by encoding the information required to produce the workhorses of the cell: proteins. This was proven in 1944 with an experiment detailing the transmission of disease traits in bacteria. With this knowledge in hand, scientists sought to discover the mechanisms of DNA-based heredity and its role in cell organization. It was found that DNA guides the inner workings of a cell by encoding a message that passes through a similar molecule, ribonucleic acid (RNA), to protein. Proteins, not so much the protein seen in work-out supplements, are the workhorses of the cell. They are responsible for the majority of activities that the cell undergoes, from structural support to immune system response. Proteins are specified in the DNA code by units of heredity previously mentioned: genes. Genes are sequences of DNA that contain the information required to construct a protein.

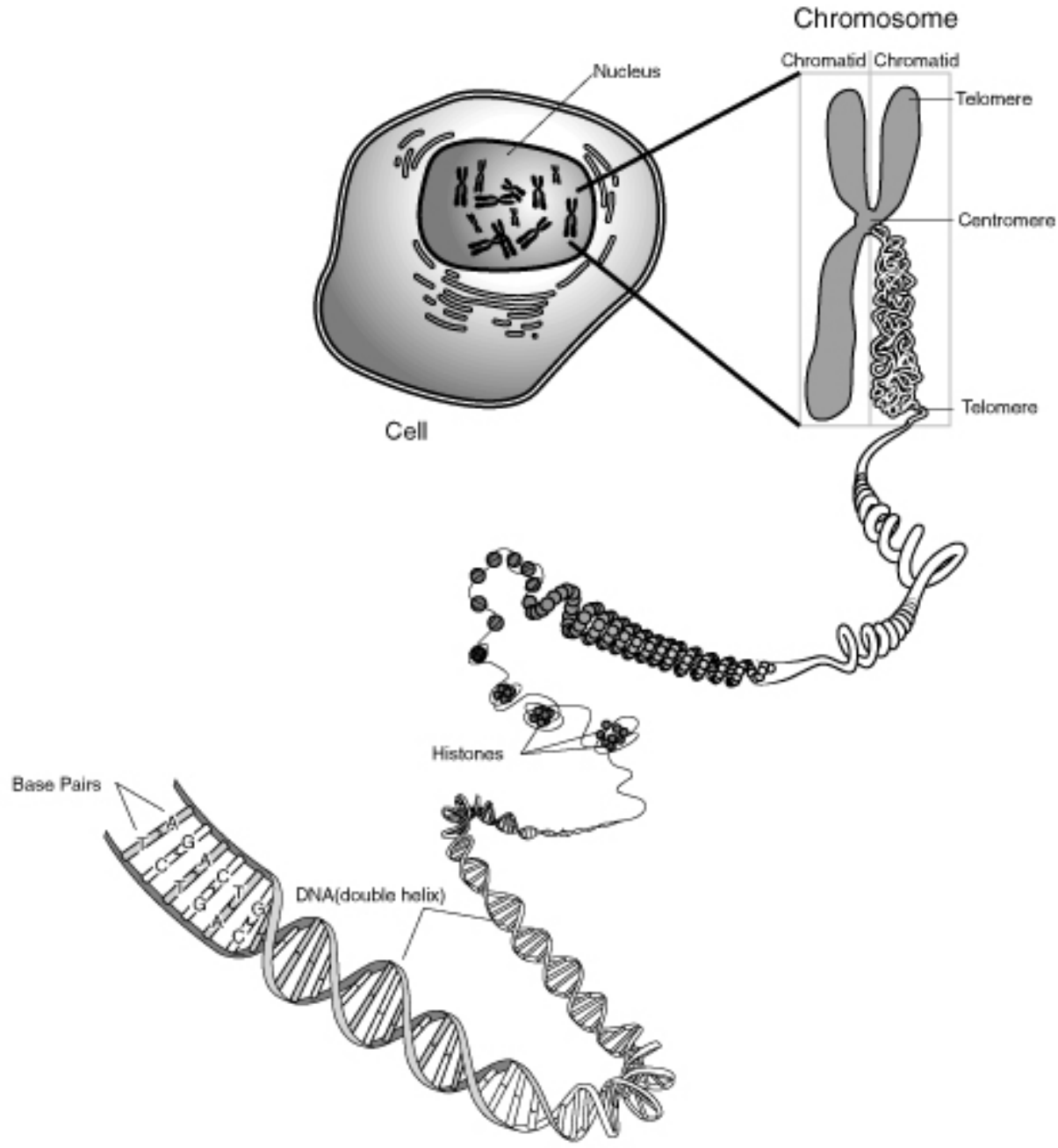
The process of transferring the information from DNA to RNA is deemed transcription, while the conversion of RNA to protein is translation. DNA subunits are defined by four identifiers based on chemical structure: A, C, T, and G. The elucidation of the structure of DNA in 1953 by Watson and Crick showed that DNA had a ‘double-helix’ structure. In other words, DNA exists in the cell as two long molecules constituted by individual subunits (A, T, C, G), with the two strands running in opposite directions. The subunits of DNA on one strand pair with the subunits on the other strand, with the pairings always taking the form of A-T and C-G. This phenomena is known as ‘base-pairing’ and was the ‘eureka’ moment for Watson and Crick. With the knowledge that the base pairs A-T and C-G occurred with equal frequency and that the DNA took on a helical structure, they were able to develop the model of DNA in a cell (“The Double Helix”). A related molecule, RNA, despite having a similar chemical structure, exists primarily as a single-stranded molecule. RNA subunits include A, C, G, and U, with the pairings as follows: A-U and C-G. RNA is then translated to protein via the ‘genetic code’. The genetic code

is a translation tool which denotes how the cellular machinery should read the RNA to build the subsequent protein. What the code was exactly was a mystery. Scientists knew that RNA was used to manufacture proteins, but could not determine how the translation was accomplished. The real heart of the problem was that RNA is encoded by four bases, while proteins are assembled from a pool of 20 amino acids. It wasn't until 1968 that the genetic code was detailed after experiments were conducted by Nirenberg, Khorana, and Holley. By using synthesized nucleotide strands these scientists were able to correlate each amino acid to a triplet 'codon' of three bases each ("How the Code was Cracked"). Their discovery allowed for the identification of the DNA to RNA to protein sequence of events, known as the central dogma of biology.



