Proposals for Human Cloning: A Review and Ethical Evaluation

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INTRODUCTION

In August of 1975, Dr. John Gurdon, a British scientist, reported the first successful cloning of frogs using nuclei from adult frogs transplanted into enucleated eggs.[1] This success generated great enthusiasm among scientists for developing techniques for cloning animals. Over the next two decades, the initial enthusiasm greatly declined, because not only did the cloned frogs never develop into adult frogs, but also further experiments seemed to indicate that cloning a mammal from either adult or fetal tissue might never be possible. As scientific interest in cloning waned, so, too, did the apparent need for extensive ethical discussion concerning the possibilities of human cloning. At times, it seemed as though only Hollywood was still interested in human cloning, with movies such as *The Boys from Brazil* and *Multiplicity*.

On February 22, 1997, Dr. Ian Wilmut and his team of researchers from the Roslin Institute in Scotland regenerated scientific enthusiasm for animal cloning with their announcement of the successful cloning of a sheep. The media reignited speculation about human cloning and its moral implications. In the wake of this renewed interest came various proposals concerning what could, what might, and what should be done with regard to applying this new cloning technique to human beings. It is the intent of this chapter to review some of these proposals and to evaluate them as to their scientific probability and ethical justification. Before evaluating these proposals, the wise course is to clarify the currently known facts about human cloning.

THE STATE OF THE SCIENCE OF HUMAN CLONING

The remarkable scientific article published by Wilmut et al. in the February 27 issue of the journal *Nature* demonstrated that it was now possible to use cells from the differentiated tissue of an adult mammal to produce a clone of apparently normal characteristics.[2] Differentiated tissue is primarily composed of cells that have taken on specialized functions, such as those performed by liver and muscle cells, and, consequently, have turned off all the other genes not needed to perform these specialized functions. Many researchers had feared that it would never be possible to turn these genes back on so that specialized cells from an adult mammal, or even a fetal mammal, could be used to produce a cell that acts like a single-cell embryo, or zygote. Zygotes are considered to be "totipotent" cells because the one cell has access to all the genes it needs to make all the different types of cells and tissues required for development. Hence, for a viable clone to be created, the adult cell had to be returned somehow to a state of totipotency. Using a kind of nuclear transfer

similar to that used by Dr. Gurdon, the researchers in Scotland were able to revert an adult mammary cell to totipotency and create a mammalian clone.

One can divide the idea of what constitutes a viable clone into two categories: reproductive clones and research clones. If one is cloning for reproductive purposes, then the concept of a viable clone is that one generates an infant animal unburdened by significant health problems so that it might live a relatively normal life. Currently, few researchers or ethicists argue for reproductive human cloning.[3] The vast majority of experts and biomedical societies are against attempting reproductive human cloning at this time.[4] Research cloning is currently the most intense focus of debate. This process is designed to create cloned human embryos that either will be experimented on directly in research on human embryonic development or will be destroyed in order to study the embryonic stem cells that can be isolated from these cloned embryos. Although stem cells taken from the embryo are not totipotent, they are of great interest to some researchers because they are still pluripotent—that is, able to make all the various tissues and cells that are present in the human body after birth. In either case, research or reproductive cloning, one creates the cloned human embryos in the same fundamental manner as Dolly the sheep was created.

Although the cloning of Dolly was rightly heralded as a major breakthrough in science, many obstacles remain to the application of this technology in humans. The research done in South Korea and published in the journal *Science* that was internationally touted as the big breakthrough in human cloning turned out instead to be a complete hoax.[5] In fact, as of November 2011 no research group has presented verifiable evidence of the creation of a stem cell line that has been derived from a cloned human embryo created by nuclear transfer into either enucleated eggs or zygotes.[6]

In light of the lack of success in achieving human cloning, why is there still so much excitement about it? A variety of articles and reports enumerate the reasons for pursuing human cloning. As mentioned earlier, these publications focus primarily on the benefits achievable from research on cloned embryos. These benefits include (1) creating tissues, organs, or other treatments that can be matched to individual patients or diseases; (2) creating cloned embryonic stem cell models for research on specific human diseases, such as how they arise during development as well as how they might be more successfully treated; and (3) using cloned embryonic stem cells for research on human reproduction and development in general.

