# Chapter 14

# Lymphatic System and Immunity

# ✶ Introduction

A. The **lymphatic system** is comprised of a network of vessels that transport body fluids, the cells and chemicals in those vessels, and the organs and glands that produce them.

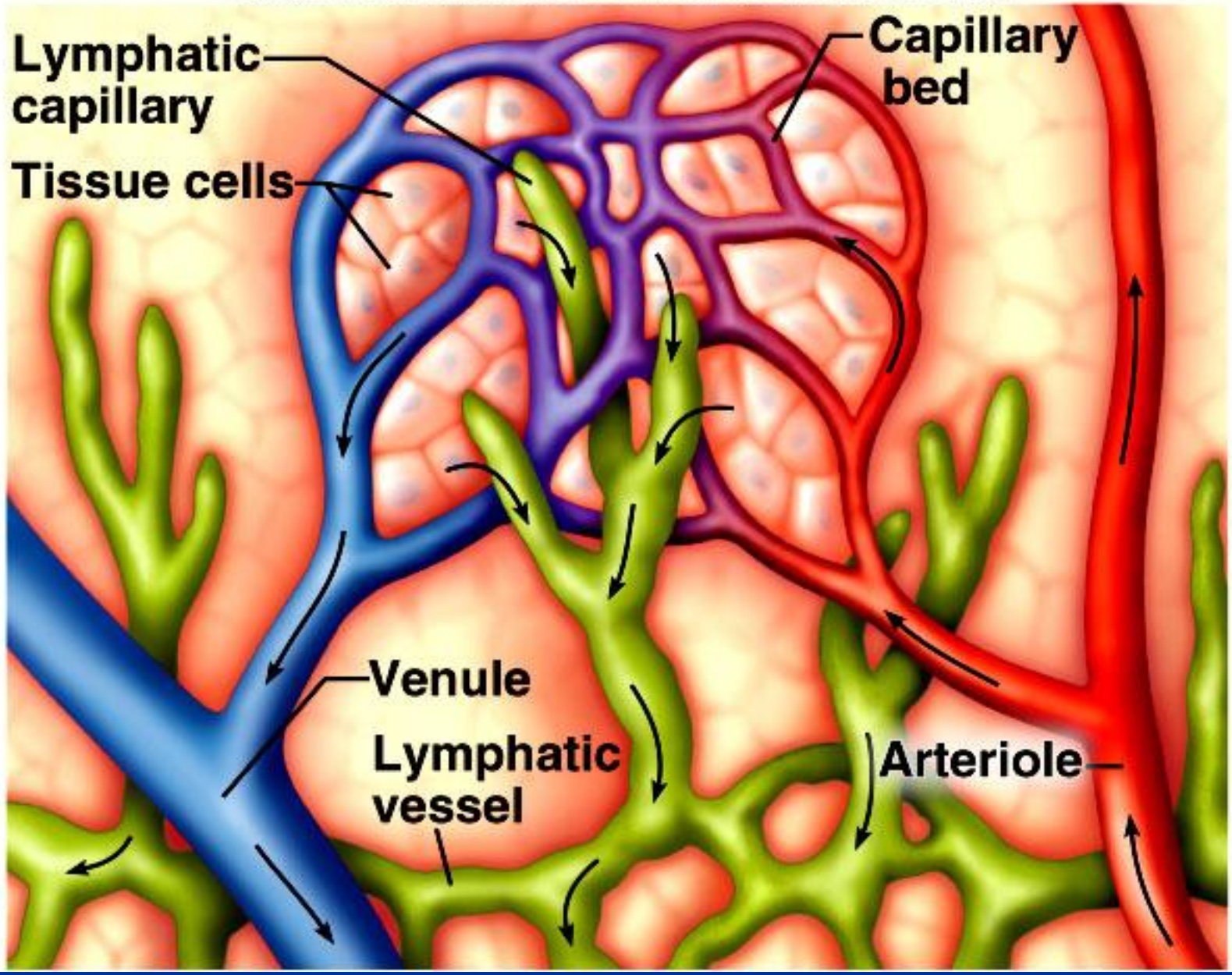
The lymphatic system is closely related to the circulatory system. It transports excess fluid to the bloodstream, absorbs fats and helps defend the body against disease-causing agents.

