Understanding Stem Cell Research

Controversy and Promise

Father Nicanor Austriaco, O.P.

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Understanding Stem Cell Research

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by

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Introduction

On August 9, 2001, one month before the 9/11 attacks on New York City and Washington, D.C., President George W. Bush addressed the nation on prime-time television to outline his administration's embryonic stem cell policy. In his speech, the President declared that the federal government would only fund research with embryonic stem cells that had been made prior to the date of his prime-time address to the nation. This policy specifically, and embryonic stem cell research more generally, has generated much moral and political controversy that continues to this day. The appearance in several state referendums of legislative proposals that seek either to fund or to prohibit human embryonic stem cell research has made the controversy over stem cells a debate that impacts the lives of everyday citizens.

What are embryonic stem cells, why are they so exciting and yet controversial, and what can be done to move our society beyond the current moral and political impasse? To provide answers to these questions, we will begin with a very basic introduction to the science behind stem cell research. We will then move to a description of the emerging field of regenerative medicine, the main reason why stem cell research has generated so much excitement in the scientific community. As we will see, the drive to develop stem cells for regenerative medicine has linked stem cell research with the controversy surrounding cloning technology. Finally, we will turn to the moral questions raised by human embryonic stem cell research: the immorality of both destructive human embryo research and human cloning, and the moral alternatives available to us as a society, which will allow us to realize the great medical promise of stem cells in a manner that respects the dignity of the human person.

What Are Stem Cells?

We begin with a basic introduction to the biology of cells in general and stem cells in particular. A typical adult human being – let us call him Jim – is made up of trillions of cells of different types. There are two hundred or so of these different cell types – bone cells, skin cells, muscle

cells and blood cells are only some of these types – each with its own unique shape and function. These specialized cells are called differentiated cells because they have different functions. In general, these specialized cells have two basic characteristics. First, they have a limited lifespan. In other words, in the laboratory, after dividing about fifty times or so, these differentiated cells grow old, stop dividing, and die. Second, when they divide, these specialized cells can only produce daughter cells of their own type. Thus, a skin cell can only produce other skin cells, while a muscle cell can only produce other muscle cells. Jim's body is made up of trillions of differentiated cells.

In addition to the numerous kinds of differentiated cells, however, Jim's body also has a different category of cells called stem cells. These cells are rare. In contrast to skin, muscle, and other differentiated cells, stem cells are relatively non-specialized, and therefore are called undifferentiated cells. Stem cells, too, have two basic characteristics. First, they are immortal. In the laboratory, stem cells will continue to divide and to grow as long as they are kept in a suitable environment and receive all necessary nutrients. Second, when they divide, stem cells can produce cells of different cell types. Thus, a stem cell could produce a skin cell or a muscle cell or a heart cell, depending on the particular environment in which it finds itself. Like the stem of a plant that can produce branches or leaves or flowers, a stem cell can generate a variety of different cell types.

In human beings, as in other animal species, there are two general classes of stem cells. Embryonic stem cells, or ES cells, are stem cells that are harvested from five-day-old human embryos, who are destroyed in the process. These ES cells are able to produce all of the two hundred or so cell types that are found in Jim's body, and are therefore called pluripotent stem cells. Adult stem cells, or AS cells, are stem cells that are found in different tissues in human beings at a later stage of development. Adult stem cells include stem cells taken from, among other tissues, bone marrow, fetal cord blood, fat and liver. They are able to produce many, but not all, of the two hundred or so cell types in the adult body, and are therefore called multipotent stem cells. There are scientific papers that

suggest that adult stem cells – especially stem cells from the bone marrow – may be pluripotent like embryonic stem cells, but these results remain controversial.[1]

Why Are Stem Cells Exciting?

Stem cell research has generated much excitement since human embryonic stem cells were discovered ten years ago at the University of Wisconsin-Madison. First, many scientists believe that stem cells are exciting because they will soon revolutionize medicine by catalyzing the emergence of the new field of regenerative medicine. Regenerative medicine will allow physicians to replace differentiated cells, which have been lost or damaged, with stem cells.[2] Second, scientists also believe that stem cells will be useful laboratory tools to better understand the origin and causes for many chronic and acute diseases. Both approaches could lead to cures that would alleviate the suffering of millions.

Many chronic and acute injuries that are common in the developed world involve the loss or death of a particular cell type in the patient. Chronic conditions include Parkinson's disease, a degenerative disease of the central nervous system that results from the loss of specialized nerve cells in the brain that secrete dopamine, and Juvenile, or Type I, Diabetes, a metabolic disease associated with the loss of specialized cells in the pancreas that secrete insulin into the blood. Acute conditions include spinal cord injury and heart attacks, which are debilitating because they lead to the death of cells in the spinal cord and in the heart.

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[1] For representative papers, see the following: D.S. Krause et al., "Multi-Organ, Multi-Lineage Engraftment by a Single Bone Marrow-Derived Stem Cell." *Cell* 105 (2001): 369-377; and A. Ianus et al., "In vivo derivation of glucose-competent pancreatic endocrine cells from bone marrow without evidence of cell fusion." *J Clin Invest*. 111 (2003): 843-850. For a review of the scientific literature, see M. Serafini and C.M. Verfaillie, "Pluripotency in Adult Stem Cells: State of the Art." *Semin Reprod Med*. 24 (2006): 379-388.

