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Stem cells: basic research on health, from ethics to panacea*

Naara Luna

Doctor in Anthropology; researcher for the Laboratório de Estudos da Ciência (Science Studies Laboratory), Núcleo de Tecnologia Educacional para a Saúde (NUTES: Nucleus for Health Education Technology); FAPERJ scholar. Rio de Janeiro, RJ. naara_luna@ig.com.br

ABSTRACT

Even though stem cell therapies are still under experimentation, the media has represented them as a panacea that would cure all diseases. This fact secured the authorization for using human embryos as research material. Therapies include manipulation of human material in tissue bioengineering, suggesting a representation of the body as a factory. This article describes stem cell research projects being carried out in the health sciences center of a higher education institution, focusing on field organization and on the system of values underlying scientific activity. Researchers at different levels were interviewed about perspectives on, and implications of, their research in order to analyze the discourse of the projects' participants. Experiments with adult stem cells enjoyed wide support, while the use of human embryos was disputed. The foundations of those arguments were sought in their relation both to the structure of the scientific field and to the researchers' religious background.

Keywords : Stem cells; Embryo; Social values; Basic research; Ethics; Anthropology.

Sciences also act as legitimating meta-languages that produce homologies between social and symbolic systems. That is acutely true for the sciences of the body and the body politic. In a strict sense, science is our myth."
(Haraway, 1991, p. 42).

"What's cool about stem cells is that it will become what you need"
(Researcher with newly minted PhD)

Introduction

This article maps out a series of research projects with stem cells which are currently being undertaken in the health sciences center of a Brazilian institution of higher learning, taking into account both the organization of the field of study itself and of the value systems which underpin the scientific activities taking place within it. Here, the perspective is to understand "science as a form of culture" by questioning it as a foundational belief system (Franklin, 1995).

The current enthusiasm surrounding stem cell research is due to the expectation that such work may result in breakthrough therapies based upon the development of tissue-engineering technologies (Carvalho, 2001; Pereira, 2002). In Brazil, one of the first stem cell research initiatives was the creation of the *Instituto do Milênio de Bioengenharia Tecidual* (Tissue Bioengineering Millennium Institute) in 2001, a virtual institution which develops cell therapy studies. In contrast to the great majority of scientific research, discussion of work with stem cells has recently gone beyond the walls of academia and has been incorporated into general public discourse. This fact was illustrated by the wave of media coverage following approval of Brazil's new biosecurity law, which gave ample air-time to congressional debates regarding research with stem cells harvested from human embryos (Braga & Damé, 2004; Éboli, 2004).[1]

In October 2004, the Brazilian Senate approved the biosecurity bill. This allowed stem cells obtained from in vitro-fertilized, non-transferred embryos to be used in research and therapy, as long as said embryos were unviable or had been frozen for three years or more. The new law also stipulates that the permission of the genitors (or of those who furnished the gametes) be obtained for such research. Stem cell extraction implies the destruction of the embryos and the biosecurity law bans cloning, including the use of embryos in therapeutic cloning[2], a technique which would allow the creation of tissues which would not be rejected by the patient. The biosecurity bill was then approved by a significant majority in the Brazilian House of Representatives on March 2nd 2005, in spite of strong lobbying by the Catholic Church and members of the Evangelical Christian

[1] The second issue present in this debate, the legalization of the planting of transgenic soybeans, is not part of the scope of the current paper.

[2] In the legislative debate described by Cesarino (2006), it was made clear that the legislators understood that they were banning cloning therapies with this law.

congressional coalition (Brígido & Braga, 2005; Segatto & Termero, 2004). Members of the Brazilian scientific community and representatives of associations of patients who could benefit from the new therapies were present for the congressional debates.

Stem cell research is an innovative area which is of central concern to the scientific institution which is the object of the present study. In 2002, the Institute of Biophysics of the Federal University of Rio de Janeiro (UFRJ) opened a public competition for the recently-created stem cell studies chair. The University's Cell Therapy Program brought together researchers from both the Health Sciences Center as well as the Clementino Fraga Filho University Hospital (HUCFF). Interest in this research has also infected the campuses' students: of the 11 participants in UFRJ's medical research MD/PhD program, 5 are working on stem cell research projects and 4 of these students began their work in 2007.

The mapping of adult and embryo stem cell research was undertaken at UFRJ's Health Sciences Center (*Centro de Ciências da Saúde* – CCS). From March to June 2006, we conducted interviews with 36 researchers involved in stem cell work at the CCS. These interviews were semi-structured, with a schedule of open questions and were recorded and later transcribed. The schedule was divided into three parts: the first section collected the researchers' personal data; the second asked about the project in particular and research perspectives in general, as well as positions regarding conceptual questions; the final section inquired into the researchers' opinions regarding the ethical and social questions involving stem cell research. This third part of the schedule asked about personal reactions to stem cell research, the ethical implications in the use of adult and embryo cells, definitions of the human embryo and the researchers' personal religious beliefs. 17 of the informants were professors and 19 were students, with this second group including one post-doctoral student, 3 recent PhDs (doctors or post-doctors who continued as collaborators in the laboratory), ten doctoral candidates and 3 masters' students. I used the social network mapping method (cf. Bott, 1976) to investigate the laboratories. Three researchers were already known to us before we began, due to the divulgation of their work in the media and their participation in scientific conferences. Contact with the rest came through academic activities or through the indications of other informants. These techniques were essential to the success of the research, given that a significant number of the professors interviewed (5 of 17) have only been involved in stem cell research at the

