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Ethics in Science: Debates Surrounding Stem-Cell Research

Introduction

Research on stem cells is advancing knowledge concerning how an organism develops from a single cell and how healthy cells replace damaged cells in adult organisms. Stem cells have attracted significant attention for their potential for cell-based therapies to treat diseases, often referred to as regenerative or reparative medicine (NIH, 2007). Stem-cell research is a growing field that has made significant impact on biomedical research since the 1980s.

For example, when large, fast-growing cancers invade the liver, some patients are unable to undergo surgery because removing the cancerous tissue would leave too little liver to support life. Recent studies have shown that an intravenous injection of stem cells can accelerate the liver's natural capacity to regenerate itself. (Schulte am Esch et al, 2005)

Despite the growing interest surrounding amazing advances in stem-cell research, and despite the potential stem cells hold to cure a variety of serious diseases, many people have objected to research with human embryonic stem cells (hESCs). The destruction of a human embryo to obtain a stem cell line for biomedical research has raised moral and religious issues. According to objectors, the main concern is that this process denies life to potential human beings. Moreover, public policy issues have arisen concerning federal regulation of hESC research. To show the relation between humanities and science, we review here the science of stem cells, the current (2007) federal regulation of cell lines, and the various debates surrounding stem-cell research

Background

All stem cells have a unique property: although they are initially unspecialized, they can differentiate into a wide range of specialized cell types (Odorico et al, 2005). Two types of stem cells used in research today are human embryonic stem cells and human adult stem cells.

Current samples of hESCs were derived from blastocysts, that is, 4-5-day-old embryos consisting of 50-150 cells. These embryos were obtained from *in vitro* fertilization clinics because they were in excess of clinical need. Extraction of a blastocyst's inner cell mass, a section of cells in the middle of a blastocyst, destroys the embryo and the production of a stem-cell line. hESCs are useful in regenerative medicine because they are pluripotent; that is, they can yield numerous specialized cell types that make up the heart, lung, skin, and other tissues (Elçin, 2003).

Adult stem cells are found in most adult tissues, such as bone marrow, muscle, and brain. Their main role is to generate replacements for cells that are lost through normal wear and tear, injury, or disease. Therefore, they can produce only a small number of different cell types. Extraction of adult stem cells does not result in destruction of any adult tissue (Prentice, 2007). With the ability to differentiate into an unlimited number of possible cell types, hESCs are more attractive than human adult stem cells for their potential use in regenerative medicine, tissue engineering, and gene therapy for spinal cord injuries, organ transplants, Parkinson's disease, and many other ailments.

Current federal regulations on stem-cell research were set August 9, 2001. President George W. Bush announced that for research using hESCs, federal funds may be awarded only if the following criteria are met:

- The derivation process (which begins with the destruction of the embryo) was initiated prior to 9:00 P.M. EDT August 9, 2001.
- The stem cells must have been derived from embryos of *in vitro* fertilization procedures, in which the embryo was created for reproductive purposes and was no longer needed.
- Informed consent must have been obtained from the donor of the embryo, and the donation must not have involved financial inducements.

Along with this executive order, President Bush established a President's Council of Bioethics, under the chair of Dr. Leon Kass, a leading biomedical ethicist from the University of Chicago, to recommend guidelines and regulations. This council of prominent scientists, physicians, ethicists, lawyers, and theologians has been working to consider all medical and ethical ramifications of stem-cell research (Cohen, 2007). Lastly, the National Institute of Health (NIH), the federal government's major biomedical research organization, has been authorized to implement the President's policy. NIH funds research on existing hESCs and to explore the enormous promise of these unique cells, including their potential to produce breakthrough therapies and cures. In accord with federal criteria, investigators from 14 laboratories in the United States, India, Israel, Singapore, Sweden, and South Korea have derived stem cells from 71 individual, genetically diverse blastocysts (NIH, 2007; Ruse & Pynes, 2003).

Prior to and following President Bush's announcement, the stem-cell controversy is alive and active. Positive results in hESC research give hope and promise for future work toward finding cures for a multitude of diseases, such as Parkinson's and diabetes (Maienschein, 2003). For example, in 2001, Dr. John Gearhart and Dr. Douglas Kerr were able to help paralyzed mice walk again after a few injections of hESCs in their spinal cords (Ruse & Pynes, 2003). However, these impressive scientific advances are accompanied by fervent debates concerning morality, religion, and public policy that the scientific community cannot neglect. The core of these debates concerns fundamental questions, such as "When does human life begin?" "What does it mean to be human?" and "What is an embryo and when does it become a human being?" (Cohen, 2007)

The Moral Debate

If an embryo is regarded as a potential human being, society debates if it is ethically permissible to conduct research with hESCs. Some claim that destruction of an embryo is wrong because a researcher is denying life to a potential human being. On the other hand, others have argued that numerous civilizations perform "those acts which result in the greatest

good for the greatest number of people." (Kiessling & Anderson, 2007) Therefore, hESC research could possibly maximize healthy life and minimize pain for mankind. In other words, the social, economic, and personal "costs" of the diseases that embryonic stem cells may cure are far greater than the "costs" associated with the destruction of embryos. (Cohen, 2007)

The Religious Debate

Different religions have different positions on stem-cell research based on when they believe human life begins. The Roman Catholic Church believes that life begins at conception; therefore, it opposes the destruction of human embryos. Reform Jews believe that a fetus is not a person until it takes its first breath at birth. Buddhists consider life to be a continuum, both in time and between species. Therefore, killing an embryo is wrong because it negatively affects one's "karma," that is, the total effect of a person's conduct that will determine his or her destiny in the next life. Muslims accept abortion before the 80th day following conception, and the sin increases with the duration of a pregnancy (Waters & Cole-Turner, 2003).

The Legal Debate

Who has the right to make the decision to use embryos for research – the parents or the government? The government has already created regulations on the use of these embryos for research, but there is still a debate surrounding whether the government is entitled to do so. The government has the right to create laws to protect human life. However, one side of the debate believes that parents have the inherent power to determine the ultimate fate of their embryos.

Why is this important to chemical engineers and chemists? Moral, religious, and legal debates shape the future of stem-cell research. A variety of religious and moral views influence decisions in federal public policy. National legislation controls funding and the sources of stem-cell samples. Thus, there are limits to advances in stem-cell research due to lack of funding and due to restrictions set by regulation. Because scientists and engineers are vitally concerned

about scientific research, they need some humanistic education to better understand the moral and legal issues. They need to know how decisions in the federal government affect their work. These debates have forced many researchers to realize that they must be able to communicate effectively with an anxious public and its legislators about fundamental questions concerning the beginning of life and the goals of science. Scientists and engineers require understanding and sympathetic appreciation of ethics, a discipline of philosophy that informs what is right and wrong in human behavior and moral conduct (Cohen, 2007).

The current controversy may decline due to promising research in creating adult stem cells that are reprogrammed to have the pluripotency of embryonic stem cells. Researchers at Kyoto University in Japan claim to have produced ESC-like cells. By stimulating expression of four certain chemicals in adult mouse cells, the cells revert to an ESC-like state. (Okita, 2007) These induced pluripotent stem cells (iPSCs) are able to develop into all types of tissues in mice. Moreover, the Whitehead Institute at MIT in Cambridge, MA, and several collaborators proved that these cells can become functional reproductive cells and create a whole organism. (Wernig, 2007) Although this research is exciting, more work, such as human clinical trials and education for the general public, needs to be accomplished before the world is ready to fully accept stem-cell research.

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