

## Crossing the Line: ART and Genetics

Note: The topic for this issue of *Ekklesia Then & Now (ET&N)* was originally "Being Blessed," but as I related a couple of weeks ago, I am in the midst of writing my third novel. *The Whole is Greater* is centered on the issues involved in modern Assisted Reproduction Technology (ART, a rather ironic acronym). My research into this topic has led me to this issue of *ET&N*.

### Then

More than a year and a half ago, I distributed an issue of *ET&N* on [Abortion](#) (see *ET&N* 27). In it, I pointed out that the Bible is silent on the topic, although one can certainly extend a number of biblical arguments. Similarly, the New Testament is silent on infanticide, a practice that was not uncommon in the Roman world. For about as long as Man has been around, he has sought to control the reproductive process through these and other means. God gave us sex for two primary reasons—procreation, certainly, but also pleasure, and He celebrates the latter in the *Song of Songs*. He intended it as a special privilege between a man and woman in marriage—the biology alone is sufficient evidence—but again, for most of the history of mankind, we have sought to circumvent God's purposes, taking what we want while eliminating or modifying what we don't.

Paul understood the strong influence of human sexuality and the role sexual activity plays in bonding a man and a woman:

*Now concerning the matters about which you wrote [in an earlier letter]: "It is good for a man not to have sexual relations with a woman." But because of the temptation to sexual immorality, each man should have his own wife and each woman her own husband. The husband should give to his wife her conjugal rights, and likewise the wife to her husband. For the wife does not have authority over her own body, but the husband does. Likewise the husband does not have authority over his own body, but the wife does. Do not deprive one another, except perhaps by agreement for a limited time, that you may devote yourselves to prayer; but then come together again, so that Satan may not tempt you because of your lack of self-control (1 Corinthians 7:1-5).*

Man's use of God's creation shows a similar tendency. He created the world for mankind's use and pleasure, or at least he granted us dominion after He had created it:

*"So God created man in his own image, in the image of God he created him; male and female he created them. And God blessed them. And God said to them, "Be fruitful and multiply and fill the earth and subdue it and have dominion over the fish of the sea and over the birds of the heavens and over every living thing that moves on the earth." And God said, "Behold, I have given you every plant yielding seed that is on the face of all the earth, and every tree with seed in its fruit. You shall have them for food. And to every beast of the earth and to every bird of the heavens and*

to everything that creeps on the earth, everything that has the breath of life, I have given every green plant for food." And it was so" (Genesis 1:27-30).

Man has certainly taken advantage of this dominion. In the years just before and after the establishment of the church, Romans criss-crossed their world with roads, some of which even survive today. They constructed elaborate aqueducts to carry water into their growing cities. They brought animals from distant lands to serve as curiosities for the rich or to fight for their amusement in their arenas. They built lighthouses to guide their ships in dangerous waters. They built long walls to protect their territory.

## Now

In the arena of environmentalism, the question that remains unanswered is where mankind closes the line from responsible respect and use of God's creation to predatory exploitation. An increasing number of researchers argue that we have already crossed that line. The combined effects of deforestation and pollution are, many claim, leading to global warming and its potentially disastrous consequences. The recent dramatic increase in the number and severity of hurricanes may be simply a cyclical phenomenon, but it would be irresponsible to ignore the role global warming may be playing.

God created an orderly universe, and He has given us the ability to observe and understand much of it. Most dramatically perhaps, we have developed the ability to manipulate the enormous forces contained within the basic building blocks of creation. Learning how to split the atom was not inherently evil—it is Man's use of that powerful knowledge that determines its impact on humanity. This issue of *ET&N*, however, is not about environmentalism vs. technology, but a similar question needs to be asked—and resolved—about Man's intervention in reproduction.

While Man has sought to control reproduction for centuries through various birth control methods, abortion, and infanticide, these approaches have at least been limited to individuals. Today, we possess the rudiments of technologies that could change the very nature of our species. As with virtually every technological advance by Man, the initial underlying motivations of most researchers may be benevolent, but there is always an unscrupulous minority that pursues less altruistic directions.

### The Birth of Assisted Reproduction

Discoveries and technologies of the past thirty years or so are coming together to create scenarios that make Aldous Huxley's *Brave New World* seem relatively pedestrian. Man has tampered with the reproduction of other organisms through plant cuttings and graftings and selective animal breeding for many years, but the sea change for human reproduction probably began with the 1978 birth of Louise Joy Brown. Her parents, Lesley and John Brown of Bristol, England, had been trying to conceive a child for nine years before Lesley's blocked fallopian tubes were discovered. Natural conception was therefore impossible, but when they were referred to Dr. Patrick Steptoe, they found hope. On November 10, 1977, Dr. Steptoe removed an egg from Lesley's ovaries and mixed it with John's sperm in a nutrient solution. Two and a half days later, the resultant fertilized egg was transferred to Lesley's uterus. On July 25, 1978, Louise was born by Caesarean section, in first successful human **in vitro fertilization** (IVF).

