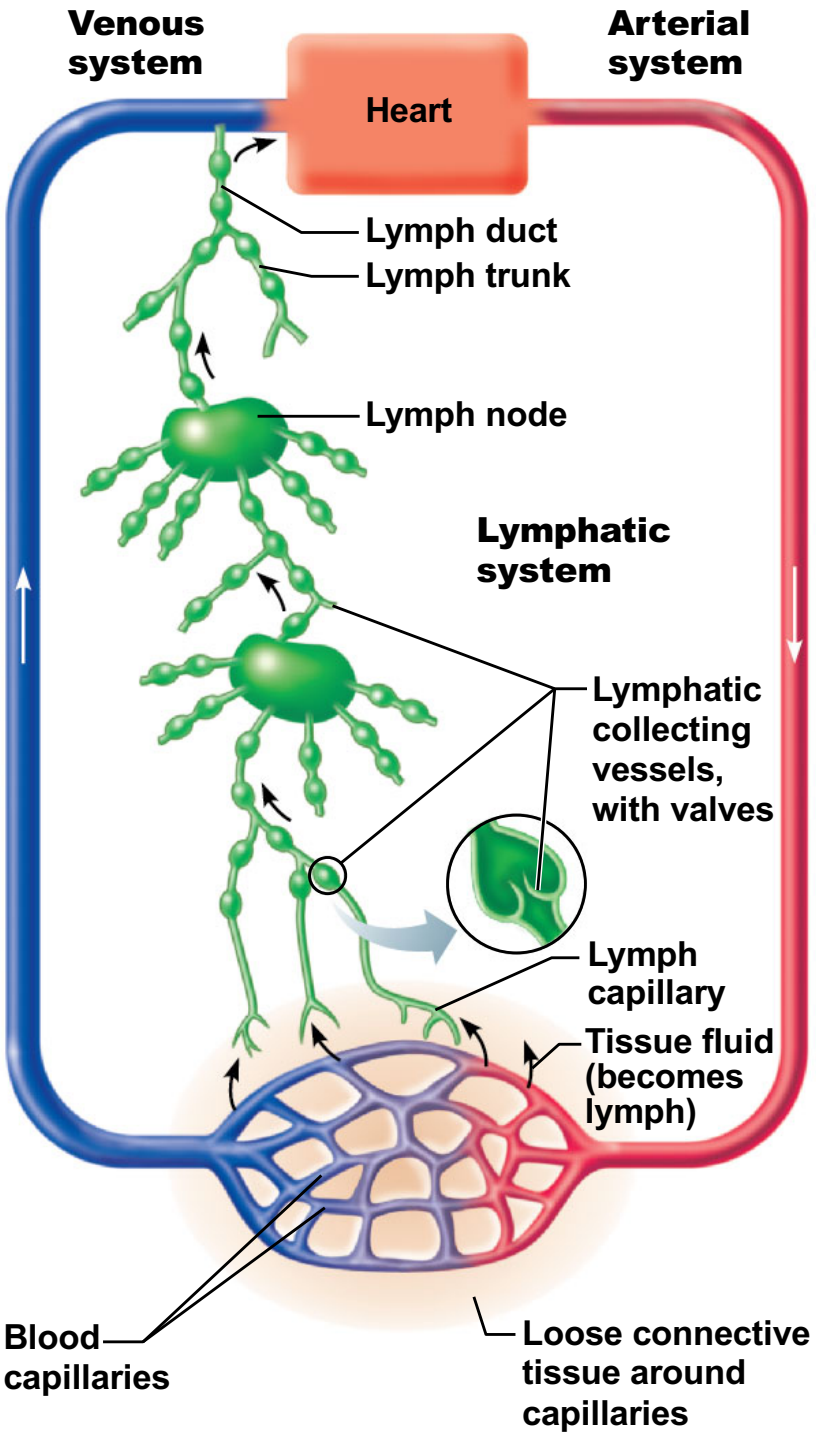
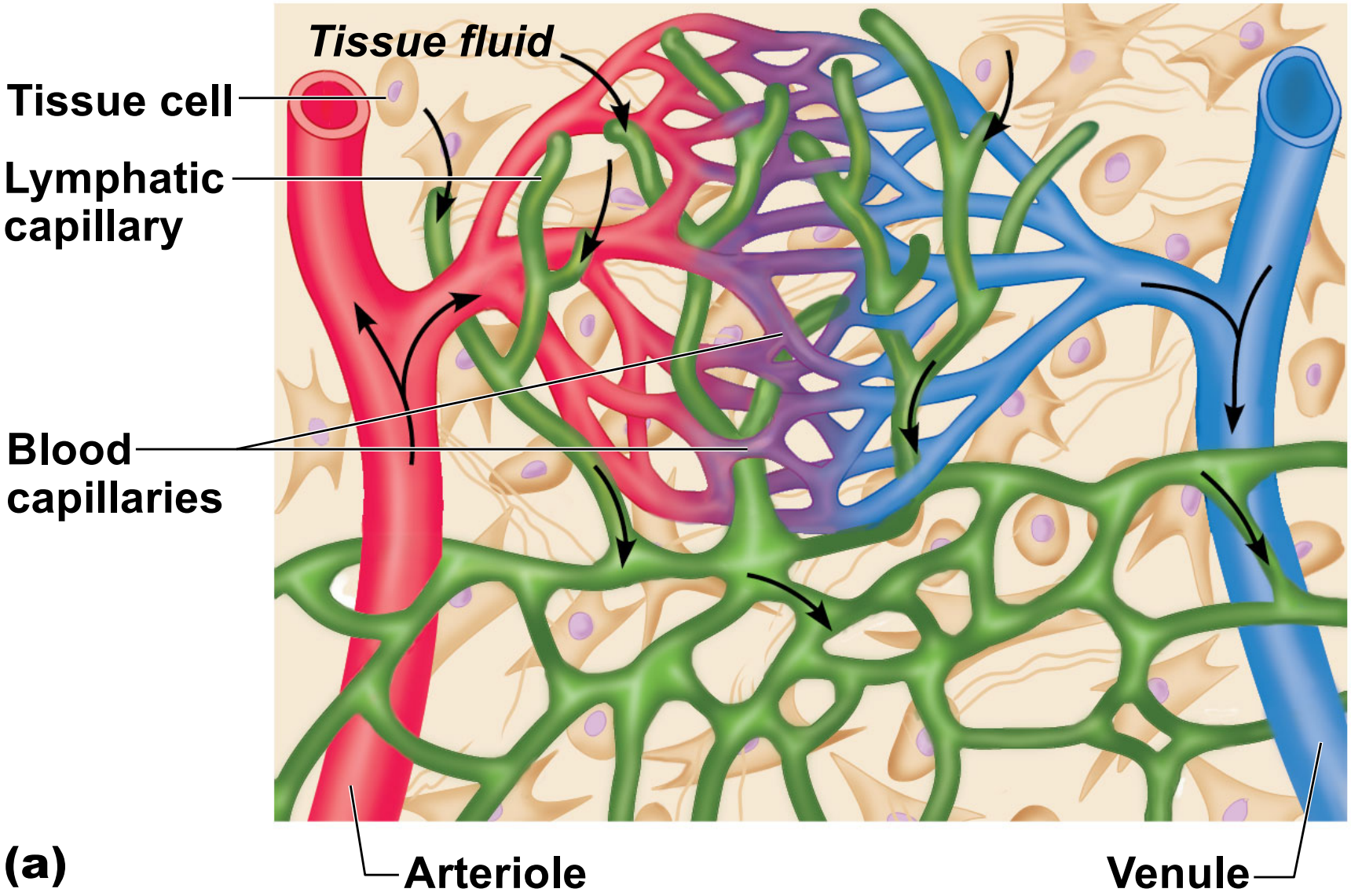
