

STEM CELL RESEARCH AND CLONING

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Certain misconceptions surrounding stem cell research and cloning have come to be routinely presented in the mass media. These are the ten great media myths in the debate over stem cell research:

Myth 1: Stem cells can come only from embryos.

In fact, stem cells can be taken from umbilical cords, the placenta, amniotic fluid, adult tissues and organs such as bone marrow, fat obtained by liposuction, and regions of the nose, and they can be taken from cadavers up to twenty hours after death.

Myth 2: The Catholic Church is against stem cell research.

There are four categories of stem cells: embryonic stem cells, embryonic germ cells, umbilical cord stem cells, and adult stem cells. Given that germ cells can come from miscarriages that involve no deliberate interruption of pregnancy,

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the Church really opposes the use of only one of these four categories, i.e., embryonic stem cells. In other words, the Catholic Church approves three of the four possible types of stem cell research.

Myth 3: Embryonic stem cell research has the greatest promise.

Up to now, no human being has ever been cured of a disease by the use of embryonic stem cells. Adult stem cells, on the other hand, have already cured thousands. An example is the use of bone marrow cells from the hip bone to repair scar tissue on the heart after a heart attack. Research using adult cells is twenty to thirty years ahead of research using embryonic stem cells, and holds greater promise. This is in part because stem cells are part of the natural repair mechanisms of an adult body, whereas embryonic stem cells do not belong in an adult body, where they are likely to form tumors and to be rejected as foreign tissue by the recipient. Embryonic stem cells really belong only in the specialized microenvironment of a rapidly growing embryo, which is a radically different setting from an adult body.

Myth 4: Embryonic stem cell research is against the law.

In reality, there is no federal law or regulation against destroying human embryos for research purposes. Although President Bush has banned the use of federal funding to support research on embryonic stem cell lines created after August 2001, such research is not illegal. Anyone using private funds is free to pursue it.

Myth 5: President Bush created new restrictions on federal funding of embryonic stem cell research.

The 1996 Dickey Amendment prohibited the use of federal funds for research that would involve the destruction of human embryos. Bush's decision to permit research on embryonic stem cell lines created before a certain date thus relaxed this restriction from the Clinton era.

Myth 6: Therapeutic cloning and reproductive cloning are fundamentally different from one another.

The creation of cloned embryos either to make a baby or to harvest cells occurs by the same series of technical steps. The only difference is what will be done with the cloned human embryo that is produced: Will it be given the protection of a woman's womb in order to be born, or will it be destroyed for its stem cells?

Myth 7: Somatic cell nuclear transfer is different from cloning.

In fact, somatic cell nuclear transfer is simply cloning by a different name. The end result is still a cloned embryo.

Myth 8: By doing somatic cell nuclear transfer, we can directly produce tissues or organs without having to clone an embryo.

At the present stage of research, scientists are unable to bypass the creation of an embryo in the production of tissues or organs. In the future, it may be possible to inject elements from the cytoplasm of a woman's ovum into a somatic cell (a nonreproductive cell, or body cell) to "reprogram" it into a stem cell. This is called "dedifferentiation." If so, there would be no moral objection to this approach to getting stem cells.

Myth 9: Every body cell, or somatic cell, is somehow an embryo and thus a human life.

People sometimes argue: "Every cell in the body has the potential to become an embryo. Does that mean that every time we wash our hands and are shedding thousands of cells, we are killing life?" The problem is that this overlooks the basic biological difference between a regular body cell and a cell whose nuclear material has been fused with an unfertilized egg cell, resulting in an embryo. A normal skin cell will give rise to more skin cells only when it divides, whereas an embryo will give rise to the entire adult organism. Skin cells are not potential adults. Skin cells are potentially only more skin cells. Only embryos are potential adults.

Myth 10: Because frozen embryos may one day end up being discarded by somebody, that makes it morally allowable, even laudable, to violate and destroy those embryos.

The moral analysis of what we may permissibly do with embryos does not depend on their otherwise "going to waste." In other words, the fact that somebody may commit an evil act (throwing away human embryos) does not permit us to jump ahead in line and do the evil act (destroying the embryo for its stem cells) first ourselves.

Common Questions

The following questions are frequently asked about stem cell research:

What are stem cells and why are they important?

