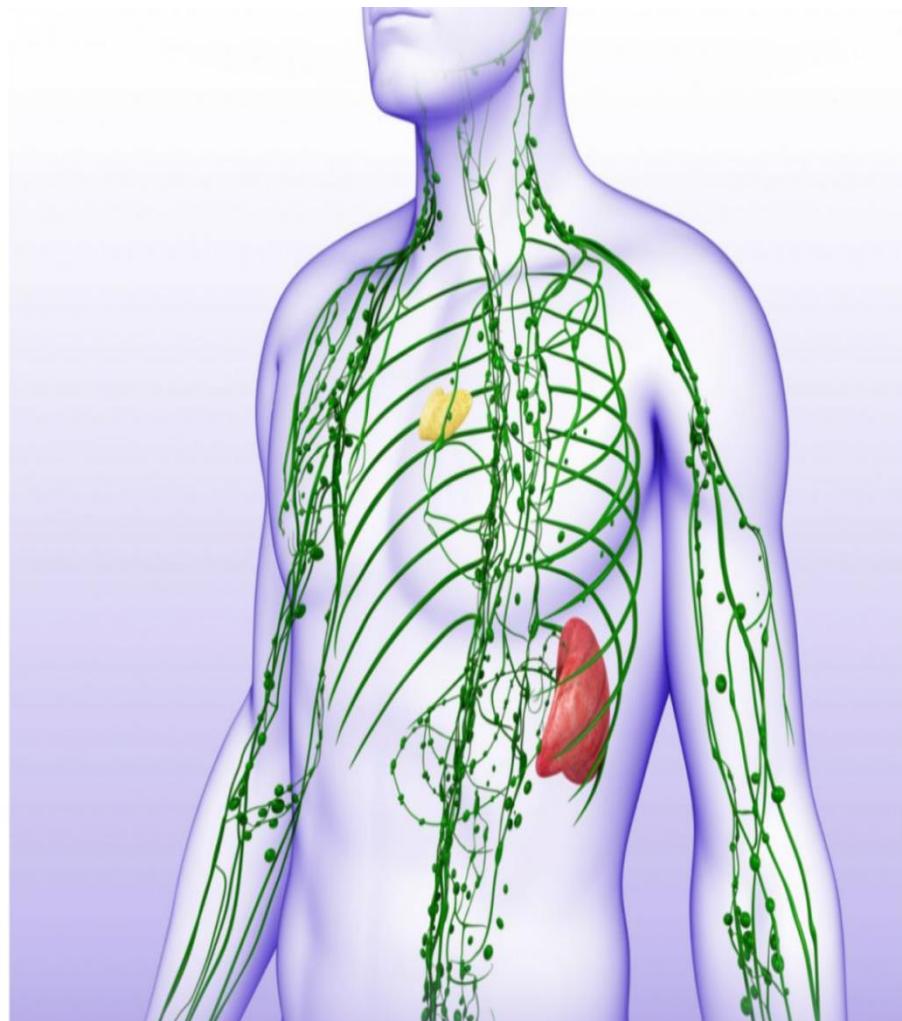


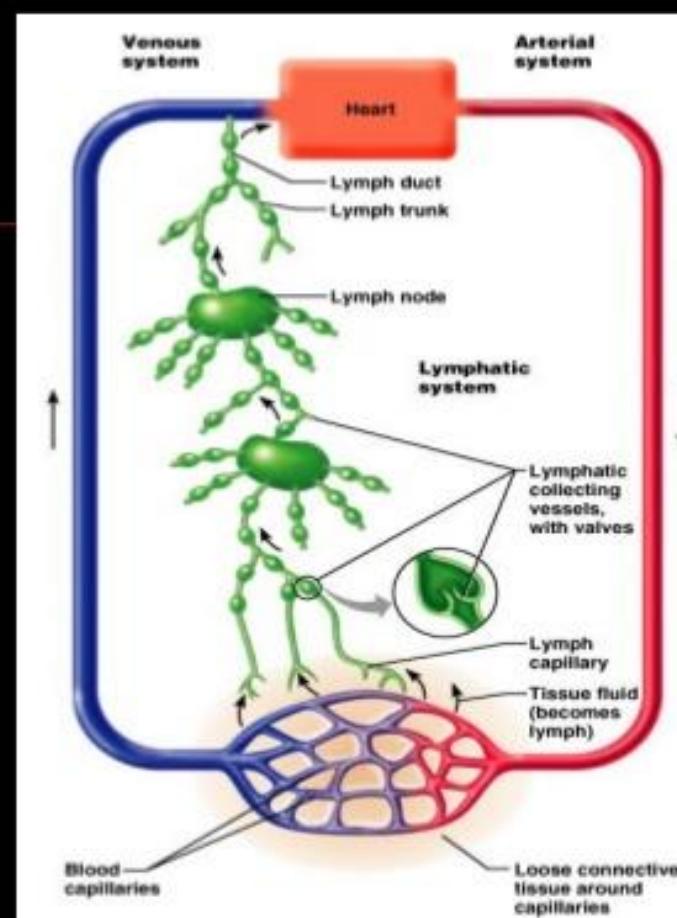
# LYMPHATIC SYSTEM



# LYMPHATIC SYSTEM

## Components

- Lymph fluid
- Lymph vessels
- Lymphatic organs
  - Lymph nodes
  - Tonsils
  - Spleen
  - Thymus



# LYMPH

- Lymph is a clear, watery fluid that surrounds body cells and flows in a system of thin walled lymph vessels (the lymphatic system) that extends throughout the body.
- Lymph differs from blood
- Lymph fluid does not contain erythrocytes or platelets, but it is rich in two types of white blood cells (leukocytes): lymphocytes and monocytes

- The liquid part of lymph is **similar to blood plasma** in that it contains water, salts, sugar, and wastes of metabolism such as urea and creatinine, but it differs in that it contains **less protein**
- Lymph actually originates **from the blood**.

# LYMPHATIC FLOW

FLUID THAT FILTERS OUT OF TINY BLOOD CAPILLARIES INTO THE SPACES BETWEEN CELLS  
(INTERSTITIAL FLUID)



INTERSTITIAL FLUID PASSES CONTINUOUSLY INTO SPECIALIZED THIN-WALLED VESSELS  
CALLED LYMPH CAPILLARIES



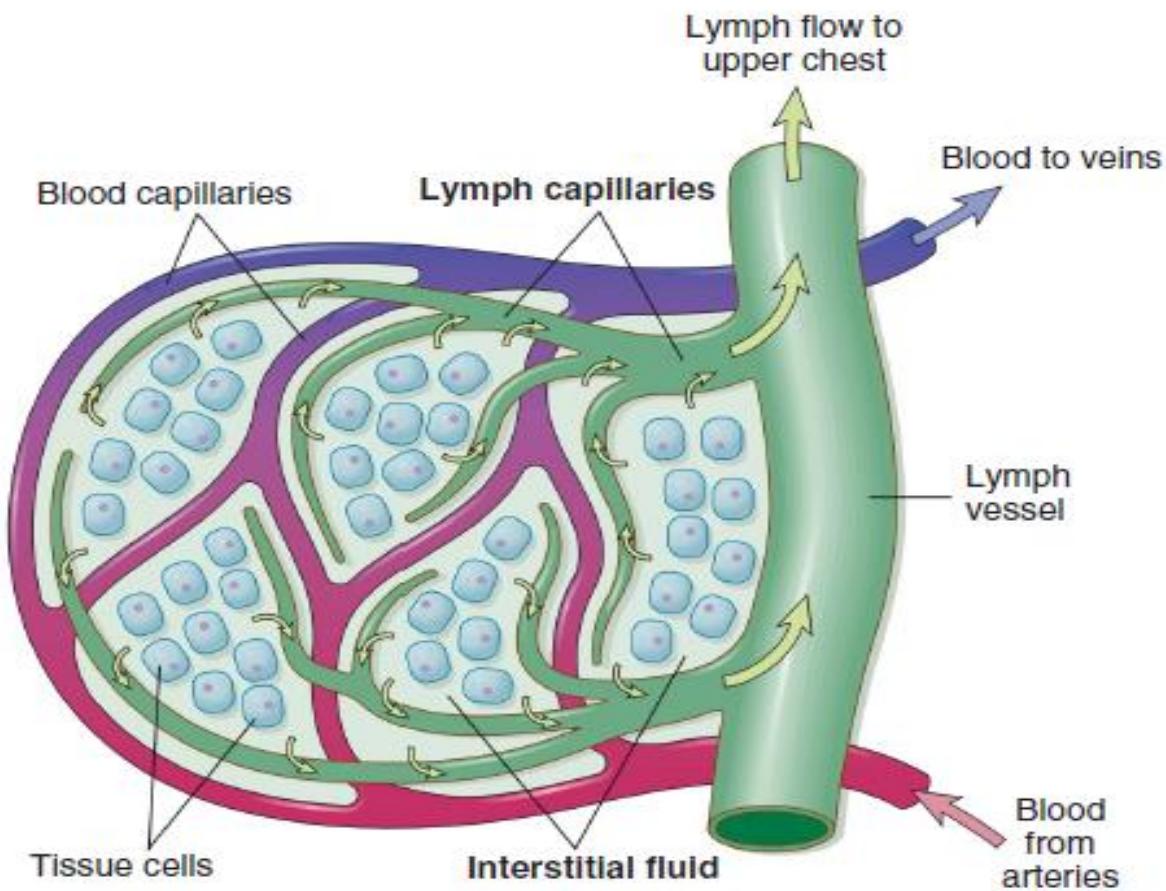
THE FLUID IN THE LYMPH CAPILLARIES, NOW CALLED LYMPH PASSES THROUGH LARGER  
LYMPHATIC VESSELS AND THROUGH CLUSTERS OF LYMPH TISSUES (LYMPH NODES)



