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Stem Cells: Scientific Progress and its Ethical Implications

Submitted in partial fulfillment of the requirements for graduation with honors from the Department of Natural Sciences at Carroll College, Helena, MT

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Abstract

It is maintained by many scientists that stem cell research is an important resource for new discoveries and understanding, especially in the newly developing field of regenerative medicine. However, research involving embryonic and fetal stem cells remains a highly controversial undertaking in today's world, due to both ethical concerns and skepticism regarding the effectiveness of the treatments obtained through this research. In this thesis, I examine the differing arguments for the continuation of stem cell research, as well as their counter arguments, in an effort to find a compromise between the two positions. Additionally, I examine alternatives to the use of fetal and embryonic tissues in stem cell research and the role American politics plays in the continuation of this research. This investigation further establishes that a compromise between these two stances would be hard to find. However, alternative sources of stem cells, from adult individuals or otherwise, would likely be a more sustainable substitute to embryonic and fetal stem cells in research efforts. This is due to current political constrains and moral concerns against embryonic and fetal stem cells, in addition to new found efficiency in the methods for obtaining such alternatives.

Stem cells are miraculous. They can become almost any type of human cell due to their pluripotent nature. The research and application of stem cells as the answer to many health problems has been underway for a little over half a century. Although there is some argument as to the exact date of their discovery (sources vary between the years 1959 and 1960) these cells have been under intense scientific scrutiny due to the unique elasticity of character they possess (Dantuma, et al., 2010; Helmy et al., 2010). There are many who are in support of continuing research on these cells, and many who are opposed. I conducted research in order to gain a better understanding of fetal and embryonic stem cell research and the ethics behind it, as well as to search for an acceptable compromise to the various positions and philosophies on the issue, if such a compromise is possible. In my research, I used the databases Pubmed Central and Science Direct to locate resources relating to this topic. Google searches were also used to find sources relating to the ethical and political aspects of fetal and embryonic stem cell research. In particular, the review of articles by Dr. Irving Weissman proved helpful in gaining an understanding of those in support of stem-cell research. I also reviewed the ethical issues with such research, as cited in documents by the Catholic Church. In addition, I sought out and used scientific documents that would aid in elucidating a compromise between the ethical problems found in such research.

Stem cells can be given different classifications based on their source. Human embryonic stem cells are derived from human embryos that have been in development for a few days, while fetal stem cells are derived from fetal tissues that have been in development for more than 8 weeks (NIH, 2012). Many scientists support embryonic stem cell research as it promises to yield results where other methods have failed

(Steinbock, 2007). Advocates cite that there have been many important scientific discoveries due, at least in part, to the investigation of fetal and embryonic stem cells (Blank, 2012). A field directly affected by the research of fetal and embryonic systems is that of developmental medicine, which has learned much in regards to the mapping of normal fetal development, as well as the fetal response to certain drug stimuli (Blank, 2012). Supporters also argue that it is a reproductive right to be able to donate one's sex cells to research efforts, regardless of whether or not they are fertilized (Holm, 2005). The argument states that, since the matter of stem cell research involves the reproductive process, what one does with their germ cells is an individual decision (Holm, 2005). Weissman (2012) also argues that deceptively labeled treatments have marred the name of stem-cell research. In fact, Weissman (2012) states that more specific definitions of what constitutes stem-cells must be enacted in order to eliminate preconceived notions of their ineffectiveness; notions due primarily to incorrectly worded studies in which legitimate stem cell treatments were not used. Examples of this include the administering of bone marrow cultures and cord blood, which lack sufficient quantities of stem cells, as well as other treatments which lack the scientific backing and federal oversight necessary to guarantee their effectiveness (Weissman, 2012).

Perhaps the aspect of stem cells that most excites researchers today is that of their application in the now developing field of regenerative medicine (Daley, 2012). However, in order for stem-cell-based therapies on a large scale to be feasible, it would require advances in promoting tolerance of the cells, to prevent rejection by the patient, or the suppression of their immune system (Daley, 2012). This becomes necessary due to the nature of the allogenic cells, cells foreign to the individual being treated, which would

be utilized due to constrains such as the cost of personalized cell cultivation (Daley, 2012). While it may not be ideal, immune suppression is a practice that has yielded positive results in the donation of organs (Daley, 2012). One worry regarding this medical suppression of the immune system is that some of the benefits of the stem cells could be lost (Sanburg et al., 2012). It is also worth noting that pharmaceutical companies have interest in the field of stem cell research, although this interest lies in isolating proteins from the stem cells which can then be used as treatments (Weissman, 2012). The basis of this approach is to induce the body to self-renew without the transplantation of cells (Weissman, 2012). Although this method may seem appealing, Weissman (2012) has his doubts in regards to its effectiveness, as it is very difficult to trigger all of the genes necessary to induce this process.

