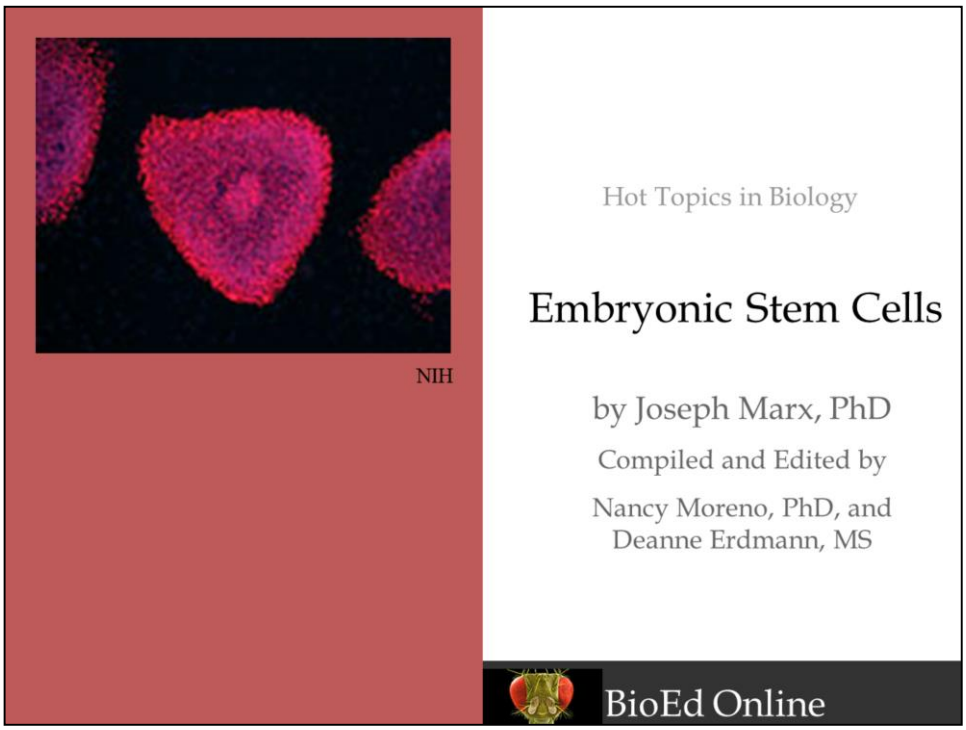

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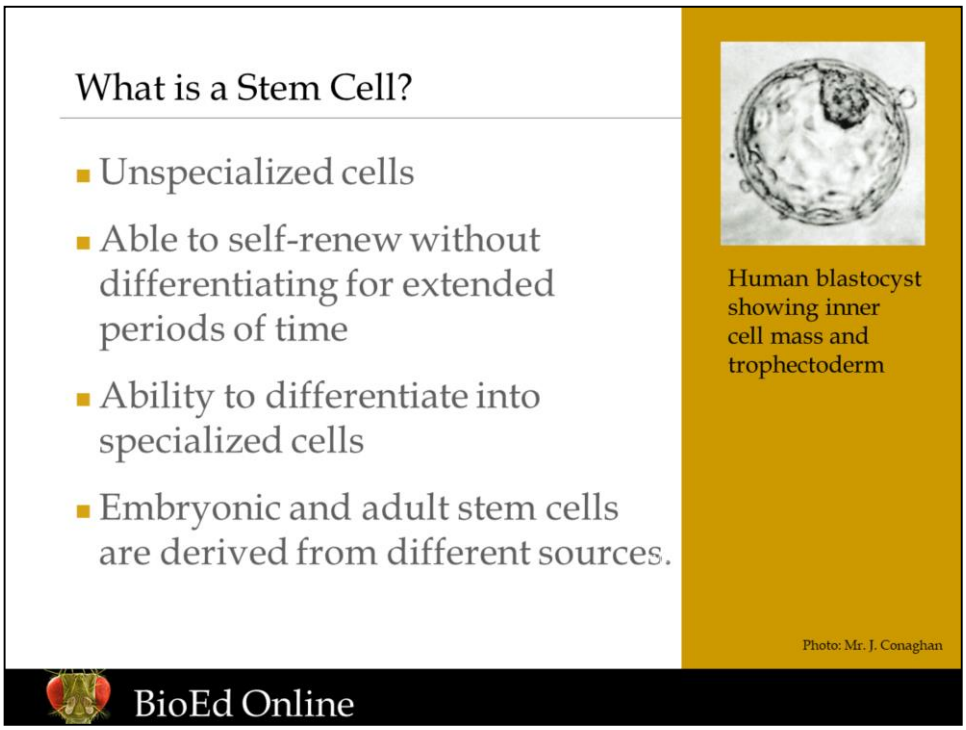

What Is a Stem Cell?