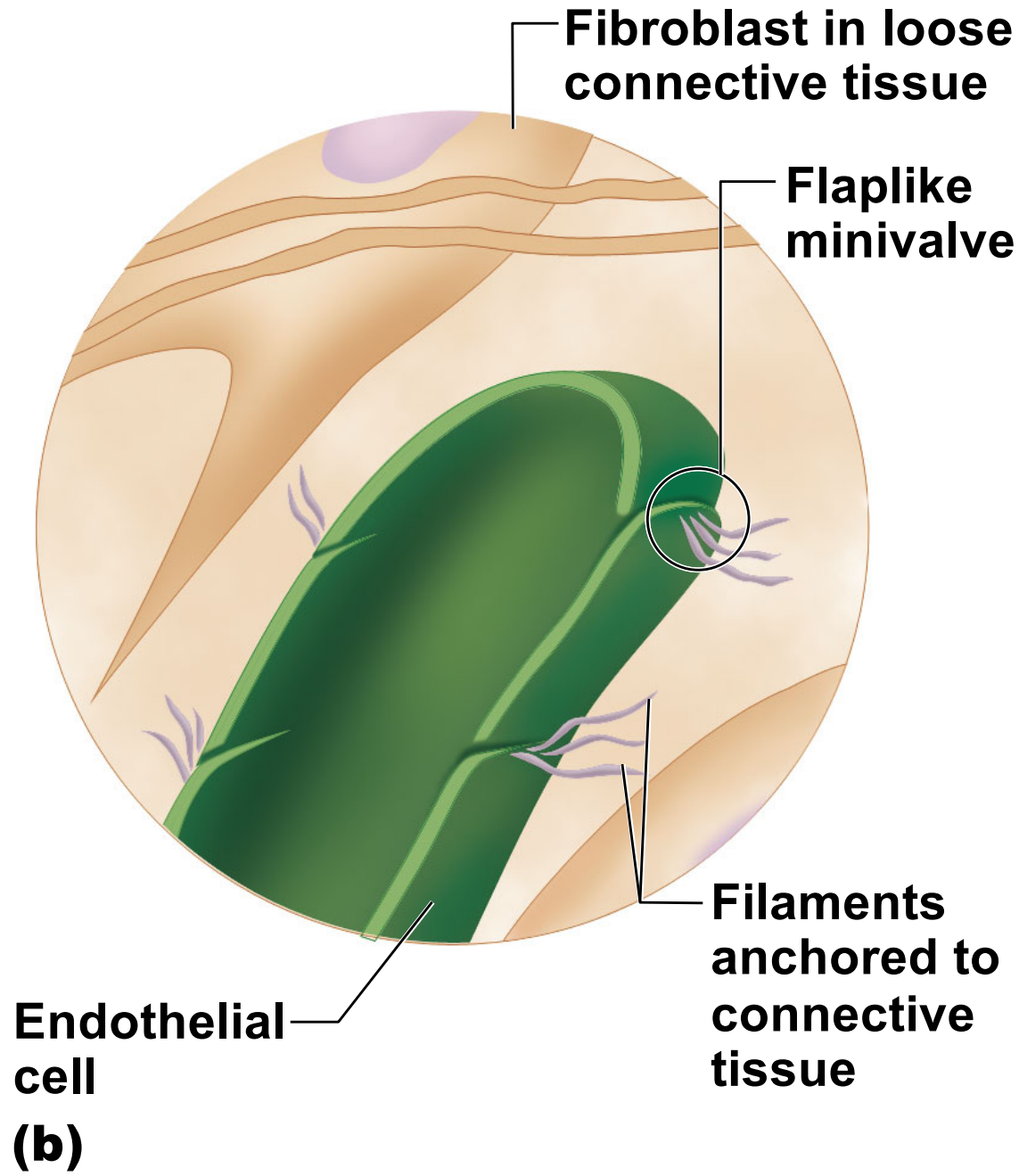
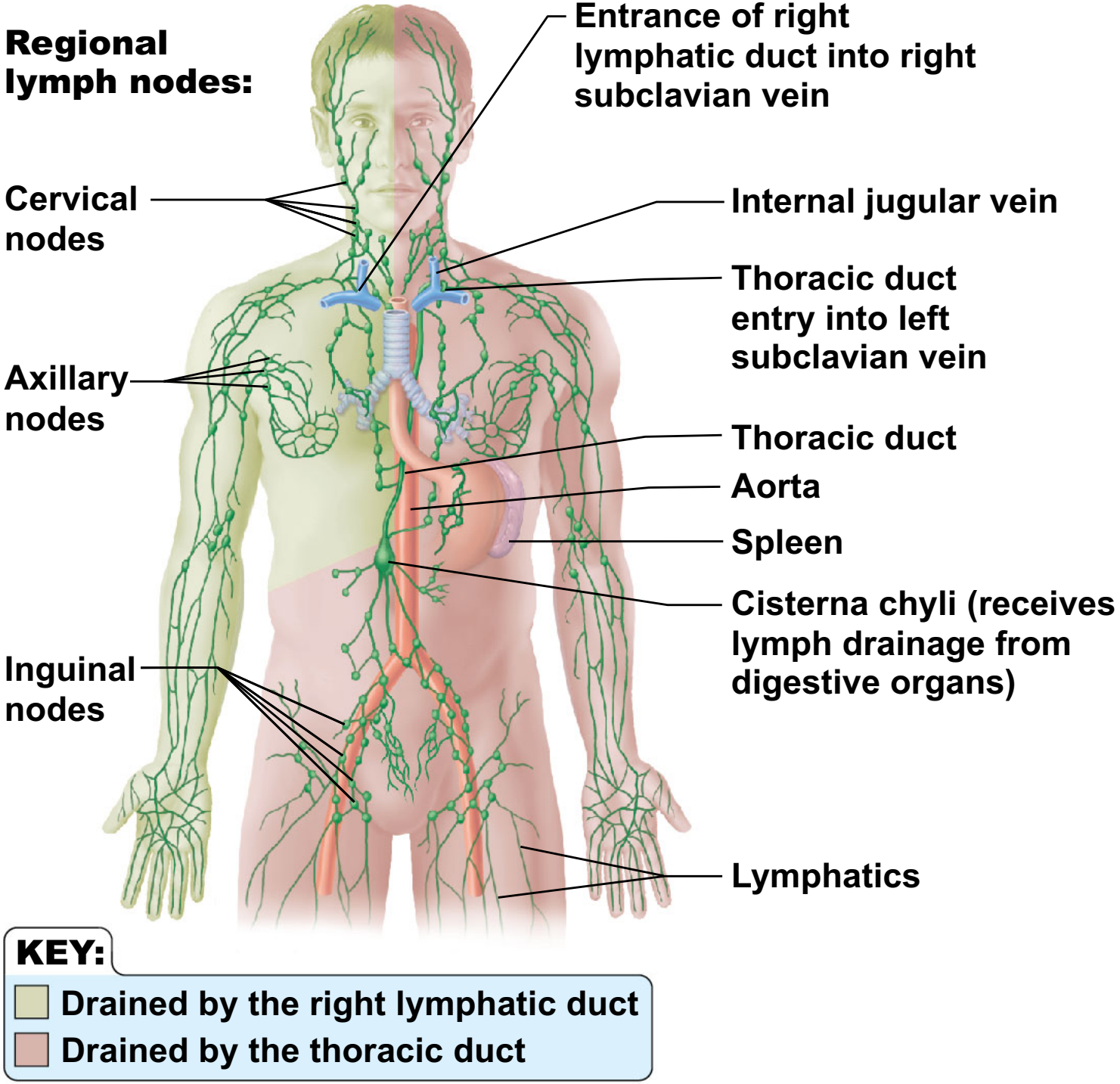