Source: Comparison of a single-stranded RNA and a double-stranded DNA with their corresponding nucleobases, *Difference DNA RNA*, Wikimedia Commons, 23 Mar. 2010.

Now that the structure and function of DNA was understood, the next question was how DNA was stored in the cell. DNA was assumed to be packaged in some way, given that if all the DNA of a cell were to be stretched out it would reach over 6 feet ("Chromosomes"). So in what form does DNA exist in the cell and how does this affect expression? The packaging of DNA must perform two crucial roles for the cell: provide protection to the DNA and provide access to the DNA when needed ("Chromosomes"). The integrity of DNA is essential to the survival of the cell, but the cell will not survive if access to it is impossible. Scientists discovered that DNA exists in a complex called chromatin. Chromatin is the functional assemblage of DNA and associated proteins. DNA coils around proteins, which provide protection and allow, as well as inhibit, access to the DNA. The regulation of DNA via proteins is one of the keys to the complexity of human life. While the human genome has significantly fewer genes than some plants or simple single-celled organisms, it is capable of producing an organism composed of trillions of cells. How does the human genome accomplish this? Through regulation and organization of the DNA. What was also noticed by scientists was that DNA needed to be carefully passed on from generation to generation to ensure survival of offspring. If the cell was to do this, it would be difficult to duplicate and transfer the long-stringy mess that is chromatin in the nucleus. Cells have devised a work-around, condensing their DNA into tightly-packed structures of protein and DNA called chromosomes. A chromosome is a single DNA molecule that encompasses many thousands of genes, or functional units. When the DNA exists in the chromosome state it is much easier for the cell to divide and separate the DNA intact. Once the chromosomes are segregated to their destination cells they unwind down to chromatin.



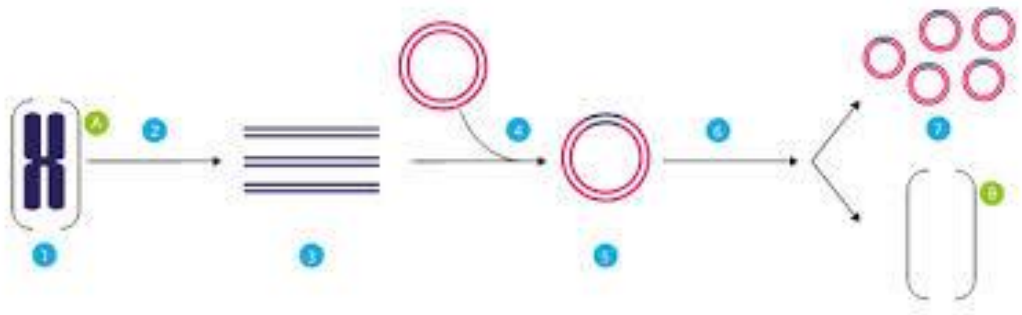

Source: Organization of DNA in the Chromosome, *Chromosome,* Wikimedia Commons, 26 Nov. 2004.

*"What we see depends mainly on what we look for." – John Lubbock*

As the race to understand DNA and its secrets continued, a potent molecular tool was discovered through experiments leading up to the awarding of a Nobel Prize in 1978 for restriction endonucleases. Commonly known as restriction enzymes, they were first seen to work through viruses that were infecting bacterial strains. The viruses being used seemed to be able to infect only certain strains, a phenomenon that was soon discovered to be the result of these bacterium's susceptibility to these enzymes. What did these enzymes do, exactly? Restriction enzymes typically cleave DNA sequences at very specific target sites, dictated by a small segment of base pairs (Simmer and Secko). Application of these restriction enzymes to DNA allowed for scientists to cut DNA at desired sites, though a reason to do so was lacking until it was coupled with another breakthrough in molecular biology: the discovery of plasmids.

Plasmids were characterized after the discovery that DNA was the hereditary material and were on their way to becoming an effective tool of molecular biologists in the late 1960's (Summers). Plasmids are small, circular DNA molecules that are prominent in bacteria. They exist apart from chromosomes and can be transferred from bacteria to bacteria, the mechanism by which bacterial cells can develop and transfer drug resistance genes. A limitation of plasmids is the fact they are primarily only used in bacterial cells, but that is not to say that they are not useful tools of a molecular biologist. Scientists have developed a technique termed DNA cloning involving plasmids. DNA cloning is the process of incorporating foreign DNA into a plasmid, in a cut-and-paste manner. Scientists use restriction enzymes to cut both DNA of interest and the plasmid in order to create identical cut sites. As a result, the DNA of interest can be inserted into the plasmid, which is then resealed ("Cloning Fact Sheet"). Utilizing plasmid cloning techniques

and harnessing the fast replication times of bacteria, scientists can essentially create bacterial factories that produce desired proteins in large quantities (“Bacterial Plasmids”).



Source: Cloning a gene using a plasmid, *PCR Clone*, Wikimedia Commons, 24 Feb. 2013.

The next logical step in the refinement of molecular identification techniques was to develop the technology capable of sequencing DNA base by base. In 1974, two labs developed such a technique, which lead to a joint Nobel Prize being awarded in 1980. Termed the “Sanger Method” after the principal investigator of one of the labs, this sequencing procedure opened the door to identifying genes in detail (Obenrader). Sanger devised a way to discern each individual base in a DNA sequence with the use of slightly modified bases. The modified bases act in such a way that when they are added to a growing DNA strand they halt further addition of bases. Sanger took DNA fragments of many lengths for a gene of a sequence of interest and added these modified bases one at a time, in isolation from one another. The resulting products were the original variety of fragments, all with one modified base added on. Now, Sanger had a map of the sequence detailed by fluorescent colors that corresponded to one of the four DNA bases. By this method, he and his lab were able to determine the exact sequence of DNA segments (Obenrader). While this technique has been modified and streamlined, Sanger sequencing represented a seismic leap in technological ability for molecular biology.