A stem cell is essentially a nonspecialized or "blank" cell, which is capable of becoming another, more differentiated cell

type in the body, such as a muscle cell, nerve cell, or skin cell. Stem cells can be used to replace or heal damaged tissues and cells in the body.

Where do embryonic-type stem cells come from?

Embryonic-type stem cells basically come from two sources: embryos and fetuses:

- *Embryonic stem cells* are extracted from living embryos that are three to five days old. The removal of embryonic stem cells invariably results in the destruction of the embryo.
- *Embryonic germ cells*, another kind of stem cell, can be obtained from aborted or miscarried fetuses.

Where do adult-type stem cells come from?

Adult-type stem cells come from three sources:

- *Umbilical cords, placentas, and amniotic fluid.* Adult-type stem cells can be derived from various pregnancy-related tissues.
- *Adult tissues.* In adults, stem cells are present in various tissues and organ systems. These include the bone marrow, liver, epidermis, retina, skeletal muscle, intestine, brain, and dental pulp. Even fat obtained by liposuction has been shown to contain significant numbers of adult-type stem cells.
- *Cadavers.* Neural stem cells have been removed from specific areas in postmortem human brains as late as twenty hours following death.

Which sources of stem cells are always morally objectionable?

The only intrinsically objectionable source for harvesting stem cells is the human embryo. This is because it is necessary to destroy the early embryo (sometimes referred to as a blastocyst) in order to procure the embryonic stem cells. On the other hand, there is no moral objection to using stem cells obtained from a fetus if the fetus died of natural causes (miscarriage) and the parents gave consent to use their child's stem cells. This would be analogous to an organ donation from their deceased child. It is not morally permissible to harvest stem cells from a fetus that was killed in an induced abortion.

In other words, of the five tissue sources listed previously (i.e., the two embryonic sources and the three adult sources), it can be permissible to make use of four of them to obtain stem cells. The Church therefore vigorously supports

and encourages most types of stem cell research. Only stem cell research that depends on the direct killing of another human being is morally excluded.

To summarize:

- Research involving *embryonic stem cells* is *always morally objectionable*, because the human embryo must be destroyed in order to extract its stem cells.
- Research involving *embryonic germ cells* is morally objectionable when it uses fetal tissue derived from elective abortions, but it is morally acceptable when it uses material from spontaneous abortions (miscarriages) if the parents have given informed consent.
- Research involving *umbilical cord stem cells* is morally acceptable, since the umbilical cord is no longer required after delivery has been completed.
- Research involving *placentally derived stem cells* is morally acceptable, since the afterbirth is no longer required after delivery has been completed.
- Research involving *adult stem cells* is morally acceptable, if the adult donor has given informed consent.

Why are adult stem cells preferable to embryonic stem cells?

Adult stem cells are a “natural” solution. They naturally exist in our bodies, and they provide a natural repair mechanism for many tissues of our bodies. They belong in the microenvironment of an adult body, whereas embryonic stem cells belong in the microenvironment of the early embryo, not in an adult body. In an adult body, embryonic stem cells tend to cause tumors and immune-system reactions.

Adult stem cell research has been going on for decades, and many therapies in humans (such as bone marrow transplants) have been successfully developed using adult stem cells. In contrast, embryonic stem cell research in humans is a relatively new field; the first human embryonic stem cell lines were developed only in 1998. Thus, *adult stem cells have already been successfully used in human therapies for many years. As of the date of this publication, NO therapy in humans has ever been successfully carried out using embryonic stem cells.*

This point is an important one: Thousands of people have been cured of diseases using adult stem cells, but none has ever been cured using stem cells from embryos.

Why do many patient advocacy groups push so strongly for embryonic stem cell research if all the cures are coming from adult stem cells?

The bottom line is that promoters of embryonic stem cell research have sold a bill of goods to many of these patient advocacy groups. They have promised a cure for every ailment, as well as the betterment of mankind.

The trouble is that patients with debilitating diseases are a vulnerable group, and some will latch onto even the flimsiest hopes and most improbable solutions in their desperate desire for a cure. Those scientists and advocates of embryonic destruction who take advantage of the desperation and vulnerability of these patient groups are guilty of a grave injustice against them, not only by offering them a medically ineffective approach but also by encouraging them in their vulnerability to support an inherently immoral and disordered approach to obtaining cures.

