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Adult Stem Cells

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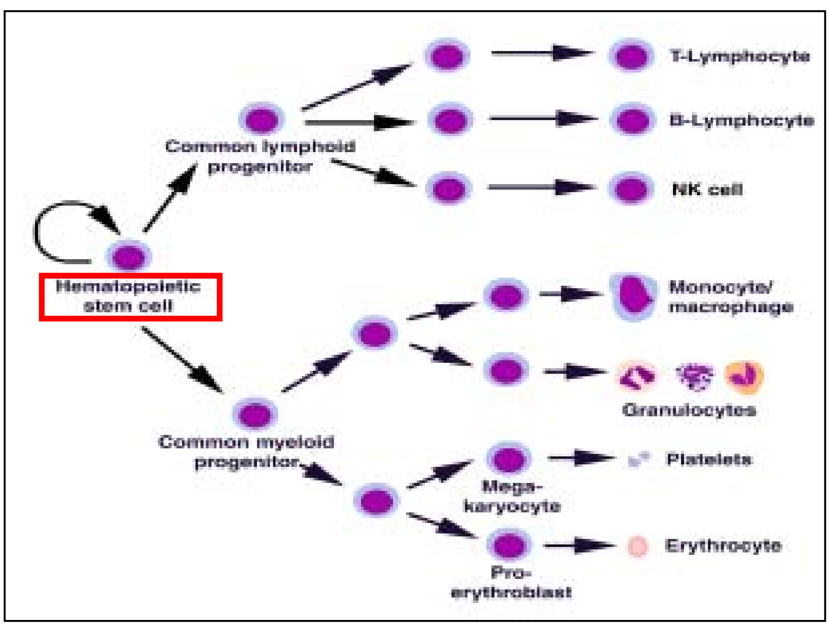
Adult stem cells are stem cells that can be derived from different parts of the body and, depending on where they are from, have different properties. They exist in several different tissues including bone marrow, blood and the brain. Some studies have suggested that adult stem cells are very versatile and can develop into many different cell types.
However, other studies have concluded that adult stem cells are only able to develop into a limited number of cell types related to the tissue that the stem cells originally came from. Although a wealth of information on adult stem cells has already accumulated, scientists still do not understand their specific properties well. Research continues with the hope of one day being able to use these cells to restore or replace damaged tissues or organs.

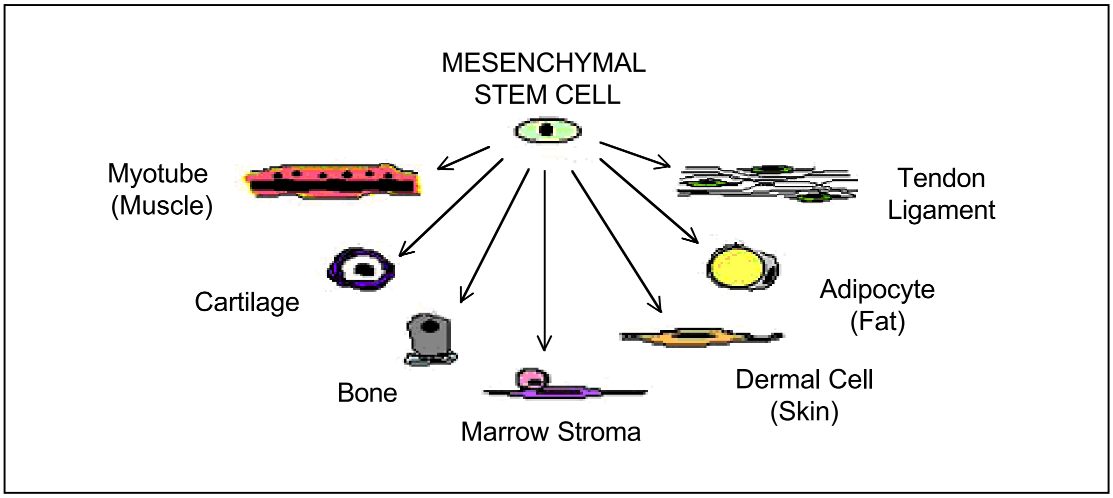
Hematopoietic stem cells are adult stem cells found mainly in the bone marrow and they provide the blood cells required for daily blood turnover and for fighting infections. Compared to adult stem cells from other tissues, hematopoietic stem cells are easy to obtain, as they can be either aspirated directly out of the bone marrow or stimulated to move into the peripheral blood stream, where they can be easily collected.

