

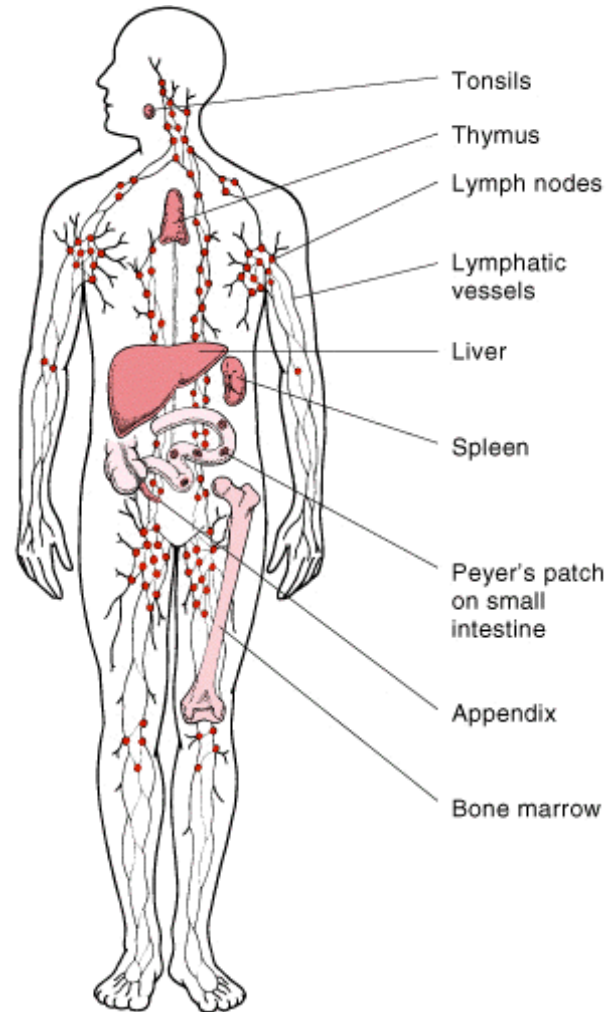
Chapter 12

The Lymphatic System and Body Defenses

Slides 12.1 – 12.22

Lecture Slides in PowerPoint by Jerry L. Cook

The Lymphatic System



The Lymphatic System

- Functions
 - Transport fluids (lymph) back to the blood
 - Play essential roles in body defense and resistance to disease

Lymph

- Materials returned to the blood
 - Water
 - Blood cells
 - Proteins

Lymph

- Harmful materials that enter lymph vessels
 - Bacteria
 - Viruses
 - Cancer cells
 - Cell debris

Lymphatic Vessels

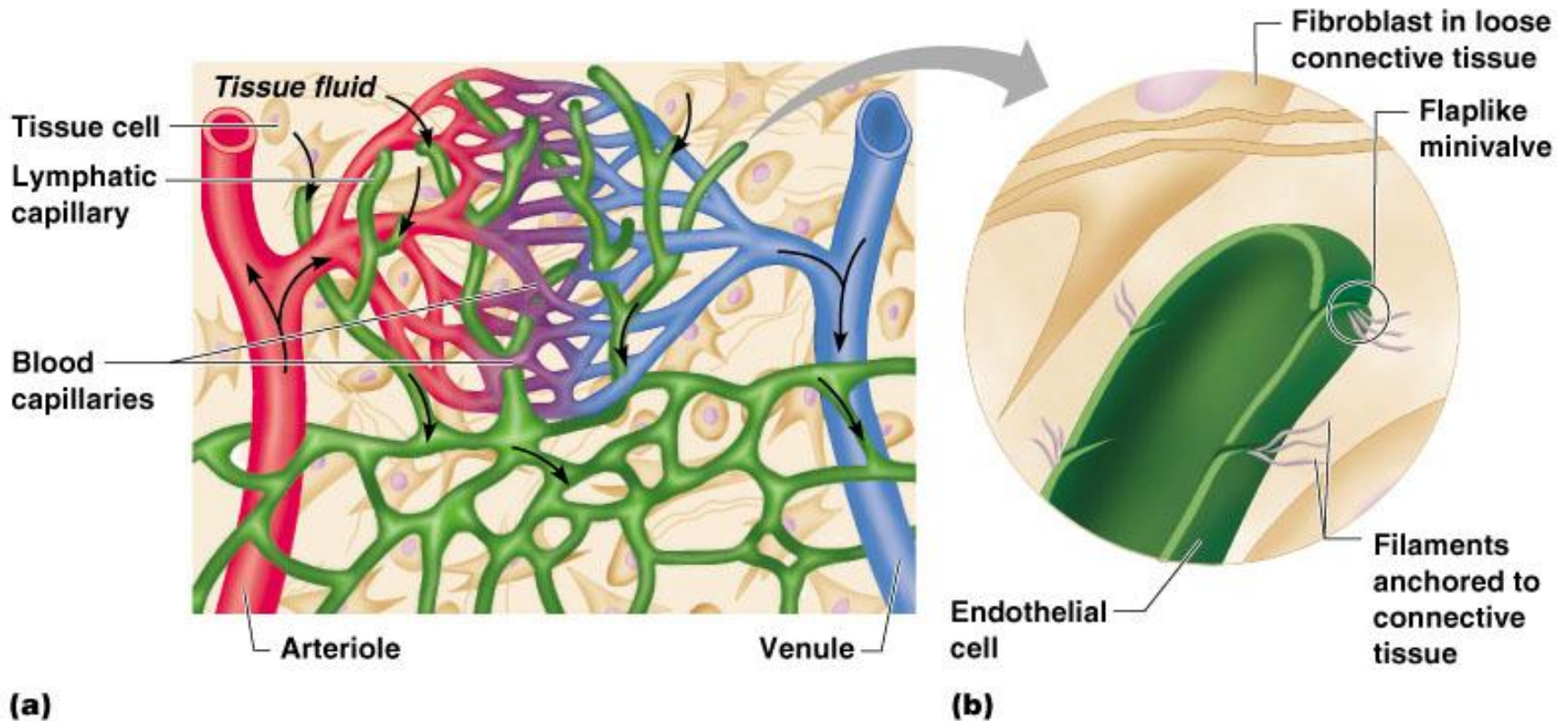


Figure 12.1

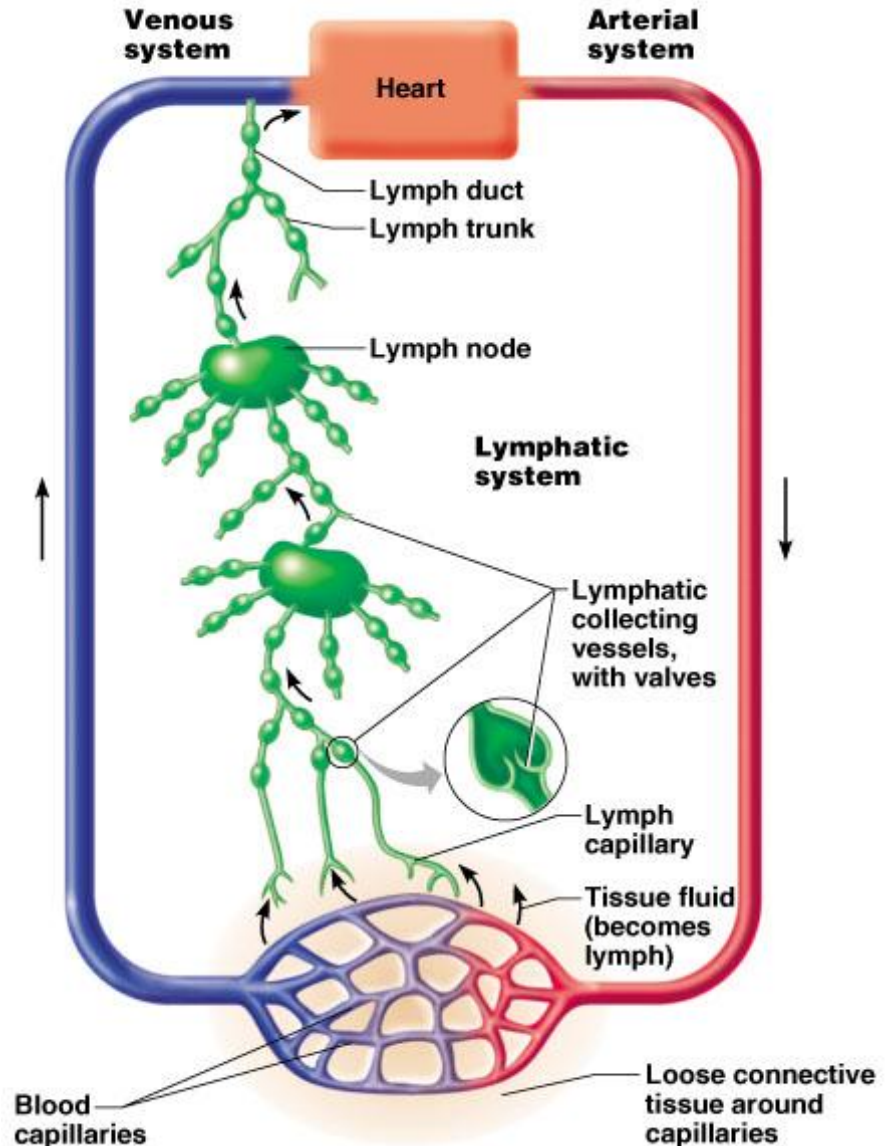
I. Lymphatic Vessels

- Transport of Lymph
 - No pump
 - One way system towards the heart using
 - Milking action of skeletal muscle
 - Rhythmic contraction of smooth muscle in vessel walls

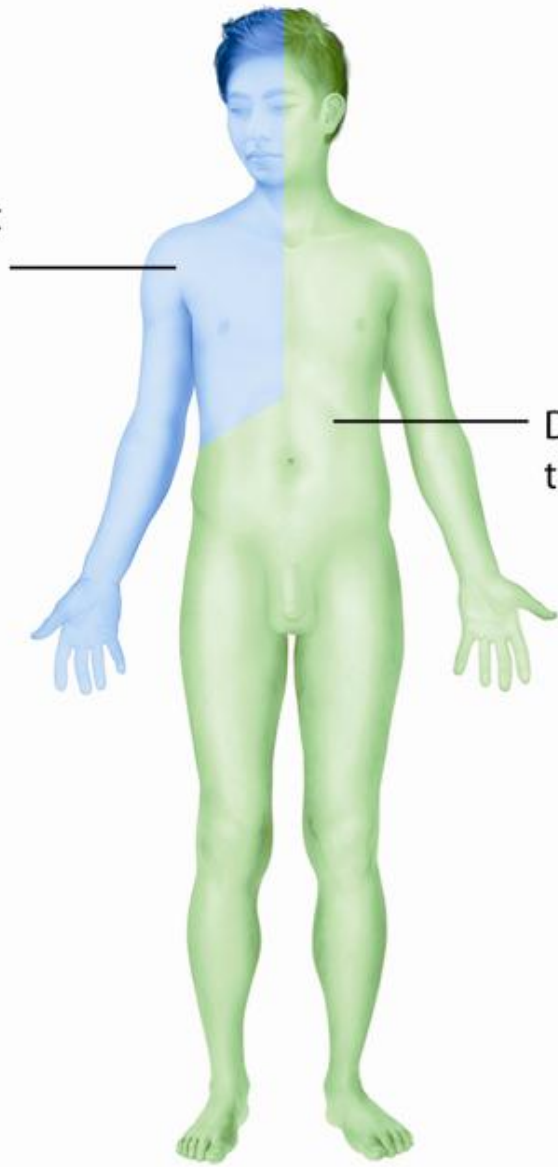
I. Lymphatic Vessels

● Characteristics

- Collects lymph from lymph capillaries
- Carries lymph to and away from lymph nodes
- Returns fluid to circulatory veins near the heart at the
 - Right lymphatic duct
 - Thoracic duct



Drained by right
lymphatic duct



Drained by
thoracic duct

II. Lymph Nodes

- Function
 - Filter lymph (about 4 liters per day) before it is returned to the blood

Lymph Nodes

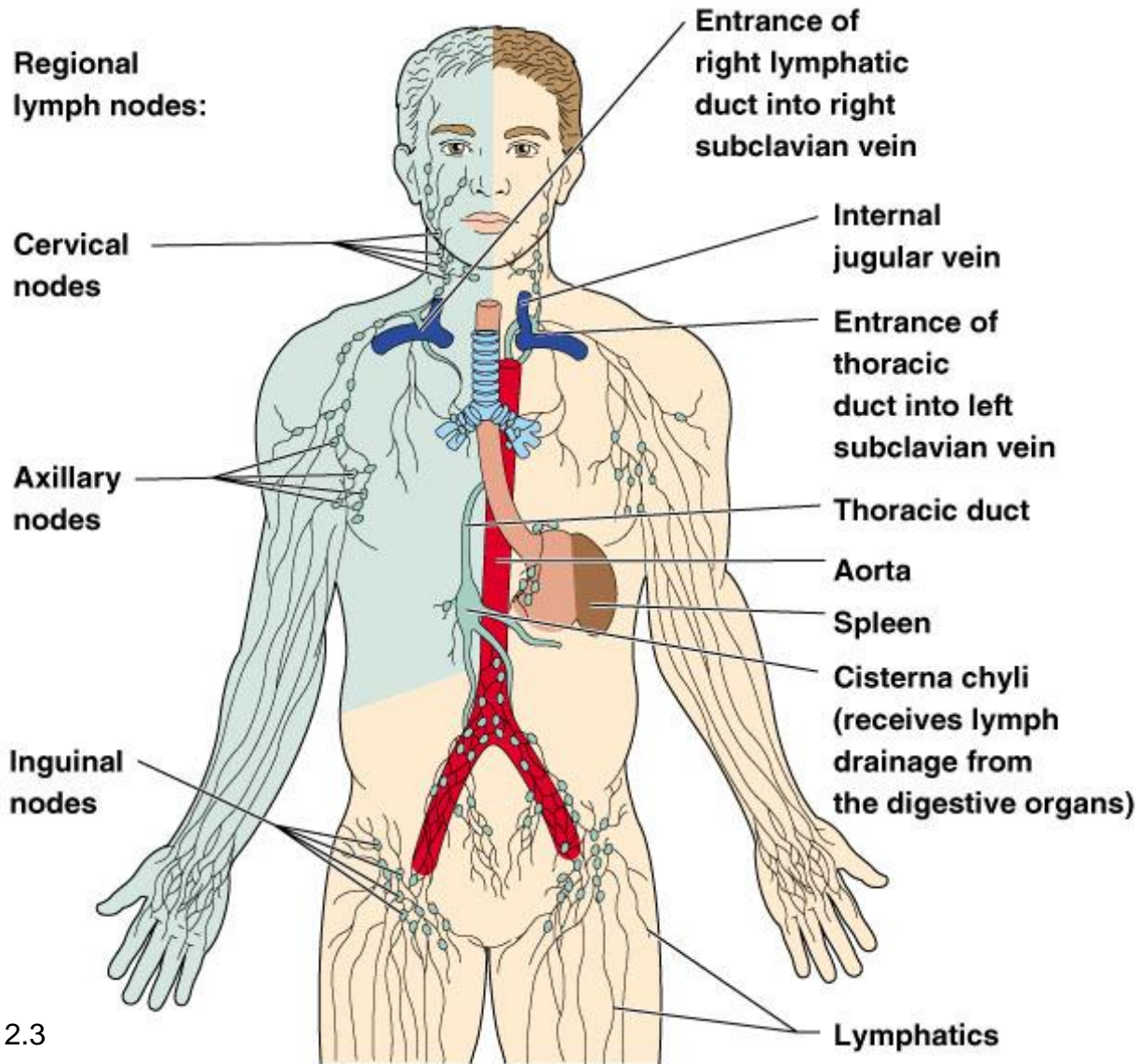
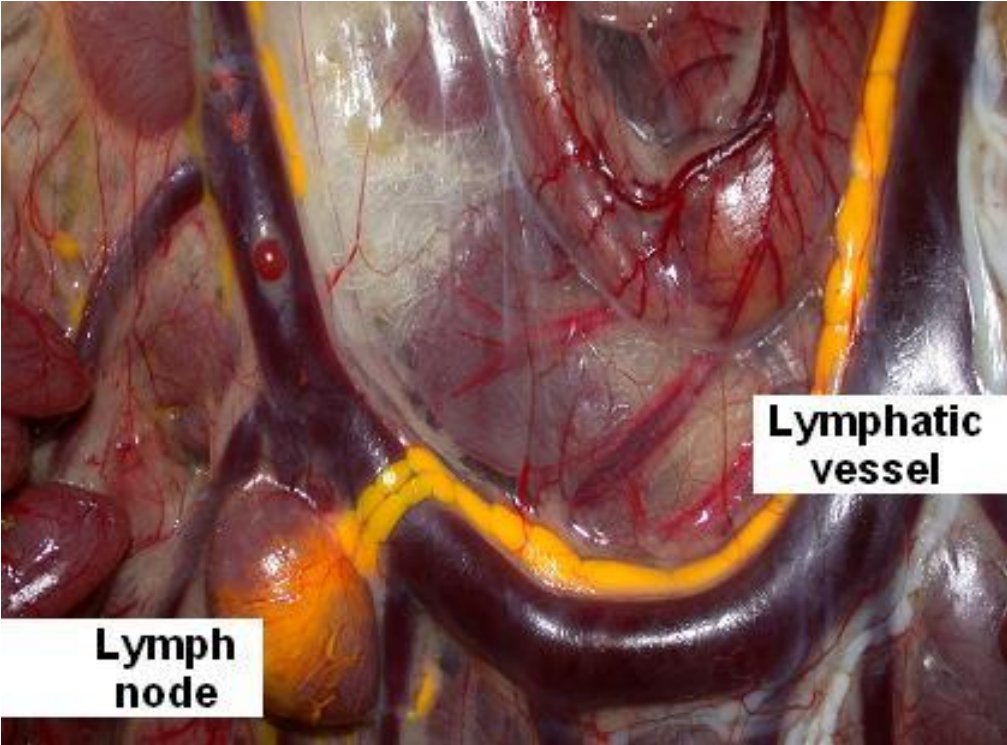


Figure 12.3



**Lymph
node**

**Lymphatic
vessel**

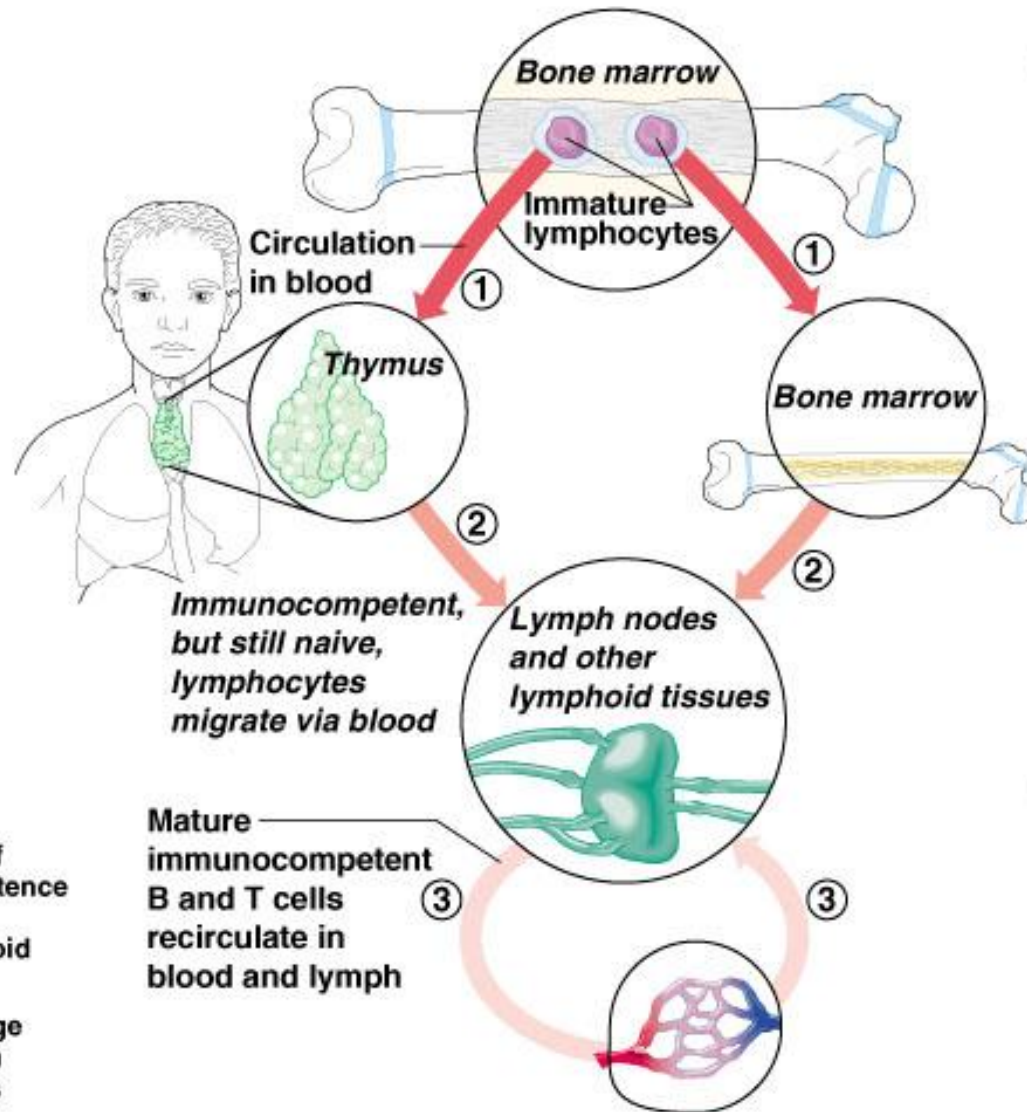
Lymph Node Structure

- Most are kidney-shaped, less than 1 inch long
- Cortex
 - Outer part, contains follicles – collections of lymphocytes
- Medulla
 - Inner part, contains phagocytic macrophages



Enlarged mesenteric lymph nodes in a case of AIDS and *Mycobacterium avium*-complex (MAC) infection.

Activation of Lymphocytes



- ① Lymphocytes destined to become T cells migrate to the thymus and develop immunocompetence there. B cells develop immuno-competence in the bone marrow.
- ② After leaving the thymus or bone marrow as naive immunocompetent cells, lymphocytes “seed” the infected connective tissues (especially lymphoid tissue in the lymph nodes), where the antigen challenge occurs and the lymphocytes become fully activated.
- ③ Activated (mature) lymphocytes circulate continuously in the bloodstream and lymph and throughout the lymphoid organs of the body.