While Louise Brown was conceived using just one egg from her mother, she beat the odds. The probability of a successful pregnancy from the transfer of a single fertilized egg is generally thought to be less than twenty-five percent. To increase the odds, IVF now usually involves stimulating the woman's ovaries into superovulation through hormone and drug therapies (with unknown consequences). A dozen or more eggs may therefore be harvested and seeded with the man's sperm. Consequently, the increased incidence of IVF has produced a plethora of surplus embryos, which are then destroyed or frozen for either future research or donation to infertile couples. Hundreds of thousands of frozen embryos are now stored in cryogenic facilities in the United States alone.

New ART techniques are also not limited to women. A recent innovation, known as **intracytoplasmic sperm injection (ICSI)**, involves the removal of sperm from the man's testicles and insertion of a single sperm into an egg. Typically, sperm are sorted for motility and abnormalities before insertion, but some critics question the efficacy of sperm that are not forced to navigate the arduous journey involved in natural conception.

In 1952, English physician Douglas Bevis described a procedure performed by inserting a hollow needle into the uterus and withdrawing a small amount of amniotic fluid. Within a few years, **amniocentesis**, despite associated risks of miscarriage and uterine infection, became an increasingly popular technique for diagnosing fetal genetic defects or other chromosomal abnormalities, particularly Down's syndrome. Typically, couples who opt for amniocentesis and discover a serious defect choose abortion. At about the same time, **ultrasound** technology was applied to obstetrics. While ultrasound cannot detect genetic problems, it can be used to examine the developing child in the womb and is important to the procedures used in IVF.

IVF brought hope to couples previously unable to conceive, but it was certainly not without considerable controversy. Many religious leaders accused the reproductive medical community of "playing God." In subsequent years, IVF has become a generally accepted procedure. Approximately one percent of babies are conceived through IVF in the United States, although the numbers are much higher in countries where IVF enjoys government subsidies. In Australia, for example, as high as twenty percent of births are the result of IVF.

Similarly, amniocentesis is routinely recommended for high-risk pregnancies, such as women over forty, and ultrasound is approaching universality in pre-natal care. These technologies aren't inherently wrong—prospective parents informed of fetal abnormalities can better prepare themselves for the challenges they will face in raising a disabled child. When the results of amniocentesis are used to support an abortion decision, however, more than a few Americans have significant reservations. In the case of ultrasound, fetal gender can often be determined, but there are very few known instances of aborting for gender choice.

## The Human Genome

On June 26, 2000, the government-sponsored Human Genome Project and the private company, Celera Genomics, joined to announce the cracking of the **human genetic code**. While the media event may have been a bit premature (the human genome had not been completely mapped), it heralded the advancing human understanding of the blueprint of life. Human DNA is carried on twenty-three pairs of chromosomes, each consisting of long sequences of four substances (bases): adenosine, cytosine, guanine, and thymine—usually abbreviated A, C, G, and T.

Sections of the ACGT chromosomal sequences are identified as individual genes. The forty-six human chromosomes carry approximately six billion bases in twenty-five thousand or so genes (the number is still uncertain). A small amount of additional DNA is found in the mitochondria, our cellular power plants which reside outside the cell nucleus. Each gene represents encoded amino acid information that is used by the body to synthesize proteins which carry messages controlling all biological functions.

When an egg is fertilized, whether in utero or in vitro, the twenty-three chromosomes carried by the woman's egg merge with the twenty-three of the man's sperm, creating a complete blueprint for the new embryo. This single-celled zygote soon begins dividing. In natural conception, the embryo travels through the woman's fallopian tubes, entering the uterus after about four days. At that point, the embryonic cells begin to differentiate and the embryo enters the blastocyst stage, during which it implants on the uterine wall. (Note: for a fascinating and detailed look at embryonic and fetal development, go to [The Visible Embryo](http://www.visembryo.com) at [www.visembryo.com](http://www.visembryo.com).)

