

## Lymphatic System

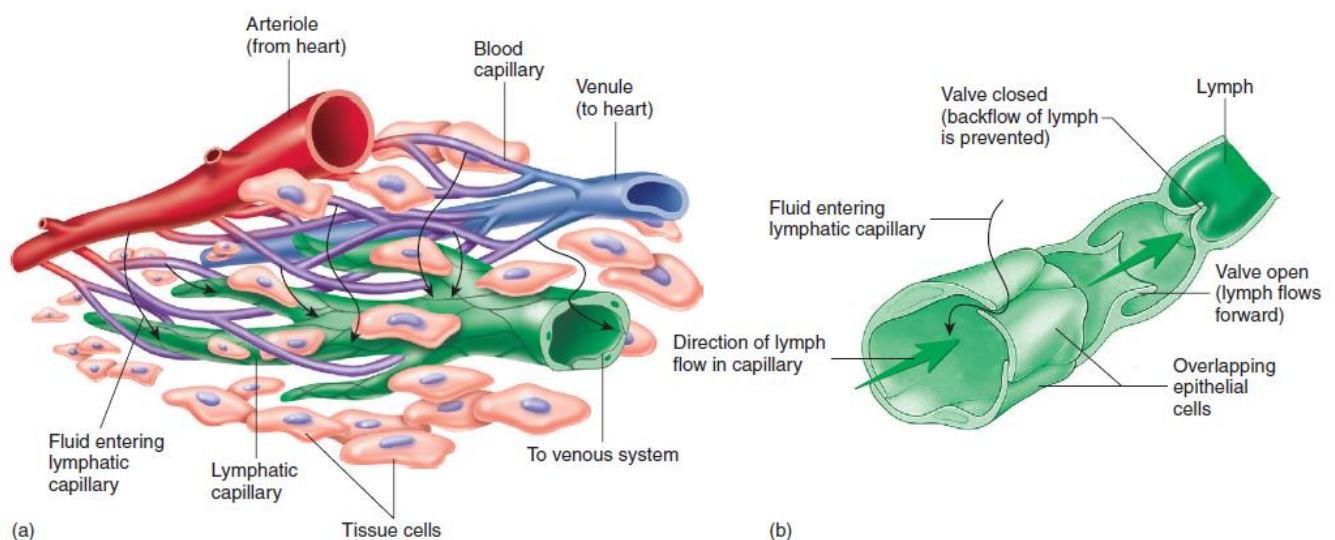
The **lymphatic system** includes lymph, lymphatic vessels, lymphatic tissue, lymphatic nodules, lymph nodes, the tonsils, the spleen, and the thymus.

### Lymphatic Vessels

The lymphatic vessels are essential for the maintenance of fluid balance. They begin as small, dead-end tubes called **lymphatic capillaries**. Fluids tend to move out of blood capillaries into tissue spaces. Excess fluid passes through the tissue spaces and enters lymphatic capillaries to become lymph.

Lymphatic capillaries are in most tissues of the body. Exceptions are the central nervous system, the bone marrow, and tissues without blood vessels, such as cartilage, epidermis, and the cornea.

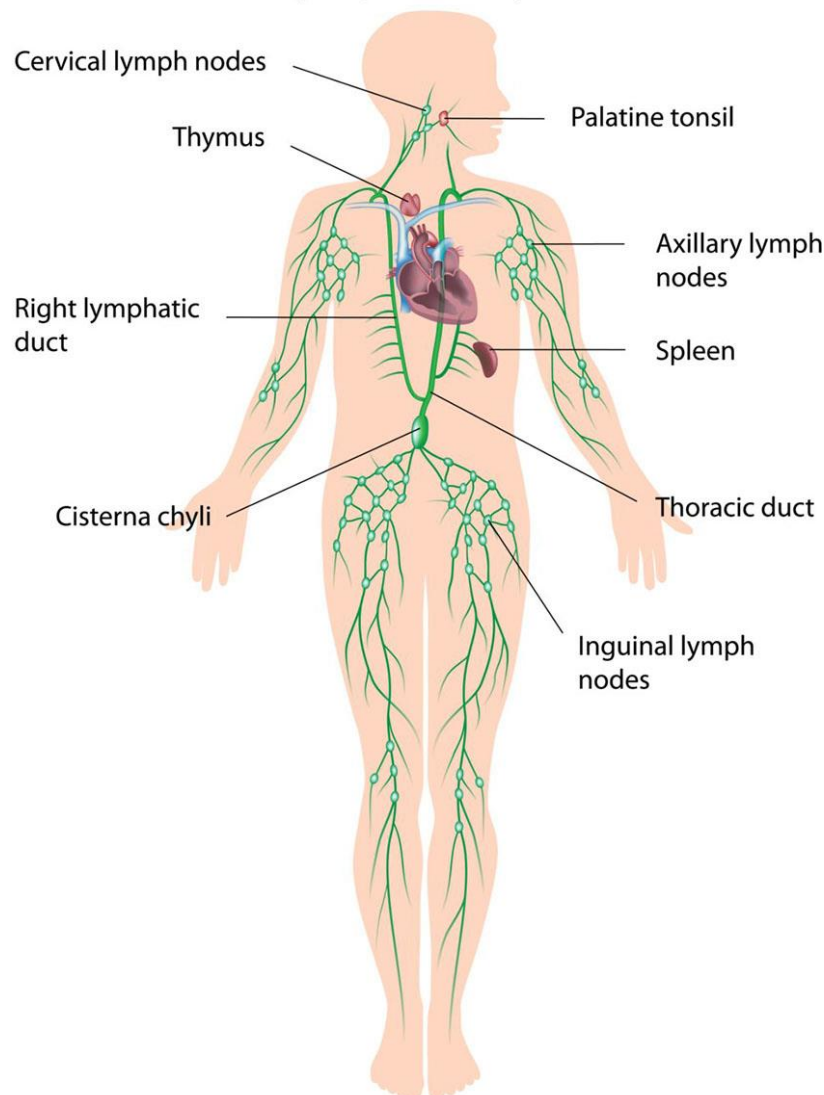
The lymphatic capillaries join to form larger **lymphatic vessels**, which resemble small veins. Small lymphatic vessels have a beaded appearance because they have one-way valves along their lengths that are similar to the valves of veins.