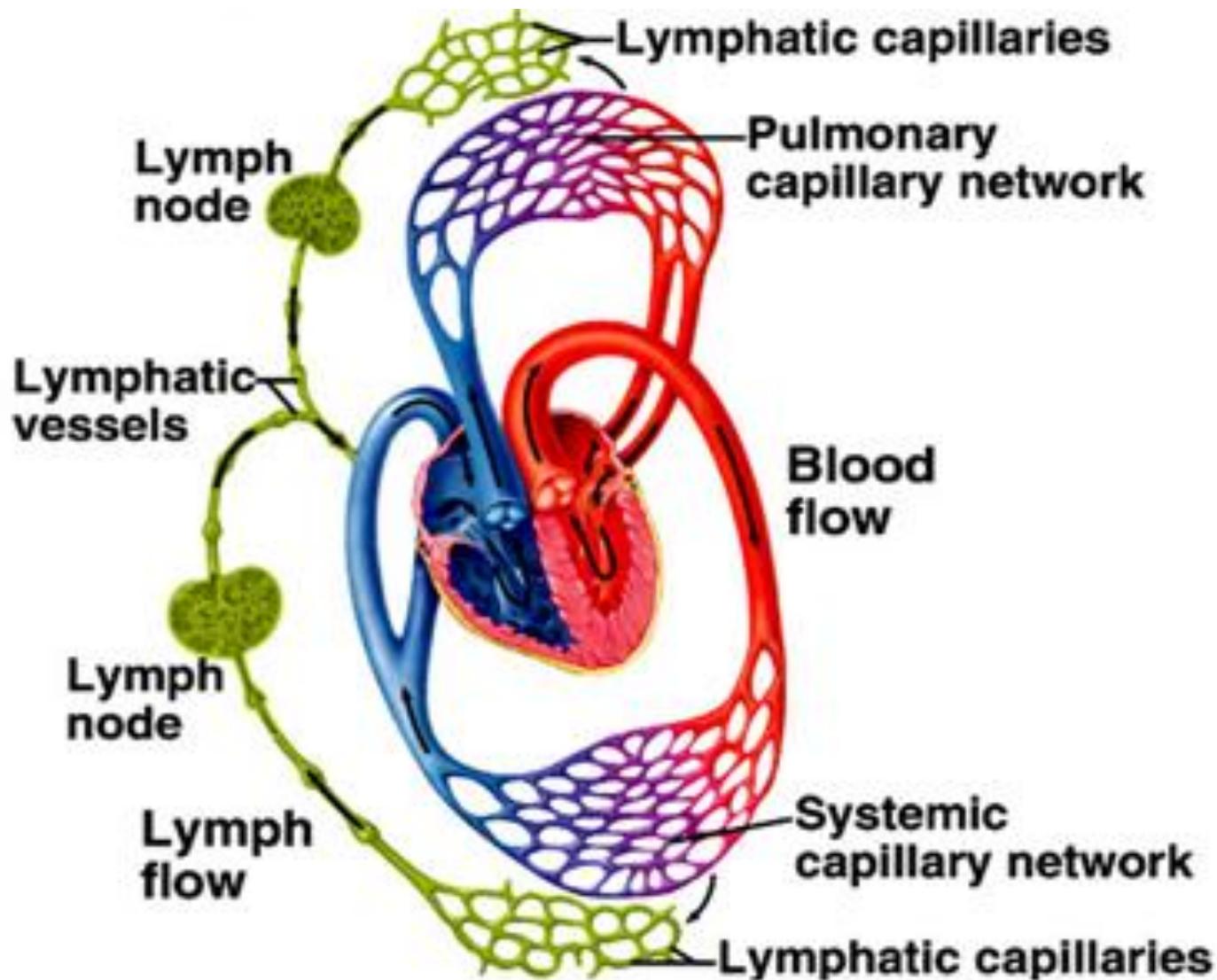
FINALLY REACHING LARGE LYMPHATIC VESSELS IN THE UPPER CHEST, WHICH THEN EMPTY  
INTO THE BLOODSTREAM.

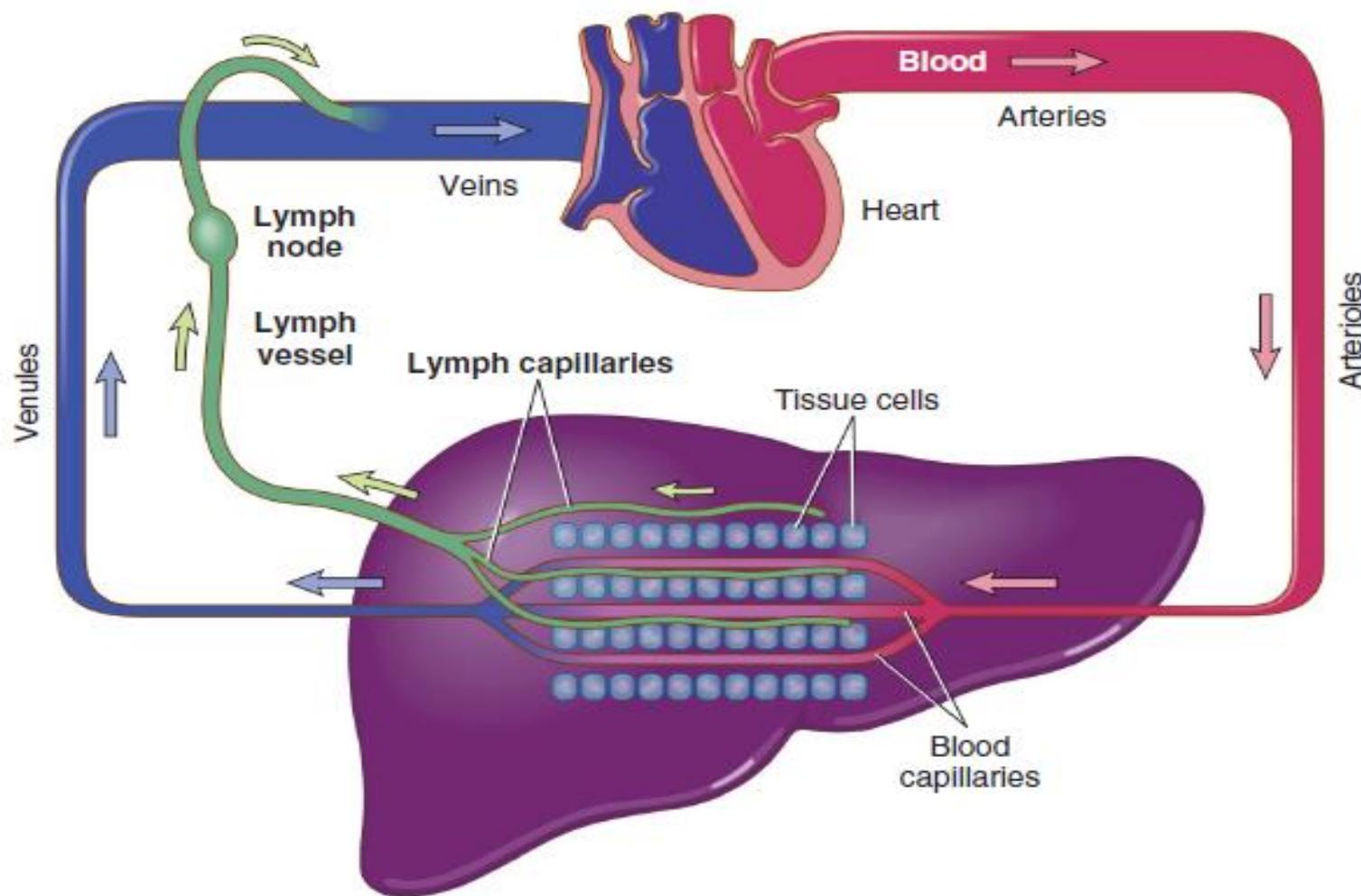
- **Lymph capillaries** - begin at the spaces around cells throughout the body - they are thin-walled tubes.
- Lymph capillaries carry lymph from the tissue spaces to larger **lymph vessels**. Lymph vessels have thicker walls than those of lymph capillaries and, like veins, **contain valves** so that lymph flows in only one direction, toward the thoracic cavity.
- Collections of stationary lymph tissue, called **lymph nodes**, are located along the path of the lymph vessels.