### Selective Reproduction

Using microscopic techniques, the natural desire of parents to know more about their developing child can now be conducted at the nuclear level. At about the eight-cell stage, it is possible to pierce the embryonic membrane and remove one or two cells without apparent harm to the embryo. This cannot be accomplished effectively in natural conception because the development is occurring in utero, but in IVF, the embryo is readily available. In a procedure known as **preimplantation genetic diagnosis (PGD)**, the nucleus is removed from an individual cell, replicated through a simple process called the **polymerase chain reaction (PCR)**, and subjected to molecular analysis. PGD can currently be used to identify a number of genetic diseases, including cystic fibrosis, hemophilia, Tay Sachs, and Downs syndrome. Other genetic abnormalities have been associated with a variety of other diseases, so the PCR report not only identifies certain defects, it can also list elevated probabilities of certain cancers, for example. It also readily identifies embryo gender.

The development of PGD has created the reality of "spare parts children," those selected through IVF and PGD to serve as matched tissue donors for siblings or even parents. Probably the best known example of this is Linda and Jack Nash, who went through several rounds of IVF and PGD in order to conceive a child to serve as a bone marrow donor for their six-year-old daughter Molly. While one can certainly sympathize with the Nashes (and cases like theirs serve as the basis for my new novel), the deliberate use of one human being to serve another raises substantial ethical questions.

Even more important, perhaps, it is a short jump (or a short trip down the proverbial "slippery slope") from selecting *out* embryos with undesirable genetic abnormalities to selecting *in* those with desirable characteristics. To date, genetic researchers cannot isolate most human traits. Intelligence, for example, appears to be influenced by at least one thousand different genes. We can probably count on the prospect of a thorough mapping of the human genome in the not-too-distant future. The opportunity will then exist for "designer children." Video technologies similar to those currently used by plastic surgeons will emerge which, linked to genome maps, will allow parents to window-shop for their next child.

The first PGD baby was born in 1989, and by 1997, only thirty babies worldwide had been born using PGD, but the growth is exponential. The [Reproductive Specialty Center](#) (RSC) in Newport Beach, CA, for example, boasts "we currently have more than 100 plus on-going and delivered PGD pregnancies and over 200 PGD cases." RSC's cost for PGD is \$4,500. The cost of single IVF cycle for a woman under thirty-five (which has no better than a fifty-fifty chance of success) is \$8,500. ICSI adds another \$1,000 or more. Assisted Reproductive Technology is not for many blue collar workers.

It should be apparent that the entire IVF process commoditizes eggs, sperm, and wombs—any combination will do. **Sperm donors** have been available for years, but the availability of "**donated**" eggs is more recent. Women can go through superovulation and sell eggs on an open market. Once any egg and any cell merge in a Petri dish, the embryo can be transferred to any woman prepped by hormone and drug injections. **Surrogacy**, while it sometimes leads to legal complications, allows an infertile couple to have a child carrying their genetic material. This array of options has led Pete Shanks, author of *Human Genetic Engineering: A Guide for Activists, Skeptics, and the Very Perplexed*, to chillingly suggest that "one day, people may view sex as essentially recreational, and conception as something best done in the laboratory" (page 108). This may not be as far-fetched as some might think given that fact that ART clinics often include a commentary on the inefficiency of natural human conception in the promotional materials (see, for example, the [Genetics and IVF Institute](#) of Fairfax, VA, at [www.givf.com/ivf.cfm](http://www.givf.com/ivf.cfm)).

### **Photocopying Humans**

Another option for a couple where one of the partners is completely infertile has emerged. **Somatic Cell Nuclear Transfer (SCNT)** involves replacing the nucleus of an egg with that of a donor cell and stimulating the egg to begin dividing. For a woman whose husband has no sperm, a cell from either (containing his or her complete set of chromosomes) could be inserted into one of her harvested eggs. The resulting embryo would carry the father's nuclear DNA (plus the mother's mitochondrial DNA). Most of us know this as **cloning**—SCNT is often used to obfuscate this fact. Most people condemn human cloning, but it's apparently already happened. In 1998, a [South Korean infertility clinic](#) claimed to have created the first cloned human embryo. In 2004, a [South Korean university](#) made the same claim, although ostensibly for different purposes. Sensationalism, such as that by the Raelians (under the brand name [Clonaid](#)), who claim 13 current cloned children, are generally discounted.

Reproductive researchers make a distinction between therapeutic cloning and reproductive cloning. **Therapeutic cloning**—growing replacement parts for an individual—is probably not going to happen, at least no time soon. The number of eggs needed to offer therapeutic cloning on a large scale would require that virtually every woman of child-bearing age undergo superovulation once a year and donate (or sell) all those eggs. That simply isn't going to happen. Nevertheless, the prospects of therapeutic cloning are apparently so captivating that some still advocate it.

**Reproductive cloning** is so repugnant to most people that it is unlikely to ever gain traction. Nonetheless, it may be attractive to the kinds of couples described above that some will seem out the unscrupulous few who may offer it.