[2] For a comprehensive discussion of regenerative medicine, see R.L. Gardner, "Stem cells and regenerative medicine: principles, prospects and problems." *C R Biol*. 330 (2007): 465-473.

Proponents of regenerative medicine hope to treat these diseases, and others like them, by using stem cells to replace the lost or damaged cells. Take our friend, Jim. Let us say that Jim gets Parkinson's disease fifty years from now. Regenerative medicine would allow Jim's physician to use stem cells to cure him of this affliction. The physician would simply take stem cells and introduce them into Jim's nervous system. Since these cells have the ability to become cells of different types, the hope is that they would repair the diseased Parkinson's brain by becoming new, dopamine-producing nerve cells, thus replacing the specialized nerve cells that had been lost. The same would hold true for treating heart attacks. If Jim suffered a heart attack fifty years from now, regenerative medicine would allow his cardiologist simply to inject stem cells into his blood stream. The hope would be that these stem cells would migrate to, and regenerate, Jim's heart by becoming new heart cells – called cardiomyocytes – thus replacing the heart cells that were killed during the heart attack.

Finally, while regenerative medicine promises to lead directly to cures, scientists also believe that stem cells taken from patients with different diseases could themselves be used as research tools in the laboratory to better understand the origins and development of disease. Stem cells obtained from a patient with Amyotrophic Lateral Sclerosis, or Lou Gehrig's disease, for instance, could help scientists to comprehend the gradual deterioration of motor neurons that occurs during the course of this debilitating neuromuscular disease. In this way, disease-specific stem cells, used as research tools, could lead indirectly to cures for many illnesses. Not surprisingly, stem cell research is a promising source of hope for many patients.

Why Are Stem Cells Controversial?

At the outset, it is important to stress that not all stem cell research is controversial. A moral consensus exists which applauds and encourages the development of cell-replacement therapies that arise from human adult stem cell research. However, much moral and political debate surrounds human embryonic stem cell research because it is associated

with the destruction of human embryos and with the effort to clone human beings for therapy. Both scientific practices are gravely immoral because they attack and undermine the dignity of the human person.

Many people think that the Catholic Church is against all human stem cell research. This is inaccurate. The Catholic Church is opposed to any research that attacks and undermines the dignity of the human person, but would enthusiastically support all morally acceptable research that seeks to alleviate the suffering of the sick. Indeed, though the Church is opposed to destructive human embryo research, several dioceses, including all of the dioceses in South Korea and the Archdiocese of Sydney, have funded efforts to develop adult stem cell technology. Moreover, the Catholic Church would not be opposed to human embryonic stem cell research if these cells could be obtained without destroying human embryos.

Why Is Destructive Human Embryo Research Immoral?

The destruction of human embryos is immoral because it involves the killing of innocent human beings who have an intrinsic dignity and thus the same moral status as you and I. To affirm that a human being has dignity is to affirm that there is something worthwhile about each and every individual, and that certain things ought not to be done to any human being, while certain other things ought to be done for every human being.[3] For the believer, especially for the Catholic, human dignity is grounded in the truth that the human being is unique in all creation, for he is made in the image and likeness of God: "God created man in his image; in the divine image he created him; male and female he created them" (Genesis 1:27). The human being is the only creature on earth that God has chosen for its own sake.[4] He alone is called to share, by knowledge and by love, in God's own inner Trinitarian life. This transcendent and

[3] I am indebted to Michael J. Perry for this notion of human dignity, which I take with some modification from his book, *The Idea of Human Rights* (Oxford: Oxford University Press, 1993), p. 13.

[4] *Catechism of the Catholic Church*, no. 356

eternal destiny is the fundamental reason for the human being's dignity, a personal dignity that is independent of human society's recognition.[5] For the non-believer, human dignity is grounded in the truth that the human being is unique among all animal species in that he alone has autonomy and the ability to choose. Despite their differing perspectives, both believers and non-believers should be able to acknowledge that human beings have a dignity that has to be respected and protected.

From this account of the dignity of the human being, three conclusions necessarily follow that bear on the moral controversy surrounding destructive human embryo research. First, human dignity is intrinsic.[6] According to the *Oxford English Dictionary*, to call something *intrinsic* is to affirm that it is something "belonging to the thing in itself or by its very nature."[7] It is a quality that is inherent, essential, and proper to the thing. Thus, to affirm that human dignity is intrinsic is to claim that this dignity is constitutive of human identity itself, either because the human being is made in the image and likeness of God, or because the human being has autonomy. In other words, to affirm that human beings have intrinsic dignity is to claim that they are worthwhile because of the kind of things that they are. This type of dignity is not conferred or earned. It is a dignity that is simply recognized and is attributed to every human being regardless of any other considerations or claims. It is also a dignity that can only be possessed in an absolute sense – one either has it completely or one does not have it at all – since one is either a human being or not one at all. There is no such thing as partial human dignity, since there is no such thing as a partial human being.[8]

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[5] *Catechism of the Catholic Church*, no. 356.

