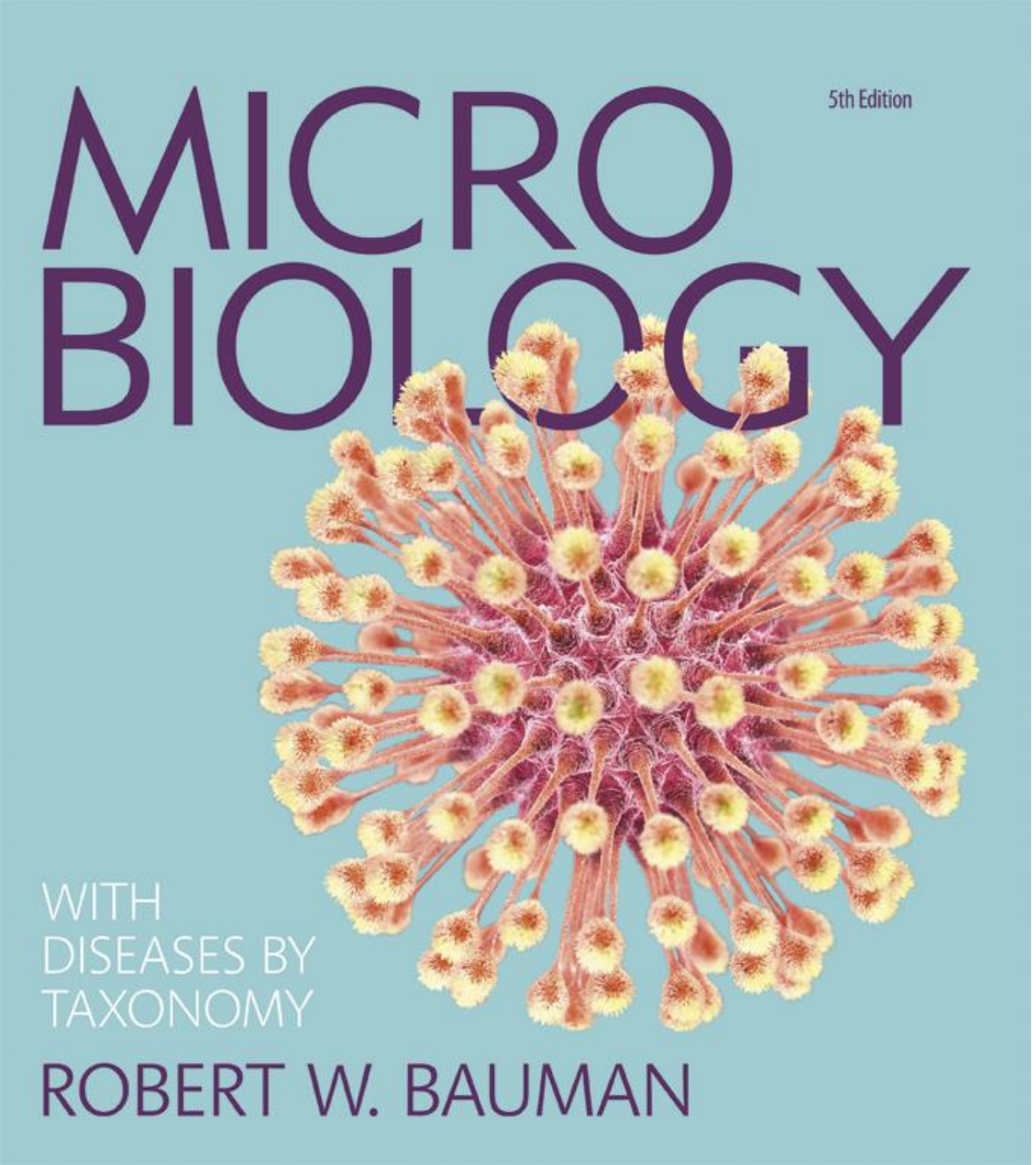


PowerPoint® Lecture Presentations prepared by Mindy Miller-Kittrell, North Carolina State University

