HEMATOLOGY & HEMOSTASIS ACADEMY

## Section 5

# WHITE BLOOD CELLS

### LEARNING OBJECTIVES

**When you complete this section, you will be able to:**

1. **Recognize descriptions of the various WBCs**
2. **Indicate their primary functions**

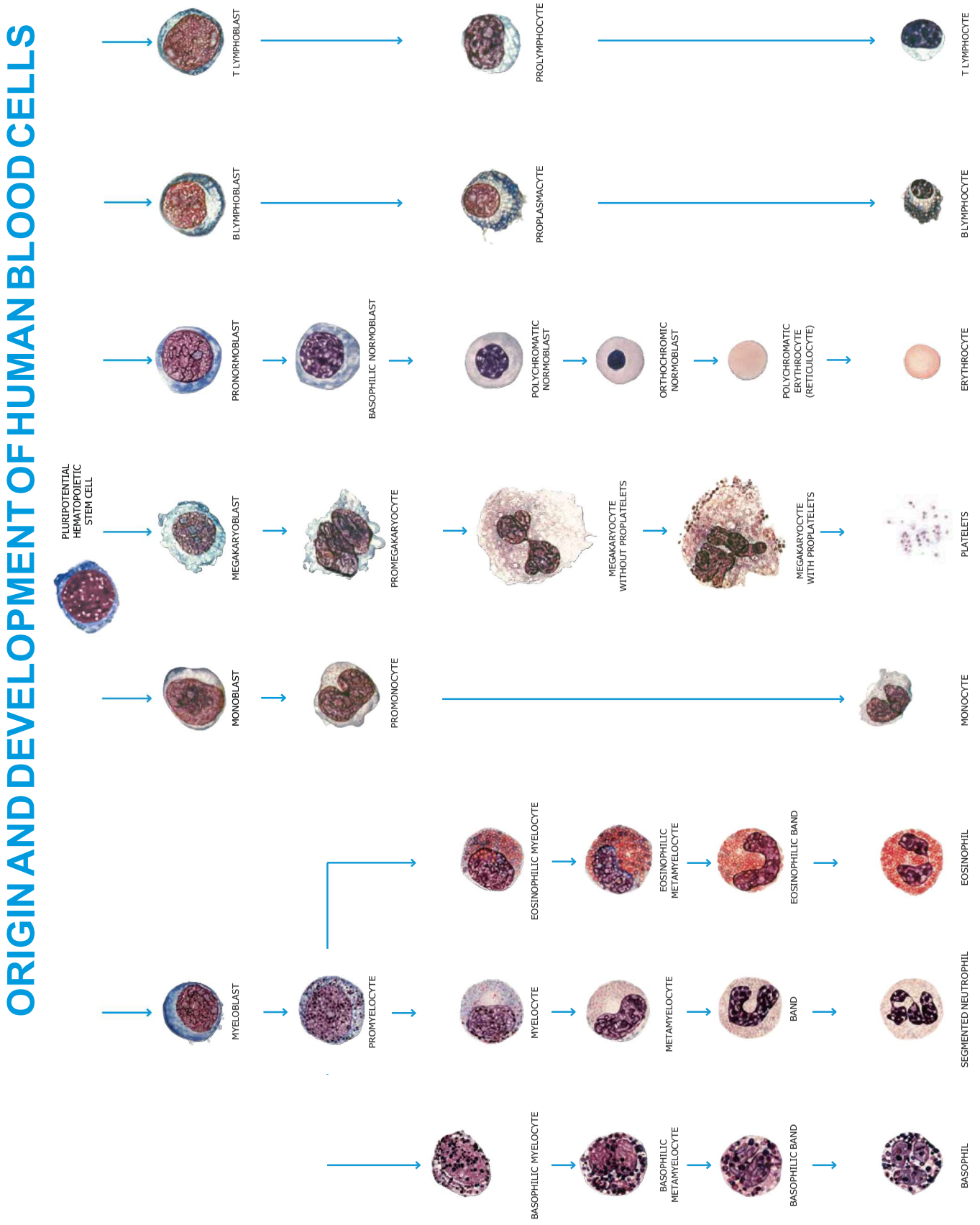



**Figure 4.** The developmental progression of WBCs, RBCs and platelets.

# GRANULOCYTES

Granulopoiesis is the formation of granulocytes, the most numerous white cell. As a granulocyte matures, the cell nucleus undergoes many changes; it shrinks, indents, assumes a band form, and segments. Granules containing enzymes and antibacterial agents appear; they are clearly evident in **Figure 5**. Myelocytes are distinguished according to the staining characteristics of their granules: neutrophilic, eosinophilic, and basophilic. Mature granulocytes are polymorphonuclear cells (PMNs) (sometimes called polys).

