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Stem Cells: A Literary Approach

Derek McHaffie

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A Place to Turn

Fear and promise are probably the two most frequent words used to characterize the debate over human embryonic stem cell research. The promise lies in the truly unique potential these cells possess. Embryonic stem cells are pluripotent, which means they retain the ability to become any cell type found in humans, be it neuron or cardiomyocyte. As such, the future of this research is aimed at channeling the pluripotentiality of these cells toward a hopeful regenerative solution for many complicated medical conditions, a process referred to as therapeutic transplantation for the likes of Alzheimer's disease, spinal cord injuries, Parkinson's disease, diabetes, muscular dystrophy, and heart disease. The current understanding of how to reach this goal, however, is at a very basic and experimental stage that relies primarily on theory, but the sheer promise of a treatment for the otherwise untreatable is something that has filled both scientists and the public alike with high hopes.

The fear lies in the necessary means of the research, the embryo. Some feel that the embryo is not the proper subject of experimentation, which would require its destruction, or an appropriate option for treatment resources, due to its potential for life. "One goes with a heavy heart if we use these," one researcher says, "because we are dealing with the seeds of the next generation" (Bush 3). Central to the debate, then, is the amount of moral protection an embryo should receive. Does it constitute an "individual" and is, therefore, something that should be prevented from being destroyed or a cluster of cells in the early stages of the developmental process that has no claims to life?

This is in no way an unfamiliar question, but one first asked several decades back at the inception of the abortion debates. Here, viability became the legal precedent for granting complete moral status, but only as it relates to the opposing rights of pregnant women. There is still no standard, legal or otherwise, for declaring the "beginning of life." With the issue unresolved, there is no shortage of opinion, which comes from all angles and seemingly complicates the issue further. There are societal, philosophical, and religious perspectives that fall at all points along the developmental continuum, producing a debate that tends to polarize as quickly as the abortion issue, leaving no consensus or clear direction. Furthermore, science, which has traditionally served to answer society's questions in matters such as these, cannot bring the debate to a conclusion, only highlight the significant places within the process. The truth seems to be that the beginning of life, in the moral sense, is and will remain forever mysterious.

With that in mind, the literature and cultural history of the Enlightenment represents a place one can look for some direction outside of the polarizing moral status debate, a place to turn. This period includes the first glimpse of a technology and progress-driven world. As a child of the Enlightenment, modern society is left to grapple with many of the same questions that were introduced in the late 17th and early 18th centuries, including defining the role of science. As history, the Enlightenment is a place where we can see ourselves in the past and, thus, discover the foundations of the present while attempting to improve the future. As literature, it is an interpretive vehicle to uncover the underlying assumptions, motives, implications, and fears of a culture that has chosen science and technology as the lamp to light its path.

The Current State of Stem Cell Research

There is currently much speculation and debate in the public arena concerning the capabilities of stem cells, including scientists' ability to work with them. The term stem cell is actually very generic. A stem cell is a cell that has the ability to replicate itself for extended periods, in many cases the entire life span of an organism, and has the potential to become fully mature, specialized cells. In the correct cellular environment, for example, a stem cell can undergo differentiation, the process whereby cells mature and gain specialization, to become a pancreatic cell, nerve cell, etc. Some have the potential to give rise to many types of specialized cells, while others are more limited, and may only be able to produce one specific classification of cell. This is what makes stem cell such a general term. Most often, stem cells are defined by their capabilities, responses to particular environments, and origin.

Typically, stem cells fall into three broad classes. First, there are totipotent stem cells, which is derived from the Latin word totus, meaning entire (Stem 1). The fertilized egg, or zygote, is an example. It has the potential to produce all the different types of cells that make up an organism, which includes over 200 types of cells in the human, plus all of the tissues essential for its growth and development, such as the placenta and umbilical cord. The second class is pluripotent stem cells, which is derived from plures, the Latin for several or many. A cell that is pluripotent has the ability to generate specialized cells that are derived from all three germ layers. These are found in the embryo and include the endoderm, mesoderm, and ectoderm. All of the cells in the human body are derived from one of these three embryonic layers.

Embryonic Germ Layer	Differentiated Tissue
Endoderm	Thymus Thyroid, parathyroid glands Larynx, trachea, lung Urinary bladder, vagina, urethra Gastrointestinal (GI) organs (liver, pancreas) Lining of the GI tract Lining of the respiratory tract
Mesoderm	Bone marrow (blood) Adrenal cortex Lymphatic tissue Skeletal, smooth, and cardiac muscle Connective tissues (including bone, cartilage) Urogenital system Heart and blood vessels (vascular system)
Ectoderm	Skin Neural tissue (neuroectoderm) Adrenal medulla Pituitary gland Connective tissue of the head and face Eyes, ears

(stem 3)

The most common example of pluripotentiality is the embryonic stem cell, which is also named for its origin. Pluripotent stem cells, then, have the ability to give rise to any type of cell found in an organism. The third class is the unipotent stem cell, which is limited in direction and is only capable of producing cells from the same lineage. This class is most common in adults, where it is responsible for replenishing lost or damaged cells, thus maintaining a "steady state" (Stem 1). Adult stem cells are found in the various specialized tissues and renew cell types from the tissue where it originated. For example, adult hematopoietic stem cells are found in the bone marrow and are responsible for replacing the different types of cells found in the blood.

A majority of the current interest and public debate surrounds human embryonic stem cells. These cells are extracted from the embryo at a stage early in its development. This stage is known as a blastocyst and corresponds to day 5 in the development of the embryo. The blastocyst marks the first sign of cellular differentiation on the part of the embryo and is chosen by most physicians as the optimum phase for implantation during *in vitro* fertilization (13). For this reason, IVF clinics have become the primary source of

human embryonic stem cells. During the normal course of the IVF process, more embryos are produced than can be implanted. A normal blastocyst, which consists of between 200 and 250 cells, is spherical in shape and has three distinct features, an outer layer of cells (trophectoderm), a fluid-filled interior (blastocoel), and a cluster of cells on the interior of the trophectoderm known as an inner cell mass. The trophectoderm will go on to form the essential components of fetal development, such as the placenta and umbilical cord, while the inner cell mass is the precursor for all the tissues of the human body. It is the inner cell mass, which consists of only 30 to 34 cells, that provides the source for human embryonic stem cells. The trophectoderm is removed by either microsurgery or immunosurgery, which allows scientists to obtain the inner cell mass (13). These cells are then cultured and allowed to proliferate, thus producing an entire colony of human ES cells. One of the properties of an ES cell is that it is clonogenic, or able to produce an entire colony of genetically identical cells with the same identity as the original. In fact, human ES cells have the ability to proliferate for up to two years, through between 300 and 450 population doublings (14).

Most of what is currently understood about embryonic stem cells was gained during experiments performed on mice. In 1981, Evans and Kaufman derived the first mouse embryonic stem cells from the inner cell mass of blastocysts (11). They established proper culture conditions and were able to produce colonies with normal cell lines. They were also responsible for the first demonstration of pluripotentcy in these cells. When the ES cells were injected into mice, they produced the formation of teratomas. Teratomas are benign tumors that consist of cell types with origins from all three primary germ layers. In the absence of the proper guidance through intercellular

signaling, the ES cells differentiated in an uncontrolled manner producing the teratomas. The induction of teratoma growth provided the first evidence that ES cells are in fact pluripotent, due to the presence of cells derived from the endoderm, mesoderm, and ectoderm. In 1998, James Thomson performed a similar study using the inner cell mass of human blastocysts donated by couples receiving fertility treatment. He was also able to produce healthy colonies and maintain them *in vitro*. By injecting them into immune-deficient mice and inducing the production of teratomas, he was able to prove that human ES cells are as equally pluripotent (12). This has since been proven in several different laboratories through several different methods.

Proving their pluripotentcy was the first step in beginning to characterize and understand the nature and capabilities of human ES cells. The promise lies in their therapeutic potential. At the current state of research, however, any potential use of human ES cells is hypothetical and must be subjected to extensive amounts of experimentation (17). The most hopeful possibility is their potential aid in transplant therapy. The thought is that human ES cells can be used as a replacement for injured or diseased tissue. Possible candidates for therapeutic transplants include Parkinson's disease, diabetes, traumatic spinal cord injury, Purkinje cell degeneration, Duchenne's muscular dystrophy, heart failure, and osteogenesis imperfecta (16). Other potential uses of human ES cells include testing drugs and screening potential toxins (15).

Currently, the first barrier to embryonic stem cell use in transplant therapy, or any other potential application, is scientists' inability to direct differentiation. If these cells are to ever be of value in this area, researchers must first be able to control the differentiation of human ES cells to produce the desired cell types. The most promising

approach is to alter the growth conditions in different ways, by adding growth factors and promoting or inhibiting cell aggregation in culture. Since cell-cell interactions are essential to embryonic development, producing conditions that allow cells to adhere to one another has been shown to induce differentiation, and vice versa. Growth factors work on the level of the gene, whose products, once activated, can trigger a cascade of events that lead a cell in a certain developmental direction (7). The process, however, is very tedious and must be approached using trial and error in an attempt to discern all the various influences that affect differentiation. Using mouse ES cells, scientists have been able to induce differentiation into several cell types, including cardiomyocytes, endothelial cells, neurons, pancreatic islets cells, smooth muscle, and striated muscle, to name a few (8). Despite the promise, both methods and understanding must be extensively refined as scientists attempt to unravel the many influences on cell specialization.