[6] For a detailed discussion and defense of the intrinsic nature of human dignity especially within the context of a liberal society, see my essay N. Austriaco, "Debating embryonic dignity in a liberal society." *Stem Cell Rev.* 1 (2005): 305-308.

[7] *Oxford English Dictionary*, 2nd edition. (New York: Oxford University Press, 1989).

[8] This is the fundamental error behind arguments that assert that the moral status of the human being develops gradually. As one example, Michael J. Sandel has claimed that the moral status of the human embryo differs from the moral status of the human adult in the same way that the value of the acorn differs from the value of the oak tree. For discussion, see Michael J. Sandel, "Embryo Ethics: The Moral Logic of Stem Cell Research." *N Engl J Med* 351 (2004): 207-209; and the critique by Robert P. George and Patrick Lee, "Acorns and Embryos." *New Atlantis* No. 7, Fall 2004/Winter 2005, pp. 90-100.

Next, because human beings have dignity, human life is sacred. It is worthy of respect and has to be protected from all unjust attack. As the Servant of God, Pope John Paul II, clearly explained: "The inviolability of the person, which is a reflection of the absolute inviolability of God, finds its primary and fundamental expression in the *inviolability of human life*."[9] Human life is inviolable because it is a gift from God. He alone is the Lord of life from its beginning until its end. Thus, no one can, in any circumstance, claim for himself the right to destroy an innocent human being including, and especially, an embryonic human being. Sacred Scripture expresses this truth in the divine commandment: "You shall not kill" (Exodus 20:13; Deuteronomy 5:17).

Third, because of their dignity, human beings can never be treated as objects. As persons, they can never be treated purely as a means to an end. They cannot be used merely as tools to attain a goal, but have to be respected as free moral agents, capable of self-knowledge and self-determination in all the actions involving them. As Pope John Paul II forcefully declared: "…The human individual cannot be subordinated as a means to an end, or as an instrument of either the species or the society; he has value of his own. He is a person. By this intelligence and his will, he is capable of entering into relationship, of communion, of solidarity, of the gift of himself to others like himself."[10] We know this truth from our own experience. Individuals who discover that they have been manipulated or used often feel violated and diminished. They intuit that they are persons who have a dignity that is attacked when they are used merely as objects.

Proponents of destructive human embryo research often make two arguments in support of their moral position. The simplest argument is that human life does not begin at conception. Thus, it is argued that the

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[9] *Christifideles Laici: Post-Synodal Apostolic Exhortation of His Holiness John Paul II on the Vocation and the Mission of the Lay Faithful in the Church and in the World* (Vatican City: Liberia Editrice Vaticana, 1988), no. 38. Unless otherwise noted, all citations from the magisterial documents of the Catholic Church are taken from the official Vatican translations. See www.vatican.va.

[10] Pope John Paul II, "Message to the Pontifical Academy of Sciences: On Evolution," October 22, 1996, no. 5. See www.vatican.va.

destruction of a human embryo does not involve the destruction of a human being. Second, supporters of destructive embryo research may also argue that human embryos are not human persons because they cannot sense or think or feel or desire. Consequently, it is argued that human embryos do not have moral status, and thus cannot claim any rights, including the right to life. They conclude that only human persons have a right to life, and human embryos are not human persons.

To respond to the first argument, the most recent biological research has demonstrated that the origin of the individual human being can be traced back to the union of sperm and egg, the biological event called either conception or fertilization. There are two lines of evidence that support this fact.

First, from the moment of conception, the human embryo is a unique human organism, a unique human being. The human embryo is *unique* because fertilization brings together a unique combination of forty-six chromosomes in the embryo: twenty-three chromosomes come from the father, while twenty-three come from the mother. A distinctive combination of genes distinguishes the embryo from any other cell either in his mother or in his father. Next, the human embryo is *human* because his forty-six chromosomes is the defining genetic feature of the human species. Finally, the human embryo is an *organism* because his molecular organization gives him the active and intrinsic self-driven disposition to use his genetic information to develop himself into a mature human being, the telltale characteristic of a human organism. Therefore, as the Congregation for the Doctrine of Faith put it:

> From the time that the ovum is fertilized, a life is begun which is neither that of the father nor of the mother, it is rather the life of a new human being with his own growth. It would never be made human if it were not human already. …[M]odern genetic science brings valuable confirmation [to this]. It has demonstrated that, from the first instant, there is established the program of what this living being will be: a man, this individual man with his characteristic aspects already well determined. Right from

fertilization is begun the adventure of a human life, and each of its capacities requires time – a rather lengthy time – to find its place and to be in a position to act.[11]

Thus, it is incorrect to say that the human embryo is a potential human being. Rather, it is a human being with great potential.

Second, from the moment of conception, the zygote is an *individual* human organism. Biologically, individuality is defined by the presence of body axes, the coordinate system that tells the body where is up and down, left and right, front and back. All multicellular organisms have at least one of these axes. Most have all three. Body axes are significant because they establish the blueprint for the organism's body plan and manifest the intrinsic biological organization that makes an organism an integrated whole. Significantly, recent experimental work from two independent laboratories in the United Kingdom has demonstrated that the embryonic axes, though not rigidly determined, are already present in the one-celled mammalian zygote.[12] Finally, one of these research groups has also shown that the axes of the single-celled embryo establish the axes of later stages of embryonic development, including the fetus, suggesting that an organismal continuity exists between the one-cell embryo, the fetus, and therefore, the newborn. Human life begins at conception.