Stem cells are unspecialized cells that can self-renew (or "proliferate") for extended periods of time without differentiating (turning into other kinds of cells). They exhibit a stable, normal chromosome complement. Stem cells cannot perform any specialized functions but have the potential to generate cells with specialized functions (a process known as "differentiation"), such as pulsating heart muscle cells or defensive immune cells.

A fertilized egg is said to be "totipotent" because it has the potential to generate all cell types and tissues that make up an organism. Embryonic stem cells, derived from the inner cell mass of the blastocyst stage of development (pre-implantation, ~5-6 days old) have the potential to generate cell types and tissues from all three primary germ layers of the body (pluripotent). Adult stem cells (somatic stem cells) are found in tissues such as brain, bone marrow, skin, liver, skeletal muscle and peripheral blood vessels. It is suggested that some of these cells may be able to differentiate into multiple cell types (called "plasticity" or "trans-differentiation"). For example, brain stem cells may be able to generate blood and skeletal muscle cells. However, stem cells in adult tissues appear to have a more limited capacity or potential to differentiate than do embryonic stem cells. It may be that adult stem cells in many differentiated tissues are typically unipotent (capable of only one lineage).

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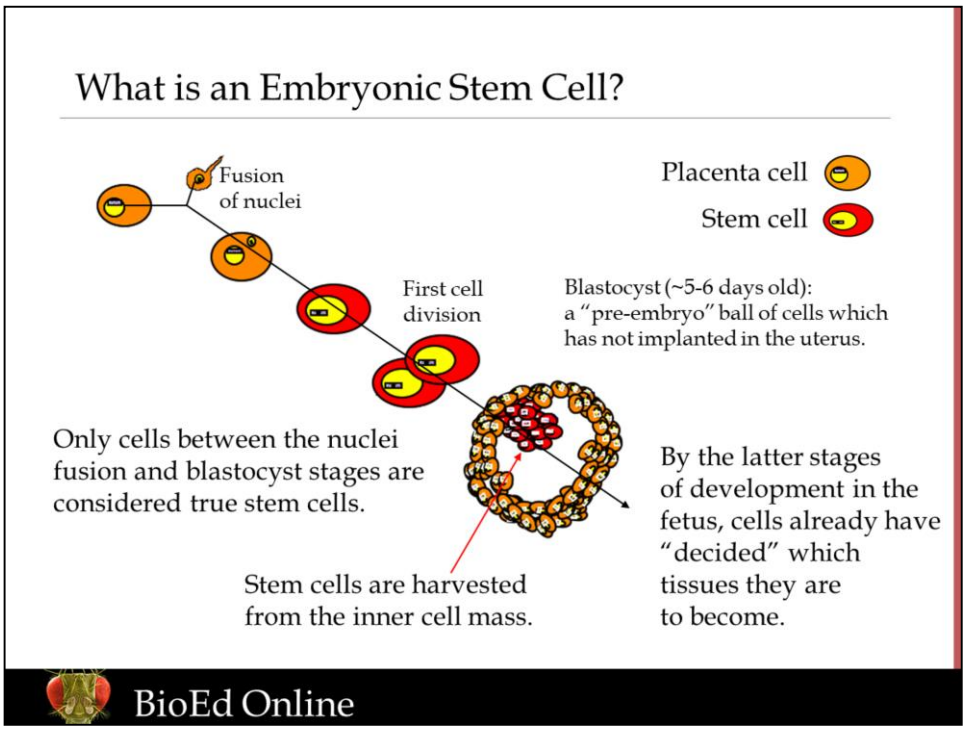

What is An Embryonic Stem Cell?

