Creating New Types of Stem Cells

En Español

Generating new stem cell lines is a major focus of many CIRM-funded researchers. Learn why these new lines are considered so important as we accelerate discoveries from the lab bench to the patient's bedside.

What is a stem cell line?

A stem cell line is a group of identical stem cells that can be grown and nurtured in a lab dish. A line originates with either a single induced pluripotent stem cell or from the cells of a five-day-old blastocyst—*and all resulting cells in the line are replicates of the original cells*. Researchers working with these lines can grow large volumes of cells. They can even freeze some in liquid nitrogen for future use or to share with colleagues.

We are still learning the best way to grow and maintain stem cells. The cells need nutrients and a recipe of biological factors in the lab dish in order to grow well. Figuring out the best combination of factors to maintain a stem cell line is the focus of several CIRM grants.

Find out More


Peter Donovan talks about maintaining stem cell lines in the lab

What are the different ways of creating pluripotent stem cell lines?

There are many different approaches to creating new cell lines. CIRM considers this to be such an important endeavor that it has funded $23 million in grants dedicated to the creation of new cell lines and to techniques that make the process more efficient:

Option 1: In vitro fertilization

All human embryonic stem cell lines in use today were created from embryos generated by vitro fertilization (IVF) and *donated by the couple for research purposes*. In IVF, researchers mix a man's sperm and a woman's eggs together in a lab dish. Some of those eggs will become fertilized. After fertilization, the cells divide for about five days to form a ball of cells called a *blastocyst*.

The blastocyst is essentially a hollow ball of cells containing an inner clump that is known as the inner cell mass. This clump is what give rise to embryonic stem cells if grown in a dish. To generate an embryonic stem cell line, a researcher removes the outer layer of the five-day-old blastocyst then puts the remaining portion on a lab dish containing factors that allow cells of the inner cell mass to grow and thrive. These cells form the basis of a new embryonic stem cell line.

Find out More:


Amander Clark talks about creating embryonic stem cell lines (4:11)

Option 2: Nuclear Transfer

Another method called stem cell nuclear transfer (SCNT) involves removing the genetic material from an egg, then injecting a different set of genetic material from an adult person's cell into that egg. Researchers then stimulate the egg to begin maturing. About five days later the egg develops into a *blastocyst*—the same type of blastocyst that would be used to create cell lines from donated IVF embryos. Researchers remove the inner cell mass from the blastocyst and grow those cells in a lab dish to create a new stem cell line.

Researchers have used SCNT to create stem cell lines from a wide range of animals including non-human primates. In 2013, scientists for the first time created human stem cell lines through nuclear transfer.

Embryonic stem cells created through SCNT have the advantage of being genetically identical to a person's *own* cells, reducing the risk of immune rejection.

The process of using nuclear transfer to create cell lines identical to a person's own cells is sometimes referred to as *therapeutic cloning*. That's because those identical stem cells would be created with the intent to derive therapies.

Therapeutic cloning should not be confused with reproductive cloning, in which the intent is to create an identical human being. The California constitution, CIRM regulations and all other states that are actively supporting stem cell research expressly prohibit human reproductive cloning.

Find out More:

Robert Blelloch talks about creating embryonic stem cell lines through SCNT (3:15)
SCNT, an Illustration (Stanford University)

Option 3: Induced Pluripotent Stem Cells

The first human induced pluripotent stem (iPS) cells were created by inserting four genes into the DNA of human skin cells. Those introduced genes effectively turned back the clock, causing the adult skin cells to revert back to an embryonic-like state, rendering them pluripotent.

These cells are an exciting and valuable research tool, however, iPS cells face some hurdles before they can advance towards clinical trials. For example, the earliest versions of the technique used a virus to shuttle the genes into the skin cell, which can integrate into the cell's DNA and possibly cause hazardous mutations. What's more, some of the genes used to create the iPS cells have some cancer-causing potential.

Many CIRM-funded researchers are working to identify safer ways of creating iPS cells, which would allow researchers to create patient-specific stem cells that can be transplanted as a treatment for disease. These researchers are looking into using methods that don't require the genes to incorporate into the cell's DNA or finding a combination of chemicals or proteins to replace those genes as alternative ways of creating iPS cells.

Find out More:

Jerome Zack talks about creating iPS cells (3:40)
Profile of iPS cell researcher and CIRM grantee Kathrin Plath (UCLA)

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