But what about twinning? For many, the line of argument most threatening to the position which accords the early human embryo the moral status of a human being from the moment of fertilization is the proposal that scientists have shown that the early embryo is not an individual. To put this argument another way: If one sign of the individuality of an adult human being is that he or she cannot be split into twins, then an early human embryo cannot be a individual since it can give rise to twins. Thus, the argument continues, individuality only arises with

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[11] *Declaration on Procured Abortion*, November 18, 1974, nos. 12-13.

[12] For a review of the scientific literature, see M. Zernicka-Goetz, "The first cell-fate decisions in the mouse embryo: destiny is a matter of both chance and choice." *Curr Opin Genet Dev* 16 (2006): 406-412. For discussion, see my essay, N. Austriaco, "The Pre-implantation Embryo Revisited: Two-celled Individual or Two Individual Cells?" *Linacre Quarterly* 70 (2003): 121-126.

the appearance of the primitive streak, when the human embryo no longer has the potential for twinning. This conclusion has been widely used in support of proposals that would lead to the destruction of early human embryos, since the lack of individuality would suggest that no single entity – no single human being – is present who would merit moral status.

As we discussed above, however, recent work on the appearance of organization and of body axes within mammalian embryos provides compelling evidence that the embryo, even during its earliest stages of development, is an integral whole. Moreover, note that twinning does not necessarily preclude individuality. For instance, take the planarian, a flatworm found in many freshwater lakes throughout the world. It can be divided into nearly three hundred pieces, including brain, tail, and gut fragments, each of which has the potential to regenerate a complete organism, and yet no one would doubt the individuality of the original, intact invertebrate.[13] In the same way, the early human embryo, though already an individual, manifests a developmental flexibility, what scientists call a developmental plasticity, which allows each of its cells to give rise to an intact organism if the embryo is disrupted. This, however, would interrupt the normal developmental process of the human being. Not surprisingly, therefore, it is significant that twinning is associated with an increased incidence of birth defects in humans.[14] This is just another reminder that twinning is the exception and not the rule in human development.

To respond to the second argument – the argument that human embryos can be destroyed because they are not human persons with the same moral status as you and I – we should point out that the fundamental mistake of this non-personhood argument is that it embraces a flawed dualistic anthropology. It embraces a false understanding of the human being. Numerous scholars have convincingly shown that the non-

[13] For details, see the scientific review by A. Sanchez Alvarado, "Planarian regeneration: its end is its beginning," *Cell* 124 (2006): 241-245.

[14] For details and citations to the scientific literature, see the review, J.G. Hall, "Twinning," *Lancet* 362 (2003): 735-743.

personhood argument inevitably leads either to substance dualism or to the rejection of the embodied experience of human persons.[15] In other words, it forgets that human persons are not just minds. We are embodied beings. Thus, our personhood and our bodies are inseparable. Consider our commonsense experience. When we are sick, we do not say, "My body is sick." We say, "*I* am sick." When someone hits us, we do not say, "Don't hit my body." Instead we say, "Don't hit *me*!" Our identity, our personhood, has a bodily dimension. Thus, a proper understanding of personhood has to appreciate that *wherever* our bodies are, there we are. More important for our purposes, however, a proper understanding of personhood would acknowledge that *whenever* our bodies were, there we were as well. As we discussed above, if there is anything that developmental biology has shown us over the last few decades, it is that our bodies have their origins at fertilization. Thus, a human embryo is a person because he is the same embodied being, the same person, as he will be when he is an adult.

Finally, it is important to recognize that the non-personhood argument rests upon a revisionist understanding of the concept of personhood. Commonly understood, calling someone a person tells you something about what *kind* of being he or she is. It is just like calling someone a mammal. Recall that a mammal is an animal that can lactate and bear live young. Now a human embryo cannot lactate or bear live young. Thus, if we follow the logic of the non-personhood argument, then we would have to say that the human embryo is not a mammal. In fact, to be consistent, we would also have to say that an *adult* human male is not a mammal because he certainly cannot lactate or bear live young. But adult human males are mammals! As a human male, a man is a mammal not because he, as an individual, can lactate or bear live young, but because he belongs to a class of animals, some of which can lactate and

[15] For example, see both Germain Grisez, "When Do People Begin?" *Proceedings of the American Catholic Philosophical Association* 63 (1989): 27-47; and Helen Watt, "The Origin of Persons," in *The Identity and Status of the Human Embryo*, Ed. Juan de Dios Vial Correa and Elio Sgreccia (Vatican City: Libereria Editrice Vaticana, 1999), pp. 343-364.

bear live young. In the same way, an adult human male is a person not because he can think or feel or desire right now, but because he belongs to a class of animals, a species of animal, which, by nature, is able to think and feel. Thus, the human embryo is a mammal and a person, not because it can lactate or bear live young or feel or think, but because it is a kind of being, a human being which has a nature that includes the capacities to do these things.

