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Stem Cells: Ethical and Religious Issues

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1. Introduction

Stem cells are capable of generating various tissue cells which can be used for therapeutic approaches to debilitating and incurable disease. Even though many applications of stem cells are under investigation, such research has raised high hopes and promises along with warnings and ethical and religious questions in different societies. Generally, there is little concern about using non-human or adult stem cells. However, embryonic stem cell research has been confronted with questions from medical professionals, the public, religious groups, and national and international organizations. The debate is partly related to "personhood" and the notion of human dignity. Sources of stem cells, the moral status of human embryo, the slippery slope toward commercialisation of human life, concerns about safety, germ line intervention and the challenge of proportionality are some ethical issues.

Stem cell research is a promising but controversial issue on which many religions have taken strong positions. The point at which human life begins is a pivotal challenge. Conception, primitive streak development, implantation, ensoulment and birth are specific stages in which different groups claim dignity begins in the course of human development. In this chapter, we will review the history and scientific facts of stem cells in brief; then, ethical considerations will be discussed. Our other aim is to clarify the religious debate on the issue, particularly monotheistic perspectives. Some related international and national guidelines will be reviewed in brief.

2. Definitions

In vivo (normal reproduction) or in vitro fertilization (IVF) of ova (female germ cells) and spermatozoa (male germ cells) forms *zygotes* which contain the total genetic materials, one half from the male DNA and one half from the female DNA. In favourable condition, the zygote divides and forms the *blastomere* (8 cells), and then the *blastocyst* (120-150 cells) around day five. Blastocysts consist of stem cells. At this stage, division of a blastocyst may produce two or more normal human embryos. During the third week of human development, the *primitive streak*, which is the primitive central nervous system, appears. At this stage, the embryo is a unique entity which is no longer twinnable. Some scientists consider this point as the moment when human life begins as such (Balint, 2001).

Stem cells in blastocysts are capable of differentiating along each of the germ layers of the ectoderm (skin, nerves, brain), the mesoderm (bone, muscle), and the endoderm (lungs, digestive system) (Hyun, 2008). After this stage of human foetus development, stem cells

can be also found in different tissues but their capability is limited. For instance, as Lewis (2009) stated, while mesenchymal stem cells are able to produce bone, cartilage, and muscle, bone marrow stem cells can give rise only to white blood cells. The following part sheds more light on the issue.

3. Stem cells: The facts and promises

Stem cells are undifferentiated cells with the capacity of renewal which can be used for regeneration of body cells and tissues. Many potential therapeutic benefits are defined for different types of stem cells. Based on the power of differentiation, stem cells can be classified as totipotent, pluripotent, multipotent, and unipotent (table 1).

Term	Definition	Example	Sources
Totipotent	Able to produce an entire being	Blastomeres	Fertilized egg driven cells (1-3 days embryo)
Pluripotent	Able to differentiate to germ layers of ectoderm, mesoderm and endoderm	Embryonic stem cell	5-14 days embryo
Multi potent	Able to produce many cell types and self-renew over the lifetime of the being and over many subsequent generations if transplanted	Hematopoietic stem cell	Cord blood, fetal tissues, bone marrow, Adult stem cells
Unipotent	Able to differentiate to only one lineage, and with limited or no capacity of self-renewal	Neural stem cell	Adult stem cells
Induced pluripotent (iPS)	Normal adult cells reprogrammed to an embryonic state, able to produce all tissues	---	Derived from a non-pluripotent cell

Table 1. Stem cell classification and potential for differentiation.

Embryonic stem cells (ESCs) are able to produce all tissues and germ lines (sperm and eggs) and to self-renew indefinitely. These pluripotent stem cells were first isolated in 1998. However, the resources of ESCs are limited, and since human embryos have to be destroyed for ESC production, many people oppose the use of this kind of stem cell for scientific research or therapeutic approaches.

