

Lesson Overview Cell Differentiation

THINK ABOUT IT

The human body contains hundreds of different cell types, and every one of them develops from the single cell that starts the process. How do the cells get to be so different from each other?

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From One Cell to Many

How do cells become specialized for different functions?

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From One Cell to Many

How do cells become specialized for different functions?

During the development of an organism, cells differentiate into many types of cells.

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- All organisms start life as just one cell.
- Most multicellular organisms pass through an early stage of development called an embryo, which gradually develops into an adult organism.

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- During development, an organism's cells become more differentiated and specialized for particular functions.
- For example, a plant has specialized cells in its roots, stems, and leaves.

Cells that store sugar

Cells that transport materials

Cells that carry out photosynthesis

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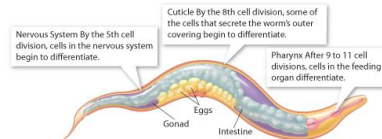
Defining Differentiation

- The process by which cells become specialized is known as **differentiation**.
- During development, cells differentiate into many different types and become specialized to perform certain tasks.
- Differentiated cells carry out the jobs that multicellular organisms need to stay alive.

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Mapping Differentiation

- In some organisms, a cell's role is determined at a specific point in development.
- In the worm *C. elegans*, daughter cells from each cell division follow a specific path toward a role as a particular kind of cell.



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Differentiation in Mammals

- **Cell differentiation in mammals is controlled by a number of interacting factors in the embryo.**
- **Adult cells generally reach a point at which their differentiation is complete and they can no longer become other types of cells.**

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Stem Cells and Development

← **What are stem cells?**

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STEM CELLS IN THE NEWS

Jan. 7, 2013 — Blind mice can see again, after Oxford University researchers transplanted developing cells into their eyes and found they could re-form the entire light-sensitive layer of the retina.

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STEM CELLS IN THE NEWS

Feb. 21, 2013 — Researchers at the Institute of Bioengineering and Nanotechnology (IBN) have successfully generated human kidney cells from human embryonic stem cells *in vitro*¹

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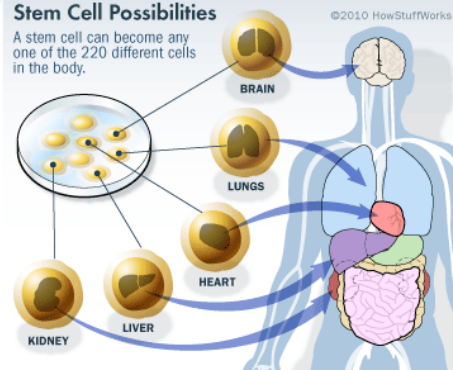
US STEM CELL LAWS

President Barack Obama removed the restriction of federal funding passed by Bush in 2001, which only allowed funding on the 21 cell lines already created. However, the Dickey Amendment to the budget, The Omnibus Appropriations Act of 2009, still bans federal funding of creating new cell lines. In other words, the federal government will now fund research which uses the hundreds of more lines created by public and private funds.

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Stem Cell Possibilities

A stem cell can become any one of the 220 different cells in the body.

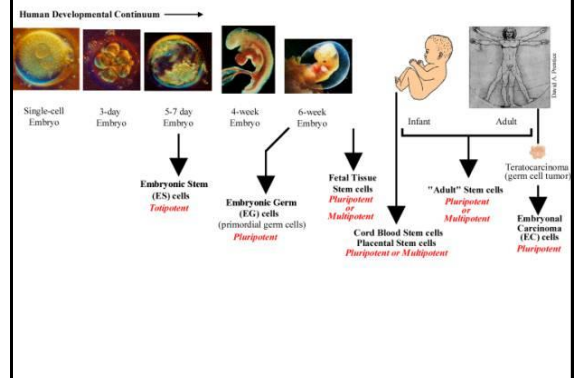


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Potential uses of Stem cells



Stem Cells



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Stem Cells and Development

What are stem cells?

The unspecialized cells from which differentiated cells develop are known as **stem cells**.

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Biologists say that such a cell is **totipotent**, literally able to do everything, to form all the tissues of the body.

Only the fertilized egg and the cells produced by the first few cell divisions of embryonic development are truly totipotent.

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Human Development

- After about four days of development, a human embryo forms into a **blastocyst**, a hollow ball of cells with a cluster of cells inside known as the inner cell mass.
- The cells of the inner cell mass are said to be **pluripotent**, which means that they are capable of developing into many, but not all, of the body's cell types.

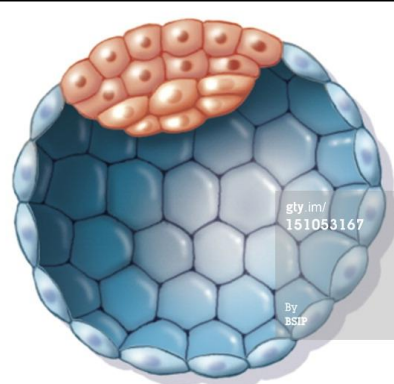
Lesson Human Blastocyst



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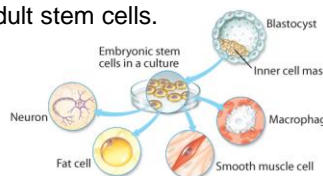


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Stem Cells

Stem cells are unspecialized cells from which differentiated cells develop.

There are two types of stem cells: embryonic and adult stem cells.



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Embryonic Stem Cells

Embryonic stem cells are found in the inner cells mass of the early embryo.

Embryonic stem cells are pluripotent.

Researchers have grown stem cells isolated from human embryos in culture. Their experiments confirmed that embryonic stem cells have the capacity to produce most cell types in the human body.

Adult Stem Cells

Adult organisms contain some types of stem cells.

Adult stem cells are **multipotent**. They can produce many types of differentiated cells.

Adult stem cells of a given organ or tissue typically produce only the types of cells that are unique to that tissue.

Frontiers in Stem Cell Research

- What are some possible benefits and issues associated with stem cell research?

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- Stem cells offer the potential benefit of using undifferentiated cells to repair or replace badly damaged cells and tissues.
- Human embryonic stem cell research is controversial because the arguments for it and against it both involve ethical issues of life and death.

Potential Benefits

Stem cell research may lead to new ways to repair the cellular damage that results from heart attack, stroke, and spinal cord injuries.

One example is the approach to reversing heart attack damage illustrated below.



Ethical Issues

Most techniques for **harvesting**, or gathering, embryonic stem cells cause destruction of the embryo.

Government funding of embryonic stem cell research is an important political issue.

Groups seeking to protect embryos oppose such research as unethical.

Other groups support this research as essential to saving human lives and so view it as unethical to restrict the research.