Embryogenesis is the process by which a single cell, formed from the union of the nuclei from a sperm and an egg, produces a complete organism. The fertilized egg is said to be totipotent, meaning that it has the potential to generate all the specialized cells and tissues of the body, as well as the tissues necessary for its (the egg's) development in the uterus.

The DNA within the fertilized egg instructs the cell to divide (usually 24–36 hours after fertilization). The cell divides into two cells, and then each cell divides again, producing four cells. This process continues for five to six days. At that point, the single cell has become a hollow ball of cells, called a blastocyst, that has not attached to the uterus. All mammals produce a blastocyst during embryogenesis. The blastocyst is composed of two distinct cell types: 1) cells that will become the placenta; and 2) the inner cell mass. The inner mass of cells (in red) is stem cells. These unique cells are described as pluripotent, since they retain the ability to read all information contained in the DNA within their nuclei and the capacity to generate cells from all three primary germ layers (mesoderm, ectoderm, and endoderm). In other words, they can produce the cell types corresponding to all of the tissues in the body.

A very specific event occurs after 5-6 days: the blastocyst changes very subtly and the cells in the inner cell mass lose their ability to read all of their DNA. In other words, cells are no longer pluripotent after this point in development.

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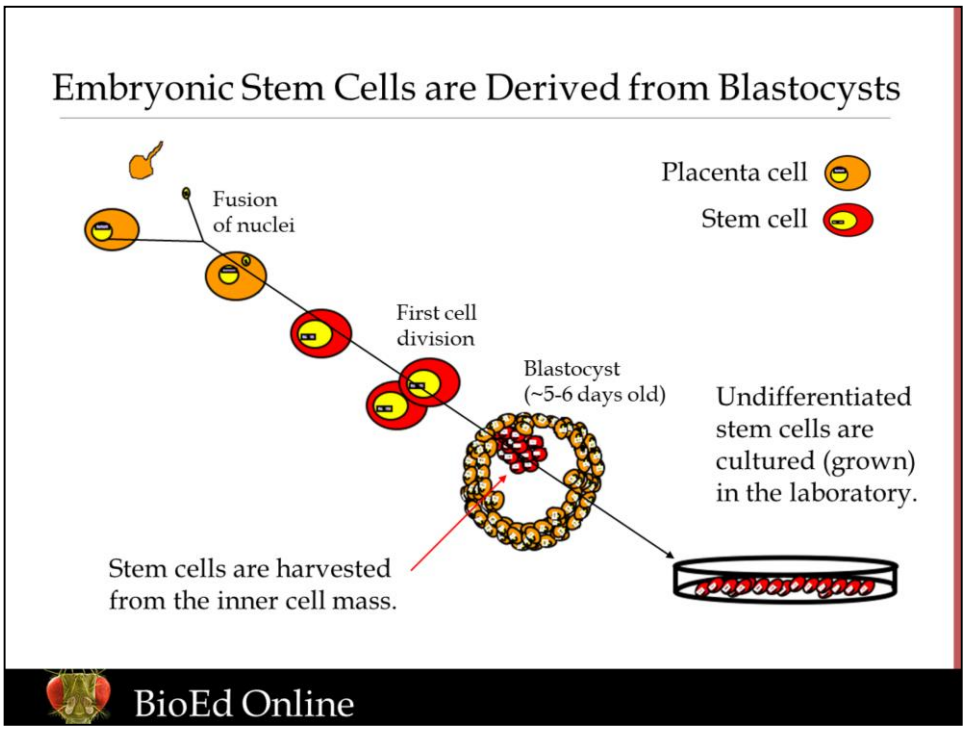

Stem Cells Are Derived from Blastocysts

Scientists can remove the inner cell mass of a blastocyst by microsurgery or immunosurgery (use of antibodies). The harvested cells are transferred to a petri dish containing a specialized nutrient broth, known as a culture medium. After 9-15 days, when clumps of cells have formed, cells from the periphery are separated and plated in the same type of culture medium. Not all cells of the inner cell mass will survive. Some will differentiate pre-maturely. Cells that do not differentiate retain the ability to generate any cell type. These become stem cell lines. As the cells grow and crowd the dish, individual cells are removed and placed in a new dish to continue the cell culture. Cells that grow and do not differentiate for at least six months are called a stem cell line. These cells are described as being pluripotent, which means they are able to generate cells of all three embryonic germ layers.

