

STEM CELLS FOR DUMMIES

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What is a Stem Cell?

A stem cell is an undifferentiated cell (i.e., a cell that has not yet specialized into a particular cell type, e.g., liver cell, pancreatic cell, or cardiac cell) with two unique capacities: the first, for rapid and prolonged self-multiplication into daughter cells identical with itself; and the second, for development and differentiation into specific types of cells such as liver and cardiac cells.

What is a Stem Cell's Potency?

A stem cell's "potency" refers to its capacity for differentiation, that is, for developing into particular kinds of human cells, e.g. liver, kidney, blood, etc. Different types of stem cells have different scopes to their potency: e.g., totipotent, pluripotent, multipotent or unipotent. A totipotent cell is capable of differentiating into every tissue in the human body, including extra-embryonic support tissues necessary for human gestation (e.g., placenta, umbilical cord, amniotic sac); a single-celled embryo, also called a zygote, possesses the capacity of totipotency; also, the individual cells of an embryo's body, called blastomeres, in the first few days of the embryo's life are totipotent; if a blastomere splits off from the embryo's body, it has the capacity for complete human development, which is how we get identical twins. A pluripotent cell is capable of differentiating into almost all the tissues of the human body, but not the extra-embryonic support tissues; embryonic stem cells are pluripotent. Stem cells can also be multipotent (capable of differentiating into the cells of a cell group type, e.g., blood cells) and unipotent (unable to differentiate into any other cell type than itself).

What are the Differences between Embryonic and Adult Stem Cells?

Embryonic stem cells (ESCs) are undifferentiated, self-renewing, pluripotent cells. They are harvested from the bodies of embryos at approximately day five of human development. At day five the embryo's body takes the shape of a hollow sphere (the embryo at this time is called a "blastocyst"). The blastocyst has an *outer cell layer* and an *inner cell mass* (picture a basketball with a small group of marbles clumped together on the inside). The cells of the inner cell mass will eventually differentiate into the varied tissues of the person's body; and the outer cell layer will develop into the placenta and other support tissues. But it is important to understand that at *this* point, both the outer cell layer and inner cell mass constitute the embryo's body. The inner cell mass can be understood to be the embryo's internal organs. These cells are what we call *embryonic stem cells* and have the capacity of pluripotency; they are coveted by ESC researchers precisely because of their pluripotency. Just as harvesting all the internal organs of an adult would kill the adult, harvesting the stem cells of an embryo kills the embryo.

Adult stem cells (ASCs) also have the capacities of self-proliferation and



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differentiation, but are not derived from the bodies of embryos. They are ‘adult’ not because they’re found only in adults, but because the tissue in which they’re found is *differentiated* tissue (as opposed to the undifferentiated tissue of an embryo’s body). Thus ASCs can be found in newborn tissue. In fact, some of the most clinically valuable ASCs are found in umbilical cord blood. Although some ASCs have been found with the capacity of pluripotency, most are only capable of differentiating into the tissue type or related group type of the tissue in which they’re found.

Ethical controversy surrounding stem cell research

Every reasonable person agrees that the clinical end being sought in stem cell research is praiseworthy—namely, finding clinical solutions for remediating serious illnesses. Controversy surrounds the *means* by which that end is pursued. The familiar ethical question raised by ESC research is this: *Is it justifiable to kill human embryos in order to explore potentially healing remedies for other persons?* Those who judge human embryos to be human beings, albeit at an early stage of development, think it’s wrong. Those who believe embryos are “pre-human” entities, developmental precursors to whole human beings, think it sometimes can be justified. [1]

ASC research avoids this ethical problem by avoiding research on embryos altogether. The ethical questions surrounding ASC research then are similar to those involved with all research on human subjects: Do the benefits promised by the research outweigh the burdens imposed by it *for the human subjects of the research*? Is fully informed consent being secured? Is truthfulness in reporting of data being maintained? Are unwarranted promises of benefit being eschewed? And so on. If the answer to these is yes, then one may proceed with confidence that the research is legitimate. In fact, the Vatican and the United States Conference of Catholic bishops have consistently supported research on stem cells that does not exploit or destroy human embryos [2]. This support is reaffirmed in the new Vatican document on bioethical questions, *Dignitas Personae* [3].

Don’t current findings demonstrate that ESC research is clinically unnecessary?

This is a very important question and should be asked often of scientists and public officials. Let me elaborate it: since ASCs have already proven remarkably effective in treating serious diseases, including formerly untreatable diseases [4], and since ESC research, despite billions of dollars spent, has produced nothing but failures on the clinical front, and even human tragedies [5], and since the desire to develop clinically useful patient-specific pluripotent stem cells is being rapidly and efficiently fulfilled by the new and remarkable Induced Pluripotent Stem Cells (iPSCs) [6], why aren’t embryonic stem cells obsolete in the minds of scientists? Why does the scientific community insist on greater liberties for embryo-destructive experimentation when both moral reasoning and cutting edge science point in another direction? Why this lust for the embryo? [7]

I don’t have a satisfactory answer to this. Some researchers obviously believe that embryonic stem cells, despite current evidence, promise benefits that ASCs and iPSCs do not. I’m also told that many of the best researchers are turning away from



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ESCs because of the mounting problems they pose, and turning towards research with iPSCs. If this is the case, then the questions posed above need to be put frankly to our politicians, because some still seem to think that the future of stem cell research lies with ESCs.