**FIGURE 22.2** Lymph Formation and Movement

In summary, lymph enters lymphatic capillaries, which converge to form larger lymphatic vessels. Lymph passes through the lymphatic vessels and through associated lymph nodes, where it is filtered. Lymphatic vessels converge to form larger lymphatic trunks, which drain lymph from major regions of the body. Lymphatic trunks empty directly into thoracic veins or combine to form larger lymphatic ducts, which empty into thoracic veins.

## The Lymphatic System



### Lymphatic Tissue and Organs

Lymphatic organs contain **lymphatic tissue**, which consists primarily of lymphocytes but also includes macrophages, dendritic cells, reticular cells, and other cell types. **Lymphocytes** are white blood cells. The two types of lymphocytes, **B cells** and **T cells**, originate from red bone marrow and are carried by the blood to lymphatic organs and other tissues. When the body is exposed to microorganisms or other foreign substances, the lymphocytes divide, increase in number, and become part of the immune response that destroys microorganisms and foreign substances.

### Lymphatic nodules

are denser arrangements of lymphatic tissue organized into compact, somewhat spherical structures, ranging in size from a few hundred microns to a few millimeters or more in diameter (figure 22.4). Lymphatic nodules are numerous in the loose connective tissue of the digestive, respiratory, urinary, and reproductive systems. **Peyer patches** are aggregations of lymphatic nodules in the distal half of the small intestine and the appendix.

## Tonsils

**Tonsils** are large groups of lymphatic nodules located deep to the mucous membranes within the pharynx .

The tonsils protect against bacteria and other harmful material entering the pharynx from the nasal or oral cavity.

There are three groups of tonsils, but the **palatine tonsils** are usually the ones referred to. They are relatively large, oval lymphatic masses on each side of the junction between the oral cavity and the pharynx. The **pharyngeal tonsil** is a collection of somewhat closely aggregated lymphatic nodules near the junction between the nasal cavity and the pharynx. When the pharyngeal tonsil is enlarged, it is commonly called the **adenoid**. The **lingual tonsil** is a loosely associated collection of lymphatic nodules on the posterior surface of the tongue.

Sometimes the palatine or pharyngeal tonsils become chronically infected and must be removed. The lingual tonsil becomes infected less often than the other tonsils and is more difficult to remove.