The next sections of this chapter review these proposals, with the pursuit of human cloning for research reviewed first because it is currently of greatest relevance to the public discussion and debate. Reproductive human cloning is reviewed second because the likelihood of pursuing reproductive cloning will depend on the success, or lack of success, researchers have with their attempts to clone human embryos for research.

HUMAN CLONING FOR RESEARCH PURPOSES

The goal of research cloning is to create human embryos that will develop up to the blastocyst stage. At this stage of development, usually around five to seven days after fertilization has occurred, the embryo is a small, hollow

sphere with some cells in its interior, called the inner cell mass. The entire embryo may be about 200 cells at this point of development. The cells of the inner cell mass are the cells that are of interest to researchers, because they are pluripotent and can become embryonic stem cell lines. These cells must be separated from the rest of the embryo in order to become a cell line.

Currently, destruction of embryos must occur in order to create embryonic cell lines. This destruction of human embryos is one of the main points of contention in the public debate concerning human cloning for research. There is a more detailed examination of this issue in the later ethics section of this chapter.

What do researchers propose to do with the cloned human embryonic stem cell lines they wish to create? As mentioned previously, several things. First, the primary advantage researchers think these cell lines will have is that they can come from an individual with a specific disease or condition. The idea then is that the underlying genetic or biochemical cause of the disease might be investigated more precisely by using the cloned embryonic stem cell line to produce the different types of cells affected by the disease and to observe how their proper functioning is disrupted by the disease during the process of differentiation and afterward.

Using this information and the particular cloned cell line, researchers might then be able to attempt different types of interventions aimed at preventing, reversing, or compensating for the disease condition. If an intervention is efficacious, then there might be manipulation of the cell line to create cells, tissues, or even organs that no longer have the disease. If a given manipulation demonstrates success and safety, then the tissues or organs created might be useful for transplantation back into the person whose adult cell was used to create the cloned embryo that was the source of the embryonic stem cell line.

Although the creation of transplantable tissues and organs might be the ultimate goal, researchers could also claim that, even if they do not achieve that goal, they might still learn some very important basic biology about disease processes from this research, such that it would help treat diseases in some other way. Hence, the fundamental emphasis put forth as justification for human research cloning is the widely accepted idea that research is done primarily to benefit people. In other words, if the research will benefit people, we should do it. Whether this justification of human research cloning is legitimate is analyzed in the upcoming section of the chapter on ethical issues. However, currently many of the purported benefits of research cloning are still speculative, because no cloned human embryonic stem cell lines have been created.

Recently, cell lines that have many if not all of the key features of cloned cell lines have been created by a revolutionary technique that does not use human eggs to transform adult cells into cells that act like embryonic stem cells. This technique induces pluripotency in adult cells and so creates "induced pluripotent stem cells," or iPSCs.

HUMAN INDUCED PLURIPOTENT STEM CELL RESEARCH

iPSCs are the result of reprogramming adult cells to act like embryonic stem cells. This reprogramming is done by adding factors to the cells that change the expression pattern of the genes in the cells to mimic gene expression patterns

found in embryonic stem cells. In the 2006 publication of the breakthrough research led by Dr. Shinya Yamanaka of Japan, scientists reported that by forcing the overexpression of four genes linked to pluripotency, they were able to make adult fibroblast cells change into cells that behaved like embryonic stem cells.[7]

Although the cloning of Dolly had reinvigorated the idea of directly reprogramming mammalian adult cells into embryonic-like cells, many scientists were surprised at how rapidly this goal was achieved and how few genes were needed to achieve the reprogramming. Since this breakthrough experiment, researchers around the world have reprogrammed a variety of human cells using a variety of gene combinations and techniques. Some research groups have even produced iPSC lines from patient samples in order to have pluripotent cell lines that reflect the genetics and biology of a particular disease. In addition, one collaborative international group of researchers used a mouse iPSC line with a known genetic mutation to demonstrate that it is possible to perform genetic repair on the mutation in the iPSCs.[8] Such genetic treatments could result in the creation of large numbers of patient-specific healthy cells and tissues that could be given to the patient to treat a particular disease.