In the shadow of President Obama’s executive order overturning the Bush stem cell policy, the House Majority Leader Steny Hoyer (D-Md.) stated on the House floor that the U.S. House will take up a bill in early April to overturn the 1996 Dickey-Wicker Amendment prohibiting federal funding from research involving the creation or destruction of human embryos [8]. With all we now know, why is Congress bent on spending taxpayer money for embryo destructive experimentation? Isn’t that scientifically retrogressive and economically wasteful, not to mention morally unjust to the embryos killed as a result of the decision and to taxpayers who object to public funds being used for such research when alternatives are available?

Postscript:

Some might be wondering what distinguishes the “Bush stem cell policy” (Aug. 2001) from the restrictions imposed by the Dickey-Wicker amendment (1996). Dickey-Wicker was passed before ESC research was launched in 1998 by the first successful isolation of ESCs by James A. Thomson’s lab at the University of Wisconsin, Madison. It simply restricted funding on research that created or destroyed human embryos. After 1998, pressure was exerted on the Clinton administration to free up funds for this new ‘promising’ type of research. But Dickey-Wicker stood in the way. Thus, to sidestep the restrictions Clinton, as he was leaving office (2000), approved federal guidelines permitting the NIH to fund research on stem cells *derived* from ‘spare’ embryos slated for destruction at fertility clinics. Do you see the slight of hand? By the time stem cells are derived, the killing is over. If private funds paid for the killing, then the federal government would fund the subsequent research. Clinton’s lawyers argued that his guidelines conformed to Dickey-Wicker, and legalistically construed, they did. At once, the NIH began accepting grant proposals from scientists bent on embryo destructive research. Aware of the loophole, newly elected President George W. Bush passed an executive order permitting federal funds for ESC research only on certain pre-approved stem cell lines created by that date. Since stem cells can self-proliferate indefinitely, these sixty lines, he thought, would provide subject matter for years of viable research. But under the new policy, funding would be prohibited from all stem cell lines derived after August 2001. NIH grant proposals thereafter were carefully reviewed to ensure that federal funds would not be used to facilitate harm to human embryos. Obama’s recent presidential order overturned the Bush restrictions. Dickey-Wicker however still stands. But for how long?

Notes:

[1] I critiqued several of the most prominent theoretical arguments against the personhood of human embryos in my June 2008 CLF Brief entitled “Arguments for and Against the Personhood of the Embryo”, so I do not intend to engage that question here.



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[2] See Pontifical Academy for Life, Declaration on the Production and the Scientific and Therapeutic Use of Human Embryonic Stem Cells (August 25, 2000); Catholic Online, “American Bishops Reaffirm Church Support for Adult Stem-Cell Research,” www.catholic.org, June 26, 2006, www.catholic.org/national/national_story.php?id=20275.

[3] See Congregation for the Doctrine of the Faith, Instruction *Dignitas Personae* (On Certain Bioethical Questions) (2008), nos. 24, 31, 32.

[4] For an enlightening updated summary of clinical successes using ASCs prepared by the Family Research Council, see <http://www.frc.org/insight/adult-stem-cell-success-stories-2008-update-july-december>

[5] Recall the recent tragic story of the 9 year old Israeli boy, who received embryonic stem cell injections in Russia for a lethal brain disease, and contracted as a result tumors on his brain and spinal cord; see CBS News report, “Study: Stem Cell Injections Caused Tumors: Israeli Researchers Say Fetal Stem Cells Led To Benign Tumors For Boy With Rare Genetic Disease,” Feb. 17, 2009; available at http://www.cbsnews.com/stories/2009/02/17/health/main4808339.shtml?source=RS&attr=Health_4808339

[6] Induced pluripotent stem cells are differentiated cells such as a skin cell that are “reprogrammed” back to a state of pluripotency. They were first reported in research with human cells in November 2007. I describe their advent and initial promise in my CLF Brief from January 2008, “A Moral Tsunami”. Since then dozens of studies have been carried out (and published) perfecting the initiate technique. For example, researchers at the Whitehead Institute in Cambridge, Mass., recently converted skin cells from patients with Parkinson’s disease into the type of neuron destroyed by the disease. Although the technique needs perfecting, it promises to provide a therapy one day that replaces the damaged neural tissue of Parkinson’s sufferers with healthy tissue derived from the patient’s own body, and therefore with no risk of immune rejection. See the *NY Times* on line report, “Converting Cells Shows Promise for Parkinson’s”, March 6, 2009, available at www.nytimes.com/2009/03/06/health/06parkinsons.html

[7] See Bernadine Healy’s piece in *US News and World Report* on line, “Why Embryonic Stem Cells Are Obsolete” March 04, 2009, available at <http://health.usnews.com/blogs/heart-to-heart/2009/3/4/why-embryonic-stem-cells-a-re-obsolete.html>

[8] The exchange between Hoyer and House Minority Whip Eric Cantor (R-Va.) on the floor of the U.S. House of Representatives on March 12, 2009 can be read in the *Congressional Record*, House, page H3376, March 12, 2009.

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