The fact is that cloning animals is extraordinarily difficult, time-consuming, and expensive. The most famous clone is undoubtedly Dolly, the sheep born in 1996 at the Roslin Institute in Scotland. According to Shanks, the efficiency rates for cloning ranges from 0.1% for horses (one from 841 eggs) to 1.5% for goats (page 54). Retrieving large numbers of animal eggs may be of little consequence to researchers, but the same cannot be said for humans. On the other hand, it is certain that research will continue, and efficiency rates will almost inevitably improve. In the meantime, the current inefficiencies have not dissuaded some entrepreneurs. John Sperling, who made his estimated \$3 billion fortune from the University of Phoenix, has given his substantial financial backing to a firm known as [Genetics Savings & Clone](#) (GSC) (see [www.savingsandclone.com](http://www.savingsandclone.com)), which offers owners the opportunity to clone a beloved pet. To date, GSC has cloned a number of cats (at a reported \$50,000 each) and promises dogs in 2006. In 2003, GSC began using a newer technique known as **chromatin transfer**, developed by Connecticut-based Aurox LLC. Chromatin transfer involves the removal of "molecules associated with cell differentiation" from the animal to be cloned.

## Miraculous Cells

Raising the ante on those hundreds of thousands of frozen embryos is the research surrounding **stem cells**, which have been hailed by extreme proponents and a fawning press as a universal cure. For those extremists, **embryonic stem (ES) cells** are the holy grail, while the **adult stem (AS) cells** are denigrated. The difference between ES and AS cells appears to lie in their potentiality. The fertilized egg (zygote) is a **totipotent** stem cell because it can produce *all* kinds of cell in the organism. At the blastocyst stage of embryonic development, an inner cell mass (embryoblast) consists of **pluripotent** stem cells, able to produce *many* kinds of cells (all except totipotential cells and some embryonic tissue layer cells). As development continues, stem cells differentiate to become blood cells, organ cells, etc. Some cells, however, remain undifferentiated (AS cells) and are **multipotent**, able to produce *some* other kinds of cells. Blood AS cells, for example, can produce white blood cells, red blood cells, and platelets.

Another source of stem cells is umbilical blood, and the attraction of this as-yet unproven but potentially powerful treasure trove has already led to the creation of a number of specialized firms. [Cyro-Cell](#) (see [www.cyro-cell.com](http://www.cyro-cell.com)) offers collection units and long-term cryo-storage of a newborn's umbilical blood for an initial fee of \$1,110 and an annual storage fee of \$115.

The allure of ES cells lies in precisely their ability to produce many kinds of cell. Some researchers dream of discovering the triggers that cause an ES cell to differentiate into a specific type of cell and therefore being able to grow replacement parts, whether in a laboratory or in the body itself. Some animals possess this capability—a salamander, for example, will regrow a lost tail and lobsters regrow lost claws. The perceived potential of ES cells has therefore spawned the new field of **regenerative medicine**. Some see the possibility of regrowing damaged heart muscle or severed spinal cords, but to date, no one has identified the triggers which cause of pluripotent ES cell to differentiate into a specific type of cell. With continued research, however, it is likely scientists will learn how to "teach" an ES cell to become what they want.

At least one major stem cell therapy is already a universally-accepted medical practice—so much so that it is no longer considered experimental by health insurance companies. **Bone marrow transplants** involve the destruction of the patient's bone marrow and the replacement by donor bone marrow. The adult stem

cells in the donor marrow produce all blood components. Another recent development is the report of multipotent AS cells being stimulated to undifferentiate into pluripotent cells.

## Being All That We Can Be

Finally, there is the near-term potential for significant human genetic engineering, which takes two forms. **Somatic gene therapy** involves the manipulation of genes within a specific group of cells, such as blood cells. In 1990, four-year-old Ashanti DeSilva was the first known human to receive gene therapy. Suffering from severe combined immune deficiency (SCID), popularly known as bubble boy disease, because of defects in her genes carrying the instructions for the production of a protein critical to T cell development. After approval from the [Recombinant DNA Advisory Committee](#) of the National Institutes of Health, doctors first extracted some of Ashanti's blood. Outside her body, a harmless virus was used to transport sound copies of the target genes into her blood. Doctors then injected the genetically-reengineered blood back into her body. Without the gene therapy, Ashanti would almost certainly be alive today; instead, she lived a fairly normal childhood.

What distinguishes Ashanti's somatic gene therapy from **germline gene engineering** is inheritability. Because the gene vectored into her blood did not affect the genetic inheritance contained in her reproductive system. If she has children in the future, their genes will come from her original genome (combined with the father's). Even though germline gene engineering has the potential to eliminate inherited diseases, it entails a permanent change in human genes. Germline gene engineering is done on early embryonic cells which, unlike somatic therapy, continue the changes into future generations.