The importance of iPSC research for the human cloning debate is that it might well provide an alternative to research cloning. All the benefits that human cloning research is purported to bring to patients are already being pursued by iPSC research. What impact this stem cell research advance has on the ethical arguments surrounding the issue is considered in the ethics section of this chapter. The next section contains a review of the current state of human reproductive cloning.

HUMAN CLONING FOR REPRODUCTIVE PURPOSES

To address the issue of reproductive cloning, one must first acknowledge the significantly higher level of control over the cloning process that will be required for reproductive cloning relative to that required for the research cloning process. Basically, the reason for this difference is safety. Proponents of research cloning need not be nearly as concerned about the loss of embryos or the creation of useless embryos than proponents of reproductive cloning need be regarding the creation of cloned children. Proponents of research cloning might well be satisfied with the creation of one useful cloned cell line out of several or many attempts, whereas those who desire to pursue reproductive cloning would likely be dissatisfied with the creation of one healthy child out of several or dozens that are born, or even carried in pregnancy. This safety issue is one that leads many research cloning proponents to back away from supporting reproductive cloning at least for the foreseeable future.

If these safety issues could be adequately addressed and human cloning technology perfected to an acceptable level (again, there is no evidence of this progress currently), what reasons are then given for the pursuit of reproductive cloning? Can parents who face both genetic and reproductive obstacles to having their own children use it? Some have proposed that human cloning could be another alternative in the array of assisted reproductive technologies

(ART) offered to such couples. One could imagine the possibility that no alternatives are available to a given couple except attempting to clone one of them. Of course, the question arises at this point: What do we mean by having one's "own" child? A cloned child would actually be biologically more like the much-delayed identical twin of the parent used for his or her cloning. Because one's biological children are actually only half related to each parent, one could argue that any cloned child would be as biologically different from a natural child as an adopted child is.

When pushed to an extreme, it becomes evident that a genetic reductionism underlies this reproductive cloning perspective. Are genes the only possible basis for the parent–child relationship? Are human identity and personality merely genetic? What of adopted children who call their parents "Mom and Dad," or those who look to teachers or mentors as the ones who have been most instrumental in forming their identities? A consistent response from most scientists regarding the furor about the possibility of human cloning has been to remind people that we are more than our genes, even on a physiologic level. One's environment plays a significant role in shaping one's identity and characteristics. Examining still another proposed use for reproductive human cloning will help elucidate this point.

Some have proposed that human cloning be employed so that a couple could "replace" a dying child or a person could replace a dying spouse. As in the previous case, there is a dangerous biological reductionism inherent in this proposal. No human being is replaceable—not even physiologically. We are all unique, including identical twins. The desire to clone a child or spouse to "replace" the lost loved one may well indicate a misguided attempt to find a biological solution to the age-old problem of dealing with the grief and trauma of death. Even if parents successfully deal with the psychological struggle of the loss of a loved one, the cloned child or spouse would always have to live with the reality of being cloned in an attempt to replace another.

From this brief overview, one can see that even if the immense safety issues could be surmounted with regard to reproductive cloning, many other significant issues remain concerning what exactly the purpose would be in pursuing human reproductive cloning. In addition, there are ethical issues, which the next section addresses.

ETHICAL ISSUES IN HUMAN CLONING

Before one can address the ethical issues surrounding human cloning, it is necessary to clarify some details that are often confused in the mass media and the public debate. One can see evidence of this confusion in the different answers that are obtained when people are polled about whether they agree with human cloning or not. Depending on how one phrases the questions asked, one can reliably get the majority of respondents to be either in favor of human cloning or against it. Comparing two past polls will help demonstrate this point.