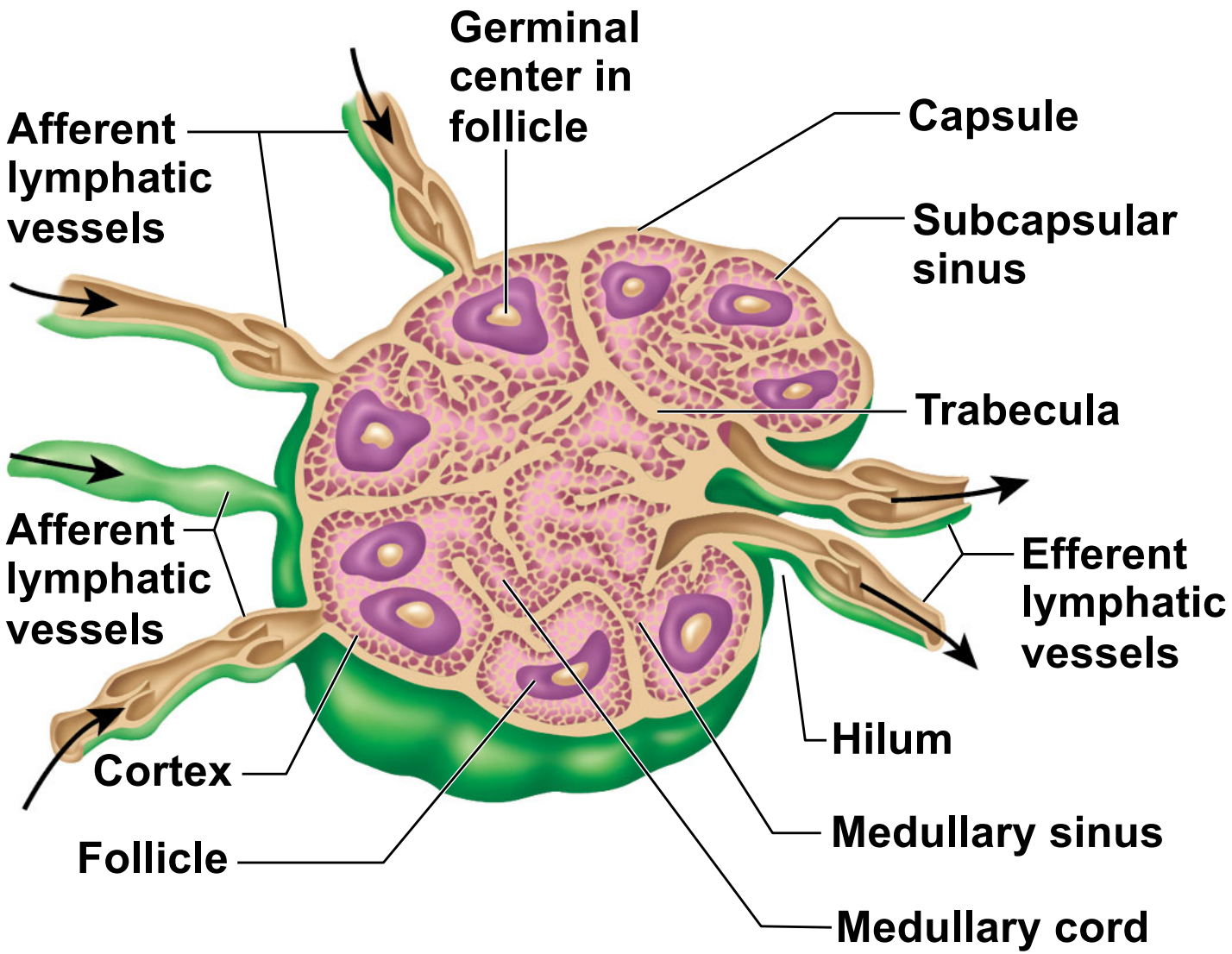
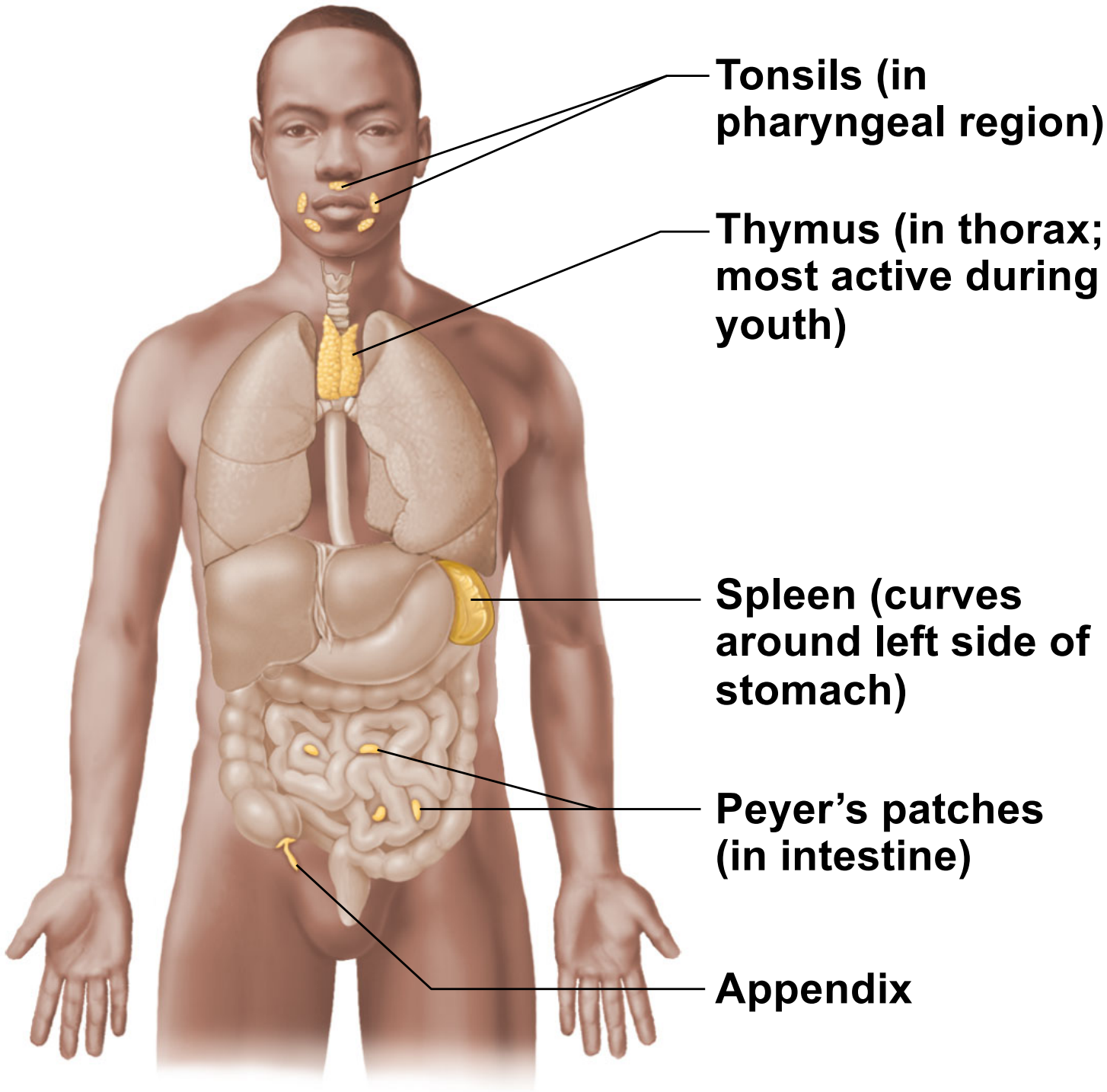