- **Lymph vessels** all lead toward the thoracic cavity and empty into **two large ducts** in the upper chest. These are the **right lymphatic duct** and **the thoracic duct**.
- The **thoracic duct** drains the lower body and the left side of the head
- the **right lymphatic duct** drains the right side of the head and the chest (a much smaller area)
- Both ducts carry the lymph into **large veins** in the neck, where the lymph then enters the bloodstream.



**FIGURE 14-1** Interstitial fluid and lymph capillaries.





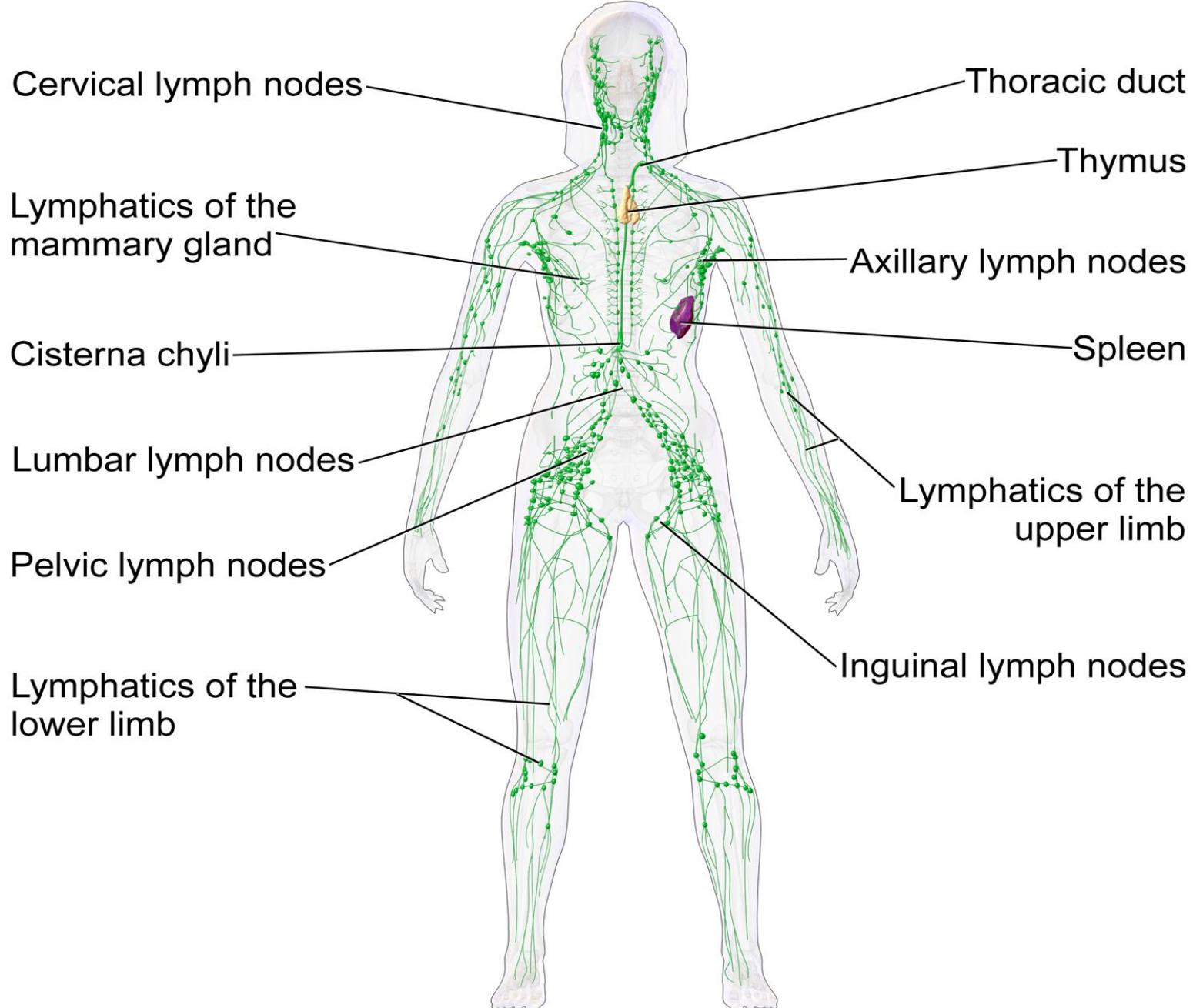
**FIGURE 14-2** Relationship between the circulatory systems of blood and lymph.

