

Hematopoietic stem cells

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Stem Cell class for postgraduate Students

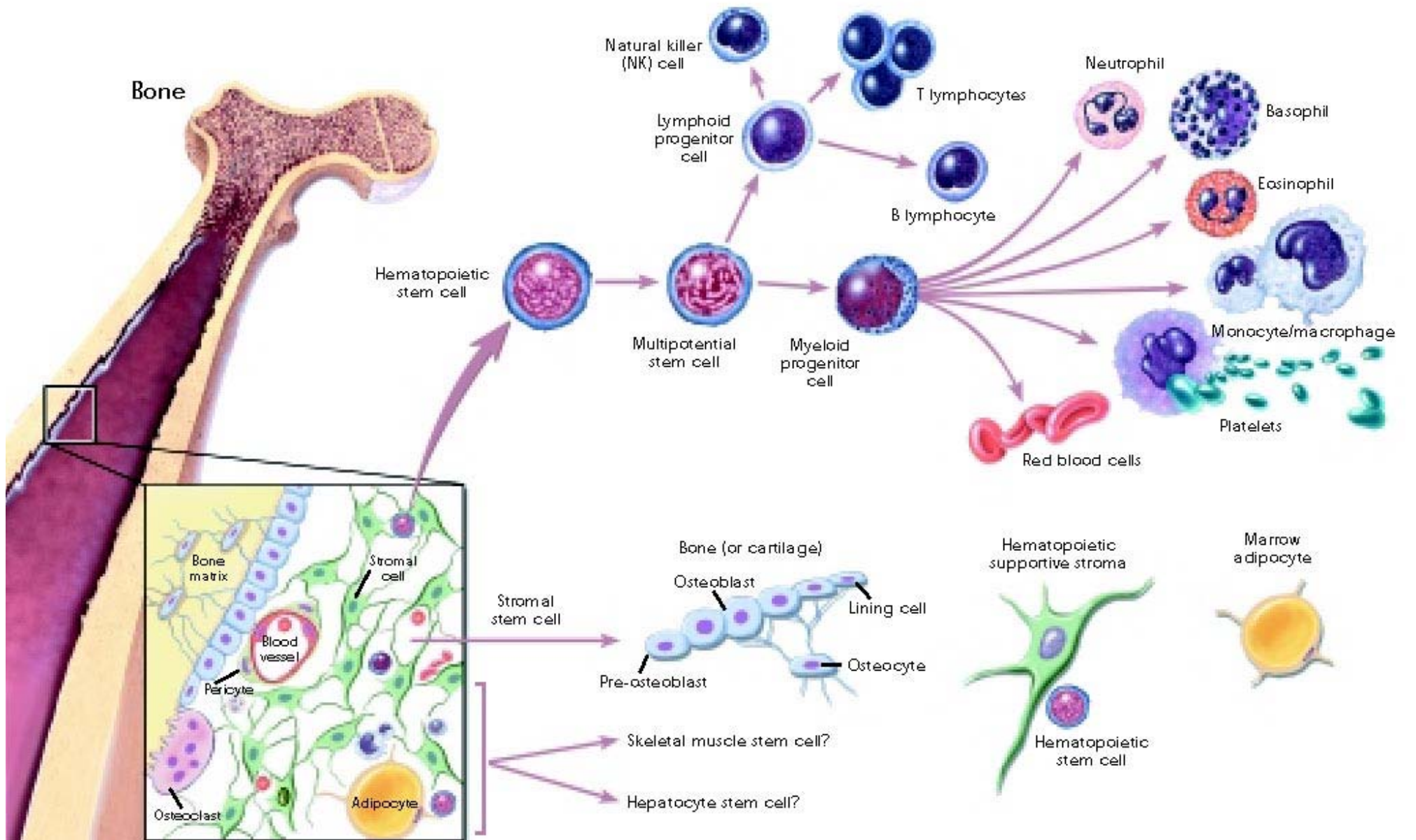
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<https://stemcells.nih.gov/info/2001report/chapter5.htm>

- The stem cells that form blood and immune cells are known as hematopoietic stem cells (HSCs). They are ultimately responsible for the constant renewal of blood—the production of billions of new blood cells each day. Physicians and basic researchers have known and capitalized on this fact for more than 50 years in treating many diseases. The first evidence and definition of blood-forming stem cells came from studies of people exposed to lethal doses of radiation in 1945.

