



DEVELOPMENTS IN STEM CELL RESEARCH AND THERAPEUTIC CLONING: ISLAMIC ETHICAL POSITIONS, A REVIEW

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Keywords

embryonic stem cell research, therapeutic cloning, Islam, Islamic jurisprudence, induced pluripotent cells, ethics, Islamic countries

ABSTRACT

Stem cell research is very promising. The use of human embryos has been confronted with objections based on ethical and religious positions. The recent production of reprogrammed adult (induced pluripotent) cells does not – in the opinion of scientists – reduce the need to continue human embryonic stem cell research. So the debate continues.

Islam always encouraged scientific research, particularly research directed toward finding cures for human disease. Based on the expectation of potential benefits, Islamic teachings permit and support human embryonic stem cell research. The majority of Muslim scholars also support therapeutic cloning. This permissibility is conditional on the use of super-numerary early pre-embryos which are obtained during infertility treatment in vitro fertilization (IVF) clinics. The early pre-embryos are considered in Islamic jurisprudence as worthy of respect but do not have the full sanctity offered to the embryo after implantation in the uterus and especially after ensoulment.

In this paper the Islamic positions regarding human embryonic stem cell research and therapeutic cloning are reviewed in some detail, whereas positions in other religious traditions are mentioned only briefly.

The status of human embryonic stem cell research and therapeutic cloning in different countries, including the USA and especially in Muslim countries, is discussed.

Stem cell research has generated lengthy and heated debates in scientific literature and religious circles as well as in the political arena. Its prospect of leading to the cures of many debilitating diseases and malignancies is pitted against the moral principle of protecting human life from the time of its inception.

The embryonic stem cells (ESCs) are the original cells from which all the 220 different types of cells that compose the human body develop. When the egg is fertilized by a sperm it becomes a zygote, which begins to divide into 2, 4, 8, 16 cells etc., making a morula that subsequently becomes a blastocyst with an outer wall and an inner cell mass consisting of pluripotent stem cells. These cells continue to divide and start to differentiate into multipotent and then progenitor cells, which develop

into the various types of cells that eventually make the different tissues and organs of the body.¹

The ESCs used in research are the pluripotent cells derived from the inner cell mass. Most ongoing research has been utilizing ESCs derived from murine sources. The first human ESCs (hESCs) lines were developed in 1998.² Since then, many other cell lines have been developed in other labs in many countries.

¹ A.M. Wobus & K.R. Boheler. Embryonic Stem Cells: Prospects for Developmental Biology and Cell Therapy. *Physiologic Review* 2005; 85: 635–678.

² J.A. Thomson et al. Embryonic Stem Cell Lines Derived from Human Blastocysts. *Science* 1998; 282: 1145–1147.

Stem cells are also present in adult tissues in small numbers. They may be able to replace lost or damaged cells but they have a limited potential of self renewal. Their ability to transdifferentiate into cells of another lineage is very limited compared with that of ESCs. There is probably one exception, umbilical cord blood (UCB) SCs. These show a great promise in their ability to differentiate into other cells.

The ability of ESCs and UCB stem cells to transdifferentiate opened the field of regenerative medicine, whereby the newly acquired cells can be made to replace and/or regenerate damaged cells, e.g. neurons to treat, for example, Parkinson disease, pancreatic beta islet cells to treat type 1 diabetes mellitus or cardiomyocytes to treat patients with myocardial infarcts.

Moreover, ESC research will allow the study of the basic biology of cells, the process of fertilization, implantation and embryonic development. Such information can be used in the treatment of infertility, repeated miscarriages, etc. It will also allow the understanding of mechanisms of diseases, especially genetic diseases and malignancies. It could make gene therapy a reality by introducing a normal gene or genes into the developing embryo to replace or compensate for the defective gene. In addition, SC research could allow the study of the efficacy and toxicity of drugs, particularly on the developing human embryo (embryotoxicity) to avoid such calamities as the thalidomide experience.³

These are lofty goals but have not been achieved. However, there have been definite cures, based on stem cell therapies, of diseases such as leukemias and many other malignancies and hematologic disorders of children. These were successfully treated with bone marrow derived stem cells and more recently with UCB stem cell transplants. Nevertheless, scientists still believe that ESCs (ideally hESCs) hold much greater promise and that the pursuit of that research should be continued.

To obtain hESCs one has to destroy a 5–7-day-old embryo. Even though it is only 5–7 days old, it is still ‘human’. Here lies the ethical dilemma. SC research definitely promises worthwhile goals but it brings into conflict two fundamental moral principles:

- 1 the duty to prevent or alleviate human suffering
- 2 the duty to respect human life.

The crux of this conflict is the question whether the 5–7-day-old embryo is a human being entitled to protection against harm or destruction.

Moralists have divergent views. Some consider that the fertilized ovum (zygote) has full moral status and should not be subjected to research/destruction.⁴ Other moral-

ists, at the other end of the spectrum, argue that the embryo is merely a ball of cells with no moral status.⁵ The majority of moralists, however, take a middle-ground view: that the zygote has a moral status but may only become deserving of protection at a later stage of development. In this view the embryo does not acquire ‘personhood’ till the end of the second week, 14 days after fertilization. Before then, they call it a ‘pre-embryo.’ They base this view on the fact that the pre-embryo has no nervous system and cannot be considered sensate. Only at the end of the second week will there be no possibility of twinning. Also at that time the primitive streak appears. This establishes the head-tail and right–left orientation and along which the major tissues and organs begin to differentiate.⁶

Theologians also have a wide range of views about the humanity of the early embryo and whether it is permissible to tamper with it. Their views are based on their concept of when human life begins. I will briefly mention the views of different religious traditions but will discuss the Islamic viewpoint in more detail.