The Immune System		
Innate (nonspecific) defense mechanisms		**Adaptive (specific) defense mechanisms**
First line of defense	**Second line of defense**	**Third line of defense**
• Skin • Mucous membranes • Secretions of skin and mucous membranes	• Phagocytic cells • Natural killer cells • Antimicrobial proteins • The inflammatory response • Fever	• Lymphocytes • Antibodies • Macrophages and other antigen-presenting cells

Table 12.1 Summary of Innate (Nonspecific) Body Defenses

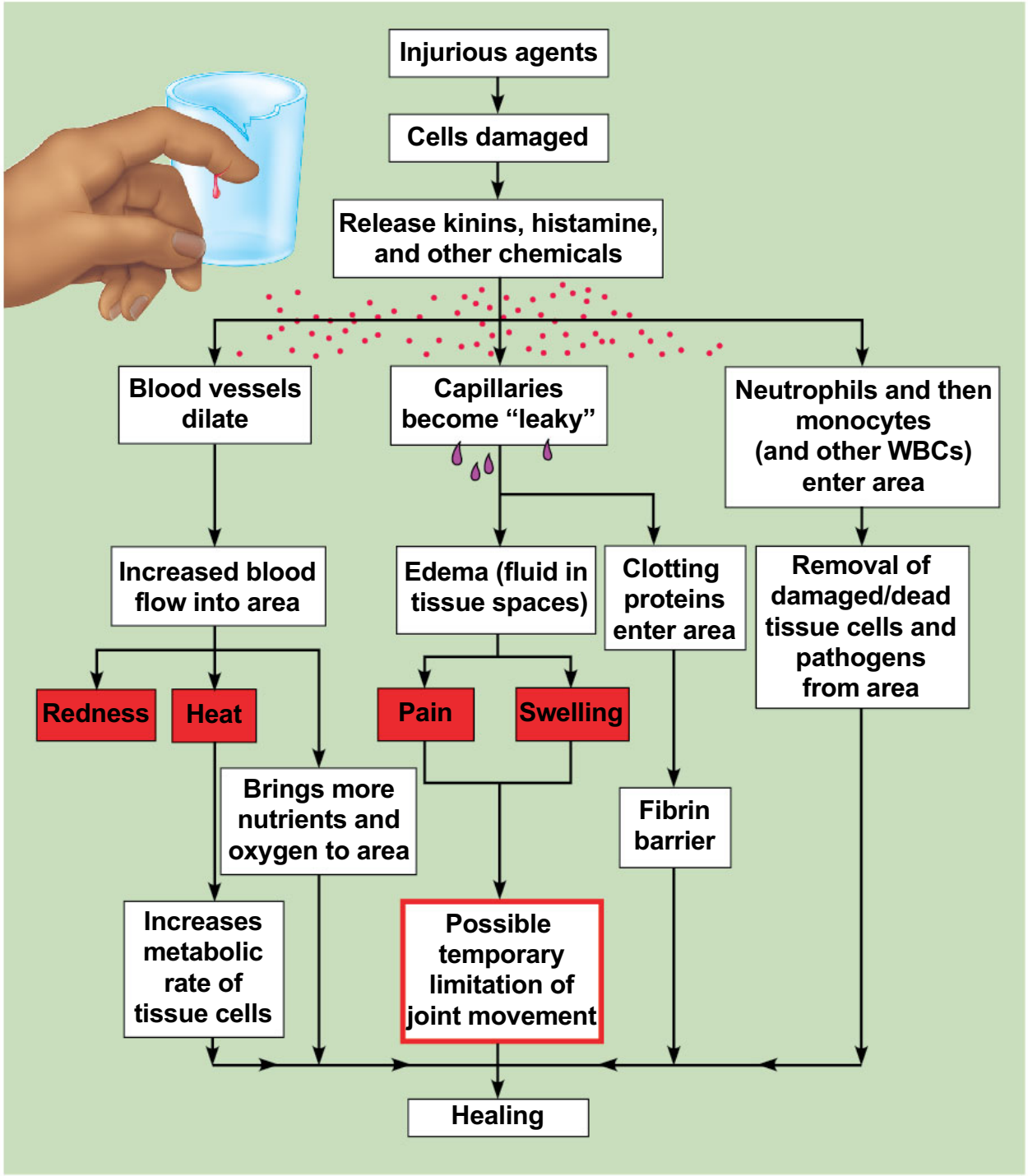
Category and associated elements	Protective mechanism
Surface membrane barriers—first line of defense	
Intact skin (epidermis)	Forms mechanical barrier that prevents entry of pathogens and other harmful substances into body.
• Acid mantle	Skin secretions make epidermal surface acidic, which inhibits bacterial growth; sebum also contains bacteria-killing chemicals.
• Keratin	Provides resistance against acids, alkalis, and bacterial enzymes.
Intact mucous membranes	Form mechanical barrier that prevents entry of pathogens.
• Mucus	Traps microorganisms in respiratory and digestive tracts.
• Nasal hairs	Filter and trap microorganisms and other airborne particles in nasal passages.
• Cilia	Propel debris-laden mucus away from lower respiratory passages.
• Gastric juice	Contains concentrated hydrochloric acid and protein-digesting enzymes that destroy pathogens in stomach.
• Acid mantle of vagina	Inhibits growth of bacteria and fungi in female reproductive tract.
• Lacrimal secretion (tears); saliva	Continuously lubricate and cleanse eyes (tears) and oral cavity (saliva); contain lysozyme, an enzyme that destroys microorganisms.

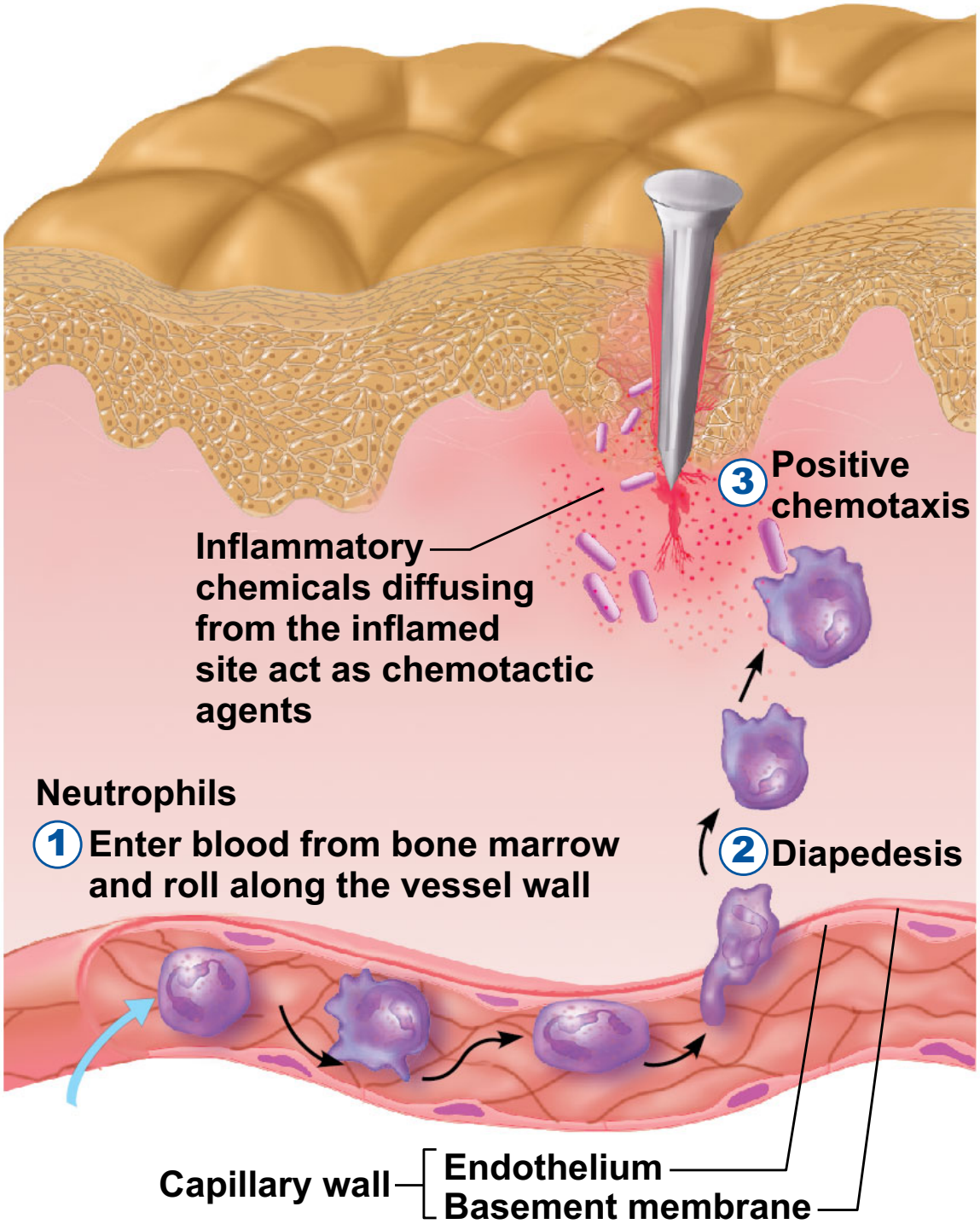
Table 12.1 **Summary of Innate (Nonspecific) Body Defenses** (*continued*)