As researchers sharpen techniques for working with embryonic stem cells in culture, a larger, more practical barrier awaits. As is the case with more standard transplants, such as kidney, there is the problem of immune rejection. In the case of human ES cell transplantation, however, immunosuppressant drugs are not sufficient. The human body has two lines of defense. The first is innate immunity, which includes such things as mucus, nose hair, macrophages, skin, etc. The second is specialized immunity, which is dependant on B cells and T cells. These two classes of cells are responsible for the recognition, destruction, and removal of all foreign molecules, known as antigens. These are highly specific processes that require the production of antibodies, for B cells, and T cell receptors, which are produced with a unique specificity to bind

antigens. Both these classes of molecules undergo extensive maturation processes, whereby any cell that has the ability to bind a self-antigen, or non-foreign cell or molecule, is triggered into apoptosis (programmed cell death) or remains functionally inert. Up to 80% of the 5 million T cells produced each day are destroyed for this reason. What remains is a highly specific line of defense against any invader.

Important for ES cell transplantation are T cells, which are responsible for cell-mediated immunity. T cell receptors bind co-receptors located on virtually all other cells, known as the major histocompatibility complex, or MHCs. MHCs are responsible for the presentation of intracellular antigens and are essential for proper immune function. These, too, are highly specific and, excluding DNA, are the most distinguishing characteristic of the individual. The problem arises when foreign MHCs located on donor human ES cells attempt to bind a T cell receptor. They are incompatible and would instantly target that particular cell for destruction. Obviously, this would be completely detrimental to the success of a stem cell transplant.

There are currently two possible solutions in the minds of scientists. The first possibility involves the genetic engineering of a new class of MHC molecules for a donor ES cell. This capitalizes on a process known as transfection, whereby viruses transmit their genetic material inside a cell. This is the standard means by which a virus typically infects a healthy cell. However, scientists now have the ability to reconfigure the contents of a virus' DNA. By deleting any harmful DNA and repackaging the virus with the necessary genes, it would be possible to provide a stem cell with a new set of genes for MHC molecules, which would result in compatibility between T cell receptors and MHCs.

A second and more popular option also exists, which involves somatic cell nuclear transfer (SCNT). A somatic cell is any non-gametic cell in the body, which includes everything but egg and sperm cells. This is also referred to as therapeutic cloning. The process involves removing the nucleus from any of a patient's cells, such as a skin cell, and injecting it into an oocyte, or egg. The fertilized oocyte would then be nourished *in vitro* until it reaches the blastocyst stage, where it would be harvested for embryonic stem cells. Once directed to differentiate along the desired lines, the ES cells would be ready for transplantation. Each ES-derived cell would be expressing MHC molecules identical to those of the patient who donated the somatic cell nucleus, and who is also the intended recipient of the transplant (17). The result, then, is a perfect immunological match.

One of the primary objectives of human ES cell research is to uncover ways in which to ensure the safety of transplant recipients. One of the main risks of any transplant is the transmission of infectious agents. Before ES cells could ever be used in clinical trials, it must be proven that scientists have the ability to prevent the inadvertent spread of infectious disease (94). It also must be proven that therapeutic ES cell transplants can be performed without inducing tumor formation (16). As seen in studies done on mice, the transmission of undifferentiated ES cells causes the growth of teratomas. This is due to the fact that these cells do not receive a coordinated signal to differentiate from their environment, which will cause them to proliferate and differentiate in a random fashion, leading to the formation of tumors. Scientists have yet to identify the signal transduction pathways that are activated in differentiating human ES cells. The same is true for proliferating ES cells. Identifying the intra and extracellular

components of the signaling network, as well as the involved genes, is the first step toward preparing a homogenous colony of cells (19).

Along the same lines, researchers are still seeking to identify the intermediate stages of differentiation. As each ES cell matures, distinct precursors, known as progenitors, are formed. These cells are committed to particular specialization lines and can only give rise to a certain type of cells. It is quite possible that these cells could play a significant role in therapeutic transplantation. This leads scientists to ask the question, what is the optimal stage in ES development for transplantation? And most important, it has yet to be proven that transplanted ES cells can survive and function properly in a recipient. In general, researchers are only at the beginning stages of understanding the biology of human embryonic stem cells (19).

With the promise of human embryonic stem cells, scientists still have high hopes for the potential of adult stem cells. Once thought to be found in only certain tissues, there is evidence that adult stem cells are present in many more tissues and organs (23). To date, stem cells have been found in the bone marrow, peripheral blood, brain, spinal cord, dental pulp, blood vessels, skeletal muscle, epithelia of the skin and digestive system, cornea, retina, liver, and pancreas (25). The origin of these cells is not yet known. One theory is that stem cells are marked during fetal development and restrained from differentiating (23). This theory would seem to be congruent with their function, which is to maintain homeostasis by replacing dying cells. Much like ES cells, they are clonogenic and replace themselves in the process.

However, the challenges presented by adult stem cells for potential use in transplant therapy are just as complicated as the questions surrounding ES cells. First and foremost, there are concerns about the plasticity of adult stem cells, which refers to the ability of a stem cell from one tissue to become a functionally mature cell of another tissue. For years this was not considered as a possibility. There have been recent studies, though, that aimed to provide evidence of plasticity in adult stem cells. Most of the current work involves the use of bone marrow derived stem cells, or hematopoietic stem cells. Discovered in the 1960s, they are the most characterized of the group. There have been reports that HS cells have integrated into host tissue and assumed some of its characteristics, but there is limited evidence that these cells are fully functional (28). On the other hand, HS cells have the proven ability to repair and replenish all the components of the blood system, but plasticity remains a question mark (33). Some scientists think that plasticity occurs naturally *in vivo*, but there is still no proof (28). One of the great hopes is the possible discovery of a universal adult stem cell that has yet to be found.

If it can be proven that adult stem cells are capable of transdifferentiation, either naturally or induced, they would become the leading candidate for transplant therapy. Their primary benefit over embryonic stem cells is that they can be isolated directly from the patient. Once cultured and specialized, they could be transplanted back to that patient without the fear and threat of rejection.

Currently, though, there are several factors that make embryonic stem cells more suitable for therapeutic purposes. First, adult stem cells are much harder to isolate and extract. For HS cells, they can be isolated in one of two ways. They can be taken

directly from the bone marrow, where 1 in every 100,000 cells is a long-term hematopoietic stem cell, or taken from the peripheral blood (46). In this method, donors are given a cytokine that induces HS cells to enter the blood stream, where they are filtered based upon a cell surface marker (46). This produces a 5 to 20% sample of HS cells. Both of these methods produce only limited numbers of cells. Isolation is then complicated by a second factor. It is virtually impossible to distinguish between an HS cell and other bone marrow progenitors. Progenitors are intermediately differentiated and possess no potential for self-renewal. They are completely committed to becoming mature cells. This makes it difficult for researchers to create a homogenous colony of hematopoietic stem cells.

In vivo, HS cells reside in an area of the bone marrow known as the stroma. *In vitro,* culture conditions are created to imitate the stroma in an attempt to replicate the optimum environment for cell expansion. However, it is very difficult to induce HS cells to proliferate (34). The minute quantity of cells extracted would be acceptable if proliferation were not so difficult. This could be due to the fact that adult stem cells are much older and do not readily respond to manipulation like their embryonic counterparts. Because of their age, they also possess a greater potential for DNA abnormalities, either from the environment or the natural course of DNA replication over an extended period of time. Due to these constraints, embryonic stem cells appear more useful for purposes of transplantation.

Policy and Controversy

However promising recent scientific studies may seem, there are more questions, besides those concerning stem cell efficacy, that must be answered before scientists can perform more extensive research and trials can occur. At the heart of the issue are the moral and social implications of allowing embryos to be used for therapeutic purposes. In the current debate, which intensified during the summer of 2001, there seems to be virtually no opposition to the present research and potential implementation of adult stem cells for treatment purposes, and neither should there be. Adult stem cells have actually been used for treatment purposes for many years now, through such procedures as bone marrow transplants and, more recently, cord blood transplants. This involves the storage of the excess blood found in the umbilical cord, which is rich in hematopoietic stem cells, after delivery for future treatment potential. Adult stem cells are an integral part of each individual, to what extent however is still unknown, and their discovery was a major breakthrough for modern medicine. For this reason, there seems to be no grounds for objection to their application.

Embryonic stem cells, on the other hand, are engulfed in a storm of controversy. The primary question is whether or not it is ethical to use embryos for research purposes or harvest them for treatment purposes. Embryos are the foundations of all human life and possess the potential to become an individual. During the process of extracting the inner cell mass, the embryo is destroyed and so is its potential for life. President Bush compares them to snowflakes because of their unique genetic composition. Once one is destroyed, there will never be another one like it. Concerns over the value of life, then,

whether assigned or intrinsic, are at the core of the boisterous objections to human embryonic stem cell research.