CCS for less than a year. Given the initial contacts, the first interviews were with researchers in Histology, Embryology and Anatomy departments. Encountering greater difficulties, I also obtained interviews in the Institute of Biophysics. With CCS' major departments, these were the ones in which I encountered a dense scientific network (Latour, 2000) of stem cell researchers. Other academically prestigious departments and institutes, such as the Genetics and Biochemical Medicine departments, do not work with cells and thus tend to avoid stem cell research.

The field of cellular therapy and research: the biomedical eye

The present paper analyzes the field of cellular therapies as a segment of the wider scientific field: a system of objective relationships between acquired positions. It is a field of play for a competitive struggle in which the monopoly over scientific authority is disputed. This authority consists of technical capacities and social power which are taken together and which reinforce one another (Bourdieu, 1983). Here, we face a field of struggle in which legitimate definitions of the truth are debated (Bourdieu, 1996), with truth here understood as scientific fact. The scientific facts in question are related to stem cells and, more particularly, their properties and possible uses in therapy.

Stem cells have "unlimited/prolonged capacity for self-renewal and are capable of producing at least one type of highly differentiated cell". They "are able to divide into cells which are identical to their genitor or are quite different" (Pereira, 2002, p.65). Stem cells are distinctive in their origins and in their capacity for differentiation. Up until the third day of development, embryos are composed of totipotent cells, each of which can generate a new embryo. Stem cells are taken from blastocysts on the fifth day of development and they are capable of generating any kind of tissue. Though they cannot develop new embryos, they are thus pluripotent (Carvalho, 2001). In harvesting stem cells, it's necessary to destroy the embryo. Stem cells also exist in adult tissues. This type of stem cell can be isolated within the tissues of a patient and then cultivated, eliminating the possibility of rejection, in the case of transplants, and also the ethical problem of embryo destruction (Pereira, 2002). Researchers have tried to prove that neural and hematopoiethic (drawn from bone marrow) stem cells are not only multipotent (capable of generating the types of tissue cells which surround them), like other adult stem cells, but also pluripotent (capable

of generating cells for other types of organs and tissues). Adult cells' possible pluripotency opens up the possibility of same-patient organ transplants (autologic transplants), eliminating the possibility of rejection (Carvalho, 2001). The plasticity of adult stem cells' began to be questioned in 2000s. Pereira (2002) believes that 2 factors limit adult stem cells' utility in transplants: the rarity of cells with such wide-ranging differentiation capacities and the rapidity with which they lose said capacities in comparison with embryonic stem cells.

Borojevic (2004) describes regenerative medicine, a new specialty established within the medical field, whose goal is the repair or substitution of damaged or degenerate tissue. Bioengineering associates biomaterial with adjacent tissue cells in order to implant or promote the introduction of cells, seeking to integrate the resulting new structures with the damaged tissues. The use of stem cells in this process could permit the repetitive generation and recreation of tissue. Bone marrow is currently the principal source of stem cells for these therapies and the cells' capacity to regenerate complex and functional tissue structures in situ is critical for their use in regenerative medicine. Some regenerative therapies seek to construct tissue in the laboratory for later implants and these have already demonstrated stem cells' capabilities in vivo. Depending upon what disease is being treated, cellular therapy is a valid option. In cases of traumatic injuries accompanied by tissue or organ loss, for example, bioengineering and reparative cellular therapy can create adequate results. In the case of degenerative disease, however, Borojevic considers this sort of therapy to be palliative and also alerts readers as to common unrealistic or exaggerated expectations for stem cell therapies. There are many ethical objections to the use of cloned or embryonic stem cells, but none against the use of stem cells harvested from the patient herself (Borojevic, 2004).

In 2002, a virtual institution, the *Instituto do Milênio de Bioengenharia Tecidual* (IMBT: Tissue Bioengineering Millennium Institute) was created in Brazil, bringing together scientists from different institutions involved in developing studies of stem cell use for cellular therapies. The member organizations of the IMBT are 14 institutions financed by CNPq (one of Brazil's federal agencies for the fomentation of scientific research) and competitively chosen in 2001, with research financing for the next three years.

The Brazilian Health Ministry also initiated two programs which offer cellular

therapy: the *Rede Brasilcord* (Portal Saúde, 2004), a network of umbilical cord blood banks and a multi-centered study evaluating these therapies' efficacy in treating cardiovascular illness, with eye to offering them through the public health system at a later date (Portal Saúde, 2005).

