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TOPIC: Ethical Issues Associated with Stem Cell Biology

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Stem Cell Research & Related Ethical Issues

Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells. They are found in multicellular organisms.

Properties

The classical definition of a stem cell requires that it possess two properties:

1. **Self-renewal**

   Self-renewal is the ability to go through numerous cycles of cell division while maintaining the undifferentiated state.

2. **Potency**

Potency is the capacity to differentiate into specialized cell types. *Potency* specifies the differentiation potential (the potential to differentiate into different cell types) of the stem cell.

- **Totipotent** (a.k.a. omnipotent) stem cells can differentiate into embryonic and extraembryonic cell types. Such cells can construct a complete, viable organism. These cells are produced from the fusion of an egg and sperm cell. Cells produced by the first few divisions of the fertilized egg are also totipotent.
- **Pluripotent** stem cells are the descendants of totipotent cells and can differentiate into nearly all cells, i.e. cells derived from any of the three germ layers.
- **Multipotent** stem cells can differentiate into a number of cell types, but only those of a closely related family of cells.
- **Oligopotent** stem cells can differentiate into only a few cell types, such as lymphoid or myeloid stem cells.
- **Unipotent** cells can produce only one cell type, their own, but have the property of self-renewal, which distinguishes them from non-stem cells (e.g. progenitor cells, muscle stem cells).

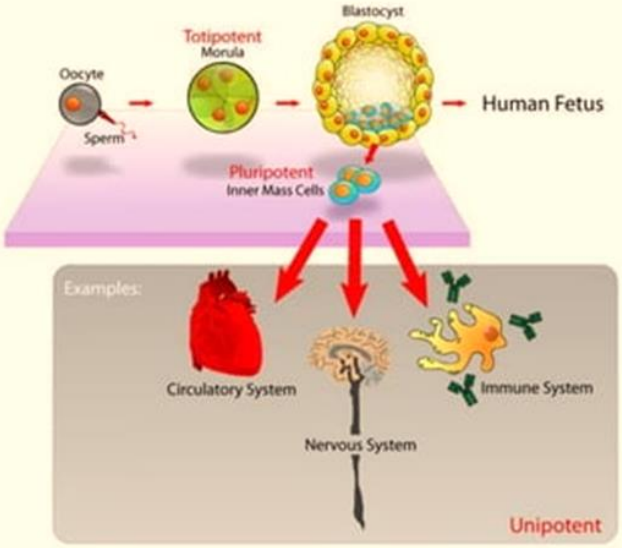

Fig. Pluripotent, embryonic stem cells originate as inner cell mass (ICM) cells within a blastocyst. These stem cells can become any tissue in the body, excluding a placenta. Only cells from an earlier stage of the embryo, known as the morula, are totipotent, able to become all tissues in the body and the extraembryonic placenta.

Types of Stem Cells

There are three main types of stem cells.

1. Embryonic stem cells
2. Adult stem cells
3. Umblical cord blood stem cells

1. Embryonic Stem Cells

Embryonic stem (ES) cells are stem cells derived from the inner cell mass of a blastocyst, an early-stage embryo. Human embryos reach the blastocyst stage 4–5 days post fertilization, at which time they consist of 50–150 cells. ES cells are pluripotent and give rise during development to all derivatives of the three primary germ layers: ectoderm, endoderm and mesoderm. In other words, they can develop into each of the more than 200 cell types of the

adult body when given sufficient and necessary stimulation for a specific cell type. They do not contribute to the extra-embryonic membranes or the placenta.

ES cells can be collected from:

- ✓ Embryos created in vitro fertilization
- ✓ Aborted embryos

Isolating the inner cell mass destructs the embryos, this raises ethical issues.

2. Adult Stem Cells

Adult stem cells, also called somatic stem cells, are stem cells which maintain and repair the tissue in which they are found. They can be found in children, as well as adults. Appears to have a more restricted ability to produce different types and to self-renewal.

There are three accessible sources of adult stem cells in humans:

1. Bone marrow, which requires extraction by harvesting, that is, drilling into bone (typically the femur or iliac crest)
2. Adipose tissue (lipid cells), which requires extraction by liposuction
3. Blood, which requires extraction through apheresis, wherein blood is drawn from the donor (similar to a blood donation), passed through a machine that extracts the stem cells and returns other portions of the blood to the donor.

3. Umblical Cord Blood Stem Cells

Stem cells can also be taken from umbilical cord blood just after birth.

Stem cell Research

Stem cell research offers a great promise for understanding basic mechanisms of human development and differentiation as well as hope for new treatments for diseases such as diabetes, spinal cord injury, parkinson's disease and myocardial infarction. It can also be used to test different substances like drugs and chemicals.

The most notable outcome of this research is that in 2013, first time lab grown meat is made from muscle cells has been cooked and tasted.

Consequentialism

It's the basics of ethics. Anything is right or wrong on the basis of its consequences. There must be greatest happiness for greatest number of people.