In beginning to assess the ethics of this complex issue, one can not overlook the questions of moral status surrounding embryos, or in other words, "the degree of moral protection they should receive" (Green 48). In attempting to answer this question, it becomes difficult to locate any middle ground. The moral status of embryos doesn't lend itself to conditional thinking. There is no point at which it can be qualified. The decision, then, is either they are granted all full rights of protection based upon their potential for life or they are not, due to the fact that there are only several days into the developmental process and not capable of sustaining life, and, therefore, are not equal to a person morally. Pre-natal life in general, on the other hand, is subject to many qualifications. One of the largest and most unsettled debates in bioethics is when exactly does life begin; and thus, when should pre-natal life, be it embryo or fetus, be granted the moral protection of personhood? Opinions vary widely depending on the party involved and there is a definite lack of a consensus among those who take an interest for philosophical, legal, or religious reasons.

The most enduring legal precedent comes from the 1973 Supreme Court decision involving *Roe v. Wade*. In his opinion, with which seven justices concurred, Justice Harry Blackmun writes, "we need not resolve the difficult question of when life begins. When those trained in the respective disciplines of medicine, philosophy, and theology are unable to arrive at any consensus, the judiciary, at this point in the development of man's knowledge, is not in a position to speculate as to the answer" (Blackmun 554). However proper his stance in this matter may be, the Supreme Court's decision in this

case casts a cloud of uncertainty around the legal protection granted to pre-natal life. Referring to precedent, however, he goes on to write, "the unborn have never been recognized in the law as persons in the whole sense" (554). This statement seems congruent with the Court's ultimate ruling regarding the issue of abortion. It subsequently concurs that the rights of the unborn, with respect to its potentiality for life, are not equal to those of the mother. A fetus, then, is subject to the rights and decisions of its mother. The ruling does include, though, a certain amount of protection for the child. With respect to "legitimate interest in potential for life, the 'compelling' point is at viability. This is so because the fetus then presumably has the capability of meaningful life outside the mother's womb" (555).

Viability is designated as somewhere between the 24-28th week or approximately the beginning of the third trimester. It is at this point that the state may exercise its own discretion in regards to protecting the potential for life, even beyond the rights of the mother. Attempting to discern the amount of protection granted to the unborn is complicated in this case by the rights of pregnant women. This was, after all, a suit filed seeking a ruling on the amount of protection given to the choices of pregnant women. However, the ruling could not be made without first addressing the questions of the fetuses. The legal precedent that arises out of this case is that a pre-natal entity is not granted complete moral status until the point at which it is capable of sustaining its own life, be it week 28 or after birth, as deemed by the state. The ruling in this case has since been reaffirmed in several courts, including *Planned Parenthood of Southeastern Pennsylvania v. Casey*, which occurred in Pennsylvania Federal Court during the summer of 1992 (Madron). However, the question remains, how applicable is this precedent to

the current dilemma? Here, the rights of the mother are no longer an issue, for she becomes a consenting donor for embryonic stem cell research purposes, which alters the ethical judegements regarding the unborn compared to the Court's decision on abortion. The rights of a pre-natal entity must no longer be weighed against those of a mother, which, in a sense, removes some of the complications of assigning moral status. What must be resolved, then, are the lingering concerns over how much moral protection to assign them and at what stage should it come into affect. There are many more places in the developmental process other than viability that deserve attention.

Another event that has been considered important in law is "quickening," which refers to the first point in time that fetal movements are felt by the mother. Many have chosen this event, which occurs between the twelfth and sixteenth week, as the point at which life begins. But as one physician points out, "quickening is a phenomenon of maternal perception rather than a fetal achievement. It is subjective and varies with the degree of experience and obesity of the mother" (Hellegers 546). The fact that quickening is somewhat independent of fetal development calls it into question as a logical choice in attempting to define the beginning of life and, thus, grant moral status. The question remains where does life begin? Is it the pumping of the heart, or maybe measurable brain activity?

Whether one chooses viability, quickening or another standard, it is seemingly at the opposite end of the developmental continuum from the pressing issue of embryonic stem cell research. The concern here is the blastocyst, which is only 6-7 days into development. It is actually not even referred to as an embryo, but rather a pre-embryo. The distinction of embryo does not come until the second week, until which time it is still

referred to as a zygote. Few have been willing to deem blastocysts, or pre-embryos, as worthy to receive moral protection. This is due in large part to several findings and questions raised as to the biology of embryos.

First, it appears that conception is a process rather than an event. One of the key steps involved in conception is implantation. What is at stake here are pre-implantation embryos. How much weight should one give to the potential for life when the entity is not capable of beginning the process of development? Included in this line of thinking is the fact that neither doctors nor a woman are even able to discern that she is pregnant at this stage. All pregnancy tests involve the detection of increased hormone levels, which occur as a result of implantation in the uterus. In fact, depending on the source, two-thirds to three-quarters of all zygotes are never able to achieve implantation in the womb (Green 63). They are simply lost in life's own system of checks and balances. This is due to genetic abnormalities that occur during the process of recombination, or conception. The process is known as spontaneous abortion, where embryos with these defects are lost during the menstrual period because of their inability to sustain life. Furthermore, many forms of birth control function by preventing implantation of the embryo rather than the actual joining of sperm and ovum. Consequently, there already exists methods for the destruction of an entity that has already achieved a unique identity, similar to a blastocyst.

Second, there is a considerable amount of debate as to the identity of this cluster of cells and whether they are in fact "the individual," which complicates any attempts at determining moral status. What is it exactly that we are dealing with? What are we trying to assign moral protection to, a person or a cluster of two hundred cells? At this

stage there is a definite unique genetic identity, but the fate of the embryo has yet to be fully determined. If one of these cells breaks off, there is the creation of an identical twin, because it too is totipotent. Twinning can occur in humans until the fourteenth day, which leads to the production of conjoined twins past a certain point (Hellegers 544). A lesser-known fact is that, once separated, these cells also retain the potential to recombine. This phenomenon has been proven in studies performed on mice, which can achieve recombination until the 32-cell stage (545). However, the equivalent developmental phase in humans has not yet been determined, although it has been proven they possess the same capability. "The significance of this [occurrence] would seem to be that up until this stage the new individual mammal is not as yet irreversibly an individual, since it still may be recombined with others into one new, final being" (544). These characteristics of the beginning embryo complicate a stance in favor of "the existence of a single biological individual at this time in development" (Green 53).

One of the few groups or entities that has been willing to grant embryos complete moral status is the Catholic Church, which is significant not as a religious stance, but as it highlights the philosophical complications of making such a judgment. Roman Catholic theology defines the soul as "an individual substance of a rational nature" (54). As part of church doctrine, it prescribes to the "ensoulment theory." According to this theory, God grants the soul to each individual at the time of fertilization, after recombination between sperm and ovum. Therefore, an embryo is seen as a moral equal to any living person, due to the presence of a soul. In light of the current understanding with regards to the biology of pre-natal existence, such a stance opens the door to a tremendous amount of philosophical jostling. Consider the following quote by Dr. Hellegers, "in old

standard Catholic language, one could say: 'If by means of two fertilizations two souls are infused, and if a single body only contains one soul, then we are beginning to see cases in which one of the two souls must have disappeared without any fertilized egg having died'" (545). All this to point out the difficulty of making any determinations concerning the early formations of life, especially when it appears that these early stages are still highly mutable. How can one make any moral judgements on these embryos when the creative process has not yet finished making its own?

This was the source of much uneasiness for President Bush when he was left to decide the government's stance on human embryonic stem cell research in July of 2001. Admittedly, his primary concern is "are these frozen embryos human life, and therefore, something precious to be protected" (Bush 2)? At stake in his decision was government support for this research in the way of federal funding. Obtaining federal dollars is the crucial step in getting the ball rolling. This financial backing opens the door to many scientists who are, for the most part, kept in the dark when progress is restricted to the private sector. It also ensures that any new discoveries are shared among research facilities, which also expedites advancement.

As a result, President Bush ultimately decided that federal funds should be used to this end, because "research offers hope that millions of our loved ones may be cured of a disease and rid of their suffering" (3). For the current year, 250 million dollars will be designated for use in embryonic stem cell research. His decision, however, appears to be somewhat of a compromise. These funds are limited to existing cell lines that were created privately, which includes around 63 current cultures. "This allows us to explore the promise and potential of stem cell research without crossing a fundamental moral

line, by providing taxpayer funding that would sanction or encourage further destruction of human embryos that have at least the potential for life" (4). Meanwhile, privately funded research continues to be unrestricted.