With regards to scientific production, in general, and to work on stem cells in particular, what we see here is an excellent case of scientific networking (Rabinow, 1999, p.148). This is exemplified in the case of the *Instituto do Milênio* and in the case of the *Rede Brasilcord*, as well as with regards to the multi-centered cardiovascular treatment study. According to Latour, network organization permits techno-science to be simultaneously powerful and small-scale, as it is simultaneously concentrated and diluted. The very word "network" indicates that resources are concentrated in a few places (in knots or nodules) and interconnected to others (the linkages or net). These linkages transform dispersed resources into a network which can expand in any direction (Latour, 2000, p. 294).

Scientific production as the object of research

Anthropology has much to contribute to the study of science as a locus of culturally-conditioned knowledge production and, in particular, to the present investigation of the value systems associated with stem cell research. According to Emily Martin (1997, p. 132), a principal problem in the study of western science lies in science's view of itself, not as a cosmology, but as privileged field for the revelation of reality itself. The sciences take as a given the following "truths": objectivity as a point of view, nature as an object and materiality as reality. Scientists presume to discover reality and not construct it (Martin, 1997, p. 134).

Approaching biomedicine and the body through anthropology can reveal implicit presuppositions in the stem cell debate. The biomedical discourse has a particular manner of describing bodies and their parts and thus of constructing new realities such as stem cells. In western cultures, the human body is the vector of individualization, establishing the border of personal identity, which is itself understood to be equal and congruent with the body. The human condition is here understood as corporeal in nature: adding or subtracting to it immediately makes it ambiguous or intermediary. Bodily alteration thus

implies moral alteration (Le Breton, 1995, p. 64). In his study of medical texts, Martin (1989, p. 144) identifies the body as a centrally-controlled machine which produces substances and objects (semen, eggs, babies). Cell lineages are also included within this production, whether they are embryonic or adult in origin. According to Martin (1989), several metaphors exist which govern the ways in which science perceives the human body. The proliferation of new scientific discoveries, products and techniques flows from a firmly established set of metaphors which underpin scientific discourse (Martin 1989, p. 155s). The principal metaphors suggested by the cultivation of stem cells for tissue construction are the body as factory and the body as resource for the construction of biological materials. Emily Martin (1992, p. 126) observes that the maintenance of the purity of oneself within the limits of one's own body is seen as the equivalent to the maintenance of self. What happens, then, when material which has been cultivated in the laboratory is introduced into oneself? We are in the midst of a conceptual change in which the body is moving from being seen as an agent in the productive process to being seen as a resource, whose parts can be stocked, cloned and commercialized (Martin, 1992, p. 135 n. 14).

Mapping stem cell research

In the present study, we found significant lines of stem cell research in a dozen different CCS laboratories: one in the department of anatomy, four in histology and embryology and seven in the Institute of Biophysics. We visited all these labs. Of the 12, 10 work with adult stem cells and four with embryonic stem cells.[3] These last four labs received the donation of an embryonic cell line from Harvard University and, currently, none of the four laboratories are cultivating embryos to prepare new cell lines. One of the labs doesn't work with stem cells, but concentrates on producing biomaterial which induces in situ bone-tissue formation within the organism itself, being the research line which is closest to bioengineering. Two other labs have converted the greater portion of their research lines to cellular therapies, studying repair and regeneration. Others have simply added an additional line to already existing research.

Given researchers' declarations and what I could see of the experiments currently

[3] All of the projects involving embryo stem cells began their activities in 2006, authorized by the 2005 Biosecurity Law and by CNPq's approval of a Project put together by several researchers in different laboratories in 2006.

being conducted, we are still a long way away from making bioengineering an operational practice. It will be quite some time before adult stem cells can be reliably used to fabricate different kinds of tissue in laboratory conditions and longer still before embryonic stem cells can be used to do the same.[4] Several studies, however, show that the cells have effective applications in treating injuries, especially those culled with mononuclear bone marrow fractioning (a concentrate which contains stem cells, among other things). Borojevic (2001) describes a study which was published in *Nature* magazine, in which stem cells were injected into diseased heart tissue, regenerating the area in question and creating new blood vessels. This type of procedure is applied in the *Estudo Multicêntrico Randomizado de Terapia Celular em Cardiopatias* (Multicenter Randomized Trial of Cell Therapy in Cardiopathies) currently promoted by the Brazilian Health Ministry. It is part of the 2nd and 3rd phases of this study, which test the efficacy of cellular therapy on four diseases: dilated myocardiopathy, acute myocardial infarction, ischemic heart disease and Chagas disease cardiopathy. The study involves 1,200 patients and is being carried out in several different institutions throughout Brazil, coordinated through anchor centers (Portal Saúde, 2005).

Except for those studies which seek to differentiate and characterize stem cells (embryonic stem cells, neural stem cells and adipose tissue-derived mesenchymal stem cells), almost all of the research involves cellular therapy using laboratory animals. These studies include work on: orthopedic therapies, heart disease (myocardial infarction, dilated myocardiopathy, Chagas disease), pulmonary arterial hypertension, lung disease (silicosis and fibrosis), blood and liver disease (cirrhoses), serious muscular injuries, degenerative disease and traumatic injuries to the nervous system (strokes, global ischemia, spinal cord injuries, peripheral nerve injuries and optical nerve injuries) and kidney disease (diabetic nephropathy and ureteral obstruction). Aside from the multi-centered study's work on heart disease, stroke and cirrhoses studies have now also entered into phase one clinical research in order to verify the safety of the therapies involved for human subjects.

