WHAT ARE "STEM CELLS"

In simplest terms "stem cells" are cells found in our body that have the capability to differentiate into any one of the various kinds of other specialized cells.

Stem cells are the foundation for every organ and tissue in your body. There are many different types of stem cells that come from different places in the body or are formed at different times in our lives. These include embryonic stem cells that exist only at the earliest stages of development and various types of tissue-specific (or adult) stem cells that appear during fetal development and remain in our bodies throughout life.

All stem cells can self-renew (make copies of themselves) and differentiate (develop into more specialized cells). Beyond these two critical abilities, though, stem cells vary widely in what they can and cannot do and in the circumstances under which they can and cannot do certain things. This is one of the reasons researchers use all types of stem cells in their investigations.

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EMBRYONIC STEM CELLS

Embryonic stem cells are obtained from the inner cell mass of the blastocyst, a mainly hollow ball of cells that, in the human, forms three to five days after an egg cell is fertilized by a sperm. A human blastocyst is about the size of the dot above this "i."

In normal development, the cells inside the inner cell mass will give rise to the more specialized cells that give rise to the entire body—all of our tissues and organs. However, when scientists extract the inner cell mass and grow these cells in special laboratory conditions, they retain the properties of embryonic stem cells.

Embryonic stem cells are pluripotent, meaning they can give rise to every cell type in the fully formed body, but not the placenta and umbilical cord. These cells are incredibly valuable because they provide a renewable resource for studying normal development and disease, and for testing

drugs and other therapies. Human embryonic stem cells have been derived primarily from blastocysts created by in vitro fertilization (IVF) for assisted reproduction that were no longer needed.

TISSUE-SPECIFIC STEM CELLS

Tissue-specific stem cells (also referred to as somatic or adult stem cells) are more specialized than embryonic stem cells. Typically, these stem cells can generate different cell types for the specific tissue or organ in which they live.

For example, blood-forming (or hematopoietic) stem cells in the bone marrow can give rise to red blood cells, white blood cells and platelets. However, blood-forming stem cells don't generate liver or lung or brain cells, and stem cells in other tissues and organs don't generate red or white blood cells or platelets.

Some tissues and organs within your body contain small caches of tissue-specific stem cells whose job it is to replace cells from that tissue that are lost in normal day-to-day living or in injury, such as those in your skin, blood, and the lining of your gut.

Tissue-specific stem cells can be difficult to find in the human body, and they don't seem to self-renew in culture as easily as embryonic stem cells do. However, study of these cells has increased our general knowledge about normal development, what changes in aging, and what happens with injury and disease.

MESENCHYMAL STEM CELLS

You may hear the term "mesenchymal stem cell" or MSC to refer to cells isolated from stroma, the connective tissue that surrounds other tissues and organs. Cells by this name are more accurately called "stromal cells" by many scientists. The first MSCs were discovered in the bone marrow and were shown to be capable of making bone, cartilage and fat cells. Since then, they have been grown from other tissues, such as fat and cord blood. Various MSCs are thought to have stem cell, and even immunomodulatory, properties and are being tested as treatments for a great many disorders, but there is little evidence to date that they are beneficial. Scientists do not fully understand whether these cells are actually stem cells or what types of cells they are capable of generating. They do agree that not all MSCs are the same, and that their characteristics depend on where in the body they come from and how they are isolated and grown.

INDUCED PLURIPOTENT STEM CELLS

Induced pluripotent stem (iPS) cells are cells that have been engineered in the lab by converting tissue-specific cells, such as skin cells, into cells that behave like embryonic stem cells. IPS cells are critical tools to help scientists learn more about normal development and disease onset and progression, and they are also useful for developing and testing new drugs and therapies.

While iPS cells share many of the same characteristics of embryonic stem cells, including the ability to give rise to all the cell types in the body, they aren't exactly the same. Scientists are exploring what these differences are and what they mean. For one thing, the first iPS cells were produced by using viruses to insert extra copies of genes into tissue-specific cells. Researchers are experimenting with many alternative ways to create iPS cells so that they can ultimately be used as a source of cells or tissues for medical treatments.