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DERIVING SPERM AND EGGS FROM HUMAN SKIN CELLS: FACILITATING COMMUNITY DISCUSSION

Loane Skene[*]

INTRODUCTION

In April 2008, the Hinxton Group, an International Consortium on Stem Cells, Ethics and Law, issued a Consensus Statement concerning research that may lead to human sperm and eggs being derived from stem cells which could come from embryos or from body cells: *The Science, Ethics and Policy Challenges of Pluripotent Stem-Cell Derived Gametes*, 11 April 2008.[1] The Statement's purpose is to "inform public discussion about the state of the science and its potential social implications and to make recommendations about policy and practice."[2] Although the Statement is well informed and clearly written, the author, a non-scientist member of the Hinxton Group, suggests that community discussion may be facilitated by a more 'listener-based' conversation arising from questions that may be commonly asked about the new technology. Drawing on her experience in discussing stem cell technology with politicians, the press and the wider community, she illustrates how this might work with examples of possible questions and answers.

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Editor's Note: Due to the foreign residence of the author, the footnotes of this article do not conform to The Bluebook: A Uniform System of Citation.

1. The Hinxton Group, "The Science, Ethics and Policy Challenges of Pluripotent Stem-Cell Derived Gametes" April 2008, http://www.hinxtongroup.org/Hinxton Consensus_April2008.doc (accessed 3 Nov. 2008).

2. Ibid.

DISCUSSING COMPLEX SCIENTIFIC ISSUES: AN EXAMPLE

This outline of possible questions and answers is 'listener-based,' responding to what the listener may want to know. It would need to be adapted for individual conversations as each person responds to the other's questions and comments.

Is it possible for scientists to derive sperm and eggs from a person's skin cells?

This is not possible at present but scientists have recently taken the first step. They have derived human embryonic stem cells from human skin cells by using proteins to activate their development (Professor Shinya Yamanaka's technique).[3] The stem cells derived from this process are pluripotent stem cells, which means they have the potential to grow into any tissue in the body, such as heart cells, nerve cells, muscle cells and possibly gametes (sperm and eggs). Scientists have not yet been able to make the stem cells differentiate in that way but they will likely achieve this soon. So, one day, it may be possible to convert the stem cells that come from the skin cells (and also stem cells that come from embryos) into sperm or eggs. Let us call these sperm and eggs 'derived sperm and eggs' or 'derived gametes' to distinguish them from the sperm and eggs that come directly from people's reproductive organs (they are officially called pluripotent stem cell-derived gametes (PSCDGs), or loosely and misleadingly, 'artificial gametes').

If the pluripotent stem cells can be obtained from embryos, why don't scientists derive the sperm and eggs from embryos, which seems more natural, rather than from skin cells?

Pluripotent stem cells can be derived from human embryos, either donated by couples in fertility treatment programs, or created by the 'Dolly technique' - where the nucleus from a person's body cell is inserted into a human egg that has had its nucleus removed and then stimulated to develop (which has yet to be accomplished in humans). However, there are relatively few donated embryos and gametes for research. Deriving gametes from stem cells from a person's skin or other body cells (if that was possible) rather than from human embryos, would provide far more gametes for research (or later, provide a wider range of gametes to select the best for treatment). Using skin cells also avoids the sensitivity of using or creating embryos for research.

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3. Vogel, G. "Researchers Turn Skin Cells Into Stem Cells" ScienceNOW Daily News, 20 Nov. 2007, http://sciencenow.sciencemag.org/cgi/content/full/2007/1120/1 (accessed 3 Nov. 2008).

Have sperm and eggs been derived from skin cells in animal research?

This research is in the early stages. In experiments on mice, sperm-like cells and egg-like cells (the beginnings of sperm and eggs) have been derived from skin cells but they have not developed to mature sperm and eggs. The process of cell division needed for an organism to grow (meiosis) has stopped. This means that the egg-like cells have not matured to the stage where they can be fertilised. However, some of these early sperm-like cells derived from skin cells appear to have matured when inserted into the testis of a mouse.

Could derived sperm and eggs be fertilised in a laboratory so that a fertilised egg could be implanted and develop into a fetus?

This has not happened yet but it is possible in theory. In research on mice, eggs have been derived from pluripotent stem cells derived from an embryo rather than from skin cells, and those eggs have been fertilised. However, in that research, scientists were not able to fertilise an egg in the laboratory with sperm-like cells derived from body cells. In the experiment where the mouse had the sperm-like cells inserted in his testis, live pups were born but they had deformities and died within months. At the moment, it seems to be necessary for the sperm-like cells derived from body cells to be in the right 'physical environment' in the mouse to become viable sperm.