Why is Cloning for Therapy Immoral?

Human embryonic stem cell research is also controversial because it is associated with cloning technology. To understand this link, recall that advocates of regenerative medicine want to use stem cells to cure diseases in different patients. However, this therapeutic approach faces one major obstacle – if physicians inject my stem cells, your stem cells, or stem cells taken from any other person into Jim, they would be rejected and destroyed by Jim's body because his immune system would recognize the injected stem cells as foreign, as "other." For regenerative medicine to work, therefore, Jim would have to be injected with stem cells that would not be rejected by his own immune system. Consequently, proponents of human ES cell research assert that patients like Jim need to be cloned in order to obtain genetically identical, and thus immunologically safe, embryonic stem cells for regenerative medicine.

How does cloning for therapy, more commonly known as therapeutic cloning, work? First demonstrated with the creation of Dolly the sheep, cloning technology, also known as somatic cell nuclear transfer (SCNT), is relatively straightforward. To clone Jim, we would begin by using a Q-tip to isolate one of his cheek cells. We would also need a human egg, which are available for sale on the Internet for approximately US $10,000. (Eggs from women who graduated from an Ivy League university are more expensive.) Every cell, including Jim's cheek cell and the human egg cell, has two basic parts. The *nucleus* of every cell contains its DNA, or its blueprint. It is comparable to the hard drive of a computer. It tells the cell what to do. The rest of the cell is called its *cytoplasm*. It is

comparable to the rest of the computer. It allows the cell to use the blueprint in its nucleus in order to function and develop. To clone Jim, the scientist would remove the nucleus of the egg and replace it with the nucleus of Jim's cheek cell. He would then pulse the resulting cell – the cell constituted by Jim's cheek cell's nucleus and the egg's cytoplasm – with an electric charge. For reasons we still do not fully understand, this electric jolt tricks the manipulated egg cell into thinking that it has been fertilized. It therefore becomes a cloned human embryo which begins human development. If implanted into a woman's womb, this cloned embryo would continue to mature. Nine months later, a baby would be born who would be genetically identical to Jim. Jim Jr. would be Jim's identical twin brother because both would share the same DNA, the same blueprint, which governs their biological development. For the purposes of cloning for therapy, however, the cloned embryo would not be allowed to develop for more than a few days. It would be taken into a laboratory and destroyed to harvest embryonic stem cells. These embryonic stem cells would be genetically identical to Jim's other cells, and could therefore be used for regenerative medicine. They would not be rejected by Jim's body.

Cloning for therapy is immoral because it involves the destruction of human embryos. As we discussed above, the human embryo has the same intrinsic dignity and moral status as you and I, and as such, cannot be killed or sacrificed in the name of medical progress. As our Pope, Benedict XVI, declared in an address to South Korea's new ambassador to the Holy See on October 11, 2007: "[T]he destruction of human embryos, whether to acquire stem cells or for any other purpose, contradicts the purported intent of researchers, legislators, and public health officials to promote human welfare."[16] Cloning for therapy, like all other forms of cloning, is also immoral because it reduces the human being to an object who is manufactured in order to be destroyed. It fails to acknowledge that the human being is a person who, by his very exalted nature, should be

[16] "Address to the New Ambassador to the Holy See: Republic of Korea," *L'Osservatore Romano* 43 (October 24, 2007): 4.

begotten in order to be loved. Finally, cloning leads to the radical exploitation of women, especially those women struggling with poverty, who are reduced to egg making factories.

But what about using so-called "spare" embryos for human embryonic stem cell research? One study has shown that there are approximately 400,000 human embryos that are being stored in infertility clinics in the United States.[17] These embryos were created in the laboratory, using in vitro fertilization (IVF), for couples trying to have a child. Many of these IVF embryos, however, are no longer needed by their parents and are destined for eventual destruction. Proponents of human embryonic stem cell research argue that these so-called "spare" embryos should be made available for research, since they are eventually going to be discarded: Why not use them to help others since they are going to die anyway?

To see the weakness of this argument, notice how the same argument could be used to justify actions that are unquestionably immoral. The Pediatric Inpatient Unit at Memorial Sloan Kettering Cancer Center in New York City cares for many young children who are struggling with cancer. Unfortunately, many of them will not be cured and will eventually die. Does their eventual death justify killing them to help the lives of other children? It does not. Like embryos who are destined to die, children with terminal cancer, even if they, too, are destined to die, cannot be killed in order to save others. Every human being, including human embryos and human children, has a dignity and moral status that must be respected and protected.[18]

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[17] D.I. Hoffman et al., "Cryopreserved Embryos in the United States and Their Availability for Research." *Fertility and Sterility* 79 (5): 1063-1069.

[18] What then are we to do with these so-called "spare" IVF embryos? Catholic moral theologians agree that one option is to simply allow them to die in the same way that we allow terminally-ill children to die. Others suggest that these embryonic human beings could be adopted by couples who would raise them to maturity. However, there is no moral consensus among Catholic bioethicists surrounding this "embryo-adoption" option. For discussion, see Thomas V. Berg, L.C., and Edward J. Furton, *Human Embryo Adoption: Biotechnology, Marriage, and the Right to Life*. (Philadelphia: National Catholic Bioethics Center, 2006).

