

## 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?

Kristina Hug

Department of Social Medicine, Faculty of Public Health, Kaunas University of Medicine, Lithuania

**Key words:** embryonic stem cells, embryo status, biomedical research, religion.

**Summary.** Stem cells are unspecialized cells able to divide and produce copies of themselves and having the potential to differentiate, i.e. to produce other cell types in the body. Because of the latter ability, the scientists investigate their possible use in regenerative medicine. Especially embryonic stem cells have huge therapeutic potential because they can give rise to every cell type in the body as compared to stem cells from certain adult tissues which can only differentiate into a limited range of cell types. For this reason scientists stress the importance of embryonic stem cell research. However, this research raises sensitive ethical and religious arguments, which are balanced against possible great benefit of such research for the patients suffering from so far incurable diseases. The objective of this literature review is to present the main arguments in favor and against human embryonic stem cell research. Since the sensitivity of the latter issue to a large extent stems from the position of predominant religions in a given society, the positions of the main religions regarding embryo research are also presented.

**Conclusion.** There is no consensus regarding ethical aspects of human embryonic stem cell research. The article presents both the arguments supporting human embryonic stem cell research and the arguments opposing it.

### Introduction

With the discoveries of methods of isolation and differentiation of human embryonic stem cells (1, 2) and the derivation of embryonic stem cell lines from human blastocysts<sup>1</sup> (4), the ethical aspects of such research became very much debated among scientists as well as ethicists and lawyers. What is ethically at issue with embryo research where the fertilized egg has to be destroyed? What moral status does the human embryo have?

Since the sensitivity of the issue to a large extent stems from the position regarding embryo research of predominant religions, what is the opinion on embryonic stem cell research in the major religions of the world? Trying to answer these questions, the arguments against are to be balanced against the great expectation that embryo research will possibly lead to cures for many diseases. However, is this really the case? If yes, which policy should be chosen to satisfy both the need for the cure of serious human diseases and paying respect to a human embryo? All these are the actual questions where no unanimous position is found.

<sup>1</sup> Fertilized human eggs at their 5<sup>th</sup>–7<sup>th</sup> day of their development. At that stage such embryos contain only 100–200 cells (3).

The importance of this article is that it presents different positions found in the literature regarding all the above-mentioned questions and lists both the arguments in favor and against embryonic stem cell research. The aim of the author is not to take sides by arguing for or against certain opinion, but rather to provide as far as possible an objective picture of different arguments and counter-arguments existing in recent literature, and to leave it for the reader to make up his/her mind on the issue.

### What is ethically at issue with embryo research where the fertilized egg has to be destroyed?

Some scientists in the international scientific community believe that stem cell research will lead to stem cell-based therapies only if scientists can derive new human embryonic stem cell lines. Embryonic stem cells are needed, since their ability to live indefinitely in tissue culture and the wide range of cell types to which they give rise make them unique. However, with the currently known techniques, fertilized human eggs at the pre-implantation (blastocyst) stage must be destroyed in order to produce new stem cell lines. However, the moral status of the embryos used to derive

these stem cell lines is debatable (3). Therefore, embryonic stem cell research poses a moral problem, as it brings into tension two fundamental moral principles that we highly value: the duty to prevent or alleviate suffering, and the duty to respect the value of human life. The harvesting of human embryonic stem cells violates this second duty as it results in the destruction of a possible human life. Both principles cannot simultaneously be respected in the case of embryonic stem cell research. The question then is which principle ought to be given precedence in this conflict situation. Should we give more weight to the first, and permit destructive embryonic stem cell research because of its potential benefits? Or should we give more weight to the second, and prohibit destructive embryonic research because it violates respect for the value of the embryo as the very beginning of a possible human life (5)? It must be mentioned, however, that there is an opinion that this conflict could be resolved if we assume that stem cells are obtained from destroyed blastocyst. For this purpose, however, the criteria of the end of the life of a blastocyst must be defined.