## ✶ Lymphatic Pathways

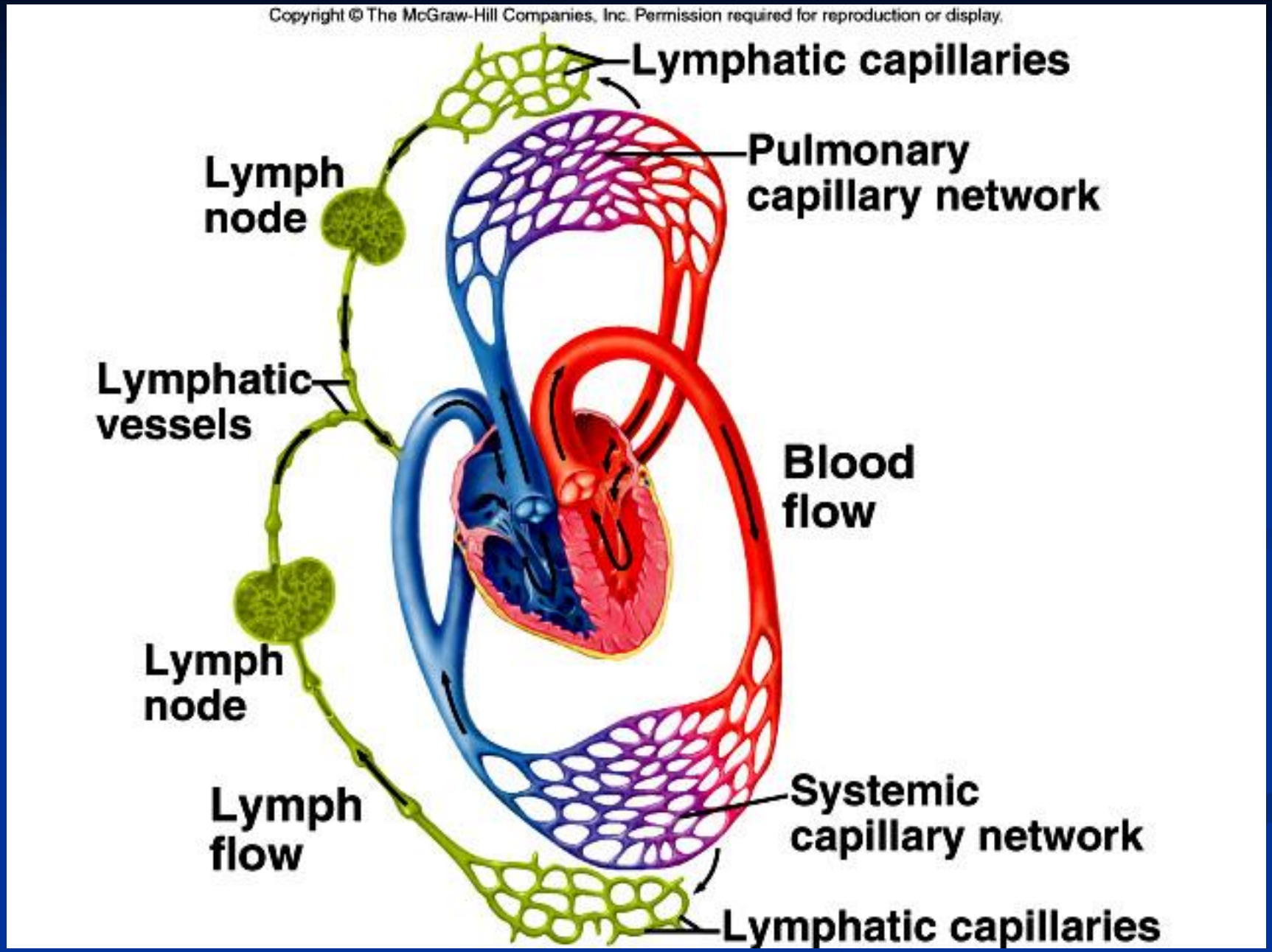
A. Lymphatic pathways start as lymphatic capillaries that merge to form larger vessels that empty into the circulatory system.

1. Lymphatic Capillaries
   a. Lymphatic capillaries are tiny, closed-ended tubes that extend into interstitial spaces.
   b. They receive tissue fluid through their thin walls; once inside, tissue fluid is called lymph.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

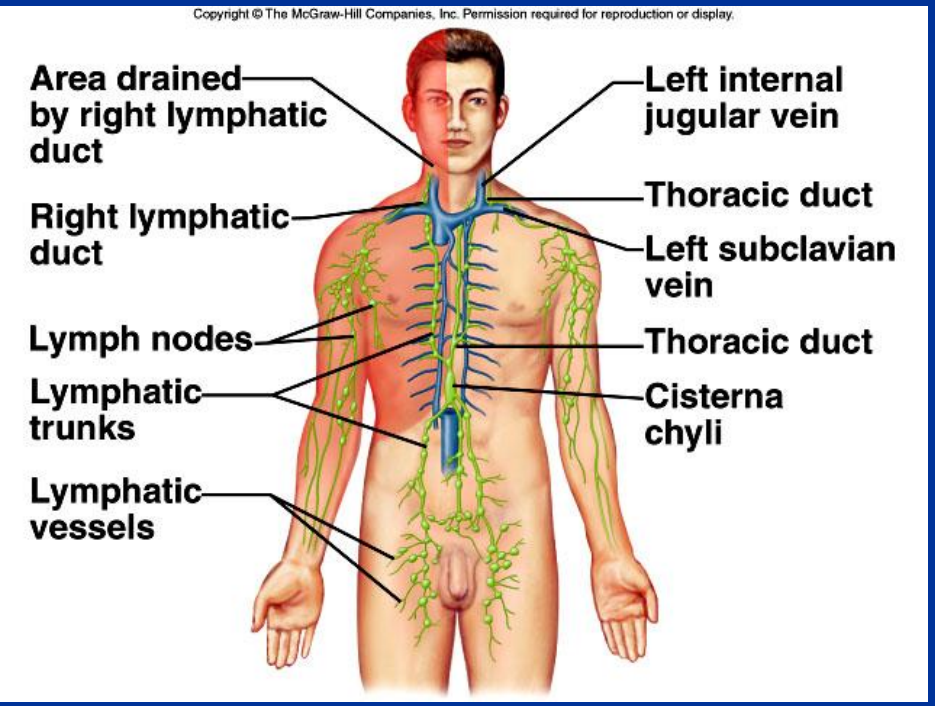


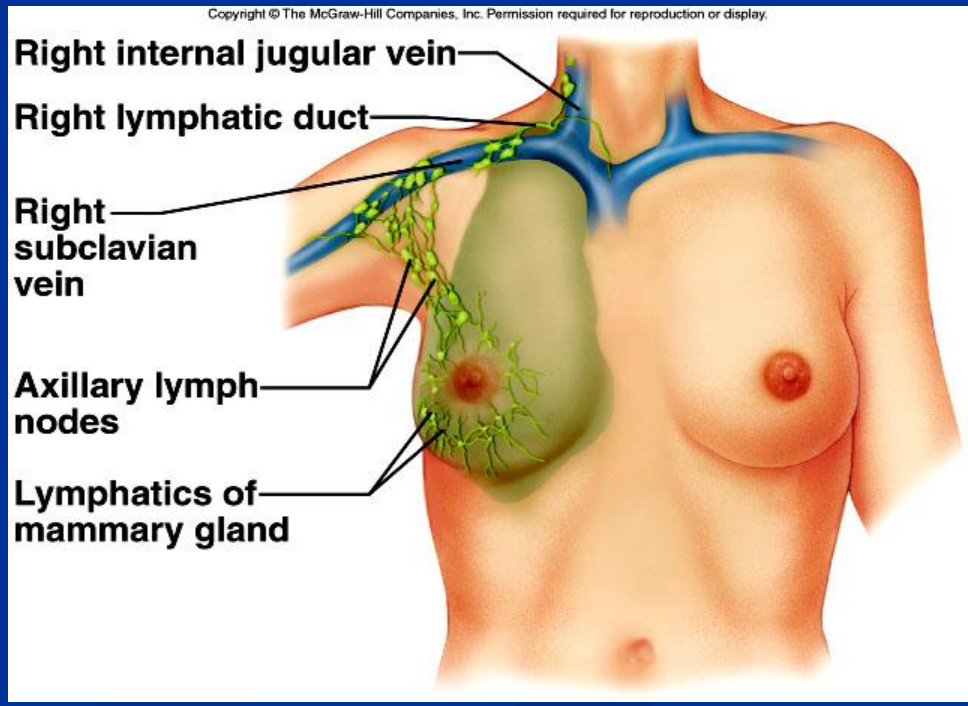
2. Lymphatic Vessels
   a. The walls of lymphatic vessels are thinner than those of veins but are constructed with the same three layers with semilunar valves on the inside.
   b. Larger lymphatic vessels pass through lymph nodes and merge to form lymphatic trunks.