More than half of the professors interviewed in the present study are involved in clinical experimentation with stem cell therapies on human beings following a series of

[4] The most proximate study found during my research involved the creation of a skin substitute which would be applied to certain injuries. The substitute was made up of already-differentiated cells, the keratinocites.

distinct steps, including: conception of experiment on animal subjects, drawing up proposals for experimenting on human subjects, execution of proposal. These professors are, of course, those working on more advanced experiments and some members of this group have already sent in (or will soon send in) proposals for permission to experiment on human subjects to the National Research Ethics Council.

Research with embryonic and adult stem cells and the possible resulting therapies has been widely covered by the media and this can be seen as a process of informal scientific education. People understood as "layman" are already seeking out stem cell therapies in the hopes that these can resolve currently incurable health problems. Almost all of the students and professors interviewed in the present study have had some sort of personal experience with this sort of premature demands.

The polemics of embryonic cell research

The tensions between research using adult stem cells and embryonic stem cells can clearly be seen in the commentaries of two doctoral students working with adult cells: "To tell the truth, I work with neural stem cells, which are not harvested from embryos, because embryonic cells are now the big thing that everyone wants to work with." The second student's comments are equally revealing: "People don't think [adult stem cells] are hot because they aren't totipotent or pluripotent… adipose tissue stem cells don't transform into all types of cells, only into some types." While the first student comments on the greater interest in research with embryonic cells, the second student talks about the expectations that such work will lead to new therapies, due to embryonic cells' pluripotency.

One of the central questions here is to define researchers' position with regards to the use of human embryos as experimental material. With regards to the professors, 13 of the 16 interviewed were in favor of the use of human embryos in stem cell production. Three were against, and 2 of these attributed human status to the embryos. One, however, was against the use of embryo cells because she considered this to be an extremely risky process and doubted science's ability to control the stem cells to the point where their therapeutic use could be considered safe. Favorable opinions regarding the use of embryonic cells were founded upon the belief in the general expansion of knowledge and

upon the possibility, however remote, that humanity can learn to control their high potential for differentiation. Among the students, responses were similar: of the 18 interviewed, 13 were in favor of embryonic stem cell research, three were undecided, one was against and one chose not to respond. Students' justifications were similar to those put forth by the professors and the undecided students felt themselves torn between the two lines of thought.

Few of the interviewees (four, to be exact) positioned themselves as absolutely against research with human embryonic stem cells. How are the arguments regarding the use of human embryos structured? What lies at their foundations? Is there any relationship between these arguments and the way in which the scientific field is organized? At first, the answers to these questions appear self-evident, with those seeing embryos as people opposed to those who didn't. However, when we look at the answers provided to the question "What do you feel is a human embryo?", things become more complicated. Here, I will analyze professors' and students' answers together as there were no significant differences observed between the distribution and types of responses. The most frequent answers were: that an embryo is a human being in its initial stage, a living being, the beginning of life, a human being, a being in development, the possibility or potential for life. As we can see, all these answers attribute human condition or a living condition to the embryo.

Many informants responded to questions regarding the ethics of research using human embryos in the same way, claiming that "it is necessary to determine when life really begins". Those informants against embryo research talked about "human being, human life, individuality", while those for embryo research debated about the "beginning of life". Regarding the definition of life or its beginning, however, several definitions were put forth, using varying criteria as to how much time needed to pass or what morphological characteristics needed to exist before on could affirm the existence of a human embryo . Some of these definitions include: "an embryo exists from the moment of fertilization", "it's only an embryo after the development of the nervous system" and "it's an embryo when its head and trunk are fully formed".

The term "pre-embryo", commonly used in bioethics and also used by reproductive health professionals, was not used by my informants, even though one of them, Who had

recently returned from the U.S.A., spoke of a 15 day limit as demarcating the formation of the nervous system[5]. This researcher believed that this limit was widely recognized. The development of the nervous system was also recognized as a significant event in the determination of "life" by other interviewees, though no one else mentioned a precise 15 day limit in connection with this.

Two professors justified this parameter as the beginning of life by referencing criteria defining death. If lack of cerebral activity is the defining moment at which and individual can be considered as dead and their organs can be donated, then life can logically be understood to begin only with the formation of the nervous system. This argument suggests symmetry between definitions of life and death. One doctoral student also used biology to formulate her definition:

> Biology believes that life begins after your nervous system forms. When you use embryos to harvest stem cells for therapy, biologists sees this as dealing with a mass of cells. There's not even any tissue formed there. [...] They have a post-fertilization date which they consider to be the beginning of life. [...]. But I know that at two or three days after fertilization, which is when... which is the type of embryo used for research, it's not considered as alive.