Figure 12.9

Cells of the Immune System

- Lymphocytes
 - Provide immune response to antigens
 - Originate in the red bone marrow
 - B lymphocytes become immunocompetent (mature) in the bone marrow
 - T lymphocytes become immunocompetent in the thymus

Cells of the Immune System

- Macrophages
 - Engulf and destroy foreign substances
 - begin as monocytes
 - leave lymphatic tissue to enter surrounding tissue

Lymph Node Structure

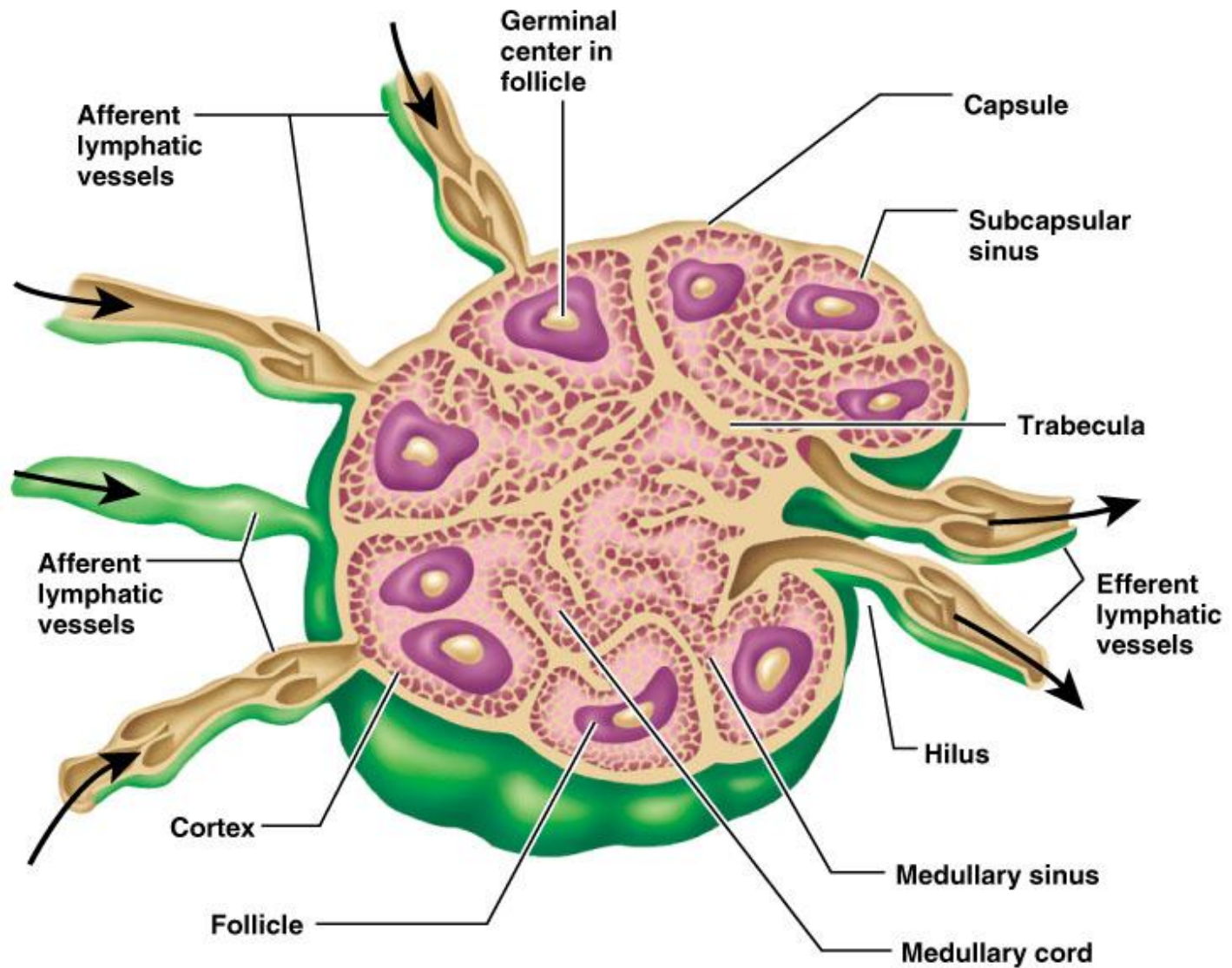
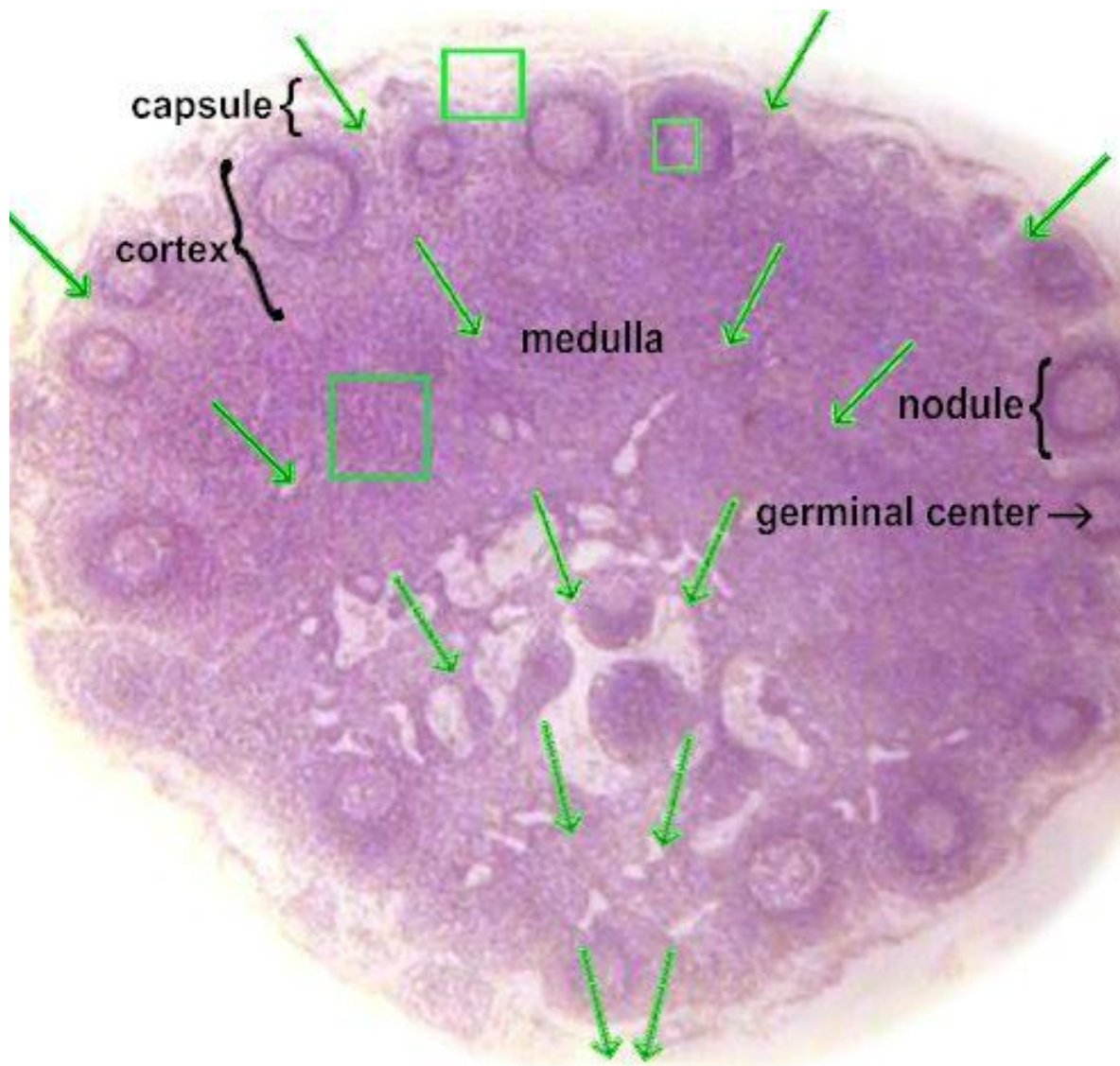
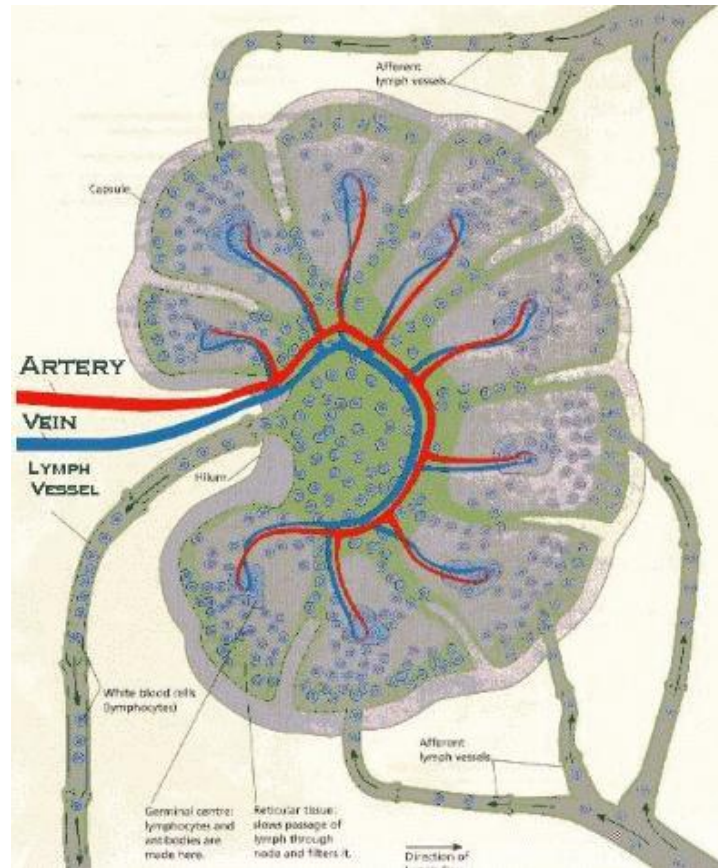
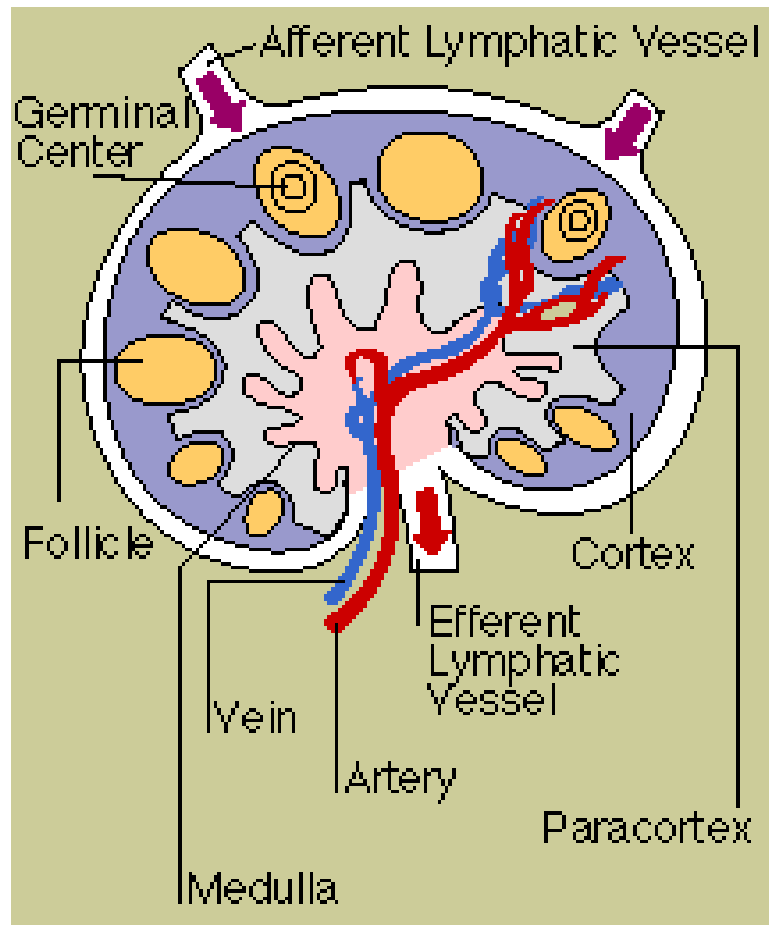


Figure 12.4



Flow of Lymph Through Nodes

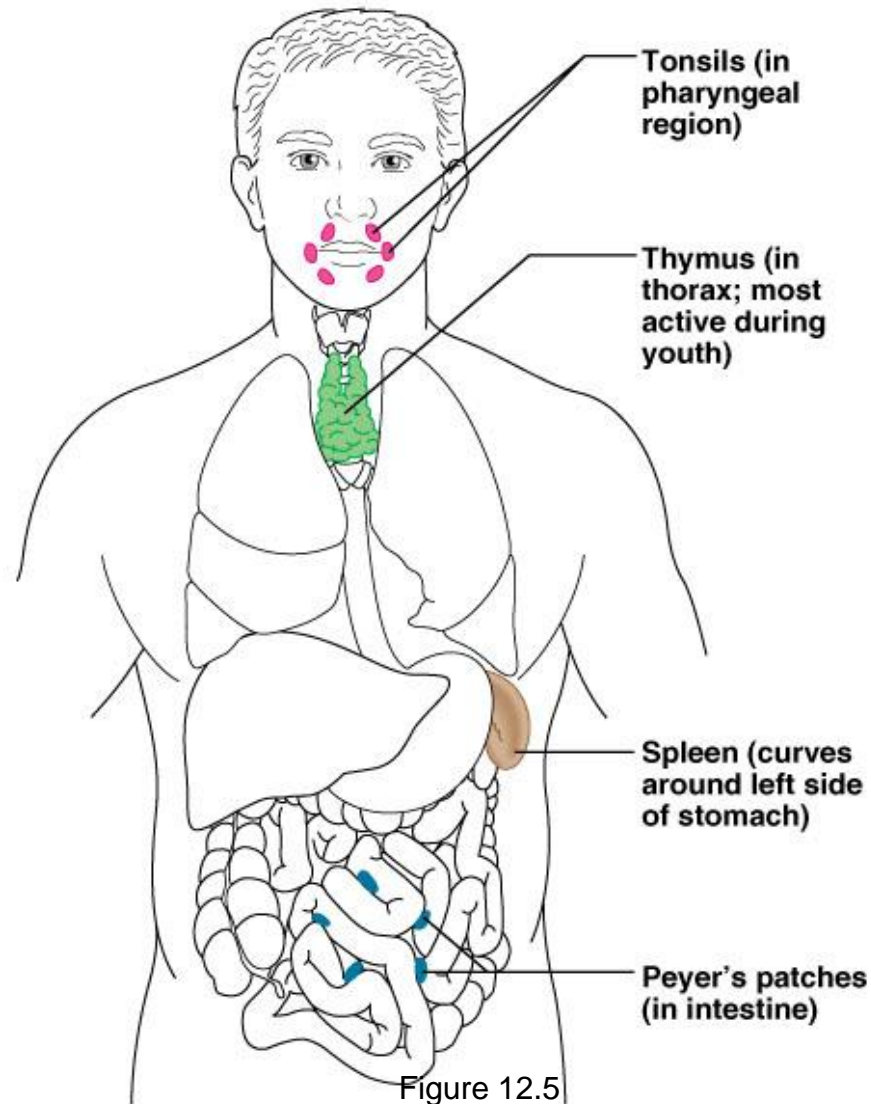




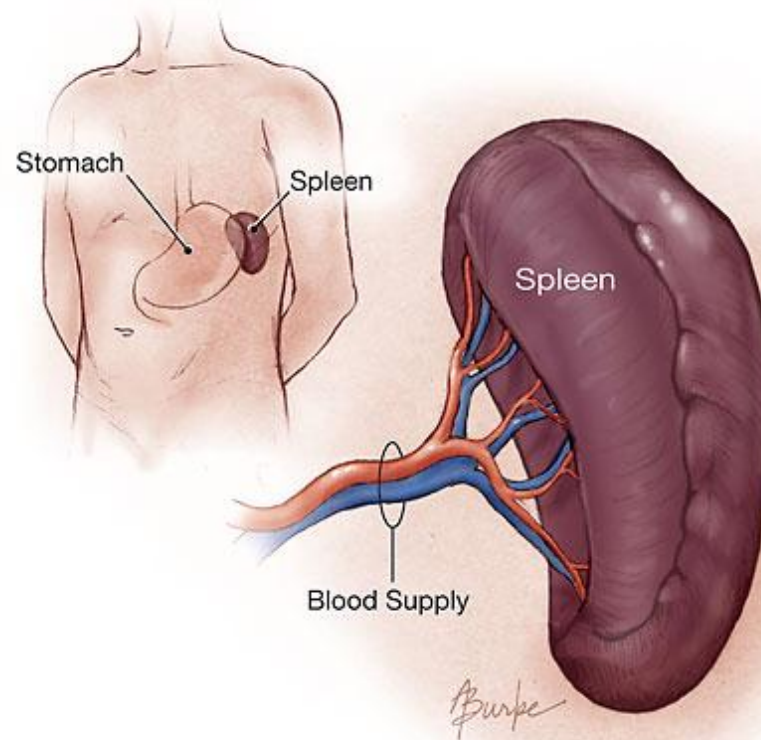
Flow of Lymph Through Nodes

- Enters the convex side through afferent lymphatic vessels
- Exits through efferent lymphatic vessels
- Fewer efferent than afferent vessels causes flow to be slowed

Other Lymphoid Organs



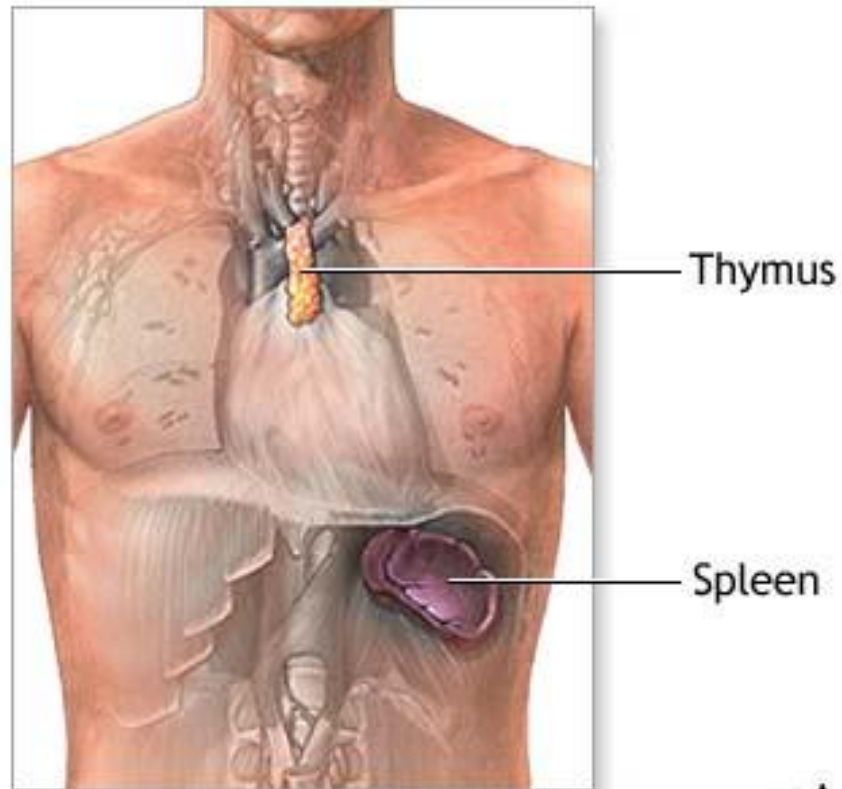
The Spleen



III. The Spleen

- Located on the left side of the abdomen
- Filters blood and destroys worn out blood cells
- Forms blood cells in the fetus
- Acts as a blood reservoir

The Thymus



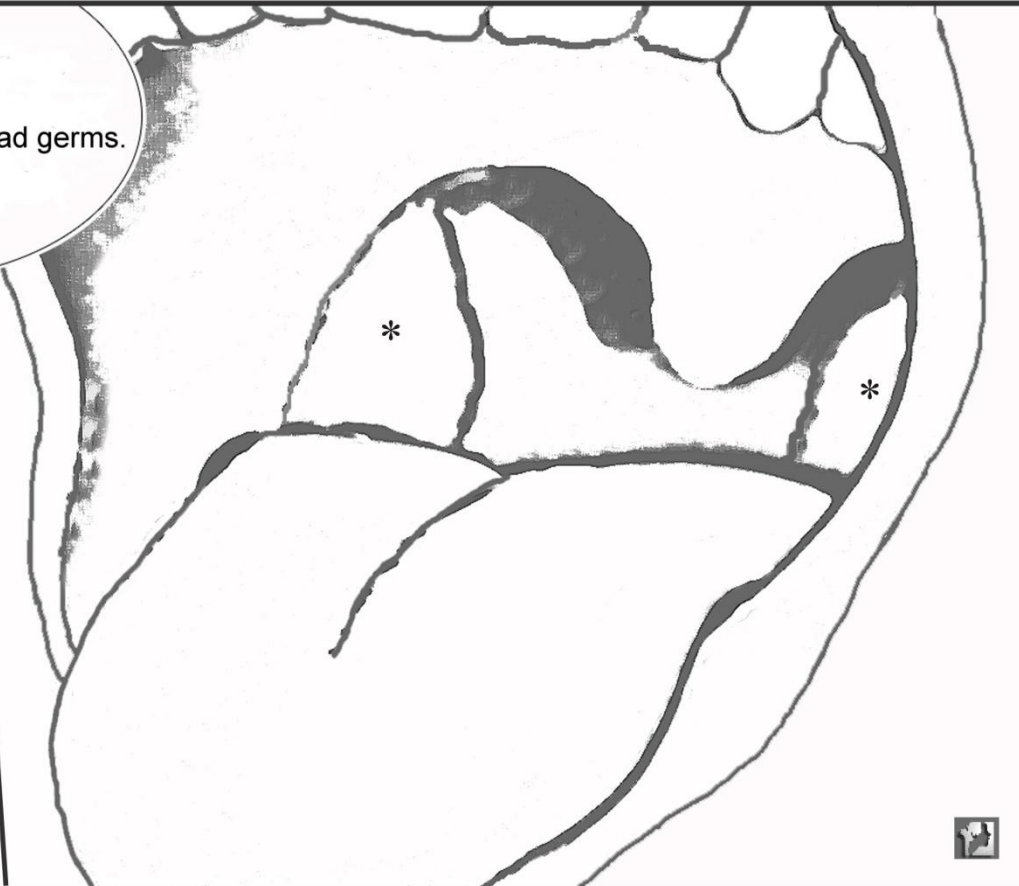
IV. The Thymus

- Located low in the throat, overlying the heart
- Functions at peak levels only during childhood
- Produces hormones to program lymphocytes (T cells)

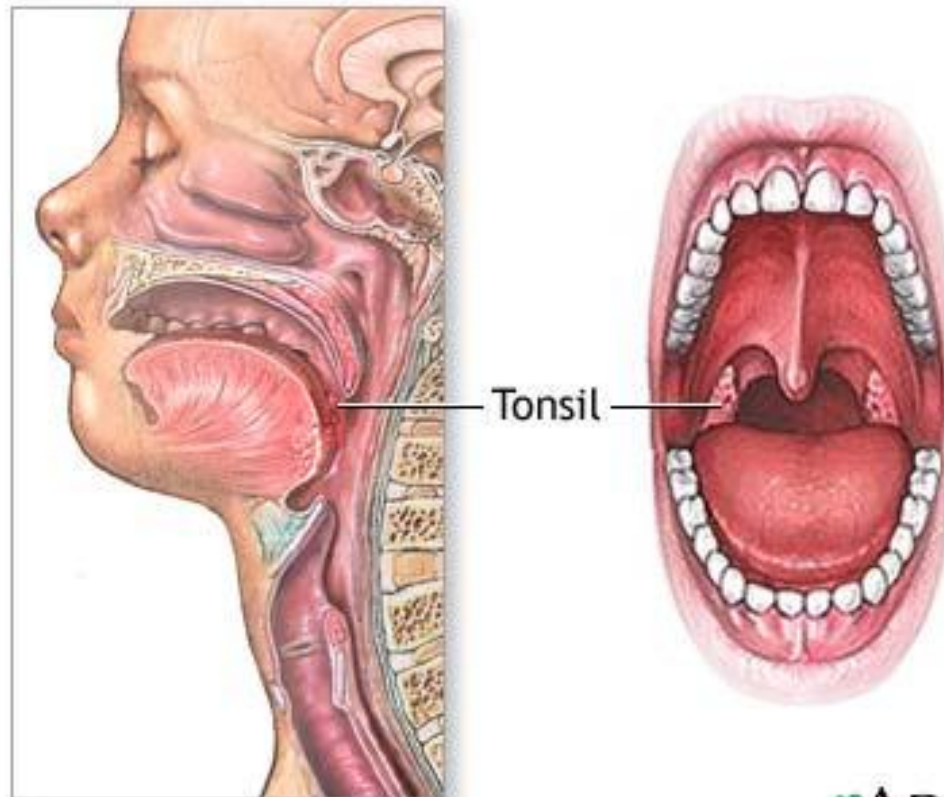
V. Mucosa-Associated Lymphatic Tissue (MALT)

- Includes:
 - Peyer's patches
 - Tonsils & Adenoids
 - Other small accumulations of lymphoid tissue
- **Acts as** a sentinel to protect respiratory and digestive tracts

Look at the tonsils!
They protect you from bad germs.