Judaism and most of the Protestant denominations support hESC research. The Catholic Church, the Eastern Orthodox (Greek/Coptic) Churches as well as the more Conservative Protestant Churches oppose it. Hindu and Buddhist religious bodies in general support hESC research. It is prohibited in the Taoist tradition.⁷

ISLAM

Islam literally means submission to the will of God, obeying His commands and abstaining from what He prohibited. Muslims believe that Islam controls their actions in both the spiritual and the material spheres of life. Muslims in performing any act should ask themselves whether it is permissible or not. The permissible and prohibited actions are embodied in the Islamic law or shariah. The primary sources of Islamic law are the Quran (the holy book of Islam) and the *hadith* or sayings and actions of the Prophet Muhammad, peace be upon him (PBUH), which are collectively called the ‘Sunnah’, or example, and are recorded in the books of *hadith*. The Quran outlines the basic principles and rules, whereas the *hadith* give more detailed regulations. New rulings about contemporary issues that do not have specific reference in

⁵ J. Harris. 1989. Should we Experiment on Embryos? In *Birthrights: Law and Ethics at the Beginning of Life*. R.G. Lee & D. Morgan, eds. London: Routledge: 85–95.

⁶ K. Hug. Therapeutic Perspectives of Human Embryonic Stem Cell Research Versus the Moral Status of a Human Embryo – Does One have to be Compromised for the Other? *Medicina* (Kaunas) 2006; 42: 107–114.

⁷ L. Walters. Human Embryonic Stem Cell Research: an Intercultural Perspective. *Kennedy Inst Ethics J* 2004; 14: 3–38.

³ Wobus & Boheler, *op. cit.* note 1, pp. 635–678.

⁴ J. Mahoney. 1984. Bio-ethics and Belief: Religion and Medicine. In *Dialogue*. London: Sheed & Ward Limited: 67–69.

these two sources are to be derived by a process of *ijtihad* (independent judgment). This is to be done by Islamic legal scholars (*fuqahā'*) or jurists. There are certain qualifications that have to be met for a scholar to be considered able to do *ijtihad*. There is certain well specified methodology to use to reach an opinion or a *fatwā*. These include *ijmā'* (consensus), *qiyās* (analogy), *istihsān* (juris- tic preference), etc.⁸

There are several basic Islamic principles that pertain to this topic. Humans occupy the highest place among God's creation. A verse of the Quran states: We honored the progeny of Adam.⁹

Health is considered among God's most important bounties. The person is not the real owner of his/her body. It belongs to God. It is a trust and one has to preserve it. Some Islamic scholars tend to consider medical research directed toward new treatments as a collective religious duty (*fardh kifāya*).¹⁰

Islam has encouraged people to contemplate and study nature, specifically how the universe was created. Many Quranic verses tell people to explore new horizons.¹¹

Prophet Muhammad (PBUH) ordered Muslims to get treated when they fall ill and to seek cures for all diseases. He is reported to have said 'God did not create a disease without creating its cure except senility (death). So children of Adam, seek cures but do not use *haram* (forbidden things) in the treatment.'¹²

So there is a clear directive for Muslims to engage in research in general and in medical research in particular. When it comes to hESC research where there is no precedent, scholars have to exert *ijtihad* utilizing the general principles of *fiqh* (Islamic law) such as:

All actions are in principle permissible as long as they are not categorically prohibited.

In matters in which other invocations are silent the concept of *maslaha* (public interest) applies. 'Where the welfare of the people resides there resides the statute of God.'¹³

The specific underlying question in hESC research is when life starts. There is no specific definition of the

timing of beginning of life in either the Quran or Sunnah. But there is a verse in the Quran that is generally understood to relate to this:

Man We did create from a quintessence (of clay). Then We placed him as a drop (*Nutfā*) in a place of rest firmly fixed. Then We made the drop into a clot that clings (*alaqa*). Then out of that We made a chewed lump (*mudgha*). Then We made out of that lump bones and clothed the bones with flesh. Then out of that We developed another creature. So blessed be God the best to create.¹⁴

This verse strongly indicates that the new creation (the person) exists only after some stage of embryonic development and not at the time of fertilization.