One of the most common ways to approach such a delicate issue, the way President Bush approached it in his address to America, is to weigh out the pros and cons of both sides, known as a cost v. benefit model. Granted, there are quite a few more issues than the ones presented here, but essentially this stance comes down to the preservation of life, or at least its potentiality, in the form of an embryo versus the possible cure for many crippling and fatal diseases. I, for one, reject this perspective, independent of which side the pendulum swings, on the grounds that it will never lead to any definitive progress. By framing the question in this manner, we are only setting ourselves up for a stalemate, and this is exactly what one finds in Bush's decision. Essentially, he has yet to decide the issue. When the existing lines expire, does he borrow more from those harvested privately and suspend the decision further? A decision must be made and the current way of analyzing the issue will not take us there. Those who initially defend the pursuit of embryonic stem cell research will still do so once they view the case in terms of cost v. benefit, and vice versa.

This is without a doubt the pragmatic approach to the question. If we continue to analyze the situation in this manner, the issue is never fully engaged. By choosing to judge the correctness of a decision based upon its practical consequences, the truth of the resolution becomes relative, depending on the circumstances and implications, and virtually unattainable. The best example of this is Bush's recent stance on the government's involvement. He feels justified in allowing the allocation of federal funds

for research on existing cell colonies, yet not in establishing more samples for the same purpose. Furthermore, the issue becomes gridlocked in a perpetual state of tug of war by a myriad of pre-conceived belief systems. This is a hotly contested debate. With seemingly so many ethical and societal implications at stake, opinions run deep. These opinions happen to be backed by many different values and interests. The importance, then, becomes not how you look at the case, but who looks at it. There are some consequences that some can't condone, while others may view them as only a small price for a great reward. In turn, the result is an almost complete polarization and no clear future direction.

Religious opinion is arguably responsible for the most deeply rooted, adamant, and motivating or inspiring values. In the name of religion, people have bombed abortion clinics, given away all their earthly possession to live a life of poverty and service, conquered civilizations, and moved their families to the other side of the globe. These views are so strong that they are largely responsible for the polarization of opinions that one finds on issues such as stem cell research. What is at stake is life, in whichever form, be it a pre-natal embryo or those crippled by debilitating conditions such as Parkinson's disease and muscular dystrophy, and life and religion are inextricably conjoined.

In addition to personal meaning, religion has also had a large impact on the psychology and philosophy of our culture. In this case, life is inseparably linked to religious understanding. In fact, in all the cultures that have provided the foundations for our own, life is characterized as the possession of a soul or spirit (Green 59). In the Hebrew, Greek, and Latin traditions the term for soul was also synonymous with the word for breath—nephesh, pneuma, and anima, respectively. Life begins when God

breathes life into His creation and ends when one ceases to inhale. As professor Green points out, "spiritual realities are mapped directly onto biological occurrences that once seemed to be definitive marker events" (60). As a result, religion and traditional biological understanding played off one another to produce what seemed to be the logical choice for the beginning of life, birth. God, of course, was at the center of all this as the provider of *breath*. In this way, one's nephesh, pneuma, or anima possess the potential for double meaning—both religious and biological.

As one can, no doubt, accurately forecast with a little clear hindsight, this early understanding of life's formations, steeped in tradition, set the stage for an interesting and complex relationship between religious understanding and technology. As science and knowledge continued to progress, they carried religious investment along with them, which created what appeared to be a sharper understanding of the beginning of life. This was made possible with the development of the microscope and the ability to isolate and preserve sperm and ova. This, in turn, led to the observation that these two gametes unite to produce an individual. As experimentation continued, it became clear that each gamete contained a haploid set of chromosomes, or only one set, and combined to create a unique, diploid zygote, the true foundation of life. There couldn't be a clearer candidate for the initiation of life at this stage in scientific development. What follows is a move away from birth as the origin toward fertilization. Metaphorically, conception could now be understood as the moment when God *breathes* a spirit into the new creation, which corresponds to the appearance of a new, unique genetic identity. As a result, we begin to see ideas such as the Roman Catholic "ensoulment theory," which holds to this precise account.

Ironically, as technology continues to advance and biological understanding sharpens, which propose to offer clarity and precision, the picture, as it pertains to the true beginning of life, appears fuzzier. The questions surrounding the identity of the embryo serve as a nice example. What exactly is it? The fact that up to two-thirds are spontaneously aborted certainly devalues the meaning of conception. Moreover, fertilization, which was once understood as a clear defining event under a light microscope, can now be seen as a process that spans up to two weeks, where no single component is less significant than any other. As Green points out, "growth in scientific knowledge has thus highlighted the complexity of these processes and the need for choice in ways that an earlier phase of science, reinforced by ancient religious ideas, helped to obscure" (61). All along the continuum now, from fertilization to birth, each phase in the developmental process is well understood, from factors that contribute to implications on viability. What remains is a long list of crucial developments, all of which run together to demonstrate a complex process that is dependent upon each phase. One cannot say that any particular point along the way designates the assignment of complete moral status, be it conception, implantation, a detectable heart beat, brain activity, and so on.

Having been thrust into a process understanding of the pre-natal existence through scientific achievement, the burden of determining moral status appears less objective, evidenced by the varying opinions and lack of a consensus that we have already examined. At the current state of human biology, there are no longer any clear defining moments during the course of development that, in themselves, announce the arrival of a moral being, as fertilization seemed several decades ago. "The curve of otherwise continuous biological processes," Green says, "converts us from passive identifiers of

biologically fixed truths to active choosers of markers on life's spectrum" (50). Any determination, then, becomes nothing more than a choice on the part of an individual or group of individuals.

This also seems to be a source of the current gridlock in the debate on the subject of moral status. Science, which offers clarity through precision and understanding, provides no remedy or solution for this philosophical dilemma. This lack of direction represents the largest barrier to resolving the issue of human embryonic stem cell research. Dr. Hellegers asserts, "it is not the function of science to prove, or disprove, where in the process human life begins" (Hellegers 548). The burden, in turn, falls upon the shoulders of society. We, as a culture, are left to determine the direction in which we will proceed. One of the most appropriate ways to begin is to decide "the question is not just to forecast when life begins, but rather: How should one behave when one does not know whether dignity is or is not present in the [embryo]" (548)? In light of the fact that there is no promising alternative, this appears to be the only appropriate and logical fashion to begin to examine the issue.

Science and technology have brought us to a place where there is the possibility of using pre-natal cells to cure millions of people, a seemingly unbelievable feat, yet it offers us no suggestions as to the direction that should be taken. Whether or not it is the role of science to decide these issues or make the distinctions for us, the fact remains that it hasn't. Society, too, including all the ethics committees that have been assembled in the name of stem cell research, has been unable to forge any progress in resolving the pressing questions that science has forced us to answer. Neither is religion able to resolve the debate for a secular and independent state. Theology is as varied as the many

sects that contribute to it, of which the Catholic Church serves as a nice example. All of these influences, religion, philosophy, and the inability of science to clarify the controversy, contribute to the complexity of the issue.

There is, however, another category where one can explore the issue—literature. Literature offers the advantage of time and distance, where one is far enough away from the demands of society, such as the loaded belief systems that are often polarize debates such as these, yet maintains a relevance that is heightened through the perspective gained by being an objective reader. One of the many roles of literature has traditionally been to take part in discussions such as these. In this way, it functions to uncover many of the underlying attitudes and influences, including hopes and concerns that often stir the waters, that would otherwise remain hidden. As such, literature takes the shape of a useful critique. The result is an interpretive vehicle for, in this case, science.

More specifically, the Enlightenment, from the late 17th through the 18th century British literature and culture, represents a comparable historical moment, where one can begin to see the formations of modern science and the seduction of progress as they merge with a historically religious society and people. The Enlightenment represents a place where we can work out the problems of the present with an eye towards the past and the related issues it was forced to address as the precursor to modern science and society. Through an unquenchable thirst for knowledge and a determined pursuit of technology, Enlightenment society provided the first glimpse of a progress-driven world. As such, it was forced to define the role of science, including its ends and its means in its society, and to address questions concerning the relationship between science and nature. As the forerunner to modern society, the Enlightenment represents the origin of what we

have become, and not unique place that stands to resolve the controversy. This era is responsible for the introduction of many relevant issues that still have a voice in the current debate over human embryonic stem cell research and many questions that have yet to be fully answered in the modern landscape. These realities are clearly seen through a cultural study of the Enlightenment, including an examination of several literary works by such authors Robert Hooke, Alexander Pope, and Jonathon Swift.

Enlightenment Culture

The term enlightenment is actually a very loaded word. It carries significance in many different fields, including philosophy, art, literature, science and religion, and has origins in several different countries. How does one begin to characterize a movement that offered so much change to, seemingly, every aspect of human and cultural existence? As an era, the enlightenment represents roughly the 18th century, having its birthplace in Europe, particularly England and France. What makes this period and movement distinct is the space it created for reason. The driving force behind the Enlightenment was the belief that the answer was obtainable. Independent of the question, knowledge and reason served as the direction that led to progress, and ultimately the answer. As a result, we find the inception of an interesting philosophy or way of viewing life. To 18th century Europe, the world is in its grasp and able to be conquered. This approach manifested itself in the pursuit of knowledge and truth, knowledge in the form of science and observation and truth through the faculties of reason, both of which would culminate in an improved world and person.