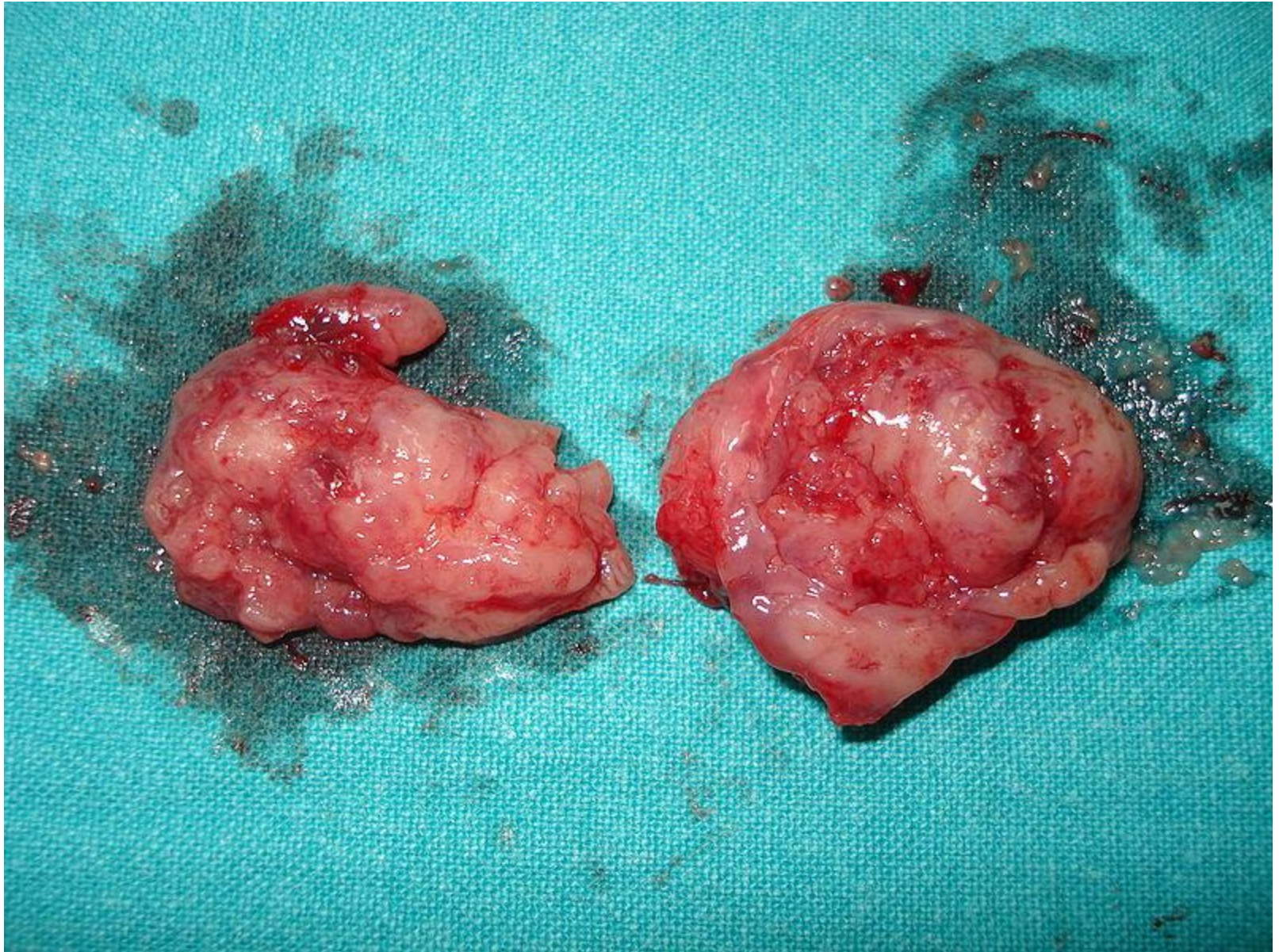
The Tonsils

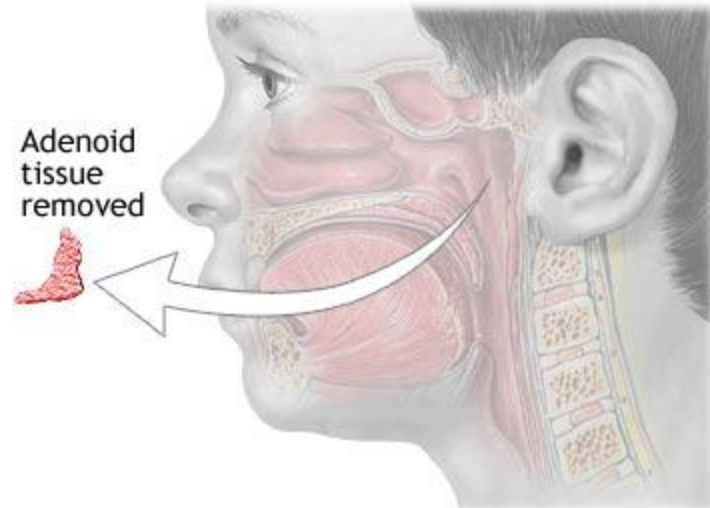
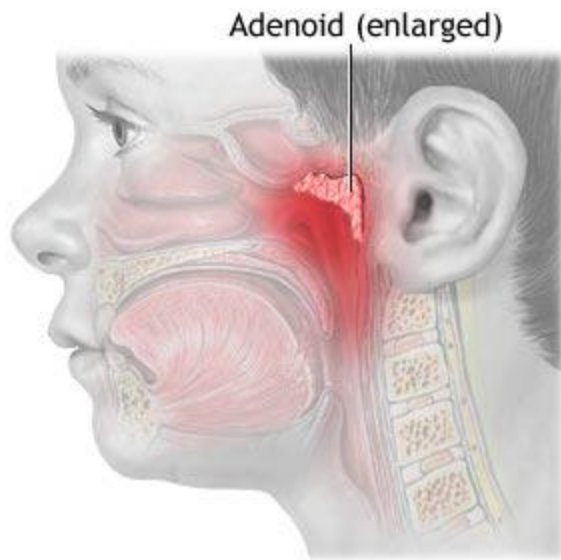
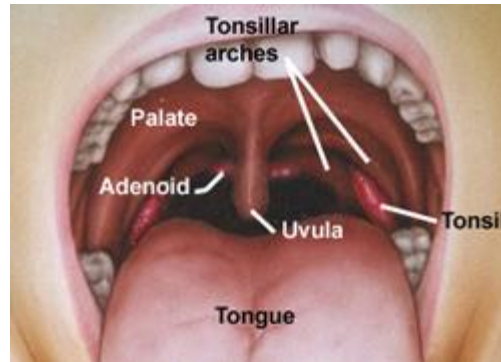


Tonsils/Adnoids

- Small masses of lymphoid tissue around the nasopharynx (adnoids) and oropharynx (tonsils)
- Trap and remove bacteria and other foreign materials
- Tonsillitis is caused by congestion with bacteria





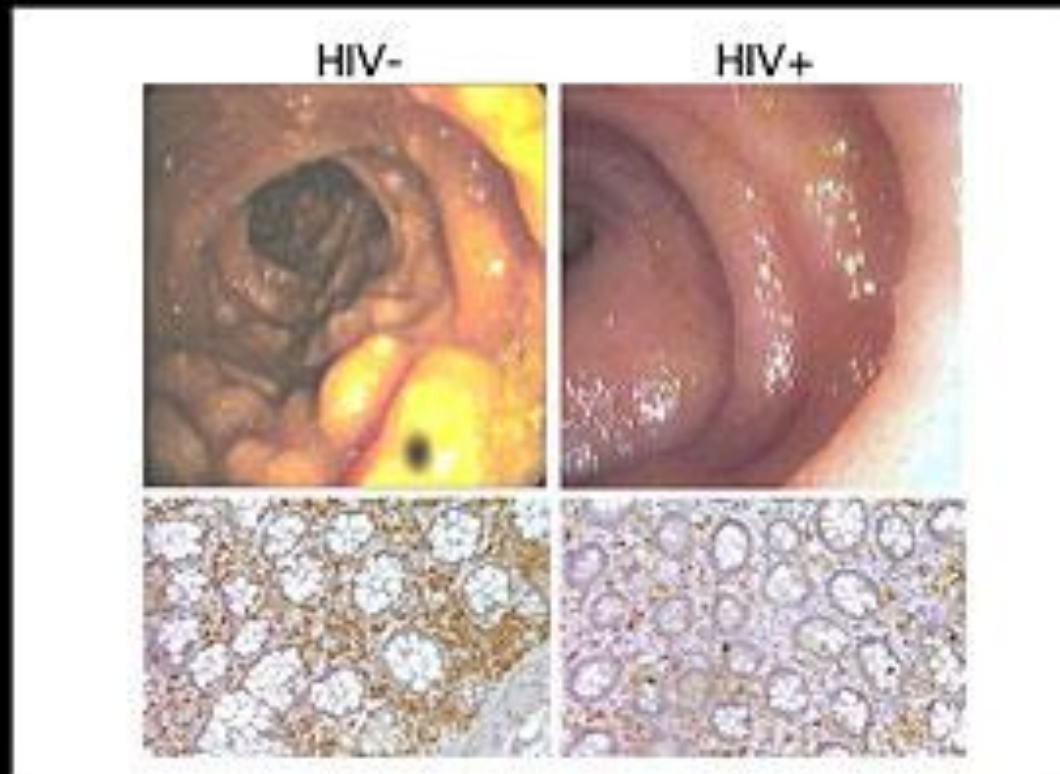


Peyer's Patches

- Found in the wall of the small intestine
- Resemble tonsils in structure
- Capture and destroy bacteria in the intestine



Absence of Peyer's Patches in HIV Infection



slide courtesy of Timothy Schacker, UM

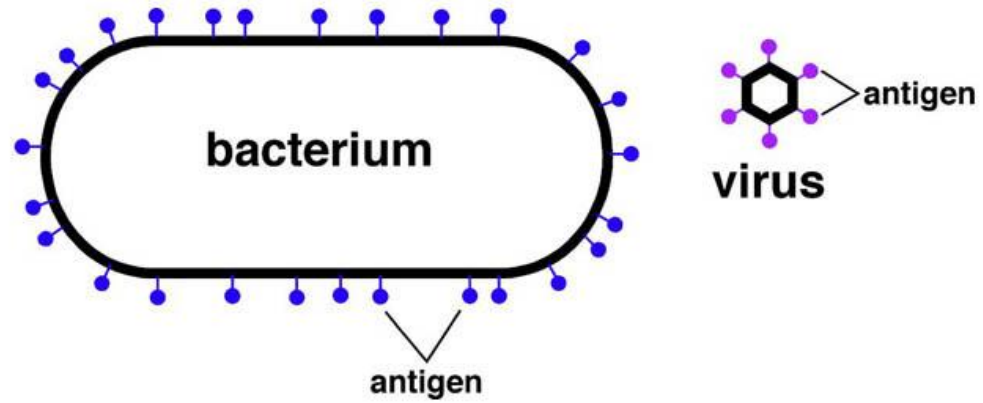
- Video: Introduction to how the immune system works



Antigens (Nonself)

- Any substance capable of exciting the immune system and provoking an immune response

ANTIGENS



Self-Antigens

- Human cells have many surface proteins
- Our immune cells do not attack our own proteins

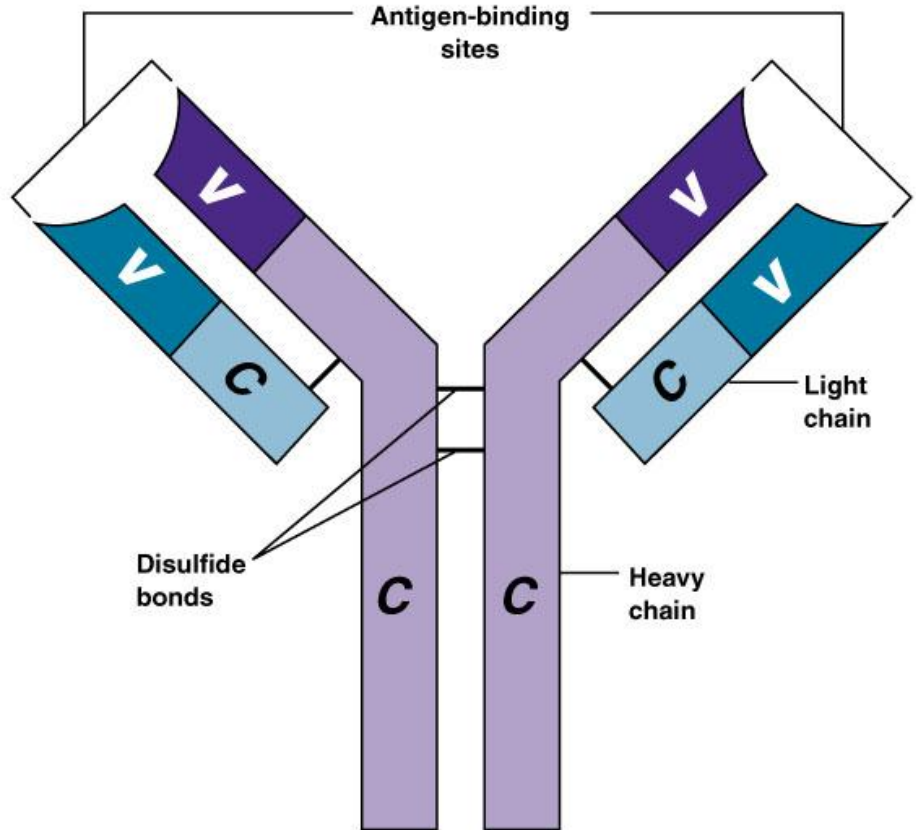
Antibodies (Immunoglobulins) (Igs)

Characteristics

- Soluble proteins secreted by B cells (plasma cells)
- Carried in blood plasma
- Capable of binding to a specific antigen

Antibody Structure

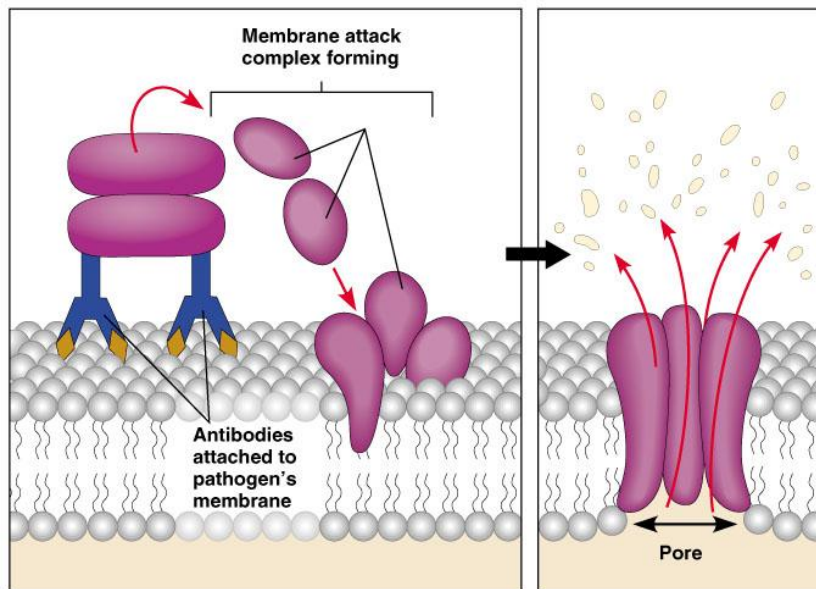
- Four amino acid chains linked by disulfide bonds
- Contains specific antigen-binding sites



(b)

Antibody Classes

- Five major immunoglobulin classes
 - IgM – can fix complement

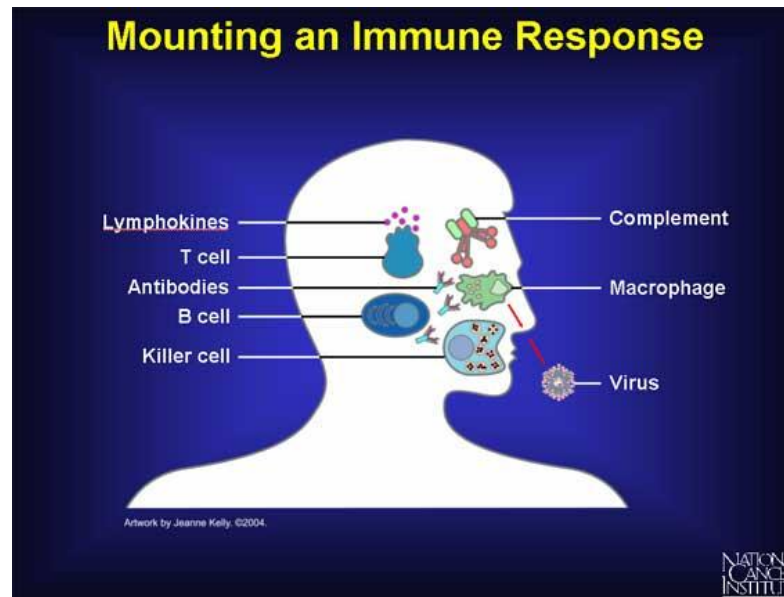


Activated complement proteins attach to pathogen's membrane in step-by-step sequence, forming a membrane attack complex (a MAC attack).

MAC pores in the membrane cause cell lysis.

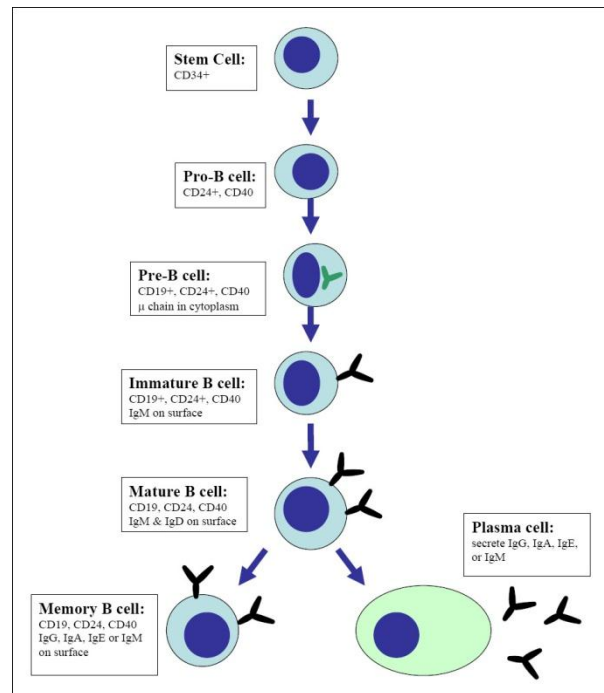
Antibody Classes

- Five major immunoglobulin classes
 - IgA – found mainly in mucus



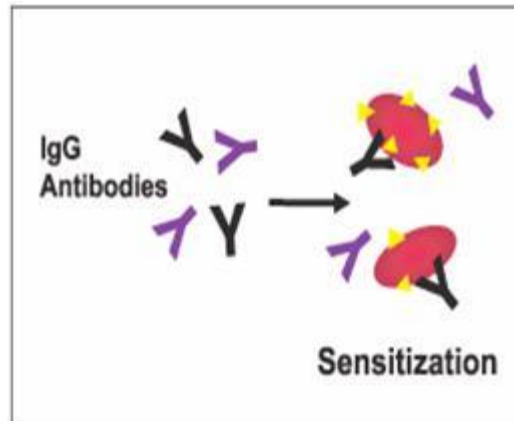
Antibody Classes

- Five major immunoglobulin classes
 - IgD – important in activation of B cell



Antibody Classes

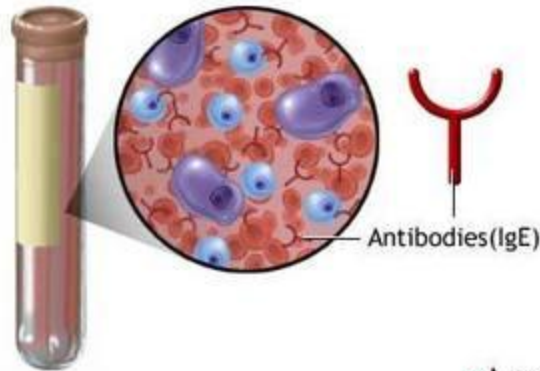
- Five major immunoglobulin classes
 - IgG – smallest, and most numerous form. Can cross the placental barrier.