3. Lymphatic Trunks and Collecting Ducts
   a. The lymphatic trunks drain lymph from the body and are named for the regions they drain.
   b. These trunks join one of two collecting ducts—either the thoracic duct or right lymphatic duct.

4. The thoracic duct drains into the left subclavian vein, while the right lymphatic duct drains into the right subclavian vein.



# ✶ Tissue Fluid and Lymph

B. Tissue fluid becomes lymph once it has entered a lymphatic capillary; lymph formation depends on tissue fluid formation.

1. **Tissue Fluid Formation**
   a. Tissue fluid originate from blood plasma.

   b. It lacks large proteins, but some smaller proteins leak into interstitial spaces.

## 2. Lymph Formation and Function

a. Rising osmotic pressure within interstitial tissues forces some tissue fluid into lymphatic capillaries and becomes lymph.

b. Lymph returns protein molecules to the blood.

## C. **Lymph Movement**

1. Lymph is under low hydrostatic pressure which drives fluid into lymphatic capillaries.
2. Lymph is moved by muscle contraction, breathing movements, and contraction of smooth muscle in the walls of lymphatic trunks.

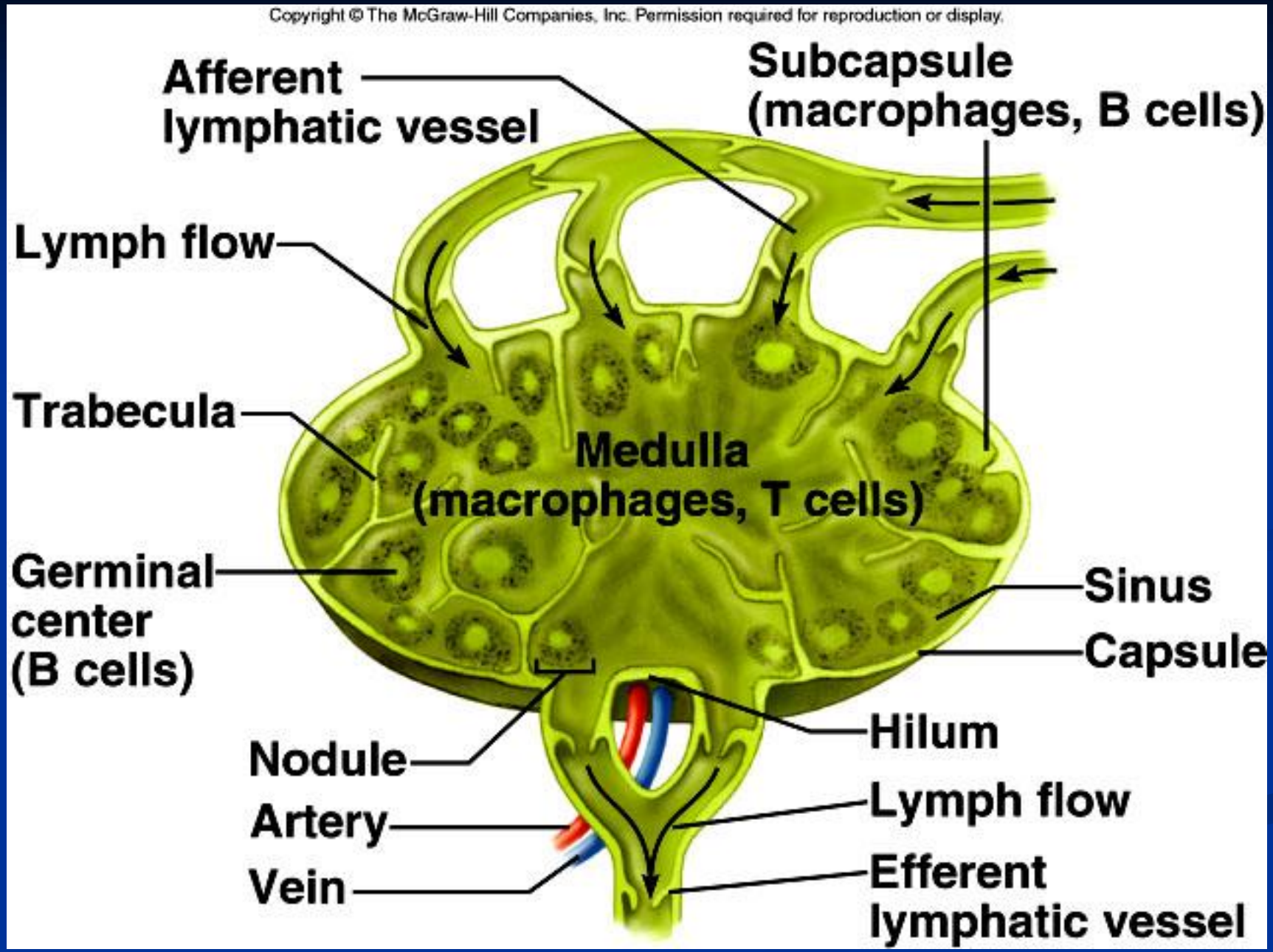
# D. LYMPH NODES

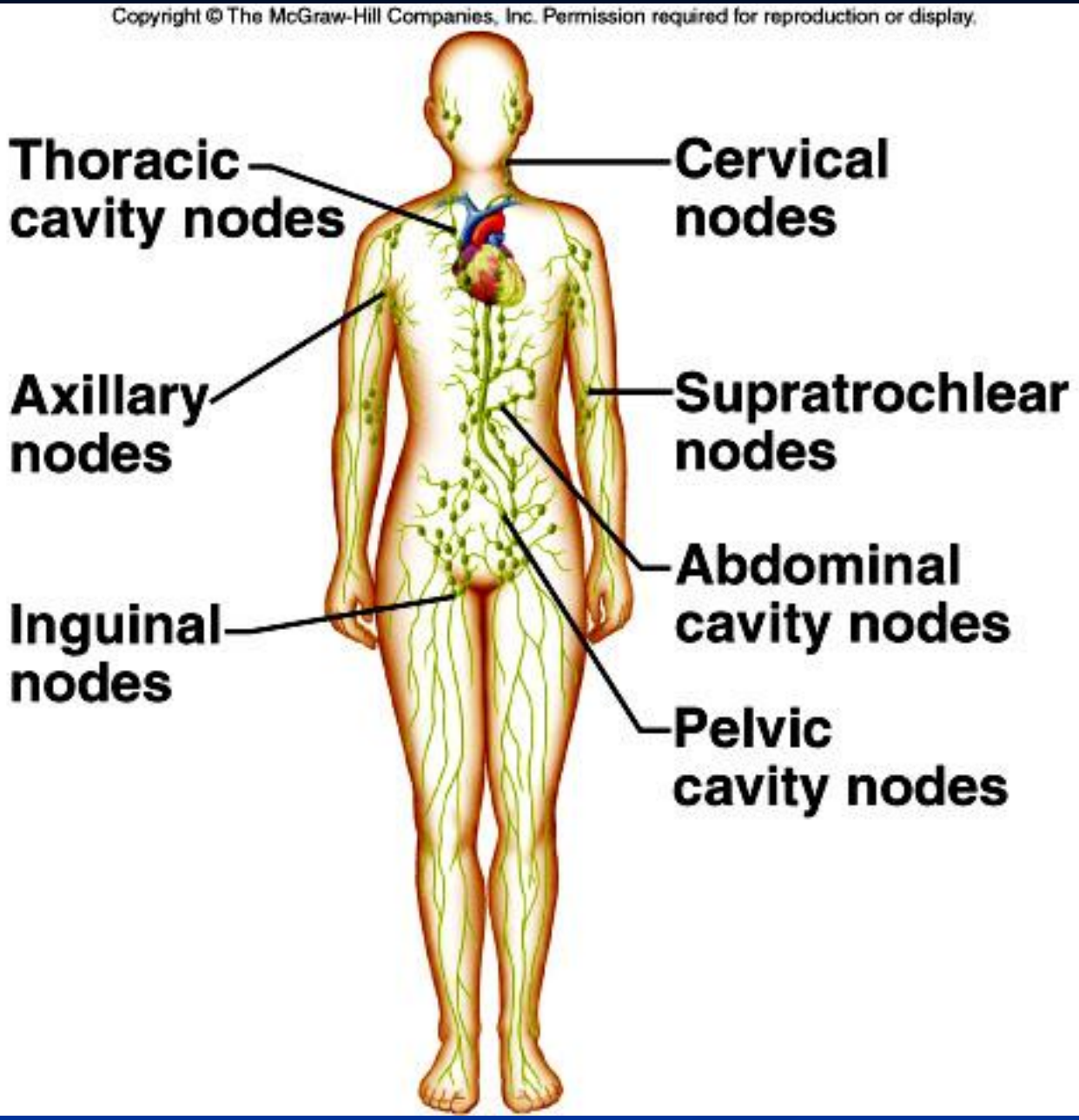
**Structure of the lymph nodes**

1. Lymph nodes are bean-shaped, and are divided into nodules. They contain masses of lymphocytes and macrophages.

2. Lymph nodes aggregate in groups or chains along paths of larger lymph vessels.

3. Functions: They filter harmful foreign particles from the lymph. They also produce lymphocytes and contain phagocytic cells.