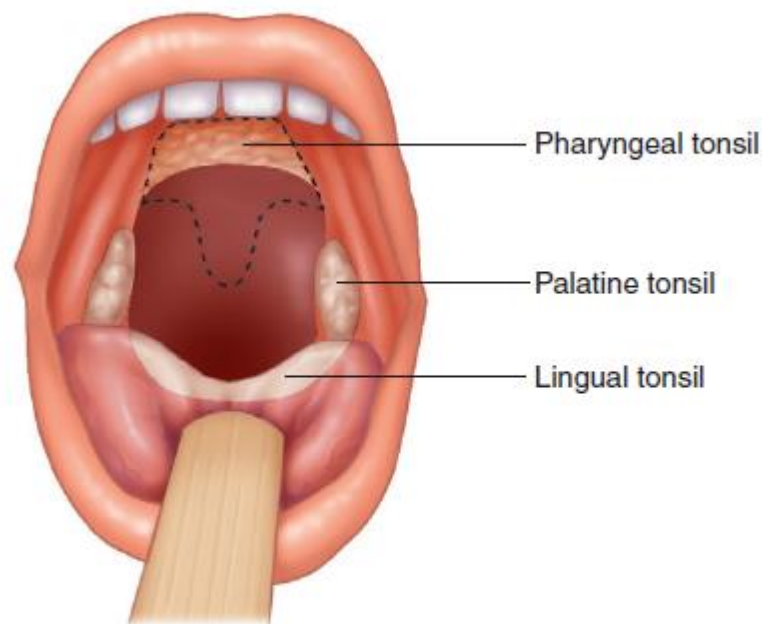


FIGURE 22.5 AP|R Tonsils

## Lymph Nodes

**Lymph nodes** are small, round or bean-shaped structures ranging from 1 mm to 25 mm long. They are distributed along the course of the lymphatic vessels. Lymph nodes filter the lymph, removing bacteria and other materials. In addition, lymphocytes congregate, function, and proliferate within lymph nodes.

## Spleen

The **spleen** is roughly the size of a clenched fist and is located on the left, superior part of the abdominal cavity . The average weight of the adult spleen is 180 g in males and 140 g in females , but in certain diseases the spleen can achieve a weight of 2000 g or more.

The spleen has an outer capsule and bundles of connective tissue fibers from the capsule form trabeculae, which extend into the organ, subdividing it into small, interconnected compartments.

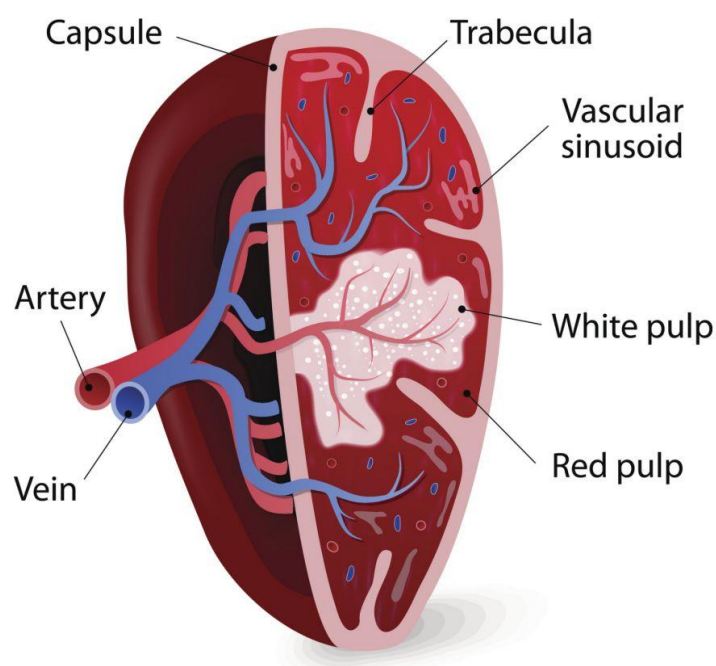
Arteries, veins, and lymphatic vessels extend through the trabeculae to supply the compartments, which are filled with white and red pulp. **White pulp** is lymphatic tissue surrounding the arteries within the spleen. **Red pulp** is associated with the vein. Approximately one-fourth of the volume of the spleen is white pulp, and three-fourths is red pulp.

Branches of the **splenic artery** enter the spleen at the **hilum**, and their branches follow the various trabeculae into the spleen. From the trabeculae, arterial branches extend into the white pulp. Arterioles enter lymphatic nodules and give rise to capillaries supplying the red pulp, which consists of the splenic cords and the venous sinuses. The **splenic cords** are a network of reticular cells that produce reticular fibers.

The spaces between the reticular cells are occupied by splenic macrophages and blood cells that have come from the capillaries. The **venous sinuses** are enlarged capillaries between the splenic cords.

The venous sinuses typically connect to trabecular veins, which unite to form vessels that leave the spleen to form the **splenic vein**.

## SPLEEN ANATOMY



### Spleen functions

The spleen destroys defective red blood cells, detects and responds to foreign substances in the blood, and acts as a blood reservoir.

As red blood cells age, they lose their ability to bend and fold. Consequently, the cells can rupture as they pass slowly through the meshwork of the splenic cords or the venous sinus walls. Splenic macrophages then phagocytize the cellular debris.

Foreign substances in the blood passing through the spleen can stimulate an immune response because of the presence in the white pulp of specialized lymphocytes.

The splenic cords are a limited reservoir for blood. For example, during exercise splenic volume can be reduced by 40–50%. The resulting small increase in circulating red blood cells can promote better oxygen delivery to muscles during exercise or emergency situations.

a **splenectomy** , removal of the spleen, may be necessary. After removal of the spleen, other lymphatic organs and the liver compensate for the loss of its functions.

### Thymus

The **thymus** is a bilobed gland located in the superior mediastinum. The thymus increases in size until the first year of life, after which it remains approximately the same size until 60 years of age, when it decreases in size .

The thymus is the site for the maturation of T cells. **Thymosin**, a hormone secreted by the thymus, is important in the T-cell maturation process.