Although there is general consensus on when life ends (brain death is considered as the condition for the end of life), the criteria for determining the death of the developing human before the start of neural development have not been formulated. However, it is known from the practice of *in vitro* fertilization techniques that many embryos generated for the purpose of *in vitro* fertilization are found to be non-viable and, therefore, dead as organisms. If this is so, the ethical framework currently used for obtaining essential tissues and organs for transplantation from deceased adults and children could be extended to cover obtaining stem cells from dead human embryos. For a developed human organism, brain death marks the irreversible loss of the capacity for all ongoing and integrated organic functioning. For a 4 or 8-cell human embryo the capacity defining its life is continued and integrated cellular division, growth, and differentiation. Therefore, an embryo that has irreversibly lost this capacity, even when its individual cells are alive, can be considered dead as an organism and this irreversible cessation of cell division rather than the death of each and every cell can be considered as the appropriate measure of the embryo's death. If the donation of embryonic cells from embryos which are no longer alive as organisms could be considered as analogous to the donation of essential organs from cadavers, we could accept the use of such cells for research purposes (6).

Despite the debates over the criteria of the death

of an embryo and its moral status, there is at least one area of ethical agreement regarding embryonic stem cell research – the aim of stem cell research (to cure diseases and relieve suffering) is universally recognized as a good aim (7).

### **What moral status does the human embryo have?**

The moral status that the human embryo is given varies. Three different main positions with variations can be separated.

#### *Having full moral status after fertilization of the egg*

This point of view can be divided into two: considering embryos *worthy of protection simply because they are human* or considering them as *potential persons*. Philosophers differ on this question. Whereas many philosophers, particularly utilitarians, do not consider a fertilized human egg before implantation to satisfy the criteria of personhood, others take a different view. However, the criteria of personhood are notoriously unclear.

- *Fertilized eggs as worthy of protection simply because they are human*

*Argument.* There is no non-arbitrary point, a morally significant dividing line in the continuum of physical growth between an embryo and a developed human. Since a developmental point at which personhood is acquired cannot be pointed out, individuals are counted as human beings at their embryonic stage as well as their fully developed stage (5). If our lives are worthy of respect simply because we are human, it would be a mistake to think that at some younger age or earlier stage of development (e.g. when we began our lives as fertilized eggs) we were not worthy of respect (8). Therefore, if we do not accept fertilization as a morally decisive moment from which full protection should be guaranteed, there is no other similarly decisive moment. If one permits to destroy fertilized eggs or pre-implantation stage embryos, then why not fetuses, and if fetuses, then why not newborns, and if newborns, then why not every human being missing certain cognitive capacities (9). Human embryos differ from other human beings not in what they are, but in their stage of development. A human embryo is a human being in the embryonic stage, just as an infant or an adolescent is a human being in the infant or adolescent stage (10). However, very few, if any, hold this view that pre-implantation stage embryos deserve the same level of respect and protection as human beings just because they are human.

*Counter-argument.* Even if it is not possible to point to an exact dividing line in human development at which personhood is acquired, it may be argued that whenever the transition occurs, early pre-implantation stage embryos do not have the psychological, physiological, emotional or intellectual properties that we associate with personhood (5). It, therefore, follows that if human embryo does not fulfill the criteria for personhood, it does not have any interests to be protected and thus may be used instrumentally for the benefit of those who are persons (11). The fact that every person began life as an embryo does not prove that embryos are persons either. For example, although every oak tree was once an acorn, it does not mean that acorns are oak trees or that we should treat the loss of an acorn as the same kind of loss as the death of an oak tree (8). There is an opinion that instead of the end of the process of fertilization of the egg, a human embryo becomes worthy of protection at around day 14 after the fertilization. There are several reasons for this opinion:

- It may be argued that it is the implantation of the blastocyst in the uterine wall that is the best landmark for the definition of human life. Indeed, this is the first stage at which the individual is defined because the embryo is past the stage in which it can split to form twins (3). The end of the possibility of twinning is around day 14 after fertilization. Before this time, a researcher in a laboratory could divide a four-cell embryo into four embryos and, on the other hand, fuse four early embryos into one. It is only after twinning is not possible any more, when the life of one individual starts as a recognizable one (9).
- It may also be argued that it is the formation of the nervous system that is the landmark for the definition of life, since this is then that the possibility of sensation first exists. Up to embryonic day 14, the blastocyst has no central nervous system and, therefore, cannot be considered sensate. If we can remove organs from patients who have been declared brain dead but are still alive in some sense in order to save the lives of those who are alive, we can use two hundred-cell embryos as cell donors at the same moral status as brain dead individuals (3).
- Embryological studies now show that fertilization is itself a process (not a “moment”). Therefore, it can be argued that an embryo in the earliest stages (including the blastocyst stage, when stem cells would be extracted for the purpose of the research) is not sufficiently individualized to have the moral weight of personhood (12).
- *Embryos as potential persons*