It is germline gene engineering that raises the nightmare scenario of designer humans such as a sub-human race optimized for combat or manual labor, or a super-race created with some combination of genes enhancing desirable traits. Barring some form of reverse germline engineering, such changes are permanent. The line between somatic and germline genetic engineering is one which most scientists will not cross, but the operative word is "most." Just as there are those who would create chemical and biological weapons, there are those who will cross the germline. Some will do it for humanitarian reasons (genetic diseases). Others will do it for more selfish reasons.

## Discussion

So, why write about Assisted Reproductive Technologies? It may be the most important issue we face today because the potential exists for fundamental changes in the nature of humanity, with unknown consequences. In America, we are woefully ignorant of the facts, must less the ethical arguments; our public policy is a hopelessly convoluted; and Christian conservatives aren't helping things.

The table below shows the results of a [2002 poll](#) (see the entire poll at [www.dnapolicy.org/research/reproductiveGenetics.jhtml.html](http://www.dnapolicy.org/research/reproductiveGenetics.jhtml.html)) conducted by the Genetics and Public Policy Center at Johns Hopkins University.

Approval of Applications of Genetic Technology	Women	Men
PGD to avoid serious genetic disease	74	73
In vitro fertilization	74	70
PGD to ensure child is a good tissue/blood match	69	69
Prenatal testing for disease	67	66
PGD to avoid a tendency to diseases like cancer	56	64
Genetic engineering to avoid disease	57	61
PGD to choose child's sex	22	33
Prenatal testing for desirable traits	13	27
PGD to ensure child has desirable traits	18	26
Genetic engineering to create desirable traits	14	25

Comments: First, I have to wonder what's wrong with men that so many more approve of the extreme side of assisted reproductive technology (screening for or creation of desirable traits). Second, the percentages for those extremes are disturbingly high for both sexes, particularly when one considers the increasing compromise revealed by polls concerning issues related to same-sex marriages. According to the Washington Times, the percentage of Americans characterizing "sexual relations between two adults of the same sex" as "always wrong" slipped from 73% in 1977 to 53% in 2002. A similar trend is evident in the genetic poll. 20% of all respondents approved of "genetic engineering to create desirable traits" in 2002, double the percentage from just ten years earlier. At that rate, the majority will approve by about 2015.

Ramez Naan, author of *[More Than Human]*, an enraptured celebration of the utopia he envisions from human genetic engineering, states, "Even beyond curing disease, the benefits to be won from biotechnology are concrete and measurable. Keeping people young longer would slow the rise in worldwide health spending and avoid the demographic crunch of an aging population around the world. Improving human memory, attention, and communication abilities would increase productivity, which in turn would lead to new scientific discoveries and faster innovation, economic growth, and scientific breakthroughs we can't anticipate today" (pg. 6). Naan's justification for unfettered human enhancement is economic, but he adds a national security component, pointing out that public acceptance of genetic engineering in eastern countries is far greater than the United States. A decision in this country to ban such practices would therefore threaten our status as a major power.

The center of the arguments advanced by Naan and other enhancement extremists is a familiar one. They worship at the alter of unrestricted individual human choice. In pointing out that parents have always chosen to enhance their children through such things as education, nutrition, and health, he presents genetic enhancement as simply another choice, one that parents will not only accept, but eventually demand. He goes so far as to suggest that the refusal of parents to give their children this advantage may someday be considered a form of child abuse. (I sometimes wonder if raising children to be Christians will someday be considered child abuse—rigid, intolerant individuals who believe in absolutes rather than the prevailing relativism.)

The human enhancement crowd also appeals to a libertarian argument. Naan claims, for example, that "the advocates of human enhancement...are arguing for individual and family choice, the opposite of state control" (166). The propagandizing in Naan's claims should be obvious. The use of the pejorative term "state control" (as opposed

to "government regulation") is undoubtedly deliberate. In this he ignores the value of societal choice and its role in protecting us from the irresponsible actions of a few, viewing government control as inherently evil. Naan not only opposes government regulation, he proposes subsidies for genetic enhancement (pg. 75). (His argument is that without government subsidies, enhancement might only be available to the rich.)

Naan uses other intellectually dishonest arguments in *[More Than Human]*. For example, he claims that "PGD has helped bring several thousand children into this world free of crippling genetic defects" (138), while failing to acknowledge the other side of the coin: that PGD has led to the destruction of many thousands of less-than-perfect embryos who might have been a burden on their parents and society. If it is true, as some suggest, that a society's humanity is measured by how it treats its least fortunate members, then most developed nations must be considered inhumane.