Muslim scholars, on the basis of this verse, described early life as occurring in two phases: biological and human. They generally agree that ensoulment, the breathing of God's spirit into the fetus, differentiates biological life that starts at fertilization from human life. This concept is an old one. A famous Muslim jurist of the fourteenth century, Ibn al-Qayyim, in his book *al-Tibyān fī aqsām al-Qur'ān* stated that the embryo and fetus before ensoulment has the life of growth and nourishment like a plant; but once the spirit is breathed into it, it acquires personhood.¹⁵ This view was expressed more recently by contemporary Muslim scholars.¹⁶

Another interesting argument supporting the differentiation of biological from human life is linguistic. The Arabic word for the embryo is *janīn* which means a hidden thing, as the embryo is hidden in the woman's uterus. Imam al-Shāfi'ī (d. 820), founder of one of the four Sunni schools of jurisprudence, has stated that the term *janīn* (embryo) should be applied to the conceptus only after the *mudgha* stage (see above).¹⁷

Scholars have identified the timing of ensoulment based on a prophetic *hadith*:

Each one of you is collected in the womb of his mother for forty days then turns into a clot (*alaqa*) just like that (*mithla dhālika*), and turns into a lump (*mudgha*) just like that, and then Allah (God) sends an angel and orders him to write four things i.e. his career, his

⁸ M.H. Kamali. 2003. *Principles of Islamic Jurisprudence*. Cambridge: Islamic Texts Society: 468–499.

⁹ *Glorious Quran*. Yusuf Ali, tr., ch. 17, verse 70. Available at: <<http://www.usc.edu/schools/college/crcc/engagement/resources/texts/muslim/quran/>>. [Accessed 16 Nov 2009].

¹⁰ M. Siddiqi. *An Islamic Perspective on Stem Cells [sic] Research*. Available at: <<http://www.pakistanlink.com/religion/2001/0803.html>> [Accessed 14 Nov 2009].

¹¹ Ali, *op. cit.* note 9, ch. 29, verse 20; ch 35, verses 29–30; chapter 7, verse 185.

¹² Sunan Abī Dāwūd. Kitāb al-ṭibb (27). Bāb fī al-adwiyya al-makrūha (11). *Hadith* 3870. Available at: <http://www.muhammad.org>. [Accessed 16 Nov 2009].

¹³ Kamali, *op. cit.* note 8, pp. 351–368.

¹⁴ Ali, *op. cit.* note 9, ch. 23, verses 12–14.

¹⁵ Ibn Qayyim al-Jawziyya. [1933.] *Al-Tibyān fī aqsām al-qur'ān*. Bayrūt: Dār al-Ma'rifah. Available at: <<http://www.halqat.com/Book-144.html>>: 150 of MS Word File. [Accessed 16 Nov 2009].

¹⁶ M.N. Yaseen. The Inception of Human Life in the Light of Statements of the Holy Qur'an and Sunnah and the Opinion of Muslim Scholars. *Journal of the Islamic Medical Association of North America* 1990; 22: 159–167. Available from: <http://jima.imana.org/article/view/5696>. [Accessed 16 Nov 2009].

¹⁷ T. Eich. 2008. Decision-Making Processes among Contemporary 'Ulama': Islamic Embryology and the Discussion of Frozen Embryos. In *Muslim Medical Ethics: from Theory to Practice*. J.E. Brockopp & T. Eich, eds. Columbia, SC: University of South Carolina Press: 61–77.

provision, his life duration, and whether he will be wretched or blessed (in the Hereafter), then the angel breathes the soul into him.¹⁸

This *hadith* mentions three 40-day stages of embryonic development before ensoulment occurs. Many scholars understand this to mean that ensoulment occurs at 120 days after conception. However some scholars understand the ‘just like that’ (*mithla dhālika*) to indicate that these three stages occur within the same time period, i.e. 40 days, at the end of which time ensoulment occurs.

All Muslim scholars agree that embryonic life is entitled to respect even before ensoulment, becomes progressively more deserving of rights as the development proceeds and definitely acquires full rights after ensoulment.

Because of the complexity of modern medical bioethical issues, a new *modus operandi* has been developed to help Muslim scholars to perform *ijtihād*: convening conferences including Islamic scholars as well as physicians and scientists of different backgrounds when discussing medical issues. The Islamic Organization for Medical sciences (IOMS) was established in Kuwait in the 1980s. This organization conducts conferences periodically to discuss and make rulings on contemporary issues. Similar organizations have been established since then for example the Society for Islamic Medical Sciences in Jordan. Many conferences have been convened by these two organizations as well as by the al-Azhar University in Cairo, Egypt.

On the basis of the concept that human life does not start until ensoulment the great majority of Muslim scholars agree that research on the pre-embryo, especially the pre-implantation embryo – as it cannot grow independently outside the uterus – is permissible, provided that these pre-embryos were legitimately developed. The permissibility is also conditioned on the fact that these embryos are not produced specifically for research. Supernumerary embryos produced at infertility clinics are considered legitimate. Several embryos are usually produced during the procedure of *in vitro* fertilization (IVF) for the treatment of infertility of a couple who are legally married at the time. Many of them are not implanted in the wife’s uterus. These are usually cryopreserved for possible future use if this cycle was not successful or if this couple wants to try another pregnancy. In Islam these extra embryos cannot be implanted into another woman’s uterus nor they can be used by either spouse if they get divorced or if one of the spouses dies. as preservation of lineage is of prime importance in Islamic

law.¹⁹ If this couple later on decides not to use their cryopreserved embryos, the frozen embryos are thawed and either left to die or destroyed. So the great majority of Muslim scholars agree that their use for research, which may bring potential therapeutic benefit, is better than letting them go to waste.²⁰

Other legitimate sources would be legally aborted fetuses, although it is almost impossible to grow stem cell lines from them.