Despite all of the potential for healing and regeneration of the body, there are still those who are opposed to medical use of stem cells (Steinbock, 2007). Some hold the perspective that the taking of biological material from the unborn poses a problem when it comes to the rights of the fetus or embryo in question (Watt, 2005). They feel that helping one individual does not justify the destruction of another (Watt, 2005). As stated by the Congregation for the Doctrine of the Faith (CDF) (2008), it is believed that, "By virtue of the simple fact of existing, every human being must be fully respected." In addition, some individuals feel that the image of the stem cell as the panacea of modern times has been grossly overstated (Steinbock, 2007). Added to this is the sentiment that the rights of the embryo fall outside of the reproductive rights held by the individual who donated the cells (Holm, 2005). It is argued that the creation of embryos solely to utilize cells for research purposes does not hold the intent to procreate, and so procreative

liberties cannot be appealed to in such instances (Holm, 2005). While some supporters cite the twinning principle, a division or recombination of the zygote within the first 14 days of development, in the denial of a zygote's claim to be living, those opposed see this as a denial of the zygote's humanity (Shea, 1985). In fact, it is not uncommon for those opposed to feel that embryos are stripped of their humanity when committed to research purposes (Blank, 2012). Irving (1999) also puts forward that not only can twinning occur after the proposed period of 14 days, but also that, "A zygote is the beginning of a new human being." A future in which fetal cells become a commodity for the highest bidder would be an ethical nightmare for many, due to the denial of the humanity they see within a zygote (Blank, 2012).

An associated issue with fetal and embryonic stem cell research is the number of embryos that are created during *in vitro* fertilization. Sunkara et al. (2011) suggest that the optimal number of eggs to be fertilized, per fertilization cycle, was roughly 15, with numbers around 20+ showing diminishing returns. This is a significant finding. Not only does it demonstrate that the fertilization of multiple eggs is ideal for those seeking a live birth, it also demonstrates an ethical problem inherent in the process. It is due to the fertilization of multiple eggs that religious groups, such as the Catholic Church (2008), are so vehemently opposed to *in vitro* fertilization and stem cell research. The CDF (2008) states that, "The human being is to be respected and treated as a person from the moment of conception; and therefore from that same moment his rights as a person must be recognized." Such practices appear to demonstrate a complete disregard for individual life, where the truth of embryonic humanity is ignored (CDF, 2008).

There are also technical issues as far as controlling the growth of embryonic stem cells (Helmy et al., 2012). Replication of these cells in a laboratory setting often occurs continually, and the injection of these cells into mice results in the formation of teratoma tumors (Helmy et al., 2012). Although this formation of tumors poses a threat to those who may seek treatments at present, there are other individuals who we should consider besides the recipients of the cells.

While the fate of the embryos may be of utmost importance in this debate, the health and welfare of those who donate tissues may be a more immediate issue. Those most directly affected are likely the women who allow their eggs to be harvested either for *in vitro* fertilization procedures or for general research. Not only are there risks derived from the drugs taken to stimulate the ovaries, but also in the gestation and development of the embryo (HFEA, 2009). Risks for mothers include ectopic pregnancies, in which the fetus develops outside of the uterus, and a higher likelihood of multiple births (HFEA, 2009). A risk that all women who undergo treatment with fertility drugs have is that of ovarian hyper-stimulation syndrome, which occurs in around 5% of patients (HFEA, 2009). Symptoms can be as mild as nausea and some stomach discomfort while more serious cases can threaten an individual's life (HFEA, 2009). Although not the center of this issue, the health of individuals who donate these cells should be considered in all cases.

Due to ethical concerns, an important consideration is the use of cells from sources other than fetal and embryonic tissues. Stem cells derived from adult individuals, otherwise known as induced pluri-potent stem cells, are one such option. Such cells lack the ethical problems that fetal and embryonic stem cells face and are much less likely to

be rejected upon implantation, but also have many issues regarding their cultivation (Ess, 2013). While desirable, problems in generating these cells pose a threat to the safety of the patient and they cannot currently be used effectively (Ess, 2013). Although not yet perfected, there have been advances in their derivation. Methods for inducing stem cells without the use of a viral vector have made the procedure much safer for the recipient of the cells, and means of their procurement has become much more efficient (Wu and Hochedlinger, 2011).

Another option that should be considered is that of pregnancy-associated progenitor cells; microchimeric fetal cells that accumulate within the mother during pregnancy (Pritchard et al., 2011). There is currently evidence that these fetal cells may play a role in the better prognosis in women, compared with men, in lung diseases (Pritchard et al., 2011). These cells are also not rejected by the mother's immune system, which suggests that they could be taken and differentiated into other organ systems that the mother might require in the future (Pritchard et al., 2011). Although there is positive evidence in regards to microchimeric cells, there has been little research on them and more must be done to fully understand how they function (Pritchard et al., 2011). It is currently unknown how diverse the cells are, and in what state they are transferred to the mother; both will be important to understand in the development of future treatments (Pritchard et al., 2011).