Antibody Classes

- Five major immunoglobulin classes
 - IgE – involved in allergies

The blood test measures the levels of allergy antibody, or IgE, produced when your blood is mixed with a series of allergens in a laboratory



ADAM.

Antibody Function

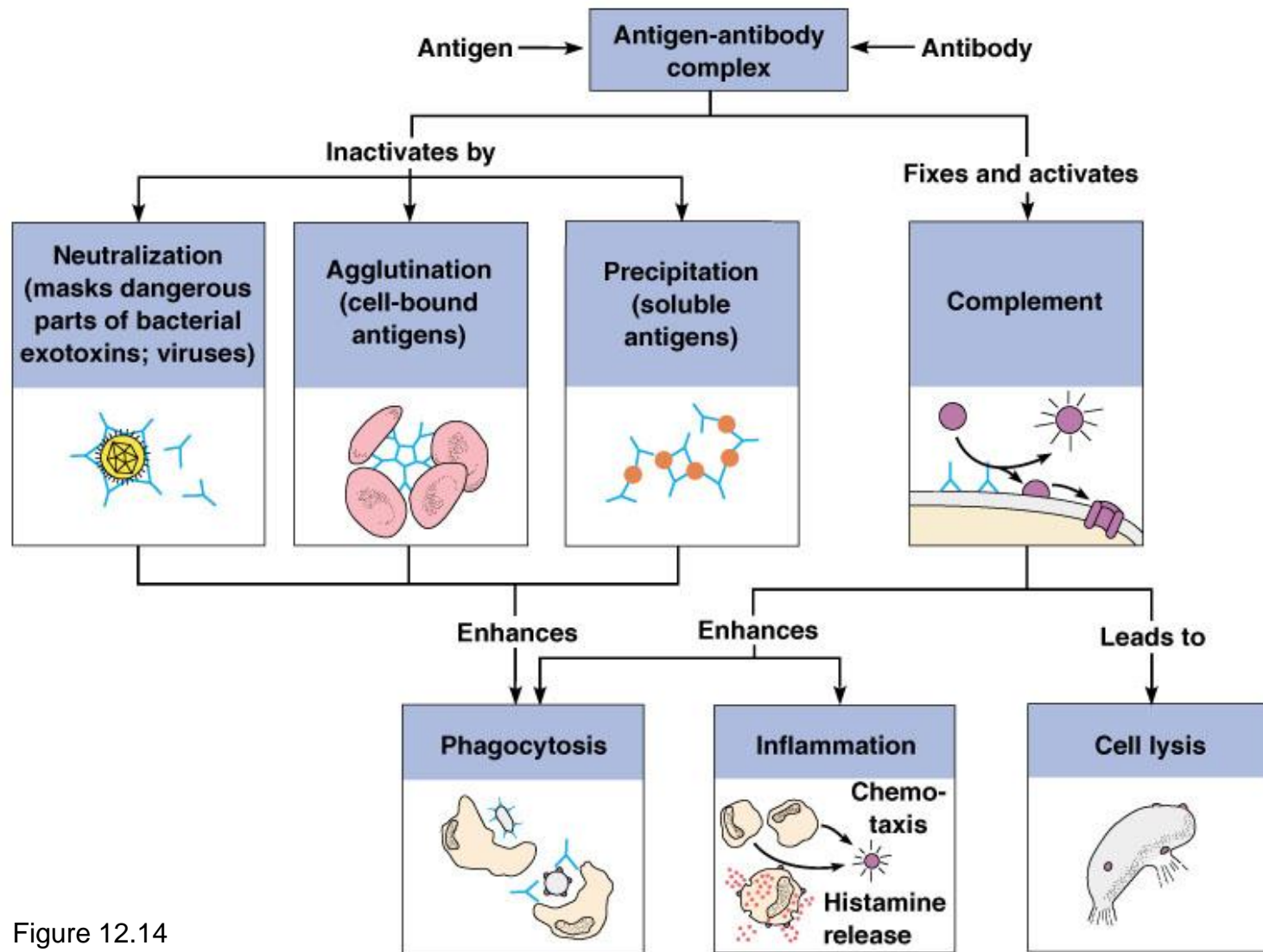


Figure 12.14

Humoral Immune Response

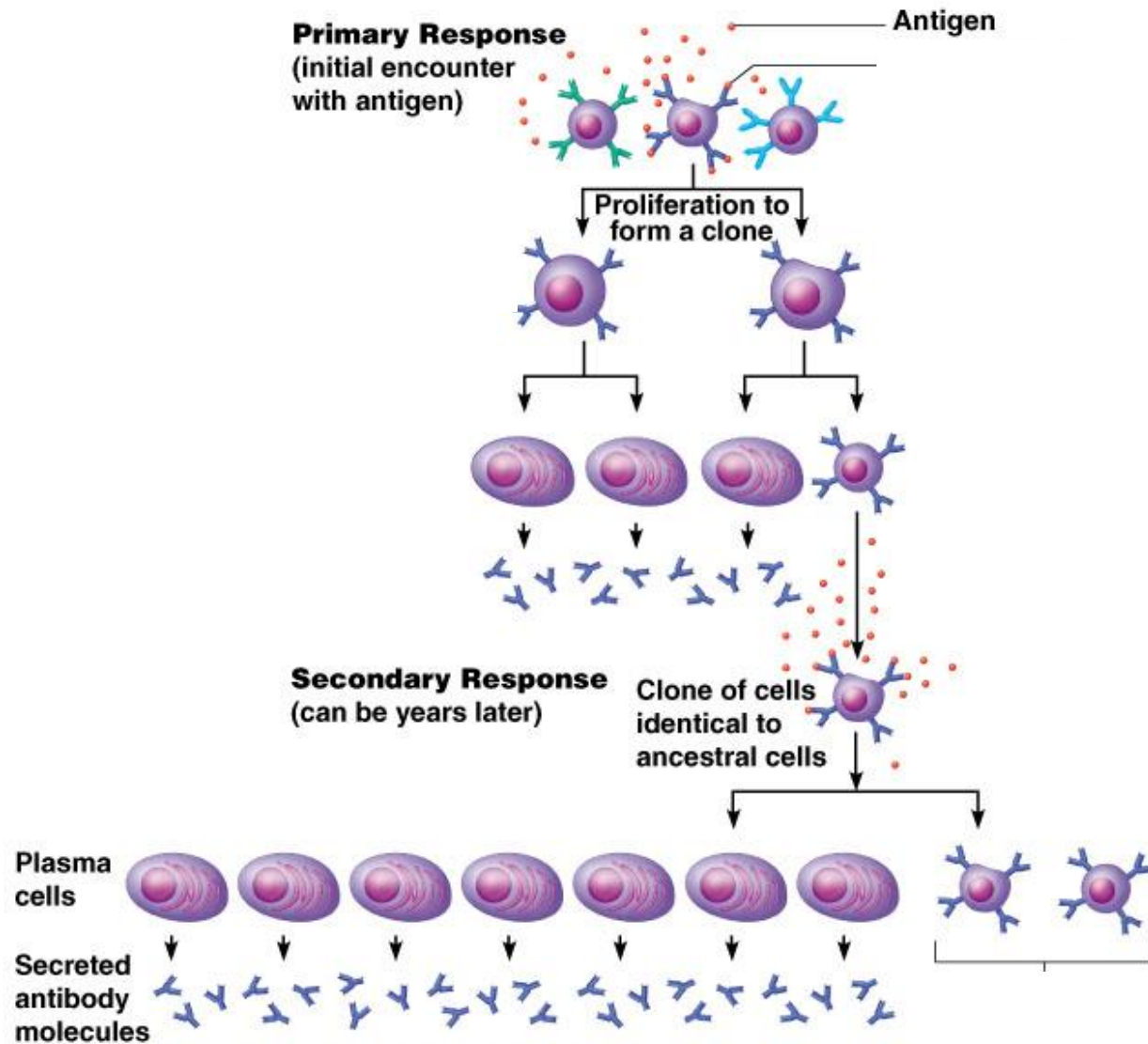


Figure 12.10
Slide 12.32

Humoral Immune Response

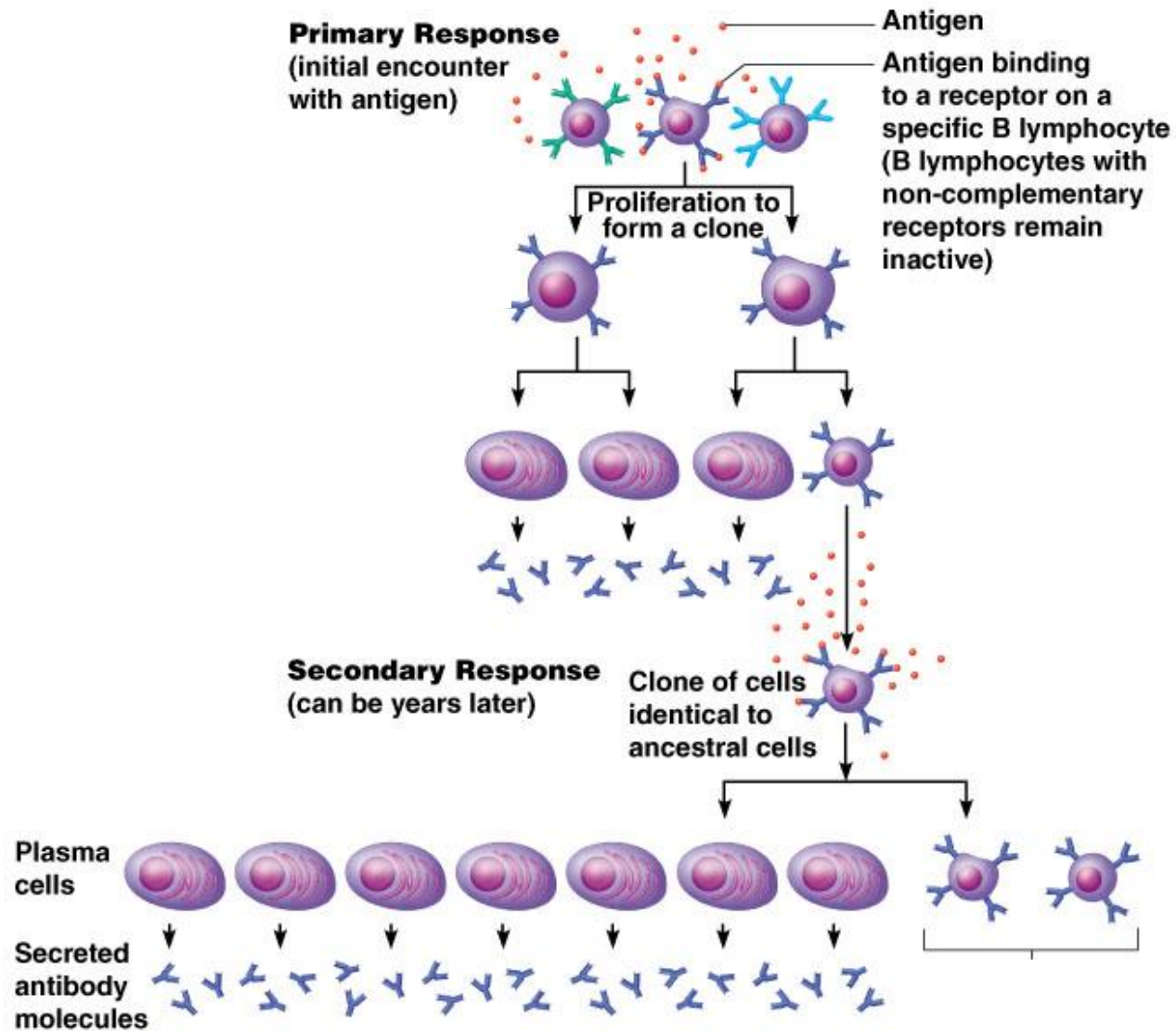


Figure 12.10
Slide 12.32

Humoral Immune Response

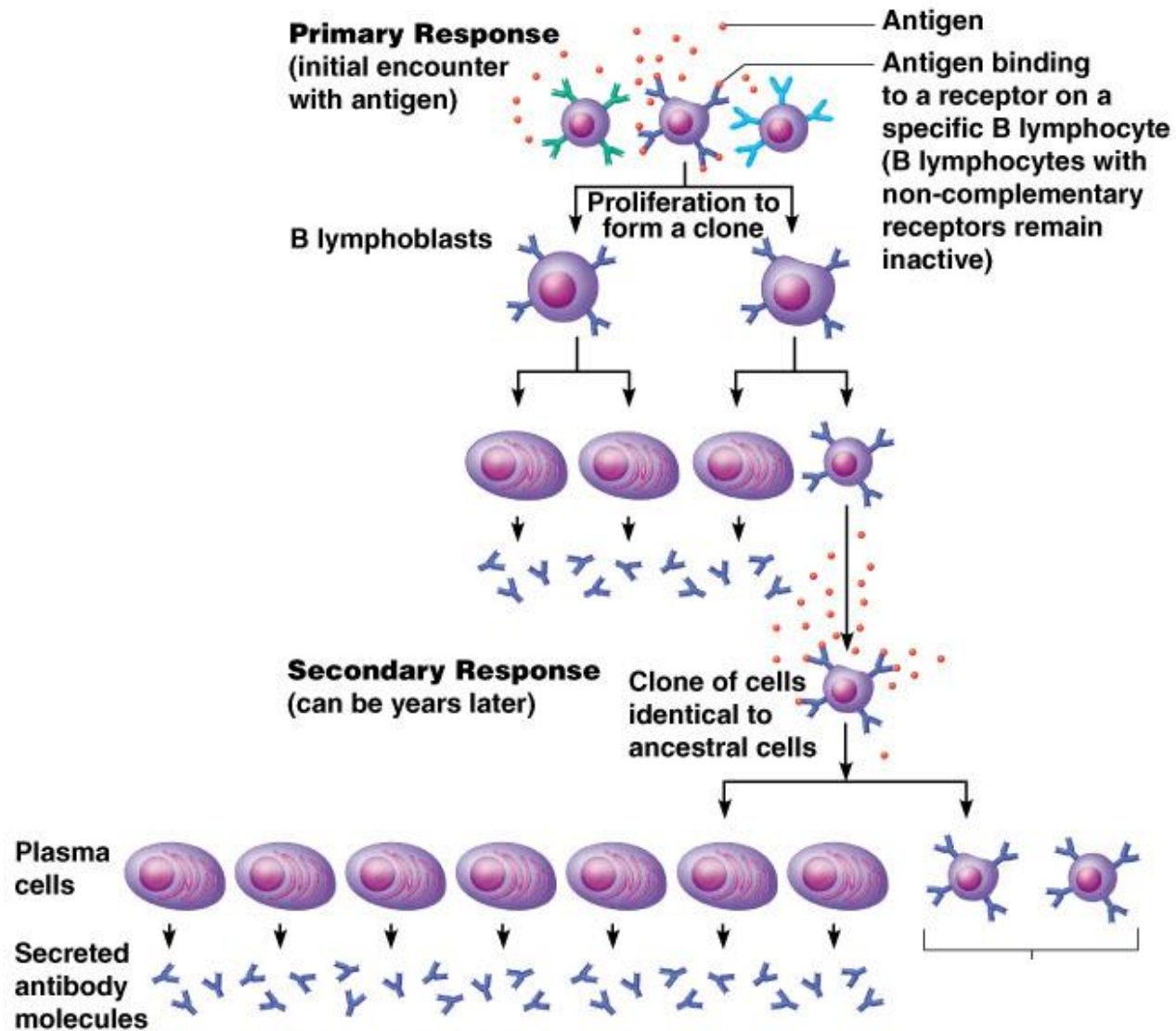


Figure 12.10
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Humoral Immune Response

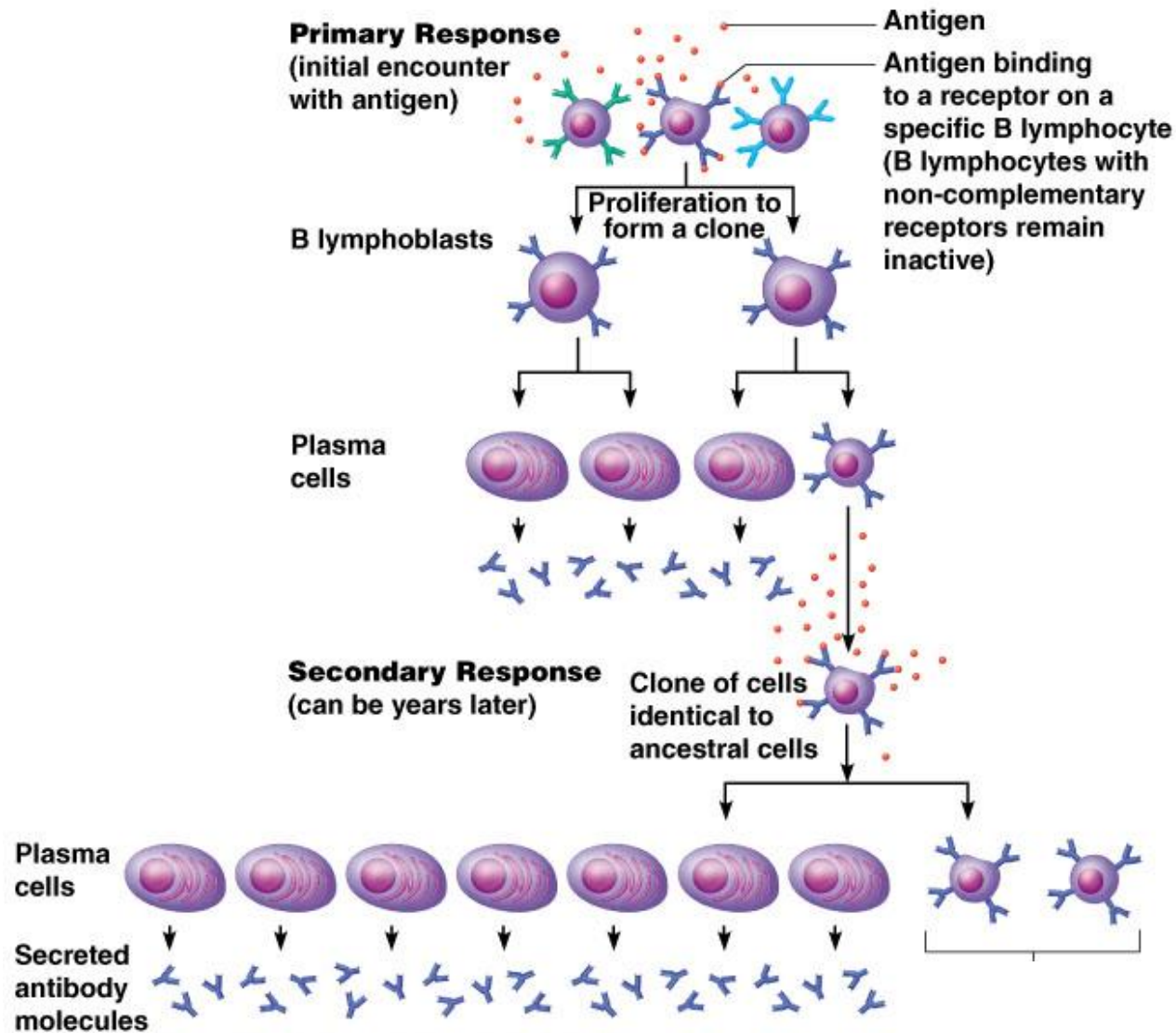


Figure 12.10
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Humoral Immune Response

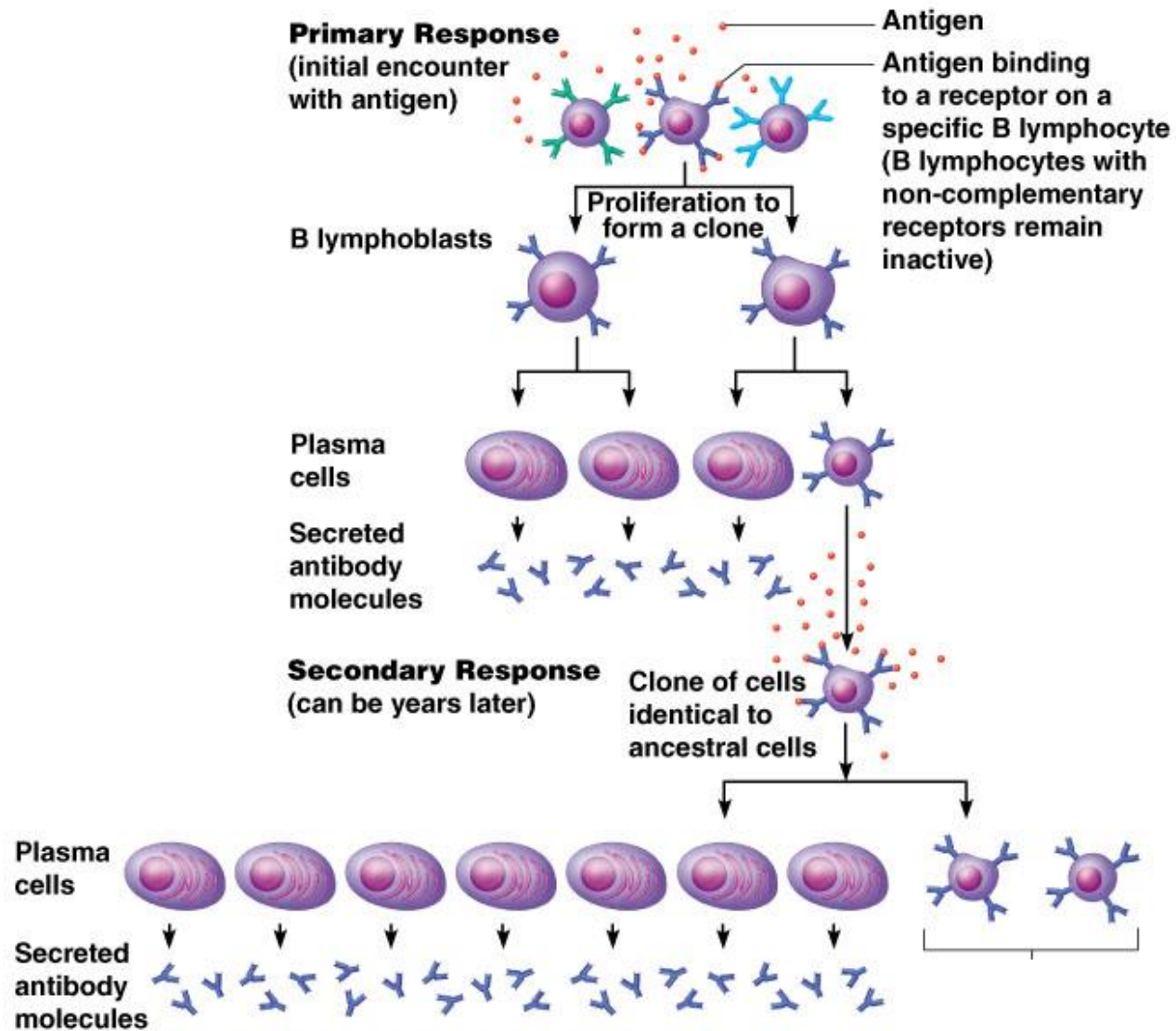


Figure 12.10
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Humoral Immune Response