Are There Moral Alternatives to Destructive Human Embryo Research?

Proponents of human embryonic stem cell research often accuse their opponents of being anti-patient. This is not true. Adult stem cell research remains one morally acceptable, pro-patient alternative to the destruction of human embryos which is associated with human embryonic stem cell research. In fact, a quick search on clinicaltrials.gov, the website that tracks all clinical trials currently being undertaken in the United States, will reveal that adult stem cells are already being used to treat human disease. As one example, at the Texas Heart Institute at St. Luke's Episcopal Hospital in Houston, TX (www.texasheart.org), patient-specific adult stem cells are already being tested on patients who have suffered heart attacks, to see if they will help restore the structure and function of the damaged heart. In contrast, there are no ongoing clinical trials for therapies based on human embryonic stem cells. In light of this, it is reasonable to argue that pro-patient advocates should invest limited research funds into developing adult stem cell research that is already reaping benefits at the bedside, rather than in embryonic stem cell work that has yet to bear fruit.

Furthermore, there are several alternatives that may allow scientists to obtain pluripotent stem cells without destroying human embryos. Here we will summarize and consider four proposals for alternative sources of human pluripotent stem cells that were described by the President's Council on Bioethics.[19]

According to the first proposal, human pluripotent stem cells could be harvested from early IVF embryos that have already died, as evidenced by the irreversible cessation of cell division. Some of these dead embryos could, however, contain individual cells that are still alive, cells that could be used to obtain pluripotent stem cells. This approach would be

[19] The President's Council on Bioethics, *White Paper: Alternative Sources of Pluripotent Stem Cells* (Washington, D.C.: The President's Council on Bioethics, 2005). Available at www.bioethics.gov/reports/white_paper/index.html.

comparable to organ donation from adult individuals who have died. In this case, the dead embryo would donate his cells to science for the benefit of others.

This first proposal has generated much debate among ethicists and moral theologians. It is based on an attractively simple ethical idea: It should be permissible to obtain cells from embryos that have died, as long as their deaths have not been caused or hastened for that purpose. However, several ethicists have argued that it is hard to know when an early human embryo is truly dead. Others are worried that we could not know if removing the individual living cell from the dead embryo would allow it to become an embryo in its own right. If so, then we would have returned to our original objections to destructive human embryo research. Finally, and this is of particular concern for the Catholic, this proposal may necessitate cooperating with the immoral practices of infertility clinics that use IVF techniques to create human embryos in the laboratory.

According to the second proposal, human pluripotent stem cells could be obtained from individual cells obtained by biopsy of an early human embryo. For this proposal to work, scientists would have to find a stage in early embryonic development where the removal of one, or a few, cells by biopsy would neither harm the embryo nor destroy the capacity of these collected cells to be used as a source of pluripotent stem cells. Preliminary studies have shown that pluripotent stem cells can be derived from individual cells taken from human embryos, but in these experiments, all of the cells in the embryos were used for the tests, thereby destroying the embryo.

Like the first proposal, this second proposal has generated much debate among ethicists and moral theologians. Several ethicists have argued that we could never justify exposing the human embryo to the harm intrinsic to experimental manipulation, no matter how small, when such technical intervention would have no direct benefit to the embryo himself. Using human beings for purposes of no benefit to them, and without their knowing consent, would be an act of injustice. Moreover, a similar concern exists as the one described above for the first proposal: We

could never know if taking the individual cell from the embryo would allow it to become an embryo on its own right. Once again, this would raise the original objections to destructive human embryo research.

According to the third proposal, variants of which include either altered nuclear transfer (ANT) or altered nuclear transfer – oocyte assisted reprogramming (ANT-OAR), pluripotent human stem cells could be obtained from non-embryonic biological artifacts created by using genetic tricks to manipulate eggs and cells. Experiments with mice suggest that this approach does lead to the production of pluripotent mouse stem cells.

This third proposal has generated much heated debate, especially among Catholic ethicists and moral theologians.[20] Critics are concerned that this proposal would lead to the creation of disabled embryos that would be killed by scientists, rather than to the creation of non-embryos that could be legitimate sources of pluripotent stem cells. They raise a critical question: What criteria should be used to distinguish bona fide embryos from non-embryos? Though advocates of this proposal have proposed such criteria, and have argued that they can be used to provide moral guidance for ANT or for ANT-OAR, these proposals remain controversial. Furthermore, there is the added concern that procuring the large numbers of human eggs needed to accomplish this proposal could lead to the commercialization of human reproductive tissue and the exploitation of women, especially poor women, in the developing world.