CHAPTER **16**

Adaptive Immunity

Test # 1

- Test 1: October 3 – October 5, 2017
  - Reattempt: October 6 – October 11, 2017
- Reattempt will be available **ONLY** if you take the first attempt in the mentioned period
- There must be min **48 hours** between the two attempts
- The test will be based on the material presented or discussed in the classroom and textbook chapters that students are required to review independently.
- Check the Moodle for more info on testing center and the exam process

Test # 1

- **Content:** chapter 14 [Infection, infectious disease, and epidemiology], chapter 15 [Innate immunity], and chapter 16 [Adaptive immunity].
- **20** multiple choice questions and/or true-false questions.
- **Duration:** 40 minutes
- **Location:** Testing Centre

Overview of Adaptive Immunity

- Adaptive immunity is the body's ability to recognize and defend itself against distinct invaders and their products
- Five attributes of adaptive immunity
  - **Specificity**
  - **Inducibility**
  - **Clonality**
  - **Unresponsiveness to self**
    - Failure can lead to autoimmune disorders or hypersensitivities
  - **Memory**

Overview of Adaptive Immunity

- Involves activity of **lymphocytes**
  - Form in the *red bone marrow* where *blood stem cells (hemopoietic stem cells)* produce all types of blood cells
- Two main types of lymphocytes:
  - **B lymphocytes (B cells)**
    - Mature in the bone marrow
  - **T lymphocytes (T cells)**
    - Mature in the thymus
- Two types of adaptive immune responses:
  - **Cell-mediated immune responses**
  - **Antibody immune responses**

Overview of Adaptive Immunity

- Long-lived B and T lymphocytes retain the ability to fight specific pathogens as long as they live aka *Immunological memory*
- Cell-mediated immune responses often act against *intracellular pathogens* such as viruses replicating inside a cell
  - Controlled and carried out by T cells
- Antibody immune responses are often directed against extracellular pathogens and toxins
  - Carried out by B cells, though T cells play roles in regulating and fulfilling antibody immune responses