# Chapter 3: Cellular Eugenics

*"Nobody knew in advance that in vitro fertilization would be, by and large, safe."-*

*Leon Kass*

After the fall of Hitler's Nazi Germany, eugenics, as it was known then, fell from grace. American scientists severed ties with their collaboratory eugenics projects with their German counterparts, focusing their efforts in related fields. The term "eugenics" became taboo as a result of gross public disapproval with past eugenic policies, largely regarding the atrocities of Nazi Germany (Paul 125). A result of the public outcry was the trial of Nazi doctors at Nuremberg and the subsequent creation of the Nuremberg Code. An attempt to define the limits and requirements of ethical human experimentation, the Nuremberg Code represented a landmark restriction of voluntary consent of the human subject ("The Nuremberg Code"). Although lacking any legal force, the code attempted to set a moral standard from which to continue. In the wake of the Nuremberg trials, the field of eugenics dissolved, though the ideas maintained by its proponents endured. Eugenic practices were kept alive in various areas of scientific research under different guises, such as abortion and birth control (Paul 125).

Several relatively modern advancements in medical technology and understanding have allowed eugenic practices to blossom: In-Vitro Fertilization (IVF) and Pre-Implantation Genetic Diagnosis (PGD). These technologies, although not initially intended to further the cause of eugenics, have provided the potential for a substantial resurgence of eugenic ideas. Accompanied with the growing selectivity of sperm and egg donors, mediated by companies and the public alike, these technologies operate under a form of eugenics that can be deemed *cellular eugenics*. A precursor to modern *molecular eugenics*, *cellular eugenics* revolves around a scientifically

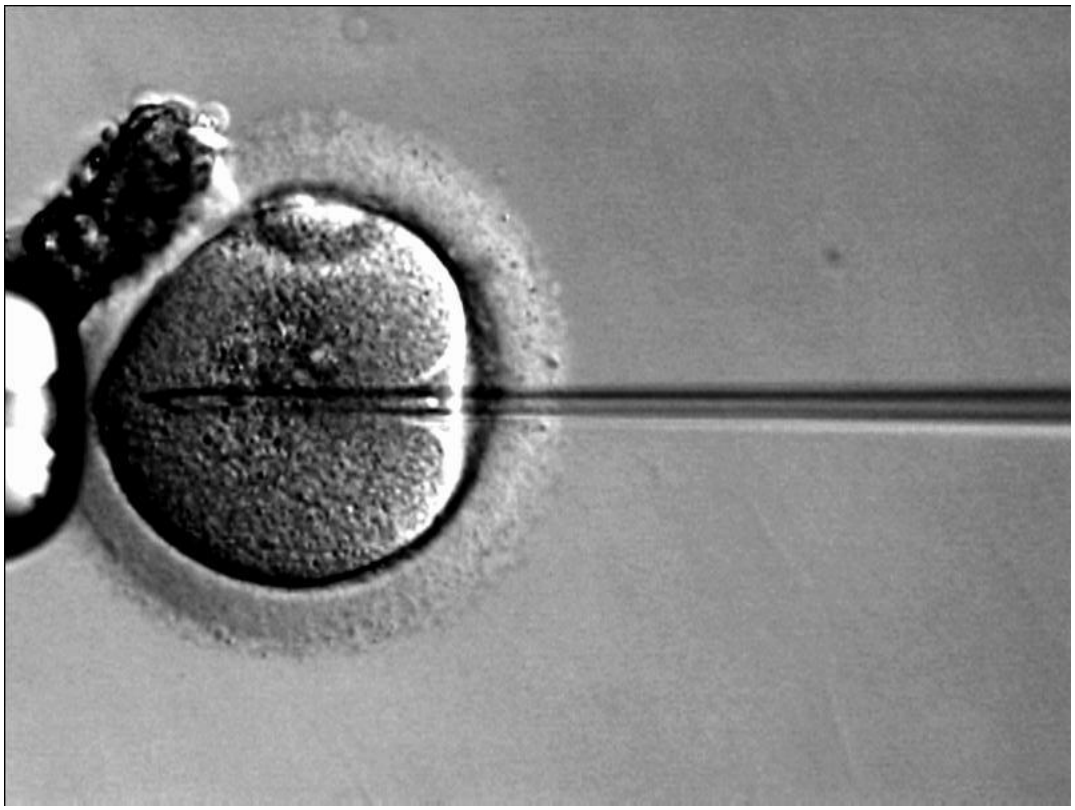
directed form of breeding manipulation. Cellular eugenics appears to render such control possible, a control sought by Galton in the 1800's. Eugenic ideas that had found disillusionment in the public sphere found solace and welcome in private practices.

Of the relatively recent medical advances that have influenced the now outdated *cellular eugenics*, none have been more influential that in-vitro fertilization, or IVF. According to the American Pregnancy Association, IVF:

> "is the process of fertilization by manually combining an egg and sperm in a laboratory dish. When the IVF procedure is successful, the process is combined with a procedure known as embryo transfer, which involves physically placing the embryo in the uterus".

Developed in 1978, IVF allows, and was designed specifically, for assisting infertile couples achieve pregnancy (Voorhis 379). In fact, a common cause of infertility is due to the age of the prospective mother. As the average age of women giving birth in the U.S. has risen over recent years, so has the incidence of infertility and other age related side effects: "As women age, fertility declines and the rate of miscarriages increases" (Voorhis 379). The process of IVF also lends itself to overcoming the obstacle of infertile or unusable eggs due to age. Women may preempt infertility issues by cryo-preserving their own eggs for later use or may use the eggs of a younger, donor woman (Voorhis 382). The donated egg may or may not be placed into the donor or the prospective mother, depending on the ability of the prospective mother to carry the baby to term. IVF can also assist if both the prospective mother and father have infertility issues. The father alone may suffer from a decreased sperm count or a motility-induced infertility. Whatever the situation, IVF was created to be a flexible solution to infertility issues.