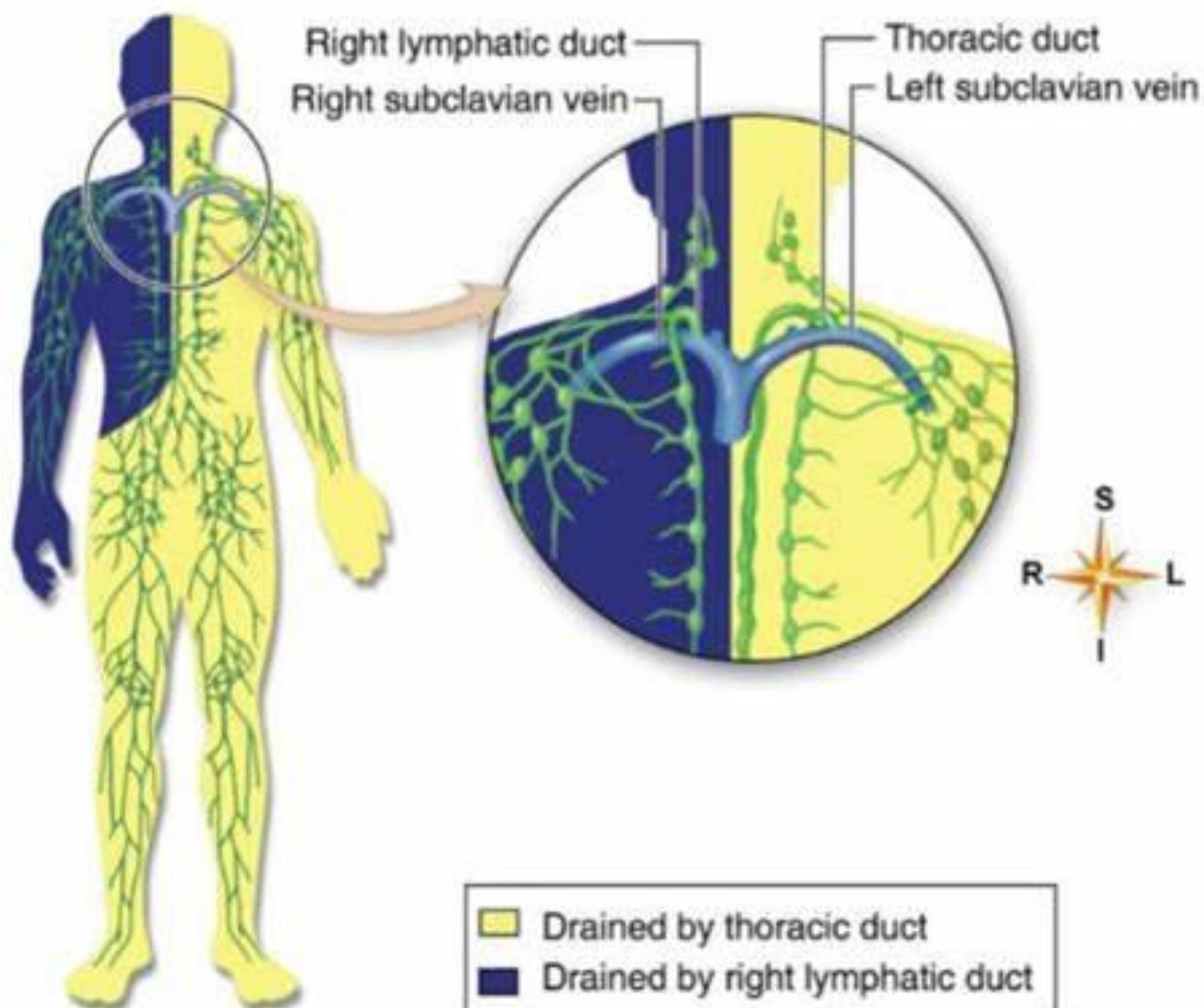
**TABLE 14-1** LYMPH AND BLOOD

Lymph (colorless)	Blood (red)
<b>NO PUMP</b> Fluid moved along by muscle movement and valves	<b>PUMP</b> Heart pumps blood through blood vessels
<b>WHITE BLOOD CELLS</b> Lymphocytes Monocytes	<b>ALL BLOOD CELLS</b> Erythrocytes (give blood its red color) Leukocytes Platelets
<b>INTERSTITIAL FLUID</b> Water Less protein and other plasma components Lipids (fats) from small intestine	<b>PLASMA</b> Water Proteins Salts, nutrients, lipids, and wastes

# LYMPH NODES

- Major sites of lymph node concentration are
  - **cervical (neck)**
  - **axillary (armpit)**
  - **mediastinal (chest)**
  - **mesenteric (intestinal)**
  - **paraaortic (lumbar)**
  - **inguinal (groin).**
- Remember that **tonsils are masses of lymph tissue in the throat** near the back of the mouth (oropharynx), and **adenoids** are enlarged lymph tissue in the part of the throat near the nasal passages (nasopharynx).





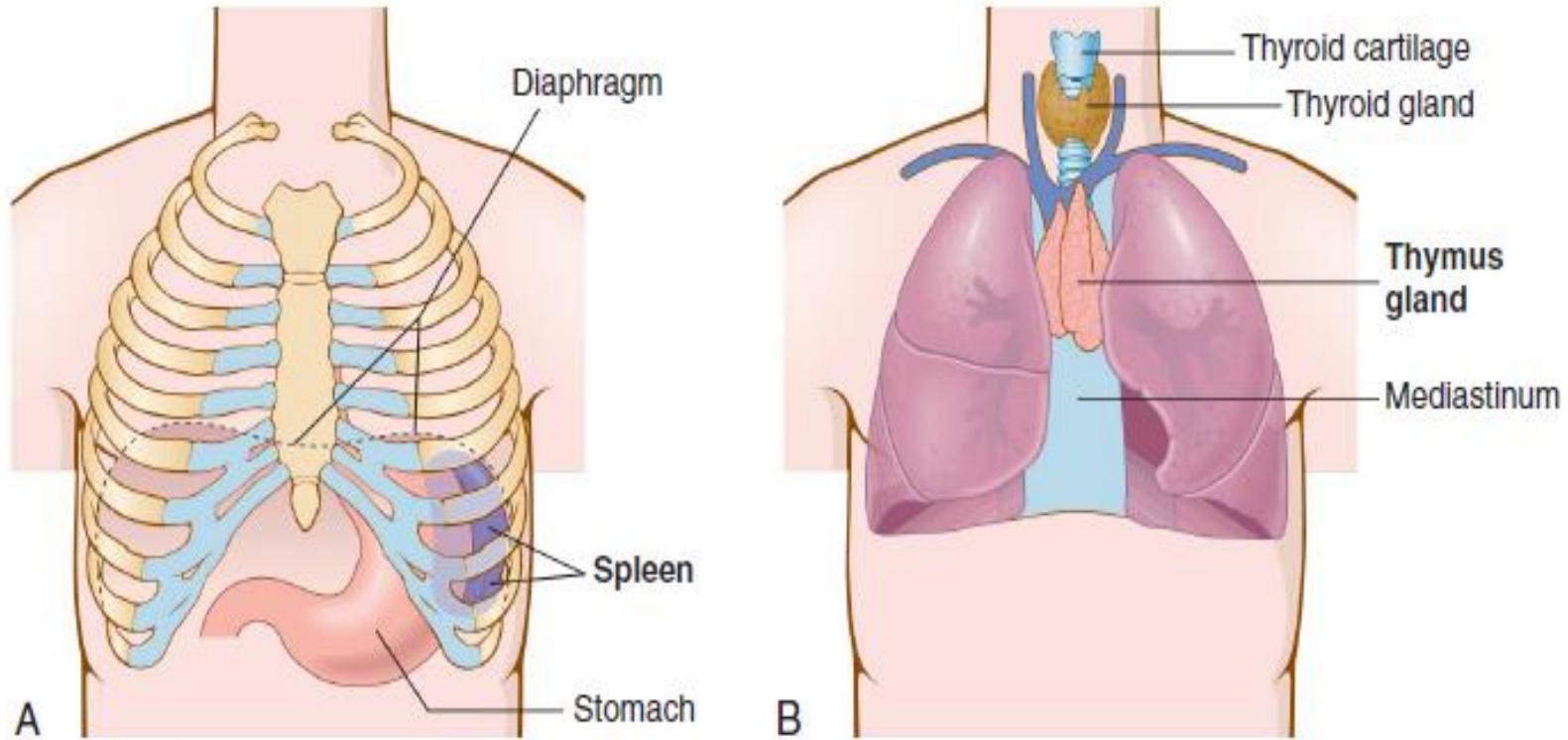
- Lymph nodes – fights disease
  - produce lymphocytes – B & T
  - Contains Macrophages – phagocytose
- Lymph nodes also fight disease when specialized lymphocytes called **B lymphocytes (B cells)**, which are present in the nodes, produce antibodies.
- Other lymphocytes present in nodes are **T lymphocytes** (T cells). They attack bacteria and foreign cells by accurately recognizing a cell as foreign and destroying it.
- B cells mature in bone marrow, while T cells originate in the thymus gland.

# SPLEEN AND THYMUS GLAND

- Specialized organs that are also a part of the lymphatic system.
- The spleen is located in the left upper quadrant of the abdomen, next to the stomach.
- Important functions:
  - Destruction of old erythrocytes by macrophages
  - Filtration of microorganisms and other foreign material from the blood.
  - Activation of lymphocytes.
  - Storage of blood, especially erythrocytes and platelets.