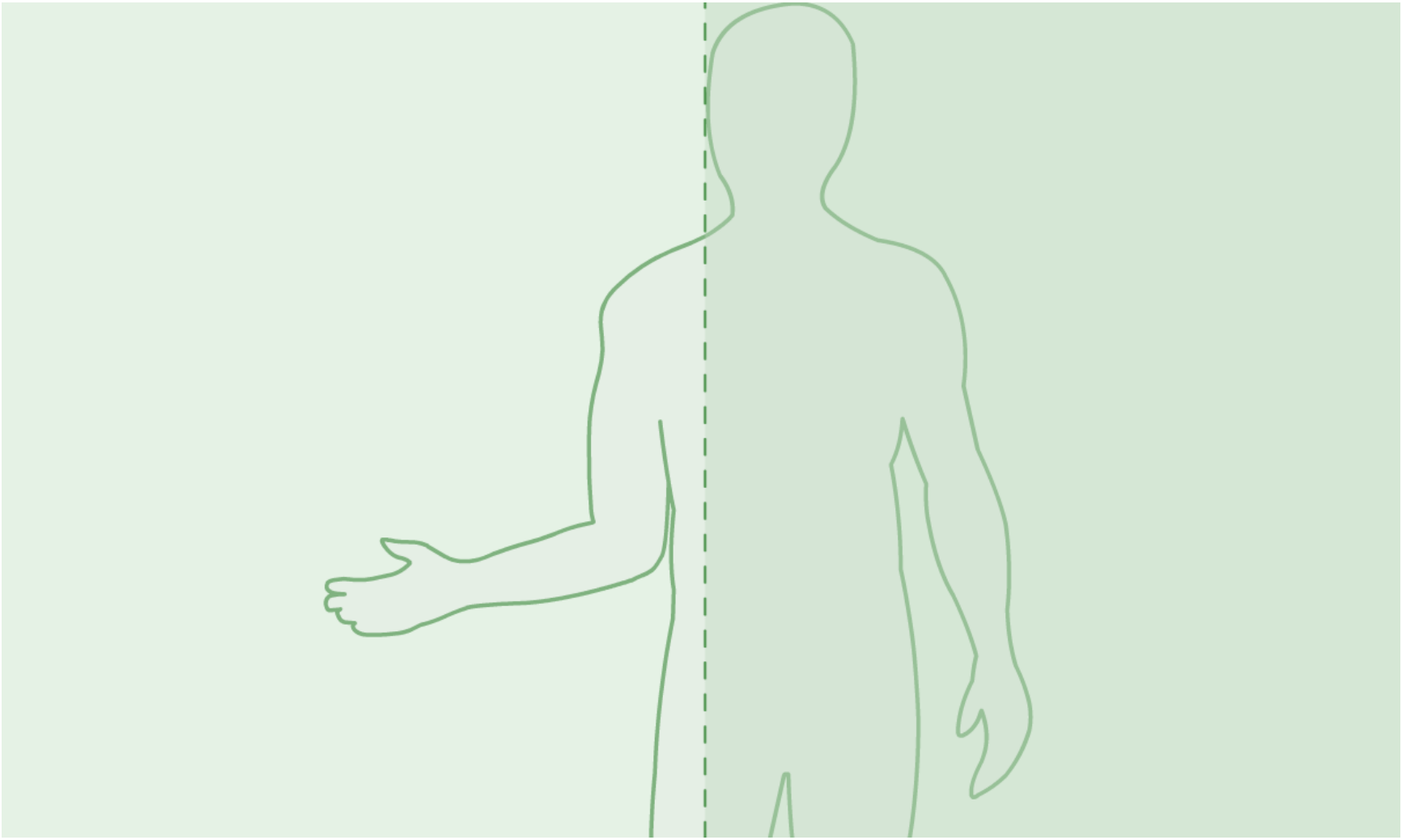
Overview of Adaptive Immunity

- An *antibody* is a protein secreted by the descendant of a B cell that recognizes a specific biochemical shape

- *Humoral immune responses,* another term for antibody immune responses, recognizes that most antibody molecules circulate in the blood.