As Foucault reminds, "we must never forget that the Enlightenment is an event, or a set of events and complex historical processes, that is located at a certain point in the development of European societies. As such, it includes elements of social transformation, types of political institution, forms of knowledge, projects of rationalization of knowledge and practices, technological mutations that are very difficult to sum up in a word, even if many of these phenomena remain important today." The significance of this complicated period in history is the introduction of a novel

perspective, or "mode of reflective relation to the present," which propelled man to new heights as discoverer and engineer, the one responsible for the present and the future (Foucault 313).

This idea acquired many different shapes, including political, social and religious change and revolution, but none more important to the present than the pursuit of science and technology. In many ways, the 18th century can be viewed as the formation of modern scientific exploration. In fact, one of this period's many contributions to modern research was the formulation of the scientific method, through the thoughts and writings several decades earlier of Francis Bacon, which still serves as the primary means of challenging, testing and proving new theories or assumptions. This epoch pursued science with a newfound vigor and enthusiasm. Much of what was discovered or practiced during this time provides the foundation for our current technology and understanding of many subjects, such as an interest in anatomy, the first explanations of physics, the introduction of the light microscope, and calculus. In many ways the achievements of the Enlightenment can be seen as the initiation of a pursuit that is being actualized in front of our very faces. What began in the 18th century is reaching new heights and levels of mastery at an amazing rate in the 21st, with human stem cells providing one of the many examples.

In 1662, Charles II initiated the charter for a group of virtuosos that was to become known as the Royal Society for the Improving of Natural Knowledge. With the support of the throne, England committed itself to discovery. During the time, this was a very novel idea, a quest for innovation. "Till about the year 1649," John Aubrey writes, "'twas held a strange presumption for a man to attempt an innovation in learnings; and

not to be of good manners, to be more knowing than his neighbors and forefathers" (Sherman 2039). The Royal Society declined to accept the natural world as its predecessors had seen it, but rather, chose to test it for themselves through experimentation, "preferring new data to old theory, the testimony of the senses over the constructs of the intellect; the works of Francis Bacon, who had articulated such a method half a century earlier, served for these investigators as something akin to scripture" (2040). The Royal Society's goal was focused upon "'promoting the knowledge of natural things and useful arts,'" or in other words, science and technology (2040).

Among the Royal Society's members there was a tremendous amount of thirst and fascination for knowledge pertaining to all things, the world and all its wrinkles. The emphasis was placed on establishing a lasting and coherent picture of the universe by beginning to develop an understanding of all they saw around them. In the absence of the many modern day specializations that we have become accustomed to, a member of the Royal Society might simultaneously have interests in and conduct experiments "investigating biology, physics, and astronomy, inventing scientific instruments and domestic appliances, advancing inquires into theology, astrology, even demonology" (2040). One such member of the Royal Society was a man named Robert Hooke.

Hooke was the Royal Society's first curator of experiments. In addition, he was responsible for the Society's lectures on geometry, assisting in the rebuilding efforts after London's Great Fire, worked tirelessly on many inventions, such as lenses, telescopes and optical theory, and ultimately left his mark on modern chemistry with Hooke's Law, a kinetic interpretation of gas pressure. Hooke's life and work embody the great

enlightenment hope. Underneath the scientific prose of his most enduring literary work, *Micrographia*, lies a celebration of the human spirit, the idea that characterizes most of the literature from this time and establishes it as unique. Restoration and 18th century British literature placed an emphasis on the expanded role of man, while embracing humanity. In a work like *Micrographia* and a figure like Hooke the reader is made aware of the possibility for improvement and actualization, as an individual, a nation, and a species.

Micrographia serves as a metaphor for enlightenment thought in general and provides a clear illustration of the scientific shape it assumed during the day. Considered an ingenious idea during his own time by the likes of Samuel Pepys, Hooke, using a light microscope, set out to provide "Observations" of sixty different magnified objects complete with illustrations. As a metaphor, the microscope functions in the same role as enlightenment philosophy, as the discoverer of truth and knowledge. Applying light, or clarity, to any situation or object results in the expansion of one's mind. As light, in the form of knowledge and reason, shines upon the world, a new reality is uncovered, and humanity is the beneficiary.

Then there is his actual work with the light microscope. His writing also includes the clear assumption that the knowledge gained and applied through the microscope offers advancement to both the current level of understanding and humanity. The preface alludes to the fact that this optical clarity provides the opportunity to discover more of what composes our world, seen through the lines, "the footsteps of Nature are to be traced, not only in her ordinary course, but when she seems to be put to her shifts, to make many doublings and turnings, and to use some kind of an art in endeavoring to

avoid our discovery" (Hooke 2049). Within this passage one finds Hooke's admission of the difficulty of the task at hand. To man, "Nature" appears to be the most skilled magician. Included in this confession is a certain degree of promise. There is much more that can be known besides what lies within "her ordinary course," many things currently beyond human understanding and capabilities that can be illuminated through such devices as the microscope. The promise is that of discovery, including the newfound realities that appear as "the footsteps of Nature are...traced" by science. Discovery brings possibilities. According to Hooke, it soon becomes clear that reason, as it manifests itself through science, serves as a means of advancement for the natural world.

Micrographia, and this passage in particular, also illustrates the human desire for control. In this work Hooke provides some of the first attempts to completely catalog the world, which reveals a hope for mastery and triumph. With the microscopic observation of these sixty objects, it is as if he is initiating the process. The idea of mastery is one with interesting ties to the present and demonstrates most effectively the extent to which we are still children of the Enlightenment. Consider the Human Genome Project. We are on the cusp of mapping every gene that comprises the individual, including the particular trait(s) that it is responsible for. The exponential growth in technology and knowledge is astounding. "A weekday edition of the *New York Times* now carries more information than the average seventeenth-century person would have digested in a lifetime. Scientific information doubles every 12 years. General information doubles every two and a half years" (Banister 141). According to one projection, knowledge will double every four days by the next century, as opposed to every several hundred years during pre-historic times.

What began in the 17th century has reached incredible heights during the 21st. For example, who among us would disagree with Hooke's assumption that science and technology serve as a valuable means of investigation and advancement for our world. This statement, more or less, functions as our *modus operandi*. Modern Society has taken the discoveries of the 17th and 18th centuries, like the light microscope, and seemingly reached the limits of mastery, such as the electron microscope, which can resolve details down to 1nm in size. In fact, one of the largest challenges of today is attempting to stay afloat in a progress driven world that has given new meaning to the enlightenment goal of mastery, be it computer innovations or medical advancements. As a result, Our society has reached a place were one begins to wonder whether or not we should proceed with such things as human embryonic stem cell research.

As children of the Enlightenment, *Micrographia* displays another key similarity to modern science and relevance to the stem cell debate. Hooke's writing exhibits an excitement and fascination very similar to what arises from the new possibilities of the human blastocyst. As a scientist, his writing is very technical. Yet, there are moments where his enthusiasm shines through. In an address to the Royal society he writes, "there may perhaps be some expressions, which may seem more positive than your prescriptions will permit" (2048). This can primarily be seen through the fact that he is writing extensively about mundane subject matter, such things as a period, a needle, and a flea.

This work embodies the joy, and also fear, of discovering that the limits of human potential have been raised, shown through the lines, "but if viewed with a very good microscope, we may find that the top of a needle (though as to the sense very sharp) appears a broad, blunt, and very irregular end not resembling a cone, as is imagined, but

only a piece of a tapering body, with a great part of the top removed, or deficient" (2050). Throughout the course of history, the senses, which are interpreted here as a limitation, have told man that a needle is sharp, yet this is no longer completely the case. As technology sharpens the resolution, a new reality is uncovered. Human boundaries, or the senses, have been overcome. What was once believed to be a sharp object can now be seen as blunt and dull. Likewise, an object that certainly feels smooth to the touch "could not nevertheless hide a multitude of holes and scratches and ruggedness from being discovered by the microscope" (2050). No longer limited by himself, his invention or power of invention becomes the new boundary for man.

This sort of transition accurately mirrors the current trend in modern medicine. Treatment options have reached a barrier when confronted with certain conditions and genetic disorders, such as Parkinson's disease, diabetes, spinal cord injuries, muscular dystrophy, Alzheimer's disease, heart failure, and osteogenesis imperfecta, all the places that stem cells offer the most promise. For the most part, infectious diseases have been conquered, which were the leading causes of death up until the turn of the 20th century. Due in large part to the development of antibiotics and vaccines, they have virtually been eradicated from the face of all first world countries, at least as a source of mortality.

However, the new barriers to health have a preventative aspect. Heart disease, cancer, stroke, lung disease and accidents make up the top five leading causes of death respectively, all of which are largely related to behavioral choices. The recent emphasis has been placed upon such things as diet, exercise and reducing behavioral risks through such measures as wearing one's seat belt. Beyond the preventative front, embryonic stem cells also show promise for use in transplant therapy for several of these causes, namely

heart disease. Coupled with their potential for treatment of the various genetic disorders, embryonic stem cells stand to revolutionize modern medicine by potentially reducing the mortality rates for several conditions and providing treatment options where there previously were none. Through the use of pluripotent stem cells, what was once dead heart tissue could possibly be regenerated, or dysfunctional islet cells of the pancreas replaced as a cure for diabetes. Through this new technology and research, the bar stands to be raised once more and the limits of human mastery extended to diseases that are currently difficult to treat or incurable. To this, Robert Hooke, a man who personifies the enlightenment spirit and hope of human triumph, would applaud and encourage.