# THYMUS GLAND

- The thymus gland is a lymphatic organ located in the upper mediastinum between the lungs.
- During fetal life and childhood it is quite large, but it becomes smaller with age.
- The thymus gland is composed of nests of **lymphoid cells**
- It plays an important role in the body's ability to protect itself from disease (**immunity**), especially in fetal life and during the early years of growth.
- the thymus gland is important in development of an effective immune system in **childhood**.
- **TOLERANCE?**
- **AUTOIMMUNE DISEASE?**



**FIGURE 14-5** A, Spleen and adjacent structures. B, Thymus gland in its location in the mediastinum between the lungs.

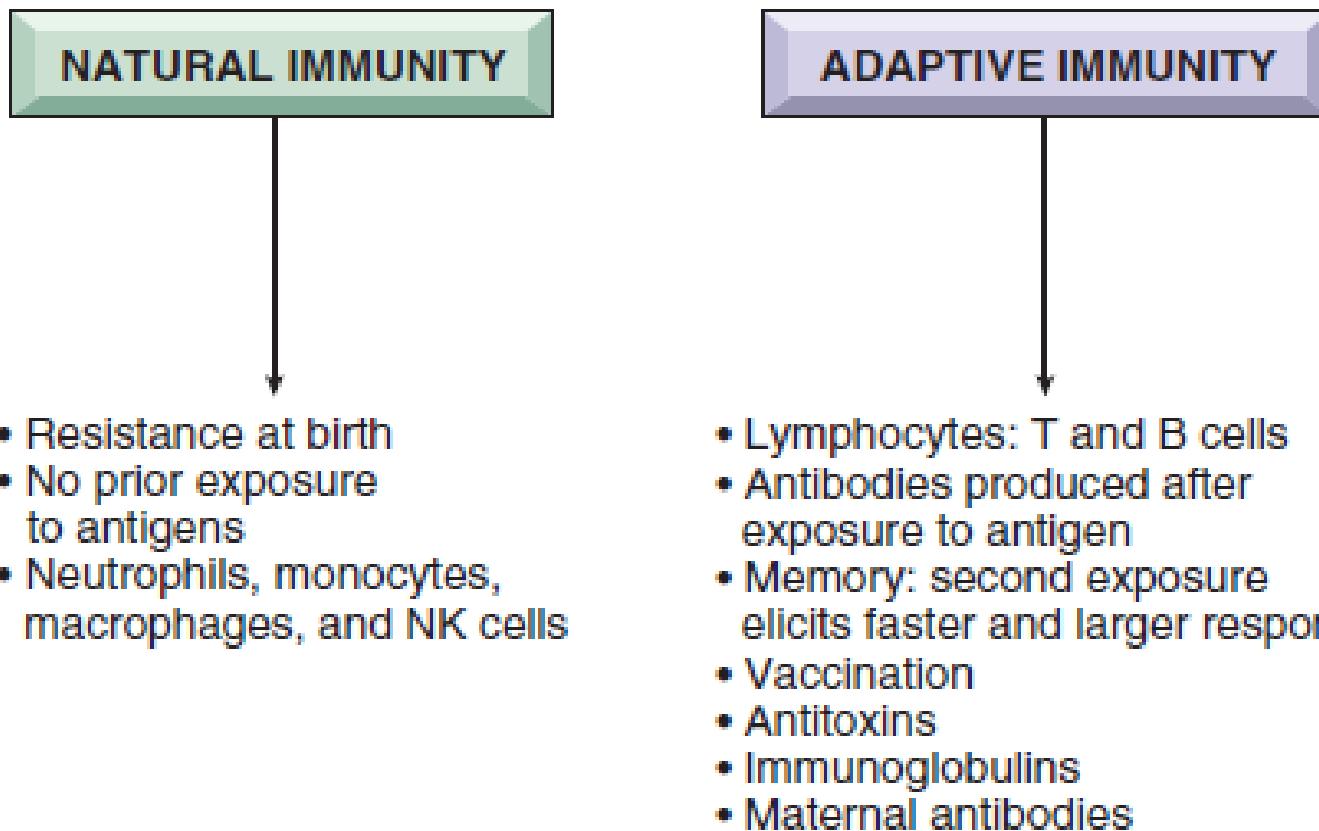
# FUNCTIONS OF LYMPHATIC SYSTEM

- First, it is a **drainage system** to transport needed proteins and fluid that have leaked out of the blood capillaries (and into the interstitial fluid) back to the bloodstream via the veins.
- Second, the **lymphatic vessels in the intestines absorb lipids (fats)** from the small intestine and transport them to the bloodstream.
- A third function of the lymphatic system relates to the immune system: the **defense of the body against foreign organisms** such as bacteria and viruses.
- **Lymphocytes and monocytes**
- **lymph nodes**
- **organs such as the spleen and thymus gland**
- **protect the body by producing antibodies and by mounting a cellular attack on foreign cells and organisms.**

# **IMMUNE SYSTEM**

- The immune system is specialized to defend the **body against antigens** (such as toxins, bacterial proteins, or foreign blood cells).
- This system includes **leukocytes** such as **neutrophils, monocytes, and macrophages**, which are **phagocytes** found in blood and tissues throughout the body.
- In addition, **lymphoid organs**, such as **the lymph nodes, spleen, thymus gland, tonsils, and adenoids**, produce **lymphocytes and antibodies**