ESCs can be produced in the laboratory in two ways: by derivation from the inner cell mass (ICM) of a blastocyst in a 5-14 days embryo, or by somatic cell nuclear transfer (SCNT). SCNT or cloning, which was brought into public attention after cloning of the sheep "Dolly" in 1997 (Wilmut et al., 1997), is also used as a technique to produce stem cells for basic developmental biology research and cell-based therapies. Through cloning, the DNA of an unfertilized egg is replaced with the DNA of the patient's cell. Although a Korean scientist claimed to extract stem cells from human cloning in 2004 (Hwang, 2004, 2005), his work was recognized as a scientific fraud later on (Kennedy, 2006). Although there are important

concerns about the safety of cloning, as Fischbach and Fischbach state, stem cells produced by therapeutic cloning have the advantage over those harvested from embryos resulting from IVF or aborted fetuses in that the cells generated through therapeutic cloning are genetically similar to the cells of the individual who donated the nucleus (Fischbach & Fischbach, 2004), therefore they are immunologically matched to the patient, which avoids problems of rejection (Coors, 2002; Weissman, 2002). Another source of pluripotent cells are human embryonic germ (hEG) cells which are derived from the gonadal ridges of aborted fetuses (Gogle et al., 2003; Balint, 2001).

Multipotent stem cells have a research history of more than 40 years and have been successfully used for treatment of some disorders such as leukaemia for decades (Hyne, 2008). The use of these stem cells is surrounded with less ethical and religious debate since they can be naturally found as adult stem cells throughout the body; however, their limited potential of differentiation has restricted their practical uses. Also, mass production of multipotent (and unipotent) stem cells is time consuming.

Inactive adult stem cells (SCs) exist in many tissues and need to be signalled. Haematopoietic SCs, which are used for bone marrow transplantation in oncology, are a good example of the use of this kind of SCs in cell and tissue transplantation. Medical waste, such as amniotic fluid, placenta, menstrual blood, synovial fluid from knee, teeth, liposuction aspirate, umbilical cords, is a source of adult stem cells (Lewis, 2009).

Induced pluripotent stem (iPS) cells have been reprogrammed with retroviruses to behave like embryonic stem cells (Hyne, 2008). The methods that reprogram adult human cells to a pluripotent state were described firstly by two groups of researchers from Japan and the United States (Takahashi et al., 2007; Blow, 2008). Considering the mutagenicity of the viruses and the potential to activate oncogenes, and the debate on their properties and potential as embryonic stem cells, iPS cells are not used as a practical therapeutic agent yet (Blow, 2008). Further experiments showed that reprogramming genes can be done in safer ways without the use of viruses (Lewis, 2009).

The main potential use of stem cells in medicine is for cell and tissue replacement therapies. There are hopes for lifelong treatment of disorders such as Huntington's disease, Parkinson's disease, type 1 diabetes mellitus, myocardial infarction, spinal cord injuries, stroke, chronic skin ulcers and burns by transplantation of stem cells. The utilization of stem cells in the treatment of Alzheimer's disease, avascular necrosis, neural deafness, osteoarthritis, liver failure, and some autoimmune disorders including multiple sclerosis (MS), rheumatoid arthritis, and systemic lupus erythematosus (SLE) is also under research.

Stem cell research may pave the way for designing novel approaches in regenerative medicine. Since ESCs can proliferate without limit and can differentiate to any cell type, they offer unprecedented access to tissues from the human body, and they have the potential to provide an unlimited amount of tissue for transplantation therapies to treat a wide range of degenerative diseases (National Institute of Health [NIH], 2006). Genetic research, understanding of normal development, research on the differentiation of human tissues, and birth defects investigations are other potential uses of stem cells. Stem cells can be used for drug development and toxicity tests too. They can support research on safety and efficacy of new drugs.

The therapeutic potential of stem cells has been publicized, and much related public enthusiasm has been reflected in some stories and movies. There are scientific, ethical, legal, religious, and social challenges for the use of stem cells for cell and tissue transplantation.

The concerns should be addressed before the widespread use of this science and technology. We intend to review main ethical issues and religious perspectives in the following sections.

4. Ethical issues

Moral arguments for and against stem cell research and therapy are many, regarding issues such as the types of cells, the sources and techniques of production, and utilization. There are few concerns about research on or therapeutic uses of adult stem cells. But embryonic stem cells have been associated with serious ethical debates. The use of this new science and technology for human reproduction has triggered ethics and policy disputes around the world. Human cloning has been a cause of concern for ethicists, lawyers, religious scholars, sociologists and politicians, among others.