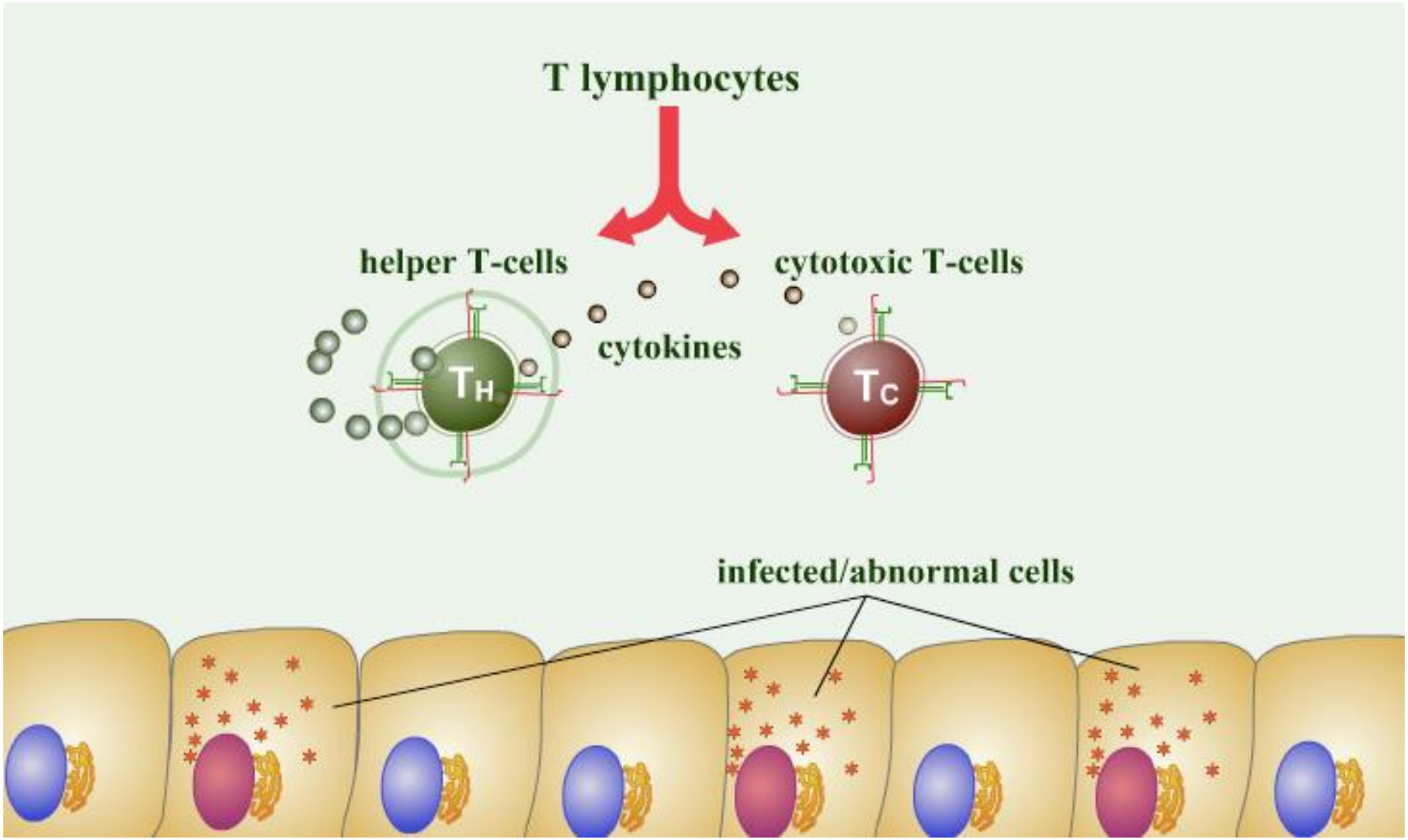
- The adaptive immune response must be regulated to prevent damage to uninfected healthy tissues.

Host Defenses: The Big Picture



PLAY **Host Defenses: The Big Picture**

Cell-Mediated Immunity: Overview



PLAY **Cell-Mediated Immunity: Overview**

Elements of Adaptive Immunity

- **The Tissues and Organs of the Lymphatic System**
  - Composed of lymphatic vessels and lymphatic cells, tissues, and organs
  - Screen the tissues of the body for foreign antigens