Finally, according to the fourth proposal, pluripotent human stem cells could be obtained from reprogrammed differentiated cells taken from adult human beings. This proposal is the most exciting of the four proposals described by the President's Council on Bioethics, especially since a moral consensus exists for its liceity. To date, it is also the proposal that has attained the most scientific success: On November 20, 2007, two

[20] For a summary and commentary on the ANT debate among Catholic ethicists and moral theologians, see J. Thomas Petri, O.P., "Altered Nuclear Transfer, Gift, and Mystery: An Aristotelian-Thomistic Response to David L. Schindler." *National Catholic Bioethics Quarterly* 7 (2007): 729-747.

research teams, one in Japan and the other in the United States, independently reported that they had successfully reprogrammed adult human cells into pluripotent stem cells called induced pluripotent stem (iPS) cells, which were indistinguishable from pluripotent stem cells taken from human embryos.[21] The scientists took the differentiated human cells and were able to reprogram them into non-differentiated stem cells simply by introducing four genes into their nucleus. Two weeks later, a team from M.I.T. used the technique to cure sickle-cell anemia in mice, providing proof-of-principle that this nuclear reprogramming (iPS) technology could be used for regenerative medicine.[22] Though the iPS technique needs to be developed before it can be used to treat human patients – at the moment, the technique could predispose recipients of the reprogrammed cells to cancer – numerous commentators agree that it will soon lead to the end of the stem cell wars. It is not surprising that Ian Wilmut, the creator of Dolly the sheep, has recently announced that he and his laboratory have abandoned their plans to pursue cloning technology to obtain patient-specific embryonic stem cells. Instead, his team has decided to focus all their efforts into perfecting the nuclear reprogramming (iPS) approach.

Conclusion

Scientists pursuing destructive human embryo research are often left confused and befuddled by public opposition to their work. In their eyes, they are striving to alleviate the suffering of millions of patients who have placed their hope in the promise of regenerative medicine. How could this not be a laudable goal? It will be important for their opponents to convince them that both sides of the stem cell debate share the common goals of advancing scientific progress and healing the sick. This is not controversial. Rather, the debate over the liceity of destructive human

[21] K. Takahashi et al., "Induction of Pluripotent Stem Cells from Adult Human Fibroblasts by Defined Factors." *Cell* 131 (2007): 861-872; and J. Yu et al., "Induced Pluripotent Stem Cell Lines Derived from Human Somatic Cells." *Science* 318 (2007): 1917-1920.

[22] J. Hanna et al., "Treatment of Sickle Cell Anemia Mouse Model with iPS Cells Generated from Autologous Skin." *Science* 318 (2007): 1920-1923.

embryo research is fundamentally a *philosophical* disagreement – and not a religious disagreement as many commentators have assumed – over the nature of the human embryo and its legal and moral status. More fundamentally, it is a debate over the nature of human dignity: What, if anything, makes us special? What, if anything, is the ground for the claim that you and I can never be killed, even if our deaths would benefit others? These are questions that every citizen – including every scientist – needs to answer and to answer correctly.

Update: President Barack Obama and Stem Cell Research

On March 9, 2009, several weeks after his inauguration, President Barack Obama signed Executive Order 13505 that not only overturned his predecessor's funding restrictions for embryonic stem cell research, but also rescinded the Bush initiative – Executive Order 13435 of June 20, 2007 – that had explicitly mandated federal funding for alternative methods of stem cell research that would avoid the destruction of human embryos. The President's executive order was not only immoral but also scientifically unnecessary.

First, as we discussed above, every human being has an inherent or intrinsic dignity. Because of this intrinsic dignity, the life of a human being is sacred. It is worthy of respect and has to be protected from all unjust attack, including those attacks that come from scientists who want to destroy the human embryo to harvest his stem cells. President Obama's executive order encourages such attacks by funding research using new embryonic stem cell lines derived from the destruction of human embryos, and is therefore gravely immoral.

Next, the discovery and development of induced pluripotent stem cell (iPS) technology, the process that reprograms adult cells into pluripotent stem cells, allows scientists to find cures and study diseases in a more efficient and less controversial manner than ES cell research. Ironically, the Jaenisch Laboratory at M.I.T. reported – *just one week before President Obama signed his executive order!* – that they had invented a virus-free, and thus safer, way to create patient-specific iPS cells that brings this technology one

step closer to human clinical trials.[1] A few months later, another lab showed that they could reprogram human nerve-like cells into iPS cells using a single gene called *OCT4*.[2] The original Yamanaka iPS protocol had required four genes. Finally, a more recent study from Spain showed that scientists can now combine gene therapy and iPS technology to generate disease-free cells that could be used to cure patients with Fanconi anemia, a rare genetic disease that affects 1 in 350,000 children.[3] The same approach may be used to correct other diseases with gene therapy. President Obama claimed that his directive would promote embryonic stem cell research and retire words like "terminal" and "incurable" from our vocabulary by providing cures for life-threatening diseases. However, as these recent papers demonstrate – and there are many others – induced pluripotent stem (iPS) cell research has the same, if not more, therapeutic potential than ES cell research, without the moral controversy. Scientifically, the Obama executive order was and remains unnecessary.

Finally, it is likely that iPS technology and other moral avenues of research like it – research that President Obama's order now implicitly discourages – would not have been pursued if all available federal funds had been channeled into destructive embryo research. Prof. Shinya Yamanaka, who discovered iPS cells, has admitted that he had pursued this novel and groundbreaking line of research because he wanted to avoid destroying the human embryos that reminded him of his daughters![4] Thus, in cultivating and funding alternative stem cell methods to create patient-specific stem cells that can now be tested in human clinical trials, President Bush's stem cell policies were in fact pro-science and pro-patient. In the end, President Obama claimed that his own stem cell executive order was amoral and scientifically necessary. It was neither.

