Designer Babies:  
Eugenics Repackaged or Consumer Options?

By Stephen L. Baird

The forces pushing humanity towards attempts at self-modification, through biological and technological advances, are powerful, seductive ones that we will be hard-pressed to resist.

Almost three decades ago, on July 25, 1978, Louise Brown, the first “test-tube baby” was born. The world’s first “test-tube” baby arrived amid a storm of protest and hand-wringing about science gone amok, human-animal hybrids, and the rebirth of eugenics. But the voices of those opposed to the procedure were silenced when Brown was born. She was a happy, healthy infant, and her parents were thrilled. The doctors who helped to create her, Patrick Steptoe and Robert Edwards, could not have been more pleased. She was the first person ever created outside a woman’s body and was as natural a baby as had ever entered the world. Today in vitro fertilization (IVF) is often the unremarkable choice of tens of thousands of infertile couples whose only complaint is that the procedure is too difficult, uncertain, and expensive. What was once so deeply disturbing now seems to many people just another part of the modern world. Sell in vitro fertilization (IVF) is often the unremarkable choice of tens of thousands of infertile couples whose only complaint is that the procedure is too difficult, uncertain, and expensive. What was once so deeply disturbing now seems to many people just another part of the modern world. Soon we may be altering the genes of our children to engineer key aspects of their character and physiology. The ethical and social consequences will be profound. We are standing at the threshold of an extraordinary, yet troubling, scientific dawn that has the potential to alter the very fabric of our lives, challenging what it means to be human, and perhaps redesigning our very selves. We are fast approaching the most consequential technological threshold in all of human history: the ability to alter the genes we pass to our children. Genetic engineering is already being carried out successfully on nonhuman animals. The gene that makes jellyfish fluorescent has been inserted into mice.
embryos, resulting in glow-in-the-dark rodents. Other mice have had their muscle mass increased, or have been made to be more faithful to their partners, through the insertion of a gene into their normal genetic make-up. But this method of genetic engineering is thus far inefficient. In order to produce one fluorescent mouse, several go wrong and are born deformed. If human babies are ever to be engineered, the process would have to become far more efficient, as no technique involving the birth of severely defective human beings to create a "genetically enhanced being" will hopefully ever be tolerated by our society (Designing, 2005).

Once humans begin genetically engineering their children for desired traits, we will have crossed a threshold of no return. The communities of the world are just beginning to understand the full implications of the new human genetic technologies. There are few civil society institutions, and there are no social or political movements, critically addressing the immense social, cultural, and psychological challenges these technologies pose.

Until recently, the time scale for measuring change in the biological world has been tens of thousands, if not millions of years, but today it is hard to imagine what humans may be like in a few hundred years. The forces pushing humanity toward attempts at self-modification, through biological and technological advances, are powerful, seductive ones that we will be hard-pressed to resist. Some will curse these new technologies, sounding the death knell for humanity, envisioning the social, cultural, and moral collapse of our society and perhaps our civilization. Others see the same technologies as the ability to take charge of our own evolution, to transcend human limitations, and to improve ourselves as a species. As the human species moves out of its childhood, it is time to acknowledge our technological capabilities and to take responsibility for them. We have little choice, as the reweaving of the fabric of our genetic makeup has already begun.

**The Basic Science**

Biological entities are comprised of millions of cells. Each cell has a nucleus, and inside every nucleus are strings of deoxyribonucleic acid (DNA). DNA carries the complete information regarding the function and structure of organisms ranging from plants and animals to bacterium. Genes, which are sequences of DNA, determine an organism's growth, size, and other characteristics. Genes are the vehicle by which species transfer inheritable characteristics to successive generations. Genetic engineering is the process of artificially manipulating these inheritable characteristics.

Genetic engineering in its broadest sense has been around for thousands of years, since people first recognized that they could mate animals with specific characteristics to produce offspring with desirable traits and use agricultural seed selectively. In 1863, Mendel, in his study of peas, discovered that traits were transmitted from parents to progeny by discrete, independent units, later called genes. His observations laid the groundwork for the field of genetics (Genetic, 2006).