On March 25, 2005, the results of a poll done by the Opinion Research Corporation and commissioned by the Coalition for the Advancement of Medical Research (CAMR) indicated that "a strong majority of Americans

solidly support embryonic stem cell and therapeutic cloning research."[9] As stated on the CAMR Web site:

> Of the 1,045 people responding, the specific breakdown of responses was as follows: 59% said they favored medical research that uses stem cells from human embryos (30% strongly favor, 29% somewhat favor); 33% are opposed (13% somewhat oppose and 20% strongly oppose), and 8% of respondents answered they did not know. Once a description of embryonic stem cell research was read, 68% said they favored it (39% strongly favor, and 29% somewhat favor), only 28% opposed the research (11% somewhat oppose, and 16% strongly oppose), and 4% responded they did not know. For therapeutic cloning, 60% of Americans approved the research (27% strongly approved, 33% somewhat approved), whereas 35% disapproved (12% somewhat, and 23% strongly), and 5% of respondents answered they did not know. Once a description of therapeutic cloning research was read, 72% favored it (30% strongly, 42% somewhat), and roughly 23% opposed the research (11% somewhat, 11% strongly), and 6% of respondents answered they did not know.[10]

Interestingly, a different poll focusing on the same issues, done by International Communications Research and commissioned by the United States Conference of Catholic Bishops (USCCB), was released on May 31, 2006, with the results stating that "48% of Americans oppose federal funding of stem cell research that requires destroying human embryos, while only 39% support such funding."[11] In addition, the USCCB Web site states:

> When survey respondents were informed that scientists disagree on whether stem cells from embryos, or from adult tissues and other alternative sources, may end up being most successful in treating diseases, 57% favored funding only the research avenues that do not harm the donor; only 24% favored funding all stem cell research, including the type that involves destroying embryos. . . . The new poll also shows overwhelming opposition to human cloning, whether to provide children for infertile couples (83% against) or to produce embryos that would be destroyed in medical research (81% against).[12]

Because these two polls were a year apart, one might conclude that the public's attitudes had changed during that year. However, one finds earlier polls cited on the USCCB Web site. These polls were done during the previous two years by the same company and showed similar negative responses to human embryonic stem cell research and cloning research.[13] How, then, can two presumably accurate polls reach opposite conclusions? The answer, in part at least, is found in the contradictory descriptions and evaluations of the human embryo.

The current debates surrounding cloning often revolve around the biological and moral realities of human embryos. What was once a seemingly clear concept—a sperm fertilizes an egg and creates an embryo—has now become a convoluted intersection of cutting-edge biological research, ethical reflection, and religious perspective. For instance, some proponents of research cloning

will argue that there is no creation or destruction of human embryos in the process of creating cloned stem cells. They base this argument on the fact that there was no sperm used in the cloning procedure, only eggs. Because they define embryos as the result of the union of sperm and egg, cloning cannot produce an embryo.

However, a cloning procedure created Dolly the sheep. No one argues that Dolly was not a sheep. If Dolly was a sheep, then she must have been a lamb at some point. If Dolly was a lamb, then she must have been a fetal sheep before she was born as a lamb. If Dolly was a fetal sheep, then what was she before she was a fetus? In mammalian developmental biology, Dolly must have been an embryo. Hence, cloning produces embryos, and does so without sperm.

Unfortunately, there is even more convolution regarding the embryo definition problem than this issue of whether cloning produces embryos. For example, knowledge of biology indicates that the process of fertilization can create abnormal growths, some of which are cancerous, rather than generating developing organisms. One such growth is a hydatidiform mole.[14] No one argues that a complete hydatidiform mole is an organism or a human being, yet it can arise from the union of sperm and egg. Hence, whereas the processes of fertilization and cloning can both create embryos (i.e., organisms in the earliest stage of development), they can also both create nonorganismal growths that are not embryos. Considering the apparent contradictory results of the two polls just cited, clarification of exactly what one means by the term *embryo* would be crucial when one is arguing for or against the destruction of human embryos in research.

This clarification is crucial because it extends beyond the complexities described previously. Some proponents of cloning research will acknowledge that they accept the creation and destruction of full-fledged human embryos in research because currently the best chance for getting good stem cells comes from creating the best embryos one can. However, these proponents do not consider these embryos to be of the same moral importance or standing as a human fetus, because they are created and developed outside the human body in a Petri dish. As long as there is no transfer of the embryos to a woman's body, they cannot ultimately develop to a stage equivalent to birth. Therefore, proponents argue, embryos created by the cloning process that are intended only for research purposes are not ethically the same as embryos that are developing within a woman's body.