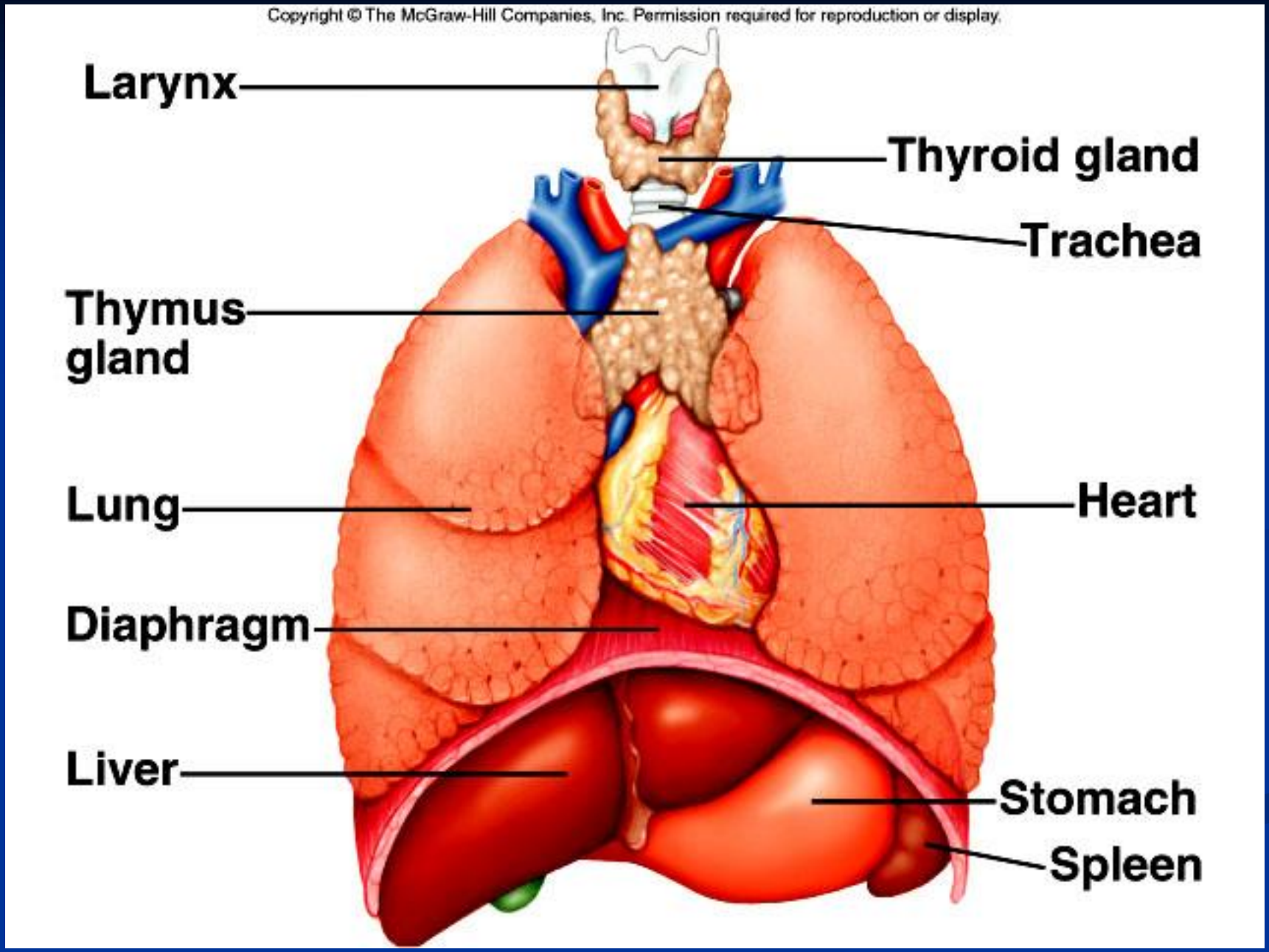


# E. **Thymus and Spleen**

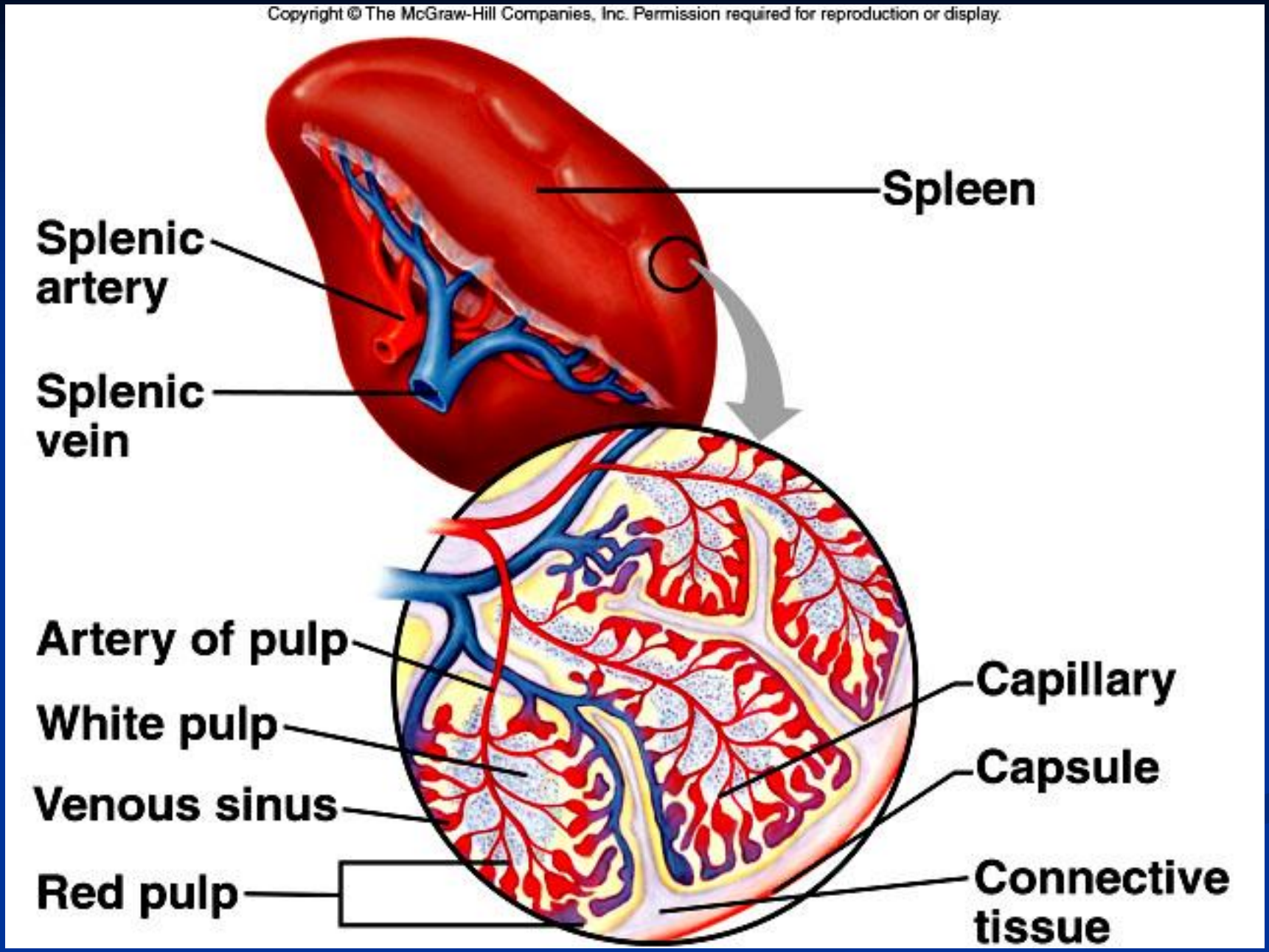
1. The functions of the thymus and spleen are similar to those of lymph nodes.