There is a rather general acceptance of hESC research by Islamic scholars.²¹ This is based on the distinction they make between biological and human life coupled with the perception of its therapeutic potential. The latter is a significant consideration based on the Islamic Shariah’s rule of public interest.²² Some scholars are so positive about this research that they believe, as mentioned previously, that if the therapeutic use of embryos saves human life, then such research is a collective religious obligation (*fard kifāya*).²³

There are several religious scholars and institutions that made official statements or issued position papers relating to the Islamic point of view re hESC research. I will cite only some examples. As early as the 1989 IOMS meeting, Shaikh Yaseen argued that while biological life starts at fertilization, human life does not start till

¹⁹ Author. The Islamic Viewpoint on New Assisted Reproductive Technologies. *Fordham Urban Law J* 2002; 30: 147–157; A. Sachedina. 2009. *Islamic Biomedical Ethics: Principles and Application*. Oxford & New York: Oxford University Press: 212.

²⁰ H.O. Turkmen & B. Arda. Ethical and Legal Aspects of Stem Cell Practices in Turkey: Where are We? *J Med Ethics* 2008; 34: 833–837; The Fiqh Council of North America. *Embryonic Stem-Cell Research*. Available at: <<http://www.fiqhcouncil.org/Articles/GeneralFiqhIssues/tabid/170/ctl/Detail/mid/569/xmid/15/xmfid/1/Default.aspx>> [Accessed 15 Nov 2009]; Dr. AbdAllah Husayn Basalama. *al-istifada min al-ajinna al-mujhada aw al-za’ida ‘an al-haja fi al-tajarib al-‘ilmiyya wazira’at al-‘ada* [Using Aborted and Superfluous Fetuses in Scientific Experiments and Organ Transplantation]. *Majallat Majma’ al-Fiqh al-Islami* 1990; 6 (3): 1837–1845.

²¹ Hug, *op. cit.* note 6, pp. 107–114; Walters, *op. cit.* note 7, pp. 3–38; H. Hathout. An Islamic perspective on human genetic and reproductive technologies. *East Mediterr Health J* 2006; Suppl 2: S22–S28; Sachedina, *op. cit.* note 19, pp. 210–215; B. Larijani and F. Zahedi. Islamic Perspective on Human Cloning and Stem Cell Research. *Transplant Proc* 2004; 36: 3188–3189; D. Atighetchi. *Islamic Bioethics: Problems and Perspectives*. Dordrecht, The Netherlands: Springer: 248–250. V. Rispler-Chaim. Between Islamic Law and Science: Contemporary Muftis and Muslim Ethicists on Embryo and Stem Cells Research. *Comparative Islamic Studies* 2006; 2: 27–50. I. Ilkilic. Ethical Assessment of Stem Cell Research from an Islamic Point of View. Some Ethical and Philosophical Reflections. Paper presented at the Qatar Stem Cell Workshop 2009: *Saving Lives or Crossing Lines*. Qatar Foundation Research Division, Weill Cornell Medical College, Doha, Qatar, 15 Mar 2009.

²² Madjid Khadduri, ‘*maslaha*’ in *Encyclopedia of Islam* (2d edn, 1991), vol. 6, explains the concept as ‘utility,’ ‘general good,’ and ‘public interest’; Felicitas Opwis. *Maslaha* in Contemporary Islamic Legal Theory. *Islamic Law and Society* 2005; 12: 182–223.

²³ Siddiqi, *op. cit.* note 10.

¹⁸ Sahīh Muslim. Kitāb al-qadar, bāb kayfiyya al-khalq al-ādāmī fī batn ummihi wa kitāba rizqīhi wa ajalīhi wa ‘amalihi wa shaqāwatihi wa sa’ādātihi, Hadith no. 2645. Available at: <<http://www.muhammad.org>>. [Accessed 16 Nov 2009].

ensoulment occurs at 120 days. He thus argued for the use of extra frozen embryos for medical research under certain conditions. This view was also supported by Shaikh Yusuf al-Qaradawi. A statement issued by the conference included this sentence: 'The opinion of the majority is that there is no reason to forbid scientific research on the supernumerary fertilized eggs before their nidation in the uterus.'²⁴

Professor Abdulaziz Sachedina, at the University of Virginia, USA stated 'Research on stem cells made possible by biotechnical intervention is regarded as an act of faith in the ultimate will of God as the Giver of all life as long as such an intervention is undertaken with the purpose of improving human health.'²⁵ Dr. Israr Ahmed, an internationally recognized Pakistani religious scholar and founder of Tanzeem-e Islami Quran Academy, stated that the use of hESCs for research was allowed in Islam.²⁶

The Muslim World League's Islamic Jurisprudence Council conference in December 2003 held in Mecca, Saudi Arabia issued this *fatwā* (religious opinion):

It is permissible to use stem cells for either legitimate scientific research or for therapy as long as its sources are legitimate for example, adults if they give permission as long as it does not inflict harm on them; children with their guardian's permission for a legal benefit without inflicting harm on them; placenta or umbilical cord blood with the permission of the parents; spontaneously aborted embryos or those aborted for a legally acceptable cause and with the permission of the parents; excess fertilized eggs produced during the course of IVF and donated by the parents with assurance that they are not to be used to produce an illegal pregnancy. It is forbidden to obtain or use stem cells if its source is illegitimate as, for example, intentionally aborted fetuses (abortion without a legal medical reason); intentional fertilization between a donated ovum and sperm; and therapeutic cloning.²⁷

A later IOMS meeting held in Cairo 2006 included presentations by physicians who concluded that embry-

onic research for therapeutic purposes, including non-reproductive cloning, is Islamically permitted and encouraged.²⁸

The Fiqh Council of North America in 2007 affirmed its earlier position of support for hESC research.²⁹ The Islamic Medical Association of North America (IMANA) Ethics Committee published a position paper on SC research and added its approval.³⁰ Both the Islamic Institute of Turkey³¹ and the Malaysian National Fatwa Council³² also supported hESC research.