# TYPES OF IMMUNITY



**FIGURE 14-6** Types of immunity.

# Types of Acquired Immunity

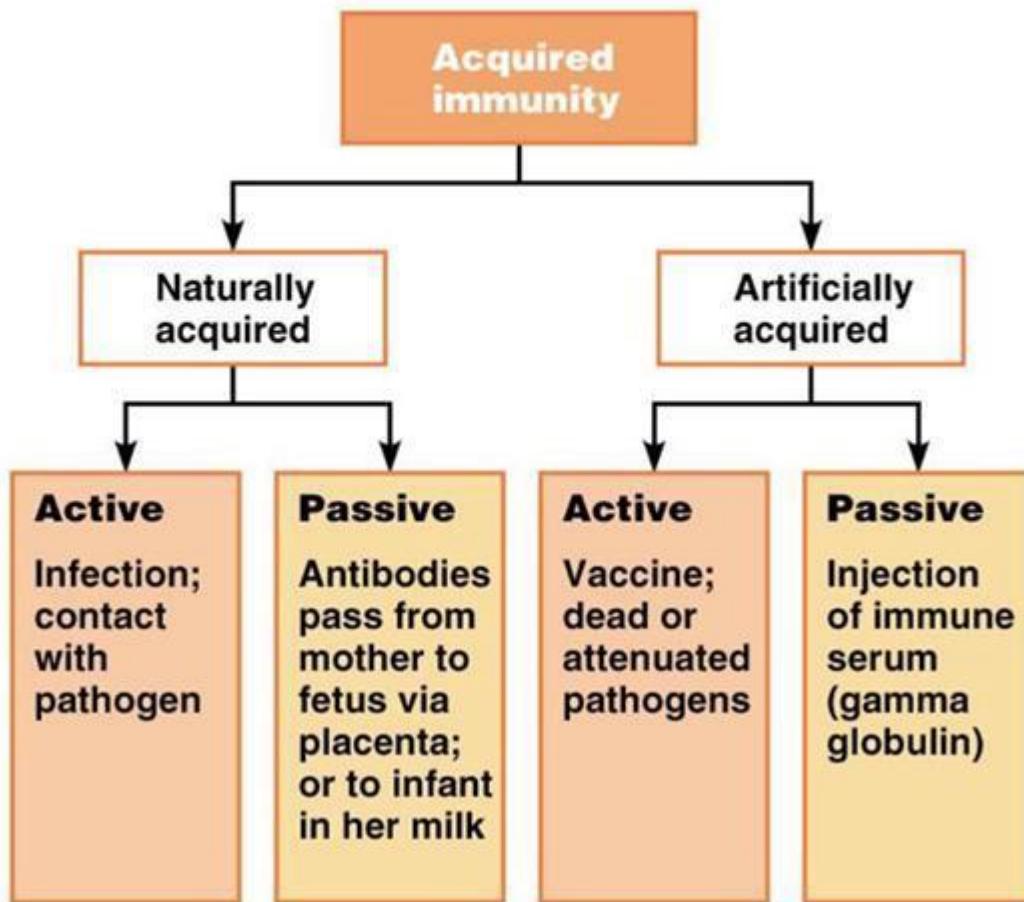
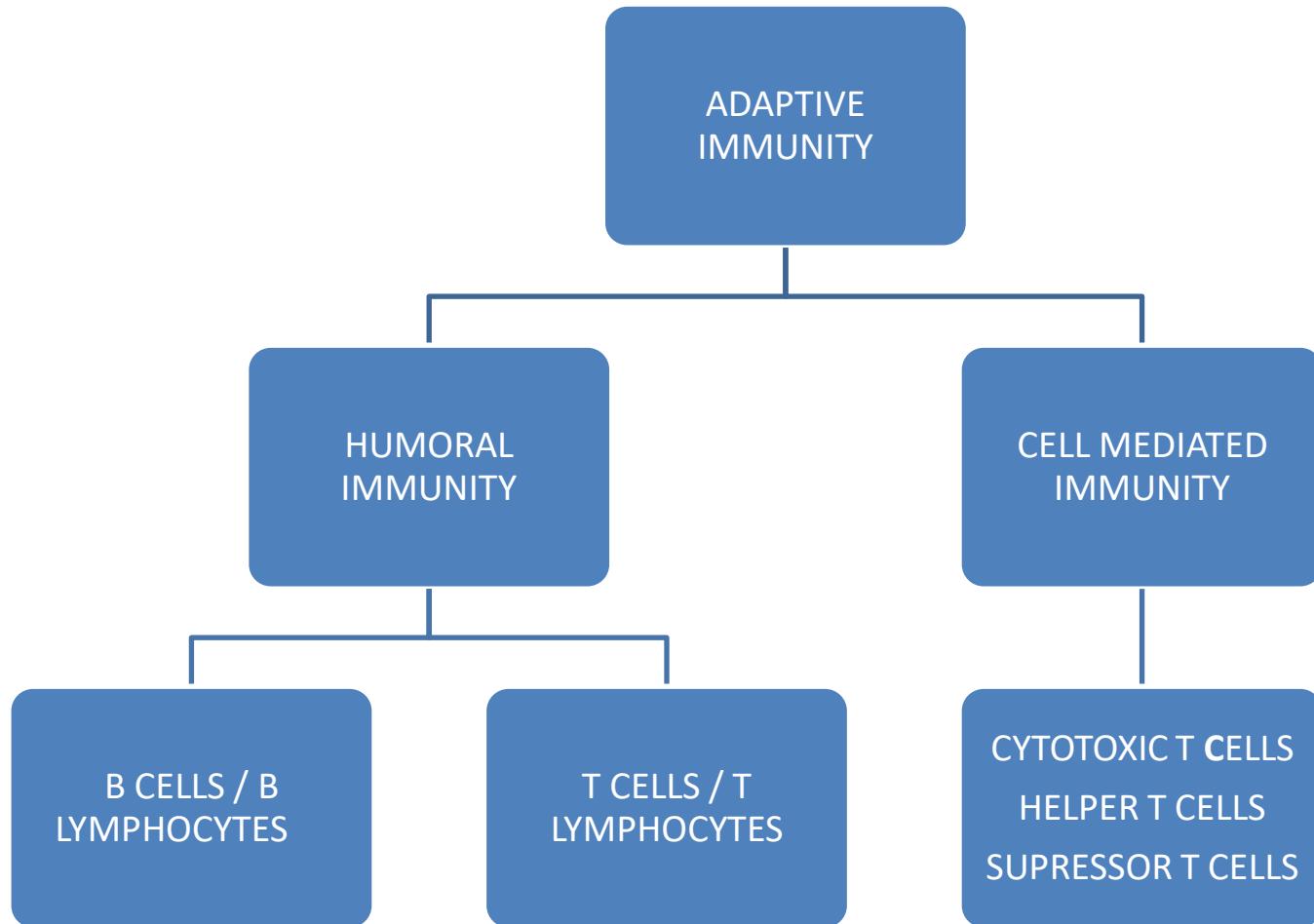


Figure 21.12

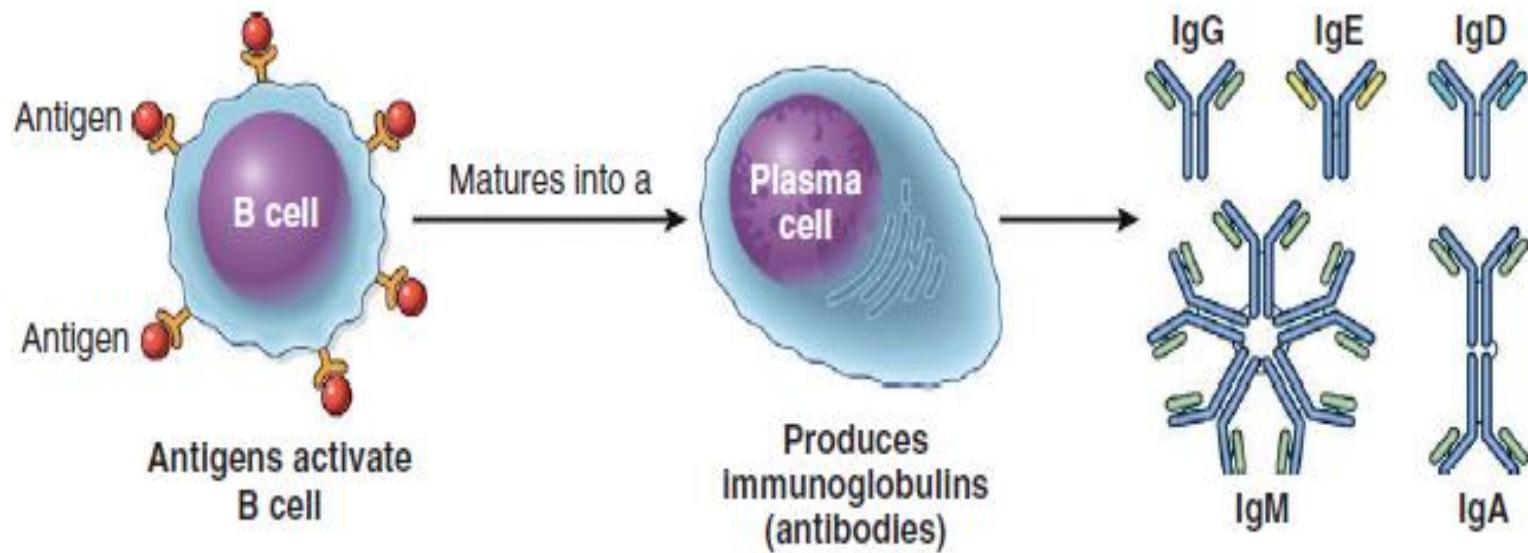
# IMMUNITY

- Immunity is the body's ability to resist foreign organisms and toxins that damage tissues and organs
- Natural immunity is resistance present at birth. It is not dependent on prior exposure to an antigen (infectious agent).
- In addition to natural immunity, a healthy person can develop adaptive immunity. This is the body's ability to recognize and remember specific antigens in an immune response.

