Chapter 9-16: The Immune System

The immune system is responsible for defending the body against bacterial and viral invasion and also provides long-term immunity to disease. The cells and other agents of the immune system are located in the lymphatic system, throughout the lymph nodes, spleen, tonsils, and other lymph-associated organs. In this plate, we present a brief overview of the immune process, and show how it relates to the lymphatic system. This is the domain of immunology and is much more complex than this plate depicts.

As you review the plate, note that we are presenting a series of events that take place in the course of an immune response. Here anatomical features are of less consequence than is the process itself. Medium light colors would be best for most of the cells and structures shown, as well as the arrows used to indicate passage from one cell group to another.

The immune system is made up of a complex series of cells, chemical factors, and organs. The cells of the immune system originate in the **bone (A)**. During the fetal stage of human development, a series of primitive cells called stem cells emerges within **bone marrow (A_1)**. These stem cells develop into the cells of the immune system.

In the fetus, some of the stem cells develop into **immature T-lymphocytes (B)**, which migrate to the **thymus gland (C)**, where they mature, leaving as **mature T-lymphocytes (D_1)**. Some of the emerging cells become **helper T-lymphocytes (D_2)**. Both types of lymphocytes have a number of chemical complexes called **T-lymphocyte receptors (D_3)** on their membranes. The T-lymphocytes gather in the **lymphatic tissue of the lymph nodes (a)**. You should color the bracket that indicates this tissue.

Some of the stem cells follow a different route, maturing in the fetus in the bone marrow, liver, and other areas of the body to become **mature B-lymphocytes (H)**. The B-lymphocytes also migrate to the lymphatic tissue and replicate, forming clusters of cells. The lymphatic tissues are pointed out in the previous plate on the lymphatic system, and you should refer to it if you feel you need to review. The T-lymphocytes and B-lymphocytes are the fundamental participants in the immune process.

Having explored the origin of the immune system, we now turn to its activity. We will discuss the major aspects of its activity in sequence. Our initial focus will be on T-lymphocytes. Color the appropriate sections as you read along.

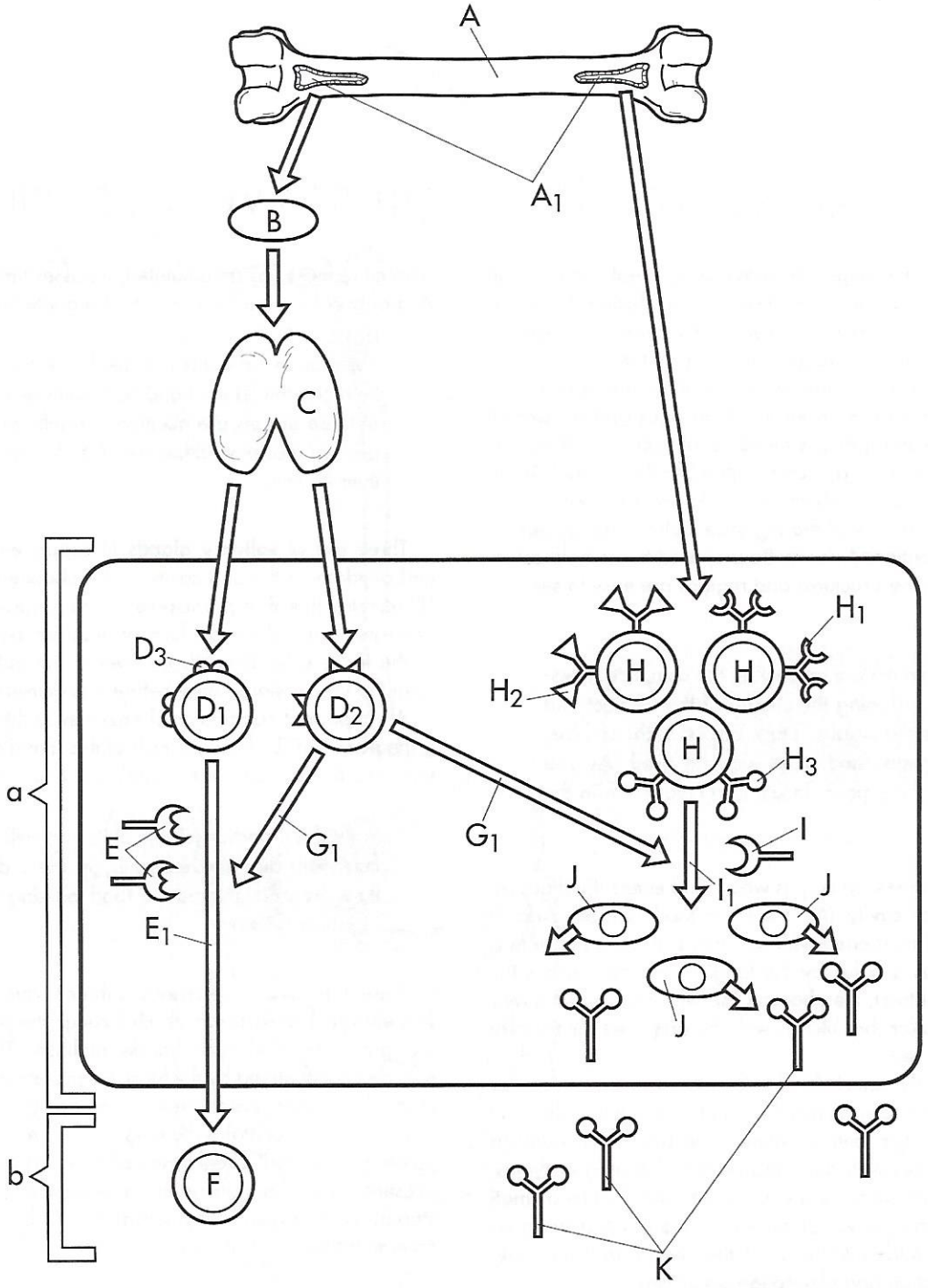
The T-lymphocytes are stimulated by antigens, which are chemical substances that are foreign to the body. Antigens include virus-infected cells, transplant tissue, cancer cells, and large microorganisms such as fungi and protozoa. These substances have **antigens for T-lymphocytes (E)**. Note that the antigens are complementary to the T-lymphocyte receptors (D_3). A reaction takes place on the surface of the T-lymphocyte, and there is **activation of the T-lymphocyte (E_1)**. The cell develops into a cell called a **cytotoxic T-lymphocyte (F)**. This activation is encouraged by the helper T-lymphocyte through a process called **helper assistance (G_1)**.