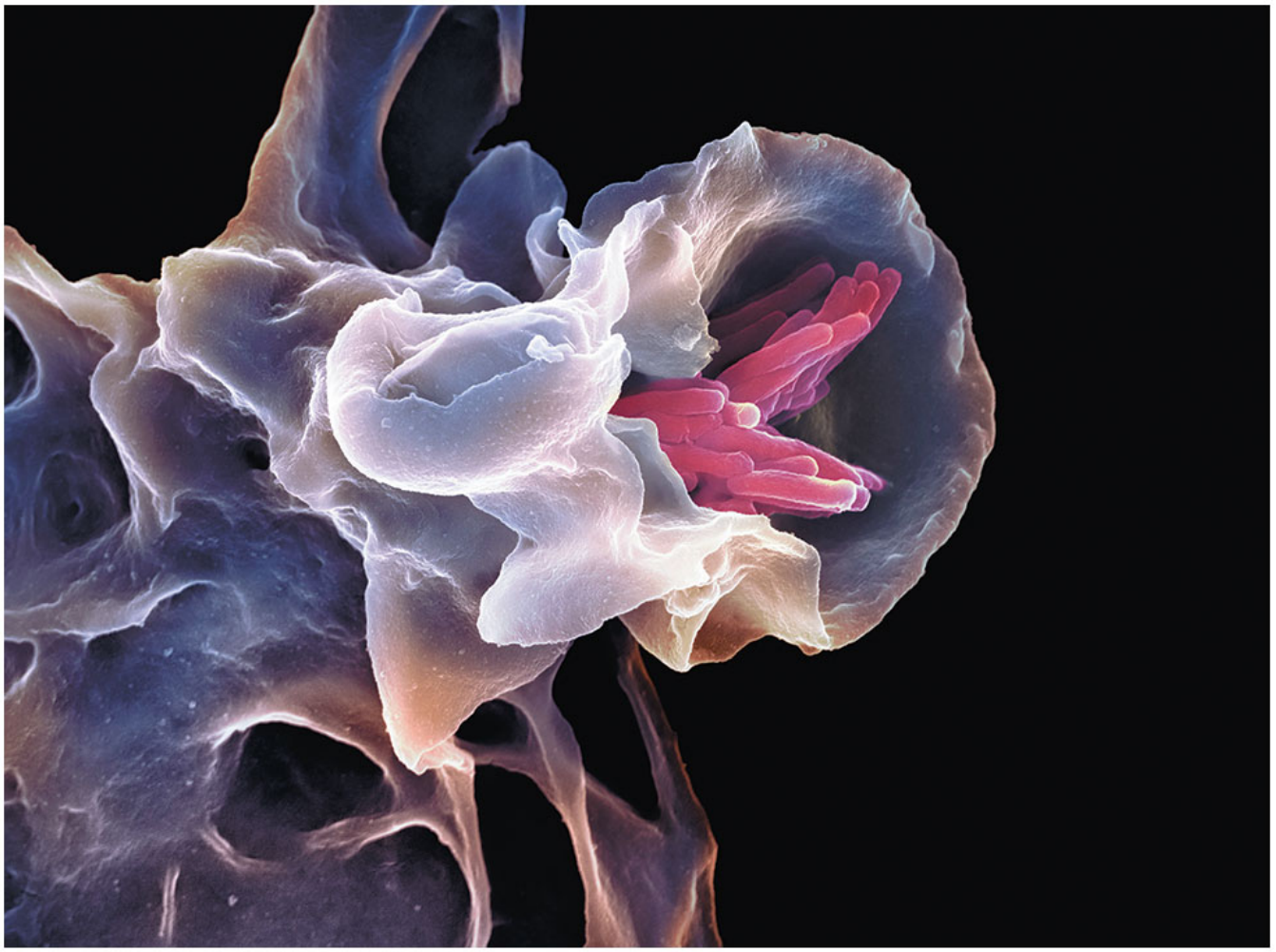
Category and associated elements	Protective mechanism
Cellular and chemical defenses—second line of defense	
Phagocytes	Engulf and destroy pathogens that breach surface membrane barriers; macrophages also contribute to immune response.
Natural killer cells	Promote cell lysis by direct cell attack against virus-infected or cancerous body cells; do not depend on specific antigen recognition.
Inflammatory response	Prevents spread of injurious agents to adjacent tissues, disposes of pathogens and dead tissue cells, and promotes tissue repair; releases chemical mediators that attract phagocytes (and immune cells) to the area.

Table 12.1 **Summary of Innate (Nonspecific) Body Defenses** (*continued*)

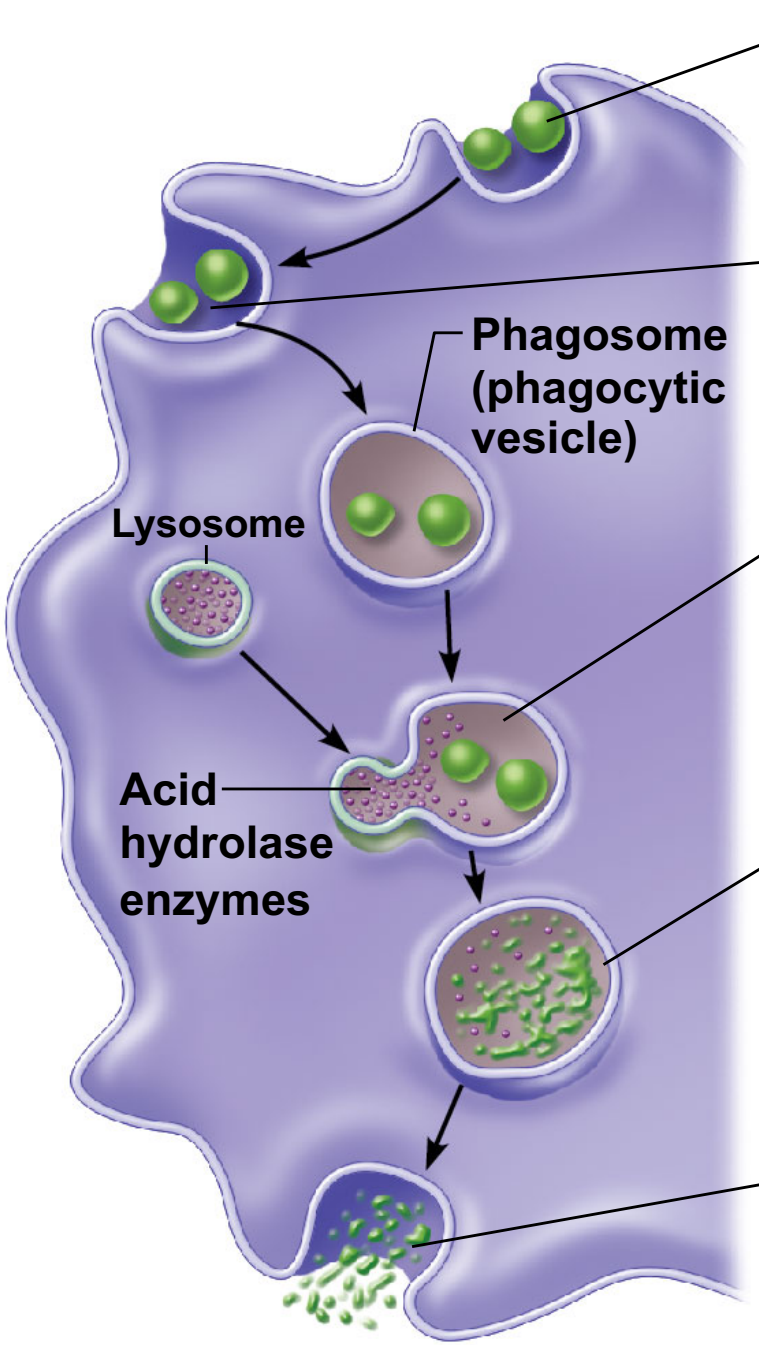
Category and associated elements	Protective mechanism
Cellular and chemical defenses—second line of defense	
Antimicrobial chemicals	
• Complement	Group of plasma proteins that lyses microorganisms, enhances phagocytosis by opsonization, and intensifies inflammatory response.
• Interferons	Proteins released by virus-infected cells that protect uninfected tissue cells from viral takeover; mobilize immune system.
• Fluids with acid pH	Normally acid pH inhibits bacterial growth; urine cleanses the lower urinary tract as it flushes from the body.
Fever	Systemic response triggered by pyrogens; high body temperature inhibits multiplication of bacteria and enhances body repair processes.