While IVF does combat infertility, it is not a completely effective solution. Success rates continue to drop with age, though the use of donor eggs as mentioned before lends itself to increasing these odds. In addition, IVF is not without its risks. Some variations of IVF involve the transfer of multiple embryos into the prospective mother. Multiple gestations occur frequently, with statistics for 2003 showing that 31% of IVF births result in twins (Voorhis 382). IVF technologies have also been linked with a slight increase in the incidence of birth defects over that of live births (Voorhis 383). Despite the potential drawbacks, IVF has allowed infertile couples around the world to achieve pregnancies when before there were no options available. As IVF technologies gained traction and acceptance in the medical and public spheres, the reasoning behind implementing it became more diverse. Accompanied with the following topic of pre-implantation genetic diagnosis, couples without infertility saw IVF as a way to influence the potential of their offspring.



Source: ICSI sperm injection into oocyte, *ICSI*, Wikimedia Commons, 6 Aug. 2005.

Pre-implantation genetic diagnosis (PGD) was developed in the 1990's as a supplement to IVF technology. PGD attempts to discern genetic information about early developing embryos, while reducing the risk to mother and offspring. Primarily aimed at screening embryos for couples undergoing IVF for fertility issues or those with family histories of severe disease genes, PGD is a non-invasive screening procedure (Sermon, Steirteghem, and Liebaers 1633). PGD is the analysis of embryos outside the human body via genetic screening techniques. Importantly, PGD relies completely on IVF in order take advantage of its screening properties, as the embryos are analyzed prior to transfer to the mother (*Molecular Diagnostics 2nd Edition* 485). PGD was initially developed for use in conjunction with a molecular biology technique called polymerase chain reaction, or PCR, to test for single gene diseases such as cystic fibrosis (*Molecular Diagnostics 2nd Edition* 485). PCR is the amplification of specific DNA fragments to levels that make the desired section of DNA readily available for analysis. As such, PCR was utilized to detect the presence of disease genes in potential offspring.

The advent of PCR and PGD led to the first implication of these techniques with eugenic practices. Although the use of PGD to screen embryos plays a greater role in *molecular eugenics*, it influenced the practices of *cellular eugenics* for a brief period of time. The precision of PCR allowed for the analysis and identification of disease genes and, importantly, sex (*Molecular Diagnostics 2nd Edition* 485). With the ability to select characteristics of the embryos, the public could entertain the idea known as eugenic selection. Originally seen as a technology to prevent disease and assist infertile couples, PGD was assimilated to provide eugenics services. The selection of gender based on parental preference was the stepping stone to development of more precise genetic selection procedures, the cornerstone of *molecular eugenics*.

In addition to IVF and PGD, the introduction of specialized sperm banks combined the scientific technology of the time with eugenics ideas of the past. With the first artificial insemination occurring in 1785 and the practice of storing sperm gaining ground in the early 1900's, the concept of sperm donation developed (Agarwal and Allamaneni 539). Much like IVF and PGD, sperm banks were developed to provide the necessary genetic material for single mothers or infertile couples to have children. And in identical fashion, this practice was employed to suit *cellular eugenics*. Adopting a similar stance to that of Wiessmann and Galton, sperm banks were developed that stressed the importance of good genes in the development of offspring. A form of "positive eugenics", specialized sperm banks aimed to provide individuals with more than just the potential for having a child, they offered a super-child. Of notable interest is a particular sperm bank known as the genius sperm bank.

The Repository for Germinal Choice, or commonly known as the "genius sperm bank", was a specialized sperm bank set up by the late Robert Graham. With money from previous business ventures and a desire to create exceptional human beings, Graham lured notable individuals to donate to his sperm bank (Plotz 1). Graham was a vocal eugenicist and adopted the concerns of Galton and Darwin, that society was in genetic decline. In order to circumvent his fear that natural selection no longer acted on the human race he sought to set up a positive eugenics program and facilitate the creation of an evolutionarily superior collection of humans (Plotz 1). After attempting to acquire Nobel Prize winners, Graham sought outstanding, young scientists and some athletes to bolster his selection (Plotz 1). Founded in 1979, though no longer active, the sperm bank produced more than 200 children. While traditional sperm banks still offer some selection options for prospective mothers and families, the Repository for Germinal Choice clearly advocated the idea of hard heredity proposed by Galton and others in the distant

past. Despite public negativity, children were still produced as a result, lending itself to the notion that eugenic ideas about the influence of genes on the success of offspring are alive and well (Plotz 1).

While the public has debated over the ethicality of selecting sperm in such a manner, an equally interesting question is the whereabouts and life stories of the children created via the Repository for Germinal Choice. A recent investigational report was able to contact 15 of the offspring/families that were involved with the Repository. The report mentions that the offspring are all exceptional individuals, even with a wide range in intellectual prowess. As noted by the report, however, it is crucial to note that these are the only families willing to come forth, and as such, may have more successful children than the average child produced by the repository (Plotz). Of key interest is another topic of the report, which is the debate over the amount of pressure placed upon the offspring by the parents and even by the children on themselves (Plotz). As these children mature they will be the first example of an attempt to discern the effects of genes on offspring in terms of heritability of characteristics such as intelligence. Such scenarios foreshadow the world of *molecular eugenics* that will be introduced in the following chapter.

Much like sperm banks, egg donor banks were set up to facilitate assisting infertile mothers to achieve pregnancy. Following the development of IVF technologies, egg donation procedures were developed in the early 1980's. The primary focus of these donor banks is for "women with three types of reproductive problems: women who lack functioning ovaries, women who cannot achieve pregnancy for some reason through IVF, and women who use donated eggs for genetic reasons" (Sargent 2). The process behind donating eggs is time consuming and physically taxing, taking as long as four months in order to successfully transfer eggs from donor to recipient (Sargent 3). As with IVF and sperm banks, the original intent

behind the development of the technology required to successfully undertake egg donation and fertilization was solely to treat infertility. However it is clear that this technology can be, and has been, adapted to suit eugenic purposes. The selection of eggs based on genetic characteristics of the mother mirror the selection of sperm based on paternal traits. While egg donation has succeeded in providing an alternative fertility option for those struggling to achieve pregnancy, it has also offered an opportunity to rise through the gene pool.