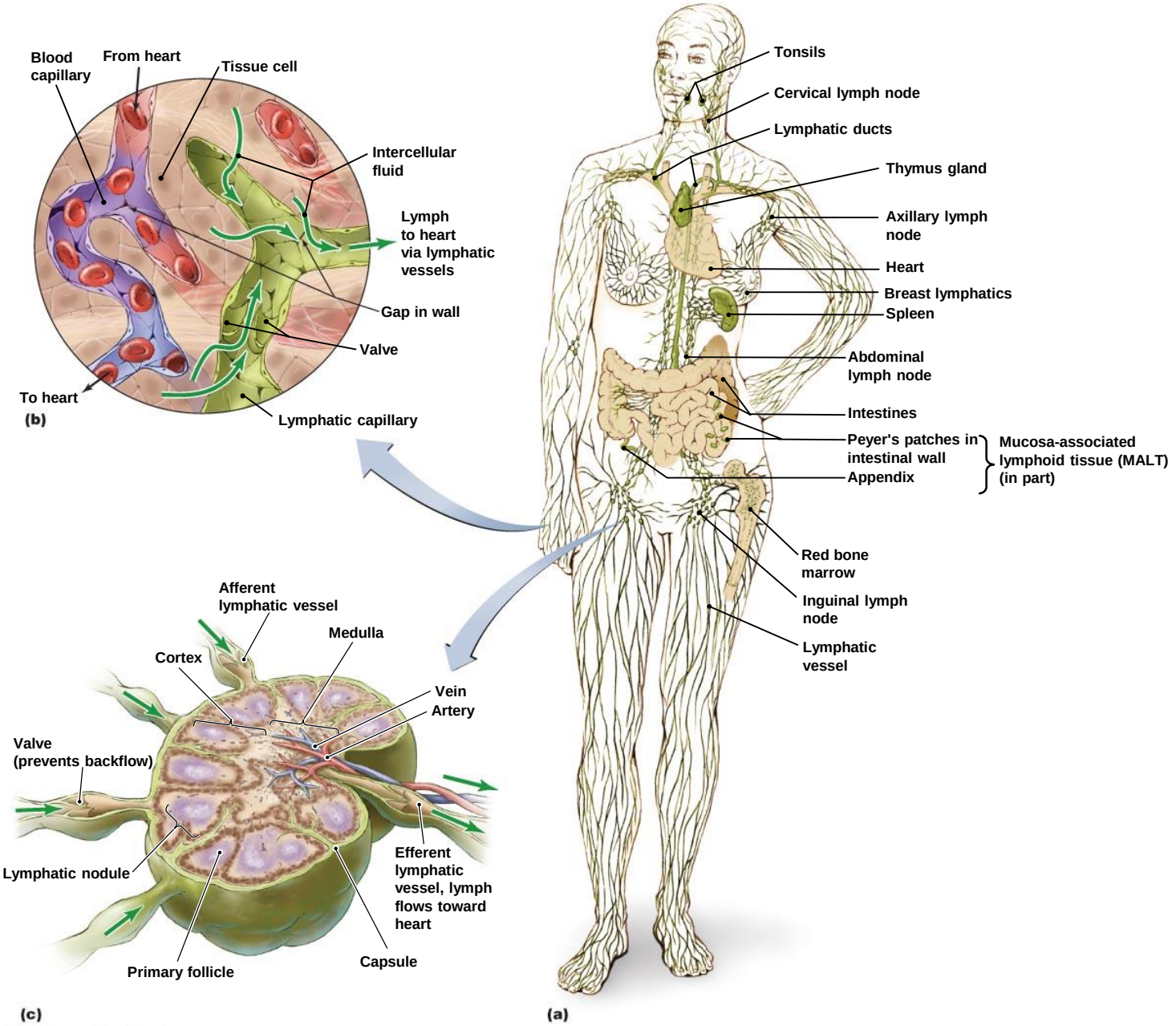
Elements of Adaptive Immunity

- **The Tissues and Organs of the Lymphatic System**
  - The Lymphatic Vessels and the Flow of Lymph
    - **Lymphatic vessels**
      - One-way system that conducts lymph from tissues and returns it to the circulatory system

Elements of Adaptive Immunity

- **The Tissues and Organs of the Lymphatic System**
  - The Lymphatic Vessels and the Flow of Lymph
    - **Lymph**
      - Colorless, watery liquid with similar composition to blood plasma
      - Arises from fluid leaked from blood vessels into surrounding tissues
      - Intercellular fluid flows into lymphatic *capillaries*, through larger *vessels* with one-way valves into *lymphatic ducts.*
      - On its way, it passes through lymph nodes, which contain B and T cells, allowing for immune surveillance and interaction.

Figure 16.2 The lymphatic system.