*Argument.* Although embryos do not *currently*

exhibit the properties of personhood, they *will*, if allowed to develop and fulfill their potential. Since embryos are *potential persons*, they ought to be accorded the moral respect and dignity that personhood requires. For example, we still treat unconscious individuals as persons even though they are not able to exercise the properties of personhood in their present state. But we know that these people *will* be able to when they become conscious again (5).

*Counter-argument.* The embryo in itself cannot develop into a child without being transferred to a woman’s uterus. It needs external aid to enable its development and hence it does not have an active potentiality to develop into a human being without help (13). Even with the external aid provided, the probability that embryos used for *in vitro* fertilization will develop into full-term successful births is low. This probability is also very much context-dependent: e.g. on the quality of external human intervention, such as transfer to uterus, and on other factors such as whether the embryo will implant and grow to term or even on the conditions of giving birth. Thus something that could potentially become a person should not be morally regarded as if it actually *were* a person. Contrary to the previous statement, the temporarily unconscious persons already had all the properties of personhood *before* falling into unconsciousness and will have them again when they come out of it (5).

*Having a moral status that begins with deserving protection and increases as the fertilized egg becomes more human-like*

*Argument.* The main point of the gradual view is that the moral status and the protection of the embryo should increase as the fertilized egg becomes more human-like. There are several reasons for such a position:

- There are degrees of value of a life depending on the stage of that life. Consequently, there are degrees of respect that ought to be shown to that life at those stages. They can be identified as follows: the implantation after the sixth day, the appearance of the primitive streak<sup>2</sup> at the end of the second week, the viability phase<sup>3</sup> or even birth itself (14). At different stages of the end of life we tend to make different judgments of how great that loss is, depending on the stage of the lost life. Thus a fertilized egg before im-

<sup>2</sup> It is along the primitive streak that the major tissues and organs of the body differentiate. The appearance of the primitive streak is referred to as the limit of 14 days, but it may be an ambiguous and unreliable standard to determine the embryo’s moral status, since measurements may be inaccurate to within a few days.

<sup>3</sup> The viability phase is now considered towards the 24<sup>th</sup> week. It can be argued that the viability phase may change together with the medical technologies becoming more modern.

plantation in the uterus could be granted a lesser degree of respect than a human fetus or a born baby (5).

- There is a natural embryo loss in pregnancy, where more than half of all fertilized eggs either fail to implant or are otherwise lost. Therefore, if natural process entails the loss of some embryos for every successful birth, the loss of embryos that occurs in stem cell research should not worry us either. Those who view embryos as persons might reply that high infant mortality would not justify infanticide. But the way we respond to the natural loss of embryos suggests that we do not regard this event in the same way as the death of an infant (8).

*Counter-argument.* However, there are also several reasons why human embryos at the very beginning of their existence should have the same protection as more developed embryos or fetuses:

- Whatever moral status does the human embryos have, the *life that it lives has a value to the one who lives this life*. We protect a person's life and interests not because those interests are valuable from the point of view of the universe, but *because they are important to the person concerned*. Therefore, the life of the human embryo should be protected because it has a value to the embryo itself<sup>4</sup> (5).

- We should be cautious and refrain from destruction of fertilized eggs even if we are not sure about their dignity, simply because being uncertain as to whether a particular organism is a human being, it would be more reasonable to refrain from destroying it. For example, a hunter refrains from shooting if he is not sure whether the particular object at which he is aiming is a deer or a man<sup>5</sup> (15).