The trend within the United States and the United Kingdom is for women to delay having children past prime of their fertility. As such, infertility is a source of greater and greater concern, causing an increased need for donor eggs. In 2004 alone, the United States had 7,588 births via donor eggs, as older women resort to egg donation coupled with IVF to achieve pregnancy. With the increase in demand has come the increase in selectivity. The commoditization of eggs, and sperm for that matter, is a dangerous road: "When eggs, sperm, and embryos can be bought and sold, there is a fine line between buying and selling gametes and buying and selling life itself" (Sargent 6). This commercialization of the egg donor market is readily seen in newspaper advertisements that reflect eugenic goals in clear language. An advertisement in the Harvard Crimson seeks young women of outstanding intellect, character, and physical ability to donate their eggs for a small fortune of $50,000 (Mendelsohn). What is striking about this article is the price offered, as the typical price in the United States is around $5,000 (Sargent 3). What is not shocking is the advertisement itself, one of many, particularly on college campuses. Clearly, those seeking egg donors have a goal, whether knowingly or not, that is driven by eugenic ideas. While egg selection based on parental characteristics represents the limit of cellular eugenics, in conjunction with PGD, egg donation can transform into an early form of molecular eugenics and allow for a greater degree of selectivity.

While the brief history of cellular eugenics has been detailed here, a crucial center-point to the efficacy of such practices has yet to be discussed: genetic determinism. The success, or futility, of cellular eugenic practices revolves around the ability of genes to determine phenotypes, or traits. Such consumers as those seeking the intelligent and athletic teen egg donor or the Nobel Prize sperm donor are committed, at least partially, to the idea that the offspring will be like the parent. It is universally accepted that genes are responsible for the traits, both seen and unseen. Genes determine who we are, but how and to what extent? Cellular eugenics is only effective if the genes have a strong correlation to their respective traits, otherwise all the effort would be a waste. So the question now is, was cellular eugenics "worth it"?

Genetic determinism is the theory that "genes produce our psychological and physical characteristics" (White). Or simply put in other words, our genes are everything. If genetic determinism holds absolutely for every trait, then DNA is the complete programming factor of the human biology and condition. In the years leading up to the Human Genome Project, strong genetic determinism held sway in the scientific community. It was not until the enlightening results of the Human Genome Project that it was discovered that genetic determinism was not as sound a theory as initially imagined (Strohman 24). The age of cellular eugenics assumed that genes determined traits directly and unambiguously. The practices of selecting sperm and egg donors was based this theory of genetic determinism, a theory that still persists in the public at large. As the Human Genome Project uncovered, genetic determinism was not all that it initially seemed. But if genetic determinism does not adhere to this absolutist nature, what then could influence the biology of our nature? The answer lies in the primary source of natural evolutionary pressure, the environment.

A modern approach to the influence of genes on traits is one of incompleteness (Strohman 26). While current thought acknowledges that genetic determinism is not completely sound, it realizes that no comprehensive alternative has been brought to light (Strohman 26). This shift away from genetic determinism is not an attempt to undermine the importance of genes on phenotypes. In fact, genes do play a critical role, sometimes more than others, in what is expressed. It is now observed that genes vary vastly in their ability to influence the expression of traits, such that "most of the causal claims related to genetic determinism are probabilistic, not deterministic" (Resnik and Vorhaus 3). According to this claim, genes do not determine absolutely, but increase the likelihood of a trait being expressed by some probabilistic condition. It is key to note that there will be genes at both ends of this spectrum, those that almost absolutely determine a trait and those that play a minor role.

The other factor that controls trait expression to some extent is the environment: "The complex interaction and interdependence of genes and environments, a fundamental and frequently ignored reality of biology, undermines the notion that genotypes alone determine (or cause) phenotypes" (Resnik and Vorhaus 4). The interplay between genes and environment remains largely unknown, as each gene may have unique interactions and activity patterns due to environmental cues. In addition to the environmental/genotype interaction, the Human Genome Project also shed light on another simple, yet important fact: a trait can be coded for by multiple genes. What is meant by this is that phenotypes are not dependent on single gene expression, but rather can be subject to inputs from a multitude of genes (Resnik and Vorhaus 4). Lastly, the developmental patterns of an organism can significantly influence the expression of genes, in a relatively new area of science, epigenetics, which studies the effect of non-DNA heritable changes to the genome (Resnik and Vorhaus 4). Thus, it can be seen that while an unambiguous

view of the influence of genes on traits is far from tangible, it is clear that genetic determinism is a theory in disrepair. The complex interaction of genes, environment, and development offer an almost insurmountable maze to be traversed by modern science.

What the complexity of the issue does bring to light is the futility of cellular eugenic practices. The quantity of unknown variables present in correlating the supposition that a parent's characteristics will be passed on, more or less whole to offspring, places a damper on the desires of selective sperm and egg donor recipients. However, as mentioned before, genes *do* play a significant role in determining traits, so there may be some success behind cellular eugenics. Perhaps this explains the extraordinary success of *some* of the offspring from the Repository for Germinal Choice. The practices of cellular eugenics, in the light of recent discoveries into the fallibility of genetic determinism, remain crude and broadly applied eugenic tools. With the advent of new molecular biology techniques and a deeper understanding of human genetics, cellular eugenics was exchanged for a more precise and unknown form of eugenics: molecular eugenics.