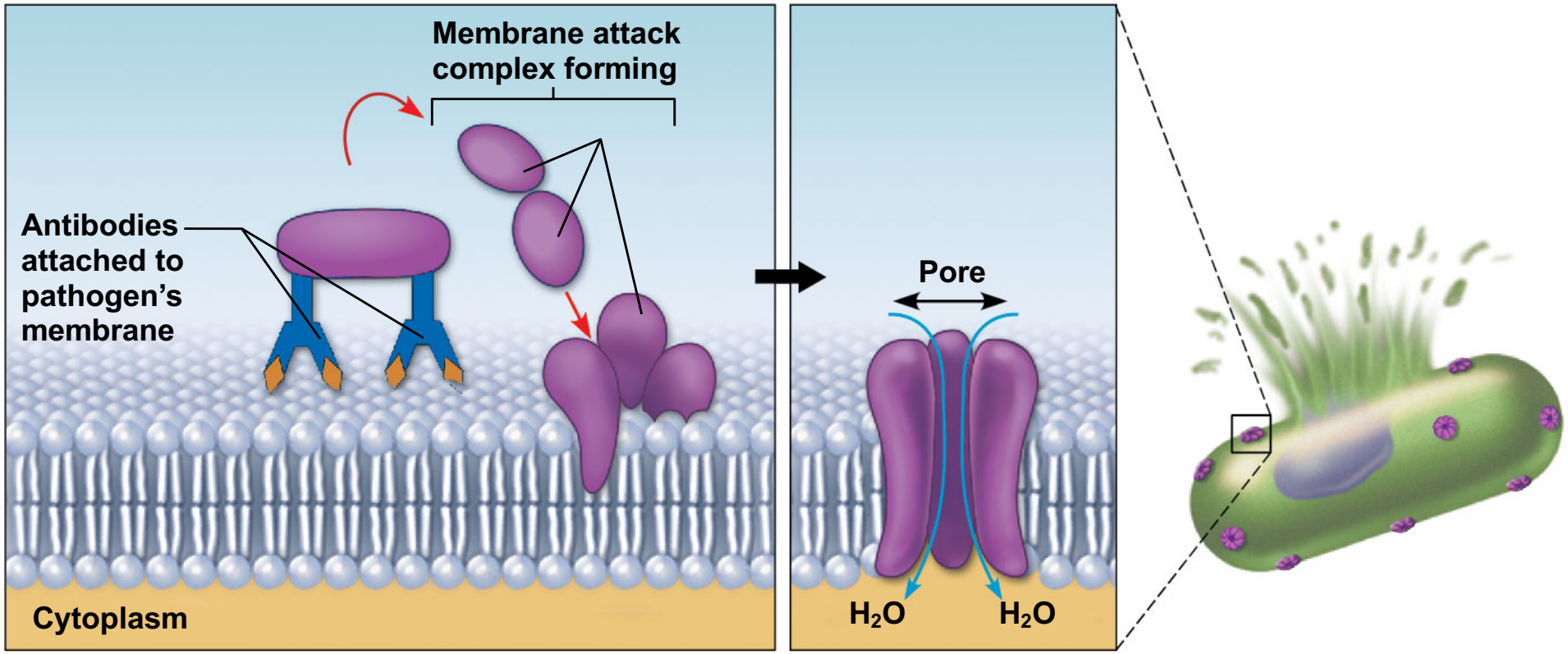


(a) A macrophage (purple) uses its cytoplasmic extensions to ingest bacillus-shaped bacteria (pink) by phagocytosis. Scanning electron micrograph.



(b) Events of phagocytosis

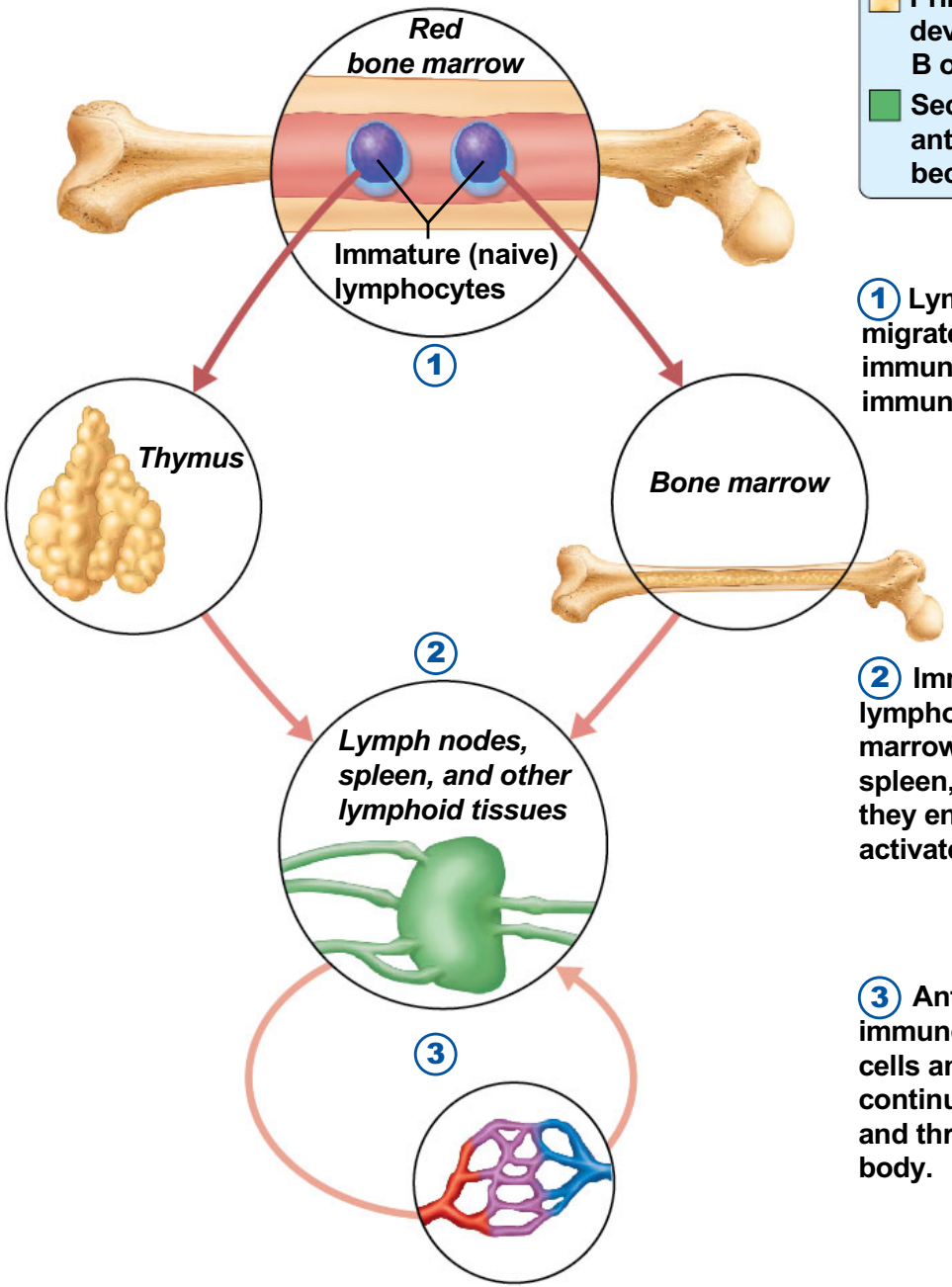
1. Phagocyte adheres to pathogens.
2. Phagocyte engulfs the particles, forming a phagosome.
3. Lysosome fuses with the phagocytic vesicle, forming a phagolysosome.
4. Lysosomal enzymes digest the pathogens or debris, leaving a residual body.
5. Exocytosis of the vesicle removes indigestible and residual material.



