



June 1, 2011

Origins and Applications of Pluripotent Stem Cells

Introduction:

The amazing ability of stem cells to produce different cell types of the body has made them the topic of much research in recent decades. From exploring the properties and sources of adult and embryonic stem cells, to reprogramming mature cell types into pluripotent stem cells, the field has come a long way. In addition to understanding the basic principles of stem cell biology, research in this field has been moving towards various exciting applications, including making stem cells specifically from patients, and using stem cells to study disease. The fundamentals of stem cell biology permeate all of biomedical science, and no doubt the coming years will be rife with a variety of exciting discoveries facilitated by this technology.

Speakers:



Daisy Robinton, originally from Palo Alto, California, is a first year graduate student in the Biological and Biomedical Sciences program at Harvard Medical School. While studying at UCLA, Daisy became fascinated with stem cell biology and the promise research in this field holds for insight into human disease and medical therapies. She is pursuing these interests while choosing a thesis lab for her doctorate.



Luis Williams, originally from Managua, Nicaragua, is a third year graduate student in the Stem Cell and Regenerative Biology department at Harvard University. Luis studies the fatal neurodegenerative disease ALS with Professor Kevin Eggan. By employing patient specific iPS cells in his research, he hopes to understand the similarities and differences between the many forms of this disease.



Gabriella L. Boulting, originally from Miami, Florida, is a fifth year graduate student in the department of Molecular and Cellular Biology at Harvard University. Interested in the pharmaceutical and clinical applications of stem cell technology, Gabriella studies how we can use human pluripotent stem cells to better understand neurodegenerative disease with Professor Kevin Eggan.

Glossary

In vitro fertilization: A medical procedure performed to help women conceive when it is difficult for them to get pregnant by normal means. This procedure includes collecting sperm from a man, and eggs from a woman. The sperm and eggs are combined in a dish in a laboratory to ensure that the maximum number of eggs is fertilized. A few fertilized eggs (embryos) are implanted into the woman, and any remaining embryos are frozen, discarded, or donated; a decision made by the parent(s).

Blastocyst: A very early stage embryo (3-5 days after the egg is fertilized, almost invisible to the naked eye), in which a group of a dozen or so cells exists called the “inner cell mass”, or the ICM. If a blastocyst implants in a woman’s uterus, then the ICM cells will go on to form the fetus. When the ICM is removed from the blastocyst, and placed under controlled conditions in a laboratory, the cells can be maintained as **embryonic stem cells**.

Stem Cell: A cell that has 2 properties: (1) the ability to grow more cells identical to itself (a.k.a **self-renewal**), and (2) the ability to make other different cell types.

Self-renewal: A cell’s ability to grow more cells identical to itself.

Pluripotency: A cell’s ability to make all the different cell types in the body. This is a trait of inner cell mass cells in the **blastocyst**, and of pluripotent stem cells (**ES cells** and **iPS cells**).

Multipotency: A cell’s ability to make different cell types in the body, but not all of them. It is a trait of cells undergoing normal development in an embryo, as they grow and change to make the different parts of the body. This is also a trait of **adult stem cells**, which are usually restricted to making cell types of the organ in which they are found.

Embryonic stem (ES) cells: Name given to cells after they have been taken out of a very early stage embryo (called a **blastocyst**), and grown in a culture dish such that they do not develop further, but continue to grow more of themselves while maintaining their ability to make all the different cell types in the animal. ES cells are characterized as having 2 traits: **pluripotency** and **self-renewal**.

*ES cells only exist in a dish, under controlled laboratory conditions. Strictly speaking, they do not exist normally in an animal or person at any time.

Adult stem cells: Cells of a person’s tissue or organ which have the ability to **self-renew** and to make different cell types (**multipotency**) of that particular organ. They are known to exist for some organs, but not all.

* adult stem cells normally exist in a person, and are the cells that the body activates to make more cells if needed to repair an injury.

Reprogramming: A new way to make stem cells that can behave just like **embryonic stem cells**, but don’t come from embryos. This is done by treating a person’s adult cells, such as skin cells, with certain factors to convert them (or ‘reprogram’ them) back to the pluripotent stem cell state.

*Reprogramming takes place under controlled laboratory conditions, not inside a person.

Induced pluripotent stem (iPS) cells: Name given to cells which have the characteristics of embryonic stem cells (**pluripotency** and **self-renewal**), but were made by **reprogramming** of adult cells, like skin cells, and not made from a blastocyst. They can also be “patient-specific” when made from a patient’s cells to study their disease.

*iPS cells only exist in a dish, under controlled laboratory conditions. They do not exist normally in an animal or person at any time.

Differentiation: The normal process undergone by cells in a developing embryo as they change from **pluripotent** cells, to **multipotent** cells, and finally to adult cell types. The changes that cells make during differentiation are dependant on a series of very specific cues that they get from other surrounding cells about what to become and what other cells are turning into. This ensures that the body develops properly.

Directed differentiation: Making adult cell types from stem cells (like **ES** or **iPS** cells) using specific ingredients and signals to induce the changes observed during normal embryo development, which result in a desired adult cell type of interest. Scientists only know how to make about 15 different adult cell types from human ES or iPS cells by directed differentiation. Many laboratories are currently working on understanding how to make more cell types in better ways.

*While directed differentiation is an attempt to re-create the normal developmental process, it takes place in a dish under controlled laboratory conditions, not inside a person.

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