## Chapter 4: Molecular Eugenics

*"The social engineer is, then, the specialist still to be invented for mediation between biomedical interests and available techniques, and the social aspiration to which individuals will conform."*

*– Jacques Testart and Bernard Sèle*

The transition from cellular to molecular eugenics corresponded with scientists' increased ability to isolate and manipulate genetic material. Building upon cellular eugenics, the new molecular eugenics expanded on the reproductive technologies introduced in the 1970's and 1980's. With new insight on the variable deterministic nature of genes, molecular eugenics

expanded into groundbreaking new directions. Reproductive technologies can be used with finer precision than ever before, bringing up challenging and novel ethical issues. Enhancement of the human condition, or in other words, eugenics, is active in the research areas of embryo selection/enhancement, gene therapy, and artificial chromosomes. These innovative and rapidly expanding fields of human medical genetics offer unique and powerful tools for those who wish to modify the human genome. This chapter will explore how the transition between cellular and molecular eugenics took place, where molecular eugenics stands, and where it is leading us.

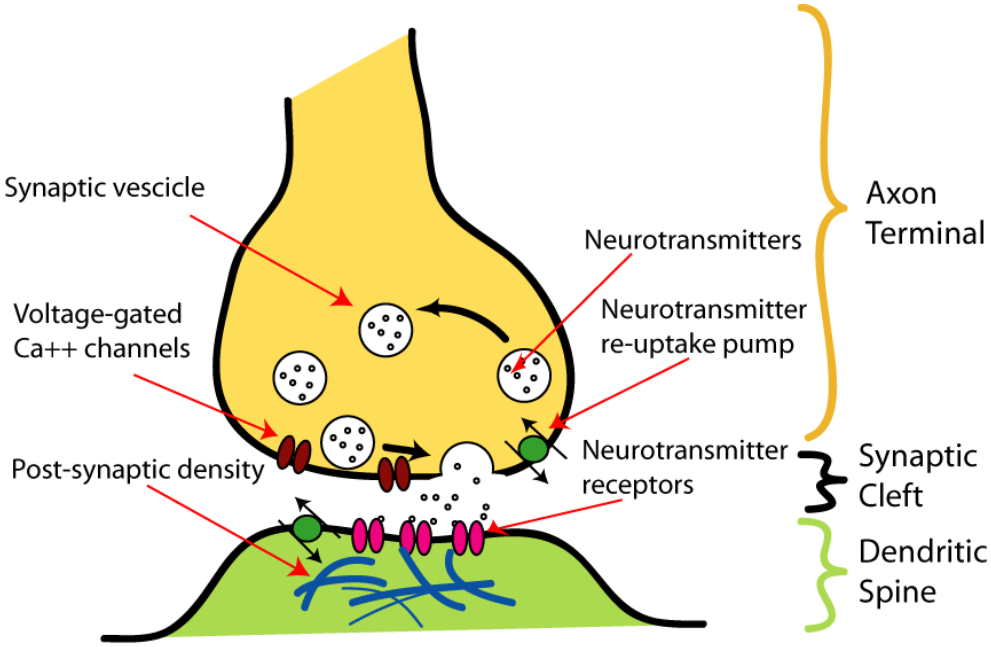
As previously mentioned, genetic determinism is the blanket phrase used to express the level at which genes determine a trait. What has been seen is that there are many factors that influence the determination of a trait, including the environment, one or many genes, and developmental cues (Resnik and Vorhaus 4). Cellular eugenics, which relied on manipulation at the cellular level, thus seems to be effective only when a gene strongly determines a trait. Even then, the rarity of finding a gene that strongly determines a trait *and* is the only gene that influences that trait is small. So it seems that if humans desire to modify themselves or their offspring they can choose from a limited set of traits that can be directly controlled. The human condition does not exist on absolutes, but it does strive to gain advantages via any mechanism possible. The egoistic nature of human beings, whether solely at work or tied up with altruistic motives, plays a significant role in guiding our decisions. If the ability to modify our offspring so that they have a 50% increased likelihood of garnering a trait becomes possible, it should be expected that some individuals would gladly pursue such an option.

Before the scenario of modifying offspring is considered, a few example cases involving the relationship between genes and traits will be shown. The Monoamine Oxidase A gene, or MAOA, is responsible for the production of a protein that is involved with the regulated

breakdown and destruction of neurotransmitters (McDermott 2119). Neurotransmitters, such as dopamine, or pleasure drug, are powerful molecules that stimulate brain activity by binding to their corresponding receptors on neurons. A Dutch scientist by the name of Han Brunner proposed that a mutation in MAOA was linked to aggression. His studies with a Dutch family that had produced a string of brutal, violent men resulted in his claim that MAOA was largely responsible for their behavior (Spiegel). Brunner concluded that a small alteration in the genetic sequence of the MAOA gene resulted in a less-functional protein, thus leading to aggression (Spiegel). A more recent study suggests that MAOA is strongly involved in causing the aggression phenotype, though environmental factors do play a lesser, but still significant, role. The presence of a low-stimuli environment may dampen the effect of mutations of MAOA and the complexity of human behavioral traits precludes any definitive deterministic claims being made about the MAOA gene (McDermott 2118).

While the debate over the deterministic strength of the MAOA gene on aggressive behavior continues, the very pronunciation of the potential impact that MAOA mutations have on behavior impact society. Consider the case in which Stephen Mobley shot and killed a pizza store manager in 1991. Mobley was well-off, seemingly deciding to commit the crime at random. He was vocal about it afterwards, in an apparent celebratory manner (Spiegel). When on trial, with the death penalty hanging over Mobley, Mobley's defense attorney argued that it was the MAOA gene that caused him to murder the pizza store manager, thus making him less or not responsible for the crime. While the courts eventually ended up convicting him and sentencing him to death, they originally reduced his sentence to life in prison because of this evidence (Spiegel). It can clearly be seen that the influence that scientific knowledge has on the population at large is tremendous. An unsubstantiated claim about the deterministic nature of a gene almost

reduced the sentence in Mobley's case, with evidence also showing that those deemed 'psychopaths' who claim genetic faults receive a year less of prison time on average (Spiegel).




Source: Synapse Illustration, *Synapse Illustration*, Wikimedia Commons, 6 May 2008.