Have there been many real-life success stories and cures using adult and umbilical cord stem cells?

Yes, there are many such success stories, which have taken place without the destruction of any embryonic human beings. People have been successfully treated for some very serious maladies, including spinal cord injuries, leukemia, sickle cell anemia, and Parkinson's disease, to name a few. Several of these stories are recounted later in this chapter, under "Success Stories from the Use of Adult and Umbilical Cord Stem Cells."

How long is the list of diseases that can be treated or cured today using stem cells from adults or umbilical cords?

The list is already very long, and growing longer all the time. A partial list of the diseases that can be treated using adult or umbilical cord stem cells appears at the end of this chapter.

But if it were possible one day in the future to find cures for sick people by using embryonic stem cells, would that not be worthwhile? Is it not always a good thing to cure people?

Curing people is generally a good thing, but not always. If we commit a grave evil in order to cure somebody's disease, the cure will end up being worse than the disease. Consider, for example, a woman who is dying of heart failure. One approach to curing her might be to do a heart transplant from her daughter. If it were necessary to end the life of her healthy

daughter in order to procure the organ and save the mother, would that kind of cure be good?

Clearly, it is not *always* a good thing to cure disease. We must use only the proper and fitting means to do so. Good medicine has always been built on such an understanding, which includes the moral recognition that the powerful should not exploit the weak in order to obtain cures. Embryonic stem cell research is an example of exploitation of the innocent and defenseless by the powerful, and is always an unjust and disordered human activity.

But are embryos not just a bunch of cells? They are not really human beings yet, are they?

This is one of the most commonly promoted misconceptions about embryos. Human embryos are very small but complete organisms of the species *Homo sapiens*. Embryos are not merely cellular life; they are *beings* who are human, and are distinct from cells, tissues, or organs which are human. Human embryos possess an internal code for self-actualization and have an independent and inherent teleology (goal-directedness) to develop into adults, and they are physiologically alive and genetically human. Human embryos possess forty-six chromosomes, and their genetic identity as male or female has been irrevocably determined.

Are embryos human? Are they really one of us?

Embryos are no different in their essential humanity from a fetus in the womb, a ten-year-old boy, or a forty-year-old woman. At every stage of development, a human being (whether zygote, blastocyst, embryo, fetus, infant, adolescent, or adult) retains his or her identity as an enduring being who grows toward each subsequent stage; embryos are integral beings structured for maturation along their proper time line. Despite their unfamiliar appearance, embryos are what very young humans look like.

Embryos are so tiny that they can fit on the point of a sewing pin, and they are smaller than the period at the end of this sentence. How can anybody take seriously the suggestion that we should be protecting something so small?

In carrying out the moral analysis, size is not a determinative factor in deciding whether human beings should be protected from exploitation and destruction. In fact, small size typically implies that *extra* protections are necessary, since the smaller the individuals, the less likely they will be equipped to defend them-

selves. Thus, we make special child labor laws to protect children from exploitation by ruthless businessmen who would use them to work in factories. We seek to protect babies and children from parents who have shown themselves to be irresponsible in the way they raise them or who plan to harm them. Those who have no voice to speak in their own defense need special protection, and embryonic humans are the preeminent example of those who are unable to speak in their own defense.

Is it not a matter of religious belief as to when human life begins?

No, it is not. It is actually a matter of biology. A human embryo is a human being, a being who is clearly and unmistakably human. It is not a zebra-type of being, a plant-type of being, or some other kind of being. Each of us was once an embryo, and this affirmation does not depend on religion, belief system, or the imposition of anything on anyone. It depends only on a grasp of basic biology. It is a matter of empirical observation.

Why is the destruction of human embryos immoral?

The well-known moral principle that good ends do not justify immoral means applies directly here. Once you are constituted a *human* being, which always occurs at fertilization (or at an event that mimics fertilization, like cloning), you are a new member of the human species and must be protected unconditionally. Once you are a being who is *human*, you are the bearer of *human* rights, and you are inviolable. Our existence as human beings is a continuum that extends all the way back to our origins in that humble ball of cells we call an embryo. Each of us had our origins in such an embryo, and embryos should never be instrumentalized for research purposes, even if the ends that might be achieved through that research would be very good.