Why would anyone want to do this type of research, especially on humans?

It is possible that derived sperm and eggs might one day be used to help couples undertaking fertility treatment have a baby who is genetically related to both of them. Many couples have fertility problems. It is often said that about ten percent of couples are infertile. For example, in the US, according to information quoted from the National Women's Health Resource Center (NWHRC), "[a]pproximately 6.1 million couples in the United States, or 10 percent of all couples of childbearing age, have difficulty conceiving."[4] However, the number of infertile couples may be higher. Another American website states, "[r]oughly 10 to 15 percent of American couples are having fertility problems at any given time. About 1 in every 5 married women in the U.S. seeks medical help to conceive at some point in her childbearing years."[5] British Health Minister, Dawn

4. "Infertility: Fast Facts" http://yourtotalhealth.ivillage.com/infertility-fast-facts.html (accessed 3 Nov. 2008).

5. "HealthSquare: Overcoming Infertility" http://www.healthsquare.com/fgwh/wh1ch18.html (accessed 3 Nov. 2008).

Primarolo, said in Parliament when opening the debate on the draft Human Fertilisation and Embryology Bill, which was passed in October 2008, "[o]ne in seven couples need help with fertility treatment."[6] Infertility may be caused by absent or non-functioning reproductive organs or gametes, chemotherapy, menopause, or other reasons. Other couples need fertility treatment to avoid having a child with a serious medical condition. They could use donated sperm or eggs but these are in short supply and the baby would then not have the genes of both parents. There are an increasing number of fertility treatments, such as IVF where the parents' sperm and eggs are fertilised in a laboratory; and ICSI where a single sperm is injected directly into the egg to help men who produce few sperm. However, some couples cannot benefit from these treatments and forming an egg or sperm from their skin or other body cells might give them another means of having a child with their genes.

There are other reasons for doing the research. Scientists will learn more about the early development of life which may help them understand more about infertility and the causes of inherited and congenital medical conditions. In time, this may lead to the development of new diagnostic tools and treatments to help infertile couples and people with a range of medical disorders, including some cancers. It could enable a man who has had cancer to have his own child and help scientists study the effect of drugs and toxins on an early embryo. One day, it may be possible to alter genes to correct genetic mutations, so that children would not be born with genetic diseases like cystic fibrosis.

If women could have sperm derived from their skin cells - or men could have eggs derived from their skin cells - could same sex couples use this technology to have a child genetically related to them both? Could people have children who have only their DNA, so a single person is both the mother and father of the child, the 'ultimate incest'?[7]

In theory, it may be possible for same sex couples to use this technology to have a child genetically related to them both but it is expected to be difficult to derive gametes (sperm or eggs) of the opposite sex from a person. Professor Robin Lovell-Badge, of the National Institute for Medical Research in London, a member of the Hinxton Group's Steering Committee,

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6. *Quoted in* AP, "Britain Widens Scope For Stem Cell Research" Oct 22, 2008, http://ap.google.com/article/ALeqM5hwnRWHehIxKqNlaS-evERLeOpHgD93VOMU81 (accessed 3 Nov. 2008).

7. Henderson, M. "Sperm and Eggs From Stem Cells 'in 15 years'" Timesonline, 15 April 2008, https://www.timesonline.co.uk/tol/news/uk/science/article3746760.ece (accessed 3 Nov. 2008).

reportedly said, "[i]t would be very difficult to get eggs from XY [men's] cells, and even more difficult to get sperm from XX [women's] cells – my own view, indeed, is that the latter is impossible."[8] If it did happen, people could theoretically have a child with only their DNA but an embryo formed in such a way, even if it was possible, might not develop (at present, developing an embryo for more than 14 days to test this in the laboratory is prohibited by law[9]).

Even with male and female partners, wouldn't the risks be so great in trying to achieve a pregnancy with derived sperm or eggs that it should not be attempted? Remember that we are talking about the birth of a child with a whole life to live.

It is true that the procedure would be new and one cannot know the outcome. However that is the case with any new technology. When Louise Brown, the first IVF baby, was born in 1978, no child had been conceived in that way. Similarly, the first child conceived with ICSI was born from an entirely new procedure. The technique could only be used after thorough testing in the laboratory and in animal research to ensure the procedures are effective and that any embryos produced are normal. Proper ethical scrutiny would be required and people would have to be fully informed about potential risks before they consent to their genetic material being used in the research, with specific consent required before any attempt to use derived gametes for reproduction.

How long will it take for this technology to be available?