### **Government Intervention**

To date, ART advocates have pretty much had their way about regulation. There are few state statutes governing practices and those that do exist focus primarily on truth in advertising (IVF success rates), informed consent, and mandated insurance coverage. A number of states have, on the other hand, constituted advisory boards which have issued recommendations and advisories (see, for example, the pamphlet [\*Thinking of Becoming an Egg Donor?\*](#) issued by the New York State Task Force on Life and the Law).

There is no constitutional basis for federal law in this area, so Washington's only source of control lies in research funding. The most publicized political football involves embryonic stem cell research, which President George W. Bush limited to existing stem cell lines (e.g., no new embryonic stem cell lines are funded for research), which was a reversal of his predecessor, President Clinton, who reversed the policy of President George H. W. Bush. The effect of the current ban is essentially to drive embryonic stem cell research "underground" where it avoids regulation.

The political debate is confounded by the misinformation promulgated by both sides. Advocates frequently employ public relations campaigns using heart-wrenching individual cases, fantasies of universal cures ignoring the failures, and, as we have seen, appeals to libertarian sentiments. The opponents of genetic ART are a mixed bag consisting of religious conservatives, feminists, and (thankfully) responsible medical scientists. Some feminists claim that cloning and stem cell research will dehumanize women as little more than egg and baby factories. Religious conservatives frequently become dogmatic, insisting that all ART-related activity represents a human intrusion into the sovereignty of God, ignoring the potential for the lessening of human suffering. Most unfortunate is that fact that much of the Christian community links ART issues to the abortion debate, but while there is some overlap, the two are really separate considerations.

### **God and ART**

The Bible clearly teaches God's sovereignty over life and his interest from early stages of human development. God not only created the universe, He gave Man the ability to understand a great deal about that creation. In astronomy, we have learned the incredible magnitude of the universe and the wonders of the regenerative processes that fuel it. He also made it possible for us to examine the

tiniest building blocks of the universe and the forces that control them. He appears to have intended for us to make responsible use of the knowledge we acquire through those observations.

Can the same also be said for life itself? In 1740, naturalist Abraham Trembley first observed the amazing regenerative capabilities of the hydra. As described in *The Proteus Effect* (Parson, Ann, and Ann B. Parson, Joseph Henry Press, 2004), Trembley conducted a series of experiments on hydra (which he called an "insecte," a generic term for any small creature at the time): "Maintaining a fine balancing act, whereby he cradled an "insecte" encased in a water drop in the palm of his left hand while wielding either scissors or a boar's bristle—also used for cutting—with his right hand, all the while constantly swapping these implements for his magnifying glass, he went about cutting one green 'insecte' after another either transversely or lengthwise, and in varying ways." To Trembley's astonishment, each divided segment regenerated into a complete hydra. This was the seminal root of stem cell research.



Humans have essentially the same capabilities of the hydra, but only for a very brief period during embryonic development. We call the division of an embryo and the development into two distinct organisms **identical twins**, a natural process.

### When Does Human Life Begin?

The Bible describes God's activity in forming the embryo in the womb (Psalm 139:13), but nowhere in Scripture is the beginning of human life explicitly defined. To me, there are at least three candidates, each carrying different implications for ART and genetic research and therapy:

1. The moment of conception, when the DNA from egg and sperm merge to form a complete human blueprint.

This is the safest option since there is no reasonable argument for an earlier time. This has been, and continues to be, the consensus choice of conservative religions, but if that is the case, God Himself is rather wasteful. Conception occurs many more times than birth, and it is estimated that at least 50% of fertilized eggs never adhere to the uterus.



At the completion of conception (about an eleven-hour process), the resultant zygote is a totipotential stem cell. If human life indeed begins at the moment of conception, then no scientific use of the embryo can be justified.

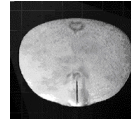
2. The moment of implantation, when the blastocyst connects to the mother's uterine wall.

The embryo begins dividing after about twenty hours after the completion of conception and begins the trip down the fallopian tubes and into the uterus. About five or six days later, at the blastocyst stage, the embryo secretes an enzyme which prepares the uterine wall for implantation. Over the next six days or so, the embryo and uterine wall interact, creating the essential blood connection. If an embryo fails to implant, it is carried out of the uterus without the mother ever knowing it existed. If human life begins at implantation, the unimplanted embryo, while deserving of some level of respect, is not truly human and scientific use can be justified.