After claiming to agree with the definitions proposed by biology, this scientist then forged ahead with her own definition of "embryo":

> It exists when it responds to stimuli, because when it's a mass of cells, it's just cells. For me, they're just like the cells I work with here. But the moment it can begin to respond to the mother's stimuli, with head and trunk formed, then it's an embryo.

Among the functional criteria used to define when an embryo begins, informants cited: the ability to respond to maternal stimuli in the uterus, the capacity to feel, think, suffer... in other words, parameters which indicate the existence of consciousness of self and the ability to relate to others. In the words of one professor, "at one week of age, the embryo doesn't know it's alive". These criteria were invoked in order to deny personhood to embryos during their first days of development and they presume a gradualist perspective regarding the development of personhood (cf. Strathern, 1992).

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[5] A pre-embryo is an embryo at a developmental stage that antecedes the appearance of the primitive streak, the beginnings of the spinal cord, which occurs around the 15th day after fertilization. Based on this reference, research with human embryos up to the 15th day after fertilization is permited in England (Strathern, 1992; Salem, 1997). Reproductive health professionals in Brazil use the term to designate an embryo created by *in vitro* fertilization before its transference to the womb (Luna, 2007).

While the above examples stipulate essencialist definitions of life which are founded upon the characteristics of the embryo itself, a significant number of my informants also proposed a clearly relational definition: the embryo depends upon its surroundings. According to this definition, one can only properly speak of embryos when they are situated within the womb or have been successfully implanted there. “An embryo must be within a woman’s uterus. When it’s in a tube of nitrogen, it isn’t an embryo”, in the words of one professor. “What’s there in the Petri dish is the potential for life. Only when it’s implanted in a uterus is it a human life which must be respected”. One of the undecided students, a recently graduated doctor, also cited a relational definition based on religious criteria. He believed that, within the Kardecist spiritualist doctrine, the spirit only arrives when the embryo is inside the body of a pregnant woman. In other words, according to this informant, an embryo in a Petri dish does not contain a spirit and thus does not have to be respected as a human being.

Yet another definition brings into focus the arbitrary character of the embryo condition. One doctoral candidate said that the status of a given embryo depended upon its socially defined value at any given moment. This was different, for example, when comparing an embryo which had been frozen for ten years and another which had just been created for an expecting couple. A professor contrasted the suffering of a seriously ill person and an embryo’s right to life. She extended her example by comparing a woman who had an abortion and one who loses her newborn son: “I don’t think all lives are equal. […] I think we need to take into consideration the love which develops, but I also believe that they are different beings”. In other words in this case, aside from emotional connections or lack thereof, we would be dealing with two different sorts of beings.

Several of the informants classified embryos in their beginning stages as *masses*, *groupings*, or *sets* of cells. One doctoral student claimed that “there’s no problem in ending a life in order to study embryonic cells, seeing as this occurs at the very beginning of the cell division process and what you’re dealing with does not configure an individual”.

In opposition to the notion of the embryo as a disorganized mass of cells, two informants who opposed research with embryos affirmed the existence of embryos as individuals. “The embryo is an individual in and of itself. Its environment is important but it does not change its nature,” commented one professor. Her master’s student claimed that

an embryo “is an individual, a human being with its own genetic make-up”. Almost all of the informants who were against embryo stem cell research or who were undecided regarding it, justified their position with arguments based on ethics, given that they considered embryos to be individual human beings.

Only one professor declared herself to be against embryo stem cell research because she believed it to be risky and ineffective. Many of the informants who were in favor of authorizing such research also pointed out possible risks or disadvantages involved in the proposed therapies. These include the possibility that embryonic stem cells could form tumors or behave differently *in vivo* than *in vitro*. The main risk here involves the formation of teratomas, a benign tumor of embryonic origin which contains several different bodily tissues. One of the professors that the formation of teratomes in an experimental subject after its injection with embryonic stem cells was a sign of the cells’ excellent quality, showing them to be adequate for the cultivation of cell lines. Several informants remarked upon the possibility that stem cells could induce cancer, as if teratomes were malignant tumors. One professor, however, made a distinction between teratomes and teratocarcinoma: only the latter is malignant and can metastasize.

Another point brought up by the informants who are against embryonic stem cell research was a warning that it would soon be necessary to specifically produce human embryos for such experiments if a continuous rhythm of research is to be maintained. One professor warned that fertility clinics’ extra embryos, have a reduced potential to produce the desired cell lines and that this, in turn, means that the demand for fresh, high quality embryos would soon increase. A professor contracted to a member laboratory of the recently inaugurated embryonic stem cell research project made a contrary argument, however. She claims that researcher Douglas Melton derived 17 cell lines from 77 embryos obtained from fertility clinics: an excellent result, according to this professor. Melton also observed that those embryos discarded as unacceptable and low quality could still generate viable cell lines for research. A technical argument also exists in favor of continued research with embryos for therapy development is the low immunogenicity of embryonic stem cells. The transplanting embryonic stem cells (cells obtained from a donor) has resulted in low levels of rejection in animal subjects.

