There are two types of lymphoid tissues

The lymphoid system is traditionally divided into primary and secondary lymphoid tissues. **Primary lymphoid tissues** are the tissues in which lymphocytes are generated and differentiate into mature naïve lymphocytes: these are the bone marrow for B cells, and the bone marrow and the thymus for T cells; they will be discussed in Chapter 7. **Secondary lymphoid tissues** are the tissues in which immune responses are initiated, and the lymphatic vessels that connect them to the tissues and the bloodstream and thus to sites of infection (Figure 1-18).

Secondary lymphoid tissue brings antigen together with lymphocytes

The adaptive immune system pays two penalties for the extraordinary diversity of the antigen receptors of lymphocytes. First, unlike those on cells of the innate immune system, the antigen receptors of lymphocytes do not distinguish microbial products from harmless ones; and second, only a very small number of lymphocytes express receptors of any given specificity. The first of these disadvantages is overcome by the requirement for cells of the innate immune system, and in particular dendritic cells, that have been activated by microbial products. The second disadvantage is overcome by the specialized architecture of the secondary lymphoid tissues, which are organized to collect antigen and antigen-presenting cells and ensure that each naïve lymphocyte is continually brought into contact with them, so that clonal selection can occur, with expansion in numbers of antigen-specific lymphocytes.

Secondary lymphoid tissues (Figure 1-19) consist of the lymph nodes, which are clustered at sites such as the groin, armpits and neck and along the small intestine, and collect antigen from the tissues; the spleen, which collects antigen from the bloodstream; and the mucosa-associated lymphoid tissues (MALT), which collect antigen from the respiratory, gastrointestinal and urogenital tracts and are particularly well organized in the small intestine, in structures known as Peyer’s patches. The lymph nodes are connected to the tissues and the bloodstream by a system of lymphatic vessels. The afferent lymphatics drain extracellular fluid (lymph) from the tissues, including mucosal tissues, into the lymph nodes; and the efferent lymphatics carry the lymph out of the secondary lymphoid tissues and ultimately into a collecting vessel known as the thoracic duct (or for lymph nodes in the neck, the cervical duct), and thence through the heart and into the bloodstream.

When mature naïve lymphocytes leave the bone marrow and thymus, they enter the bloodstream and then circulate continuously through the lymph nodes, which they enter by migrating through the walls of specialized blood vessels, leaving via the efferent lymphatic vessels, which ultimately return them to the bloodstream. Antigen is collected in secondary lymphoid tissues both directly through the blood, from which antigen reaches the spleen, and through the afferent lymphatic vessels, which drain infected tissues and deliver antigen to the lymph nodes; and more indirectly by three specialized cell types (including dendritic cells) that we discuss in the next section.

Chemokines direct the migration of lymphocytes and determine the specialized microenvironments in which they are activated

Secondary lymphoid tissues provide a highly structured microenvironment adapted to foster the cell–cell interactions required to initiate an adaptive immune response. All secondary lymphoid tissues have distinct regions specialized to support the activation of T cells and B cells, although lymphoid chemokine: constitutively expressed chemoattractant molecule that directs the migration of lymphocytes and dendritic cells into specialized regions of the secondary lymphoid tissues. Also known as homeostatic chemokine.

MALT: see mucosa-associated lymphoid tissues.
mucosa-associated lymphoid tissues (MALT): secondary lymphoid tissue in the walls of the gastrointestinal, respiratory and urogenital tracts.
PALS: see periarteriolar lymphoid sheath.

Definitions

- **afferent lymphatics**: lymphatic vessels entering lymph nodes from tissue spaces.
- **efferent lymphatics**: lymphatic vessels leaving lymph nodes and returning lymph to the bloodstream.
- **follicle**: (of lymphoid tissue) B cell area of secondary lymphoid tissue.
- **germinai center**: site of vigorous proliferation of B cells in the B cell follicles of secondary lymphoid organs.
- **lymph**: fluid drained from the tissues and flowing through lymphatic vessels.
- **lymphatic vessels**: system of vessels draining fluid (lymph) from the tissues and in which dendritic cells and antigens are delivered to lymph nodes.
- **lymph nodes**: secondary lymphoid organs distributed widely in the body but especially in the groin, the axilla and the neck, and along the small intestine.
this is most clearly seen in the lymph nodes (see Figure 1-19a). B cells are usually concentrated in relatively well defined areas known as follicles, adjacent to or surrounded by T cell areas that may be more diffuse; in the lymph nodes, the T cell area is sometimes called the paracortical area; in the spleen, the bulk of which is formed from highly vascularized tissue known as the red pulp, the lymphoid tissue is known as the white pulp and each T cell area takes the form of a cuff, known as the periaeriotial lymphoid sheath (PALS), around an arteriole from which antigen is delivered (see Figure 1-19b). In lymphoid tissue actively responding to infection, the B cell follicles are enlarged and have a perceptible central region known as the germinal center composed of rapidly proliferating B cells.

The specialized architecture of the secondary lymphoid tissues is determined by lymphoid chemokines, chemotactant molecules that are differentially expressed in the T and B cell zones and direct the migration of dendritic cells as well as T and B lymphocytes to these areas. Lymphoid chemokines and other specialized homing molecules also direct the migration of circulating lymphocytes through the specialized blood vessels through which they enter the lymphoid tissues, and regulate their exit, ensuring continued recirculation and surveillance of all lymphoid tissues in which antigen may be present. These processes are described in Chapter 2, and the control of lymphocyte homing is discussed in more detail in Chapters 5 and 6.

**Secondary lymphoid tissue is sustained and can be induced by signals from immune cells**

The chemokines that establish the architecture of the secondary lymphoid tissues, unlike the chemokines produced in the course of an immune response, are expressed constitutively. Once established however the lymphoid architecture may be maintained in part by normal lymphocyte traffic and interactions. This may explain why, in acquired immunodeficiency disease (AIDS), in which an entire class of T lymphocytes is destroyed, the organized architecture of the lymph nodes collapses. Conversely, at sites of chronic inflammation, organized lymphoid tissue may form: this is known as tertiary lymphoid tissue.

**References**