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

2 MAC pores in the membrane allow water to rush into the cell.

3 This influx of water causes cell lysis.



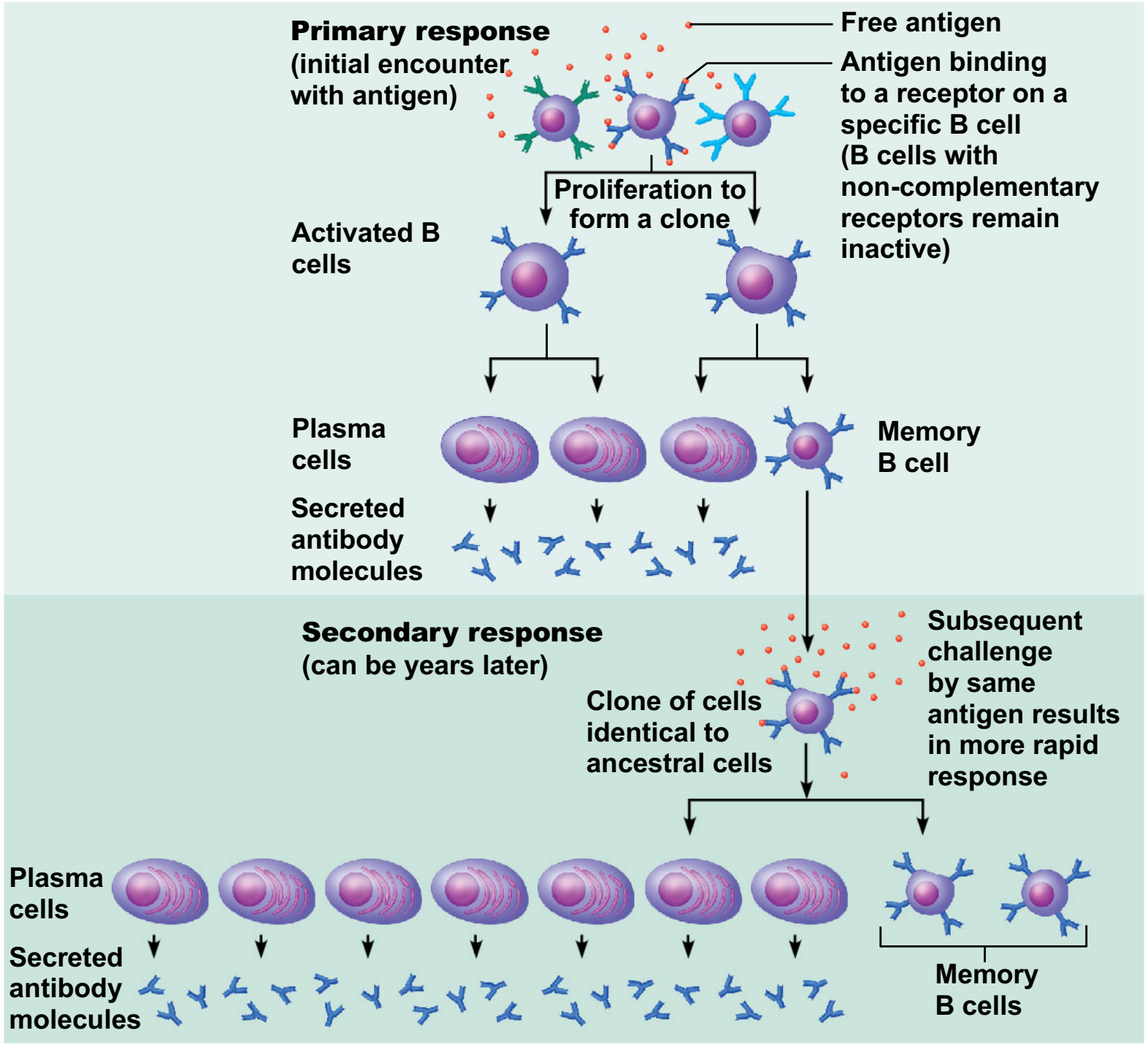
KEY:

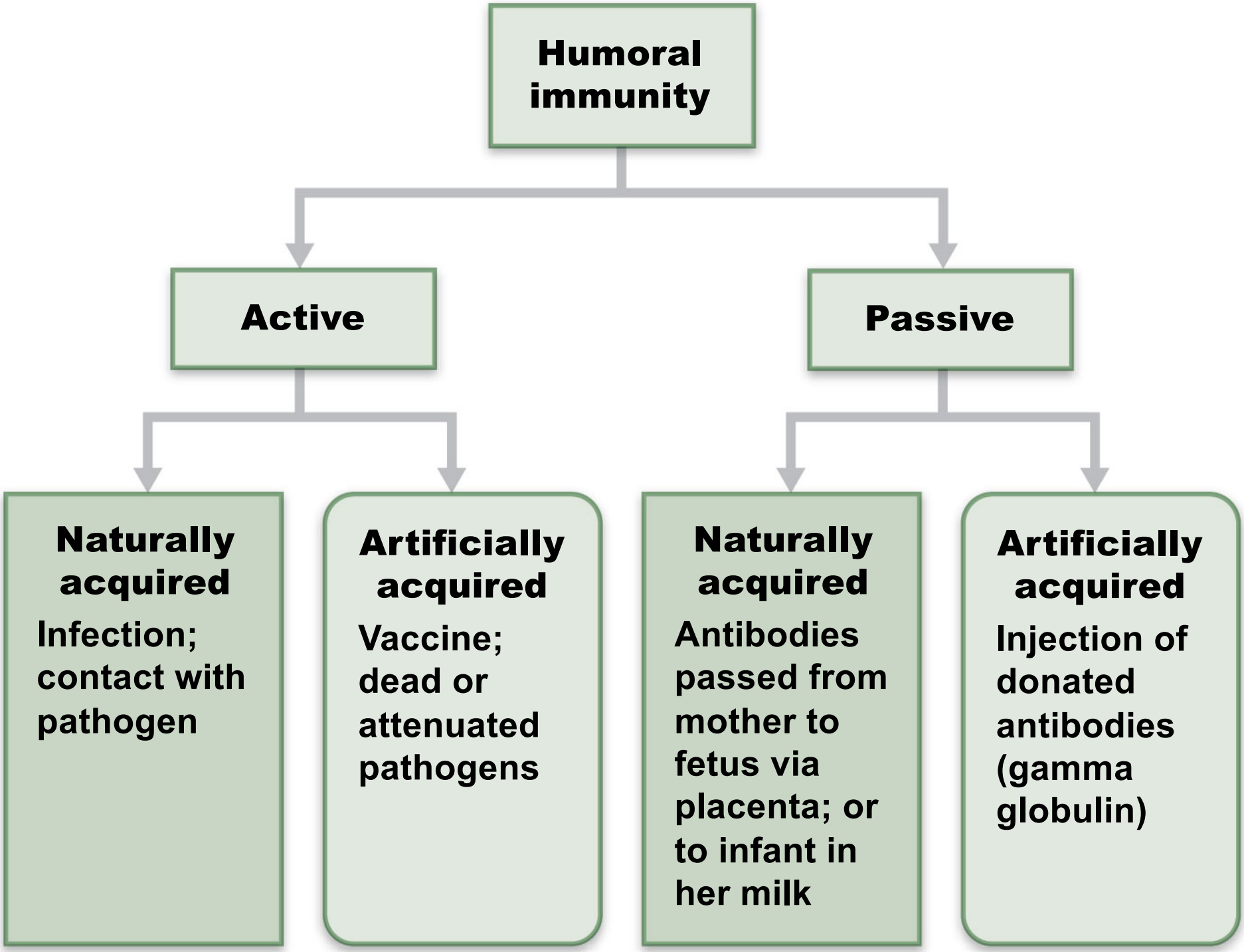
- Red bone marrow: site of lymphocyte origin
- Primary lymphoid organs: sites of development of immunocompetence as B or T cells
- Secondary lymphoid organs: sites of antigen encounter, and activation to become effector and memory B or T cells