What about the hundreds of thousands of embryos that are frozen in fertility clinics? They are just going to be thrown away anyway, so should we not get some good out of them by harvesting their stem cells?

This is a seductive argument, because at first glance it might seem that if frozen embryos may one day end up being discarded by somebody, it should be morally allowable, even laudable, to violate and destroy those embryos. However, the moral analysis of what we may permissibly do with an embryo does not depend on its otherwise “going to waste” or on the incidental fact that an embryo is “trapped” in liquid nitrogen.

Moreover, the statement that “they are just going to be thrown away anyway” needs to be scrutinized. Who says they must be thrown away? In fact, is not discarding human embryos (and thereby causing their demise) an immoral action in itself? Is not one immoral action being used to justify another immoral action in this scenario? The argument can be recast in another manner that also reveals its fallacious character. Because these embryos are about to die, it is argued, it should be morally acceptable to harvest their stem cells and thereby cause their demise. But there are many people who are about to die in our world, such as terminally ill cancer patients and children with incurable diseases. These individuals do not lose their right to protection and respect for their bodily integrity simply because of their terminal conditions.

Can human embryonic stem cells be obtained from sources other than embryos from in vitro fertilization clinics?

Yes, they can be obtained by making and destroying cloned embryos. This procedure would involve making an identical twin of a person, and then utilizing that twin brother or twin sister in their embryonic state to serve as a source for stem cells. This kind of cloning is sometimes called therapeutic cloning.

Do you always make an embryo when you carry out cloning?

Yes, cloning is a technique to make an identical twin of somebody. In order to make a twin in this way, you must first make an embryo. That embryo is a cloned embryo. Once you have successfully made a cloned embryo, you have two options available. You can strip-mine the cloned embryo for its stem cells or spare parts (“therapeutic cloning” or “research cloning”), or you can offer it the safe harbor of a woman’s womb and allow it grow into a fetus, newborn, adolescent, and adult (“reproductive cloning” or “cloning to produce children”). Once again, the crucial difference between these two types of cloning is what you do with the cloned embryos that you make: Do you implant them into a womb, or destructively harvest them for their stem cells?

But do not reproductive cloning and therapeutic cloning really differ from each other in a fundamental technical way?

No, because both types of cloning rely on making a cloned embryo by the same series of steps, which are referred to as *somatic cell nuclear transfer*. This involves taking the nucleus of a body (somatic) cell and transferring it into an egg cell (oocyte) that has had its own nucleus removed.

The body cell thus provides a full complement of DNA (instead of the half-complement that the egg originally had). The newly constituted embryo is prompted to divide and grow toward adulthood, following the same developmental trajectory that a regular embryo, produced by union of sperm and egg, does. This cloned embryo is an identical twin of the person who donated the starting somatic cell.

In sum, then, therapeutic cloning involves making a cloned embryo by the same series of technical steps as reproductive cloning, but instead of being implanted into a uterus to be born, the clone is destroyed to harvest its stem cells. Therapeutic cloning is therefore identical to reproductive cloning except for the final step, since the cloned embryo is never placed into a uterus to cause the live birth of an individual. Instead, the identical twin is destroyed in order to remove his or her stem cells at the stage where he or she is still a blastocyst.

Therapeutic cloning is sometimes referred to as the clone-and-kill technique. The aim of this type of cloning is to obtain rejection-proof stem cells for transplantation into the person from whom the clone was made. Because stem cells from the clone are actually from the identical twin of the person cloned, they should theoretically be a good immune match and should not be rejected, since identical twins can exchange organs without immune reactions.

Is it true that cloning makes a carbon copy of a person?

No, the clone is not a carbon copy, with every detail exactly the same. Instead, the cloned embryo is essentially an identical twin of the person who donated the starting DNA. Clones are not carbon copies any more than identical twins are carbon copies. No human being is truly “identical” to another; subtle differences will always exist.

Would a cloned human being have his or her own soul?

Cloning is simply another way to make identical twins. Naturally born identical twins, of course, have their own souls. A twin born by cloning would likewise have his or her own soul. Any child who is a clone would be an individual and unique human being, with his own personality and unique defining characteristics. You might say that God is “beholden” to the biology he has set into motion when he created all things, so if we generate a bona fide embryo by a technique that is different from the usual way of joining sperm and egg, He still respects the biology governing the developmental trajectory of that new embryonic human and will infuse it with an immortal, immaterial soul.