3. Gastrulation (about day 14), when the primitive streak begins its march up the embryo.

This is the current predominant embryological view of the beginning of human life because it is the point at which cellular functions begin to differentiate in earnest and the rudimentary spinal cord develops. Cells clustered at one end of the embryo migrate along the axis and interact with other cells to begin the development of human biological components. Until the beginning of gastrulation, embryos can still divide, creating twins (or triplets, etc.). Since twins are distinct individuals, some say, how can life be considered beginning at conception? If human life begins at gastrulation, then the use of the embryo before that time (often called a pre-embryo) is justified. This is the position of the British government.



Of course, there are also those who insist that human life begins at birth, but that position is embryologically unsupportable, and as medical science continues to push the age of viability (when a baby can survive outside the womb) earlier, the argument grows increasingly weaker.

Each of the three embryonic positions has merit based on what we know about human embryonic development. God created these developmental stages when He could have created others. He could, for example, have created a process in which the egg was impenetrable until it secreted enzymes and implanted on the uterus. Or he could have created one in which gastrulation occurred as soon as a fertilized egg implanted. Did God intend to allow humans to discover the potential of ES cells and use them to cure genetic abnormalities and diseases?

## Conclusions

These are completely personal, and I know at least some of you will disagree, but for what it's worth, here are my current opinions about ART and genetic engineering.

1. IVF is a wonderful technology when it is applied for the purpose of allowing married couples who could not otherwise conceive to have children. The superovulation now used in most IVF are problematic since the long-term effects on women's health are unknown. Louise Brown was conceived using a single egg—until the effects are identified, superovulation ought to be discontinued. At the very least, women seeking IVF treatment should be fully informed of the unknown consequences. ICSI is also justifiable for men with sperm problems.

2. Human life begins at gastrulation. The use of embryonic stem cells is therefore acceptable for the purpose of determining their efficacy in the treatment of genetic diseases. The use of IVF to create human embryos in order to harvest stem cells is theoretically acceptable, although, as stated above, superovulation should be discontinued. This position also forces me to conclude that very early abortion methods, such as RU-486, are also acceptable. From a life begins at gastrulation perspective, the effects RU-486 are essentially the same as the Plan B "morning after pill" and intrauterine devices.

3. Abortion after gastrulation is only acceptable to genuinely preserve the life of the mother. The discovery of a seriously defective fetus through amniocentesis represents a heart-breaking dilemma. While I might wish such babies be carried to

term and given whatever opportunity for life they have, it is difficult for me to condemn couples who choose abortion.

3. The use of PGD is acceptable, even prudent, for high-risk couples (older mothers or those with known genetic risks). Its use for the selection of desirable traits is, however, repugnant.

4. Human reproductive cloning should be banned by international treaty to prevent this blight on humanity. Violators should be aggressively prosecuted. Human therapeutic cloning, however, could be acceptable under some conditions. It is far too early in the research on cloning to draw firm conclusions. At the very least, those involved in human cloning research should be carefully monitored.

5. The cloning of animals is acceptable, I suppose, as a research base for the field of human therapeutic cloning. Given that the cloning process, even when it leads to a birth, often produces animals with significant problems, it could be considered cruelty to animals. Animals, whether cloned or conceived naturally, are deserving of our respect and protection. I find the sentimentality associated with cloning pets silly.

6. Somatic genetic therapies should be pursued and funded. Defective genes, I believe, were not part of God's original design and are the consequences of a fallen world. If God has given mankind the ability to correct these defects, I cannot see an argument against them. Gene therapies will not be a panacea, but many will certainly be a better alternative than the current chemical treatments that carry considerable undesired side effects. Somatic genetic therapies, however, should be subjected to the same FDA scrutiny currently applied to the other proposed drugs.

7. Germline genetic engineering, like human reproductive cloning, should be banned by international treaty, and violators aggressively prosecuted. This technology carries extraordinary risks for our species, and the potential for abuses exceeds that of anything else discussed in this issue of *ET&N*. Human genetic enhancement, regardless of the claims of Ramez Naan and others, is not comparable to parental provision of education, experiences, or nutrition because of the permanence of germline engineering.

8. All people and particularly Christians, who supplement secular knowledge with the truths of God's Word, should stay informed about developments in these areas. As societies, we need to make decisions about where we draw the line and how we will defend that line. Arguments about the slippery slope of technological advances can be compelling and in some ways it would be easier just to say, "No tampering with life, beginning at conception" but there is real potential for good. Throwing out that opportunity seems wasteful.

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These personal conclusions are quite different than those I would have offered just two months ago, before I dug into research for *The Whole is Greater*. In addition, they are certainly not immutable. As our continued observation of God's creative products are described and our knowledge increases, they are subject to change. Finally, I recognize that they are not comprehensive. There are additional issues, such as the use of aborted fetal tissue in research, which I have chosen not to address.

What's your opinion?

