

Vertebrate Immune Cells

Based on Janeway's Immunobiology 10th edition

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1 Hematopoietic Stem Cells

Cells of the immune system mostly emerge from the bone marrow while some may mature elsewhere. For example, T cells mature in the thymus gland to undergo positive testing for MHC binding. Some tissue-resident macrophage and lymphocyte originate from the yolk sac and fetal liver during embryonic development and are maintained throughout life as independent, self-renewing populations.

Differentiation

Below is a summarised step-by-step process by which differentiation occurs.

1. Core Progenitor Branch

- Long-term HSCs (LT HSCs) – Perpetual self-renewal in the bone marrow, fully quiescent except when triggered by injury
- Short-term HSCs (ST HSCs) – Active stem cells with limited self-renewal capacity

2. Multipotent Progenitor (transition)

- Immediate descendent of core stem cells, no ability to self-renew

3. Oligopotential Branches

(a) Common Myeloid Progenitor (CMP)

- Gives rise to all Myeloid cells (red blood cells, platelets, and various infection-fighting white blood cells)
- Megakaryocyte/Erythrocyte Progenitor (MEP) – Red blood cells, platelets
- Granulocyte/Macrophage Progenitor (GMP) – Neutrophils, Eosinophils, and Basophils, Monocytes

(b) Common Lymphoid Progenitor (CLP)

- Gives rise to all Lymphoid cells (T cells, B cells, Natural Killer cells, some dendritic cells)

- Forms both adaptive + innate immune system

4. Terminal Differentiation

From CMP:

- Erythrocytes – Red blood cells created via erythropoiesis for oxygen transport.
- Megakaryocytes – Large precursor cells that fragment to create Platelets (Thrombocytes) for blood clotting.
- Granulocytes – Innate white blood cells packed with microscopic granules (Neutrophils, Eosinophils, Basophils).
- Monocytes/Macrophages – Large frontline immune cells specialized in engulfing pathogens.

From CLP:

- B cells – Adaptive immune cells that produce targeted antibodies.
- T cells – Adaptive immune cells that coordinate defenses and destroy infected host cells.
- NK cells – Innate cytotoxic cells that rapidly target viruses and tumors.

5. Regulatory factors (chemical messengers)

- External Growth Factors (GF) and Interleukins (ILs) – General signaling proteins that trigger overall cell maturation. e.g. Erythropoietin, Thrombopoietin, IL-3, IL-6, and IL-7
- Microenvironmental Regulators