Most of the informants accept human embryonic stem cell research within the limitations imposed by Brazil's biosecurity law (some of my interviewees, however, demonstrated uncertainty as to what these limitations were). One concern, spontaneously enunciated by several of my informants and repeated by others when asked about it, is that production of human embryos for research be prohibited and that scientists limit themselves to using frozen embryos discarded by fertility clinics. The same informant who remarked on the quality of the cell lines generated by embryos also remarked that it would not be necessary to produce embryos for research, given fertility clinics' tendency to produce surplus embryos. The only possible change in this scenario would be if the clinics were to develop techniques which allowed them to reliably produce a perfect embryo on every try.

One professor responded with a biological definition of *embryo*:

> The embryo is the product of a cell called a zygote, which divides in two, then in four, forming a morula, forming a blastocyst. If this blastocyst is correctly implanted, it then begins to divide its internal cellular mass and form the three embryonic germ layers and these, in turn, begin to form tissues. So from that moment on, you [...] call the embryo a fetus. It's a histologic definition.

Even though the above definition is couched in histologic terminology, one can descry a gradualist trend, in which embryos develop according to a process and do not simply pop into being. Some informants preferred to not talk about what constitutes an embryo or claimed that they had no opinion about when life comes into being. Three related the topic to abortion. One doctoral candidate spontaneously claimed that she was in favor of abortion in cases involving rape, health risks to the mother or anencephalic fetuses. In doing so, she indirectly related the use of embryos in research with permissions for abortion. Two other interviewees – one professor and one masters student – also refered to abortion: they were against women becoming pregnant and aborting in order to furnish fetuses for research. The frozen embryos which fertility clinics would normally throw out did not represent a problem in this view of things. Other positions were ambiguous. One professor defined the embryo as "a human being in its initial formative stages" and claimed to be against the intervention in and manipulation of embryos. "I don't like to hurt life", he later told. "At least, that which I consider to be life". In spite of this, he agreed with the use of embryos in research. When asked about the use of frozen embryos, he responded that "if it's frozen, it's dead".

The most commonly repeated arguments made pragmatic justifications for embryonic stem cell research. Over a third of my informants affirmed that the embryos being used for research would otherwise have been discarded or maintained frozen and useless. They thus claimed that it was better to "find a use" for this material, as one doctoral candidate said. "If they aren't going to be used in the clinic, their role is to help advance science", claimed another. A smaller number of informants argued that the embryos were no longer able to generate human beings after three years of freezing and thus could be used in research.[6]

The vast majority of the informants accepted the legal use of human embryos in research, but this did not mean that most of their projects used this material. To the contrary: there was a clear division between those laboratories (on this point, individual opinions made no impact) which thought adult stem cells more productive and less ethically problematic and which thus preferred to direct their efforts towards this field, and those laboratories which were betting on the potential of embryonic stem cells. One researcher claimed that she preferred to not ally herself with either group, but used in her research both adult and embryonic stem cells on her animal subjects' injuries in order to better evaluate their results. Some laboratories developed distinct lines of research, the older lines using adult stem cells and the more recent lines investigating the development of embryonic stem cell lineages. One professor, a pioneer in stem cell research, began his interview with the following declaration: "I don't research embryonic stem cells". Later in the interview, he remarked on the possibility that embryonic stem cells could cause tumors, but he concluded his deposition by affirming that "for me, this question of whether life begins at fertilization is quite clear. I think we should be pragmatic: if we use a donor's organs, we also use cells from a donor embryo." This researcher's position exemplifies the fact that there is no direct concordance between believing that life begins at fertilization and being ethically against embryonic stem cell research. Many of the interviewees articulated similar beliefs.

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[6] In earlier research into assisted reproduction, there were not bibliographic references or references among the professionals interviewed regarding supposed decreases in embryonic viability caused by being frozen for an excessive number of years (Luna, 2007). Embryos lose viability after being unfrozen and this process may affect their cultivation for the formation of stem cell lines.

Agreeing with the research did not mean that researchers stopped considering embryos as a "form of life". Many professors have no interest in embryonic stem cell research as they consider adult stem cells to be more effective. I encountered no consistency in these terms.

The set of comments regarding embryos which I have described above tell us about values which are constantly attributed to humans in western cosmology: will this being gain individuality or will it be seen as an amorphous mass of cells which contradict our ideals of perfectibility? What criteria of individuality will be invoked: unique genetic constitution from fertilization on or the emergence of the central nervous system? Ideals of sensibility, consciousness of self and capacity to respond to stimuli are also all characteristics implied in the modern notion of personhood.[7] As we have seen above, a significant part of the arguments regarding the status of the human embryo are based upon its biological condition. In other words, they are based on "nature" (Strathern, 1992, Salem, 1997, Luna, 2002, 2007). This is the underlying foundation of the explanations which incorporate descriptions of the embryonic nervous system, genetic singularity at the moment of fertilization, or descriptions of the embryo as an amorphous mass of cells. At the same time, we find propositions which attempt to define death (the end of cerebral activity) and the beginning of life (development of the nervous system) according to symmetrical criteria which adopt the nervous system as the central referent and nominate western values such as rationality as the defining characteristic of the human species.