- Judging the moral status of the embryo from its age is making arbitrary definitions of who is human. For example, even if we consider that the appearance of the primitive streak at day 14 after the fertilization of the egg is the threshold of when the embryo acquires moral worthiness, we must still acknowledge that patients who have lost part of their cortex from a stroke or Alzheimer's disease are no less human than they were before (16).

*Having no moral status at all, regarded as organic material, with a status no different from other body parts*

*Argument.* Fertilized human eggs are merely parts of other people's bodies until they reach a certain auto-

<sup>4</sup> This, of course, raises the question on what ground values are attributed to someone or something, since the fertilized egg has no interests, no capacity to feel and think.

<sup>5</sup> But according to utilitarians you would have to consider also the potential benefit of those who suffer from incurable diseases and not focus only on the disputed dignity of the embryo.

nomous or independent developmental stage. Accordingly, they have no independent moral status at all, and are merely the property of the people from whose body they came. The only respect due to these blastocysts is the respect that should be shown to other people's property (5). The blastocysts before implantation cannot be harmed by being destroyed. To be harmed means to have an interest or interests defeated. For a being to have an interest, this being must have beliefs, desires, expectations, aims, and purposes. The nervous system of such early embryos is not developed enough for this. Because they are not the subjects of interests, such early embryos cannot be the subjects of basic rights that protect interests (5). A pre-implantation embryo contains potentially all the cells of the human body, and by conducting research one is not destroying it, but merely directing it to become certain cells and not others, since the cells of such an embryo are still totipotent (e.g. they are still capable of multiplying into twins) (17). It can also be argued that a new human organism (at the embryo stage) is only the predecessor of the organism that the human being ultimately born will be (15).

*Counter-argument.* By directing an embryo to "become certain cells", the embryo is prevented from developing in its normal complete fashion. It is completely reprogramming an embryo and thus preventing it from becoming what it was programmed to become – a human being (18).

### **What is the opinion on embryonic stem cell research in major religions?**

The moral status of the early human embryo before the time of its implantation in the uterus differs depending on religion.

- *Catholic, Orthodox, conservative Protestant Churches*

Since a human embryo is believed to have a status of a human individual from the moment of the fertilization of the egg<sup>6</sup>, it has the right to its own life, and every intervention not in favor of the embryo is a violation of that right. No end believed to be good (e.g. using stem cells to prepare other differentiated cells to be applied in what look to be promising therapeutic

<sup>6</sup> In the Roman Catholic Church, for example, this has not been the original belief. A traditional view, held by St. Thomas Aquinas, was that the soul entered the male fetus at the 40<sup>th</sup> day and the female fetus at the 90<sup>th</sup> day (13). From Saint Augustine through the nineteenth century (in official church teaching) and the early twentieth century (in canon law), the unformed early fetus was thought to lack a human soul because it lacked sentience. A growing number of Catholic moral theologians do not consider the human embryo in its earliest stages (prior to the development of the primitive streak or to implantation) to constitute an individualized human entity with the settled inherent potential to become a human person (12).

procedures) can justify the destruction of the embryo, which is believed to be a wrong action (19). For a comparison, killing a human being to provide organs for another human being is condemned, and the same standard should be applied to the human embryo (18). The Orthodox Churches, like the contemporary Roman Catholic Church, believe that the process toward authentic human personhood begins with the zygote, which is committed to a developmental course that will ultimately lead to a human person. Therefore, Orthodox Christians as well as Roman Catholics and Conservative Protestants affirm the sanctity of human life at all stages of development. However, they consider that already existing stem cell lines could be used for therapeutic purposes, since they had already been created and cannot be undone (12).

- *Less conservative Protestant Churches*

Less conservative Protestant Churches believe that the embryo has a potential human status, reflecting its gradual development from basic cells to a fetus. Thus some embryo research may be permitted. The life of the embryo is weighed against the possible benefit for the society from embryo research. The life of the human embryo is sacred from conception, but there are circumstances under which embryo research might be allowed prior to the “primitive streak” stage (around 14<sup>th</sup> day after the fertilization), bearing in mind the seriousness of certain medical conditions that could possibly be treated. However, if it is accepted to use the embryo instrumentally for certain purposes, it raises another problem: which other ends for should such instrumental uses of the embryo be allowed (18)?