Order and a New Interpretation of Reason

As a member of the King's Royal Society, Hooke serves as the ideal example of Enlightenment philosophy and the scientific form it acquired. His work embodies the belief that science and technology stand to offer progress that is beneficial to all of humanity. However, this is not the case for the entire range of literature that one finds coming from the late 17th and early 18th centuries. As a cultural and historical moment, Hooke's perspective is one of the many facets that is used to characterize a time period that has been reduced, with the assistance of time, to the word enlightenment. But as a literary movement, one of the largely unsettled debates is whether or not the works of the day share the same sort of optimism concerning the abilities of man to guide the course of progress through reason and science.

This issue presents itself largely through the works of John Wilmot the Earl of Rochester, whose libertine lifestyle held no room for the faculties of man and whose philosophy concluded that reason was a bankrupt end, Jonathon Swift and his biting satire that demonstrated the frequent gaps in logic, and Alexander Pope in his poem "An Essay on Man." Whether or not the literature from the time constitutes an overall critique or affirms the ideas of the day, these attitudes can be clarified by examining the purpose of literature. As scholars and people of reflection, most authors and poets see themselves as responsible for "enlightening" the reader. This is generally true independent of the time period. Most often, the results are new perspectives and ideas taking the shape of criticism. Examining the direction and course of one's own society serves as the ideal and most common manner by which an author can assert a novel interpretation. This is

precisely what the reader discovers when reading Pope's "An Essay on Man," which provides an 18th century critique of enlightenment philosophy.

To understand this work the way Pope intended it, one must regress a little, back in time before two hundred years of technology and progress, to a culture that had not yet carved out an existence founded on scientific precision. As the manifestation of the great enlightenment dream, the ideas of Pope in this poem can be seen as a threat to the entire modern way of life. There isn't a single aspect of the current lifestyle that has not been become efficient or touched in some way by the thousands of technological advancements made over the last hundred years. This is particularly true of medicine. The best example is the current average life span, which has been stretched to almost eighty years old through progress made in the field.

In the last line of the poem, appealing to providence and order, Pope concludes, "One truth is clear, Whatever IS, is RIGHT" (295). In the context of the embryonic stem cell debate, the argument would be that the people afflicted by these crippling and life-threatening conditions are the product of nature and providence and it is not the role of man, or science, to alter the situation. This is not a completely foreign argument, but one that has been asserted as of late, especially in light of the new capabilities of genetic engineering, which offer the possibility to parents of screening, selecting, or altering the genetic composition of their children. However, this is not an argument that we, as an enlightenment prodigy, are willing to accept due to the consequences of such a stance. The problem with this line of thinking is that the argument has no boundaries. Could this reasoning extend to such things as the flu or any situation requiring medical attention? Certainly the same divine order that allows for the genes that cause Alzheimer's disease

oversees someone who has a massive heart attack. Should a by-pass operation also be ruled out on the grounds that "whatever is, is right?" This particular stance poses a threat to not only medicine, but also the entire modern way of life. It is, therefore, an isolated argument in the current landscape held by only a few and can be dismissed as an unacceptable resolution to the stem cell debate.

Society has progressed to a point where one can no longer heed this particular argument of Pope. The capabilities now exist to facilitate and improve the quality of life. Presently, the potential of medicine falls under the category of "whatever is." However, "An Essay on Man" is relevant to the debate as it pertains to the function of man and science in regards to the boundaries that must be crossed, outside of the human realm, to procure such a quality of life, but not necessarily as it justifies or invalidates the suitability of the recipients as an end for the technology. The critique is that the quest for an improved existence should not go unregulated, and thus be deemed an "at all cost" pursuit.

In looking for a limit to our science, Dr. Hellegers' quote becomes particularly important, in which he claims, "it is not the function of science to prove, or disprove, where in the process human life begins" (Hellegers 548). He is able to make such a statement because the truth is that science is completely unable to provide an answer to the one question that needs to be resolved. As can be seen through the public debate already investigated, all that exists are speculations, opinions, and societal judgements. Science is only able to highlight the crucial events along the developmental continuum and throw the question back at society. The truth remains that Hellegers' stance and the reality that biology is unable to resolve the issue of whether blastocysts have a legitimate

claim to complete moral status is opposed to the Enlightenment claim that science stands to answer our questions in some objective way.

The eighteenth century and the Royal Society held to the premise that these efforts would bring clarity and precision to produce an "enlightened" world. However true this assumption may appear on many levels, there is no clarity, or even direction, concerning the ethics of embryonic stem cell research. The question then arises, does this lack of resolution on the part of science, a device designed to illuminate, necessarily indicate the presence of a realm into which man should not proceed? If we are still plagued with these moral choices and haunted by the potential consequences of where technology is leading us, then we are possibly being taken in a direction we should not go. These are symptoms that lead us to a poem like "An Essay on Man" and the concerns that Pope address in this work.

The crux of Pope's argument is built around a visible order that is apparent throughout nature, which is sustained and ordained by God. Although somewhat of a theological foundation, the argument still holds up for those who exclude the idea of God from moral reasoning. If God is replaced with the term ordering principle or creative process, the reasoning is equally valid. There is a force that subjects creation and man to its laws and power, which will be referred to as God. Pope needs only to observe nature to reach this conclusion, as seen through the lines;

> Great in the earth, as in th' ethereal frame,
> Warms in the sun, refreshes in the breeze,
> Glows in the stars, and blossoms in the trees,
> Lives through all life, extends through all extent,
> Spreads undivided, operates unspent. (267-73)

One finds this in both the cycle of the seasons and the regularity of instincts from man and beast. As one progresses through this order, he finds a natural hierarchy of powers or "great chain of being." This is not a new idea, but one taught to children through the song that begins "there was a spider who swallowed a fly," which has open-ended lyrics and progresses from animal to animal until it reaches man.

This is precisely Pope's point, that humans possess an inherent authority over all of creation. This authority is granted and secured in reason, found in the lines, "The pow'rs of all subdued by thee alone, / Is not thy reason all these pow'rs in one" (231-2)? The pinnacle of nature and culmination of all living things is a rational being, man. To Pope, and hopefully everyone, such an order of things places a burden of responsibility on our species. As reason dictates, man is responsible for the present and, most importantly, insuring that order is maintained and the balance is not disturbed, unlike Hooke and the enlightenment idea that we are capable of perfecting the world. Here, Pope charges man with not disrupting nature's system. An enlightenment perspective leads to the conclusion that one is ultimately able to improve upon what he is given.

In fact, Pope's critique largely focuses on this particular perspective, the enlightenment hubris that makes the time period distinct. He holds that it is absurd to view the natural world as something to be mastered, which he draws attention to in the lines;

> Ask for what end th' heavenly bodies shine,
> Earth for whose use? Pride answers, "'Tis for mine:
> For me kind Nature wakes her genial pow'r,
> Suckles each herb, and spreads out ev'ry flow'r. (131-4)

By aiming to modify and perfect the world, one is assuming that all was made for this purpose. In turn, one begins to see all at his disposal as a means to this end, including the

human embryo. The absurdity comes from believing that God, the initiator of life and superior reasoning force, created an existence that needs to be perfected by humanity.

The warning is not to be too quick to deem man or the universe so imperfect as to require human assistance. Advancement of the race and world, through such measures as science and technology, is not in itself a useless idea. The caution is not to be pulled beyond man's faculties and station, for "...in the scale of reas'ning life, 'tis plain / There must be, somewhere, such a rank as Man" (48-9). The question becomes, "Is the great chain, that draws all to agree, / And drawn supports, upheld by God, or thee" (33-4)? Just as the fly is subjected to the authority of the spider, so is the reason of man inferior to the order and nature of God. Herein lies the concern with embryonic stem cell research. Human devices should not tamper with what is a clear and defined structure to life, for fear of disrupting divine and natural provision. Many believe that experimenting on embryos, which requires their destruction, falls into this category.

This is a fairly popular argument and has been currently formulated under the heading of "playing God." Some claim that there are distinct boundaries between the human sphere and that which must be left to a Creator and Sustainer of life. By experimenting on, essentially, ourselves, in the form on blastocysts, we would be devaluing life. Consider the argument of President Bush in his address to the nation, "if they are going to be destroyed anyway, shouldn't they be used for a greater good, for research that has the potential to save and improve other lives" (Bush 2)? Taken in reference to the spare embryos from IVF treatments that would potentially provide the source for research purposes, this is a very economic stance and clear example of the

commodification of life that would follow a commitment to embryonic stem cell research.