It is significant that so many informants referred to the beginning of life or to the state of being alive in reaction to the question "what, to you, is a human embryo". "Life" is a concept which transcends biological representation and which is linked to religious values, even when these are couched in lay terminology.[8] It is significant that, in my informants' discourses, declarations to the effect that "embryos have life" (in the sense of a biological process) are juxtaposed with others which claim that embryos "are already a life" (in the sense that personhood is attributed to them). For this reason, so many of them discuss the beginning of life in their attempts to describe the embryo.

[7] The modern concept of the person is described in Dumont (1992, 1997).
[8] Duarte, Gomes, Jabor and Luna (2006, p. 16) propose a private and non-confessional concept of ethos in order to explain this "structuring cosmology, recognizing that 'religiosity' today embraces lay values and behaviors which are officially 'nonconfessional'."

Religion

Different from the expectations at the beginning of this study, there is no linear connection between the religion of my informants and their position regarding embryo research. Almost all of the interviewees were raised Catholic, but there are perceptible differences between the religion composition of the student body and that of their professors. All 16 professors who were asked about their religion had a religious upbringing: 15 in the Catholic Church and one in the Christian Orthodox Church. At the time of the interview, 6 defined themselves as non-practicing Catholics, five said they had no religion, two were practicing Catholics, one considered himself to be a theist, one said she had faith and the last was Catholic and Spiritualist. The number of non-religious or non-practicing professors makes it clear that this group has generally moved away from religion, at least in its institutional forms.

When we turn to the students, however, 15 out of 18 were raised Catholic, one Presbyterian and two as Kardecists. A further two claimed to have no religion and one was Baptist (self-described as Christian). There were also less well-defined religious practices in this group. Two of the students claimed an interest in Oriental spirituality, engaging in meditation and/or study, and one partially believed in every religion and claimed to have faith (though no religious upbringing). One other student claimed to not follow the religion of their childhood, but also claimed to not be an "atheist". There was thus a wider dispersal of beliefs and practices among students than among professors.

With regards to the informants' positions on research utilizing human embryos to produce stem cells, of the four who positioned themselves against this research, only one was a practicing Catholic. Two were non-practicing Catholics and one was "atheist and agnostic" (sic). Of the undecided informants, one was a non-practicing Catholic, one was a Baptist and one a Kardecist. One non-practicing Catholic professor believed that the question needed to be discussed further. He was against human embryo research precisely because of his Catholic upbringing, which "created a barrier against using something which might be a living being and which you might thus be sacrificing". This informant was particularly concerned that embryos might be turned into commercial objects in the name of harvesting stem cells.

When asked about ethical questions regarding the use of embryonic and adult stem cells, most of my informants believed that the current polemic was the responsibility of religious people and directly blamed the Catholic Church and/or its predominance in Brazil. One professor, when asked about when life began in an embryo, claimed "I don't like talking about this topic regarding the religious approach, but concerning the scientific approach". A small number of informants opposed science to religion when asked about their religious orientation or upbringing. Religion was generally seen as an intimate question, as opposed to their professional life as scientists, which was public. "My intimate life and my religion is one thing and my professional life is another," said one doctoral candidate." For me, there's no contradiction between being a Catholic and working with stem cells." Doctrine is relativized in these depositions. Other informants commented upon their progressive distancing from questions of faith: "as we grow, we begin to see that those stories don't have much basis in fact". One non-religious doctor affirmed that science was making as strong a contribution as religion to the organization of society.

> I only believe and follow good principles. [...] Maybe, for the majority of researchers, the closer you come to science... well, not that you despise religion, but you begin to see things more rationally. So even in terms of education, of disciplining a population, of organizing society, I believe that science has as much to offer as religion.

In this view of the world, science has taken over religion's place. However, one student had the opposite perception. Though raised a Catholic, today she identifies more strongly with oriental spirituality and participates in a religious study group. This has lead her to reformulate her conclusions: "I believe that a law exists. I use this term as a synonym for God." Her research practices have basically confirmed her beliefs:

> This has made me stronger in my beliefs. [...] People ask me "How is it that you, a person who is so spiritual, do basic research?" [...] All work [however] points to one thing. [...] And we have to research this more. For me, this moment has been one in which basic research has revealed the presence of the law. We won't ever be able to know anything completely. [...] Because in research, we seek answers for our questions. [...] Researchers will continue to seek, but they will never definitely find. It's a mystery.

If, for some of the interviewees, progressive involvement with science has weakened their religious faith, for this woman, research allowed to find the transcendent in the immanent.