2. The thymus is composed of lymphatic tissue developed into lobules. It shrinks after puberty. Some lymphocytes leave the thymus and provide immunity.

3. The spleen is called a large lymph node subdivided into lobules. Spaces within splenic lobules are filled with blood. The spleen contains many macrophages, which filter foreign particles and damaged rbc's from the blood.



Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



# F Body Defenses Against Infection

1. Disease-causing agents, also called pathogens, can produce infections within the body. The body has innate and adaptive defenses against disease.

# G Innate (Nonspecific) Defenses

1. Species Resistance

   A species is resistant to diseases that affect other species because it has a unique chemical environment or temperature that fails to provide the conditions required by the pathogens of another species.

## 2. Mechanical Barriers

The unbroken skin and mucous membranes of the body create mechanical barriers that prevent the entry of certain pathogens.

Mechanical barriers represent the body's first line of defense.

3. Chemical Barriers
   a. Enzymes in gastric juice and lysosomes in tears kill some pathogens.
   b. Interferons stimulate uninfected cells to synthesize antiviral proteins that stimulate phagocytosis, block proliferation of viruses and help resist infection and stifle tumor growth.

4. Fever- high temperature decreases iron in the blood and increases phagocytic activity.

5. Inflammation
   a. Inflammation, a tissue response to a pathogen, is characterized by redness, swelling, heat, and pain.
   b. Chemicals released by damaged tissues attract white blood cells to the site.
   c. Connective tissue may for a sac around injured tissue and block the spread of pathogens.

6. Phagocytosis

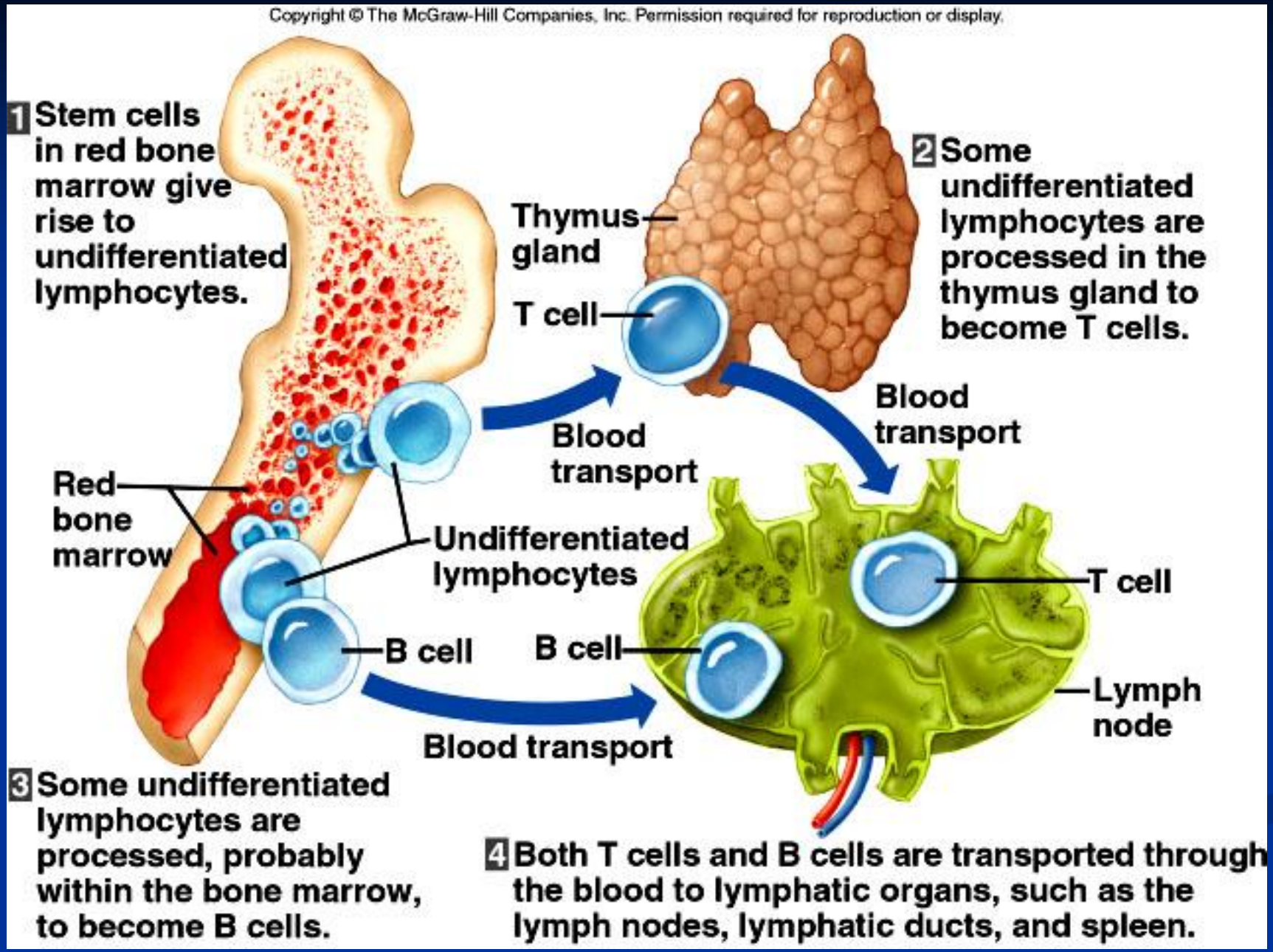
Neutrophils and monocytes (that give rise to macrophages) phagocytisize cells that are associated with the linings of blood vessels, bone marrow, spleen, lungs, and lymph nodes.