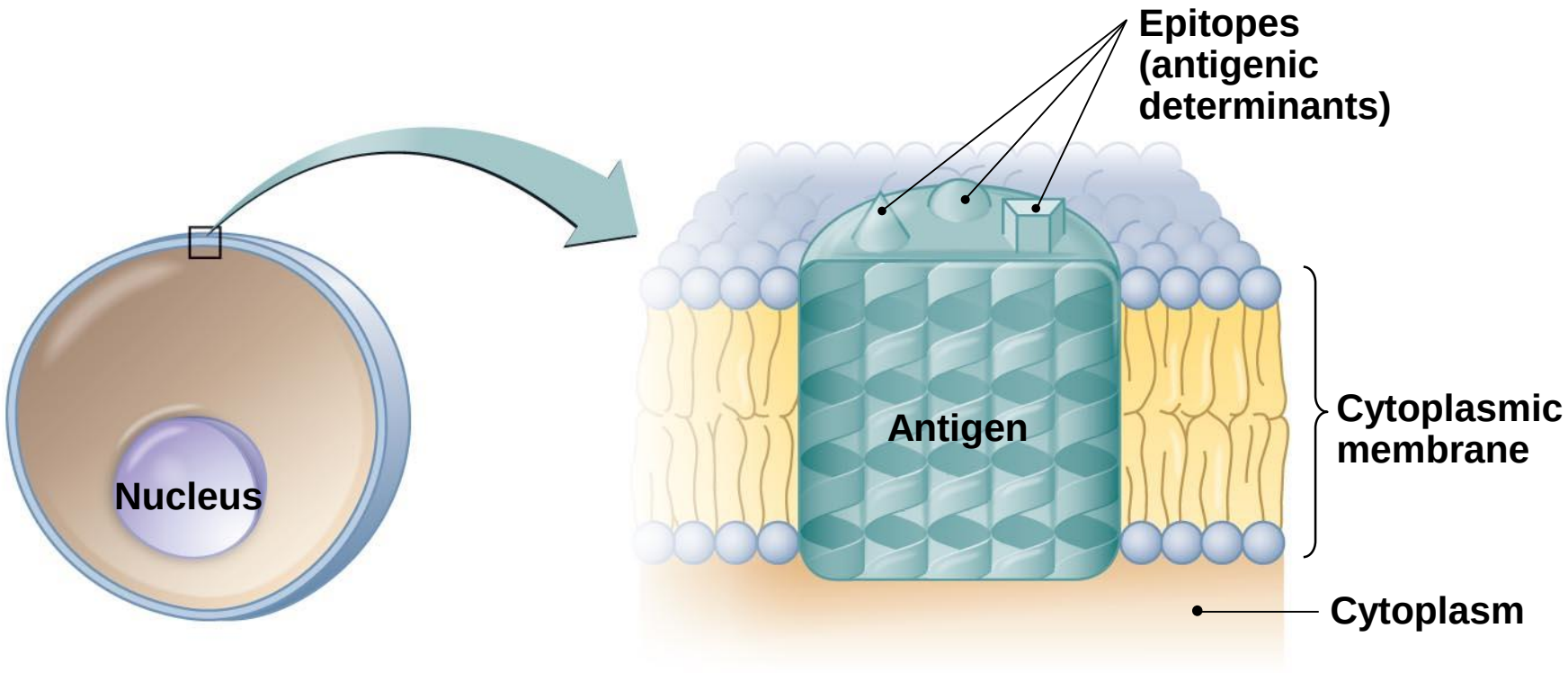
Elements of Adaptive Immunity

- **The Tissues and Organs of the Lymphatic System**
  - Lymphoid Organs
    - *Primary lymphoid organs: (Arise)*
      - Red bone marrow
      - Thymus
    - *Secondary lymphoid organs: (Migrate)*
      - **Lymph nodes**
      - Spleen
      - Tonsils
      - *Mucosa-associated lymphoid tissue (MALT)*

Elements of Adaptive Immunity

- **Antigens**
  - Portions of cells, viruses, and molecules the body recognizes as foreign
  - Properties of Antigens
    - Recognized by three-dimensional regions called **epitopes** on antigens
    - Large foreign macromolecules make the best antigens
    - Include various bacterial components as well as proteins of viruses, fungi, and protozoa
    - Food and dust can also contain antigenic particles
      - Antigens called *allergens* provoke allergic reactions

Figure 16.3a Antigens, molecules that provoke a specific immune response.