Yet another method would involve the use of amniotic fluid stem cells. Such cells are often used in prenatal diagnoses and show characteristics similar to those desired in fetal and embryonic stem cells (Phermthai et al., 2010). Methods for their derivation, in which there is a sizable population of high quality cells, have recently been developed

by Phermthai (2010) and colleagues. It has been hypothesized by Phermathai (2010) that these cells could be used similarly to other allogenic cells, as well as in autogenic applications where an individual utilizes their own cells, although an assessment of the cell lines will be necessary before the utilization of either technique in medicine.

Also of note are the many instances in which American politics has either impeded or allowed progress in fetal and embryonic stem cell research. One of the most recent instances was the passing of the Dickey-Wicker Amendment in 1996, which banned federal funding in research involving human embryos being created or destroyed in capacities that violate laws regarding research on human fetuses (Research!America, 2013). This was followed by federal funding being denied to any research involving stem cell lines created after August 9, 2001 on June 7, 2001 by President George W. Bush (Research!America, 2013). This restriction was later removed by President Obama on March 9, 2009 (Obama, 2009). As can be concluded from these political happenings, the future of embryonic stem cell research is uncertain within the American political climate. One should expect research support to ebb and flow with the coming and going of political leaders and candidates.

It has been noted previously that there are issues with the number of embryos created in *in vitro* fertilization. This appears to be among the most serious of concerns among the opponents of fetal and embryonic stem cell research. It was noted by the CDF (2008) that there is an unsolvable moral dilemma in regards to what can be done with the embryos that are created in *in vitro* fertilization. There are no easy answers as to what direction should be taken in this regard. However, I feel that we should focus not on

what we have done in the past, but on what we should do in the future, as this will dictate the direction similar research takes.

As was presented previously, the twinning principle requires that we take a second look when we define where life truly begins. Since the zygote may change in ways that create or destroy a new individuality, such as by forming two zygotes from one or one from two, it is difficult to say when a person becomes their own. However, Irving (1999) brings forth another point worth noting, which is that, "The issue [in stem cell research] is not when does human LIFE begin, but rather when does the life of every human BEING begin." No one can deny that an embryo lacks the higher faculties of humanity, however, this does not detract from its inherent humanity. Additionally, although the twinning principle brings forth a valid point, I find myself asking whether such things occur normally during *in utero* development. Since most, if not all, research on these cells has occurred *in vitro*, such things may not apply as generally to more natural cases of *in utero* development.

We must also ask ourselves if life begins for all zygotes, *in vitro* and *in utero*, at the same time or at different times depending on the mode of fertilization. My personal opinion is that life must begin at the same point in development, regardless of the mechanisms or environment through which it occurs. If we do not act on this principle, we seemingly make ethical exceptions for similar entities under relatively similar conditions of formation. This is unacceptable to me, because it robs one such entity of the respect it deserves as a similar being. Although there seem to be different scientific understandings of when an individual becomes human, I feel that conception, and not after the 14 days of the twinning principle, marks the beginning of a human being's

existence. While not human in form or practice, it cannot be denied that a zygote has the chromosomes and mechanisms necessary to achieve its potential of realizing its own humanity (Irving, 1999).

Another important consideration in conducting this research is whether or not it is worth the risks to those who donate the necessary tissues and cells. We must also ensure that the wishes of these individuals are kept, so that their tissues are used only for purposes that they deem suitable and agree to. Additionally, we should also ask if we have the right to divert potential human life in favor of sustaining one already in existence. The answer, of course, lies in when we believe life begins.

Although much has been accomplished in the field of fetal and embryonic stem cell research, it would be best to concentrate our scientific efforts on the research of stem cells derived from other sources. With increasing ethical pressures and varying political opinions, this action may be necessary in order to glean future knowledge and develop treatments. While there is much still unknown about stem cells derived from these sources, it is believed that they are just as safe as fetal and embryonic stem cells in their ability to treat individuals, or will be so should research continue, and that the effectiveness of their application will also increase with continued research (Phermthai et al., 2010; Pritchard et al., 2011; Wu and Hochedlinger, 2011). Additionally, research into different sources of stem cells may yield different treatments that will prove invaluable in different situations. It will be through methods such as these that we may be able to fuel the development of regenerative medicine in a fashion that is devoid of political pressure and moral worry.

I have a deep sense of respect for every scientist who has worked on projects related to stem cells. They have made contributions to the scientific and medical communities that cannot be underestimated. However, due to the political and ethical constraints which are present today, and likely to continue into the future, research in which fetal and embryonic stem cells are utilized should be abandoned in favor of research on alternative sources of pluripotent cells.

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