# H Adaptive (Specific) Defenses or Immunity

The body's third line of defense, immunity, refers to the response mounted by the body against specific, recognized foreign molecules.

1. **Antigens**
   a. Before birth, the body makes an inventory of "self" proteins and other large molecules.
   b. After inventory, lymphocytes develop receptors that allow them to differentiate between nonself (foreign) and self antigens.
   c. Nonself antigens combine with T-cell and B-cell surface receptors and stimulate these cells to cause an immune reaction.
   d. Haptens are small molecules that can combine with larger one becoming antigenic.

2. **Lymphocyte Origins**
   a. Lymphocytes originate in the red bone marrow and released into the blood before they differentiate.
   b. Some reach the thymus gland where they mature into T-cells.
   c. Others, the B-cells, mature in the red bone marrow.
   d. Both T-cells & B-cells, reside in lymphatic tissues and organs.



# 3. **Lymphocyte Functions**

a. T-cells provide cellular immune response in which T-cells interact directly with the antigen or antigen-bearing agents to destroy them.

b. B-cells provide a humoral immune response in which B-cells indirectly produce antibodies that destroy the antigens or antigen-bearing agents.

## 4. T Cells and the Cellular Immune Response

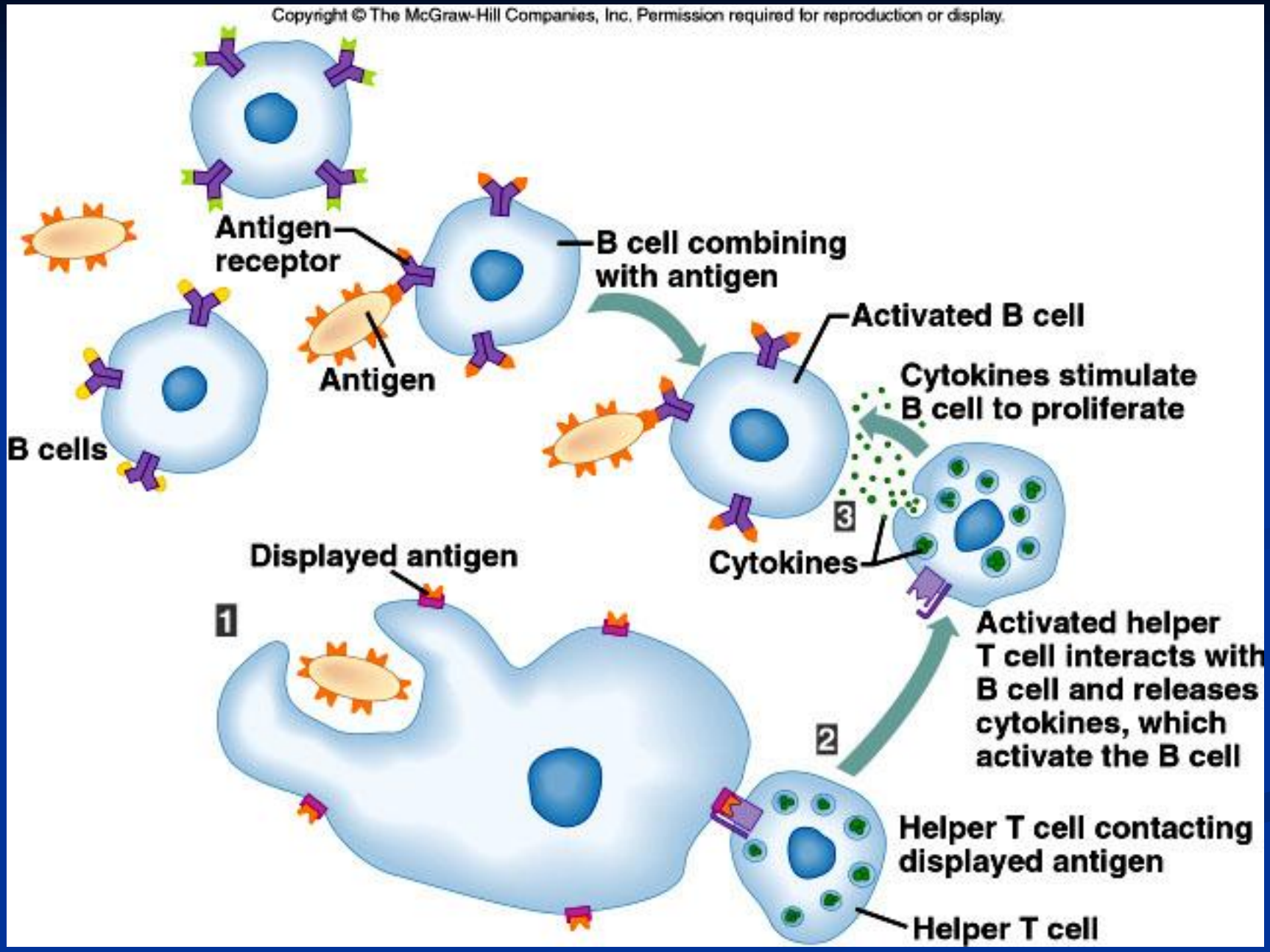
a. A helper T-cell becomes activated when it encounters antigens for which it is specialized to react.

b. The activated T-cell contacts a B-cell that carries the foreign antigen the T-cell encountered.

c. In response the T-cell secretes cytokines and stimulates B-cell proliferation and attracts macrophages.

d. Cytotoxic T-cells recognize foreign antigens on tumor cells or cells infected by viruses.