Will human therapeutic cloning raise any concerns about egg procurement?

The use of therapeutic cloning in an attempt to cure just the class of people who have diabetes (leaving aside for the moment any other diseases) would involve the donation of numerous eggs (oocytes), which would require that many women be used as donors. In order to donate oocytes, however, women must be treated with harsh hyperovulatory drugs that cause the release of multiple eggs. These drugs have a strong impact on each woman's body and are associated with their own potential risks, such as dizziness, fatigue, and the development of tumors or cysts. Complications can arise, and in a few instances fatalities have been reported.¹ Hence, if eggs were to be harvested from large numbers of women, some women would suffer serious side effects and even death. Some women's groups have been opposed to therapeutic cloning for these reasons. They realize that women could be treated as egg farms in order to provide the starting materials for therapeutic cloning. They recognize and object to this serious exploitation of women's bodies, especially of women who are financially constrained or otherwise vulnerable.

Why is human reproductive cloning immoral?

Cloning, like in vitro fertilization, participates in the basic evil of moving human procreation out of the setting of committed marital intimacy and into the laboratory. Human procreation is not meant to occur in that setting, because it is inherently dehumanizing to bring a new human being into the world through means that replace the marital act. Each of us has a right to be brought into the world as the fruit of marital love, rather than as the product of technical domination and manufacturing protocols. Each of us is meant to be treated as a *subject* of inestimable and unrepeatable value, rather than as an *object* for manipulation. Procreation is not meant to be replaced by production.

Cloning also represents a very radical sort of genetic engineering. Instead of choosing just a few of the features you would like your offspring to have—like greater height or greater intelligence—cloning allows you to choose *all* the features, so it represents an extremely serious form of domination and manipulation by parents over their own children. It represents

¹ Comment on Reproductive Ethics (CORE), "Death from Egg Harvesting," press release, April 13, 2005, <http://www.coreethics.org/document.asp?id=cpr130505.txt&se=2&st=4>.

a type of parental power that parents are not intended to have. Ultimately, cloning is a type of human breeding, a despotic attempt by some individuals to dominate and predetermine the make-up of others. This is a power that does not properly belong to parents, who are called to accept the God-given designs of sexuality. These assure a natural variability in their offspring, which is partly reflective of each parent. The God-given designs of human sexuality also assure that parents stand in a properly “receptive” mode to their children, receiving them in their uniqueness and unanticipated originality.

This notion that children are always a gift, rather than a product to be manipulated or designed according to our own fancy, stands at the heart of what is objectionable about human reproductive cloning. With cloning you also distort the relationships between generations. If a woman were to clone herself, using her own egg cell and her own somatic cell, and bear the child in her own womb, she would not need to have sperm or any involvement of a man at all. Oddly, she would end up giving birth to her own identical twin—a twin sister who would also be her daughter.

Why is human therapeutic cloning immoral?

If human reproductive cloning (i.e., the bringing to birth of a new child who is an identical twin to somebody else) is wrong, then therapeutic cloning is worse—it is the creation of that same identical twin for the premeditated purpose of ending his life to harvest his tissues. In sum, a grave evil is involved in therapeutic cloning, where life is created for the explicit purpose of its destruction. With reproductive cloning, at least we would end up with a living baby. Human therapeutic cloning—the artificial creation of a human being for the sole purpose of his exploitation and destruction—will always be gravely unethical, even if the desired end is a very good one, namely, the curing of diseases. Therapeutic cloning sanctions the direct and unvarnished exploitation of one human being by another—in this case, the exploitation of the weak by the powerful. The danger of therapeutic cloning lies in the intentional creation of a subclass of human beings, who are still in their embryonic or fetal stages and who can be freely exploited by those fortunate enough to have already passed beyond those early stages of life.

Therapeutic cloning also raises serious “slippery-slope” concerns. The temptation to make embryos that can be exploited for their stem cells offers the further temptation to

grow those cloned embryos within a uterus to the point where they become fetuses. Such a fetus can then be aborted and conveniently harvested for needed organs, so that the trouble of having to start from scratch with undifferentiated stem cells is avoided.