- *Judaism*

The Jewish religious tradition emphasizes the importance of the saving of life and considers the ultimate goal of human embryonic stem cell research to be life saving. Healing in Judaism is not only permitted, it is required to be an active partner in the world’s repair and perfection (12). Man is obliged to build and develop the world in every direction favorable to humanity. Therefore, any activity that contributes to advancements in the world cannot be considered as contradicting God’s decrees (20). It is also believed that it is God who has given the power to create new technologies (14). Anything, which has no reason to be prohibited is permitted without having to find a reason for its permissibility<sup>7</sup> (20). In Judaism the human fetus

<sup>7</sup> For example, genetic engineering is not seen as an assault on the belief in God the creator, as this technology only works on the basis of factors that already exist in the nature (since using the knowledge about nature for all sorts of reasons does not make a new creation). (4)

less than 40 days old (14) and certainly the pre-implantation embryo does not have a full human status (21). After those first 40 days the embryo in the uterus is considered a part of the woman until birth, and during this period abortion is not allowed for a healthy fetus, just like it would not be allowed to amputate a healthy limb (13).

- *Islam*

The majority of Muslim thinkers through the ages have accepted the morality of abortion through either the fortieth day or the fourth month of pregnancy (12). It is believed that the soul is “breathed in” to the human embryo on the 40<sup>th</sup> day after fertilization and this is when life becomes sacred (22). All schools of thought in Islam accept that the fetus is accorded the status of a legal person only at later stages of its development, when perceptible form and voluntary movements appear. The Koran provides no criteria for when the “breathing-in” of the soul occurs in the fetus and the thinkers make a distinction between a biological and a moral person, placing the stage of the moral person after the first trimester of pregnancy (12). However, Muslim jurists differ over whether “breathing-in” of the soul takes place in 40 or 120 days (14). Also, it is believed that there is no disease that does not have a cure, and therefore the cure should be sought. Just like in Judaism, medical progress is a strong value and stem cell research is acceptable due to its therapeutic benefits. According to the Muslim faith, the supernumerary embryos cannot be donated to other couples, as the lineage must be respected. These embryos can either be preserved or destroyed since they are still below the threshold of 40 days’ pregnancy. In this view, conducting research on supernumerary embryos that will no longer be used for *in vitro* fertilization purposes rather than destroying them is choosing the lesser of two evils (22).

- *Buddhism and Hinduism*

Buddhism is a religion based on intelligence, science, and knowledge, and its purpose is the elimination or reduction of suffering as well as the source of suffering. It is a religion, which is not grounded in the belief in God: Buddhists are taught to think and contemplate rationally before they should believe something (23). Buddhism prohibits harm to any sentient beings, which presents possible restrictions on embryo and animal research (21). Also, every action (e.g. killing) that treats human beings as non-humans is considered immoral. For Buddhists, however, not all areas of medical biotechnology lead to ethical problems: more advanced medical biotechnology (where

research is conducted on molecular level) is likely to be acceptable. Molecular human parts, such as cells, are hardly seen as human beings, thus their destruction in the process of research is not likely to be seen as morally wrong (23).

Regarding the research on human stem cells, the intention is important. If the intention of the research is to help and benefit humankind, such research is considered ethical. On the contrary, if the research is done just for the sake of making money out of it, it is considered as unethical. But since Buddhism places great importance on the principle of non-harming, it has grave reservations about any scientific technique or procedure that involves the destruction of life, whether human or animal. However, the principle of non-harming can be interpreted as prohibiting only the harm on sentient beings that is those who are able to feel. Therefore, under some circumstances Buddhism could accept research on non-sentient embryos before the day 14 of their development (12). Hinduism, like Buddhism prohibits injuring sentient beings. The Hindu tradition rejects both animal research and the destruction of embryos (21).