There are different challenges in different societies. The study by Zarzeczny and Caulfield (2009) confirms the complexity of the issues raised by stem cell research. The results of this study, which was carried out in Canada, suggest some main themes, including: theories/views on policy development, issues with focus on science and health, issues related to the supply of embryos, debates on novel technologies such as cloning, non-embryonic sources of stem cells, jurisdictional competition, intellectual property issues, the need for guidelines and standards, research funding issues, and stem cell tourism (Zarzeczny & Caulfield, 2009).

Related ethical issues may be discussed using different ethical approaches, such as utilitarianism, deontology, and principlism. Each approach may justify or reject the use of stem cells in research or therapeutics. For instance, according to the utilitarian approach, the consequences of stem cell utilization should be assessed using the benefit to harm ratio as a measure to accept or reject the new technology. In a deontologic (duty-based) approach, the duty to help those who suffer or to save lives may permit research or therapy with stem cells. In principle-based ethics, various principles should be discussed collectively to evaluate the rightness or wrongness of use of stem cells.

People who oppose or support stem cell research can be philosophically divided into different categories. For instance, some opponents emphasize the dignity of human beings and that every person is an end and not only a means to some other end. This idea is consistent with deontology. It means that every person, likely including a foetus, should be respected and protected (Balint, 2001). On the other hand, those who support research on human stem cells, either in religious or secular bioethics, support the advantages of such research to save human lives and the duty to relieve suffering in accordance with utilitarian and duty-based approaches. Some even go so far as to state that such research is a "moral imperative", considering the potential benefits of ameliorating human suffering (Balint, 2001).

There are important issues, such as respect for human dignity, which may influence these discussions. Ethical issues will be discussed in the following without reference to the philosophic basis.

4.1 Human dignity

In the process of stem cell research, stem cells must be extracted from the blastocyst, so the human embryo is destroyed. Opponents of stem cell research claim that the destruction of human embryos is morally equivalent to the killing of a human being.

The morality of destroying human embryos for the benefit of others is the main argument in both secular and religious bioethics. Opinions regarding the ontological status of pre-

implantation embryos vary widely. Some hold the "conceptionalist" view, according to which the embryo is a "person", considering its potential to develop into a person. Others believe that the embryo (and even the fetus) is a "non-person", and that it ought not to be attributed much, if any, moral status (DeWert & Mummery, 2003).

There is another viewpoint of the "relative value" of human embryos, more than cells but less than persons (Hinman, 2009). This view states that embryos deserve respect but not to the same extent as a fully developed person. According to this moral argument, the moral status of a human embryo gradually increases through its development in the uterus, and at the point of birth it is entitled to enjoy full rights of human beings (United Nations Educational, Scientific and Cultural Organization, 2004).

Another moral argument states that the status of embryos differs across milestones in the process of embryonic development (United Nations Educational, Scientific and Cultural Organization, 2004). In this argument, the question is at what point after fertilization of egg by sperm the cell mass becomes a human being. This seems an ethical impasse which science may not be able to resolve. For ethical decision making on stem cell research, we should determine when a new human entity comes into existence. According to the scientific facts, there are significant points for delineation of human embryos, including: the moment of fertilization, the point of implantation in the uterus, the initial appearance of the primitive streak (19 days), the beginning of heartbeat (23 days), the development of brain waves (48 days), the point at which essential internal and external structures are complete (56 days), the point at which the fetus begins to move (12-13 weeks) (Hinman, 2009), and the point when the foetus would be viable outside the uterus (Balint, 2001).

As mentioned above, during the third week of human embryo development, the primitive streak develops and three germ layers appear. Before this stage, embryos can split and produce two or more embryos; however, after development of the primitive streak, the embryo is a unique entity. In view of this fact, many believe that ontological individuality starts at this point, hence the embryo can be used for research prior to this stage; up to 14 days of development (DeWert & Mummery, 2003).

Religious schools also make various points which will be discussed later. There is no doubt that an embryo is a living being whether or not it merits human rights. However, an entity would have the full rights and privileges of human beings when personhood begins.