This line of slippery-slope analysis has been shrewdly analyzed by nationally syndicated columnist Charles Krauthammer:

We would never countenance such work in humans, they say. Cows, yes, but we would never implant a cloned human embryo in the uterus of a woman and grow it to the stage of a fetus. We solemnly promise to grow human clones only to the blastocyst stage, a tiny eight-day-old cell mass no larger than the period at the end of this sentence, so that we can extract stem cells and cure diseases that way. Nothing more. No fetuses. No implantation. No brave new world of fetal farming.

This is all very nice. But curing with stem cells is extremely complicated. First, you have to tease out the stem cells from the blastocyst. Then you have to keep the stem cells alive, growing one generation after another while retaining their pluripotentiality (their ability to develop into all different kinds of cells). Then you have to take those stem cells and chemically tweak them in complex ways to make them grow into specialized tissue cells—say, neurons for a spinal-cord injury. Then you inject the neurons into the patient and get your cure.

The Advanced Cell Technology cow experiment suggests the obvious short circuit that circumvents this entire Rube Goldberg process: let the cloned embryo grow into a fetus. Nature will then create within the fetus the needed neurons, kidney cells, liver cells, etc., in far more usable, more perfect, and more easily available form.

Tempting? No way, the cloning advocates assure us. We will never break that moral barrier. It is one thing to grow a cloned embryo, a tiny mass of cells not yet implanted. It is another thing to grow a cloned human fetus, with recognizable human features and carried in the womb of a woman.

I am skeptical of these assurances. Why? Because just a year or two ago, research advocates were assuring us that they only wanted to do stem cell research on discarded embryos from fertility clinics but would not create a human embryo in the laboratory just for the purpose of taking it apart for its stem cells.

Well, that was then. Today these very same advocates are campaigning hard to permit research cloning—that is, the

creation of human embryos for the purpose of taking them apart for their stem cells. They justify this reversal of position by invoking the suffering of millions. And they heap scorn on opponents for letting old promises and arbitrary moral barriers stand in the way of human betterment.²

Success Stories from the Use of Adult and Umbilical Cord Stem Cells

Spinal Cord Injury. Laura Dominguez broke her neck and was paralyzed from the chest down after a car accident in 2001. She was treated with a mix of adult stem cells and other cells obtained from olfactory tissue inside her nose. The cells were transplanted across the injury site in her damaged spinal cord. Several months after the surgery, she began to recover sensation in previously unresponsive parts of her body, and was able to move her foot. Her remarkable progress is continuing, and she is now able to walk short distances with the aid of braces. Several other patients with spinal cord injuries like hers are also showing remarkable benefits from the transplant surgery. The surgery on Laura Dominguez was carried out in Portugal, and neurologists in the United States are seeking FDA approval to begin offering the therapy here.

Leukemia. Patricia Durante was diagnosed with an aggressive form of leukemia six months into her pregnancy. Her daughter, Victoria Angel, was delivered early by cesarean section, so that Patricia could be treated with chemotherapy. Patricia was given only about six months to live. Fortunately, stem cells from her daughter's umbilical cord were saved after the delivery. After chemotherapy failed to halt the progress of the leukemia, her daughter's stem cells were used for a transplant. Several years later now, Durante is in full remission. "[Victoria] saved her mommy," Durante told reporters. "She's a little miracle. That's why we named her Victoria Angel. She's my little angel."

Sickle Cell Anemia. Keone Penn was born with sickle cell anemia, which means that his red blood cells were sickle shaped instead of round. The effect of the disease is that the sickle-shaped cells get caught in the small blood vessels of the body (the capillaries) and clog the vessels. Joint pain and

² Charles Krauthammer, "The Fatal Promise of Cloning," *Time* magazine (June 24, 2002).

swelling are one set of symptoms. The typical treatment is to carry out multiple blood transfusions as a child grows. Keone received many such transfusions, but eventually could not tolerate any more.

Doctors decided to destroy Keone's own immune system and perfuse in umbilical cord stem cells. These umbilical cord cells came from the New York Public Blood Bank, where Keone was fortunate enough to have found a match. After the transplant, Keone's blood type changed from one type to another. He is now considered cured of the disease, and is able to play basketball and participate in a range of other demanding physical activities for the first time in his life.