(a) Epitopes (antigenic determinants)

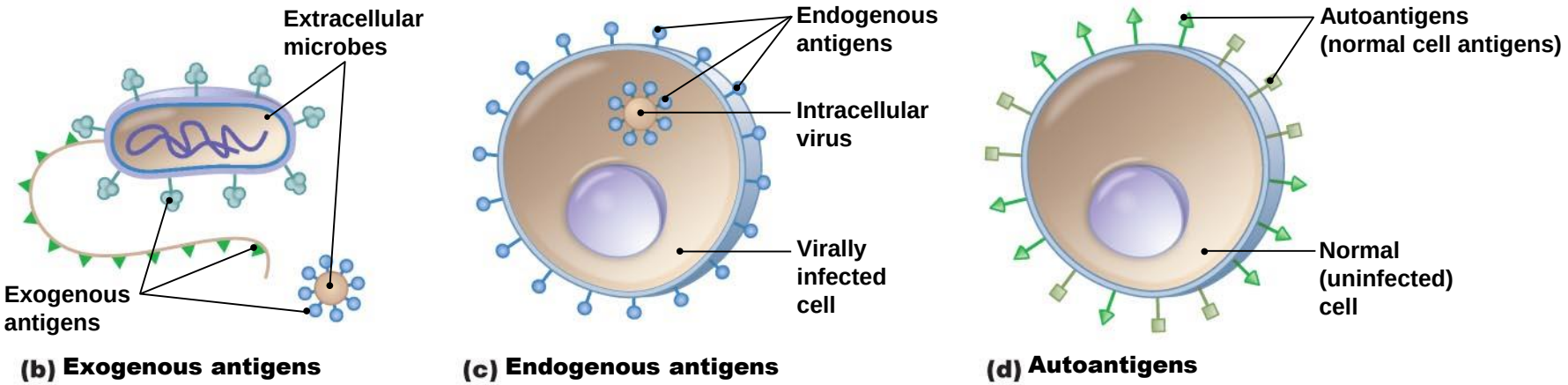
Elements of Adaptive Immunity

- **Antigens**
  - Types of Antigens:
    - **Exogenous antigens —** include toxins and other components of microbial cell walls, membranes, flagella, and pili
    - **Endogenous antigens —** produced by microbes that reproduce inside a body's cells. The immune system can respond to these antigens only if they are incorporated into the cell's cytoplasmic membrane.

Elements of Adaptive Immunity

- **Antigens**
  - Types of Antigens:
    - **Autoantigens / Self-antigens —** derived from normal cellular processes. Immune cells that treat autoantigens as foreign are normally eliminated during the development of the immune system. This phenomenon, called ***self-tolerance***, prevents the body from mounting an immune response against itself.

Figure 16.3b-d Antigens, molecules that provoke a specific immune response.



Elements of Adaptive Immunity

- **Preparation for an Adaptive Immune Response**
  - The Roles of the Major Histocompatibility Complex (MHC) and Antigen-Presenting Cells
    - Group of antigens first identified in graft patients
    - Important in determining compatibility of tissues for tissue grafting
    - Major histocompatibility antigens are glycoproteins found in the membranes of most cells of vertebrate animals
    - Antigens on the surface of cells known as major histocompatibility antigens are how the body can distinguish “self” from “non-self.”
    - **Hold and position antigenic epitopes for presentation** to immune cells

Elements of Adaptive Immunity

- **Preparation for an Adaptive Immune Response**
  - The Roles of the **Major Histocompatibility Complex (MHC)** and Antigen-Presenting Cells
    - Antigens bind in the antigen-binding groove of MHC molecules
    - Two classes of MHC proteins:
      - MHC class I
        - Present on all cells except red blood cells
      - MHC class II
        - Present on antigen-presenting cells (APCs)
        - Include macrophages and dendritic cells (aka Professional Antigen Presenting Cells)
        - Nonprofessional antigen-presenting cells: microglia and stellate macrophages

Figure 16.4 The two classes of major histocompatibility complex (MHC) proteins.