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[1] F. Soldner et al., "Parkinson's disease patient-derived induced pluripotent stem cells free of viral reprogramming factors," *Cell* 136 (2009): 964-977.

[2] J.B. Kim et al., "Direct reprogramming of human neural stem cells by OCT4," *Nature* 461 (2009): 649-653.

[3] A. Raya et al., "A protocol describing the genetic correction of somatic human cells and subsequent generation of iPS cells," *Nat Protoco*. 5 (2010): 647-660.

[4] Martin Fackler, "Shinya Yamanaka: Risk Taking is in His Genes," *The New York Times*, December 11, 2007

Adult Stem (AS) Cell: A *stem cell* obtained from different adult tissues, including bone marrow, fat and liver. Stem cells obtained from fetal cord blood and amniotic fluid are also considered adult stem cells. Adult stem cells are *multipotent*, though there is some evidence that suggests that some of them are *pluripotent*.

Altered Nuclear Transfer (ANT) and Altered Nuclear Transfer Oocyte Assisted Reprogramming (ANT-OAR): Two variants of a proposal to obtain pluripotent stem cells from embryo-like entities created using genetic tricks to manipulate eggs and adult cells.

Body Axes: The biological coordinate system that establishes up and down, left and right, and front and back, in the body. There is scientific evidence that suggests that these axes are established at fertilization.

Cloning: The production of identical copies of genes, cells, or organisms. One form of organismal cloning involves *somatic cell nuclear transfer*.

Cytoplasm: The part of a cell other than its *nucleus*. It allows the cell to use the genetic blueprint in its nucleus in order to function and to develop.

Developmental Plasticity: Biological property of cells and of organisms that are able to change their identity when external conditions change. The cells of the flatworm are developmentally plastic. They can change their identity during the process of worm regeneration.

Differentiated Cell: A cell with a specialized function. Examples include bone cells, skin cells, muscle cells, and blood cells. Differentiated cells are not immortal – they die after a limited number of cell divisions – and are only able to produce daughter cells of the same specialized type.

Dualism or Dualistic Anthropology: An erroneous understanding of the human person that presupposes that there is a difference between the human being and the human *person*. Dualism is flawed because it denies the integral and embodied nature of human personhood.

Embryo: An organism at its earliest stage of development. A human being is an embryo for the first eight weeks after conception.

Embryonic Stem (ES) Cell: A *pluripotent stem cell* obtained from a five-day old embryo who is destroyed in the process.

Human Dignity: The intrinsic and inestimable worth of the human being, who is made in the image and likeness of God. To affirm that a human being has dignity is to affirm that there is something worthwhile about each and every human being, such that certain things ought not to be done to any human being and that certain other things ought to be done for every human being.

Induced Pluripotent Stem (iPS) Cell: A *pluripotent stem cell* that is created by reprogramming *differentiated* adult stem cells so that they are virtually indistinguishable from *embryonic stem cells*.

In Vitro Fertilization (IVF): The technical procedure of bringing together human sperm and human eggs in the laboratory to create a human embryo.

IVF Embryo: A human embryo that is created in the laboratory using *in vitro fertilization* to fulfill the reproductive needs of infertile couples. Over 400,000 IVF embryos are currently being stored in cryogenic tanks in IVF clinics in the United States.

Multipotent Stem Cell: A *stem cell* that is able to produce many, but not all, of the different specialized cell types in the mature human being.

Nucleus: The part of a cell that contains DNA, its genetic blueprint. The nucleus is the control center of the cell.

Organism: A living thing, like a plant or an animal. More precisely, an organism can be defined philosophically as a complete living substance that has its own internal principle of motion and change directed towards its natural perfection, and scientifically, as a discrete unit of living matter that follows a self-driven, robust developmental pathway that manifests its species-specific self-organization.

Person: A being with a rational nature. As such, a person is able to think, to choose, to feel, and to desire.

Pluripotent Stem Cell: A *stem cell* that is able to produce most, if not all, of the two hundred or so different specialized cell types in the mature human being.

Regenerative Medicine: An emerging field of medicine that is working to use *stem cells* to treat and to cure debilitating diseases or conditions by replacing damaged or lost cells.

Somatic Cell Nuclear Transfer (SCNT) or Nuclear Transfer: A process of *cloning* where the *nucleus* of a *differentiated* adult cell – for example, a skin cell – is inserted into an egg that has had its own nucleus removed. This egg, which now contains the nucleus and therefore the genetic material of the adult cell, is then stimulated to become a cloned embryo.

Stem Cell: A relatively unspecialized cell that is immortal and is able to produce daughter cells of different specialized cell types.

Therapeautic Cloning: One form of human cloning to obtain pluripotent embryonic stem cells for *regenerative medicine*.

Twinning: The process that splits an embryo into two, generating individuals with the same genetic blueprint. In humans, embryo splitting generates identical twins. In contrast, fraternal twins are individuals that develop from separate embryos conceived at the same time.

Undifferentiated Cell: A cell without a specialized function. *Stem cells* are undifferentiated cells.

Zygote: A single-celled embryo.

For Further Reading

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