Basic Principles of Immunology

Understanding of immunity date to 1798, when the English physician Edward Jenner (1749-1823) published a report that people could be protected from deadly small pox by sticking them with a needle dipped in the pus from a cowpox boil. The great French biologist and chemist Louis Pasteur (1822-1895) theorized that such immunization protects people against disease by exposing them to a version of a microbe that is harmless but is enough like the disease-causing organism, or pathogen, that the immune system learns to fight it. Modern vaccines against diseases such as measles, polio, and chicken pox are based on this principle.

In the late nineteenth century, a scientific debate was waged between the German physician Paul Ehrlich (1854-1915) and the Russian zoologist Elie Metchnikoff (1845-1916). Ehrlich and his followers believed that proteins in the blood, called antibodies, eliminated pathogens by sticking to them; this phenomenon became known as humoral immunity. Metchnikoff and his students, on the other hand, noted that certain white blood cells could engulf and digest foreign materials: this cellular immunity, they claimed, was the real way the body fought infection.

Modern immunologists have shown that both the humoral and cellular responses play a role in fighting disease. They have also identified many of the actors and processes that form the immune response.

Fundamentals of Blood Cell Biology

The modern word "immunity" derives from the **Latin** *immunis*, meaning exemption from military service, tax payments or other public services.
Immunology; is the study of the way in which the body defends itself from infectious agents and other foreign substances in environment. Its include physical barriers like skin, protective chemical substances in the blood and tissue fluids, and the physiological reaction of tissue to injury or infection, but most dynamic and effective defence strategies are carried out by cells that have evolved specialized abilities to recognize and eliminate potentially infectious substances. Some of these cells circulate continually through the

body in search of foreign invaders; others are sentinels and lie in wait in solid tissue or at body surfaces.

All specialized defensive cells have two things in common: They all spend at least part of their lives in blood stream, and they all derived from cells produced in the bone marrow.

Hematopoiesis: The process by which blood cell generated, grow, divided, and differentiated in the bone marrow.

Three general classes of cells are produced:

1- Red blood cells (erythrocytes): responsible for oxygen transport.

2- Platelets: responsible for the control of bleeding.

3- White blood cells (leukocytes): which involved in host defence.

All three classes are hematopoitic stem cells (HSCs) which reside in the marrow and have the unique ability to give rise to all of different mature blood cell types, under the appropriate conditions. Both myeloid and lymphocytes are critical to host defence.

Myeloid account 60%, lymphoid 15%, while erythroid 25% of marrow cells.

The myeloid progenitor (stem) cell in the bone marrow gives rise to erythrocytes, platelets, neutrophils, monocytes/macrophages and dendritic cells whereas the lymphoid progenitor (stem) cell gives rise to the NK, T cells and B cells. For T cell development the precursor T cells must migrate to the thymus where they undergo differentiation into two distinct types of T cells, the CD4+ T helper cell and the CD8+ pre-cytotoxic T cell. Two types of T helper cells are produced in the thymus the TH1 cells, which help the CD8+ pre-cytotoxic cells to differentiate into cytotoxic T cells, and TH2 cells, which help B cells, differentiate into plasma cells, which secrete antibodies.

The HSCs are self-renewing cells, when they proliferate at least some of their daughter cells remains as HSCs, so that the pool of stem cells dose note becomes depleted.

Both self-replicating of HSCs and their ability to produce differentiated cells depend on hormonal growth factor called cytokines (group of polypeptides, secreted by both hematopoietic and non hematopoietic cell) many cytokines have specific effect on growth, differentiation, survival, or function of blood cells.