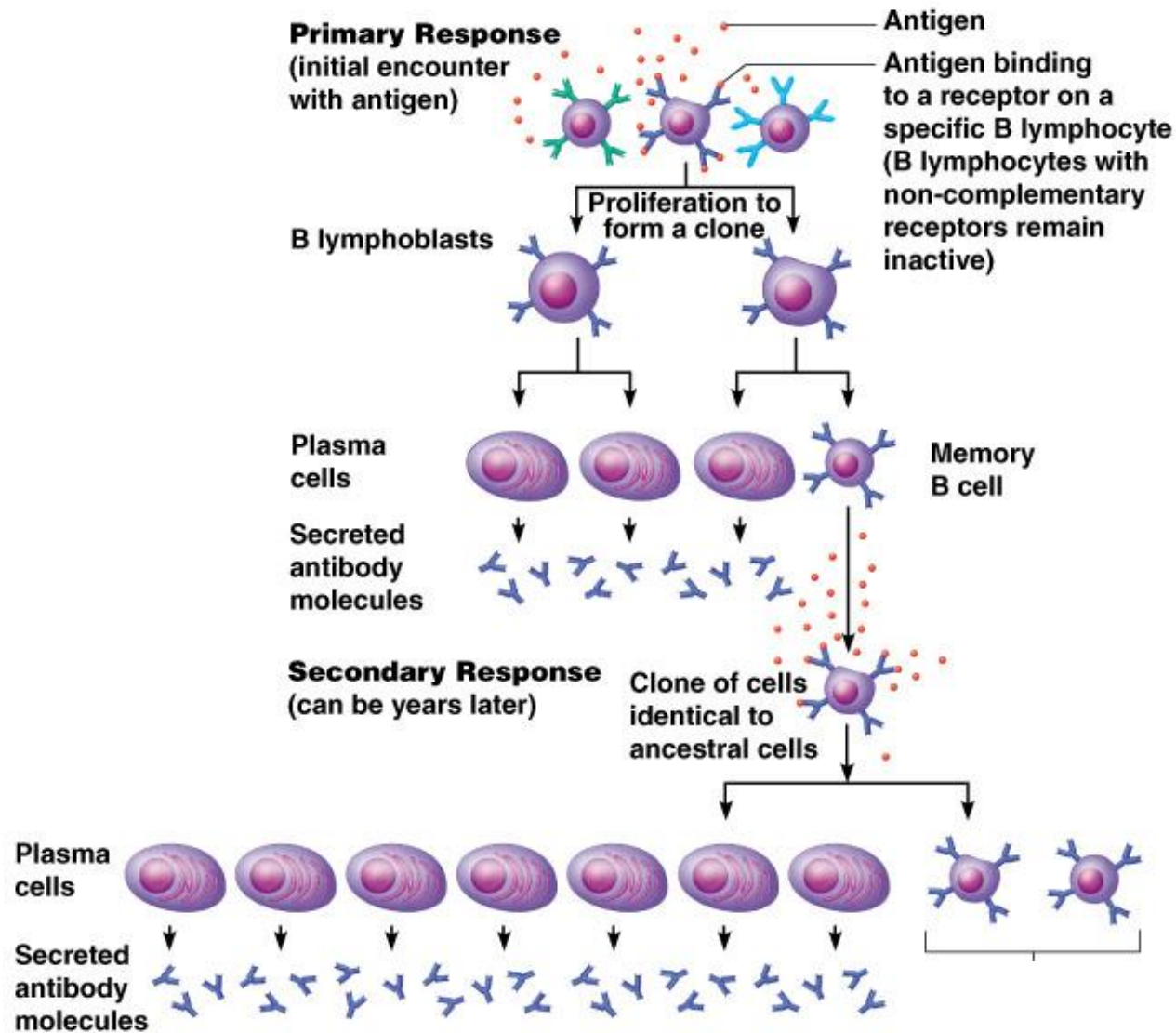


Figure 12.10
Slide 12.32

Humoral Immune Response

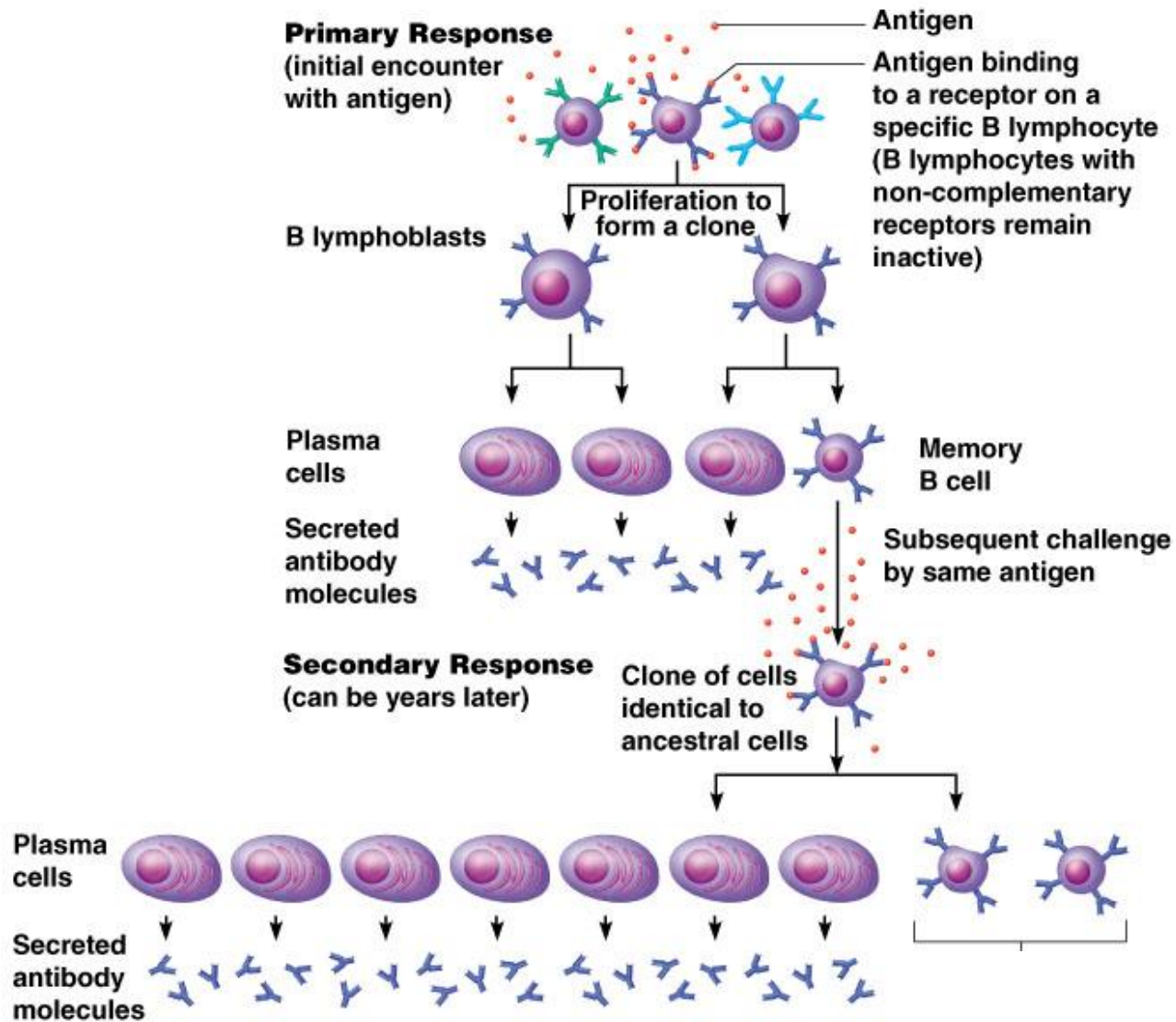


Figure 12.10
Slide 12.32

Humoral Immune Response

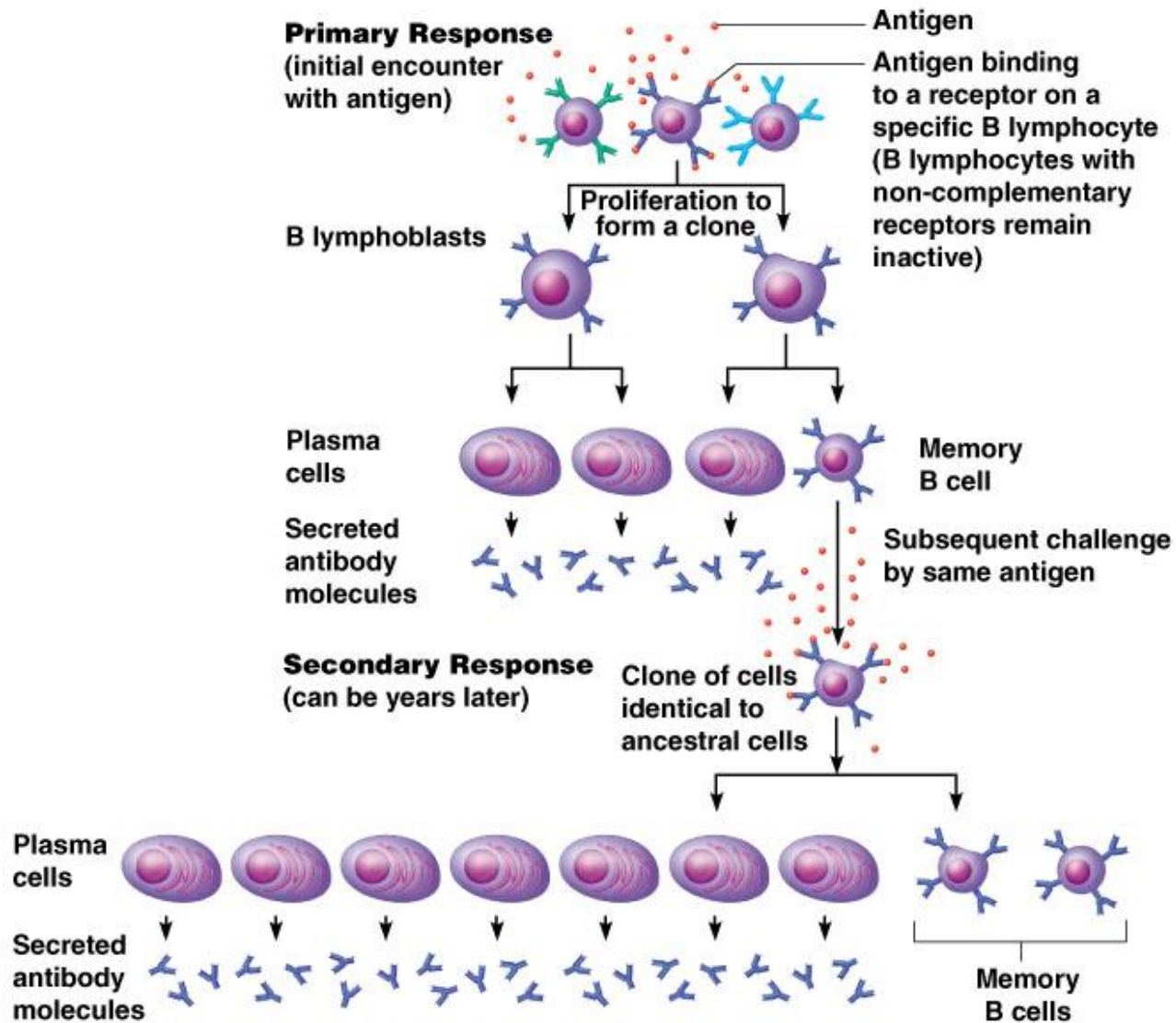


Figure 12.10
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Secondary Response

