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*Perspective*

# Function of hematopoietic stem cells and blood stem cells

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## DESCRIPTION

Hematopoietic Stem Cells (HSCs) are stem cells that give rise to other blood cells. This process is called hematopoiesis. In vertebrates, the very first terminal HSCs arise from the ventral endothelial wall of the embryonic aorta in the (interstitial) aorta-gonad-mesonephros region by a process known as endothelial-to-hematopoietic transition. In adults, hematopoiesis occurs in the red bone marrow, in the nucleus of most bones. Red bone marrow is derived from a layer of the embryo called the mesoderm.

Hematopoiesis is the process by which all mature blood cells are formed. It must balance the enormous production demands (the average person produces more than 500 billion blood cells each day) with the need to regulate the number of each type of blood cell in circulation. In vertebrates, the vast majority of hematopoietic processes occur in the bone marrow and originate from a limited number of hematopoietic stem cells that are multipotent and capable of extensive self-renewal.

Hematopoietic stem cells give rise to different types of blood cells in lineages called myeloid and lymphoid. Myeloid and lymphoid lines participate in the formation of dendritic cells. Myeloid cells include monocytes, macrophages, neutrophils, basophils, eosinophils, erythrocytes, and megakaryocytes to platelets. Lymphoid cells include T cells, B cells, natural killer cells, and innate lymphoid cells. The definition of hematopoietic stem cells was developed after HSCs were first identified in 1961. Hematopoietic tissue contains cells with long-term and short-term regenerative capacity and committed multipotent, oligopotent, and unipotent progenitors. Hematopoietic stem cells make up 1:10,000 cells of myeloid tissue.

HSC transplantation is used to treat cancer and other disorders of the immune system.

### Function of Blood Stem Cells

**Haematopoiesis:** Hematopoietic stem cells are necessary for hematopoiesis, the formation of cells in the blood. Hematopoietic stem cells can replenish all types of blood cells (ie, are multipotent) and self-renew. A small number of hematopoietic stem cells can expand to give rise to very large numbers of daughter hematopoietic stem cells. This phenomenon is used in bone marrow transplantation, when a small number of hematopoietic stem cells restores the hematopoietic system. This process indicates that symmetric cell division into two daughter hematopoietic stem cells should occur after bone marrow transplantation.

Stem cell self-renewal is thought to occur in the stem cell niche in the bone marrow, and it is reasonable to hypothesize that key signals present in this niche would be important for self-renewal. There is great interest in the environmental and molecular requirements for HSC self-renewal, as understanding the ability of HSCs to self-renew will eventually allow the generation of expanded HSC populations in vitro that can be used for therapeutic purposes.

**Quiescence:** Hematopoietic stem cells, like all adult stem cells, are mostly in a state of rest or reversible growth arrest. Altered metabolism of immobile HSCs helps the cells to survive long periods of time in the hypoxic environment of the bone marrow. Provoked by cell death or damage, hematopoietic stem cells come out of their resting state and begin to divide actively again. The transition from quiescence to proliferation and back is regulated by the MEK/ERK pathway and the PI3K/AKT/mTOR pathway. Dysregulation of these transitions can lead to stem cell exhaustion or the gradual loss of active hematopoietic stem cells in the blood system.

**Mobility:** Hematopoietic stem cells have a higher potential than other immature blood cells to cross the bone marrow barrier and thus can travel in the blood from the bone marrow to one bone to another. When they settle in the thymus, they can turn into T cells. In the case of fetuses and other extramedullary hematomas. Hematopoietic stem cells can also settle in the liver or spleen and develop.

This allows obtaining hematopoietic stem cells directly from the blood.

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