There are different views on preimplantation embryos. Some bioethicists suggested "the trajectory argument" to defend the human rights of a human embryo before implantation (Hinman, 2009). According to this argument, since an early embryo has the potential to be a human being in the future, it deserves protection. However, others claim that an entity before implantation is no more than a seed. There is also another viewpoint, according to which human embryos, even if they are not persons, deserve respect (Hinman, 2009). As Hinman (2009, slide 20) concludes: *"We can see some advocates of both sides of the hESC debate as accepting the general principle of respect for innocent human life; their disagreement may not be over the principle, but over the way in which the principle is to be applied in particular cases."*

The fear of "instrumentalization" of human embryos is a barrier to create embryos (DeWert & Mummery, 2003). However, despite opposition to creation of embryos for research, there are arguments in support of the use of spare embryos in the process of IVF as sources of embryonic stem cells because such embryos would be destroyed anyway. Several hundred thousands of unwanted embryos are discarded annually in IVF clinics. The use of such embryos before the appearance of the primitive streak is supported by many ethicists.

However, as stem cells that are derived from surplus embryos may cause immune rejection when transplanted to a patient, some researchers emphasize the production of genetically identical stem cells by the use of cloning or other techniques in order to avoid immune rejection in transplantation (United Nations Educational, Scientific and Cultural Organization, 2004).

The research carried out in Canada (Zarzewny & Caulfield, 2009) shows that even though issues related to the moral status of embryos continue to be a main issue in the literature on stem cell research, discourses associated with the moral status of embryos may not receive the same attention in social and other realms. For instance, while the moral status of embryos has a central role in legal discourse, it plays a relatively minor role in print media (Zarzewny & Caulfield, 2009).

4.2 Safety

Many people are excited about the potential benefits of stem cells in clinical practice. There are many claims about the power of stem cells as an unparalleled cure in medicine. Potential benefits coupled with great public interest have produced significant pressures on scientists to continue research. Along with the promises, stem cell science poses a threat to human safety. As Dresser (2010) states, many claims about the therapeutic power of stem cells lack a solid evidentiary foundation and many data are not examined in human clinical trials. In other words, there is much to learn regarding the use of stem cells for the treatment of diseases. Therefore, prior to any decision about using stem cells, their safety and efficacy must be determined.

Risks of stem cell treatment, including tumors after stem cell injections (Amariglio et al., 2009, as cited in Lindvall, et al., 2004, 2006), drew attention to safety issues and importance of medical and ethical standards before clinical application of this new type of treatment. Some who agree with stem cell research claim that such research is still in the early stages and very far from clinical, therapeutic or reproductive uses.

Based on the principle of non-maleficence, harms to the embryo cannot be justified by future benefits to society. It is also suggested that "... *the harm done to the society by allowing the destruction of embryos is more significant.*" (Balint, 2001).

4.3 Informed consent

Many scientists believe that people are misinformed about stem cells, their sources, their potential benefits, and harms. It also seems that medical companies and industries are optimistic about stem cell future. So, a demand for stem cell research and therapy has been created in many societies. Some centres for the treatment are in countries with a lesser ethical oversight, such as China and some Eastern European countries. An increase in stem cell tourism has received attention in many countries (Zarzewny, 2010). For these reasons, disclosure of information to patients and their families is essential. Murdoch et al (2010, page 21) have emphasized that such disclosure should have at least three elements:

1. *Disclose and discuss the potential for real physical, psychological, and economic harm from the interventions and travel, including costs of the procedure relative to patient's means.*
2. *Disclose and relay independent scientific evidence of risk or benefit for a defined intervention.*
3. *Disclose any evidence of ethical misconduct or questionable practices. This includes:*
 - *Failure to supply local and national evidence of oversight.*
 - *Engaging in questionable patient recruiting practices.*

- *Clear misrepresentation, fraud, or patient abuse.*"

As mentioned before, the extra embryos of IVF clinics which are no longer wanted by the parents are sources for stem cell research. Obtaining consent for such embryos is problematic. There are questions of whether consent of biological parents is enough and how the consent should be obtained and recorded. Also, as Balint (2001) states, there may be emotional pressure on parents to consent. The parents' feelings and beliefs may also cause additional anxiety and a sense of guilt about embryo donation for use in research.