Modern human genetic engineering entered the scientific realm in the nineteenth century with the introduction of Eugenics. Although not yet technically considered "genetic engineering," it represented society's first attempt to scientifically alter the human evolutionary process. The practice of human genetic engineering is considered by some to have had its beginnings with in vitro fertilization (IVF) in 1978. IVF paved the way for preimplantation genetic diagnosis (PGD), also referred to as preimplantation genetic selection (PGS). PGD is the process by which an embryo is microscopically examined for signs of genetic disorders. Several genetically based diseases can now be identified, such as Downs Syndrome, Tay-Sachs Disease, Sickle Cell Anemia, Cystic Fibrosis, and Huntington's disease. There are many others that can be tested for, and both medical and scientific institutes are constantly searching for and developing new tests. For these tests, no real genetic engineering is taking place; rather, single cells are removed from embryos using the same process as used during in vitro fertilization. These cells are then examined to identify which are carrying the genetic disorder and which are not. The embryos that have the genetic disorder are discarded, those that are free of the disorder are implanted into the woman's uterus in the hope that a baby will be born without the genetic disorder. This procedure is fairly uncontroversial except with those critics who argue that human life starts at conception and therefore the embryo is sacrosanct and should not be tampered with. Another use for this technique is gender selection, which is where the issue becomes slightly more controversial. Some disorders or diseases are gender-specific, so instead of testing for the disease or disorder, the gender of the embryo is determined and whichever gender is "undesirable" is discarded. This brings up ethical issues of gender selection and the consequences for the gender balance of the human species.

A more recent development is the testing of the embryos for tissue matching. The embryos are tested for a tissue match with a sibling that has already developed, or is in danger of developing, a genetic disease or disorder. The purpose is to produce a baby who can be a tissue donor. This type of
procedure was successfully used to cure a six-year-old-boy of a rare blood disorder after transplanting cells from his baby brother, who was created to save him. Doctors say the technique could be used to help many other children with blood and metabolic disorders, but critics say creating a baby in order to treat a sick sibling raises ethical questions (Genetic, 2006).

The child, Charlie Whitaker, from Derbyshire, England, was born with Diamond Blackfan Anemia, a condition that prevented him from creating his own red blood cells. He needed transfusions every three weeks and drug infusions nearly every night. His condition was cured by a transplant of cells from the umbilical cord of his baby brother Jamie, who was genetically selected to be a donor after his parents' embryos were screened to find one with a perfect tissue match. Three months after his transplant, Charlie's doctors said that he was cured of Diamond Blackfan Anemia, and the prognosis is that Charlie can now look forward to a normal quality of life (Walsh, 2004). Is this the beginning of a slippery slope toward "designer" or "spare parts" babies, or is the result that there are now two healthy, happy children instead of one very sick child a justification to pursue and continue procedures such as this one? Policymakers and ethicists are just beginning to pay serious attention. A recent working paper by the President's Council on Bioethics noted that "as genomic knowledge increases and more genes are identified that correlate with diseases, the applications for PGD will likely increase greatly," including diagnosing and treating medical conditions such as cancer, mental illness, or asthma, and nonmedical traits such as temperament or height. "While currently a small practice," the Council's working paper declares, "PGD is a momentous development. It represents the first fusion of genomics and assisted reproduction—effectively opening the door to the genetic shaping of offspring (Rosen, 2003)."

In one sense PGD poses no new eugenic dangers. Genetic screening using amniocentesis has allowed parents to test the fitness of potential offspring for years. But PGD is poised to increase this power significantly: It will allow parents to choose the child they want, not simply reject the ones they do not want. It will change the overriding purpose of IVF, from a treatment for fertility to being able to pick and choose embryos like consumer goods—producing many, discarding most, and desiring only the chosen few.