Hematopoietic stem cells have been studied by scientists for many years, and they were the first stem cells to be used successfully in therapies. Hematopoietic stem cells have been used for decades to treat blood cancers (e.g. leukemia) and other blood disorders. More recently, their use in treatment of breast cancer and coronary artery diseases has also been explored.

The potential for hematopoietic stem cells to produce cell types other than blood cells has become the subject of intense scientific controversy, and it is still not clear whether they could be used on a clinical scale to restore tissues and organs other than blood and the immune system.



Hematopoietic Cascade. Illustration of the different cells within the blood that are generated by the hematopoietic stem cells. In murine transplantation experiments it has been demonstrated that one single hematopoietic stem cell can reconstitute an entire mouse which had its blood wiped out entirely, including its own hematopoietic stem cells. This mouse can then live healthily with the new blood generated by one single stem cell.



Mesengenic Lineage. Differentiation potential of human mesenchymal stem cells along the mesengenic lineage.

Mesenchymal stem cells are another well-characterized population of adult stem cells. These cells, also found in the bone marrow, can form a variety of cell in the laboratory, including fat cells, cartilage, bone, tendon and ligaments, muscles cells, skin cells and even nerve cells.

Mesenchymal stem cells have been studied in great detail and scientists have advanced knowledge about how to grow these cells in culture. Unlike most other human adult stem cells, mesenchymal stem cells can be obtained in quantities appropriate for clinical applications, making them good candidates for use in tissue repair. Techniques for isolation and amplification of mesenchymal stem cells in culture have been established and the cells can be maintained and propagated in culture for long periods of time, without loosing their capacity to form all the above cell types.

The ease of culture has facilitated the characterization of mesenchymal stem cells, and scientists are making rapid progress in understanding the molecular pathways that regulate their development into different cell types.

Furthermore, mesenchymal stem cells can take up and keep introduced genes, a phenomenon that could be exploited for the delivery of beneficial molecules to targeted locations.

Mesenchymal stem cells can also be frozen to preserve them, and when they are thawed they function apparently normally, thus allowing for future "off-the-shelf" therapy approaches. Animal trials looking at reconstitution of damaged tissues such as cartilage, bone, muscle, heart muscle and tendon using mesenchymal stem cells have shown great promises for human applications.

Perhaps one of the important considerations for human applications is that mesenchymal stem cells can be derived from a small bone marrow sample from a given patient, expanded in culture, and given back to the patient. This would avoid the problems associated with immune rejection of foreign transplanted cells or tissues. Clinical trials are currently underway in several clinical centers, to assess safety and effectiveness of these techniques in humans.

Umbilical cord blood stem cells can be obtained from the umbilical cord immediately after birth. Like bone marrow, umbilical cord blood is another rich source of hematopoietic stem cells. These hematopoietic stem cells are usually referred to as neonatal stem cells and are less mature than those stem cells found in the bone marrow of adults or children.

The advantages of using cord blood as a source of stem cells are its non-invasive procurement and its vast abundance; thousands of babies are born each day. Until recently, umbilical cord blood was discarded after birth, along with the placenta. Now, in several countries around the world, cord blood is collected and either banked in public banks for general use, or stored by private companies for private use, in private cord blood banks.

Cord blood has recently emerged as an alternative source of hematopoietic stem cells for treatment of leukemia and other blood disorders. In these applications, umbilical cord blood has the notable advantage that despite its high content of immune cells, it does not produce strong graft-versus-host disease, a condition where the graft immune cells attack the patient's body cells. Therefore, cord blood grafts do not need to be as rigorously matched to a recipient as bone marrow grafts.

This expands the available donor pool for hematopoietic stem cell transplants considerably. However, a disadvantage of umbilical cord blood, and an argument against generalized use, is the limited number of stem cells in any given cord. This increases the risk of graft failure once transplanted into an adult.

The use of umbilical cord blood stem cells for other uses, such as organ and tissue repair, is under investigation. However, the stem cells themselves would be recognized as foreign and rejected the same way as a transplanted organ, unless the patient's immune system is strongly suppressed, or has been ablated before transplantation, such as is the case prior to bone marrow transplantations.

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