As the leader of the largest economy in the free world, undoubtedly President Bush thinks in such terms. However, he is referring to embryos, which retain a potential for life, not terrorist-seeking warheads or oil. Citing the opinions of some, he continues with an objection, "there is no such thing as excess life, and the fact that a living being is going to die does not justify experimenting on it or exploiting it as a natural resource" (3). The danger here is apparent. By experimenting on human embryos and using them for therapeutic transplantation purposes they would be stripped of any intrinsic value and would bear only an instrumental worth. Humanity, as the highlight of nature, should not be subjected to this sort of devaluation to the level of a commodity.

A practical result would be the establishment of an economic market, much like any other product. In any market, businesses are in competition, which is usually accompanied by underhanded tactics to receive a financial advantage. To this end we would begin to see stolen embryos and coercion during the donation process, all in the name of profit. Even the hopes of scientists and the potential uses they foresee for pluripotent stem cells illustrate the extent to which the end result is the creation of a human product. Part of the cultivation process requires that these cells either be genetically engineered to produce matching MHCs or produced through "therapeutic cloning" to create a precise cellular match with the recipient, a truly customized therapy, made to order. These consequences are a clear violation of Pope's "great chain of being" and an exit from the ordained human realm. Human life, even in the form of potential,

should not be subjected to man as something instrumental, but rather to the order that sustains it.

Along with a warning not to overstep man's boundary, Pope provides the reader with a sense of the sphere in which he operates. Consider the lines;

> Say first, of God above, of Man below,
> What can we reason, but from what we know?
> Of Man what see we, but his station here,
> From which to reason, or to which refer? (17-20)

Here, reason, which he argues places man at the height of creation, also sets his boundary, a double-edged sword that provides for both his strength and his Achilles heel. The limits to reason are a result of a lack of vision, an inability to grasp, see, and control the larger force that orders the universe, God. A lack of insight leads to limited capabilities and a defined "station" from which to operate and reason. The suggestion, then, is that the realm of man is confined to his own understanding and to cross out of this station would entail aspiring towards things that require knowledge beyond what he is able to comprehend.

It would be hard to argue with the fact that the modern concept of the human realm would appear much larger than the idea Pope used to conceive this poem. However, there is, within the present scientific understanding, a clear boundary between what is attainable and what appears to be forever elusive. One of these mysteries happens to be the ability to determine when life begins, when a soul is present, when an entity should be granted the rights of personhood. In the beginning of my argument it became clear that there is nothing more than opinion—legal, societal, and religious. Furthermore, there is no consensus, and more importantly, no truth. Biology has progressed to the point where there is nothing left to be known that could decide the

debate. In the enlightenment sense, science has failed us in this regard. In Pope's view, attempting to answer the question was a useless pursuit from the outset.

Within the ethical dilemma of stem cell research there are two opposing forces, the unresolvable concern over the moral status of pre-natal existence against a possible treatment for millions of suffering Americans. I would argue, though, that discerning the level of moral responsibility an embryo should receive preempts any use of future potential on the part of these cells as valid reasoning in favor of moving ahead with the research. If it could be concluded that blastocysts are our moral equals, would that not settle the issue? Pope asserts;

> The bliss of Man (could pride that blessing find)
> Is not to act or think beyond mankind'
> No pow'rs of body or of soul to share,
> But what his nature and his state can bear.
> Why has not Man a microscopic eye?
> For this plain reason, Man is not a fly.
> Say what the use, were finer optics giv'n,
> T' inspect a mite, not comprehend the Heav'n? (189-96)

Once again the reader finds the idea of usurping the role of the divine, trying to understand the heavens by attempting to reach an objective conclusion about the beginnings of life, the question on which the entire debate hinges. But the answer, however, escapes discovery due to the fact that it is not within our reach. Moreover, such a pursuit is not a proper end to the technology and capabilities that man has acquired. "Comprehending the heavens" is more than our reason will allow and more than our "state can bear."

The second part of Dr. Hellegers' quote concerning the inabilities of science provides a nice example of not "thinking beyond mankind." He writes, "the question is not just to forecast when life begins, but rather: How should one behave when one does

not know whether dignity is or is not present in the [embryo]" (548). His conclusion appears to be the corner that society is forced into. A reinterpretation would be, can we, with a clear conscience, commit ourselves to the destruction of embryos for experimentation and therapeutic purposes when they may or may not be our moral equal in the eyes of God, the superior reasoning power? Pope says no, for to do so would not only be a violation of the authority of man, but also a demonstration of the hubris that distinguishes him. To Pope, it becomes difficult to proceed with any research efforts, no matter the potential, when humans lack the vision and understanding to realize the implications of their work, as it pertains to destroying embryos, and grasp the reasoning that dictated such an order of things.

The result would be a disturbance in the state of nature, part of which includes the creation of a pre-natal commodity. The ultimate consequence of such a disruption, he claims though, is naturally hidden in the future;

> ...On superior pow'rs
> Were we to press, inferior might on ours:
> Or in the full creation leave a void,
> Where, one step broken, the great scale's destroyed. (241-4)

Certainly the possible implications extend, not only to the future, but toward the center of societal perception and direction. If we can advance our treatment potential by using embryo derived cells, how else may we implement this technology to customize our lives, our children, the working class. Referring to the Huxley novel, Bush says, "we have arrived at that *Brave New World* that seemed so distant in 1932," which should be warning enough in itself (Bush 3).

A Question of Distribution

A misallocation of resources is one of the most immediate implications of pursuing the potential of human embryonic stem cells. By seeking a regenerative fix through therapeutic transplantation, which requires large amounts of money and effort by many of the leading minds in scientific research, the country is missing the opportunity to attack these diseases from a preventative angle. During the current year, the government will spend 250 million dollars on stem cell research, which is mere start up cost in light of the fact that this amount is limited to the sixty or so cell lines that already exist. The same amount of money, including future spending, could be put toward efforts to reduce the amount of people affected by such conditions. This is especially true of heart disease, which causes the death of 750,000 Americans each year. Such a plan would entail educating the public concerning the risk factors for heart disease, the lifestyle choices that can lead to it, and encourage people to live healthy lives, which might include incentives to stop smoking. In addition, it would free up many research facilities to pursue advancement in areas that stand to benefit the health of a greater portion of society.

These are not cheap technologies, either in regards to funding the research or prepping the cells for treatment purposes. If all the kinks are worked out, it would require a serious amount of time, expertise, and money to prepare a cell culture ready to be transplanted, which must include either the ability to genetically engineer the sample or produce it through cloning technology. It seems unlikely that most people who stand to benefit from these capabilities would have the money to afford them. The cost of health care is the gravest issue facing medicine in this country today, which is spirally out

of control due to, among others, advanced technologies. Insurance could not pay for a stem cell transplant; if it did, the cost would be spread to all Americans, most of whom are struggling to afford their premiums or are unhappy with the coverage they receive under their current plans.

As a result, the potential embryonic stem cells offer would be limited to the highest socio-economic class. Within the larger scope of modern medicine, it doesn't seem cost effective to focus treatment efforts on methods that stand to primarily benefit the rich. A recent study claims that African-Americans and Hispanics, which statistically make up a large portion of the lower class, receive inferior forms of healthcare and have higher mortality rates compared to whites for the same diseases. In a situation that is already out of balance socially, with the scales tipped toward the wealthy, aiming at expensive technologies becomes an even greater injustice, one that offers only to widen the distance to equality.

Jonathon Swift appears to have foreseen the problems concerning the distribution of resources that science has the potential to create almost three hundred years ago. In the third book of *Gulliver's Travels*, Gulliver finds himself on an island named Balnibarbi, which is a land bent toward the sciences. The peak of its technology is the floating island of Laputa that hovers above the island. Laputa is built upon mathematical principles, is perfectly circular, and is able to prevent the falling of rain. After viewing Laputa the people of Balnibarbi, as a society, "began to dislike the Management of every thing below; and fell into Schemes of putting all Arts, Sciences, Languages, and Mechanicks upon a new Foot" (Swift 169).

A more efficient and productive life is the general goal of these pursuits. A chief aim is the invention of new "Tools for all Trades and Manufactures," where one man can do the work of a whole crew, a palace can be completed in a week, and materials never need repair. In addition, they seek to ensure that all crops come into season as they design with a "hundred fold" increase in yield. Gulliver observes;

> The only Inconvenience is, that none of the Projects are yet brought to Perfection; and in the mean time, the whole Country lies miserably waste, the Houses in Ruins, and the People without Food or Cloaths. By all which, instead of being discouraged, they are Fifty Times more violently bent upon prosecuting their Schemes, driven equally on by Hope and Despair. (169)

The critique, then, lies in the choice of direction for Balnibari. All the science and knowledge that prospered the floating Laputa offers no aid to the people of the island. What good is a hovering city to a starving people? Likewise, what's the purpose of attempting to attain greater heights and develop other such devices and technologies when everyone is naked or in rags? Much like modern medicine, the proper direction for Balbarni is to address the larger and more fundamental needs of the people. See to it that everyone understands the implications of a poor diet and the numerous areas of personal health affected by smoking. Make sure everyone has proper access to healthcare. Strive to eliminate all the impoverished environments that contribute to the onset of and cause so many life-threatening diseases. All this comes before the regenerative potential of stem cells and the efficiency of innovative "Tools for all Trades and Manufactures."