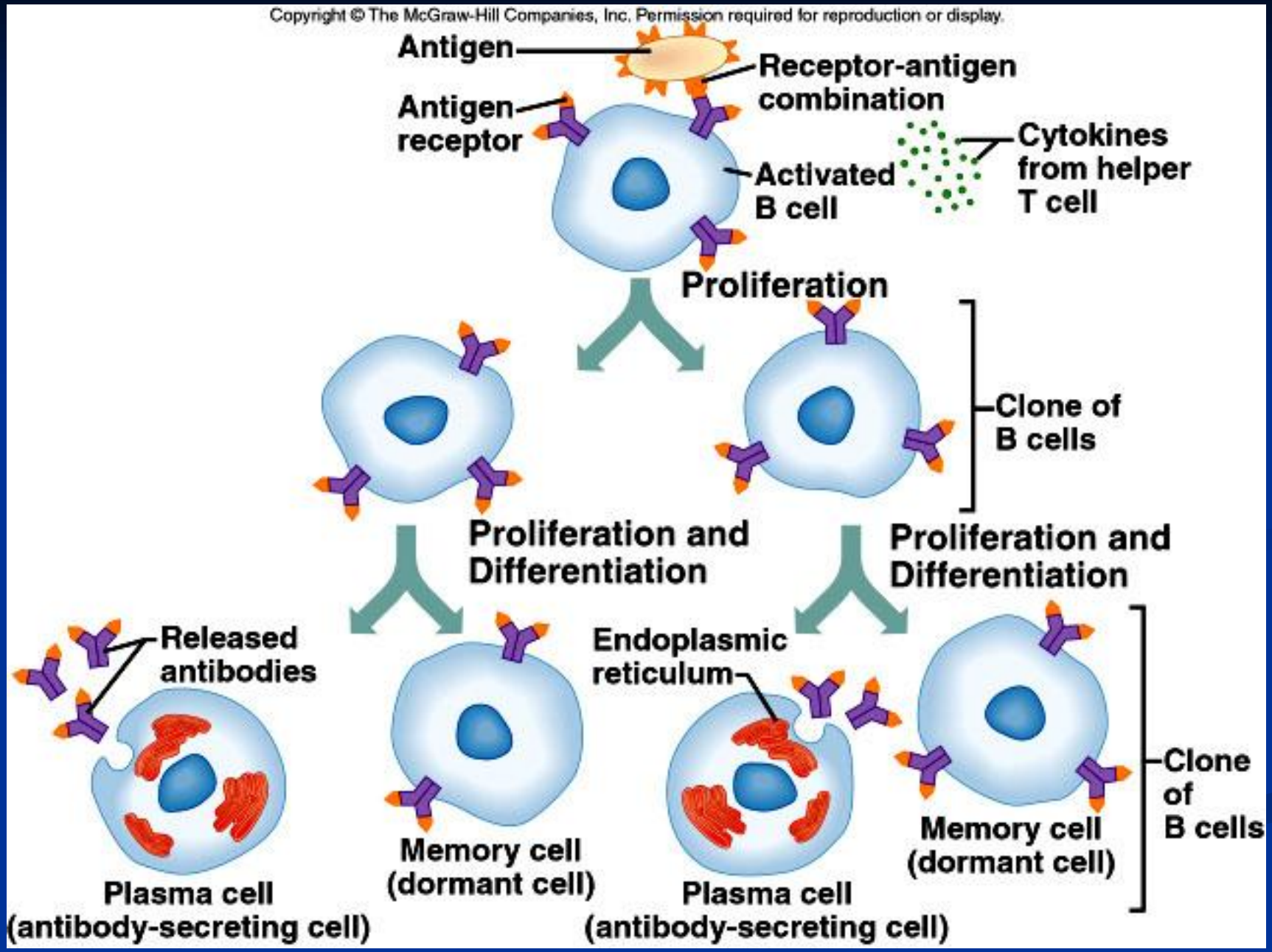
e. Memory T-cells respond quickly to the next antigen exposure



5. **B Cells and the Humoral Immune Response**
   a. A B-cell is activated when it encounters an antigen that fits its antigen receptors. It then divides repeatedly.
   b. An activated B-cell proliferates when stimulated by a T-cell, enlarging its clone.
   c. Some activated B-cells specialize into antibody producing plasma cells.
   d. Antibodies react against the antigen-bearing agent.

e. Some of the B cells become plasma cells, producing and secreting antibodies.

f. Like T cells, some of the B cells become memory cells to respond to future encounters with the antigen.



6. **Types of Antibodies** these are soluble proteins called immunoglobulins.
   a. There are five major types of antibodies (immunoglobulins) that constitute the gamma globulin fraction of the plasma.
   b. The five major types are: IgG. IgA, IgM, IgD and IgE

7. **Antibody Actions**

   a. They directly attach to antigen, activate complement or stimulate local tissue changes unfavorable to the antigen.

   b. Direct attachment can result in agglutination, precipitation, or neutralization.

   c. Activated proteins of complement attract phagocytes.

8. **Immune Responses**

   a. A primary immune response is the first reaction to an antigen. During this response antibodies are produced for several weeks and some B-cells remain dormant as memory cells.

   b. Secondary immune response occurs rapidly as a result of memory cell response.

9. **Practical Classification of Immunity**
   a. Naturally acquired active immunity occurs after exposure to the antigen itself.
   b. Artificially acquired active immunity occurs through the use of vaccines, without the person becoming ill from the disease.

c. Artificially acquired passive immunity involves the injection of gamma globulin containing antibodies and is short-lived.

d. Naturally acquired passive immunity occurs as antibodies are passed from mother to fetus and is short-lived.

## 10. **Allergic Reactions**

Allergic reactions to allergens are excessive immune responses that may lead to tissue damage.

a. Delayed-reaction allergy results from repeated exposure to substances that cause inflammatory reactions in the skin.

b. Immediate-reaction allergy is an inherited ability to overproduce IgE.

11. **Transplantation and Tissue Rejection**
    a. A transplant recipient's immune system may react with foreign antigens on the surface of the transplanted tissue, causing a tissue rejection reaction.
    b. Close matching of donor and recipient tissues can reduce the chances of tissue rejection, and use of immunosuppressive drugs may reduce rejection, although the individual may be more susceptible to infection.

12. **Autoimmunity**
    a. In autoimmune disorders, the immune system manufactures antibodies against some of its own antigens.
    b. Autoimmune disorders may result from viral infection, faulty T cell development, or reaction to a nonself antigen that bears close resemblance to a self antigen.