Once cytotoxic T-lymphocytes are formed, they enter the **circulation (b)**. Numerous cells move through the circulation until they locate foreign objects or antigens. T-lymphocytes unite with and destroy the cells in a process known as cell-mediated immunity, and abbreviated as CMI.

In the second part of the plate, we take a look at the second process of immunity, known as antibody-mediated immunity. As you will see, there is no cell-to-cell interaction here. Continue coloring as

Antigens in the form of bacteria, viruses, and foreign chemicals enter the body and stimulate the mature B-lymphocytes (H) in the lymphatic tissue. The **antigen (I)** does this by selecting, from a number of different B-lymphocytes, the one that has complementary receptors. Note that the **B-lymphocyte receptor (H_3)** complements the antigen. The cells then undergo **activation of the B-lymphocyte (I_1)**.

When the B-lymphocytes are activated, they transform into protein-secreting cells called **plasma cells (J)**. Plasma cells secrete enormous numbers of **antibody molecules (K)**, which are strands of protein that enter the circulation (b). They travel to the sites of the virus, bacteria, or other antigen, and their thick strands bind to them, rendering them inactive. Soon, large clumps of microorganisms accumulate and phagocytes come along and engulf and destroy them. Specific defense to disease is provided by this process, known as antibody-mediated immunity, or AMI. Antibodies remain in the circulation for years, which brings about long-term immunity.



The Immune System

- Bone ..... A
- Bone Marrow ..... A_1
- Immature T-lymphocytes ..... B
- Thymus Gland C
- Mature T-lymphocytes .. D_1
- Helper T-lymphocytes .. D_2
- T-lymphocyte Receptors ..... D_3
- Antigens for T-lymphocytes ..... E
- Activation of T-lymphocyte ..... E_1
- Cytotoxic T-lymphocyte ..... F
- Helper Assistance .... G_1
- Mature B-lymphocytes .. H
- B-lymphocyte Receptor ..... H_1
- B-lymphocyte Receptor ..... H_2
- B-lymphocyte Receptor ..... H_3
- Antigen for B-lymphocyte I
- Activation of B-lymphocyte ..... I_1
- Plasma Cells ..... J
- Antibody Molecules .... K
- Lymphatic Tissue ..... a
- Circulation ..... b