Parthenogenesis – A new possibility for regenerative medicine and a new bioethical dilemma

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Source: Observing Bioethics.

Parthenogenesis have allowed pluripotent stem cells to be obtained from oocytes (eggs) which have been stimulated to divide without having been fertilised by sperm. ***Can individuals be obtained from parthenogenesis? What is a partenote?***

Introduction

A recent sentence from the European Court of Justice supports the possibility of **patenting stem cells** from ova (eggs) whose development has been stimulated without fertilisation, with the condition that this stimulated egg cannot become a human being[1].

Biotechnology company International Stem Cell Corporation (ISCO) has submitted two patent applications to the appropriate authorities in the United Kingdom; these relate to a technology that produces stem cells from ova activated without sperm, using chemical and electrical techniques, by a process known as parthenogenesis.

London turned down both applications, pursuant to a Justice Court decision in 2011. However, the company appealed, alleging that the restrictions on patentability set by this ruling are not applicable to their technology, since the activated ovum cannot become a human being because it lacks paternal DNA.

The ruling was favourable to the company, on the basis that "in order to be classified as a human embryo, a non-fertilised human ovum must necessarily have the inherent capacity of developing into a human being". "Consequently, the mere fact that a parthenogenetically- activated human ovum commences a process of development is not sufficient for it to be regarded as a human embryo", as set forth in the judgment.

So, what is parthenogenesis?

The reproductive possibility known as "parthenogenesis", which occurs naturally in some reptiles and lower animals, was first artificially induced in sea urchins in 1899 by German- American scientist Jacques Loeb (1859-1924). Loeb produced sea urchin embryos from unfertilised eggs, by submerging them in appropriate saline solutions [2] .

Later developments in this technique have allowed pluripotent stem cells to be obtained from oocytes (eggs) which have been stimulated to divide without having been fertilised by sperm.

Mammalian oocytes can be artificially activated using a variety of stimuli which enable them to complete the second meiosis and eliminate the polar body (or conserve it), in addition to the other half of the genetic contribution of the ovum as pronucleus [3,4,5].

This implies that "diploid" oocytes can be obtained using these techniques, i.e. oocytes with twice as many chromosomes as a normal oocyte, by substituting the genetic contribution of the sperm and instead stimulating the duplication of the oocyte chromosomes themselves.

In certain conditions, this "diploid oocyte" or "parthenote" can start to divide, resulting in something very similar to an embryo ("embryoid")[6], which is differentiated by small but important changes in certain genes.

These changes are due to the absence of the paternal genetic contribution, which provides the zygote with a genetic imprint that is essential for its subsequent evolution.

The paternal genetic contribution

The genetic material contributed by the sperm in the fertilisation process has particular characteristics, different to those of the oocyte, which have come to be known as "parental imprinting". The absence of this paternal genetic signature

makes it impossible for the embryoid or parthenote obtained by stimulating the oocyte to develop normally. Specifically, two regions have been identified in mice containing the genes H19 and lgf, which are expressed differently in the genomes from the oocyte and the sperm, due to epigenetic mechanisms of DNA cytosine methylation.

Can individuals be obtained from parthenogenesis?

Starting up the development process in a zygote that will lead it to constitute an individual of the species concerned requires the paternal genetic imprinting provided by the sperm, as has been indicated.

But would it be possible to genetically modify the parthenote to make its genome resemble that of a normal zygote? Although today it seems far removed from being a real possibility, it is not unreasonable to think that this genetic modification could be achieved before long, and could perhaps pave the way for asexual reproduction, in which the female would no longer need the male, to produce only females.

Current possibilities of parthenogenesis

Parthenogenesis experiments have been conducted in animals, from which pluripotent stem

cells have been derived; these cell lines have been able to be differentiated into nerve, muscle

[7] or fat cells in macaque monkeys, opening the way for their use in regenerative therapy .

The limitation of possible regenerative therapy obtained after parthenogenesis in humans is that it is directed only towards females, in which immune rejection processes would be circumvented as they are cells with a genome identical to that of the egg donor.

Bioethical aspects of parthenogenesis

The application for authorisation to register patents for stem cells obtained following parthenogenesis processes indicates that its potential application in medicine could be real.

The definition of whether or not a parthenote is an individual of the human species is not a closed matter, particularly if it can subsequently be genetically modified to “resemble” a naturally-obtained zygote. Without these subsequent

manipulations, the human nature of a parthenote cannot be claimed; however, but the debate has just begun.

Moreover, the need to obtain oocytes from women for experimentation and derivation of cell lines that can be used in medicine requires the well-known ovarian stimulation processes, which are not free from risks and side effects.

Defenders of the parthenogenic method say that it avoids the ethical problem entailed in cloning for obtaining embryos from which cell lines can be derived that may be useful in regenerative therapy. In the case of cloning, and in the use of embryos obtained by in-vitro fertilisation (IVF), these must be destroyed to obtain the stem cells, which implies the destruction of human beings. This would not be the case here, according to those in favour of parthenogenesis, a technique in which the parthenote would not be considered as a human being[8] but, unquestionably, the character of living human being of the parthenotes and consequently the ethics of its use remain to be defined.

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