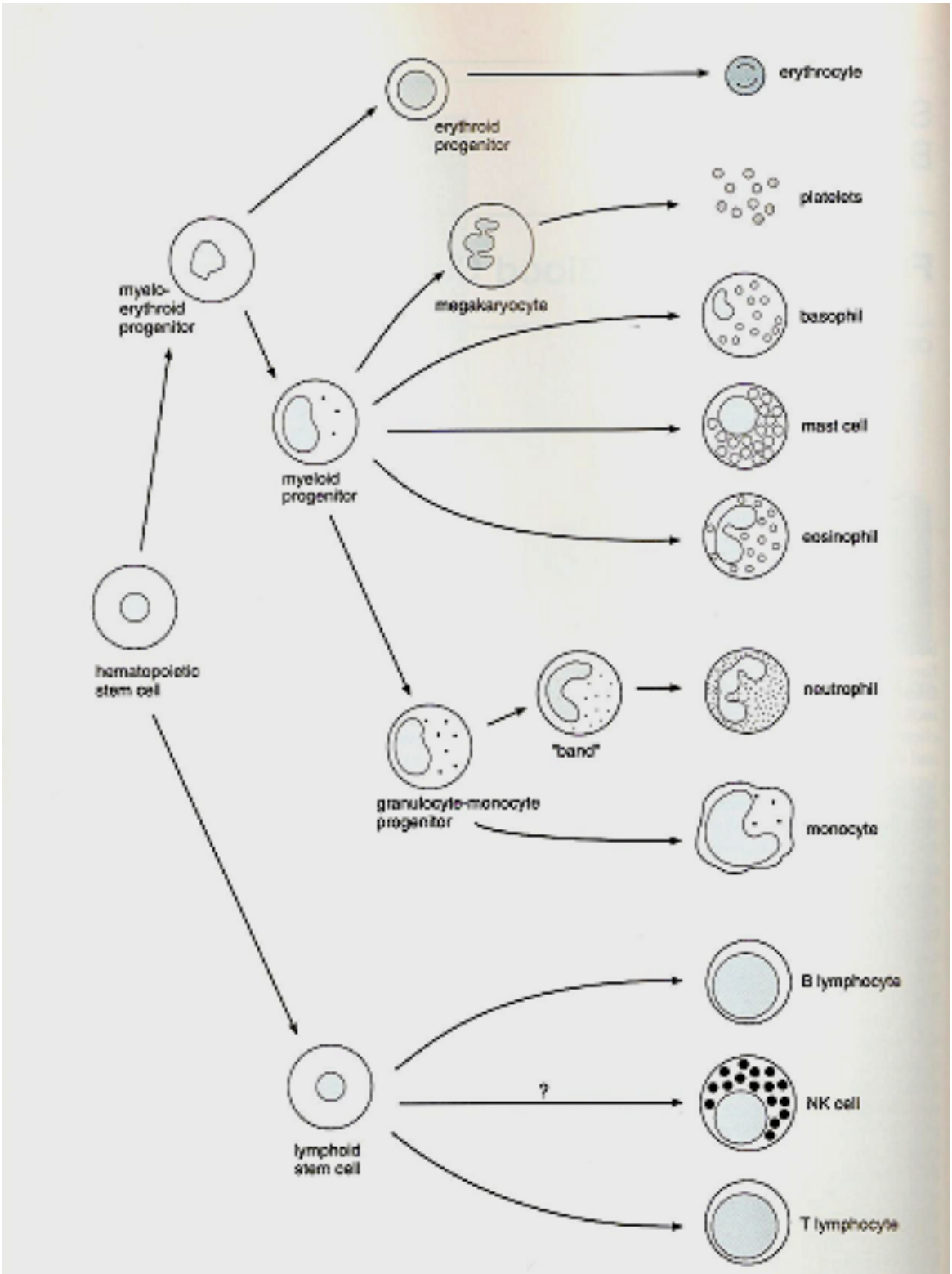

Figure 1–1. Schematic overview of hematopoiesis, emphasizing the erythroid, myeloid, and lymphoid pathways. This highly simplified depiction omits many recognized intermediate cell types in each pathway. All of the cells shown here develop to maturity in the bone marrow except T lymphocytes, which develop from marrow-derived progenitors that migrate to the thymus (see Chapter 3). A common lymphoid stem cell is believed to exist but has not yet been isolated. The histogenesis of natural killer (NK) cells is unknown.

Ontogeny of hematopoiesis

HSCs arise in the mesoderm of the yolk sac during the first week of embryonic life. Within 2 months most HSCs migrate to fetal liver and its here bulk of hematopoiesis occurs. Most embryonic and fetal hematopoisis is devoted to the production of RBC, platelet production appears at 3 months of gestation and the leukocytes do not appear until the fifth month. Later HSCs begin to colonize in developing bone marrow cavities throughout the skeleton that contain a network of epithelial cell which provide necessary environment for growth and differentiation of HSC and their progeny. By birth, all of the bone marrow occupied by developing hematopoietic cells, hematopoietic activity in the long bones then declines with age, so that after puberty it's largely confined to the axial skeleton (The pelvis, sternum, ribs, vertebrae, and skull).

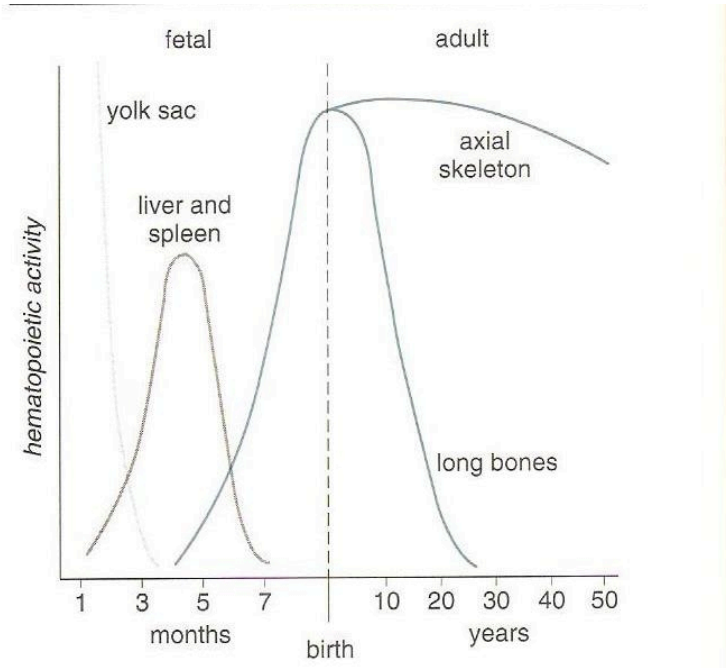

Figure 1–2. Tissue localization of hematopoiesis at various phases of prenatal and postnatal development in humans.

If the bone marrow is injured by infection or malignancy or altered hematopoiesis can resume in the liver and spleen of an adult to maintain the supply of blood cells.