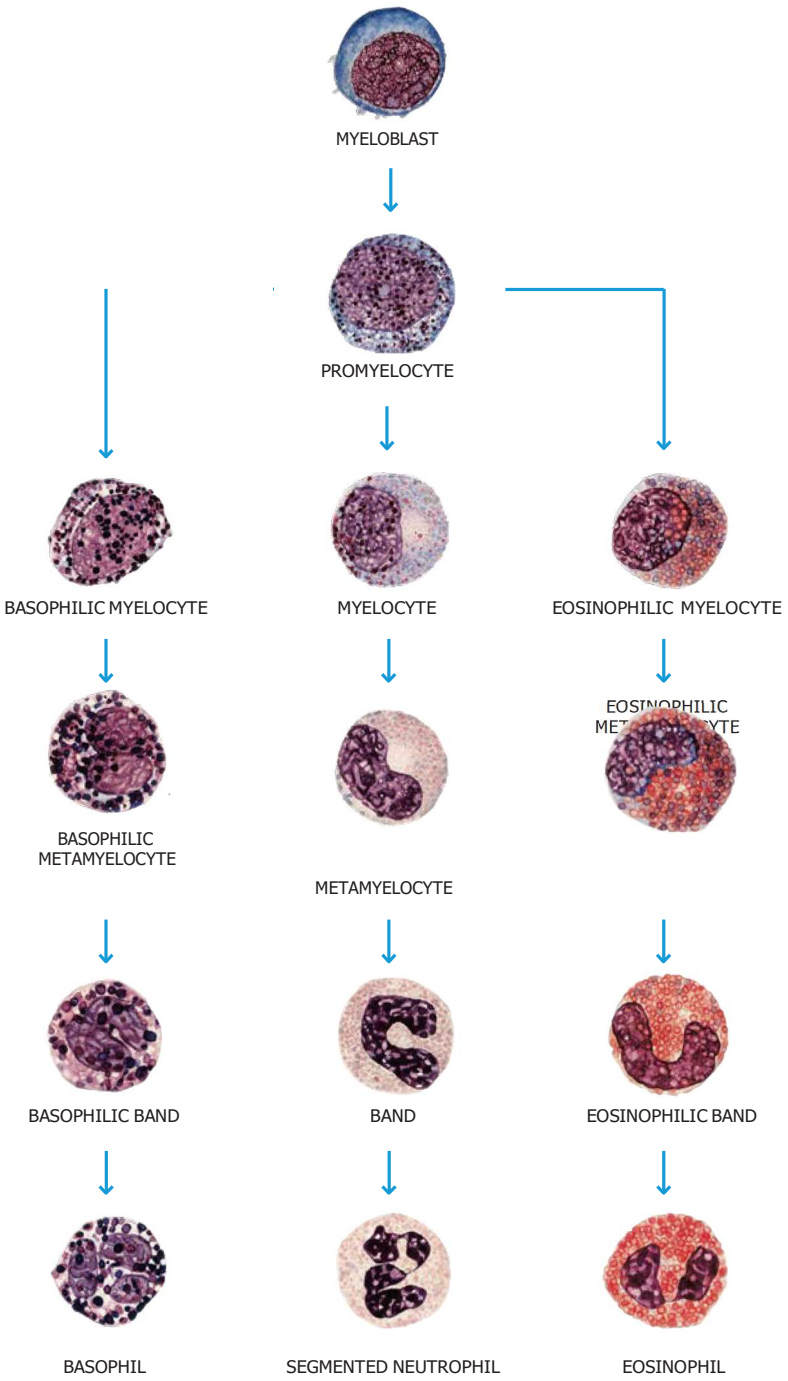



**Figure 5.** Granulocytes. Granules are evident in each cell. C-F are basophils, G-J are neutrophils, and K-N are eosinophils. E, I, and M are band forms. F, J, and N are segmented forms.

Normally, granulocytes are regulated at a constant level. During infection, the number of granulocytes rises dramatically.

**Functions of Granulocytes.** Neutrophils seek out and kill bacteria – a process called phagocytosis (see below). Eosinophils attack some parasites and inactivate mediators released during allergic reactions. Basophils contain histamine and are important in immunity and hypersensitivity reactions; they also contain heparin (an anti-clotting substance), but their role in blood clotting is uncertain.