This argument also raises some contentious issues. Presume that a researcher creates two cloned embryos that are equally functional, developing human organisms. This argument asserts that the embryo intended to be destroyed for research is somehow of less value or importance than the embryo that is intended to be transplanted for reproductive purposes. What happens if the two embryos get mixed up in the lab and the one intended for research is transferred to a woman's uterus while the other is destroyed? Has some significant wrong occurred that would not have occurred if there had been no mix-up? What if no one ever finds out about the mistake? Did no wrong occur because people think that there was proper application of their intentions? Can we treat some human organisms as disposable because some people decide that they should be treated as disposable?

Fundamentally, the interpretation of this argument of intentionality is that embryos can be treated similar to property. One can treat one's possessions as precious or not, as one intends. The question is then: Are embryos to be treated the same as property, or does the fact that they are human organisms preclude such treatment?

Some opponents of cloning research argue that embryos must be treated the same as other human beings, at least to the extent that they should not be created and destroyed for research purposes. However, they recognize the potential usefulness that might come from research done on stem cells that have specific disease characteristics. Their proposal is to attempt to create stem cells with such disease characteristics. These stem cells act like embryonic stem cells for research purposes, but do not come from embryos. One way to create these embryonic-like stem cells would be to employ an altered nuclear transfer (ANT) technique. ANT techniques can be done in several different ways.[15] The key point of all the ANT approaches is not to include the destruction of a human embryo in the process of generating the stem cell lines desired for research.

One can place these ANT proposals alongside the iPSC research reviewed earlier, which also pursues the benefits of stem cell research while avoiding the destruction of human embryos. Often all these anti-human-cloning proposals are lumped together in the "adult stem cell research" versus "embryonic stem cell research" choice. This designation of adult versus embryonic is not completely accurate. If the goal of research is to gain understanding of disease and develop better treatments, then opponents of research that destroys human embryos can actually point to all the biomedical research done on diseases and treatments that does not destroy human embryos. Considering that most biomedical research is not specifically stem cell research (either adult or embryonic), it is scientifically quite a stretch to claim that only human cloning research will provide an answer or treatment to a given disease.

Of course, it is part of the nature of scientific research to be unable to predict where and when the breakthroughs will come. Hence, proponents of human cloning research often respond that we need to do all the research we can in order to provide the best chance that we will find answers or treatments as soon as possible. In fact, more recently some proponents have even begun to claim that pursuing human cloning research is a moral obligation because it might help us achieve treatments for those suffering from terrible diseases earlier than we might otherwise.

Although these arguments might appear compelling at first glance, they rest on false assumptions. First, there is already a great deal of human research that is theoretically possible to do and that might readily result in more rapid discoveries and treatments. However, these researchers do not do these studies because they would harm human beings in the process. Because of many past tragedies involving biomedical research that unjustifiably harmed human beings, our society has decided to place limits on human research, regardless of how useful the research might be. Hence, what is good for research is not always what is good for society. The key issue here regarding human cloning research is whether to create and destroy human embryos in research—not whether the research might lead us to treatments sooner.

The second false assumption presented is that we must do human cloning research because it might lead to earlier treatments for those suffering from terrible diseases. This claim assumes that the key aspect of disease treatment is research. In actuality, our world is replete with examples of cures and treatments that exist but are not getting to the people who are in desperate need of them. Hence, if everyone responded fully to the logic of the claim that one needs to do all one can to treat those who are suffering from tragic diseases, then most, if not all, research would have to be stopped.

If the goal to provide treatment for those suffering from terrible diseases trumps all other concerns, then most of the available resources would need to be shifted to healthcare delivery and preventive medicine. After all, what good is a treatment if those who need it cannot get it? In addition, would it not be better to avoid the disease altogether rather than having to treat it once some people get it? Because we are already faced with serious problems in preventing disease and getting the treatments we already have to those who need them, the logical response to the above moral claim about needing to treat people would be to reduce research and do better with the treatments and preventive strategies we already have.

