Patient Information

Mechanisms of stem cell development during human embryogenesis

Summary

This research is about understanding how human embryos develop. We will use special techniques to label different types of cells to see what happens to them as they divide and move about during the first 13 days of embryo development. We will explore how changes we make to the medium that the embryos are grown in affect the normal behaviour of the labelled cells – in that way we will know if what we added or removed is important for normal development. Some embryos will have their cells separated out into different types and manipulated so that they can continue dividing indefinitely in the laboratory. If we are able to make the cells divide indefinitely, we can culture enough cells to analyse them in detail. We can also make small targeted changes to the cells and then inject them back into a developing embryo to see whether the changes we made stopped the embryo developing normally or not. In this way we can try to understand what is important for healthy development.

Donated frozen embryos are transferred from CARE then stored in our HFEA licensed and inspected research laboratory before they are thawed for use. We will only store your embryos for research purposes for the length of time you consented to. Only licensed researchers have access to the stored embryos.

Background

Six days after fertilization the human embryo contains two main types of stem cells, those that will generate the future foetus, and those that will form the organs that support pregnancy, such as the placenta and the yolk sac. As soon as the embryo implants in the womb, these stem cells start to divide, become reorganized and initiate a process of specialization, to generate cells with different identities and functions. All these events need to be carefully coordinated, as failure to do so would lead to pregnancy loss. It is estimated that approximately 30% of human embryos fail to develop shortly after implantation, but the mechanisms behind remain unknown. To understand the causes of failure, we need to study the genes, chromosomes and proteins that are important in regulating the development of the embryo and its cells.

What is the purpose of this study?

Our goal is to understand the basic mechanisms of human embryo development to shed light on the reasons behind early pregnancy loss. We hope that the results of these studies will benefit medical knowledge in a number of important ways, including:

- Understanding how cells in the human embryo become specialized. During the first two weeks of human development cells acquire different fates, and therefore different functions. A small subset of cells is set aside to form the future foetus and the amnion, the membrane that protects the developing foetus from damage. A second population of cells gives rise to the future placenta, which supports the development of the foetus throughout pregnancy. The third cell population forms the yolk sac, a sac that provides nutrients to the foetus. Understanding the molecular characteristics of these different cell types could provide insight into the mechanisms of stem cell formation and the causes of early pregnancy loss.
- Understanding how embryos acquire their shape as they develop beyond implantation. As embryos implant in the maternal uterus, they grow and their cells reorganize to form different structures, such as the amniotic cavity, which protects the future foetus throughout the pregnancy. We would like to

understand how these changes in embryo shape take place and which genes are involved in this process. These findings could explain why so many human pregnancies fail shortly after implantation.

- Establishing the consequences of chromosomal alterations for early human embryo development. Alterations in the normal number of chromosomes typically lead to pregnancy loss, but the reasons behind this remain unknown. We wish to study how an abnormal number of chromosomes affects embryo development, specifically the specialization of cells into different cell types, and the changes in embryo shape that take place after implantation.
- Developing stem cell lines that can be taken out of the embryo and multiplied in the laboratory for many years can help us study and understand devastating human diseases more fully at the cellular level in the laboratory and potentially develop new drug treatments.

How will the work be carried out?

To achieve our goal, we will carry out the following laboratory procedures:

- Growing human embryos in a new culture system that permits correct development beyond implantation and up to day 13 of development[1]. This will allow us to study how embryos grow and change their shape.
- Performing biochemical studies to understand the biological properties of the embryos. This involves labeling specific types of cells and structures using chemical compounds, and/or isolating cells to characterize the types of genes and proteins that they express.
- Modifying the conditions of culture to assess how embryos respond to the presence of specific compounds.
- Recording the development of the embryos using highly specialized time-lapse microscopy.
- Deriving stem cell lines from the embryos. If an embryo is used for the purpose of producing stem cells, it is separated into individual cells or groups of cells, so that it is no longer intact. These separated cells may die naturally, or they may survive and multiply indefinitely as stem cells. These stem cells can be used to further study many types of diseases, which can be replicated in the laboratory to look at their cause and progression as well as search for treatments.
- Altering the cellular composition of a human embryo by introducing human stem cells. The resulting embryo, a chimera, will be composed of human cells with different genetic information, originally coming from different zygotes. This technology will allow us to alter the genetic information of the stem cells without modifying the genetic information of the embryo.

At the end of the research all embryos will be allowed to perish.

How will this help me?

The research we do will not help you specifically, and we are unable to provide any information on any particular embryo. However, the information we get from these studies may help us to improve fertility treatments, to develop cures for serious disorders such as miscarriage, and to generate new research tools. The collective information will be studied scientifically and the information gained published in the appropriate medical and scientific journals. You will not be identified personally in any way in any publication or scientific presentation.

It is possible that discoveries resulting from research on donated embryos, or stem cells

that may be generated from them, could result in patents or licenses being awarded to the researchers or to commercial organisations. You will not receive any financial benefit from research discoveries arising from the embryos you donate or from stem cells generated from them.

Where will this work be performed?

These studies will be done in collaboration with researchers at the MRC Laboratory of Molecular Biology (LMB) in Cambridge, under a research licence issued by the Human Fertilisation and Embryology Authority (HFEA) and approval of the East of England – Cambridgeshire and Hertfordshire Research Ethics Committee. The funding for this research is covered by the Medical Research Council (MRC), which supports the research in the group of Dr. Marta Shahbazi, and funding from the CARE Fertility Group and its Rachel Foundation. Additional information can be found at: https://www2.mrc-lmb.cam.ac.uk/

Important Regulatory Aspects

If you have consented to the use of your embryos in the research project you can still withdraw your consent to research at any time up to when the embryos are used in the research project. If you choose to do this, it will have no effect on you or your treatment if that is still on-going. If you wish to withdraw your consent please email alison.campbell@carefertility.com, or contact the unit at which you were treated and ask to communicate with the Laboratory Manager.

You are under no obligation to donate embryos for research and if you decide not to this will not affect your treatment in any way. If you do decide to donate your embryos, we will only use embryos that you no longer want to use for your treatment or that are considered unsuitable for treatment

If your embryos are used to derive stem cell lines, once these have been created, they may continue indefinitely and be used in many different research projects. These stem cells will be deposited in the UK Stem Cell Bank, which will allow researchers from other laboratories, nationally and internationally, to access the cells and use them for their own research. The stem cells, or any discoveries made using them, could potentially be patented and used for commercial purposes. In this case you would not have any financial benefits.

The scientists involved in the research may have access to identifiable information, which cannot be erased before providing the researchers with the 'straws' containing the frozen embryos. The identifying information will however be discarded with the straws after the embryos are thawed and will not be used or recorded by the researchers. The embryos will be coded and your identity and participation in the research will be kept strictly anonymous. If stem cells are generated in the research, a sample of these will be deposited with the UK Stem Cell Bank. In this case only, it will be necessary for your treatment clinic to provide a copy of your consent form in confidence to the Secretary of the UK Stem Cell Steering Committee. Your identity will not be disclosed to the staff of the UK Stem Cell Bank or to anyone else.

Please note that we encourage you to ask any questions that are on your mind at the time of signing the Consent Form or anytime thereafter. Access to counselling independent from the study team is available. If you have any questions you should contact the Laboratory Manager at the CARE clinic at which you had your treatment.

1. Shahbazi, M.N., et al. Self-organization of the human embryo in the absence of maternal tissues. Nat Cell Biol 18, 700-708 (2016).