Since 1998, scientists have created about 30-40 stem cell lines for research. These stem cell lines can be maintained for a very long time in the laboratory, and even can be frozen for use at a later date.

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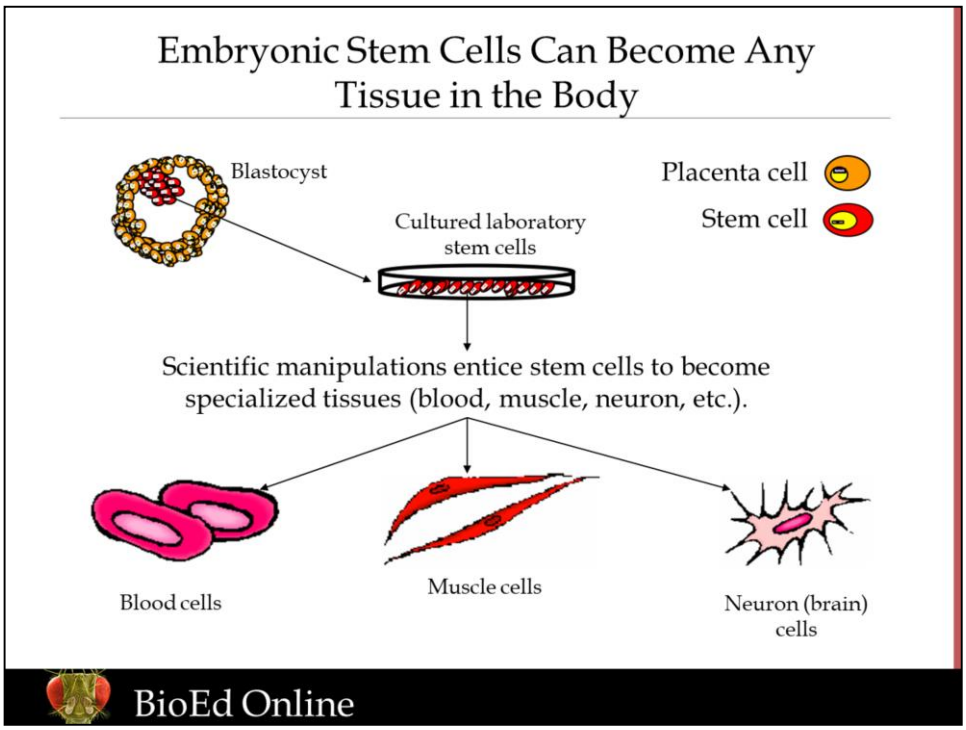

Embryonic Stem Cells Can Become Any Tissue In The Body

Stem cell cultures grown in the laboratory may be used to generate specialized, differentiated cells. The most common method of inducing embryonic stem cells to differentiate is to introduce growth factors or change the chemical composition of the surface on which they grow. For example, if the growth surface medium is treated in such a way that the cells cannot adhere to it, the cells float and begin to interact with each other. This cell-to-cell interaction, when combined with the introduction of specific growth factors (*in vitro*), can induce cells to differentiate along a specific pathway.

In 1998, James Thomson at the University of Wisconsin-Madison was the first scientist to keep human embryonic stem cells alive in the laboratory. Before this, scientists could harvest the inner cell mass of the blastocyst, but were able to keep them alive only for a very short time.

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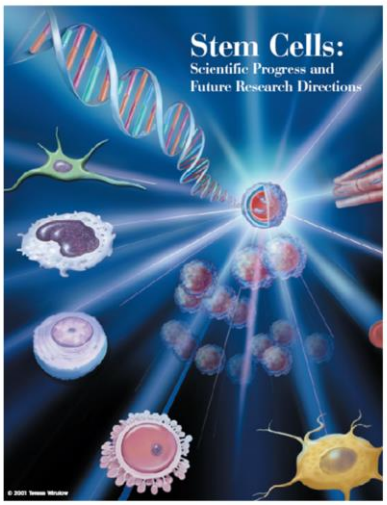
http://stemcells.nih.gov/info/scireport/.



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