Shite Clergy also generally support and encourage SC research including hESC research. In 2002 Iran's Supreme leader Ayatollah Khamenie publicly supported human embryo research.³³

While almost all Islamic jurors permit hESC research, all agree that that creating embryos for the sole purpose of research is prohibited. They all agree that there should be strict guidelines for the use of human embryos for research. These guidelines should limit their use to research with reasonable promise of alleviating serious human disease, and there should be procedures and laws to ensure that these guidelines are followed.³⁴

In his recent book, Professor Sachedina affirmed that all Sunni and most Shite jurists do not see any moral problem with the use of frozen embryos for biomedical research. However, he cautions that allowing the use of 'spare' embryos may have a negative effect of devaluing preimplanted embryos, which may lead to their becoming commercialized and expressly produced as a source of therapeutic products. He cautions that Muslim jurists have not considered all the negative aspects of their ruling allowing both unregulated IVF and the discarding of unused embryos. He points out that the principle of public good that formed an important argument for allowing hESC research should be balanced against an equally important principle that 'averting corruption has preponderance over advancing public good.'³⁵

²⁴ Eich, *op. cit.* note 17, p. 69.

²⁵ A. Sachedina. 2000. Testimony. In *Ethical Issues in Human Stem Cell Research* Vol. III. Religious Perspectives. National Bioethics Advisory Commission, ed. Rockville, MD: National Bioethics Advisory Commission: G, 1–6. Available at: <http://bioethics.georgetown.edu/nbac/stemcell3.pdf>. [Accessed 16 Nov 2009].

²⁶ Israr. 2009. Islam Allows Stem Cell Research. *The Nation* (Pakistan). Available at: <http://www.nation.com.pk/pakistan-news-newspaper-daily-english-online/Regional/24-Mar-2009/Islam-allows-stem-cell-research-Israr>. [Modified 24 Mar 2009; Accessed 1 Apr 2010].

²⁷ Muslim Word League, Islamic Jurisprudence Council Conference. 2003. *Regarding Stem Cells*. Fatwa number 3. Makka, Saudi Arabia. Available at: <http://www.themwl.org/Fatwa/default.aspx?d=1&cid=152&l=AR&cid=12>. [Accessed 16 Nov 2009].

²⁸ M.M. Nordin. 2006. Islamic Medical Ethics Amidst Developing Biotechnologies. *The Human Genetic and Reproductive Technologies: Comparing Religious and Secular Perspectives*. Islamic Organization of Medical Sciences. Cairo, Egypt.

²⁹ Fiqh Council of North America, *op. cit.* note 20.

³⁰ IMANA Ethics Committee. 2007. *Stem Cell Research: the IMANA Perspective*. Lombard, IL: Islamic Medical Association of North America. Available at: <http://imana.org/PDF%20Files/Stem%20Cell%20Position.pdf>. [Accessed 16 Nov 2009].

³¹ Turkmen & Arda, *op. cit.* note 20, pp. 833–837.

³² K. Mahmood, Malaysia Taking Steps to Ban Reproductive Cloning: Report, <http://www.islamonline.net/english/news/2003-01/11/article06.shtml>. [Accessed 16 Nov 2009].

³³ M. Saniei & R. De Vries. Embryonic Stem Cell Research in Iran: Status and Ethics. *Indian J Med Ethics* 2008; 5: 181–184.

³⁴ IMANA Ethics Committee, *op. cit.* note 28.

³⁵ Sachedina, *op. cit.* note 19.

THERAPEUTIC CLONING

In this technique a somatic cell, e.g. a skin cell, is fused with an enucleated ovum. The fused cell is then induced to divide and form a blastocyst. Stem cells are then harvested from the inner cell mass of this cloned embryo. It has the same DNA as the original somatic cell. This process termed Somatic Cell Nuclear Transfer (SCNT) holds great promise for regenerative medicine. Take for example a type 1 diabetic patient. If the somatic cell is obtained from the patient, and the stem cells are made to transdifferentiate into pancreatic beta islet cells, these can then be transplanted in the patient and replace his damaged islet cells, producing insulin and affecting a cure. Another advantage is that the transplanted tissue will not be subject to rejection, as it has the same DNA as the patient, who will not require lifelong immunosuppressive therapy. This technique is also very useful in the study of the pathogenesis of diseases including genetic diseases. It can be useful in gene therapy. Obviously these applications are still in the realm of expectations and had not been subjected to clinical trials yet. SCNT raises many moral objections in addition to what has been discussed already in relation to hESC research. The cloned embryos will be produced exclusively for research, unlike other hESC research that is utilizing 'spare' embryos at IVF clinics. Further, the ova are to be derived from volunteer women. The process includes inconvenient hormonal treatment, to stimulate egg production, which can occasionally be associated with serious side effects and an invasive (albeit simple) surgical procedure to retrieve the ova. Further, there is concern that if the research seems promising, especially if it is developed as a therapeutic modality, there will be a significant increase in the demand for eggs with the inherent risk of exploitation of women by undue financial incentives to obtain the needed eggs. A more serious objection is that perfecting this technique may make reproductive cloning more feasible and reproductive cloning is almost universally condemned.