Another gene of interest in the quest to understanding genetic determinism is the DRD4 gene, or dopamine D4 receptor gene. As mentioned before, dopamine is the pleasure drug, a neurotransmitter that activates pleasure pathways in the brain. Dopamine is specifically involved in the pleasure-reward system (Almenberg 9). Altering the standard levels and responses of neurotransmitters and their receptors can have drastic impacts on the human body (Almenberg 7). Anti-depression drugs such as Prozac and illicit drugs like cocaine are involved in the same types of pathways. The DRD4 gene was found to appear in human populations in many forms, differentiated by the length of the DNA sequence (Winstead). The DRD4 gene contains repeated segments of DNA that vary according to evolutionary patterns (Winstead). Studies found that two major forms of DRD4, 7R and 4R, had interesting differences in relation to bodily response

to dopamine. The more common 4R variant requires less dopamine in order stimulate the reward response than the 7R variant. As such, individuals with the 7R variant may potentially seek out risks in order to stimulate their reward pathways (Almenberg 9). A study undertaken to discover the influence of the 7R variant on behavior suggests that men with the 7R variant took more risks in financial scenarios than men without the 7R variant (Almenberg 14). The 7R form of DRD4 is also associated with Attention Deficit Hyperactivity Disorder and substance abuse (Almenberg 11). While the results from similar studies somewhat contradict this study, the consensus is that the relationship between DRD4 and the suggested activities is still unknown (Winstead). What is known is that DRD4 plays *some* part in determining these behaviors. The takeaway from the DRD4 case, as well as the MAOA case, is that the deterministic strength of many genes is not known. Behaviors are notoriously complex, as conceded by the existence of the field of psychology as a whole.

In the current field of human reproductive technological research, genetic selection and enhancement are facilitating the caretaking of eugenic ideas. With cellular eugenics it was seen that scientists were limited to manipulating at the cell level, hoping to capture a set of good genes by selecting embryos based on parental characteristics. Molecular eugenics is a level deeper, at the level of genes. Since the advent of technology that allows scientists to characterize, synthetically produce, and manipulate DNA sequences, the human genome is open for alteration. While much is still not known, scientists can identify different alleles and suggest phenotypes that correspond with those alleles, such as with the MAOA and DRD4 genes (Savulescu 157). IVF and PGD allow scientists to delve into embryos and identify the alleles of genes of interest in each embryo. PGD has already made headlines as a tool for identifying gender at a pre-zygotic stage, thus allowing for simple sex selection (Sermon, Steirteghem, and Liebaers 1637). In

addition, rare diseases such as Huntington's disease can be avoided by simply not selecting embryos that were screened positive as carriers (Sermon, Steirteghem, and Liebaers 1637). While the selection of sex may or may not seem like a justifiable use of PGD, the discovery of rare genetic disorders seems to be a universally accepted plus. Both cases do have something in common, however. They are forms of eugenic selection. In rough terms, eugenic, or genetic, selection is the selection of genes based on one's wishes for the best genome. A parent can accomplish this by using PGD on embryos isolated for IVF. The embryos can be screened for a growing number of genes, mostly disease genes (Sermon, Steirteghem, and Liebaers 1633).

The futility of positive and negative cellular eugenics programs has led society to the point of genetic selection (Testart 3086). With the advent of new medical technologies, this genetic selection technology has moved from sex and disease identification to trait selection. Current PGD technology allows for simple and rapid analysis of a multitude of embryos (Testart 3087). Such analytical capability allows for the selection of embryos based on the genes present. When publicly available, this technology will be seen as a tool for the expectant couple to shape and meld a child as they wish (Testart 3088). Western couples are having fewer and fewer children statistically, with greater emphasis placed on their wellbeing (Testart 3086). While the abolishment of disease traits is an undeniable positive result of couples who undergo IVF and PGD therapies, the selection of non-critical traits is in question (Refer to Ch. 3).

A plethora of ethical issues arise when genetic or eugenic selection is brought under scrutiny. Of chief interest and concern is the motive behind prospective parents in selecting their embryo, or future child. At base, parents are most likely driven by the desire to produce the best offspring possible. Much like was seen in the time of early eugenics and Darwin, the definition of "best" leaves much to be discussed. There is a two-faced nature behind the intent to select

traits. On the one hand, parents may be viewed as caring and altruistic for wishing to have a child that has the qualities it needs to succeed, while on the other they may be seen as egoistic and controlling for 'superseding' nature. The race for this "best" set of traits may lead to a new concept of normal, driven by competition among parents to produce the best suited offspring possible. Other thoughts bring the conclusion that the needs of society may eventually override the wishes of the parents, fostering offspring that are tailor-made for the current societal system (Testart 3089). Considerations of deterministic effects of genes on behavior, like the MAOA and DRD4 cases, may influence the selection of traits which is poignantly stated by Testart and Sele: "For the first time, genetics allied with computerized data handling and statistics, will claim that it can forsee the risk of pathology and to evaluate its degree in the case of each individual and thus for each embryo" (3089).

Of further ethical interest is contemplating the potential harms of genetic selection. Savulescu et al bring forth arguments for a number of issues revolving around the selection of traits. While the most glaring harm that comes to mind seems to be the harm to the offspring, this argument is effectively deconstructed by Savulescu et al. They discuss how each embryo represents an individual person. The selection of one embryo over another results in the creation of one person and the inhibition of the creation of another. They are two distinct entities, and as such, harm cannot be done to embryo #1 by selecting embryo #2 (Savulescu, et al 162). With that being said, issues of social injustice, diversity, and devaluation are legitimate concerns (Savulescu, et al 166-7). By partaking in genetic selection procedures, parents may be harming society as a whole. Society may bear the cost of the choices of that couple (Savulescu, et al 166). Another concern closely tied with the burden on society is the harm of reduced diversity. As hinted at before, the desire to produce the "best" offspring may lead to a convergence of selected

traits, with a de-emphasis on diversity (Savulescu, et al 166). The possibility of devaluation is also a potential result of a decrease in diversity, as exceptional traits become commonplace (Savulescu, et al 167). Genetic selection represents an ethically muddled affair; a practice on the cusp of widespread usage. Even now clinics are reported to be offering selection of eye and hair color, all according to the desire of the parents (Goldberg).