The next step in disease elimination is to attempt to refine a process known as "human germline engineering" or "human germline modification." Whereas preimplantation genetic diagnosis (PGD) affects only the immediate offspring, germline engineering seeks to affect the genes that are carried in the ova and sperm, thus eliminating the disease or disorder from all future generations, making it no longer inheritable. The possibilities for germline engineering go beyond the elimination of disease and open the door for modifications to human longevity, increased intelligence, increased muscle mass, and many other types of genetic enhancements. This application is by far the more consequential, because it opens the door to the alteration of the human species. The modified genes would appear not only in any children that resulted from such procedures, but in all succeeding generations.

The term germline refers to the germ or germinal cells, i.e., the eggs and sperm. Genes are strings of chemicals that help create the proteins that make up the body. They are found in long coiled chains called chromosomes located in the nuclei of the cells of the body. Genetic modification occurs by inserting genes into living cells. The desired gene is attached to a viral vector, which has the ability to carry the gene across the cell membrane. Proposals for inheritable genetic modification in humans combine techniques involving in vitro fertilization, gene transfer, stem cells, and cloning. Germline modification would begin by using IVF to create a single-cell embryo or zygote. This embryo would develop for about five days to the blastocyst stage (very early embryo consisting of approximately 150 cells. It contains the inner cell mass, from which embryonic stem cells are derived, and an outer layer of cells called the trophoblast that forms the placenta. (It is approximately 1/10 the size of the head of a pin.) At this point embryonic stem cells would be removed. (Figure 2) These stem cells would be altered by adding genes using viral vectors. Colonies of altered stem cells would be grown and tested for successful incorporation of the new genes. Cloning techniques would be used to transfer a successfully modified stem cell nucleus into an enucleated egg cell. This "constructed embryo" would then be implanted into a woman's uterus and brought to term. The child born would be a genetically modified human (Inheritable, 2003).

Proponents of germline manipulation assume that once a gene implicated in a particular condition is identified, it might be appropriate and relatively easy to replace, change, supplement, or otherwise modify that gene. However, biological characteristics or traits usually depend on interactions among many genes and, more importantly, the activity of genes is affected by various processes that occur both inside the organism and in its surroundings. This means that scientists cannot predict the full effect that any gene modification will have on the traits of people or other organisms.
There is no universally accepted ideal of biological perfection. To make intentional changes in the genes that people will pass on to their descendants would require that we, as a society, agree on how to classify “good” and “bad” genes. We do not have the necessary criteria, nor are there mechanisms for establishing such measures. Any formulation of such criteria would inevitably reflect particular current social biases. The definition of the standards and the technological means for implementing them would largely be determined by economically and socially privileged groups (Human, 2004).

Summary

“Designer babies” is a term used by journalists and commentators—not by scientists—to describe several different reproductive technologies. These technologies have one thing in common: they give parents more control over what their offspring will be like. Designer babies are made possible by progress in three fields:

1. **Advanced Reproductive Technologies.** In the decades since the first “test tube baby” was born, reproductive medicine has helped countless women conceive and bear children. Today there are hundreds of thousands of humans who were conceived thanks to in vitro fertilization. Other advanced reproductive technologies include frozen embryos, egg and sperm donations, surrogate motherhood, pregnancies by older women, and the direct injection of a sperm cell into an egg.

2. **Cell and Chromosome Manipulation.** The past decade has seen astonishing breakthroughs in our knowledge of cell structure. Our ability to transfer chromosomes (the long threads of DNA in each cell) has led to major developments in cloning. Our knowledge of stem cells will make many new therapies possible. As we learn more about how reproduction works at the cellular level, we will gain more control over the earliest stages of a baby’s development.

3. **Genetics and Genomics.** With the mapping of the human genome, our understanding of how DNA affects human development is only just beginning. Someday we might be able to switch bits of DNA on or off as we wish, or replace sections of DNA at will; research in that direction is already well underway.