Therapeutic cloning has been successful only in monkeys and mice so far. Claims of successful human cloning made by Wao Suk Hwang proved to be a hoax.³⁶ Human cloned embryos have been recently developed in California, USA, but no stem cell lines could be established.³⁷

³⁶ H. Gottweis. Ethics and Politics of Stem Cell Research, paper presented at the Qatar Stem Cell Workshop 2009: *Saving Lives or Crossing Lines*. Qatar Foundation Research Division, Weill Cornell Medical College, Doha, Qatar, 15 Mar 2009.

³⁷ A.J. French, C.A. Adams, L.S. Anderson et al. Development of Human Cloned Blastocysts following Somatic Cell Nuclear Transfer with Adult Fibroblasts. *Stem Cells*, 26, no 2 (2008): 485–93. Available at: <<http://www3.interscience.wiley.com/cgi-bin/fulltext/121587415/PDFSTART>>. [Accessed 16 Nov 2009].

Muslim jurists have different views. The above mentioned fatwa by the Muslim World League's Islamic Jurisprudence Council in December 2003 seems to prohibit therapeutic cloning.³⁸

A workshop conducted at al-Azhar University in Cairo in 2000 concluded that non-reproductive cloning is Islamically acceptable.³⁹ The Islamic scholar al-Qaradawi stated that 'If it becomes possible through research to clone organs, for example heart, liver, it will be permissible and it may become mandatory to pursue these endeavors.'⁴⁰ A fatwa by the Egyptian Mufti Dr. al-Tayyib in January 2003 stated that therapeutic cloning is lawful.⁴¹ The Malaysian National Fatwa Council issued a fatwa in the same year allowing human therapeutic cloning.⁴² Aksoy maintains that therapeutic cloning is acceptable to most Islamic scholars.⁴³ Shite clerics also support therapeutic cloning. A cloned sheep was born in Royan Institute in Iran in 2006 and is named Royana. It remained healthy at least until the time of that report.⁴⁴

Therapeutic cloning in different countries

Most South Asian and East Asian countries offer no opposition to cloned embryo research. It is legally supported in England and several other European countries. On the other hand it is banned in Canada, France, Germany and many other European and South American countries. It is not banned in the USA but such research is ineligible for Federal funding, even with the relaxation of the prohibition of hESC research by President Obama. Some states outlaw it.⁴⁵

In 2005 the United Nations adopted a declaration banning human cloning. It was supported by only 24 Islamic countries. Iran along with some other Islamic countries abstained because the ban included a ban on therapeutic cloning.⁴⁶

³⁸ Muslim World League, *op. cit.* note 25.

³⁹ G.A. Al-Serour. 2000. *Ethical Implications of Human Embryo Research*. Rabat, Morocco: Islamic Educational, Scientific and Cultural Organization. Available at: <<http://www.isesco.org.ma/english/publications/Human%20Embryo/humanEm.php>>. [Accessed 16 Nov 2009].

⁴⁰ Y. Al-Qaradāwī. *Istinsākh al-bashar wa ra'y al-Qaradāwī fih*. Available at: <http://www.qaradawi.net/site/topics/article.asp?cu_no=2&item_no=2883&version=1&template_id=130&parent_id=17> [Accessed 16 Nov 2009].

⁴¹ Walters, *op. cit.* note 7, pp. 3–38.

⁴² Mahmood, *op. cit.* note 30.

⁴³ S. Aksoy. Making Regulations and Drawing up Legislation in Islamic Countries under Conditions of Uncertainty, with Special Reference to Embryonic Stem Cell Research. *J Med Ethics* 2005; 31: 399–403.

⁴⁴ K. Aramesh & S. Dabbagh. An Islamic View to Stem Cell Research and Cloning: Iran's Experience. *Am J Bioth* 2007; 7: 62–63.

⁴⁵ Gottweis, *op. cit.* note 34.

⁴⁶ M. Abdur Rab & M.H. Khayat. Human Cloning: Eastern Mediterranean Region Perspective. *East Mediterr Health J* 2006; 12 (S2): S29–S37.