Of even greater interest, and concern, is the potential of genetic enhancement. Unlike genetic selection, genetic enhancement will allow for the manipulation of the genome of an embryo. The traits could then be engineered on demand, as per the desires of the parent. While the discussion should not turn to the creation of super-babies, something that should be seen to be highly unlikely due to the environmental influence of genetic determinism, it does represent an even more challenging quandary. Though the technology to effectively do such manipulation remains out of reach, if history is anything to go by, it will not remain hidden for long. The concerns fronted by Savulescu et al remain, with additions. The threat of decreased diversity, devaluation of the human condition, and increased social injustice are just as present as with cases of genetic selection. Carrying much more weight is the argument of harm to the child. As Savulescu et al point out: "When considering a possibly-enhancing intervention, there are two possible futures for the *same person*" (162). The harm to the child is a very real possibility, though its consequences remain in the theoretical realm.

Gene therapy offers the potential to manipulate the human genome at an embryo level or at a whole organism levels. The implications of such technology suggest that an adult human may be able to one day modify their genome and see results. As Kazuki and Oshimura state: "Gene therapy has been envisioned to provide a direct and permanent correction of genetic defect" (1591). Gene therapy is the process of inserting genetic material into an organism via a

vector. The vector used is typically some sort of virus that has been modified to utilize the infiltration capacities of the normally harmful virus to deliver the desired genetic material. The hoped for result is the lasting expression of the inserted DNA in the organism (Kazuki and Oshimura 1591). It has not been without its trials and miscues, as virus based gene therapy has effectively stalled after mistrials resulted in the deaths of human patients ("6 Deaths In Gene Therapy Study"). While the search for effective viral vectors remains ongoing, recent advances in Human Artificial Chromosomes (HACs) sheds new light on gene therapy and its role as a eugenic tool for genetic enhancement. HACs are similar to the bacterial plasmids detailed in Chapter 2 of this paper in that they carry "extra" DNA. Unlike plasmids however, HACs are engineered to be like human chromosomes and in fact separate and proliferate with their host cells (Kazuki and Oshimura 1591). The fact that these HACs are able to survive and function in host cells suggests that they may one day be used to either engineer offspring or 'repair' adult humans who suffer from a heterozygous condition (one bad copy of a gene and one good copy) that could be remedied by the presence of another good allele. The field of human enhancement does not solely lie within the realm of genetics. The incorporation of machine and man underlies a closely related movement to that of molecular eugenics.

## Chapter 5: Transhumanism and Conclusion

*"Transhumanism is a class of philosophies of life that seek the continuation and acceleration of the evolution of intelligent life beyond its currently human form and human limitations by means of science and technology, guided by life-promoting principles and values." – Max More*

While molecular eugenics is only within the realm of biology, transhumanism takes into account technology as well. First used in 1927 by Julian Huxley, the term transhumanism has

come to represent a growing idea in the 21st century (Bostrom 7). In general, transhumanism is the "human liberation from our biological constraints" in the form of technological enhancements (Bailey). Transhumanism represents a movement beyond that of standard human capabilities. Proponents of transhumanism see human existence as having been a progression of advancements that elevate our status (Bailey). Modern transhumanists, led by influential Oxford Professor Nick Bostrom, believe that "humanity's potential is still mostly unrealized" (Bostrom 26). Be it in biotechnology, nanotechnology, or a plethora of other areas of study, transhumanists seek to upgrade the human condition. The innate human desire for progress and enhancement is at the core of the movement (Bostrom 1).

With transhumanism comes a score of challenging and demanding novel ethical quandaries. Whereas molecular eugenics seeks to improve humans by modifying existing human traits, transhumanism wants to expand beyond the limits of humanity. It is possible that the enhancements would lead to an organism so far greater than a human that it would be a member of a new species, or *post-human* (Buchanan 353). While the technology to create such a being does not yet exist, transhumanism may lead to that path. Humans may well take evolution into their own hands, guided by science and technology to create this race of *post-humans* (Buchanan 353). The question then is whether or not these *post-humans* should be morally equal to humans, and if not, where do humans stand? While the debate over this issue is indeed intriguing, it is beyond the scope of this paper. Suffice to say that the distinction between humans and *post-humans* will be difficult to draw, as will the moral standing of each.

The purpose of this paper has been to enlighten the reader on the history and future of eugenics. From the time of Darwin and Galton to Hitler's Nazi Germany to present day, scientific discoveries have and will continue to shape public opinion. Eugenics has presented

itself in many forms throughout the years, from positive and negative breeding programs to directed genetic techniques. While the eugenics of old was focused around social programs the new eugenics of cellular and molecular origins revolves around the private sphere. Parents can choose from a growing list of selectable traits in their offspring. Gene therapy and human artificial chromosomes offer avenues for adult humans to undergo genetic modifications. The technology of eugenics is progressing faster than ethical thought.

It is crucial to understand where eugenics has been in order to understand where it may go. While the technologies discussed in this paper may not result in fruitful eugenic techniques, other scientific breakthroughs may. The ethical discussion behind human enhancement can take a variety of paths. The harm to the offspring, in the form of open futures and free will are of paramount consideration. The authority of the parents is also to be respected, as is the harm to society. The enhancement of individuals based on private considerations may well create a separate class of humans that are enhanced beyond the average person. The concept of what determines a human may be stretched, particularly with the pressure from the transhumanist movement. It is clear that the definition of what a human is, as well as what a person is, need be agreed upon. Eugenics has persisted for over a century, a testament to the human desire for advancement and progress. Technologies developed for medical purposes have been adopted to suit these desires. Where eugenics has been is known, where it is going is yet to be seen. As Charles Darwin once said: “It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one most adaptable to change”.

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