Consent of gamete donors in cases of IVF should also be obtained and recorded. Many ethicists are worried about risks to women who participate in the egg production process. In the Korean cloning fraud, one ethical problem was related to the egg collection from the subordinate women staff, which raised the issue of coercion and violation of their rights (Longstaff et al., 2009, as cited in Saunders & Savulescu, 2008). From a feminist perspective, the instrumental use of women in the process of the creation of embryos for research is an important concern, since the creation of human embryos for research purposes requires the harvesting of eggs from women (United Nations Educational, Scientific and Cultural Organization, 2004). In animal cloning, there is a need for hundreds of unfertilized eggs to produce one cloned embryo. In women, there has to be a period of hormone treatment followed by invasive surgery to obtain oocytes for research purposes. In addition to the risk of exploitation of women and commercialization of human eggs (United Nations Educational, Scientific and Cultural Organization, 2004), there may be life-threatening risks such as Ovarian Hyper-stimulation Syndrome (OHSS).

4.4 Slippery slope

A slippery slope argument is used by opponents of stem cell research, who cast doubt on the morality of the use of stem cells by reasoning that if we accept the creation and destroying of human embryos in the process of such research, there is no logical cut-off point by which we can distinguish the point at which destroying a human embryo is permissible. As Evers (2002) states, it may open the way to a slippery slope of dehumanizing practices, such as embryo farms, cloned babies, the use of fetuses for spare parts, and the commodification of human life.

The right to reproductive freedom in individualistic social systems may be used to justify reproductive approaches with use of stem cells. Some opponents claim that eradication of an entity like a human zygote is similar to abortion, which thus has a link to stem cell research (Dresser, 2010). All societies should take a stand on the issue of eradication of human embryos in the process of stem cell research.

4.5 Resource allocation and commercialization

There are many patients, scientists, politicians and even bioethicists who have paid tribute to stem cell therapy and its hypes and hopes (Murdoch, et al., 2010), despite debates on safety and efficacy. Commodification of human embryos is a concern expressed by many ethicists. There may be loss of equity in access to stem cell benefits, as many people would not be able to pay the high cost of this new treatment.

Resource allocation and distributive justice are related important issues. Limited resources of health care systems raise questions about research priorities in many societies. Stem cell research is expensive, and its outcome may not be useful for many patients or healthy people. Thus, it could be argued that money can be more effectively spent for more

important health care plans which cover a vast range of diseases and large numbers of the general population.

However, many argue that banning stem cell research by governments would not stop such research in the private sector. Private research can raise concerns about commercialization of stem cell research, which may result in unfair distribution of benefits within society (Balint, 2001). So, some conclude that federal funding and support of research on embryonic stem cells is the only approach that may guarantee the fair distribution of benefits (Balint, 2001). Moreover, such policy can provide the way for more strict observance of ethical standards by researchers.

Private sectors usually tend to allocate their resources to fields with high potential of financial gain. However, priority of resource allocation in the public budget by governments depends on some other factors, including: public health needs, scientific value of the proposal, potential for advances in a particular area, distribution across diverse research areas, and national training and infrastructure needs (Dresser, 2010). Funding stem cell research is not considered a research priority in some countries, due to other health care needs and limitations of health budget. Many underdeveloped or developing countries are obligated to devote research funds to common disorders with high rates of mortality and morbidity.

Stem cell tourism and fear of negative health consequences due to lack of enough oversight are other concerns which have attracted special attention among ethicists and medical practitioners. Such matters deserve separate discussion elsewhere, particularly as they are not unique to stem cells.

4.6 Other issues

Many ethical issues associated with the use of stem cells apply to biomedical research generally. Some issues which were discussed above, such as priorities of research and allocation of limited resources, disclosure of truth about benefits and harms, and obtaining consent, are prominent in stem cell research. Paying appropriate attention to research integrity and related matters such as responsible conduct of research, ownership of data, and authorship, are particularly emphasized in this field.

Another relevant general ethical issue is that of conflict of interests. There are financial interests for researchers who work in this field. Honesty and openness of researchers, along with appropriate independent review of research, are required.

Some issues are more specific and require special attention. For instance, stem cells can be used for the study of normal development of human embryos and for genetic research. Therefore, concerns about germ lines interventions attempting eugenics have been raised (Balint, 2001).

An issue is the principle of subsidiarity, according to which stem cell research can be ethically permissible only if there are no alternatives (DeWert & Mummery, 2003). Some options have been discussed as alternatives of human embryonic stem cells, which consist of: human embryonic germ (hEG) cells, adult stem cells, and xenotransplantation. For comparison of these alternatives, many elements should be analysed, including: burdens and/or risks, the chance of success and applicability, and the time-scale in which clinically useful applications are to be expected (DeWert & Mummery, 2003). Low success rates of the use of hEG cells and uncertain outcomes, and cross-species infections caused by xenotransplantation and high rates of immunity rejection are the barriers for the first and third alternatives.