To avoid confusion, there needs to be a clarification of the critique just presented. The critique is not against biomedical research. Biomedical research can be a great good in a society. The critique is against those who would claim that a given type of research is morally obligated based on it possibly resulting in treatments for those suffering from terrible diseases. All health care is oriented toward the prevention and alleviation of suffering, if possible. Decisions regarding what elements of health care should get priority over others depend on many factors. The fact that a particular line of research might bring about good treatments is certainly not by itself a sufficient justification for doing that research, especially when contentious ethical issues of human subject research are involved.

Contentious ethical issues are certainly involved in human cloning research, as has already been demonstrated. However, the ethical issues are not limited to those already described. Another issue that many argue is still not receiving adequate attention involves the acquisition of human eggs for cloning research.

Currently, animal cloning is still a very inefficient process. In addition, as cited previously, no one has provided verifiable evidence of the creation of cloned human embryonic stem cell lines. Combine these two facts and one is faced with the daunting probability that it will require an enormous number of human eggs and embryos to achieve human cloning on a scale that will be adequate for the number and kinds of cloning research programs envisioned by proponents of this research.[16] This probability is daunting because the process of procuring eggs for research involves the hyperstimulation of a woman's ovaries, which involves risks to the woman's health. These risks are of such significance that people from many different perspectives—pro-life and pro-choice, Democrat and Republican, feminist, Green, and social conservatives—have joined in calling for a moratorium on the use of human eggs for cloning research.[17]

Again, society faces the challenge of protecting human beings from harm (i.e., the many young women needed as egg donors) in the face of interest in pursuing research that is seen as desirable to many. Considering the fact that

there are many alternative avenues of research that can be pursued without putting women or embryos at risk, the burden of proof should be on those who argue this research is not only good for science but also for society.

When arguing for human cloning research as a good for society, the argument often arises that if our society decides for whatever reason not to pursue this research, we will put ourselves at a disadvantage because other societies or nations will do it. They then will get the benefits and we will lose out. Again, although this argument might seem compelling at first, closer examination reveals that it, too, is flawed. Many historical examples are available to remind us of the harms that may befall a society that too eagerly pursues technological advance at the cost of other societal values and goods. The past catastrophes of eugenic policies pursued both in the United States and Germany should be reminder enough of the harms that can occur in the name of medical advancement.

If one can question research cloning on the grounds of its potential harm to individuals and society, then one can also question reproductive cloning on these grounds. Even if cloning is the only reproductive option an individual or couple might have, should people pursue it? Proposing human cloning to solve reproduction problems depends heavily on the argument that people have the right to have genetically related offspring. When discussing such rights, it is important to distinguish between negative (liberty) rights and positive (welfare) rights.

In 1994, the Ethics Committee of the American Fertility Society (now the American Society of Reproductive Medicine) stated that in the context of procreation, "A liberty right would encompass the moral freedom to reproduce or to assist others in reproducing without violating any countervailing moral obligations. A welfare right to reproduce would morally entitle one to be assisted by another party (or other parties) in achieving the goal of reproduction."[18]

If the ethical problems associated with reproductive cloning trouble society, one can certainly argue that society is not obliged to support it as a welfare right. Additionally, if society concludes that the rights or dignity of the child to be born are violated by reproductive cloning (e.g., to be made as a copy of someone else), then society can also deny even a liberty right to clone oneself because of the countervailing moral obligation to protect the cloned child from harm.

SUMMARY

This chapter has considered several proposals regarding the possibility of human cloning. These range from possible medical interventions for directly treating disease to meeting perceived reproductive needs. In the final analysis, considering the possibility of alternatives both in research and in reproduction, as well as the multitude of ethical problems still plaguing the cloning issue, the burden of proof regarding whether we should pursue human cloning should be on those who desire to clone human embryos—whether for research or reproduction. Currently, the arguments employed by human cloning proponents do not provide enough justifiable reason to apply the recent advances in cloning techniques to human beings.

QUESTIONS FOR DISCUSSION

1. Why do you think there is a renewed interest in human cloning? Does the media attention increase this interest?
2. Do you think science has an ethical obligation to present the public with both the benefits and burdens of cloning research?
3. What is the role of autonomy in cloning research? When evaluating autonomy, how should you consider it?
4. What would be the deontologist's position on cloning?
5. The healthcare community also is concerned about the business aspects of cloning. Do you think cloning will become a good business opportunity?

