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Stem Cells and Self-Renewal

By Suzanne Kadereit

Stem cells can be found within the different tissues of the human body at all stages of life, before and after birth. Stem cells are specialized cells that continually generate progeny cells for organ formation and maintenance. There are different types of stem cells, which vary in terms of their location in the body and the type of cells they can produce.

Embryonic stem cells can be only found in very early embryos, while the tissues of children and adults contain stem cells defined as adult stem cells. The best-characterized and most studied adult stem cells are the hematopoietic stem cells and the mesenchymal stem cells.

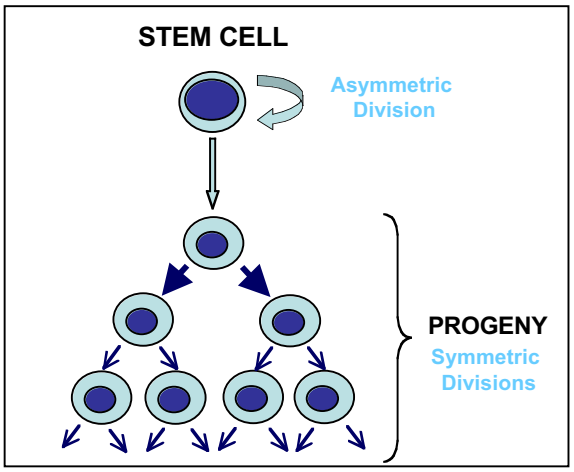
Both stem cell types reside in the bone marrow and are relatively easy to obtain. In addition to the bone marrow, umbilical cord blood is another source of readily available stem cells. Cord blood is rich in hematopoietic stem cells, and also contains endothelial precursor cells that can give raise to vascular and skeletal muscle cells.

All other adult stem cells have to be isolated from the tissues in which they reside, and they are present in extremely low numbers. As a result, it is very difficult to obtain more than a few of these stem cells, and this limits their use for wider clinical application.

Self-renewal and expansion

A stem cell is defined as a cell that can renew itself indefinitely, while producing cell progeny that mature into more specialized, organ-specific cells. To accomplish this task, the stem cell has to divide continuously. These divisions are asymmetric. One of the two daughter cells retains the stem cell characteristics, while the other is destined for a limited number of future divisions and will produce the more organ-specific cells.

Although scientists are learning more and more about this mechanism, they are still a long way from understanding it. For example, researchers have been trying for many years to grow human hematopoietic stem cells in culture, without much success. A cocktail of growth factors can be used to increase the numbers of cells dramatically, but the cells do not maintain stem cell characteristics. Instead, they become more mature, differentiated progenitor cells which eventually exhaust themselves after having divided a specific number of times. However, recent advances in the characterization of hematopoietic stem cells in murine models have pointed towards possible clinical applications.



Stem Cell Division. The stem cell divides asymmetrically, generating one cell that repeats the feat indefinitely, and one cell that continues to divide symmetrically, dividing each time into two equal daughter cells.

In the meantime, the only stem cells that can be propagated and amplified in culture without loosing their stem cell character are embryonic stem cells. These cells are therefore a primary subject of research, not only for potential use as a tissue or organ replacement source, but also as a model to unravel the mystery behind the asymmetric divisions of the stem cells.

Research is ongoing, analyzing global gene expression patterns in the different types of stem cells, including embryonic stem cells, in the hope to unravel the molecular pathways behind self-renewal. Scientists will have to have a good understanding of these pathways to be able to work with the small numbers of adult stem cells that can be obtained from patients, and to grow these few cells in culture for therapeutic purposes.

Suzanne Kadereit, P.hD. is science editor of the ISSCR Web site.