Adult stem cells experiments have had great success in recent decades. Scientists have been studying them since the 1960s (United Nations Educational, Scientific and Cultural Organization, 2004). Avoidance of immunity system rejection problems is an important advantage of these cells. However, there are many doubts about their developmental potential and their proliferation capacity as a substitute for embryonic stem cells (Kuehnle & Goodell, 2002; Gavaghan, 2001).

As mentioned above, iPS cells are suggested as another alternative for human embryonic stem cells (Hyne, 2008; Takahashi et al., 2007; Blow, 2008). Many experiments have been done in recent years to test the efficacy and safety of this novel option (Lewis, 2009).

Aborted fetuses are suggested as sources for obtaining germ line stem cells, though critical issues are raised (Balint, 2001). Women coercion, their safety, stem cell recipient safety, informed consent issues, and vulnerability of the fetus are concerns which cause this suggestion to remain controversial.

According to some advocates, stem cell research can save many lives. But the principle of proportionality urges ethicists to weigh potential benefits and harms. Pursuance of medical progress at any cost does not seem ethical.

5. Legislation and guidelines

During recent decades, stem cell research has posed a challenge for politicians and national and international regulatory agencies. Despite challenges across different societies, stem cell research continues to be conducted by researchers. The need for oversight and regulation to prevent unethical conduct and negative outcomes is recognized by many scientists. As a result, international and national bodies have tried to guide stem cell activities ethically.

General ethical guidelines such as the Belmont report (Department of Health, Education, and Welfare, 1979), Helsinki declaration (The World Medical Association [WMA], 2008), and International Ethical Guidelines for Biomedical Research Involving Human Subjects (Council for International Organizations of Medical Sciences [CIOMS], 2002) should be observed by stem cell researchers. There are also specific stem cell guidelines and standards internationally and in various countries.

Establishment of international ethical guidelines and legal frameworks for human cloning was considered at the end of the 20th century. The issue of reproductive cloning was discussed several times in United Nations agencies after the birth of Dolly in 1997. In 1998, the United Nations General Assembly endorsed a Declaration in which reproductive cloning of human beings was banned (United Nations Educational, Scientific and Cultural Organization, 2004).

The Universal Declaration on the Human Genome and Human Rights (The United Nations Educational, Scientific and Cultural Organization [UNESCO], 1997) (Section C-Article 11), and the report of UNESCO's International Bioethics Committee (IBC) on "The Use of Embryonic Stem Cells in Therapeutic Research" (UNESCO, 2001) were compiled to address these complex issues in different societies. Other international organizations such as the World Health Organization (WHO) compiled relevant resolutions too.

The International Society for Stem Cell Research (ISSCR) has also tried to address relevant scientific, cultural, religious, ethical, and legal differences across national borders by preparation of the "Guidelines for the Conduct of Human Embryonic Stem Cell Research" (ISSCR, 2006). The mission of the taskforce for compiling the guidelines was stated as: "...to emphasize the responsibility of scientists to ensure that human stem cell research is carried out

according to rigorous standards of research ethics, and to encourage uniform research practices that should be followed by all human stem cell scientists globally." Due to the ever-increasing therapeutic uses of stem cells in clinical practice, the "Guidelines for the Clinical Translation of Stem Cells", were compiled in 2008 (ISSCR, 2008). The Guidelines address three major areas of translational stem cell research: (a) cell processing and manufacture; (b) preclinical studies; and (c) clinical research.

As to the disputes on the time when personhood starts, the guidelines and Acts determine this. The United Kingdom's Human Fertilization and Embryology Act, for instance, determines the point of primitive streak development as the point when human life begins and research must be stopped (Balint, 2001, citation of Human Fertilization and Embryology Act, 1990).

As Childress (2004) emphasizes, the connection between ethics and public policy remains important. Two types of public policies have special relevance to human stem cell research, public policies on use of governmental funds, and public policies on whether, apart from the use of governmental funds, to permit, regulate, or prohibit activities such as human cloning (Childress, 2004).