#### **Will embryo research lead to cures for many diseases?**

Embryonic stem cell research, like stem cell research in general, is promising, but still at an early stage. It is expected that embryonic stem cell-based therapies will help to treat diseases like Parkinson's (24–26), Alzheimer's (27) or diabetes (28–30). However, from the time that the public was promised real benefits (stem cell therapies in routine clinical use) of this research within 5–10 years, several years have already passed of those 5–10 years, and the promised therapies are still not anywhere close to routine clinical use (31). Research (mainly with animals) suggests that therapeutic cloning (taking stem cells from embryos and programming them to grow into tissues or organs for therapeutic use) may be scientifically possible. However, there remains much more basic research to be done before scientists could say with any confidence that genetically compatible human tissue for therapy or transplantation can be produced (11). Recently Korean scientists have succeeded to derive cell lines from patients in the age group 2 to 56, suffering from spinal cord injuries, genetic disorders and diabetes. The scientists state, however, that they still remain years away from transplanting cells into people, as they have to be over-convinced that the cells are safe (32). It is not known yet how successful cloned

cells would be on patients or what risk there is of cultured cells becoming cancerous (18). It is the nature of scientific discoveries and progress that they are not easily predicted: both advances and impediments to advancement can arise unexpectedly. Therefore it is important to assess how realistic the potential of the benefits is, and to compare the alternatives with different combinations of benefits and drawbacks to see all the possible consequences of embryonic research (5). For example, in the case of genetic research, the patients (suffering from genetic diseases) that have been promised the greatest benefit from this research have not benefited significantly yet from gene therapy (31). The possible risks to patients undergoing stem cell-based therapies should also be taken into consideration. The speed with which researchers, throughout the world, are moving to test stem cells in patients is remarkable, but the risk-benefit assessment is crucial in stem cell research, as in any research, but is more difficult as the uncertainties are considerable given the gaps in our knowledge. To minimize the risks and increase the benefits of such therapies, the strategies for safety should be well developed. For example, the risks that transplanted stem cells cause abnormalities or induce creation of tumors or cancer have to be assessed. The possibility that irreversible and potentially harmful changes may be introduced by stem cell-based therapies should be minimized by introducing techniques that enhance the possibilities of reversibility. Introducing stem cell-based therapies, precautionary approach must be taken and potential benefits for the patients should be taken into account but not exaggerated (33).

#### **Conclusions**

There is no unanimous position regarding all the above-discussed questions among both scientists and ethicists, except the general agreement about the laudability of the aims of embryonic stem cell research and the necessity of precautionary approach when introducing stem cell-based therapies. The aim of this article was to present an objective picture regarding the controversial issue of human embryonic stem cell experimentation and to enable the reader to look at the problem from both conflicting sides and thus to help the reader to make up his/her own informed position. The author hopes that this aim has been achieved.

#### **Acknowledgements**

This work was supported by the EU project LHSB-CT-2003-503005 (EUROSTEMCELL).

## Žmogaus embrioninių kamieninių ląstelių tyrimų perspektyvos ir žmogaus embriono statusas. Ar viena turėtų būti paaukota dėl kito?

Kristina Hug

Kauno medicinos universiteto Visuomenės sveikatos fakulteto Socialinės medicinos katedra

**Raktažodžiai:** embrioninės kamieninės ląstelės, embriono statusas, biomedicininiai tyrimai, religija.

**Santrauka.** Kamieninės ląstelės yra nespecializuotos ląstelės, kurios gali skirti į dukterines ir turi potencialą diferencijuotis, t. y. sudaryti kitus žmogaus kūno ląstelių tipus. Mokslininkai tyrinėja galimybes panaudoti ląsteles, turinčias potencialą diferencijuotis, regeneracinei medicinai. Embrioninės kamieninės ląstelės turi didžiulį terapinį potencialą, nes iš jų gali susidaryti kiekvieno tipo ląstelių, kokių tik yra žmogaus kūne, o suaugusio žmogaus audinių kamieninės ląstelės gali diferencijuotis tik į ribotą skaičių ląstelių tipų. Dėl šios priežasties mokslininkai pabrėžia embrioninių kamieninių ląstelių tyrimų svarbą. Tačiau dėl šių tyrimų kyla diskusijų, kurias sudaro etiniai bei religiniai argumentai bei galima tokių tyrimų rezultatų nauda pacientams, sergantiems iki šiol nepagydomomis ligomis. Šio darbo tikslas – apžvelgti pagrindinius argumentus už ir prieš žmogaus embrioninių kamieninių ląstelių tyrimus. Kadangi ši aktuali tema labai priklauso nuo visuomenėje dominuojančios religijos pozicijos, todėl pagrindinių religijų požiūris į žmogaus embrionų tyrimus taip pat analizuojamas straipsnyje.