Faith and Reason

Through book III of *Gulliver's Travels*, Swift also goes to great lengths to demonstrate the true relationship between faith and reason, which appears mutually exclusive on the surface. The Enlightenment, as the age of reason, experienced a philosophical paradigm shift from a God-centered existence, which provided the model for the centuries preceding it, to a human-based reality. The assumption that man retained the ability to perfect himself and the world around him helped catalyze this transition. In a society that embraced the human potential for mastery on every front, ideas and beliefs concerning the function and sphere of God must be altered. In fact, this revolution in cultural theology is another one of the distinguishing characteristics of the age. Whether in line with the optimistic views of humanity or as a response to the de-centering of the divine, the topic occupies a large portion of the debate found during the time. Pope's "An Essay on Man" serves as a clear example of a typical response to the issue. Moreover, changes in the perception of God posed a serious threat to many enlightenment thinkers. For example, George Berkeley, in his work "Three Dialogues between Hylas and Philonous," answered the threat by reasserting the endless dominion and omnipresence of God through his claim that to exist is to be present in His mind and perception.

The theological transformation was cast into the minds of the people by the new world of discoveries and explanations that scientific progress opened up. The work of the Royal Society and Isaac Newton provided understanding in areas that were previously mysterious and unexplained, and therefore accepted on faith as under divine control.

Referring to the Royal Society, Sherman writes, "in its first decades its members made enormous advances...producing (among innumerable innovations) new explanations of heat, cold, and light; an air pump capable of creating a vacuum; a newly efficient pocket watch; and a newly coherent and durable account of the universe" (Sherman 2040). In addition, Newton almost single handedly redefined the world. Through his work on the physics of motion, he gave an understanding to what could be attributed to nothing else but the visible manifestation of an invisible God, proving that motion, whose chief influence is gravity, is subject to mathematical rules and scientific laws on earth and in the cosmos that are within the grasp of man. He gave cause to reason that humans do possess the ability to master. Through the theological ideas of Newton, as well as his physics, the God of the enlightenment came to be seen as a clock maker. Newton was a deist. He held to the idea that God ordered the universe and took leave, allowing it to function according to the systems already in place. Metaphorically, he built and wound the clock and returns periodically to make adjustments, such as daylight savings time.

Concerning Newton, Pope writes, "Nature, and Nature's Laws lay hid in Night. / God said, Let Newton be! And All was Light" (Sherman 2626). Referring back to the moment of creation, Pope illustrates the extent to which Newton was responsible for the recreation of the world in terms that people could put their minds around. If one can understand the operating principles of the natural world, there is less room to see the world in terms of blind faith. Thus, the order of the universe becomes less of a belief and more of a study. In this sense, reason precludes faith. A nice literary example can be found in Defoe's *Robinson Crusoe*, which is a spiritual journey as well as an economic one. In his attempts to acquire provision, Crusoe attributes the sudden appearance of

corn on his island to a blessing from God. Once he discovers that it came from some useless scraps that had sprouted after he discarded them, his notion of God's providence is supplanted. The point here is that as explanations are provided and human's begin to demonstrate some control of the world through knowledge, God becomes de-centered and questions are raised as to His place in the realm of human perception. To this end, faith and science came to be seen as distinct. The assumption is that, by investing in the "enlightenment" science offers, one is able to transcend the uncertainty of simple faith. Faith is necessarily mysterious, and mystery did not sit well in the 18th century.

However, one of the things we have already seen from book III of *Gulliver's Travels* is the mysterious nature of the Balnibarian's scientific pursuits. The island's efforts include the development of new scientific academies. The quest for technology and understanding is so great "there is not a Town of any consequence in the Kingdom without such an Academy" (Swift 169). This can be seen as Swift's satirical response to the Royal Society. Much like the Balnibarians, many of the Royal Society's goals seem utterly ridiculous, for "even Charles II laughed out loud when he learned that the members were busy weighing air" (Sherman 2040). The Academies of Balnibari, too, were busy;

> The first man I saw was of a meagre aspect, with sooty hands and face, his hair and beard long, ragged and singed in several places. His clothes, shirt, and skin were all of the same colour. He had been eight years upon a project for extracting sun-beams out of cucumbers, which were to be put into vials hermetically sealed, and let out to warm the air in raw inclement summers. He told me, he did not doubt in eight years more, that he should be able to supply the Governors gardens with sunshine at a reasonable rate…I went into another chamber…His employment from his first coming into the Academy, was an operation to reduce human excrement to its original food, by separating the several parts, removing the tincture which it receives from the gall, making the odour exhale, and scumming off the saliva. He had a weekly allowance from the Society, of

> a vessel filled with human ordure, about the bigness of a Bristol barrel. (170-1)

The absurdity of it all is apparent. All these endeavors are obviously dead ends, weighing air, extracting sunlight from a cucumber, and reversing the digestion process. But, how is a new age of science supposed to now its limits, except through trial and error? Anyone living today would know these things are impossible, but an 18th century virtuoso had no clue.

It could be that Swift is satirizing the common sense of his contemporaries in the sciences. More likely however, he is demonstrating the extent to which faith is also invested in science and reason. The two are not as distant and incompatible as the enlightenment would like to tell us, and may in fact be inseparable. The Academies of Balnibari *believe* they are able to bring sunshine into the world by a new means and recycle their food for greater agricultural efficiency. They have put their faith and hope in both of these processes, as well as science and reason to guide their world.

With this in mind, the enlightenment can be seen as a period that placed its faith in reason. Through its knowledge and explorations, it acquired sound and coherent explanations. Coming to an understanding of the world, it deduced that reason, in the form of discovery, is greater than faith in a natural order because it reveals the ways of God to men, which consequently excluded Him from the working model of the universe by allowing no room for the traditional concept of faith. Though, if one grounds his beliefs on science, he is necessarily putting faith into that science. A clear example of this point is the way that staunch Darwinists often appear as religious minded as many of the most boisterous denominations. Where one formulates his convictions, there he puts

his faith. Swift suggests that the philosophy of the enlightenment ultimately concerns a reallocation of faith.

Hooke's *Micrographia* also serves to bolster this point. As well as a piece of literature, it also doubled as a form of institutional propaganda designed to promote the Royal Society's methods. Sherman writes, "some clergy men and politicians saw in the new enterprise a threat to religion and to social hierarchy, a challenge to past, present, and divine authority, mounted by persons so presumptuous as to suppose that the truths of the world could be determined by human investigation" (2040). The need for persuasion demonstrates that science cannot completely offer us freedom from the uncertainty that accompanies blind faith. Not knowing fully if science, or any particular scientific endeavor, can bring forth the light and understanding it promises shrouds any given pursuit in mystery, and invests it in faith.

One finds a similar level of persuasion that accompanies the embryonic stem cell debate. The recent push to expand research efforts can be seen as one of the most zealous attempts at advocacy on the part of the scientific community in quite some time. The National Institute of Health, for example, has a link to an index dedicated solely to stem cells at the top of its homepage. The design is to promote the "Royal Institute's" methods to the people. Within the index, there is an educational report, over fifty pages of which details the ways stem cells stand to benefit particular diseases, statements outlining its stance on the issue, and copies of lobbying efforts aimed at Capitol Hill. Even the controversial creators of South Park are getting in on the act, claiming on one episode that millions of people can be saved and our friend Kenny will die without a stem cell transplant.

The truth remains that stem cell research is still at a highly experimental stage and there are no guarantees of its efficacy. At its current state, scientists lack the ability to accurately control proliferation and direct differentiation *in vitro*. Furthermore, there are no easy solutions to matching the cells of the donor with those of the recipient. If researchers are able to gain these capabilities, patient trials, too, are uncharted territories. Without all the hype, there were similar hopes for fetal tissue cells several decades ago that never panned out. Scientists believed that cells derived from these tissues offered the potential for therapeutic transplantation as well. In reality, we are ultimately dealing with aspirations and promise.

With this in mind, the ideas of Swift offer some direction to the debate other than the polarizing pro-life like positions that offer no solution. As the reader has seen through the Academies of Balnibari and the element of persuasion associated with both stem cell research and the scientific pursuits of the enlightenment, reason does not exclude faith. In issues such as these, one seemingly has two options. He can choose to place his faith in the order of a Creator or creative process that Pope yields to, or faith in the enlightenment vision that knowledge and science will ultimately provide the progress we are seeking. In line with the ideas of Pope and the belief that stem cell research represents a boundary outside of the human sphere, science and technology must have certain limits for fear of violating the supreme reason that instilled the order we see around us and disrupting the natural course of life, no matter the potential. Included in the latter is the belief that man is not out of his realm as Pope asserts, but ultimately responsible for the direction of the world and good that will come from the future, similar to a figure like Hooke. Here, there are certain consequences associated with discovering

the potential of human triumph that fall within the natural course of perfecting the world. In short, the argument has two sides, the enlightenment hope or the forbidden realm.

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