What Is a Hematopoietic Stem Cell?

- 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



cell-surface markers of undifferentiated hematopoietic stem cells.

listed here are cell surface markers found on mouse and human hematopoietic stem cells as they exist in their undifferentiated state *in vivo* and *in vitro*. As these cells begin to develop as distinct cell lineages the cell surface markers are no longer identified.

Mouse	Human
CD34 ^{low/-}	CD 34 ⁺
SCA-1 ⁺	CD59 ⁺ *
Thy1 ^{+/low}	Thy1 ⁺
CD38 ⁺	CD38 ^{low/-}
C-kit ⁺	C-kit ^{-/low}
lin ⁻ *	lin ⁻ **

* Only one of a family of CD59 markers has thus far been evaluated.

** Lin⁻ cells lack 13 to 14 different mature blood-lineage markers.

What Are the Sources of Hematopoietic Stem Cells?

- **Bone Marrow**

- The classic source of hematopoietic stem cells (HSCs) is bone marrow. For more than 40 years, doctors performed bone marrow transplants by anesthetizing the stem cell donor, puncturing a bone—typically a hipbone—and drawing out the bone marrow cells with a syringe. About 1 in every 100,000 cells in the marrow is a long-term, blood-forming stem cell; other cells present include stromal cells, stromal stem cells, blood progenitor cells, and mature and maturing white and red blood cells.

Peripheral Blood

- doctors now prefer to harvest donor cells from peripheral, circulating blood.
- It has been known for decades that a small number of stem and progenitor cells circulate in the bloodstream,
- but in the past 10 years, researchers have found that they can coax the cells to migrate from marrow to blood in greater numbers by injecting the donor with a cytokine, such as granulocyte-colony stimulating factor (GCSF).
- The donor is injected with GCSF a few days before the cell harvest.
- To collect the cells, doctors insert an intravenous tube into the donor's vein and pass his blood through a filtering system that pulls out CD34+ white blood cells and returns the red blood cells to the donor.
- Of the cells collected, just **5 to 20 percent will be true HSCs**. Thus, when medical researchers commonly refer to peripherally harvested "stem cells," this is something of a misnomer. As is true for bone marrow, the CD34+ cells are a mixture of stem cells, progenitors, and white blood cells of various degrees of maturity.

Umbilical Cord Blood

- Since the first successful umbilical cord blood transplants in children with Fanconi anemia,
- **Fanconi anemia is a condition that affects many parts of the body. People with this condition may have bone marrow failure, physical abnormalities, organ defects, and an increased risk of certain cancers. The major function of bone marrow is to produce new blood cells.**
- the collection and therapeutic use of these cells has grown quickly. The New York Blood Center's Placental Blood Program, supported by NIH, is the largest U.S. public umbilical cord blood bank and now has 13,000 donations available for transplantation into small patients who need HSCs. Since it began collecting umbilical cord blood in 1992, the center has provided thousands of cord blood units to patients. Umbilical cord blood recipients—typically children—have now lived in excess of eight years, relying on the HSCs from an umbilical cord blood transplant.

- There is a substantial amount of research being conducted on umbilical cord blood to search for ways to expand the number of HSCs and compare and contrast the biological properties of cord blood with adult bone marrow stem cells.
- There have been suggestions that umbilical cord blood contains stem cells that have the capability of developing cells of multiple germ layers (multipotent) or even all germ layers, e.g., endoderm, ectoderm, and mesoderm (pluripotent).
- To date, there is no published scientific evidence to support this claim.
- While umbilical cord blood represents a valuable resource for HSCs, research data have not conclusively shown qualitative differences in the differentiated cells produced between this source of HSCs and peripheral blood and bone marrow.
- <http://stemcells.nih.gov/info/scireport/pages/chapter5.aspx>

- Thank you