Parkinson's Disease. Dennis Turner was diagnosed with Parkinson's disease and, by early 1991, suffered extreme shaking of the right side of his body and stiffness in his gait and movements. Putting in his contact lenses became difficult or nearly impossible. He became unable to use his right arm.

Neurosurgeon Dr. Michel Lévesque removed a small tissue sample from Mr. Turner's brain, and isolated adult neural stem cells from it. Dr. Lévesque multiplied and matured these cells into dopamine neurons, and injected these cells back into the left side of Mr. Turner's brain, which controls the right side of the body. Soon after, the Parkinson's symptoms began to improve in Mr. Turner's right side. Mr. Turner's trembling decreased until to all appearances it was gone, reappearing only slightly when he became upset or nervous. Neurological evaluation indicated a marked improvement, which lasted for about five years.

Because Parkinson's is a progressive ailment, Mr. Turner's condition is deteriorating again, but as he recently testified at a U.S. Senate Committee hearing, "I have no doubt that because of this treatment I've enjoyed five years of quality life that I feared had passed me by." He enthusiastically expressed a willingness to undergo a repeat surgery of this sort to further slow the progression of his symptoms.

Krabbe's Leukodystrophy. Gina Rugari was born with Krabbe's leukodystrophy. This is a rare, degenerative enzyme disorder of the nervous system, in which a baby shows initial signs of irritability and developmental delay or regression. Seizures and fevers often follow, then blindness and deafness, until the baby dies, usually before age two. Gina was tested for Krabbe's leukodystrophy shortly after she was born, because she had a brother who had died from the disease. Doctors

treated Gina with chemotherapy to destroy her immune system, and introduced new umbilical cord blood stem cells from a closely matched donor. The transplanted cells produced the missing enzyme. Her body accepted the cells, and she is thriving several years after the transplant.

*Human Diseases That Currently Can Be Treated or Cured
by the Use of Adult or Umbilical Cord Stem Cells*

What follows is a partial list of human diseases that can be treated or cured today using stem cells from adults or umbilical cords. None of these diseases has ever been cured in humans using stem cells from embryos.

- Acute biphenotypic leukemia
- Acute lymphoblastic leukemia
- Acute myelofibrosis
- Acute myelogenous leukemia
- Acute undifferentiated leukemia
- Adrenoleukodystrophy
- Advanced chronic lymphocytic leukemia
- Agonogenic myeloid metaplasia (myelofibrosis)
- Aplastic anemia (severe)
- Ataxia-telangiectasia
- Bare lymphocyte syndrome
- Beta thalassemia major
- Chediak-Higashi syndrome
- Chronic granulomatous disease
- Chronic myelogenous leukemia
- Chronic myelomonocytic leukemia
- DiGeorge syndrome
- Essential thrombocythemia
- Ewing sarcoma
- Familial erythrophagocytic lymphohistiocytosis
- Fanconi anemia
- Gaucher's disease
- Hemophagocytosis
- Histiocytosis-X
- Hodgkin's disease
- Hunter's syndrome (MPS-II)
- Hurler's syndrome (MPS-IH)
- Juvenile chronic myelogenous leukemia
- Juvenile myelomonocytic leukemia
- Kostmann syndrome
- Krabbe disease
- Leukocyte adhesion deficiency

Maroteaux-Lamy syndrome (MPS-VI)
Metachromatic leukodystrophy
Morquio syndrome (MPS-IV)
Mucopolipidosis II (I-cell disease)
Mucopolysaccharidoses (MPS)
Multiple myeloma
Neuroblastoma
Neutrophil actin deficiency
Niemann-Pick disease
Non-Hodgkin's lymphoma
Omenn's syndrome
Paroxysmal nocturnal hemoglobinuria
Plasma cell leukemia
Polycythemia vera
Polymphocytic leukemia
Pure red cell aplasia
Refractory anemia
Refractory anemia with excess blasts
Refractory anemia with excess blasts in transformation
Refractory anemia with ringed sideroblasts)
Renal cell carcinoma
Reticular dysgenesis
Sanfilippo syndrome (MPS-III)
Scheie syndrome (MPS-IS)
Severe combined immunodeficiency
Sickle cell disease
Sly syndrome, beta-glucuronidase deficiency (MPS-VII)
Waldenstrom's macroglobulinemia
Wolman's disease