Basic Ethical rules

1. Prevention and alleviation of suffering
2. Respect of human life.

Principles

1. Principle of Proportionality

It is generally agreed that research involving embryos should be related to an important goal, sometimes formulated as 'an important health interest' (the principle of proportionality).

2. Slippery Slope

The slippery slope argument can be considered as having two variants, one empirical and the other logical.

a.Empirical version

The empirical version involves a prediction of the future. The use of hES cells for the development of cell therapy would inevitably lead to applications in germ-line gene therapy and in therapeutic cloning, then ultimately reproductive cloning. This version of the argument is unconvincing too; even if germ line gene therapy and therapeutic cloning would be categorically unacceptable, which is not self-evident, it does not necessarily follow from this that the use of hES cells for cell-therapy is unacceptable. The presumed automatism in the empirical version of the slippery slope argument is disputable.

b.Logical version

The logical version is that acceptance of hES cells for the development of stem cell therapy for the treatment of serious disease automatically means there is no argument against acceptance of use, for example, for cosmetic rejuvenation (Nuf®eld Council on Bioethics, 2000).

3. Subsidiarity

The principle of subsidiarity is meant to express concern for the (albeit limited) moral value of the embryo, it is a sign of ethical one dimensionality to present every alternative, which does not use embryos, as a priori superior.

The Value of the Embryo

- Embryos have Status as Human Beings or Persons
- Embryos have Status as Potential Persons
- Embryos have Status as Divine Creations
- Embryos are Harmed by their Destruction (Whatever their Moral Status)
- Embryos have Status as Hu Human Life with Intrinsic Value
- Embryos have the Status of Mere Body Parts

Parkinson's disease

Esc's develop into organs and tissues that could replace disease organ. Cell therapies for degenerative diseases such as Parkinson's could be developed using human ESCs and ASCs. ESCs might be 'programmed' to develop into neurons and then purified and injected into the brain to regenerate new tissues to replace those that are diseased. Toxicology testing of potential new drugs could also be done on tissues developed from stem cell lines.

Disadvantages of treatment

There are however, some limitations that will need to be overcome before this technology can be used.

First, there are obstacles to organ construction using human stem cells. Stem cell-derived organs will be grown outside the human body and will therefore require some type of scaffolding during development Such scaffolds are presently being developed incorporating human or animal stem cells.

Second, cancers could be an unintended side effect of ES cell therapies. The injection of undifferentiated ESCs into an adult can produce tumours called teratomas. In order to avoid this,

undifferentiated ESCs must be eliminated before injection. Current cell-sorting technology is not yet efficient enough to do this.

Third, there is a problem of immune rejection if there is a poor match between the cells of the embryo from which the ESCs are derived and the person who will receive them during treatment.

Major Ethical Issue

The distribution of scarce health resources

An ethical issue that may arise if use of stem cells produces effective treatments for human diseases is: The costs of these treatments could be quite high, at least initially, and if they are developed by commercial companies. If this were so, such treatments may only be available to a select few for some time, even in developed countries. Even if cell replacement treatments can be made affordable, their availability may be limited by embryo supply. Creating banks of ESC lines could avoid this problem, but these banks might also be commercialized.

ESCR puts us on the road to growing humans for body parts

The un-programmed cells of an early embryo are derailed from their natural course of development and coaxed through chemical manipulation to become very specific tissue types that will be used to treat the unhealthy or diseased tissue of those already born.

Regarding the justification that the embryos "left over" in IVF clinics (reportedly >300,000 in the US alone) will simply be discarded anyway, reflects a chilling absence of moral conscience. We do not consider it appropriate to take organs from dying patients or prisoners on death row before they have died in order to increase someone else's chances for healing or cure. Neither, then, should we consider any embryos "spare" so that we may destroy them for their stem cells.

Consider the story of Adam and Molly Nash. Molly was diagnosed with Fanconi anemia—a hereditary and always fatal disease. Doctors determined that the best hope for Molly was a cell transplant from a relative whose cells matched Molly's, but without anemia. So Molly's parents produced fifteen embryos by IVF, only one of which had the right genetic material. It was implanted in Mrs. Nash who gave birth to Adam. Adam's stem cells were taken from his umbilical cord and implanted in his sister. Despite all the success of the treatment and the medical justification, the fact remains that Adam was conceived, not just to be a son, but a

medical treatment. Adam was a means—valuable only insofar as he carried the right genetic material. If he hadn't, he would have been rejected—like the other fourteen discarded embryos. The undeniable conclusion is that we are growing.

The Success and Promise of Adult Stem Cell Research

In all fairness, adult stem cells have restricted differentiation potential and do not proliferate as well as ESC. On the other hand, while ESCR yields, at best, meager results, and has only far distant possibilities of successful clinical applications, current clinical applications of adult stem cells are abundant! They include treatments for the following: corneal restoration, brain tumors, breast cancer, ovarian cancer, liver disease, leukemia, lupus, arthritis, and heart disease. Thousands of patients are treated and cured using adult stem cells. Alternative sources for adult stem cells include: placenta, cord blood, bone marrow organ donors, and possibly fat cells.