# QUICK REVIEW: PHAGOCYTOSIS

| MEANING | LITERALLY, CELL EATING |
|---|---|
| Cells | Phagocytes – neutrophils (PMNs, polys), macrophages |
| Process | Foreign substances (antigens) invade |
| Chemotaxis | Plasma factors (including lymphocytes and basophils) attract phagocytes to the invaded area |
| Opsonization | Plasma factors (immunoglobulins) coat antigens to make them "tasty" for phagocytes |

Phagocytes bind to and ingest antigens. (Neutrophils can ingest 5-25 bacteria before dying; macrophages live longer because they can extrude toxic substances.)

# MONOCYTES/MACROPHAGES

After a short time in the blood, monocytes **(Figure 6)** enter tissue, grow larger, and become tissue macrophages. Once it was incorrectly thought that endothelial cells (cells lining blood vessels) performed the same function as macrophages. This is the origin of the name reticuloendothelial system (RES); macrophage system is more accurate.

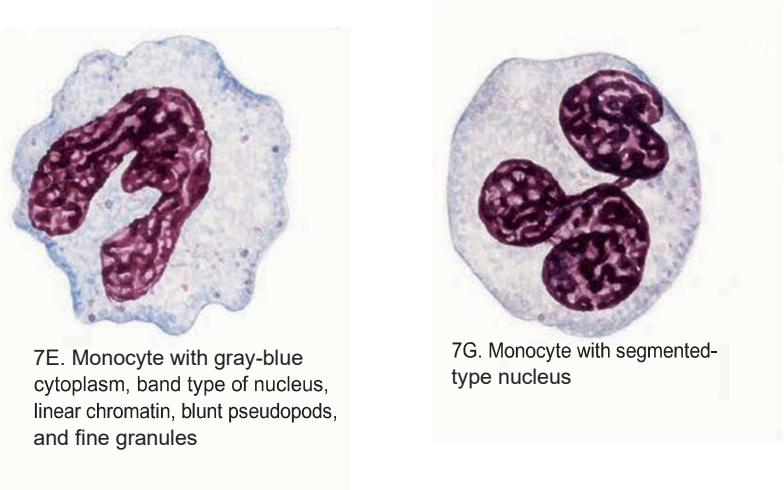
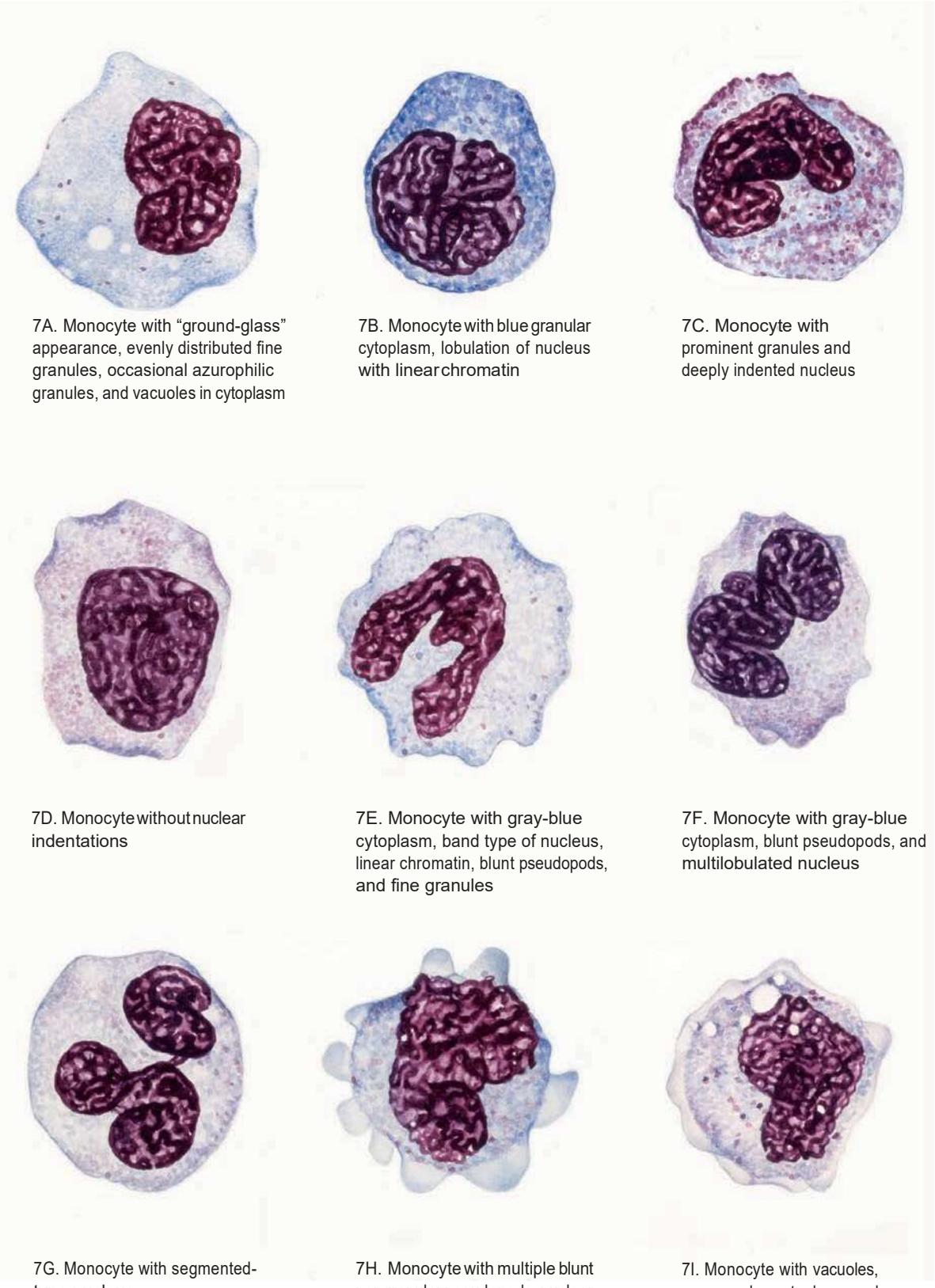