**Išvados.** Iki šiol tarp mokslininkų nėra sutarimo dėl žmogaus embrioninių kamieninių ląstelių tyrimų. Straipsnyje pateikiami tiek argumentai, pagrindžiantys embrioninių kamieninių ląstelių tyrimus, tiek jiems prieštaraujantys.

Adresas susirašinėti: K. Hug, KMU Visuomenės sveikatos fakulteto Socialinės medicinos katedra, A. Mickevičiaus 9, 44307 Kaunas. El. paštas: kristina.lukauskaite@medetik.lu.se

### References

1. Thomson JA, Itskovitz-Eldor J, Shapiro SS. Embryonic stem cell lines derived from human blastocysts. *Science* 1998;282:1145-7.
2. Rosenthal N. Prometheus's vulture and the stem-cell promise. *New Engl J Med* 2003;349:267-74.
3. Fishbach GD, Fischbach RL. Stem cells: science, policy and ethics. *J Clin Invest* 2004;114:1364-70.
4. Cowan CA, Klimanskaya I, McMahon J, Atienza J, Witmyer J, Zucker JP, et al. Derivation of embryonic stem-cell lines from human blastocysts. *New Engl J Med* 2004;350:1353-6.
5. Rickard M. Current issues brief No. 5, 2002-03: Key ethical issues in embryonic stem cell research. Department of the Parliamentary Library, Australia, 2002 [cited 2005 Jan 12]. Available from: URL: <http://www.aph.gov.au/library/pubs/CIB/2002-03/03cib05.pdf>
6. Landry DW, Zucker HA. Embryonic death and the creation of human embryonic stem cells. *J Clin Invest* 2004;114:1184-6.
7. Holm S. Stem cell transplantation and ethics: a European overview. *Fetal Diagn Ther* 2004;19:113-8.
8. Sandel MJ. Embryo ethics – the moral logic of stem-cell research. *New Engl J Med* 2004;351:207-9.
9. Knoepffler N. Stem cell research: an ethical evaluation of policy options. *Kennedy Institute Ethics J* 2004;14:55-74.
10. Cregan K. Ethical and social issues of embryonic stem cell technology. *Int Med J* 2005;35:126-7.
11. Campbell AV. Ethical issues in therapeutic cloning. Round table “Ethical aspects of human stem cells research and uses”, Brussels, 26 June 2000 [cited 2005 Jan 10]. Available from: URL: [http://europa.eu.int/comm/european\\_group\\_ethics/docs/dp15rev.pdf](http://europa.eu.int/comm/european_group_ethics/docs/dp15rev.pdf)
12. Walters L. Human embryonic stem cell research: an intercultural perspective. *Kennedy Institute Ethics J* 2004;14:3-38.
13. Welin S. Ethical issues in human embryonic stem cell research. *Acta Obstetrica et Gynecologica Scandinavica* 2002;81:377-82.
14. Lampman J. Different faiths, different views on stem cells. *Christ Sci Monitor* 2001;93:1-1.
15. Gomez-Lobo A. On the ethical evaluation of stem cell research: remarks on a paper by N. Knoepffler. *Kennedy Institute Ethics J* 2004;14:75-80.
16. Chu G. Embryonic stem-cell research and the moral status of embryos. *Int Med J* 2003;33:530-1.
17. Sowle Cahill L. Social ethics of embryo and stem cell research. *Women's Health Issues* 2000;10:131-5.
18. Bruce D. Church and society commission of the conference of European churches. “Therapeutic uses of cloning and embryonic stem cells”. A discussion document of the bioethics working group of the church and society commission. Conference of European churches. Society, religion and technology project, Church of Scotland, 5 September 2000 [cited 2005 Jan 10]. Available from: URL: <http://www.srtp.org.uk/clonin50.htm>
19. Dios Vial Correa J. Declaration and the scientific and therapeutic use of human embryonic stem cells. Pontifical Academy for Life, Vatican City, 25 August 2000 [cited 2005 Jan 12]. Available from: URL: <http://www.cin.org/docs/stem-cell-research.html>
20. Guigui A. Ethics in medicine and judaism. Round table “Ethical aspects of human stem cells research and uses”,