Human reproduction is a complex process. There are many factors involved in the reproduction process: the genetic constitution of the parents, the condition of the parents’ egg and sperm, and the health and behavior of the impregnated mother. When you consider the enormous complexity of the human genome, with its billions of DNA pairs, it becomes clear that reproduction will always have an element of unpredictability. To a certain extent we have always controlled our children’s characteristics through the selection of mates. New technologies will give us more power to influence our children’s “design”—but our control will be far from total (Designer, 2002).

Since the term “designer babies” is so imprecise, it is difficult to untangle its various meanings so as to make judgments about which techniques are acceptable. Several different techniques have been discussed, such as screening embryos for high-risk diseases, selecting the sex of a baby, picking an embryo for specific traits, genetic manipulation for therapeutic reasons, and genetic manipulation for cosmetic reasons. Although, to date, none of these techniques are feasible, recent scientific breakthroughs and continued work by the scientific community will eventually make each a possibility in the selection process for the best possible embryo for implantation.

**Arguments for Designer Babies**

1. Using whatever techniques are available to help prevent certain genetic diseases will protect children from suffering debilitating diseases and deformities and reduce the financial and emotional strain on the parents. If we want the best for our children, why shouldn’t we use the technology?

2. The majority of techniques available today can only be used by parents who need the help of fertility clinics to have children; since they are investing so much time and money in their effort to have a baby, shouldn’t they be entitled to a healthy one?

3. A great many naturally conceived embryos are rejected from the womb for defects; by screening embryos, we are doing what nature would normally do for us.
Imagine the reaction nowadays if organ transplantation were to be prohibited because it is “unnatural”—even though that is what some people called for when transplantation was a medical novelty. It is hard to see how the replacement of a defective gene is any less “natural” than the replacement of a defective organ. The major difference is the entirely beneficial one that medical intervention need occur only once around the time of conception, and the benefits would be inherited by the child and its descendants.

Arguments Against Designer Babies

1. We could get carried away “correcting” perfectly healthy babies. Once we start down the slippery slope of eliminating embryos because they are diseased, what is to stop us from picking babies for their physical or psychological traits?
2. There is always the looming shadow of eugenics. This was the motivation for some government policies in Europe and the United States in the first half of the twentieth century that included forced sterilizations, selective breeding, and “racial hygiene.” Techniques that could be used for designing babies will give us dangerous new powers to express our genetic preferences.
3. There are major social concerns—such as: Will we breed a race of super humans who look down on those without genetic enhancements? Will these new technologies only be available to the wealthy—resulting in a lower class that will still suffer from inherited diseases and disabilities? Will discrimination against people already born with disabilities increase if they are perceived as genetically inferior?
4. Tampering with the human genetic structure might actually have unintended and unpredictable consequences that could damage the gene pool.
5. Many of the procedures related to designing babies involve terminating embryos; many disapprove of this on moral and religious grounds.

As our technical abilities progress, citizens will have to cope with the ethical implications of designer babies, and governments will have to define a regulatory course. We will have to answer some fundamental questions: How much power should parents and doctors have over the design of their children? How much power should governments have over parents and doctors? These decisions should be made based on facts and on our social beliefs.

Activity

What better place to expose our students to a developing technology that could eventually change the genetic makeup of the human species and affect the dynamics of politics, economics, morals, and cultural beliefs of our society than the technology education classroom?

Winona Morrissette-Johnson, a high school teacher in Alexandria, Virginia has designed an excellent two-day lesson plan that will allow students to:
1. Discover ethical issues surrounding the practice of genetic engineering in reproductive medicine.
2. Understand key terms and concepts related to the science of genetic engineering.

This lesson plan can be accessed at: http://school.discovery.com/lessonplans/programs/geneticengineering/

References


Stephen L. Baird is a technology education teacher at Bayside Middle School, Virginia Beach, Virginia and adjunct faculty member at Old Dominion University. He can be reached via email at Stephen.Baird@vbschools.com.