FOOD FOR THOUGHT

Assuming that technology on cloning increases at its current pace, what are the possibilities for the future? For example, if there are cloned human beings, will they have the same status as noncloned human beings? If a person could clone himself or herself, what would be the limitations on the clone? Apply the principles of ethics to your responses to these issues.

NOTES

1. J. B. Gurdon, R. A. Laskey, and O. R. Reeves, "The Developmental Capacity of Nuclei Transplanted from Keratinized Skin Cells of Adult Frogs," *Journal of Embryology and Experimental Morphology* 34 (1975): 93–112.
2. I. Wilmut, A. E. Schnieke, J. McWhir, A. J. Kind, and K. H. S. Campbell, "Viable Offspring Derived from Fetal and Adult Mammalian Cells," *Nature* 385 (1997): 810–813.
3. For example, see Gregory Pence, *Who's Afraid of Human Cloning?* (Lanham, MD: Rowman & Littlefield, 1998).
4. This perspective against reproductive cloning includes organizations that have taken positions in support of research cloning, such as the National Academies and the National Research Council. For example, see their report *2007 Amendments to the National Academies' Guidelines for Human Embryonic Stem Cell Research* at http://books.nap.edu.
5. D. Normile, G. Vogel, and J. Couzin, "Cloning: South Korean Team's Remaining Human Stem Cell Claim Demolished," *Science* 311 (2006): 156–157.
6. S. Noggle, H-L. Fung, A. Gore, H. Martinez, K. Crumm Satriani, R. Prosser, K. Oum, et al., "Human Oocytes Reprogram Somatic Cells to a Pluripotent State," *Nature* 478 (2011): 70–75. Available at doi:10.1038/nature10397.
7. K. Takahashi and S. Yamanak, "Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors," *Cell* 126, no 4 (2006): 663–676.
8. S. Kosuke Yusa, R. Tamir, H. Strick-Marchand, I. Varela, P-Q Liu, D. E. Paschon, E. Miranda, et al., "Targeted Gene Correction of a A1-Antitrypsin Deficiency in Induced Pluripotent Stem Cells," *Nature* 478, no. 7369 (2011): 391–394. Available at doi:10.1038/nature10424. Accessed January 16, 2012.
9. "National Poll Shows Strong Support for Stem Cell and Therapeutic Cloning Research," World Health.net, April 4, 2005. Retrieved from http://www.worldhealth.net/news/national_poll_shows_strong_support_for_s/. Accessed June 6, 2012.
10. Ibid.

11. Office of Media Relations, "New Poll: Americans Continue to Oppose Funding Stem Cell Research That Destroys Human Embryos," United Conference of Catholic Bishops, May 31, 2006. Retrieved from http://old.usccb.org/comm/archives/2006/06-109.shtml. Accessed June 6, 2012.
12. Ibid.
13. Ibid.
14. R. Slim and A. Mehio, "The Genetics of Hydatidiform Moles: New Lights on an Ancient Disease," *Clinical Genetics* 71, no. 1 (2007): 25–34.
15. For a good introduction to ANT, see the President's Council on Bioethics report *Alternative Sources of Human Pluripotent Stem Cells* (Washington, DC: May 2005). Available at http://bioethics.georgetown.edu/pcbe/reports/white_paper/. Accessed June 6, 2012.
16. Currently, there can only be a guess concerning the number of eggs required, because no one has yet succeeded in creating a cloned human embryonic stem cell line. However, considering that hundreds, if not thousands, of eggs already have been used in human cloning research, the number of eggs needed to create the disease-specific cell lines desired by researchers could easily be in the thousands, and possibly much higher.
17. One can find an example of such a group at http://www.handsoffourovaries.com. Accessed June 6, 2012.
18. The Ethics Committee of the American Fertility Society, "Ethical Considerations of Assisted Reproductive Technologies," *Fertility & Sterility* 62, suppl. 1 (1994): 18S.