# ADAPTIVE IMMUNITY



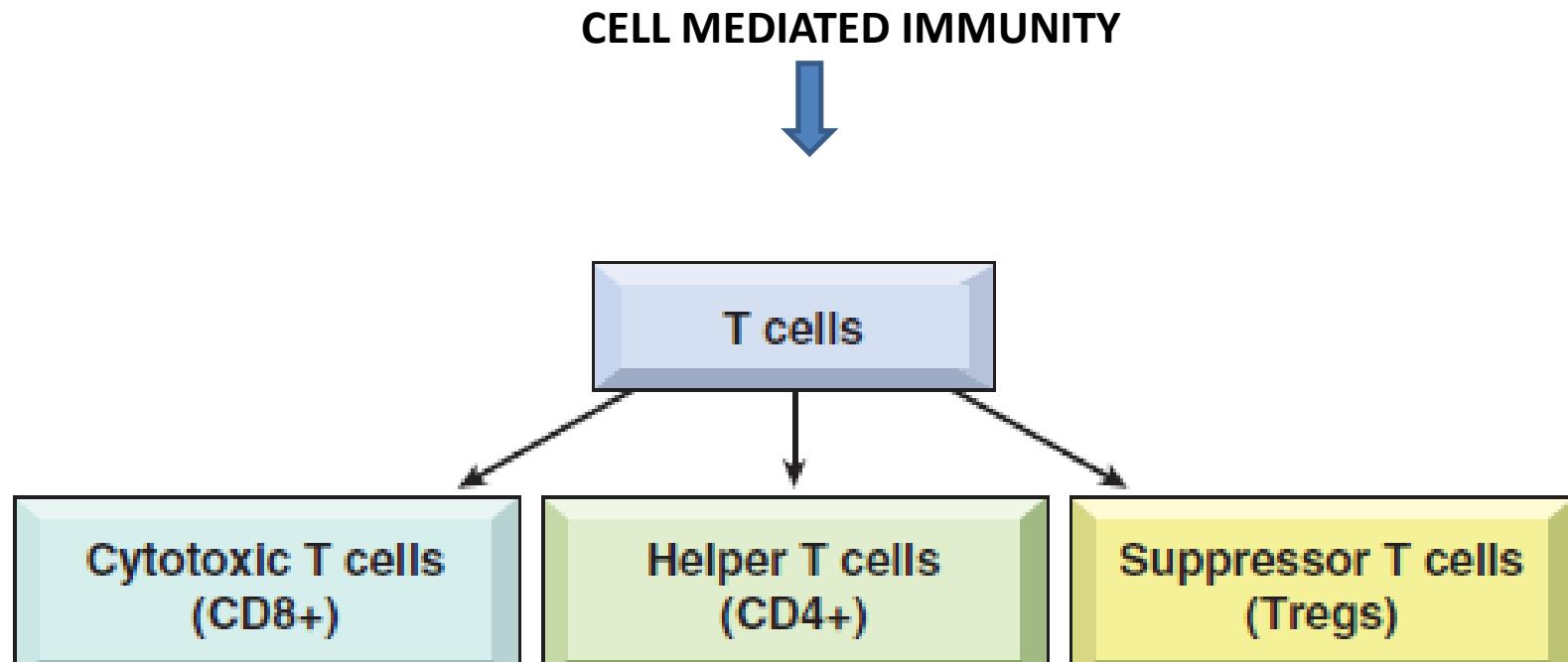
# HUMORAL IMMUNITY



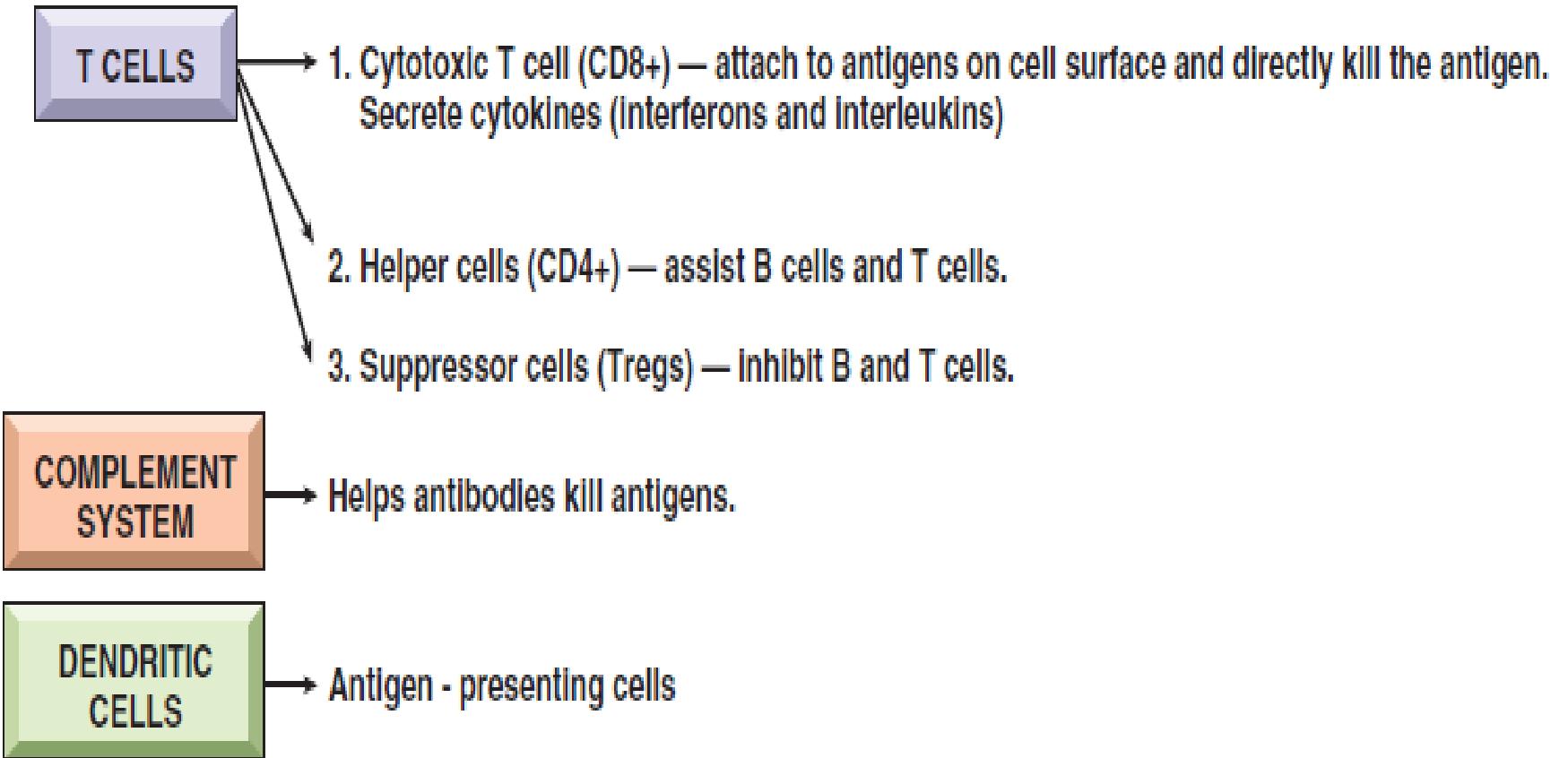
**FIGURE 14-7** Humoral immunity: B cell, plasma cell, and immunoglobulins.

**B CELLS** → Mature into plasma cells and secrete antibodies — immunoglobulins (IgM, IgA, IgE, IgD, IgG)

# CELL MEDIATED IMMUNITY



**FIGURE 14-8** Cell-mediated immunity: Types of T cells.



**FIGURE 14-9** Functions of B cells, T cells, complement, and dendritic cells.

# PATHOLOGY

- **severe combined immunodeficiency disease (SCID)** - Affected infants are born with a deficiency of B cells and T cells, resulting in a lack of immunity.
- **acquired immunodeficiency syndrome (AIDS)** - Group of clinical signs and symptoms associated with suppression of the immune system and marked by opportunistic infections, secondary neoplasms, and neurologic problems
- CAUSED BY human immunodeficiency virus (HIV). HIV destroys helper T cells (also known as CD4+ cells, containing the CD4 protein antigen).
- Infectious diseases associated with AIDS are called **opportunistic infections**

- **Opportunistic infections WITH AIDS**

- Candidiasis
- cryptococcal infection (Crypto)
- Cryptosporidiosis
- cytomegalovirus (CMV) infection
- herpes simplex
- histoplasmosis (Histo)
- *Mycobacterium aviumintracellulare(MAI) complex infection*
- *Pneumocystis pneumonia (PCP)*
- toxoplasmosis (Toxo)
- tuberculosis (TB)

- Malignancies associated with AIDS are **Kaposi sarcoma** (a cancer arising from the lining cells of capillaries that produces dark purplish skin nodules) and lymphoma (cancer of lymph nodes).
- **Wasting syndrome**, marked by weight loss and decrease in muscular strength, appetite, and mental activity, also may occur with AIDS
- Persons who were exposed to HIV and now have antibodies in their blood against this virus are **HIV-positive**
- **TRANSMISSION OF HIV?**