**Figure 6.** Monocytes. E = band form. G = segmented form.



7A. Monocyte with "ground-glass" appearance, evenly distributed fine granules, occasional azurophilic granules, and vacuoles in cytoplasm

7B. Monocyte with blue granular cytoplasm, lobulation of nucleus with linear chromatin

7C. Monocyte with prominent granules and deeply indented nucleus

7D. Monocyte without nuclear indentations

7E. Monocyte with gray-blue cytoplasm, band type of nucleus, linear chromatin, blunt pseudopods, and fine granules

7F. Monocyte with gray-blue cytoplasm, blunt pseudopods, and multilobulated nucleus

7G. Monocyte with segmented-type nucleus

7H. Monocyte with multiple blunt nongranular pseudopods, nuclear indentations, and folds

7I. Monocyte with vacuoles, nongranular ectoplasm, and granular endoplasm

**Figure 7.** Large and small lymphocytes.

Activated by the immune system, macrophages are the body's first line of defense. Powerful and long-lived, macrophages can ingest large particles – whole RBCs, parasites, bacteria – and rid the body of dead or damaged cells and other debris. Macrophages fixed in tissue often look different and have different names, e.g., Kupffer cells in the liver are macrophages.

**Macrophages and Neutrophils.** Areas of inflammation attract both macrophages and neutrophils. The few tissue macrophages present begin to attack invaders. Within a few hours, the second line of defense appears: the number of neutrophils in the blood increases substantially as substances in the blood stimulate bone marrow to release stored neutrophils. The third line and the long-term chronic defense is the proliferation of macrophages by cell reproduction in the tissue, by attracting monocytes from the blood, and by increased production of monocytes.

| QUICK REVIEW: CELLS OF THE RES OR TISSUE MACROPHAGE SYSTEM | |
|---|---|
| **DESCRIPTIONS** | **LOCATIONS** |
| Fixed macrophages: (reticulum cells) large cells, small nucleus | Spleen, lymph nodes, bone marrow, liver, skin (histiocytes), lungs (macrophages), etc. |
| Free macrophages: large wandering cells | Spleen, lymph nodes, lungs,many other tissues |
| Circulating monocytes: large, motile cells with indented nuclei | Blood |

**Table 5.** Cells of the RES or tissue macrophage system.

# LYMPHOCYTES PLAY A KEY ROLE IN IMMUNITY (Figure 7)

**T lymphocytes (T cells)**. Involved in cellular immunity, T cells carry receptors for molecules on other cells or in body fluids. T cell receptors allow them to interact with macrophages and other cells and substances in the body. T cells defend against foreign substances such as viruses that invade body cells, fungi, parasites, transplanted tissue, and cancer cells. Through a variety of T cells (helper T cells, suppressor T cells), the body initiates, carries through, and terminates antigen-antibody reactions to provide immunity.

**B lymphocytes (B cells)** are involved in humoral immunity, which consists of antibodies circulating in the blood and lymphatic system. B lymphocytes produce antibodies typically against bacteria and viruses.

Example: AIDS. In AIDS (acquired immune deficiency syndrome), the virus (HIV) infects the helper T lymphocyte cells and destroys them. It can also pass unrecognized from cell to cell by changing the surface of helper T cells. HIV may lie dormant until another infection triggers T cells to increase and the virus to multiply. With HIV, not only is part of the body's defense system lost, but the very cells that should defend the body are working against it.