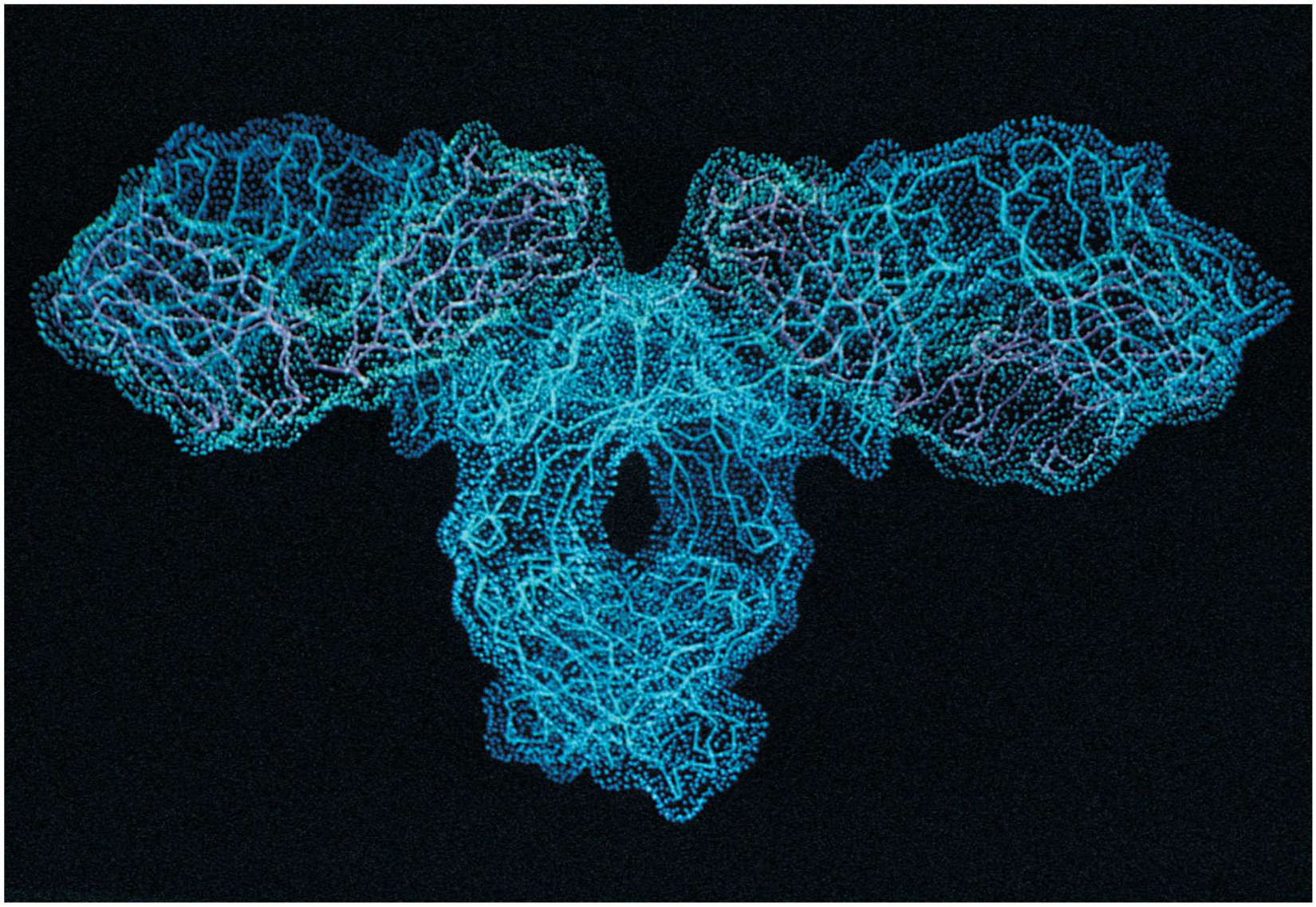
(1) Lymphocytes destined to become T cells migrate (in blood) to the thymus and develop immunocompetence there. B cells develop immunocompetence in red bone marrow.

(2) Immunocompetent but still naive lymphocytes leave the thymus and bone marrow. They "seed" the lymph nodes, spleen, and other lymphoid tissues, where they encounter their antigens and become activated.

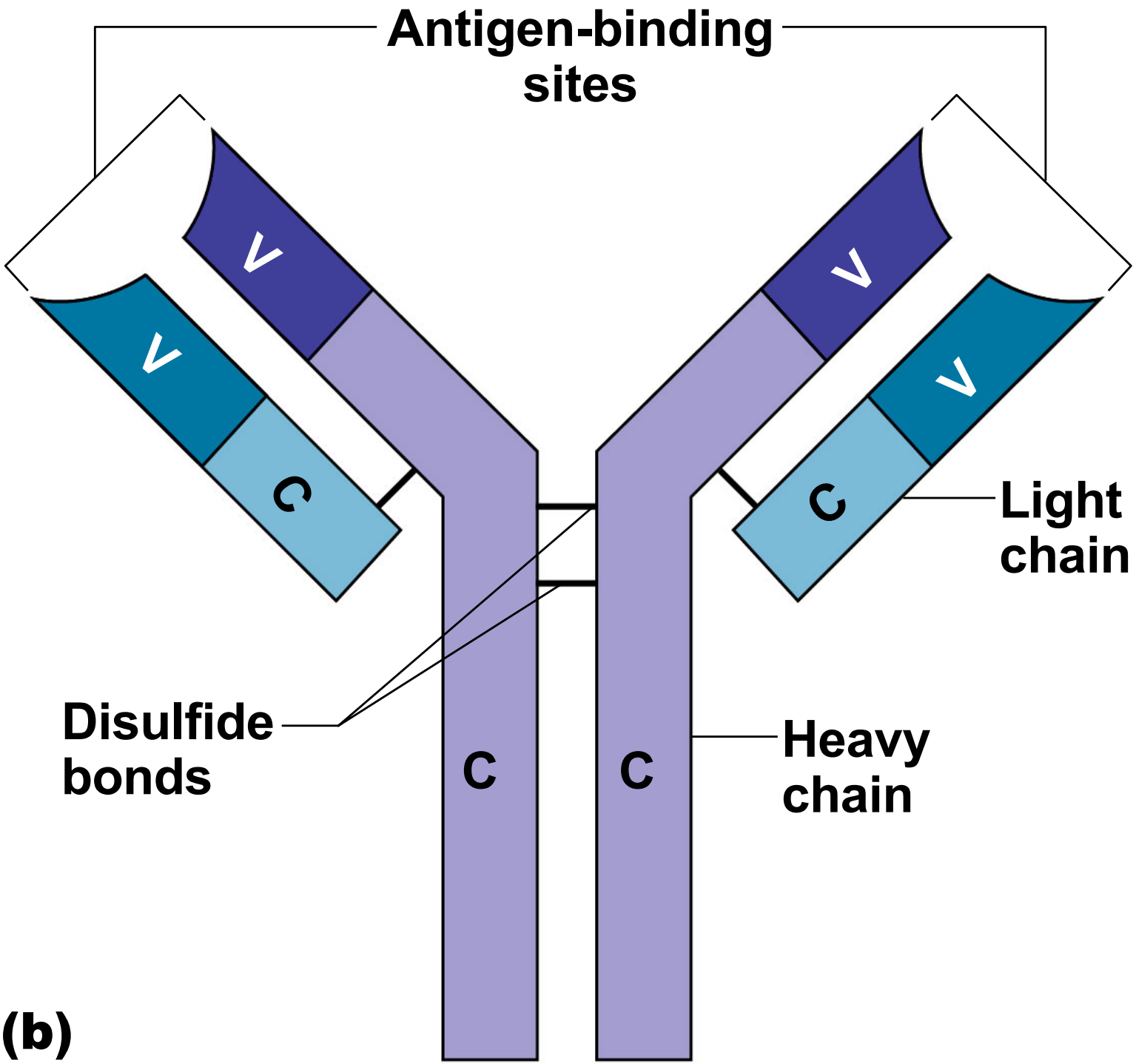
(3) Antigen-activated (mature) immunocompetent lymphocytes (effector cells and memory cells) circulate continuously in the bloodstream and lymph and throughout the lymphoid organs of the body.







(a)



(b)