A

**KAPOSI SARCOMA**



B

**WASTING SYNDROME**

# LYMPHEDEMA



- **HYPERSensitivity – undesirable reaction produced by our immune system**
- **Includes allergy and autoimmunity**
- **allergy** - Abnormal hypersensitivity acquired by exposure to an antigen.
  - allergic rhinitis
  - systemic anaphylaxis (life-threatening)
  - asthma (pollens, dust, molds)
  - hives (caused by food or drugs)
  - atopic dermatitis(rash from soaps, cosmetics, chemicals) – genetic / family history – also known as eczema

- **MALIGNANCIES**
- **lymphoma** - Malignant tumor of lymph nodes and lymph tissue.
  - **Hodgkin disease**—Malignant tumor of lymphoid tissue in the spleen and lymph nodes.
  - This disease is characterized by lymphadenopathy (lymph nodes enlarge), splenomegaly, fever, weakness, and loss of weight and appetite
  - Reed-Sternberg cell FOUND

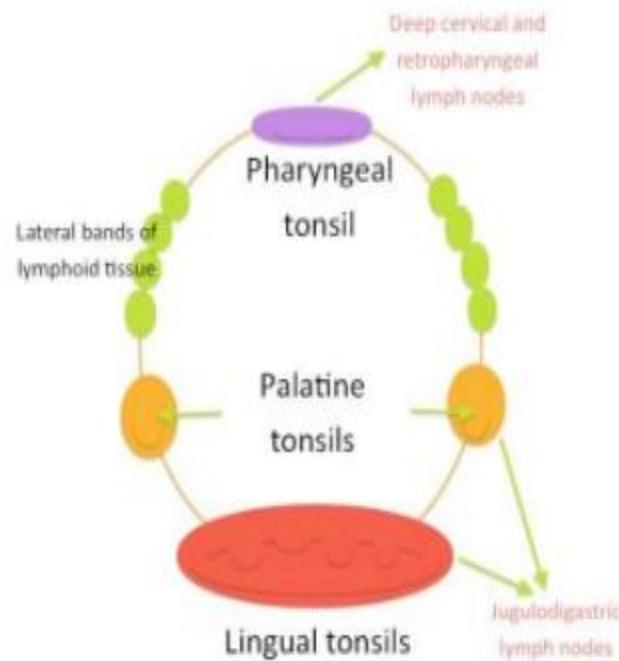
- Non-Hodgkin lymphomas—These include **follicular lymphoma** (composed of collections of small lymphocytes in a follicle or nodule arrangement) and **large cell lymphoma** (composed of large lymphocytes that infiltrate nodes and tissues diffusely).
- Non-Hodgkin lymphomas are mostly B cell lymphomas and rarely T cell malignancies.

**TABLE 13–7 Differences between Hodgkin and Non-Hodgkin Lymphomas**

Hodgkin Lymphoma	Non-Hodgkin Lymphoma
More often localized to a single axial group of nodes (cervical, mediastinal, para-aortic)	More frequent involvement of multiple peripheral nodes
Orderly spread by contiguity	Noncontiguous spread
Mesenteric nodes and Waldeyer ring rarely involved	Waldeyer ring and mesenteric nodes commonly involved
Extra-nodal presentation rare	Extra-nodal presentation common

# Waldeyer's Ring

- Waldeyer's tonsillar ring includes
  1. Adenoid tonsil
  2. Two tubal tonsils
  3. Two palatine tonsils
  4. Lingual tonsil.



- **multiple myeloma** - Malignant tumor of bone marrow cells.
- **thymoma** - Malignant tumor of the thymus gland.

# LABORATORY TESTS

- CD4+
- **ELISA cell count** (enzyme-linked immunosorbent assay)
  - detect anti-HIV antibodies
  - confirmed with a **Western blot test**
- **immunolectrophoresis** - Test that separates immunoglobulins (IgM, IgG, IgE, IgA, IgD).
- **viral load test** - Measurement of the amount of AIDS virus (HIV) in the bloodstream.
- **computed tomography (CT) scan** - X-ray imaging produces cross-sectional and other views of anatomic structures.

# **IMMUNOTHERAPY**

- **Immunotherapy** is the use of antibodies, B cells (producing antibodies), and T cells to treat disease such as cancer. Types of immunotherapy are:
- **Monoclonal antibodies (MoAb)**
- **Vaccines** (contain antigens (proteins) from a patient's tumor cells)
- **Transfer of immune cells**

COMBINING FORM	MEANING	TERMINOLOGY	MEANING
immun/o	protection	<u>autoimmune</u> disease _____ <i>Examples are rheumatoid arthritis and systemic lupus erythematosus. These are chronic, disabling diseases caused by the abnormal production of antibodies against normal body tissues. Signs and symptoms are inflammation of joints, skin rash, and fever. Glucocorticoid drugs (prednisone) and other immunosuppressants (azathioprine, methotrexate) are effective as treatment but make patients susceptible to infection.</i> <u>immunoglobulin</u> _____ <u>immunosuppression</u> _____ <i>This may occur because of exposure to drugs (corticosteroids) or as the result of disease (AIDS and cancer). Immunosuppressed patients are susceptible to infection with fungi, Pneumocystis bacteria, and other pathogens.</i>	
lymph/o	lymph	<u>lymphopoiesis</u> _____ <u>lymphedema</u> _____ <i>Interstitial fluid collects within the spaces between cells as a result of obstruction of lymphatic vessels and nodes. Radiation therapy may destroy lymphatics and produce lymphedema, as in breast cancer treatment (Figure 14-10).</i>	

COMBINING FORM	MEANING	TERMINOLOGY	MEANING
lymphaden/o	lymph node (gland)	<u>lymphadenopathy</u> _____ <u>lymphadenitis</u> _____	
splen/o	spleen	<u>splenomegaly</u> _____ <i>Note that the combining form for spleen contains only one e.</i> <u>splenectomy</u> _____ <u>asplenia</u> _____ <i>The condition may be congenital or result from surgical removal.</i> <u>hypersplenism</u> _____ <i>A syndrome marked by splenomegaly and often associated with blood cell destruction, anemia, leukopenia, and thrombocytopenia.</i>	
thym/o	thymus gland	<u>thymectomy</u> _____	
tox/o	poison	<u>toxic</u> _____	

## PREFIXES

PREFIX	MEANING	TERMINOLOGY	MEANING
ana-	again, anew	<u>anaphylaxis</u> _____ <i>The suffix -phylaxis means protection. This is an unusual hypersensitivity to previously encountered foreign proteins or other antigens. Vasodilation and a decrease in blood pressure can be life-threatening.</i>	
inter-	between	<u>interstitial fluid</u> _____ <i>The suffix -stitial means pertaining to standing or positioned.</i>	

AIDS	acquired immunodeficiency syndrome	HSV	herpes simplex virus
CD4+ cell	helper T cell	IgA, IgD, IgE, IgG, IgM	immunoglobulins
CD8+ cell	cytotoxic T cell		
CMV	cytomegalovirus—causes opportunistic AIDS-related infection	IL1 to IL15	interleukins
Crypto	<i>Cryptococcus</i> —causes opportunistic AIDS-related infection	KS	Kaposi sarcoma
ELISA	enzyme-linked immunosorbent assay—test to detect anti-HIV antibodies	MAI	<i>Mycobacterium avium-intracellulare</i> (MAI) complex—group of pathogens that cause lung and systemic disease in immunocompromised patients
G-CSF	granulocyte colony-stimulating factor—cytokine that promotes neutrophil production	MoAb	monoclonal antibody

GM-CSF	granulocyte-macrophage colony-stimulating factor—cytokine secreted by macrophages to promote growth of myeloid progenitor cells and their differentiation to granulocytes	NHL	non-Hodgkin lymphoma
HAART	highly active antiretroviral therapy—use of combinations of drugs that are effective against AIDS	PCP	<i>Pneumocystis</i> pneumonia—an opportunistic AIDS-related infection
HD	Hodgkin disease	PI	protease inhibitor
Histo	histoplasmosis—fungal infection seen in AIDS patients	RTI	reverse transcriptase inhibitor—for example, zidovudine (Retrovir) or lamivudine (Epivir)
HIV	human immunodeficiency virus—causes AIDS	SCID	severe combined immunodeficiency disease
		Treg	regulatory T cell (suppressor T cell)
		Toxo	toxoplasmosis—parasitic infection associated with AIDS



Thank

You!