Note: if any of you want to investigate these subjects on your own, there are many resources on the web. I also recommend two of the books from which I drew heavily in writing this essay:

**More Than Human: Embracing the Promise of Biological Enhancement.**

Naam, Ramez. New York: Broadway Books (Random House), 2005.

**Human Genetic Engineering: A Guide for Activists, Skeptics, and the Very Perplexed.** Shakes, Pete. New York: Nation Books (Avalon Publishing Group), 2005.

I have added both of these books to my [bookstore](#), where you can buy them from Amazon.

## Discussion

From John, a subscriber who has served on the National Right to Life Committee:

I enjoyed your piece on human reproduction technology. Obviously you have done a great deal of reading in the field as have I. I would agree with virtually all your conclusions save that the fertilized ovum is not considered human life until it is implanted in the uterus. This opens the door to much of the abuse you well describe. If it is not a human life, then who can fault stem cell collection and use, buying and selling of eggs, etc.?

[DS] Actually, I took the position that human life begins at gastrulation, which occurs about 14 days after conception, rather than an implantation, which occurs on about the sixth day. I certainly understand the potential for abuse inherent in that definition, but that potential exists in almost every advance in human knowledge and technology. The same kinds of arguments occurred when inoculations and (as Ken alludes to below) transplants were first introduced. Stem cells represent a marvelous gift of God (although their potential is probably being over-hyped by the extremists). I don't believe the answer is to turn our collective back on such a gift, but to have the societal will to find ways to use to responsibly and respectfully. Not all will, of course, but simplistic solutions will not put the genie back in the bottle. I don't believe John is taking a simplistic approach, but many Christians are. That will serve neither the Christian community, nor the world at large.

From Ken:

Thanks for showing a level of courage on this topic many in Christian circles tend to take the safe, herd mentality on. I tend to believe that many people roll all of these issues into the same package and protest out of a lack of education and understanding. It also appears to me that some (not all) of these protests are born out of personal repugnance and fear of the extreme rather than biblical teaching.

As a student of science and humanity/history, it is obvious to me that the benefits of reproductive and genetic research/implementation into the human lifestyle will outweigh the fears associated with them. And in time, we will use these technologies and others to come to improve upon the human physical condition in the same way we have with all medical advances (organ transplants come to mind as being very similar to this issue). By educating with this article, and giving each procedure a fair day in court, we have all been given a far better foundation from which to derive our personal opinions.

As a student of the Bible, I support your thesis on what God allows man to do. From what I can see in the biblical record it is also supported. Interestingly enough, God shows this early on in his human experiment. When man gathered to build the Tower of Babel, God decided that it was a technology He did not want mankind to explore and He fixed it. I believe He is imminently capable of and has interfered before in man's endeavors as He sees fit. It is obvious to me that

God has gifted mankind with the knowledge and tools to explore this field for our benefit. I too believe that God gives us tools to use responsibly. With just about anything in life, He has set examples of how they can be used and misused, from human behavior to substances, to technology, to even spirituality. Each can be used for the glory of God and each can be abused to the point of sin. I believe Genetic and Reproductive medicine is no different. It is our gift and our responsibility to use it with wisdom and godly discretion.

Thanks for having the courage to speak out on this topic. I am sure you will receive many responses to it both in support and in disagreement.

In our church right now, we have a wonderful godly man in his early 60's who has a heart condition that the doctors say is so damaged it cannot withstand a further bypass operation. His only recourse is Stem Cell (Adult Cell or Umbilical Cord...not sure) experimentation. The elders of our church not only supported this man's effort to get into the program, they used their connections to get him into it. Our church prays weekly that it will work and this man will be able to live a healthy productive life.

[DS] I appreciate Ken's comments and his notation of God's response to Man's technology. Hali, the 13-year-old daughter of good friends, was recently discovered to have brain stem glioma. Her doctors are supplementing chemotherapy and radiation with stem cell treatments (her own adult cells). Her prognosis is grim, but I am grateful that research continues on procedures to treat such inexplicable tragedies. Hali's condition, incidentally, is unrelated to my conclusions.



Unsure about or don't agree with something in Ekklesia Then & Now? First, be a Berean (Acts 17:10-11). If you still disagree, [post a message](#) so we can all share in the discussion!

## **NEXT ISSUE: Co-Workers: Aquila and Prisca (October 18)**

With the next issue of *ET&N*, which I have tentatively scheduled for October 18, will begin a new periodic series, this one discussing people of the New Testament who Paul identified as his "co-workers." I'll give the biblical and extrabiblical background on these individuals and suggest how we might be that type of person today. With continuing work on *The Whole is Greater*, the date could change a little in either direction.

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