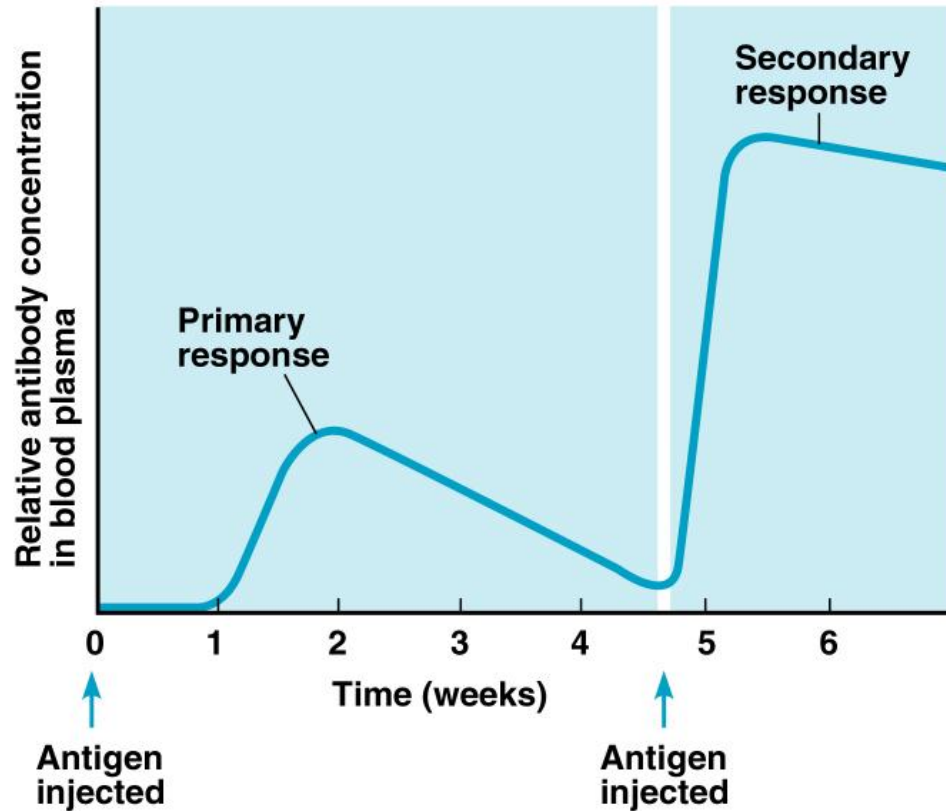


Figure 12.11

Cellular (Cell-Mediated) Immune Response

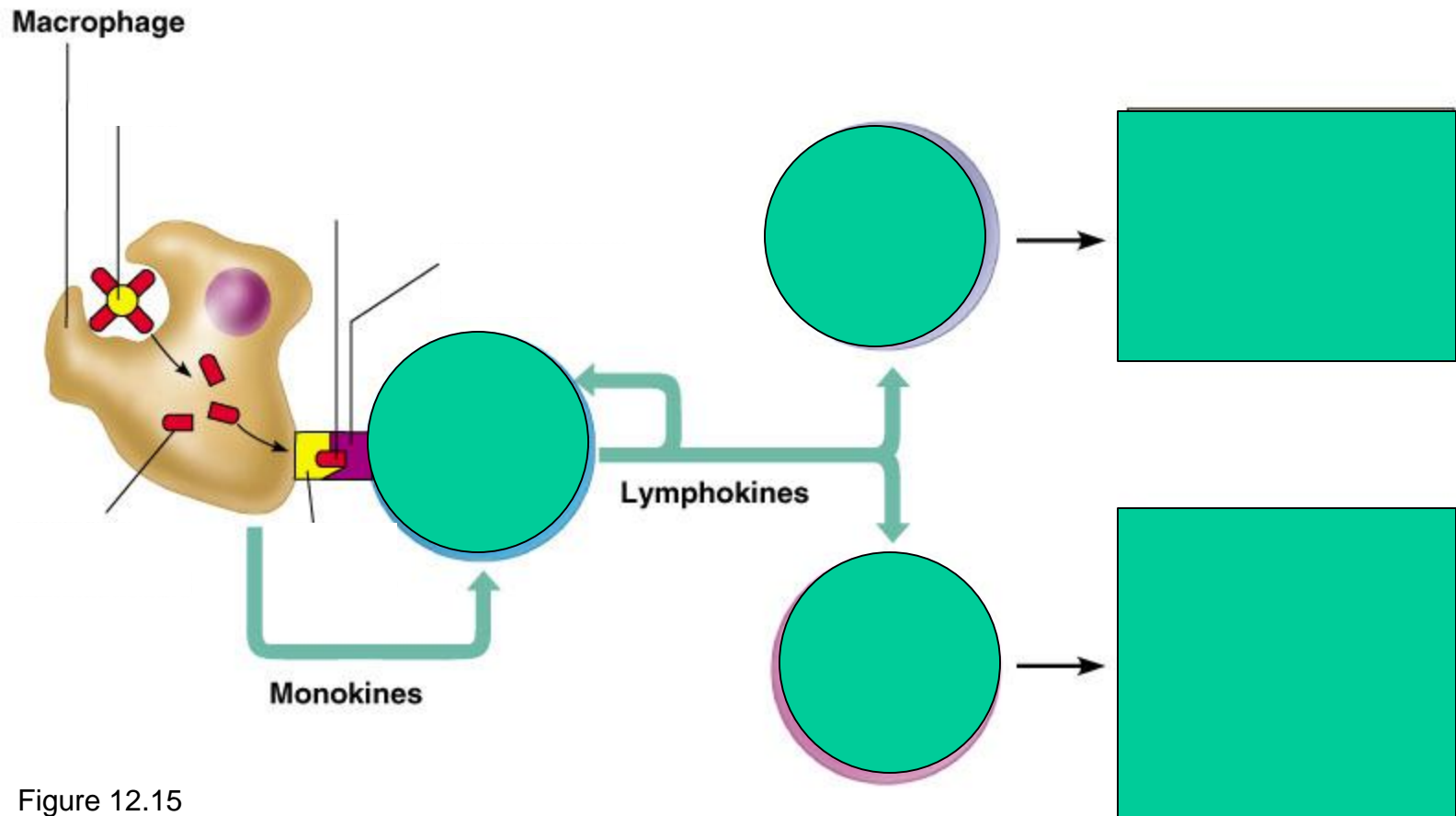


Figure 12.15

Cellular (Cell-Mediated) Immune Response

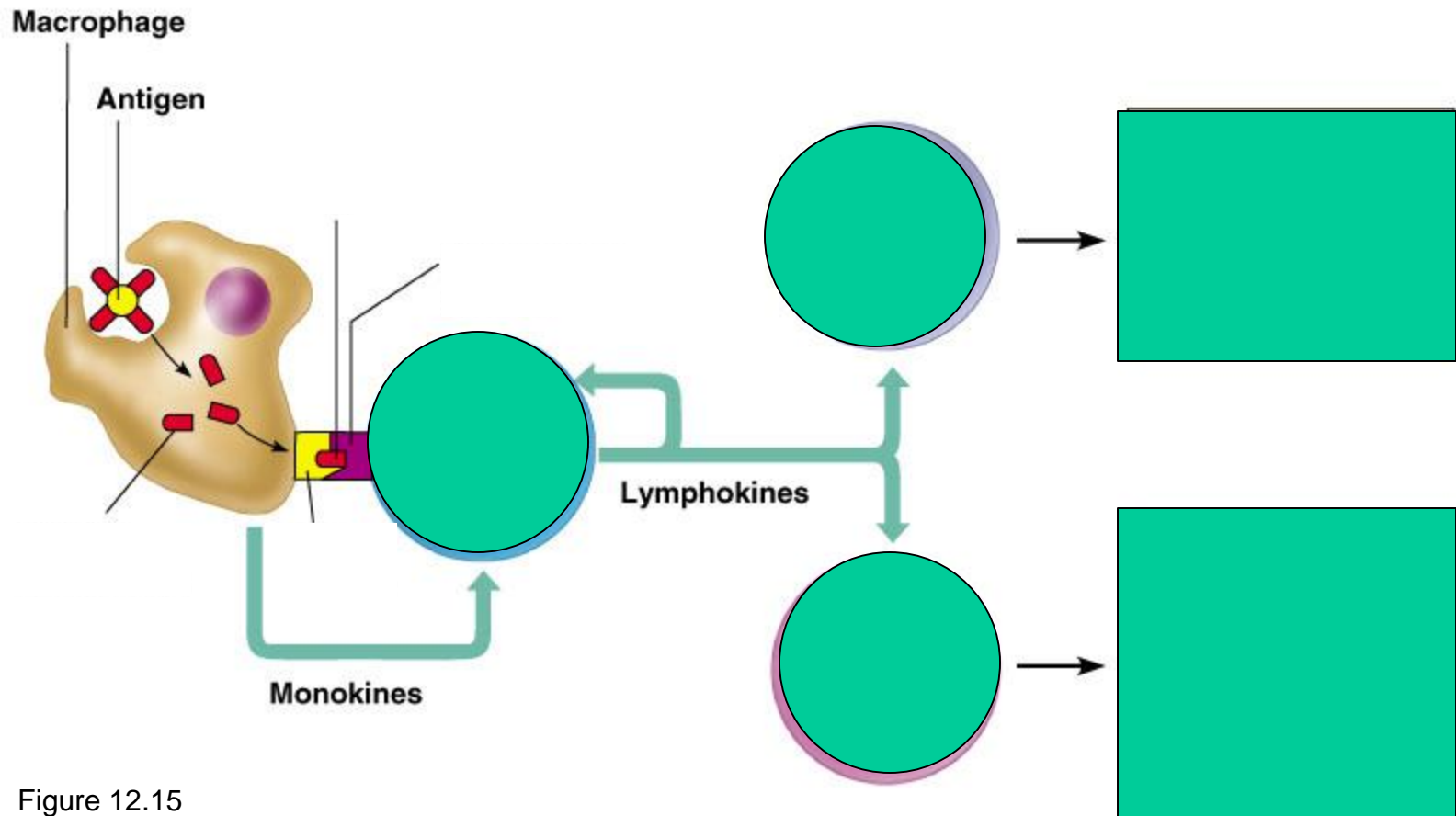


Figure 12.15

Cellular (Cell-Mediated) Immune Response

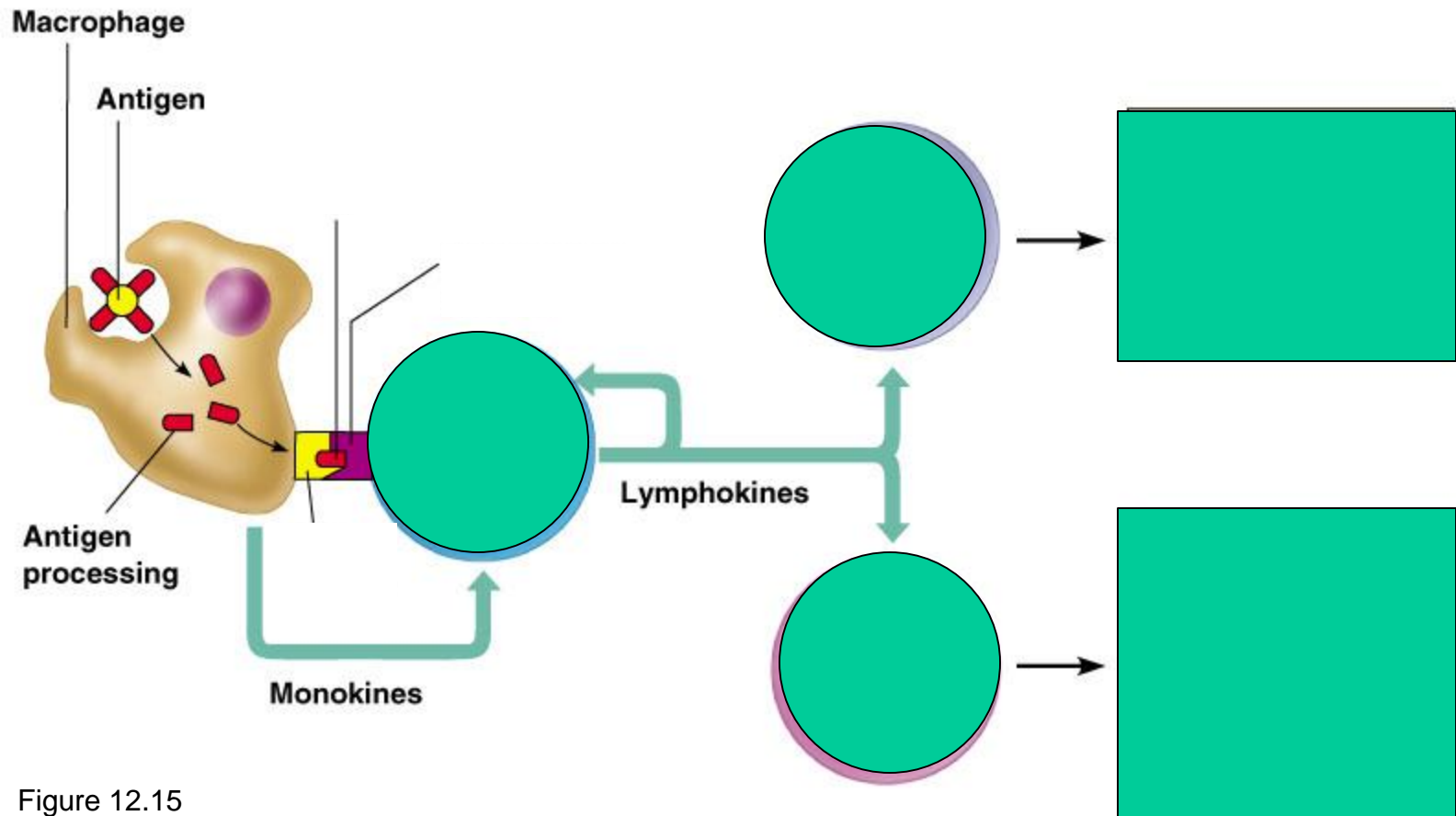


Figure 12.15

Cellular (Cell-Mediated) Immune Response

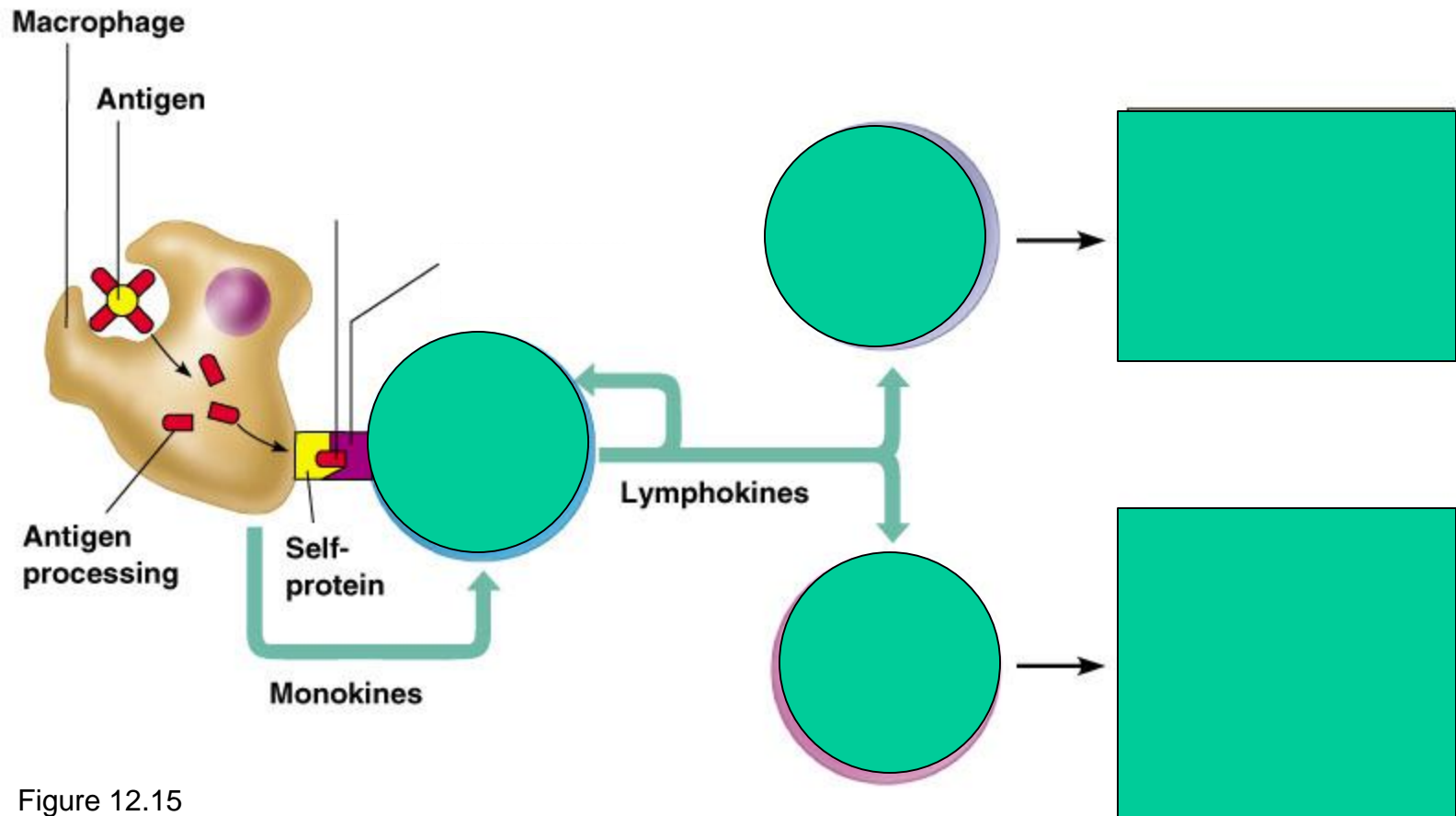


Figure 12.15

Cellular (Cell-Mediated) Immune Response

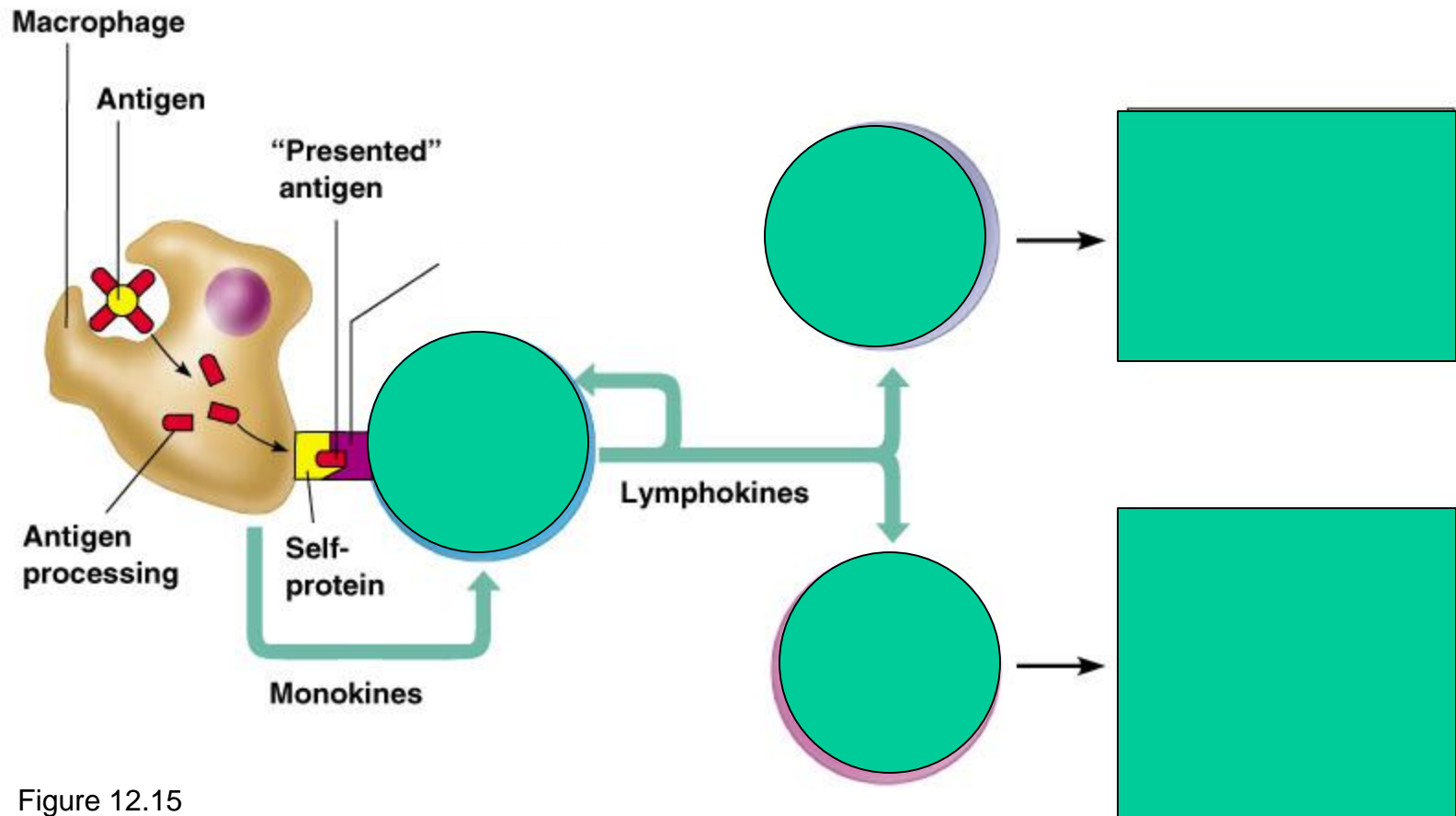


Figure 12.15

Cellular (Cell-Mediated) Immune Response

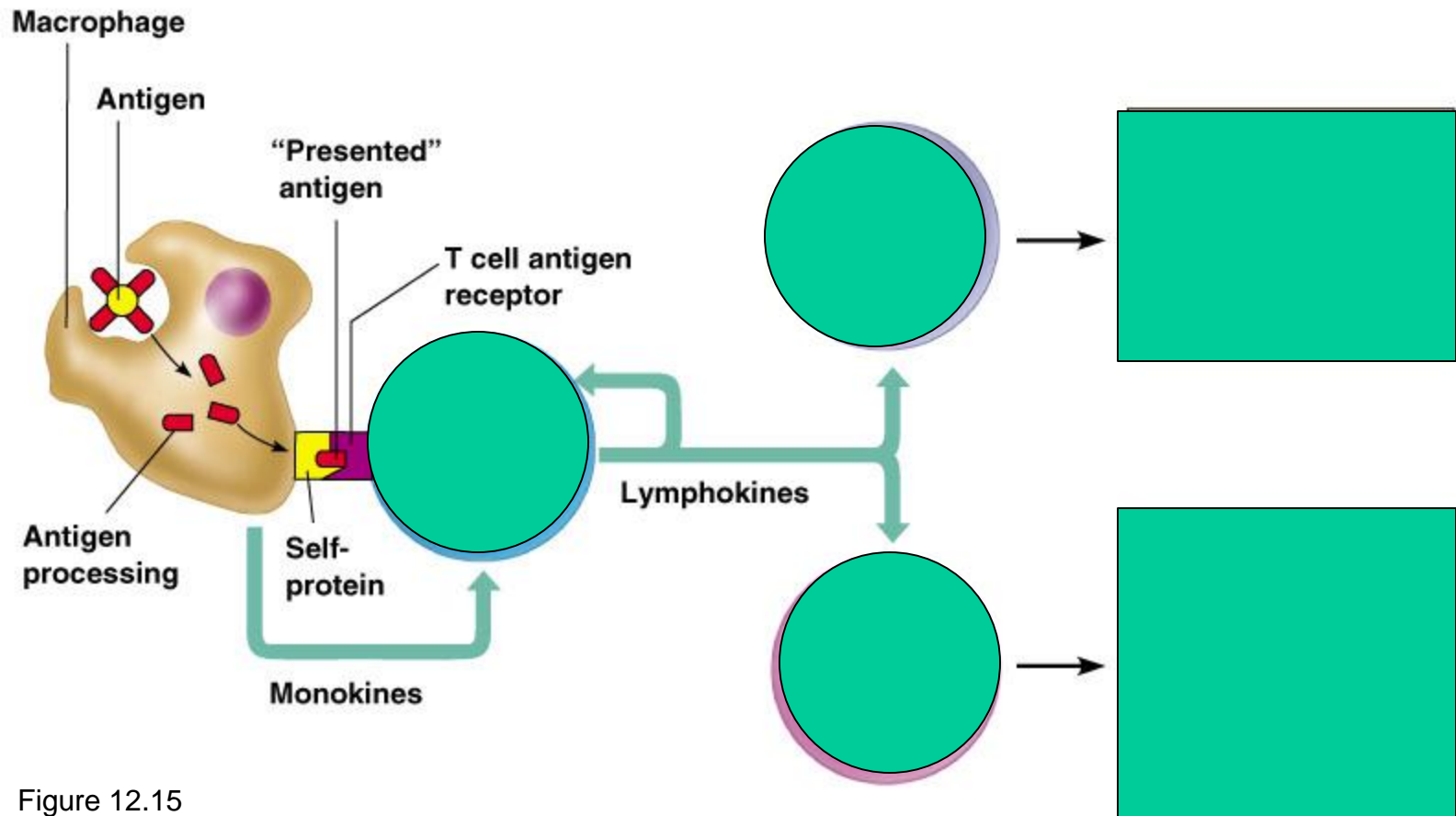


Figure 12.15

Cellular (Cell-Mediated) Immune Response

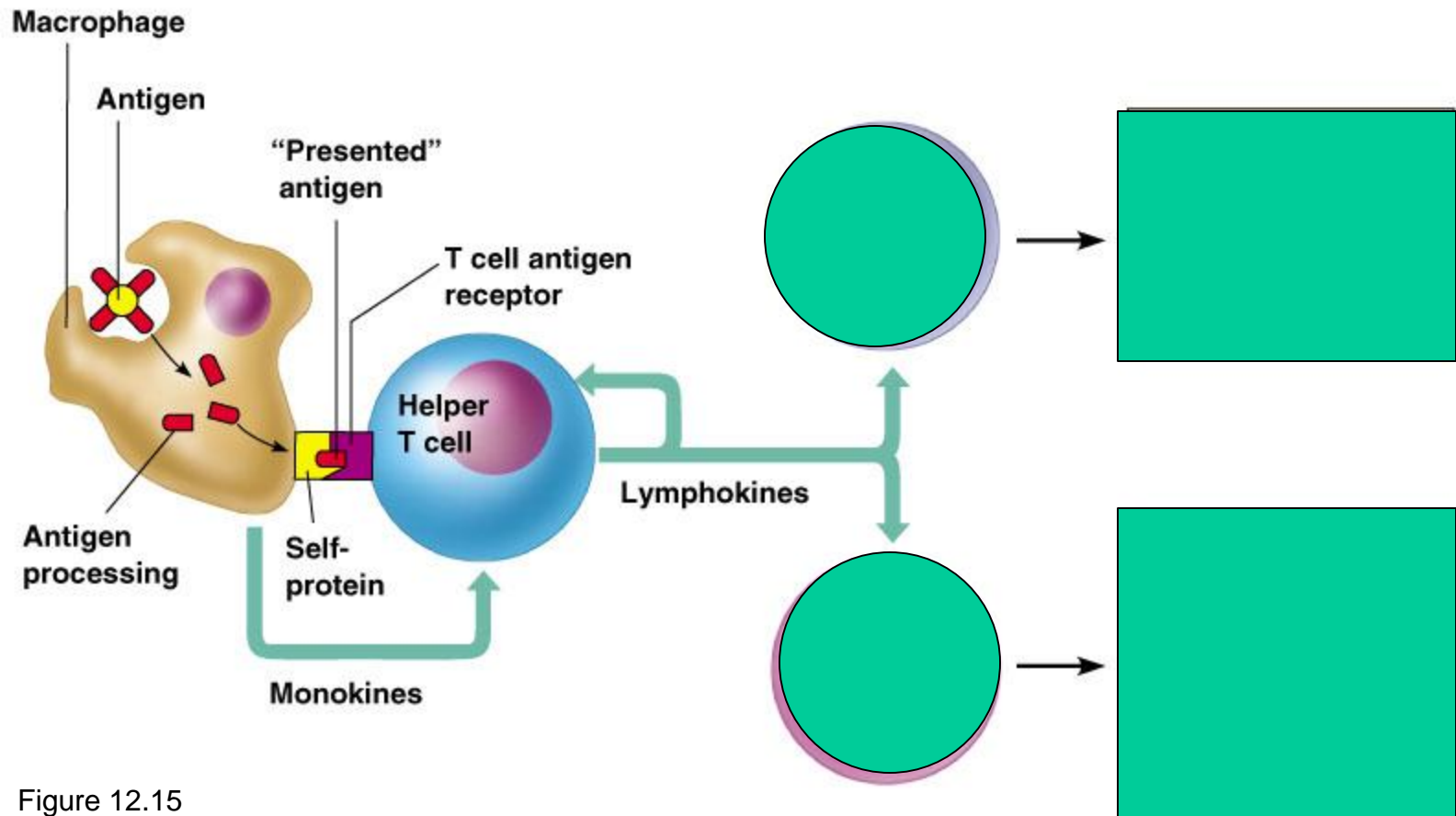


Figure 12.15

Cellular (Cell-Mediated) Immune Response

- Recruit other cells to fight the invaders
- Interact directly with B cells

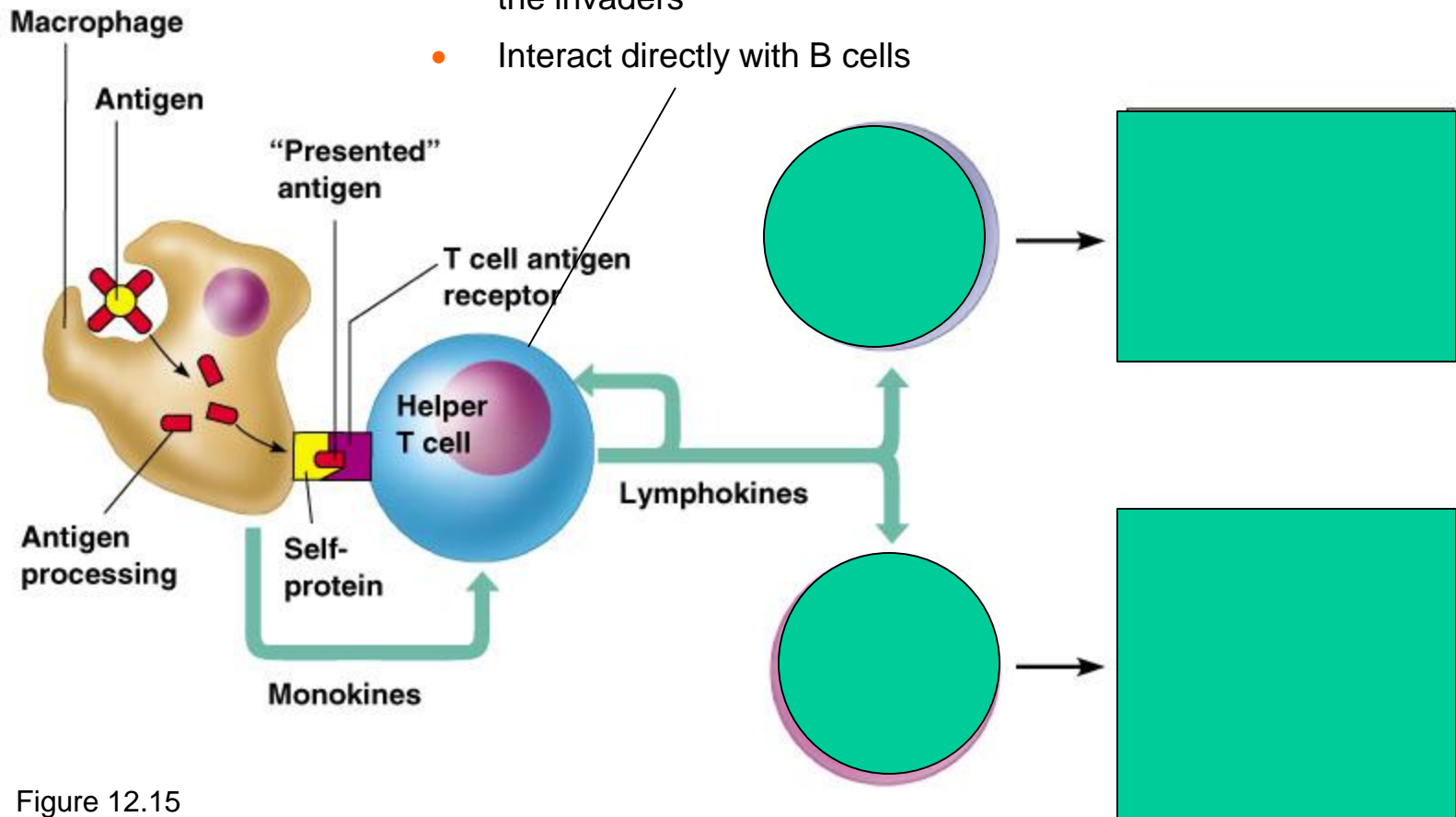


Figure 12.15

Cellular (Cell-Mediated) Immune Response

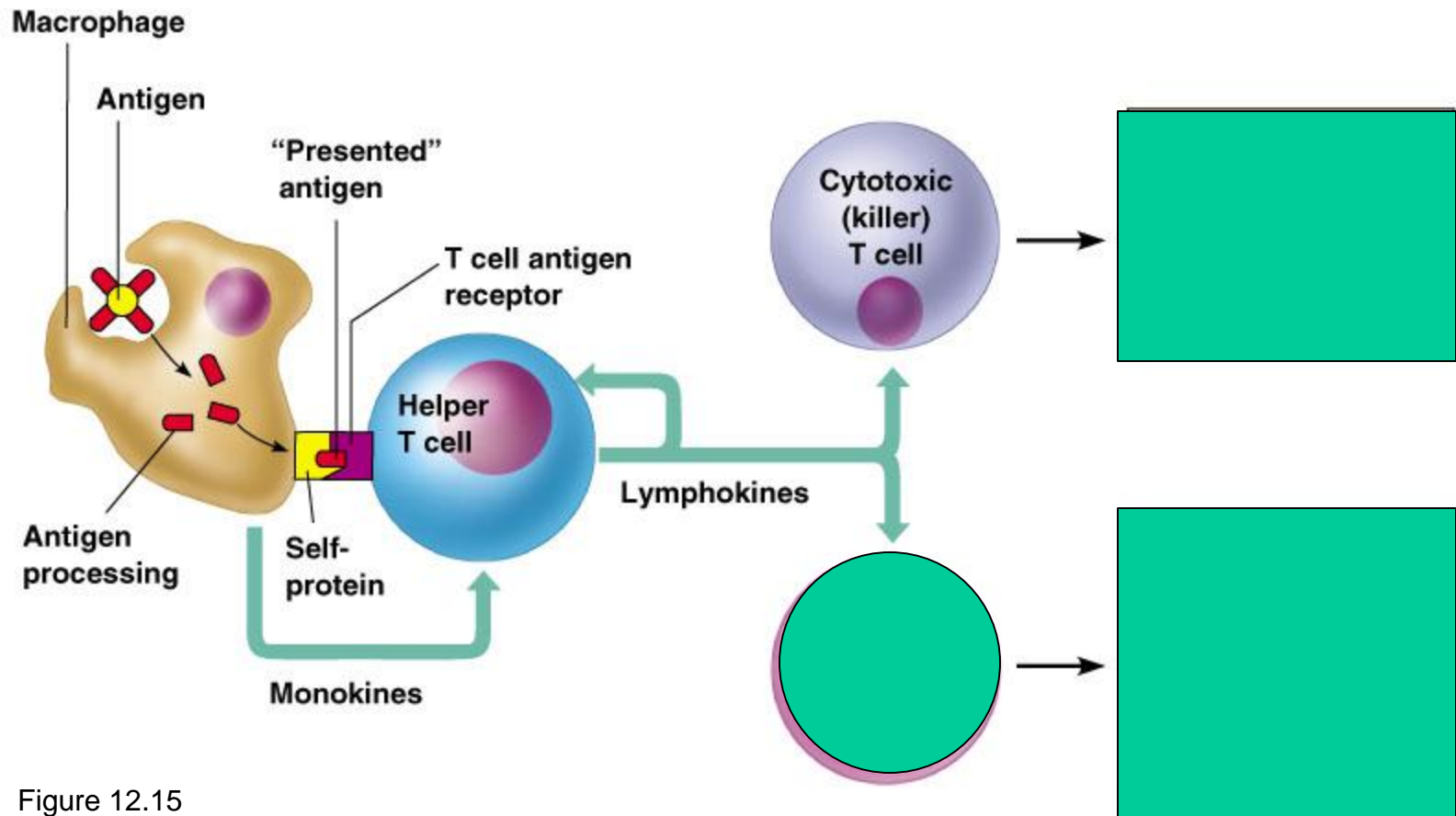


Figure 12.15

Cellular (Cell-Mediated) Immune Response

- Specialize in killing infected cells
- Insert a toxic chemical (perforin)