It is always difficult to predict developments in science. As the Hinxton Statement says, "[u]nanticipated findings can either accelerate or slow the pace of progress."[10] However, scientists have said that human eggs and sperm will be grown from stem cells within five to fifteen years[11] and

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8. Ibid.

9. *See, e.g.,* Human Fertilisation and Embryology Act 1990 (UK) §§ 3(1)(b), 3(3)(a), 4, 41(1)(b); Prohibition of Human Cloning for Reproduction Act 2002 (Cth) § 14. The US has no federal law on this point but some states have 14-day limits by law. *See* http://www.statehealthfacts.org/comparetable.jsp?ind=111&cat=2 (accessed 3 Nov. 2008).

10. The Hinxton Group, "The Science, Ethics and Policy Challenges of Pluripotent Stem-Cell Derived Gametes" April 2008. http://www.hinxtongroup.org/Hinxton Consensus_April2008.doc (accessed 3 Nov. 2008).

11. Ibid.

according to a press report, "it could be 20 years before the science can routinely create human pregnancies."[12]

Is this technology allowed by law?

Research on human embryos and other bodily material is subject to statutory controls in many countries, and even if scientists are permitted to form embryos containing human genetic material in a laboratory, they must obtain a licence to do that research.[13] It is a serious criminal offence to allow an embryo to develop for more than fourteen days[14] or to implant it in a woman or an animal.[15] Genetic manipulation of human embryos to make heritable changes is illegal in Australia[16] and many other countries. And if animals are involved in research, there are statutory provisions and codes of conduct to protect the welfare of animals.[17]

I feel very uncomfortable about this kind of research, both in its nature and where it may lead. The community has to protect itself and future generations from scientific meddling. Who knows what effect it could have on children who are not yet born – and their children and grandchildren? Some people are not meant to have children. That is God's will or Nature's way. They should accept their infertility - or the birth of children who are not 'perfect.' We should not resort to unnatural scientific interventions, which undermine human dignity, family relationships and our obligations to future generations. This research contravenes the teaching of the church and its consequences are unknown.

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12. "'Limit' to Lab Egg and Sperm Use" BBC News, 14 April 2008, http://news.bbc.co.uk/1/hi/health/7346535.stm (accessed 3 Nov. 2008).

13. *E.g.*, Human Fertilisation and Embryology Act 1990 (UK) § 3(1); Research Involving Human Embryos Act 2002 (Cth) §§ 10, 10A.

14. *See* note 9 above.

15. Human Fertilisation and Embryology Act 1990 (UK) § 3(2),(3); Prohibition of Human Cloning for Reproduction Act 2002 (Cth) § 19.

16. Prohibition of Human Cloning for Reproduction Act 2002 (Cth) § 15.

17. *E.g.*, Animals (Scientific Procedures) Act 1986 (UK), http://scienceandresearch.homeoffice.gov.uk/animal-research/legislation/ (accessed 3 Nov. 2008). *See also* the European Directive on the same site; Australian Code of Practice for the Care and Use of Animals for Scientific Purposes, 7th edition 2004: http://www.nhmrc.gov.au/publications/synopses/eA16syn.htm (accessed 3 Nov. 2008).

Some people do have intrinsic objections to particular types of research, believing it is wrong in its essence, unnatural or against their religion. Their beliefs must be respected. However, the views of some people in the community should not be permitted to override the views and interests of others, especially where the objections are based on moral or religious grounds rather than on technical or safety aspects. Moreover, the lives or health of other people could be improved if the research is successful. A major message of the Hinxton Statement is that moral disagreements in society should never be used on their own to stop scientific investigation. If there are concerns about potential uses of research (such as using the technology to have 'designer babies,' or to make heritable changes in embryos, or altering the human germ line), then the law should focus on those uses (as it does), rather than stopping the research. Also, views change over time. IVF, blood transfusions and organ transplants were once novel treatments and people were suspicious. They are now routine procedures and thousands of children have been born from IVF and related procedures around the world.

CONCLUSION

A question and answer technique of the kind described in this paper may promote more effective communication about sensitive scientific issues. This method is especially useful in the parliamentary process when politicians have to vote on these issues according to their conscience rather than on party lines and they must explain to their electorate the reasons for their vote.[18] Non-scientists can be encouraged to voice their questions and fears about innovative technologies and their implications, and scientists can respond to those questions and fears directly. It will not always be possible to reach agreement, of course, but sometimes explanations can dispel concerns, even if the science itself seems strange or frightening.

18. Skene, L. "Human cloning and stem cell research: Engaging in the political process" (2008) 27 *Journal of Medicine and Law* 119-130.