Status of hESC research in Islamic countries

Iran was the first Islamic country to establish a human embryonic stem cell line in 2003 at the Royan Institute. Since then 5 more stem cell lines have been established.⁴⁷ Iran is in the top 10 countries that produce, culture, and freeze hESCs. In Iran there is broad governmental approval and support of ESC research including funding. The funding for science increased from 0.2% of the GDP in 1990 to 0.65% in 2005. The government is planning to invest 2.5 billion US dollars over the next five years on stem cell research alone. However Iran's scientific development is still partially hampered by political and economic sanctions. There is difficulty in obtaining necessary supplies from other countries especially from the USA. The Iranian scientists are limited in their ability to leave the country to attend international conferences because of visa restrictions and thus cannot have meaningful collaborations.⁴⁸

In Saudi Arabia, the Stem Cell Therapy Program at King Faisal Specialist Hospital and Research Center was opened in 2007 in Riyadh. In addition, a multibillion dollar endowment was provided by King Abdullah to support the establishment of King Abdullah University of Science and Technology that opened in September 2009. Private companies such as FuturMed are establishing stem cell research centers in different universities in the kingdom. These are mostly involved in umbilical cord blood (UCB) stem cell research.⁴⁹ Moreover, in Jeddah, a stem cell research center has been established in a private venture, Biocity. The center is allowed to use only legally aborted fetuses. The use of supernumerary embryos is still debated.⁵⁰

Other Gulf countries are embracing this research.⁵¹ Sheikh Mohammed Bin Rashed, the vice-president of the United Arab Emirates (UAE), announced a \$10 billion endowment for 'the development of a knowledge-based society in the region'. Sheikh al-Maktoum, UAE's finance minister established an award for medical sciences in his name.⁵² In Qatar, Weill Cornell Medical

College is set to establish a stem cell research laboratory that will be able to expand, maintain, and validate currently available hESCs and in developing new stem cell lines. The British company, Virgin, launched a large cord blood bank in Doha, Qatar. It will store both private and public UCB units for both autologous and allogenic use. Qatar's scientists are ready to work on ESCs.⁵³

In Egypt the private IVF center in Cairo is conducting stem cell research using UCB but still not on ESCs. The Egyptian Medical Syndicate is an independent body, overseeing both private and public practices, which opposes the use of embryos for experimentation. On the other hand, the Academy of Scientific Research and Technology and Professor Serour, the director of the International Islamic Center for Population studies and Research, support the use of IVF surplus pre-embryos for stem cell research. The Egyptian Government has no official policy as of now.⁵⁴

In Pakistan, the Punjab University established the Center of Excellence in Molecular Biology (CEMB) that probably will be involved in stem cell research. It recently organized a conference on 'Ethical Issues Related to Work on Stem Cells.' All the participants favored the research and did not find it objectionable from the point of view of the Shariah. However, no published reports of stem cell research appeared in the literature as of now.⁵⁵ Many Muslim countries lack the necessary infrastructure and are facing the problem of financing such projects. There is the ethical dilemma of the justification of allocating existing meager resources within the healthcare sector. The question in these countries is whether it is acceptable to invest in long-term medical research instead of urgent healthcare needs.⁵⁶

Turkey and Tunisia are the only Muslim countries that have recognized national policies related to human embryonic stem cell research.⁵⁷ The Iranian Ministry of Health and Medical Ethics, along with the History of Medicine Research Center in Tehran, Iran, developed special guidelines for stem cell research.⁵⁸ In general, scientists in Muslim countries rely on religious decrees

⁴⁷ Saniei & De Vries, *op. cit.* note 31, pp. 181–184.

⁴⁸ D.W.G. Morrison & A. Khademhosseini. *Stem Cell Science in Iran*. Cambridge, MA: Iranian Studies Group at the Massachusetts Institute of Technology. Available at http://www.isgmit.org/projects-storage/StemCell/stem_cell_iran.pdf [Modified 4 Dec 2006; Accessed 25 Mar 2010].

⁴⁹ N. El-Awady. Gulf States Embrace Stem Cell Technologies at Home and Abroad. *Nature Reports Stem Cells*. Available at <http://dx.doi.org/10.1038/stemcells.2008.21>. [Modified 7 Apr 2008; Accessed 25 Mar 2010].

⁵⁰ D.M. McKay. An International View of the Regulation and Funding of Embryonic Stem Cells in Therapeutic Research. *Texas Transnational Law Quarterly* 2003; 17: 149; Available at: http://www.ilstexas.org/ttlq/2003_April.pdf. [Accessed 16 Nov 2009]. Gottweis, *op. cit.* note 34, pp. 9–26.

⁵¹ Gottweis, *op. cit.* note 34.

⁵² El-Awady, *op. cit.* note 49.

⁵³ Voice of America. *Virgin Mega-Brand Launches Stem Cell Bank in Qatar*. Available from: <http://www1.voanews.com/english/news/a-13-2009-03-23-voa50-68636117.html>. [Updated 23 Mar 2009; Accessed 21 Mar 2010].

⁵⁴ C. Dabu. Stem-Cell Science Stirs Debate in Muslim World, too. *Christ Sci Monitor*. Available from: <http://www.csmonitor.com/2005/0622/p15s02-wogi.html> [Updated 22 Jun 2005; Accessed 21 Mar 2010].

⁵⁵ *The Nation* (Pakistan), *op. cit.* note 26.

⁵⁶ Ilkilic, *op. cit.* note 21.

⁵⁷ Turkmen & Arda, *op. cit.* note 20; J.M. Flynn & K.R.W. Matthews. Stem Cell Research in the Greater Middle East: The Importance of Establishing Policy and Ethics Interoperability to Foster International Collaborations. *Stem Cell Reviews and Reports*. Available from <http://dx.doi.org/10.1007/s12015-010-9133-6>. [Modified 3 Mar 2010; Accessed 25 Mar 2010].

