Hematopoiesis

- All blood cells arise from a type of cell called the **hematopoietic stem cell (HSC).**
- **Stem cells** are cells that can differentiate into other cell types; they are self-renewing—they maintain their population level by cell division.
- In humans, **hematopoiesis,** the formation and development of red and white blood cells, begins in the embryonic yolk sac during the first weeks of development.
- In the third month of gestation, hematopoietic stem cells migrate from the yolk sac to the fetal liver and then to the spleen; these two organs have major roles in hematopoiesis from the third to the seventh months of gestation.
- After that, the differentiation of HSCs in the bone marrow becomes the major factor in hematopoiesis, and by birth there is little or no hematopoiesis in the liver and spleen.
- A hematopoietic stem cell is *multipotent,* or *pluripotent,* able to differentiate in various ways and thereby generate erythrocytes, granulocytes, monocytes, mast cells, lymphocytes, and megakaryocytes.
- These stem cells are few, normally fewer than one HSC per 5 X10^4 cells in the bone marrow.

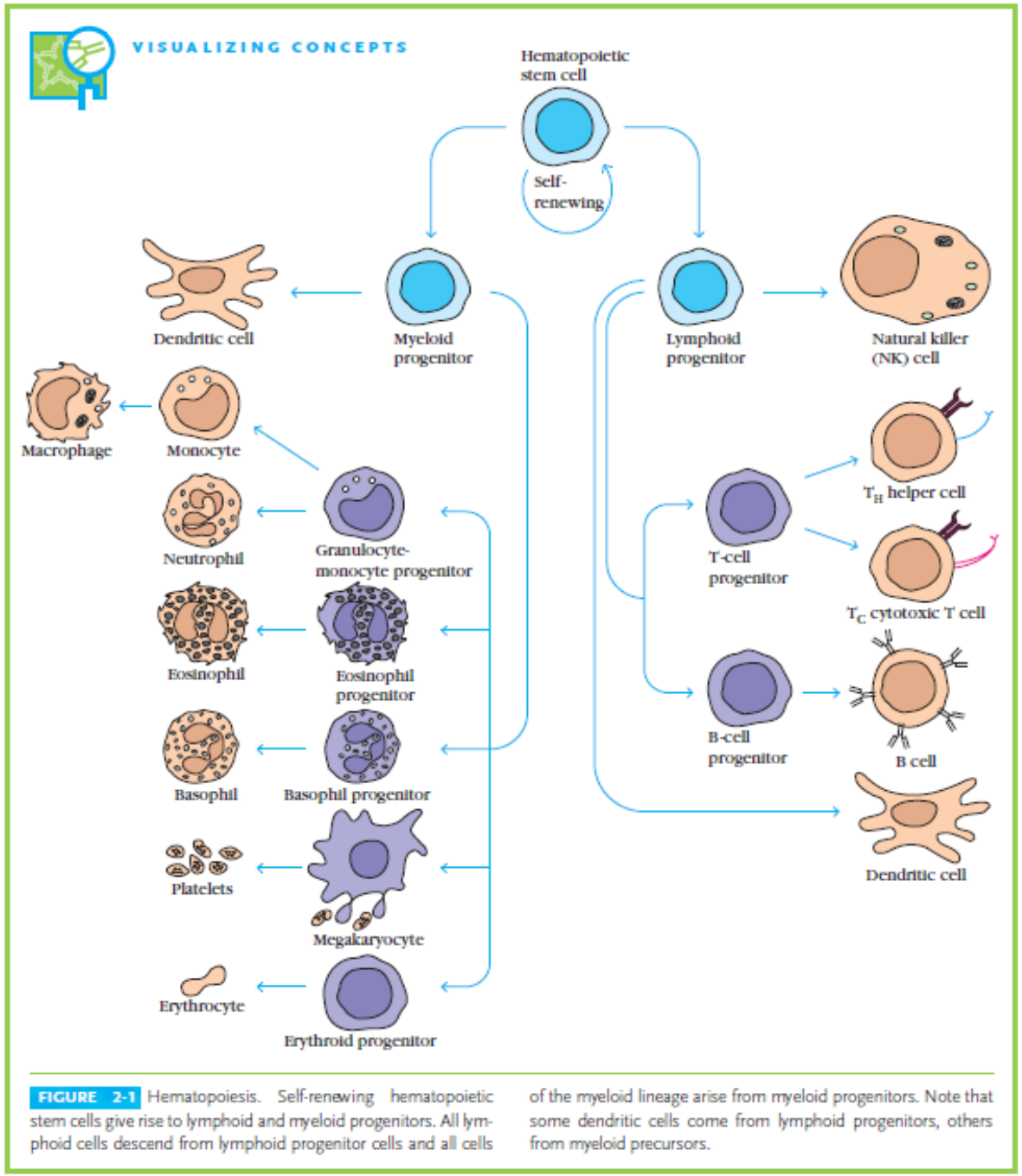

FIGURE 2-1 Hematopoiesis. Self-renewing hematopoietic stem cells give rise to lymphoid and myeloid progenitors. All lymphoid cells descend from lymphoid progenitor cells and all cells of the myeloid lineage arise from myeloid progenitors. Note that some dendritic cells come from lymphoid progenitors, others from myeloid precursors.

- The types and amounts of growth factors in the microenvironment of a particular stem cell or progenitor cell control its differentiation.

- When the appropriate factors and cytokines are present, progenitor cells proliferate and differentiate into the corresponding cell type, either a mature erythrocyte, a particular type of leukocyte, or a platelet-generating cell (the megakaryocyte).

- Red and white blood cells pass into bone marrow channels, from which they enter the circulation.

- In bone marrow, hematopoietic cells grow and mature on a meshwork of stromal cells, which are nonhematopoietic cells that support the growth and differentiation of hematopoietic cells.

- Stromal cells include fat cells, endothelial cells, fibroblasts, and macrophages. Stromal cells influence the differentiation of hematopoietic stem cells by providing a hematopoietic-inducing microenvironment (HIM) consisting of a cellular matrix and factors that promote growth and differentiation.

- During infection, hematopoiesis is stimulated by the production of hematopoietic growth factors by activated macrophages and T cells.

TABLE 2-1 Some transcription factors essential for hematopoietic lineages

Factor	Dependent lineage
GATA-1	Erythroid
GATA-2	Erythroid, myeloid, lymphoid
PU.1	Erythroid (maturational stages), myeloid (later stages), lymphoid
BM11	Myeloid, lymphoid
Ikaros	Lymphoid
Oct-2	B lymphoid (differentiation of B cells into plasma cells)