View point of Religions on Stem Cell Research

Religious groups have generally been at the forefront of those speaking out publicly for and/or against embryo research.

Buddhism

Though Buddhist teachings do not directly address the issue, there are two main tenets – the prohibition against harming or destroying others (*ahimsa*), and the pursuit of knowledge (*prajña*) and compassion (*karua*) – that divide Buddhist scholars and communities. Some Buddhists argue that stem cell research is in accordance with the Buddhist tenet of seeking knowledge and ending human suffering, while others argue that it is a violation of the notion of not harming others.

Catholicism

In accordance with their anti-abortion stance, the U.S. Conference of Catholic Bishops supports adult stem cell research but opposes embryonic stem cell research since it creates or destroys human embryos.

Hinduism

Though Hinduism believes that life begins at conception, the religion has no official position on stem cell research.

Judaism

All major Jewish denominations – including the Reform, Conservative, Orthodox and Reconstructionist movements – support both embryonic and adult stem cell research as long as it is for medical or therapeutic purposes.

View point of Islam

Since human ESC research has begun in many countries, its potential to offer new forms of treatment and insights into human development has come up against serious moral and religious questions. One of the key questions is whether human embryos at an early stage of development have the same moral significance as living human beings and thus deserve the same protections.

Islam and beginning of life

There are opposing views about the beginning of life and the time when the ensoulment—the infusion of the soul into the body of the foetus, followed by the conferring of moral status on the foetus—occurs. Determination of the time of ensoulment is based upon an interpretation of the *Qur'anic* scripture:

> We created *(khalaqna)* man of an extraction of clay, then We set him, a drop (*nutfah*) in a safe lodging (*i.e. the womb*), then We created of the drop a clot (*'alaqah*), then We created of the clot a tissue (*mudghah*), then We created of the tissue bones (*'azm*), then we covered the bones in flesh (*yaksu lahman)*; thereafter We produced it as another creature (*khalaqan akhar*). So blessed be God, the Best of creators (*khaliqin*).

In one *hadith* (Prophet Mohammad's saying) each of the first three stages (lodging *nutfah* in the woman's womb, '*alaqah*,and *mudghah*) is assigned a time period of forty days, which makes for

a total of 120 days. Another *hadith* indicates how on the 42nd night from ejaculation in the uterus, an angel sent by God begins to differentiate the organs of the foetus.

The text does not however mention ensoulment. This verse informs us about the stage of ensoulment during the intrauterine life:

> He Who created all things in the best way and He began the creation of man from clay. Then made his progeny from a quintessence of despised liquid. Then He created him in due proportion, and breathed into him of His spirit. And He gave you (the faculties of) hearing and sight and hearts. Little thanks do ye give!

Reasoning from different *ahadith*, some schools of jurists determined that until the stages were complete, the foetus had no soul, or that God had not breathed His spirit into the foetus, and therefore it had not yet been created

Muslim scholars mostly agree that the life exists from the time of the fertilization of the egg, despite the fact that ensoulment occurs at the 120th day.

"Spare" IVF Embryos in Islamic Context

In 1989, the issue of surplus IVF embryos was discussed by a committee of international Muslim religious scholars and physicians of the Islamic Organization of Medical Science (IOMS). The committee consequently issued a recommendation that explicitly permitted the use of the frozen embryos for research purposes according to Islamic law. One of the main statements for this recommendation was:

> According to the opinion of the majority that the destruction of fertilized egg[s] before their nidation in the uterus is allowed, no matter how this destruction is brought about.During these experiments the egg cells must not be multiplied. Some disagreed entirely with this view.

Following the IOMS recommendation, the Islamic Fiqh Association (IFA, *arabic majma' al-fiqh al-islami*) organised a similar meeting in 1990. They reviewed several studies about frozen embryos that are almost identical with the studies examined at the IOMS meeting in 1989.

Unlike the IOMS, the IFA opposed the scientific use of frozen embryos. In their decree, they emphasized that:

> In view of what has become reality concerning the possibility to store non-fertilized oocytes for late use, it is necessary to restrict the number of fertilized eggs to the number necessary for a single treatment, in order to avoid a surplus of fertilized eggs. If for any reason such a surplus of fertilized eggs is brought about, they are supposed to be left without medical help, so that the life of this surplus may end in a natural way.

This argument is based on the fear of the misuse of embryos, rather than on any theological or philosophical reasoning. Moreover, in the *shari'a*, any form of IVF implying procreation outside of the framework of an existing legal marriage would be forbidden. Therefore, the embryo could not be implanted after divorce or if the donor of either the oocyte or the sperm had died. In other words, those embryos would suffer no legal harm by their destruction, because, according to the *shari'a*, they could not have developed legally into a human being anyway. Hence, this would free up "spare" frozen embryos for research or discarding. The moral significance of the early embryo therefore remains at the center of the controversy associated with permission to use it.

Despite this controversy, for those Muslim jurists who want to provide moral-legal justification for the use of "spare" embryos as the source of human ESCs for research, juridical solutions are not hard to deduce.

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THANK YOU