Many societies have attempted to characterize the legal status of the human embryo and regulate stem cell research. Considerable differences exist between countries in the regulation of stem cell research. In the United States, the National Bioethics Advisory Committee (NBAC) decided that creation of embryos purely for research purposes was not acceptable, while in the United Kingdom, the Human Fertilization and Embryology Authority permits the creation of embryos for research but the embryos must never be implanted (Balint, 2001). In addition, in the United Kingdom and some other countries where stem cell research under national regulations is permitted, there are standard guidelines and recommendations for public and private sectors; there are no such regulations and supervision in the US (Balint, 2001). The National Institutes of Health (NIH) provided guidelines on Human stem cell research with the aim of "*Removing Barriers to Responsible Scientific Research Involving Human Stem Cells*" (NIH, 2009).

In Canada, *Human Pluripotent Stem Cell Research Guidelines* released by the Canadian Institutes of Health Research (Canadian Institutes of Health Research, 2010), and the Assisted Human Reproductive Act (Health Canada, 2004), are the most important regulations concerning the use of stem cells in research and reproductive technologies.

In Costa Rica and Germany, eradication of embryos for research purposes is prohibited. Some countries, such as Belgium and the United Kingdom, allow research on surplus embryos and created embryos within 14 days after fertilization. In Denmark and Japan, while research on surplus embryos is permissible, the creation of embryos solely for research purposes is prohibited (United Nations Educational, Scientific and Cultural Organization, 2004). Many European countries have prohibited reproductive cloning, but there is a wide spectrum of diverse religious and secular beliefs about that (Nippert, 2002). In the Middle East, Iran, as a pioneer country in stem cell research (Ilkilic and Ertin, 2010; Saniei and De Vries, 2008) that reported the establishment of a new stem cell line in 2003 (Baharvand et al, 2004), has recently established ethical guidelines for stem cell research and treatments in the country (Nejad-Sarvari et al, 2011).

Banning public funding for stem cell research in some countries like the US caused some worry about potential "brain drain", but funding the research costs by non-profit and private sectors has offered many opportunities for scientists to follow such research in these countries (Dresser, 2010).

6. Religious perspectives

As mentioned before, determination of the moment at which human life begins is pivotal in stem cell debates. Ensoulment is defined as the time when the entity becomes a human being, based on many religions' perspectives, although the moment when the soul arrives is long disputed.

Judaism considers the extracorporeal embryo in the preimplantation stage as genetic material, so stem cell research is permissible according to most branches of Judaism (Hinman, 2009; Childress, 2004; Ohara, 2003; Bioethics Advisory commission, 2000). A human embryo is not considered as sacred until the fourth month of pregnancy, according to most Jewish scholars (Pompe et al, 2005). Owing to this fact, research on stem cell and human embryos is allowed in this period.

In Christianity, while the current dominant belief is that ensoulment occurs at the moment of conception, the Roman Catholic theologian, Thomas Aquinas, believed that the soul arrives around the third month of pregnancy (quickening). St. Augustine believed that personhood begins with ensoulment at forty days of gestation, in accordance with Aristotle's and Talmudic scholars' views (Balint, 2001). Although this opinion was accepted by Popes innocent III (1211 AD) and Gregory XIII (1550 AD), increased use of abortion in the 18th century led to a change in the Church's thinking. As a result, Pope Pius IX decreed that ensoulment occurs at fertilization, and his viewpoint was followed by the Orthodox Church (Balint, 2001).

Currently, the Catholic Church believes personhood begins at conception (Daar et al., 2004). Despite strong opposition of Catholics to stem cell research, Protestants have a wider range of views (Childress, 2004; Ohara, 2003; Bioethics Advisory commission, 2000). Less conservative Protestant Christians support stem cell research at least before the development of the primitive streak at 14 days after fertilization (Fadel, 2007).

Most Muslim thinkers accept embryonic stem cell research (Childress, 2004; Ohara, 2003; Bioethics Advisory commission, 2000), although there are obstacles to the research in some Islamic countries (Ilkilic & Ertin, 2010). According to Islamic teachings, decisions on stem cell research and cloning research should be based on advantages and limitations. Considering inevitable consequences of reproductive cloning, it is prohibited by many Muslim religious authorities; however, stem cell research and cloning for therapeutic purposes is sometimes permissible with precautions in pre-ensoulment stages of fetus development (Larijani & Zahedi, 2004). Most branches of Islam consider ensoulment as the moment when the entity would have a full value of human beings, though the moral singularity of humans occurs at implantation.