⁵⁸ Aramesh, *op. cit.* note 44.

(fatwas) that outline acceptable practices. While these fatwas are not law they carry a great influence and effectively act as national policy. For a more detailed discussion of national guidelines / regulations, refer to the articles by Fischer and Flynn & Matthews.⁵⁹

Induced pluripotent (iPS) cells

A major recent development in SC research was announced in 2007. Two teams of scientists, one from Japan⁶⁰ and the second from Wisconsin, USA,⁶¹ published reports that they were able to reprogram adult human somatic skin cells to behave as ESCs with the capability to divide in culture, regenerate and transdifferentiate into specific cell types. They used a retroviral vector to introduce copies of genes for 4 transcription factors active in ESCs. These are OCT 4, Sox 2, c-Myc and KIF4. These derived iPS cells genetically match the donor of the somatic cell without resorting to cloning (SCNT) or the requisite donation of women's eggs. They will not be rejected by the immune system if used as replacement tissues for patients. The main problem with this technique is the use of a vector that can turn on cancer-causing genes.

Although this major breakthrough can help resolve the ethical/ religious objection re the use and destruction of human embryos, this technique is far from being perfected or made safe for clinical trials. Scientists believe that, regardless of this possibility, it will not eliminate or reduce the need for continued research and use of hESCs. They believe that both systems have limitations and research needs to be continued in both directions.

CONCLUDING REMARKS

Stem cell research is a very promising new field of medicine. It potentially holds the promise of a cure for many so far incurable diseases like Alzheimer's, genetic diseases and malignancies. Through regenerative medicine, diseased or injured tissues can be replaced. The basic scientific work is being performed in earnest. The next step is

⁵⁹ N Fischer. Embryo Research in the Middle East. *Journal of International Biotechnology Law* 2009; 6: 235–241. Available from <http://dx.doi.org/10.1515/JIBL.2009.33> [Accessed 18 Jun 2010]; Flynn and Matthews, *op. cit.* note 56.

⁶⁰ K. Takahashi, K. Tanabe, M. Ohnuki et al. Induction of Pluripotent Stem Cells from Adult Human Fibroblasts by Defined Factors. *Cell* 2007; 131: 861–872.

⁶¹ J. Yu, M.A. Vodyanik, K. Smuga-Otto et al. Induced Pluripotent Stem Cell Lines Derived from Human Somatic Cells. *Science* 2007; 318: 1917–1920.

the clinical trials that will show if these treatments are feasible, effective, and safe. Currently, there are >3500 registered clinical trials with cell therapy products worldwide.⁶² Most of these are conducted using umbilical cord blood and other adult stem cells. Examples of these are the use of umbilical cord blood in the treatment of type 1 diabetes mellitus⁶³ and neurologic disease.⁶⁴ Also, there was a trial of a drug prochymal produced from mesenchymal stem cells obtained from the bone marrow of healthy young adults for the treatment of Graft-versus-Host disease resulting from bone marrow transplants. Unfortunately, it was found to be ineffective.⁶⁵

The ban on using federal funds in hESC research was lifted by US President Obama on 9 March 2009.⁶⁶ It is expected that more research will be conducted in the USA using hESCs. On 23 January 2009, the US Food and Drug Administration (FDA) approved a stem cell clinical trial for the treatment of spinal cord injury. Oligodendrocytes derived from hESCs will be injected into the spinal cord at the site of injury within 7–14 days after the injury. The injected cells are hoped to repair myelin around the nerve cells to enable them to carry signals. There is also some hope that growth factors produced by the injected cells will spur damaged nerve cells to regenerate.⁶⁷ Unfortunately, the study was delayed by FDA on 19 August 2009 because of safety concerns after evaluating results of animal studies with high doses.⁶⁸

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⁶² Gottweis, *op. cit.* note 34.

⁶³ US National Institutes of Health. *Umbilical Cord Blood Infusion to Treat Type 1 Diabetes*. Available at: <http://www.clinicaltrials.gov/ct/show/NCT00305344?order=1> [Accessed 16 Nov 2009].

⁶⁴ P.R. Sanberg, A.E. Willing, S. Garbuzova-Davis et al. Umbilical Cord Blood-Derived Stem Cells and Brain Repair. *Ann N Y Acad Sc* 2005; 1049: 67–83.

⁶⁵ A. Pollack. 2009. First Stem Cell Drug Fails 2 Late-Stage Clinical Trials. *The New York Times* 8 September. Available at: <http://www.nytimes.com/2009/09/09/health/research/09drug.html>. [Accessed 16 Nov 2009].

⁶⁶ Executive Order 13505 of 9 Mar 2009. Removing Barriers to Responsible Scientific Research Involving Human Stem Cells. *Federal Register* 11 Mar 2009; 74 (46): 10667–10668.

⁶⁷ A. Pollack. 2009. F.D.A. Approves a Stem Cell Trial. *The New York Times* 23 January. Available at: <http://www.nytimes.com/2009/01/23/business/23stem.html>. [Accessed 16 Nov 2009].

⁶⁸ Bloomberg News. Study Using Embryonic Stem Cells is Delayed. *New York Times* August 18, 2009. Available at: <http://www.nytimes.com/2009/08/19/health/research/19drug.html>. [Accessed 16 Nov 2009].