Star Wars: **Adult VS. Embryonic stem cells.**

Different theories explain the therapeutic action of adult stem cells. Here, I will limit myself to commenting upon the transdifferentiation hypothesis as this is related to the degree of plasticity exhibited by adult stem cells. The main discussion surrounding stem cells does not have to do with whether or not they have the capacity to become more than one type of cell, but whether a stem cell which "is committed to one type of cell" can, in fact, produce others. This capacity is known as transdifferentiation. The bone marrow stem cell originating neurones is the most commonly cited example in the literature on transdifferentiation. Here, we run up against an interpretational war, or – in epistemological language – a struggle to defend or destroy hypotheses tested by other members of the scientific field and the alignment of these positions is quite significant. The more a hypothesis defends the functionality of the type of stem cell under research in a given lab, the greater the tendency of scientists associated with that lab (whether students or professors) to defend that hypothesis.

One of the pioneer investigators of cellular therapy, well known for his work with bone marrow, believes in the possibility of transdifferentiation. He cites recent articles to argue that bone marrow cells can be transformed in eggs. This would mean that one of the last barriers in the research, i.e., forming a germinative line (the egg cell) has been broken. If he is correct, this will have demonstrated the maximum degree of plasticity that an adult bone marrow cell can attain. In this professor's laboratory, creating a new line of research into embryonic stem cells – precisely those cells which, according to the literature, are gifted with the maximum possible degree of plasticity – was not an option. His laboratory cultivated cells (particularly mesenchymal cells originating in bone marrow) harvested not only from human beings, but also from rats and mice, and provided these to other laboratories for research purposes. These other laboratories, in turn, tended to prioritize adult stem cell research and avoid work with embryonic stem cells. The justifications provided for this behavior almost always emphasized the risks of embryonic stem cell

usage in future therapies as opposed to the supposedly safer adult stem cells. At the opposite pole of the research universe, however, one finds laboratories which contest the plasticity of adult stem cells and see research into these as a dead end. Though these scientists have, up to now, given priority in their work to adult stem cells, with research animal subjects currently under way and proposed human tests under consideration, they have also created new lines of exploration based upon recently donated embryonic stem cell lineages. The hypotheses defended by this second group of scientists throw doubt upon the theory of transdifferentiation.

Final considerations

The above article has sought to analyze the social practices embedded within scientific research involving stem cells. Though this is basic research, we can already see, in the lines of investigation being followed, that emphasis is being given to curative techniques and that great expectations are being generate to this effect. Some labs, in association with the University Hospital and other accredited clinical institutions, have already developed the first clinical protocols for treating heart disease, cirrhosis and stroke. Others already completed their studies' experimental phase and are directing their efforts towards developing clinical protocols or have already submitted these for National Research Ethics Council's approval.

If, as Haraway (1991) suggests, science is our myth, then the present article has only begun to scratch the surface in its analysis of the meanings produced by stem cell research. As we have seen, ideas and arguments are aligned according to laboratory membership or association. On the other hand, the arguments which are mobilized to justify embryo research are congruent with eminently modern and western cultural values, based as they are on biological definitions of life, individuality and the potential for rationality.

The objections most frequently cited to embryo stem cell research do not refer to the status of the human embryo, but rather to the risk of tumor formation during therapy or to the possibility that said cells will behave differently once removed from laboratory conditions. Such risks are not brought up in the case of therapies based on adult stem cells.

Many researchers who were for or against embryo research organized their arguments around the need to define when life begins. Instead of contrasting life with lack

of life, these opinions were centered on the organization of the cells themselves in their attempts to define what is (not) an embryo. If said cells were simply an amorphous mass, then they could not constitute an embryo but were, in fact, comparable to all other types of cells studied by laboratories. An amorphous mass of cells contradicts notions of individuality and perfectibility which define the western notion of personhood. These arguments represent embryos in essentialist terms, referencing their developmental stages (the formation of the central nervous system and the consolidation of the human silhouette, complete with head, trunk and members) and in relational terms with the surrounding environment (uterine implantation, freezing, laboratory creation). Though the main argument of those who are against embryo research is based upon an essentialist and inaugural concept of humanity which cites genetic uniqueness at the moment of fertilization as its defining characteristic, many of those scientists who favor further research also consider the human being to begin at the moment of fertilization. In these cases, I was unable to discover positional consistencies between definitions of the status of the embryo and its acceptableness for use in research. Many different gradualist positions were discovered which identified humanness as emerging in one or another moment of embryonic development and this sort of demarcation generally incorporated both essentialist and relational attributions.

Among my informants, there was no clear correspondence between religion and the position taken with regards to embryonic stem cell research. In spite of this, when we look at the value systems revealed by the interviews, we find that respect for life, originating in the religious field and given a clear metaphysical charge, lies at the center of the arguments both in favor of and against research. Everyone defended life, but informants differed in their definitions of it. These ranged from a view of life as human essence contained within the DNA and present upon fertilization, to arguments employing human morphology and organization or nervous system development as necessary conditions for life. For some, embryo's life could not be defined without reference to its placement within or outside of the uterus. Several biological and physical referents thus assumed a physical-moral complexion in correspondence with attributes such as individuality and rationality. On the other hand, there was no overall consistency between opinions regarding the status of human embryos, researchers' opinions with regards to the acceptability of studies using

them and the types of research in which these individuals were engaged. Final decisions as to what to research and when were far more a result of the history and structure of the research field itself, and not of abstract value systems.

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