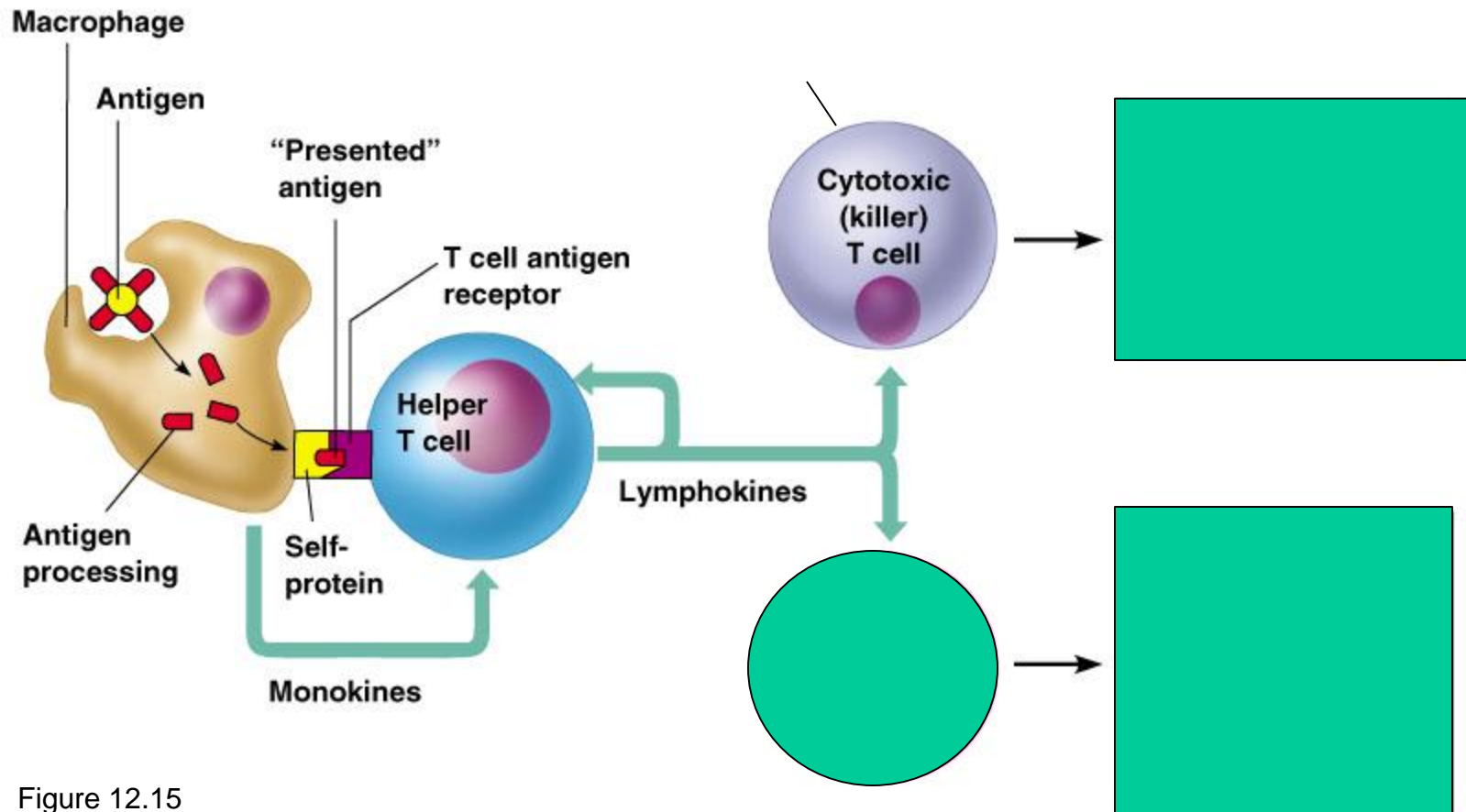


Figure 12.15

Cellular (Cell-Mediated) Immune Response

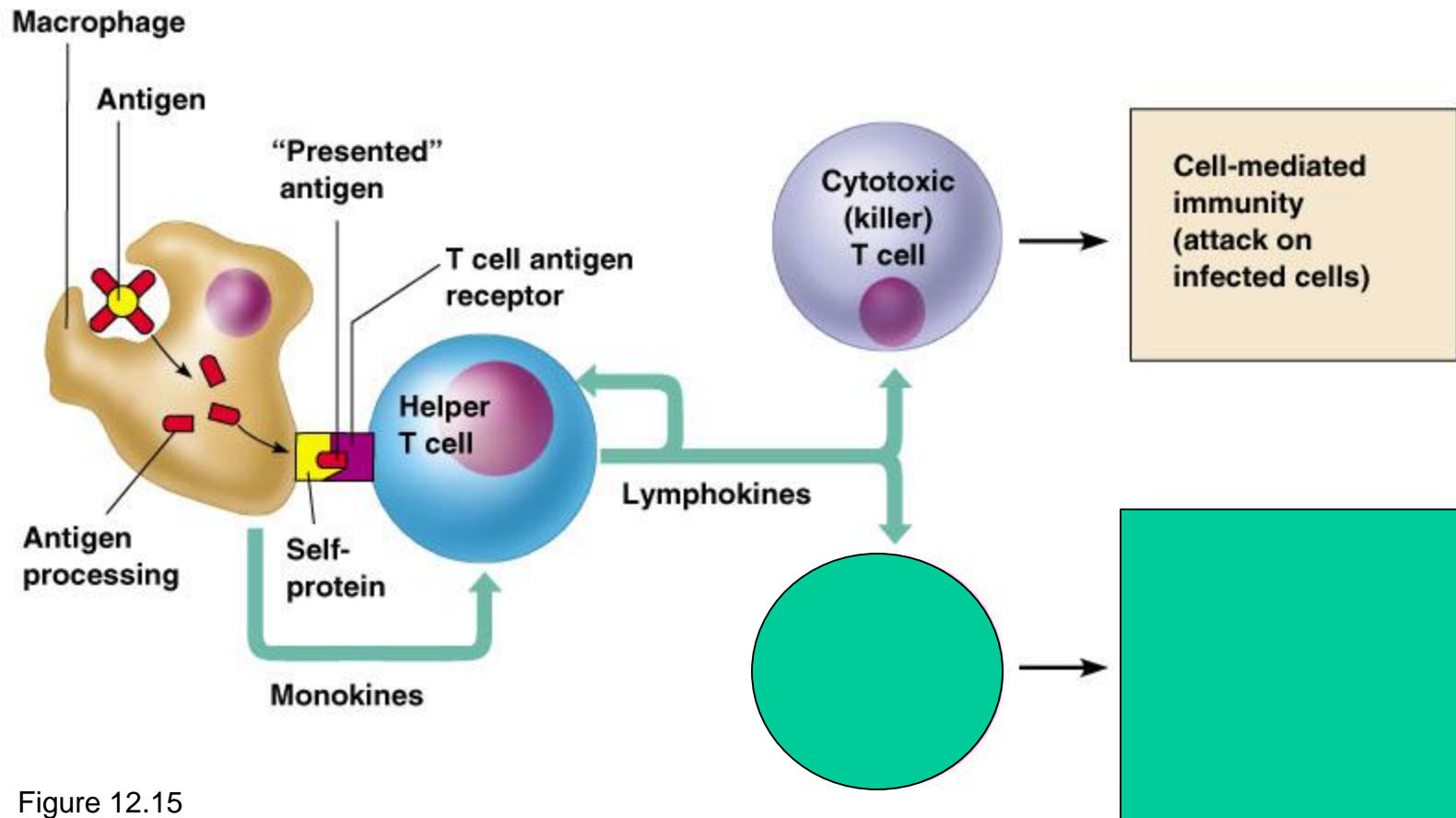


Figure 12.15

Cellular (Cell-Mediated) Immune Response

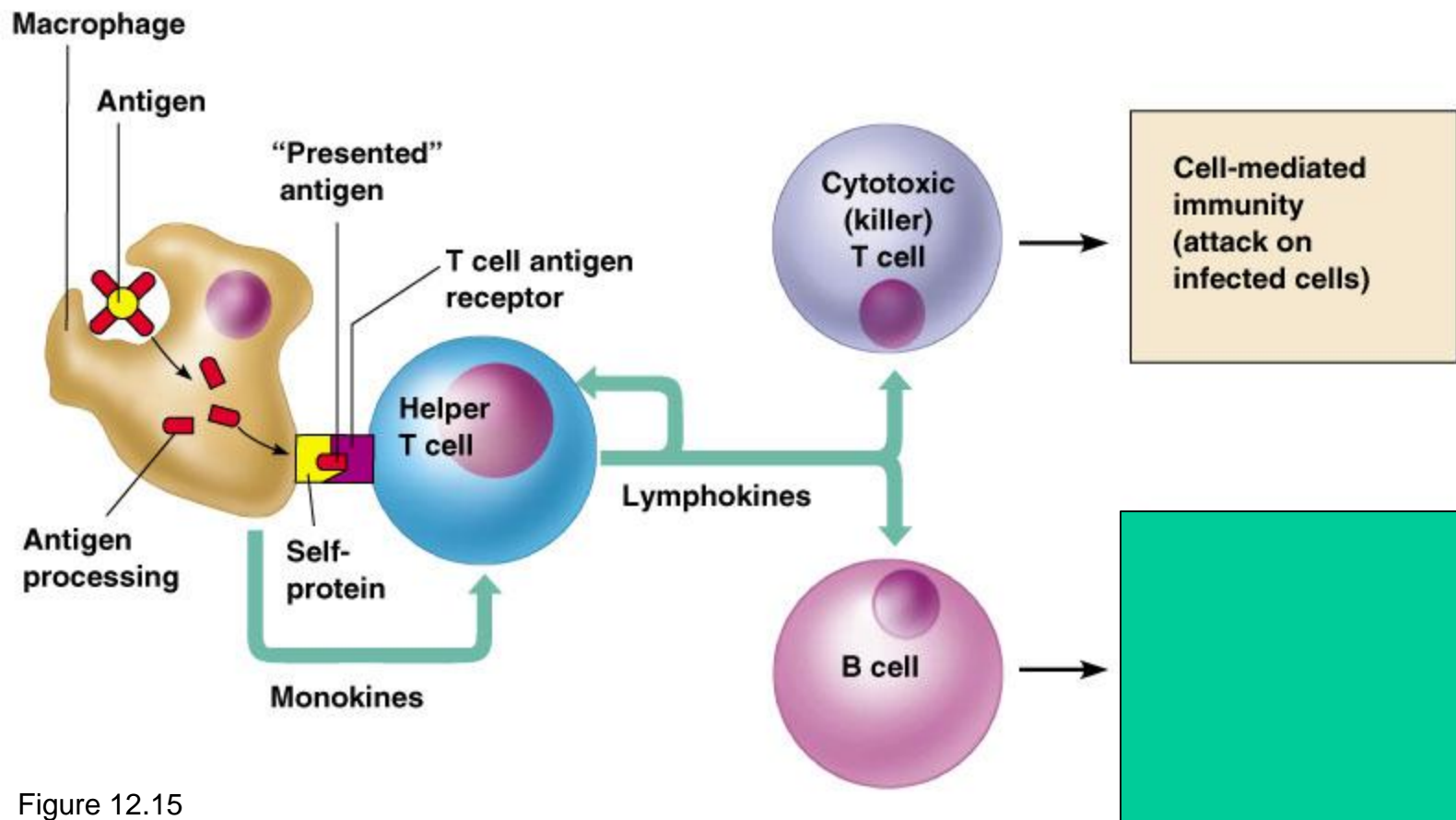


Figure 12.15

Cellular (Cell-Mediated) Immune Response

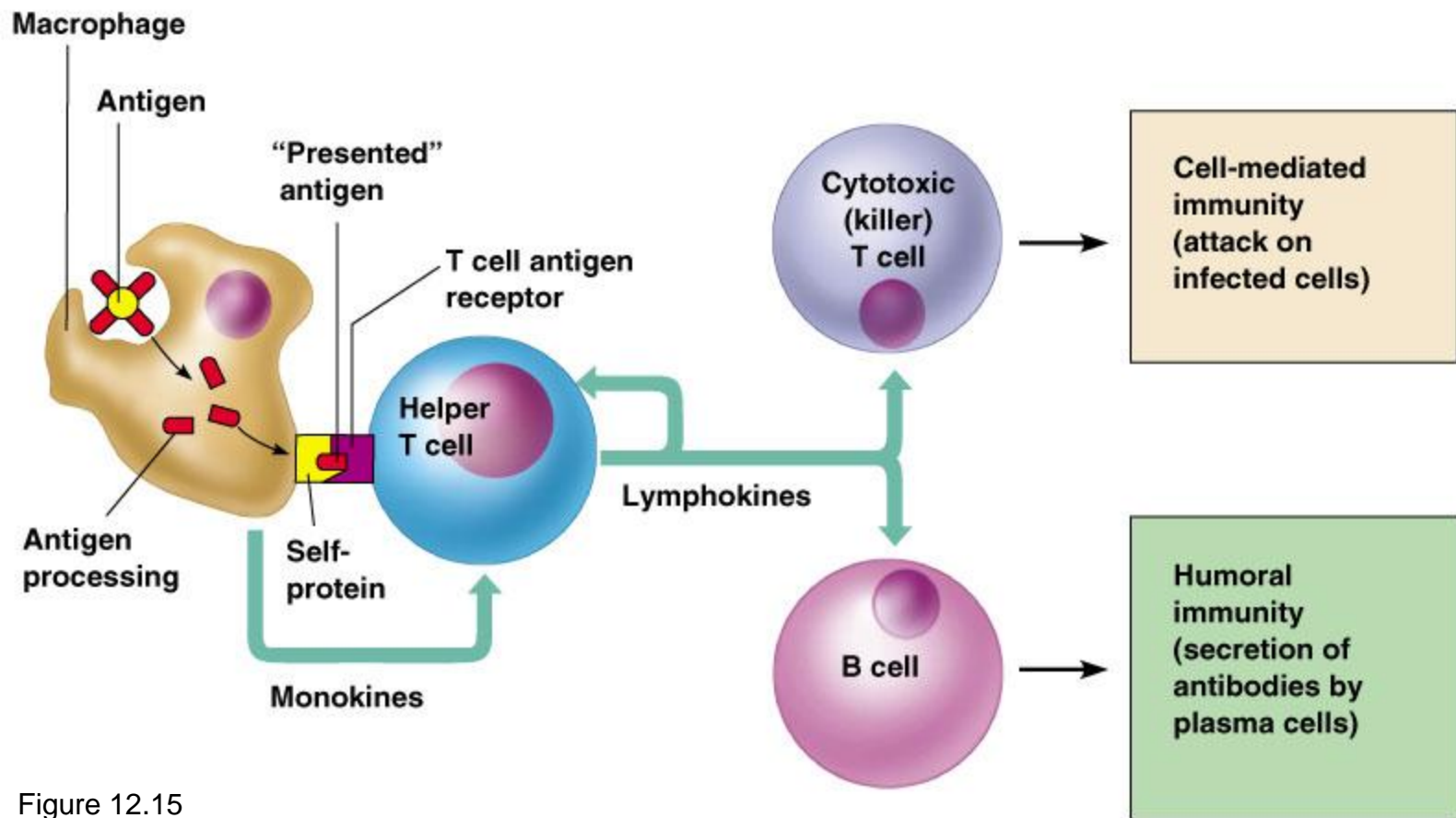


Figure 12.15

Summary of the Immune Response