Holy Quran depicts the different stages of human development in the womb in verses 12-14 of the chapter (Sura) of Al-Mumenuon (the Believers). Based on these verses and some other Islamic resources, it is accepted by Muslim scholars that ensoulment takes place at 120 days after conception (Aksoy, 2005; Morrison and Khademhosseini, 2011). It is noteworthy that in Islam human embryonic life is entitled to respect at any stages even before the breathing of spirit into the fetus (Fadel, 2007); however, the respect grows as the weeks pass until ensoulment when the child deserves the full respect of human being. As Ilkilic and Ertin (2010) state "...the ensoulment gives the embryo an exceptional moral status, which is decisive for the ethical assessment of any medical intervention affecting the embryo." So, experimental activities and therapeutic uses of stem cells are permissible before ensoulment with necessary precautions when they are justifiable based on Islamic

principles such as the public interest. Looking for scientific advancements and seeking new treatments for human disorders may also apply to justify the use of human embryonic stem cells (Fadel, 2007).

The source of stem cells has been considered by Islamic scholars in issuing fatwa (religious decree) on permissibility of stem cell research. For instance, the scholars in the conference of the Muslim World League's Islamic Jurisprudence Council held in Mecca in 2003 issued that the use of stem cells for therapy or scientific research is permitted as long as the cells' sources are permissible. Adults who consent, placenta or umbilical cord blood, excess fertilized eggs produced during the course of IVF and spontaneously aborted embryos are some acceptable resources, and intentionally aborted fetuses are forbidden to be used as a source for stem cells (Fadel, 2007, citation of Muslim Word League, 2003).

7. Conclusion

Human stem cells have introduced many hopes in medicine. There are still many scientific questions and unknowns surrounding the issue. Stem cell therapeutic options may not have widespread application in the short term. Significant concerns exist about the ethical, social and legal consequences of the use of the cells in research and treatment. Bioethicists, religious leaders, regulatory bodies, and political bodies have discussed these matters and attempted to address the consequences in appropriate ways. We aimed to review some relevant challenges in this chapter, in the hope of strengthening the relation between science and ethics. The various positions that different monotheistic religions have adopted regarding this novel type of research were also reviewed in this chapter.

Stem cell science is rapidly evolving in the world; however, finding alternatives and carrying out parallel research are important. While some scientists believe that ethical concerns are barriers to scientific progress, others are worried about the harms and seek new alternatives such as iPS cells which can address the issue of human dignity in the field of stem cell research.

Given the promises of stem cell research, it seems that there is a conflict between the duty to reduce suffering and the duty to respect human life. It is more sensible to regulate stem cell research than to ban it. In countries with government-sponsored activities in the field of stem cell research, ethical observance and control over private and public activities can be more effectively maintained.

Stem cell markets and tourism should be controlled, regulated and supervised. The general public should be engaged more actively in this discussion and in finding solutions and guidelines.

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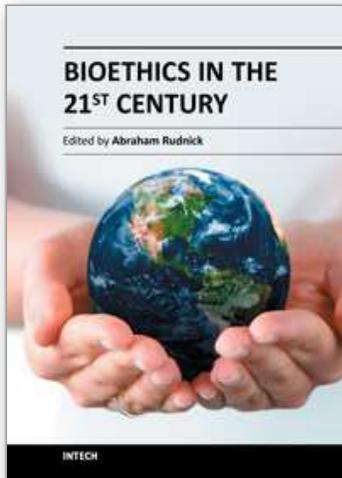
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Bioethics is primarily an applied ethics of health related issues. It is considered an important guide for health care and its discourses and practices. Health related technology, such as information technology, is changing rapidly. Bioethics should arguably address such change as well as continue to address more established areas of health care and emerging areas of social concern such as climate change and its relation to health. This book illustrates the range of bioethics in the 21st century. The book is intentionally not comprehensive but rather illustrative of established, emerging and speculative bioethics, such as ethics of mental health care, ethics of nano-technology in health care, and ethics of cryogenics, respectively. Hopefully the book will motivate readers to reflect on health care as a work in progress that requires continuous ethical deliberation and guidance.

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