- Brussels, 26 June 2000 [cited 2005 Jan 11]. Available from: URL: [http://europa.eu.int/comm/european\\_group\\_ethics/docs/dp15rev.pdf](http://europa.eu.int/comm/european_group_ethics/docs/dp15rev.pdf)
21. Sullivan B. Religions reveal little consensus on cloning. MSNBC News, 2004 [cited 2005 Jan 11]. Available from: URL: <http://msnbc.msn.com/id/3076930/>
  22. Beloucif S. The Muslim's perspective related to stem cell research. Round table "Ethical aspects of human stem cells research and uses", Brussels, 26 June 2000 [cited 2005 Jan 10]. Available from: URL: [http://europa.eu.int/comm/european\\_group\\_ethics/docs/dp15rev.pdf](http://europa.eu.int/comm/european_group_ethics/docs/dp15rev.pdf)
  23. Changthavorn T. Bioethics of IPRs: What does a Thai Buddhist think? Round table discussion on bioethical issues of IPRs, Selwyn College, University of Cambridge, 28–29 March 2003 [cited 2005 Jan 12]. Available from: URL: <http://www.shef.ac.uk/ipgenethics/roundtable/abstracts/TChangthavorn.doc>
  24. Kim JH, Auerbach JM, Rodriguez-Gomez JA, Velasco I, Gavin D, Lumelsky N, et al. Dopamine neurons derived from embryonic stem cells function in an animal model of Parkinson's disease. *Nature* 2002;418:50-6.
  25. Freed CR, Greene PE, Breeze RE, Tsai WY, DuMouchel W, Kao R, et al. Transplantation of embryonic dopamine neurons for severe Parkinson's disease. *New Engl J Med* 2001;344:710-9.
  26. Wichterle H, Lieberam I, Porter JA, Jessell TM. Directed differentiation of embryonic stem cells into motor neurons. *Cell* 2002;110:385-97.
  27. Abe Y, Kouyama K, Tomita T, Tomita Y, Ban N, Nawa M, et al. Analysis of neurons created from wild-type and Alzheimer's mutation knock-in embryonic stem cells by a highly efficient differentiation protocol. *J Neuroscience* 2003;23(24):8513-25.
  28. Ricordi C, Strom TB. Clinical islet transplantation: advances and immunological challenges. *Nature Rev Immunol* 2004;4:259-68.
  29. Liu EH, Herold KC. Transplantation of the islets of Langerhans: new hope for treatment of type 1 diabetes mellitus. *Trends Endocrinol Metab* 2000;11:379-82.
  30. Shapiro AM, Lakey JR, Ryan EA, Korbutt GS, Toth E, Warnock GL, et al. Islet transplantation in seven patients with type 1 diabetes mellitus using a glucocorticoid-free immunosuppressive regimen. *New Engl J Med* 2000;343:230-8.
  31. Holm S. Going to the roots of the stem cell controversy. *Bioethics* 2002;16:493-507.
  32. Hwang WS, Roh SI, Lee BC, Kang SK, Kwon DK, Kim S. Patient-specific embryonic stem cells derived from human SCNT blastocysts. *Science* 2005;308:1777-83.
  33. European Group on Ethics in Science and New Technologies. Group of Advisers on the Ethical Implications of Biotechnology to the European Commission. Opinion N° 15 14/11/2000 Ethical aspects of human stem cell research and use [cited 2005 May 7]. Available from: URL: [http://europa.eu.int/comm/european\\_group\\_ethics/index\\_en.htm](http://europa.eu.int/comm/european_group_ethics/index_en.htm)

*Received 26 May 2005, accepted 16 December 2005*  
*Straipsnis gautas 2005 05 26, priimtas 2005 12 16*