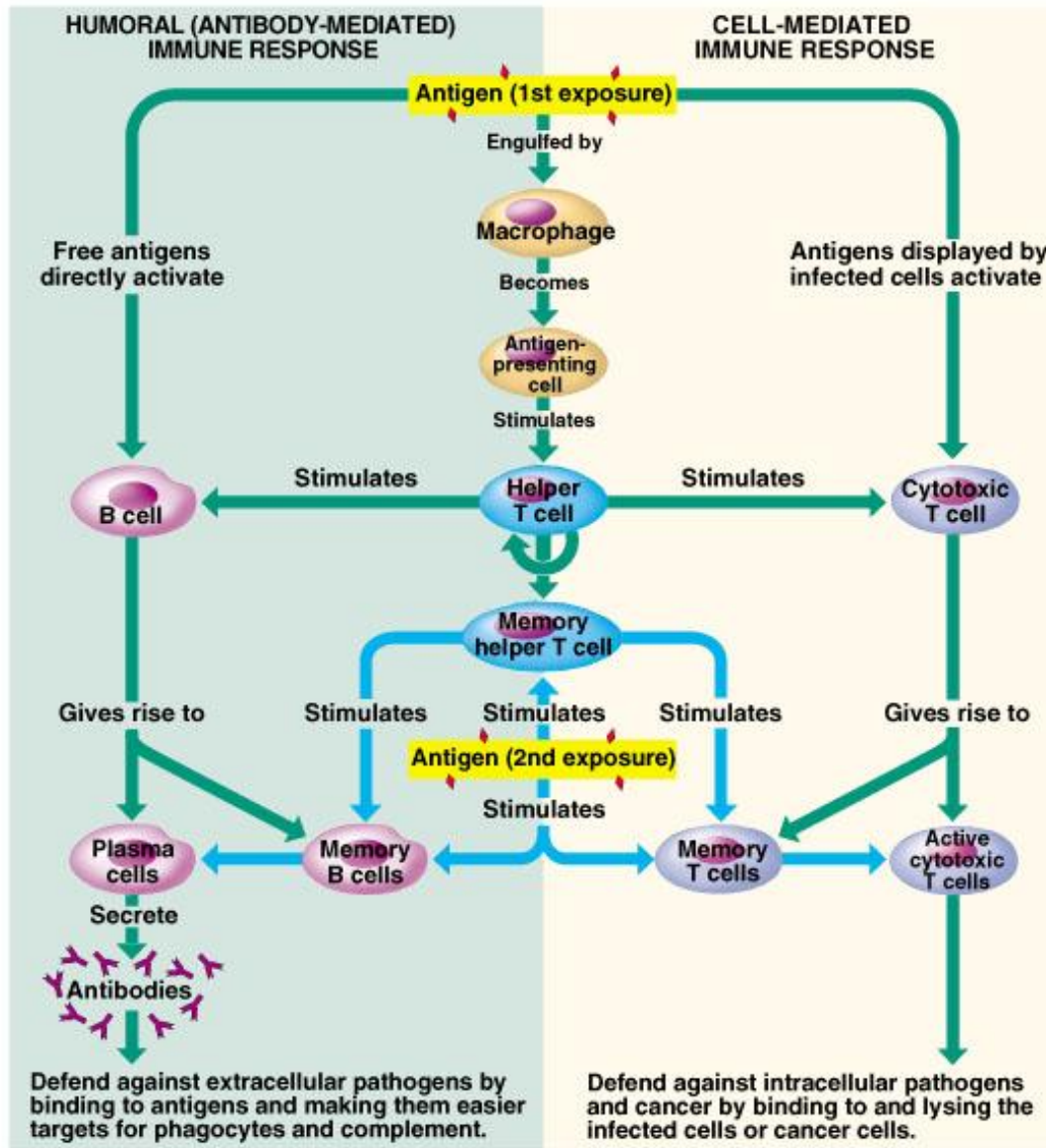


Figure 12.16

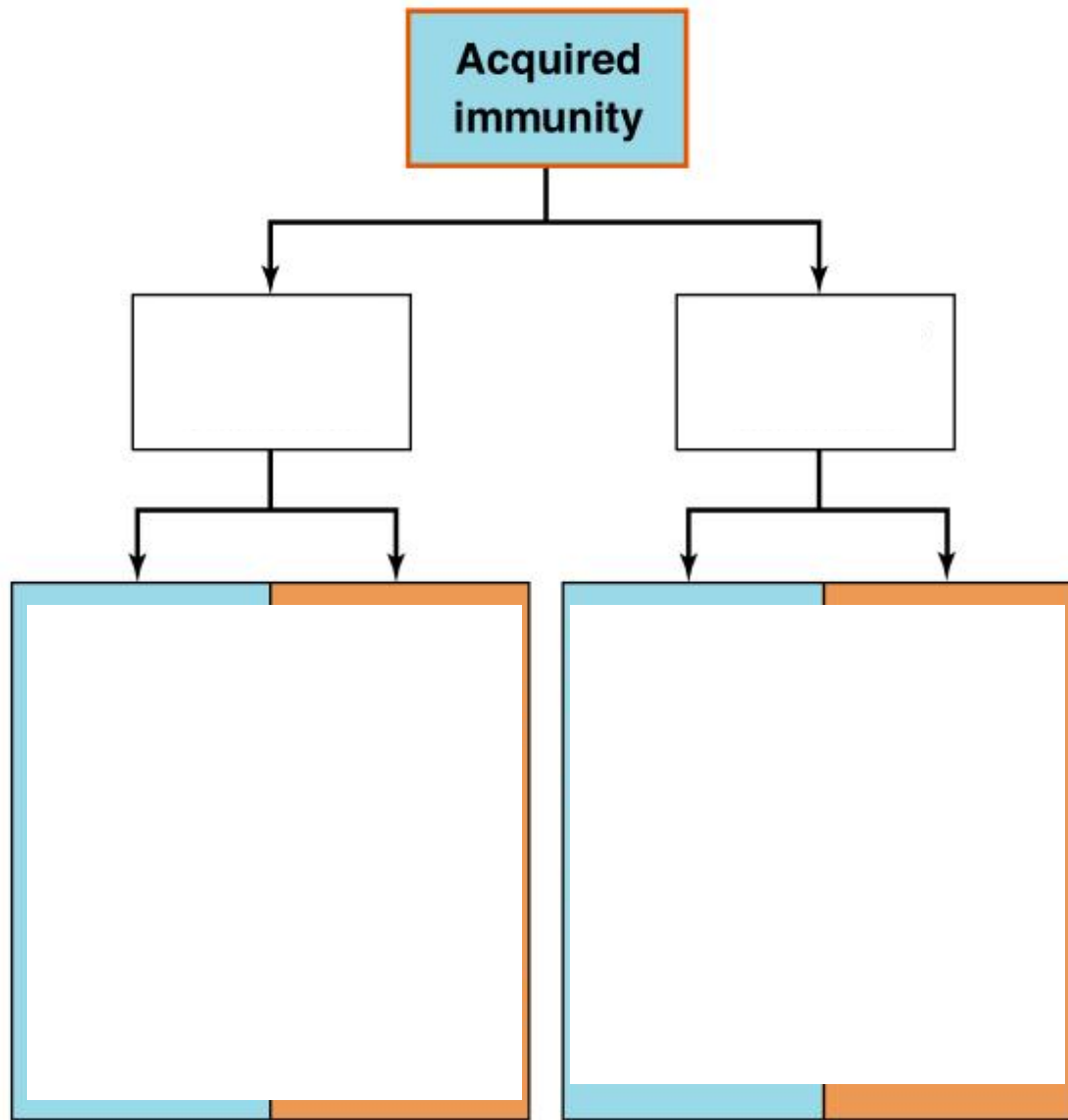


Figure 12.12

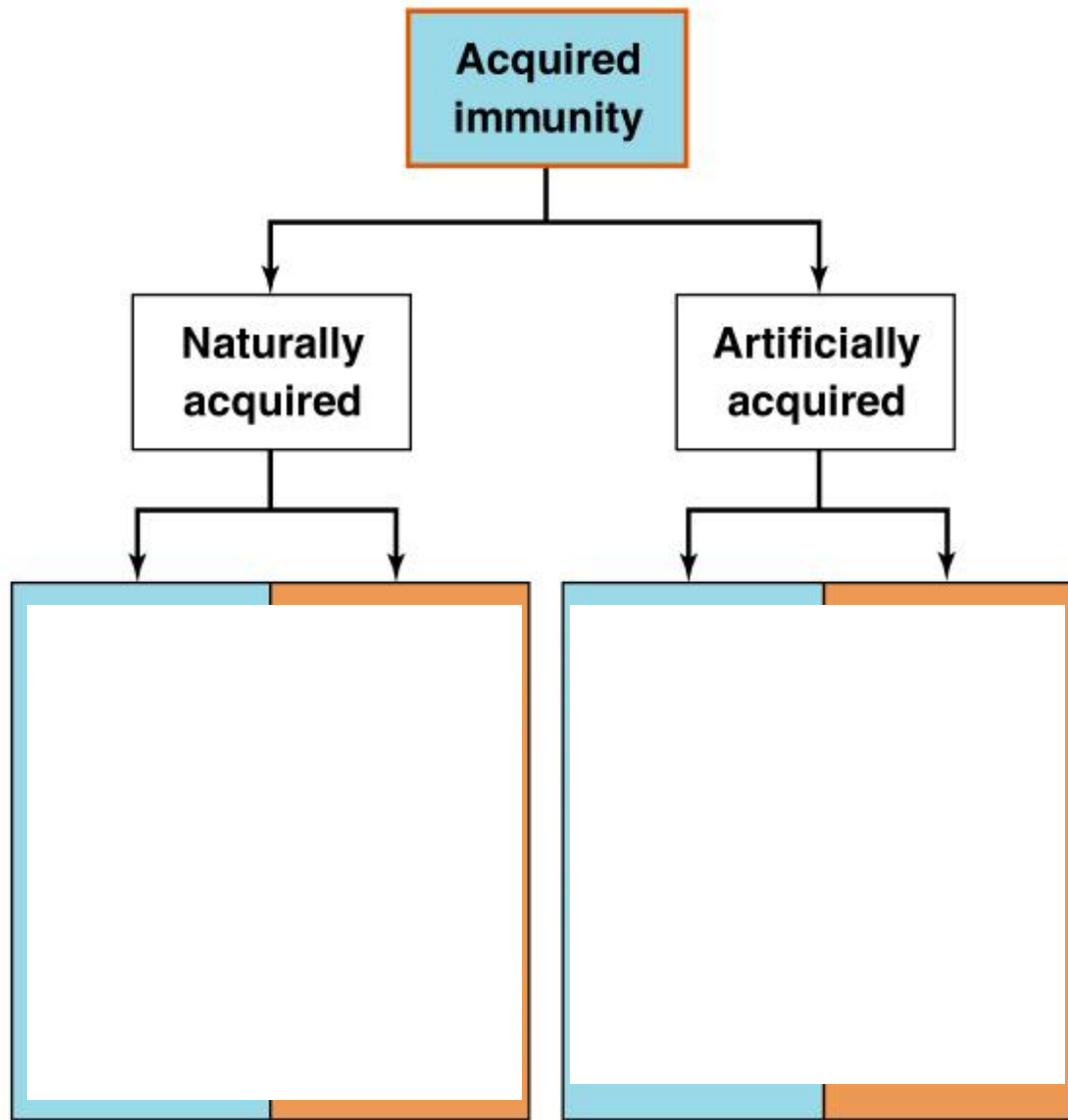


Figure 12.12

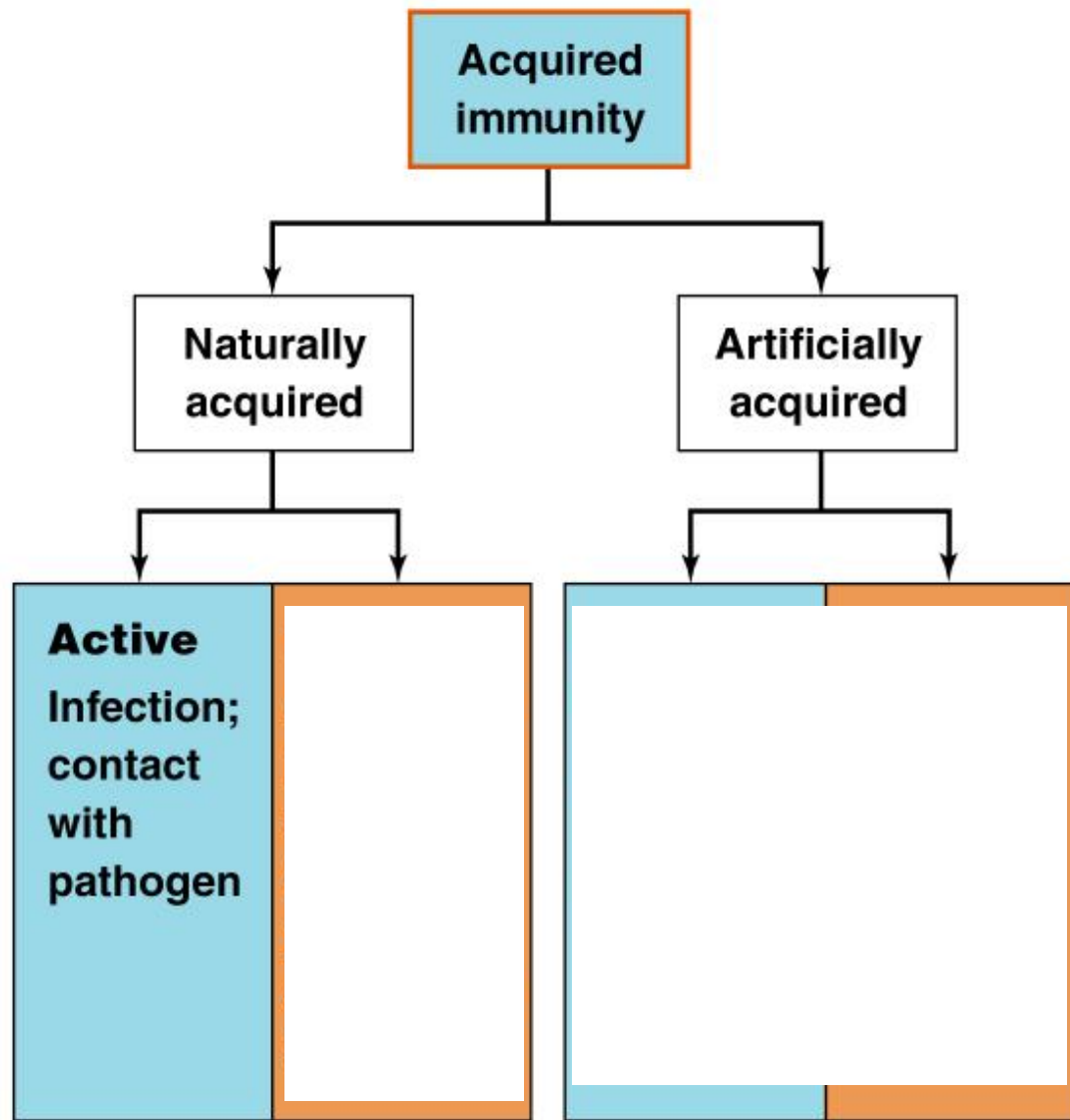


Figure 12.12

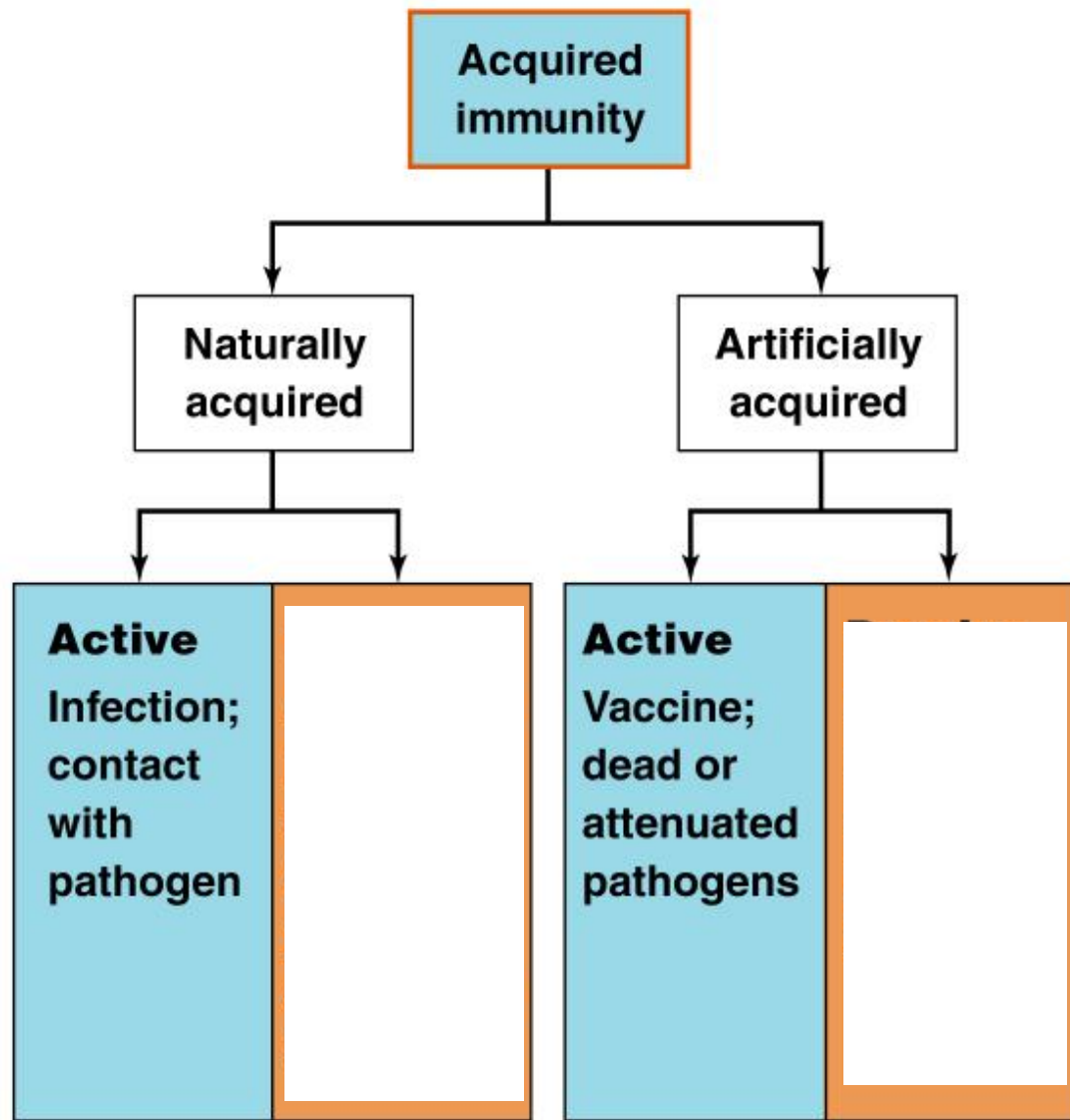


Figure 12.12

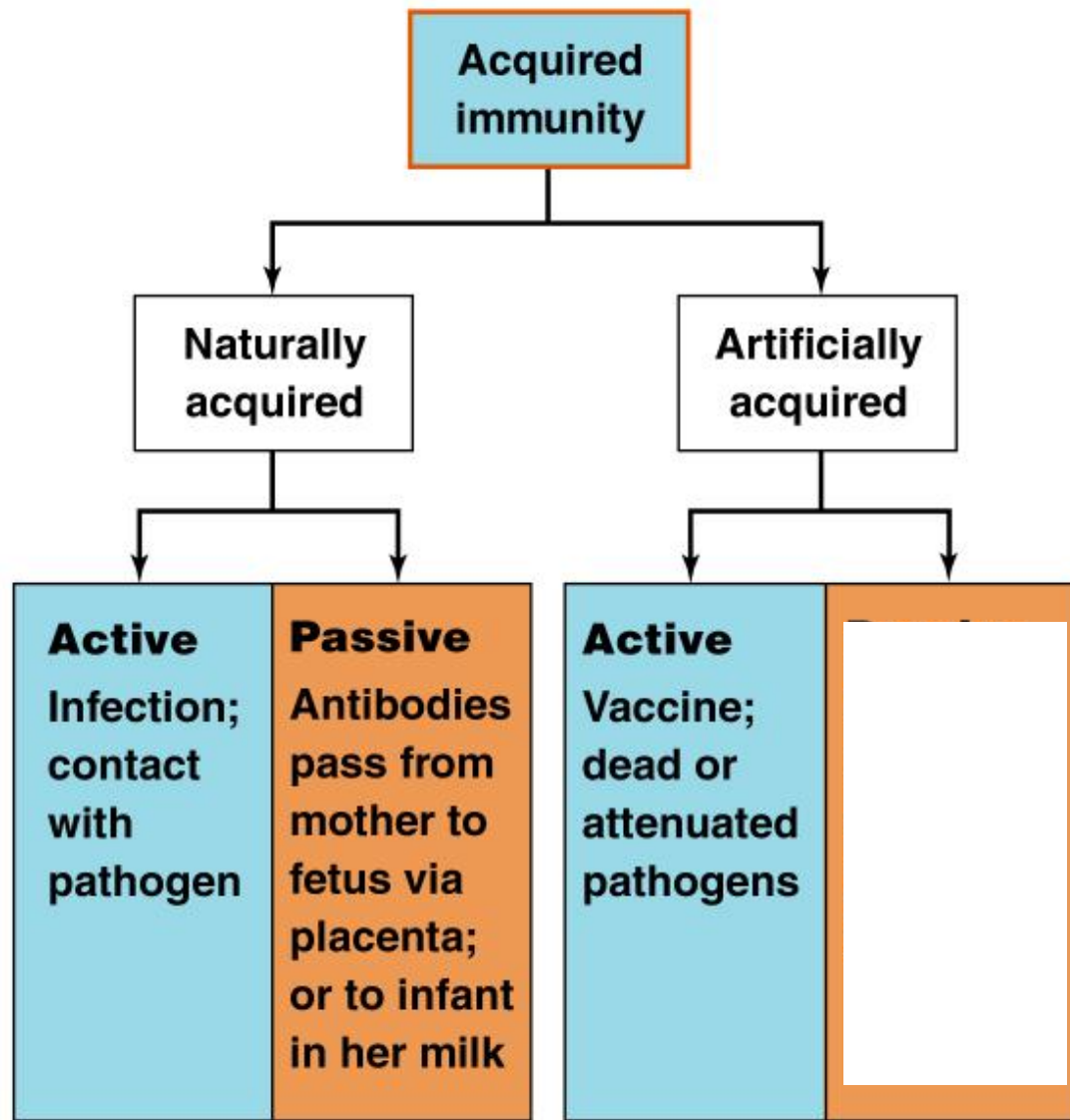


Figure 12.12

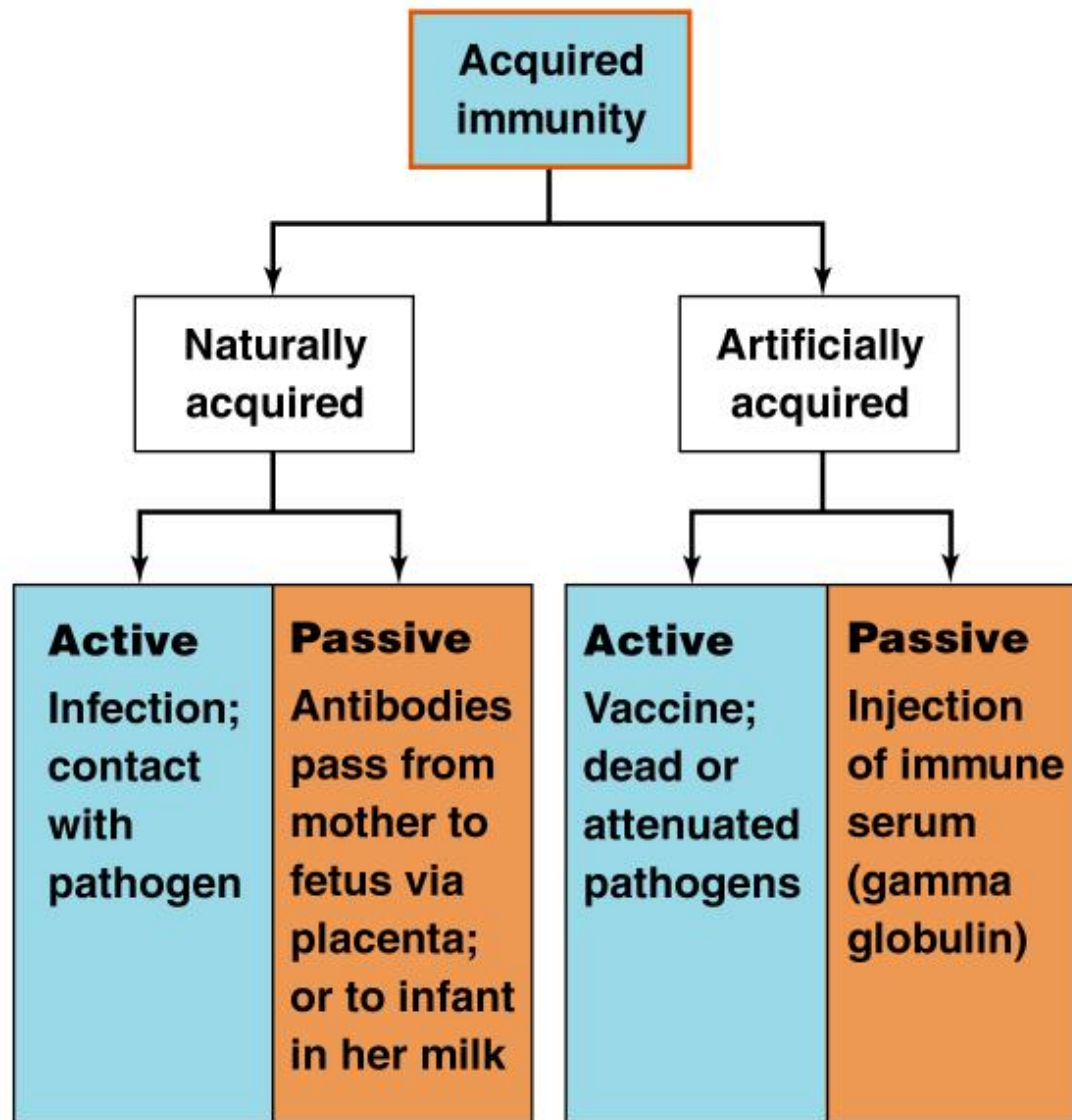


Figure 12.12