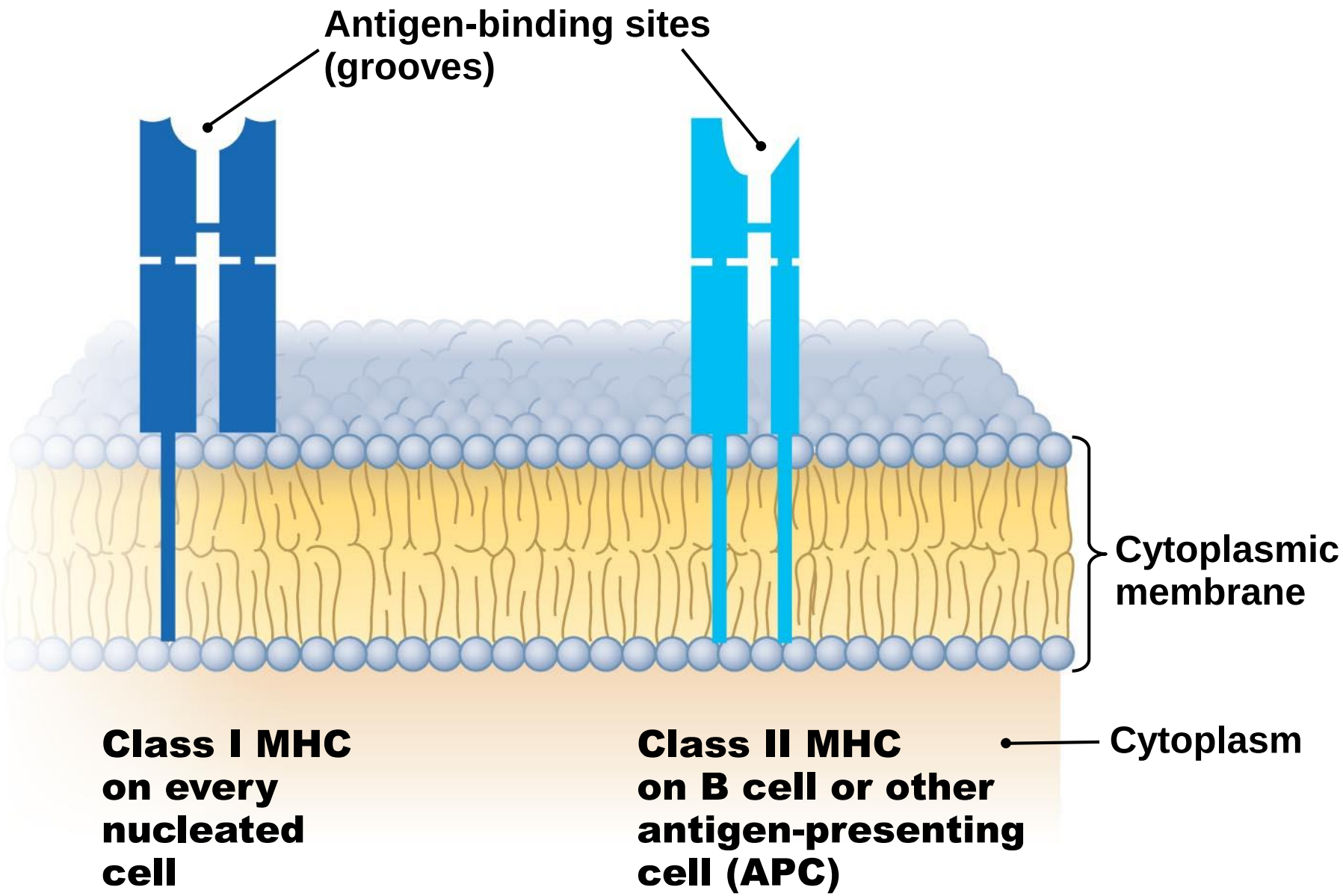
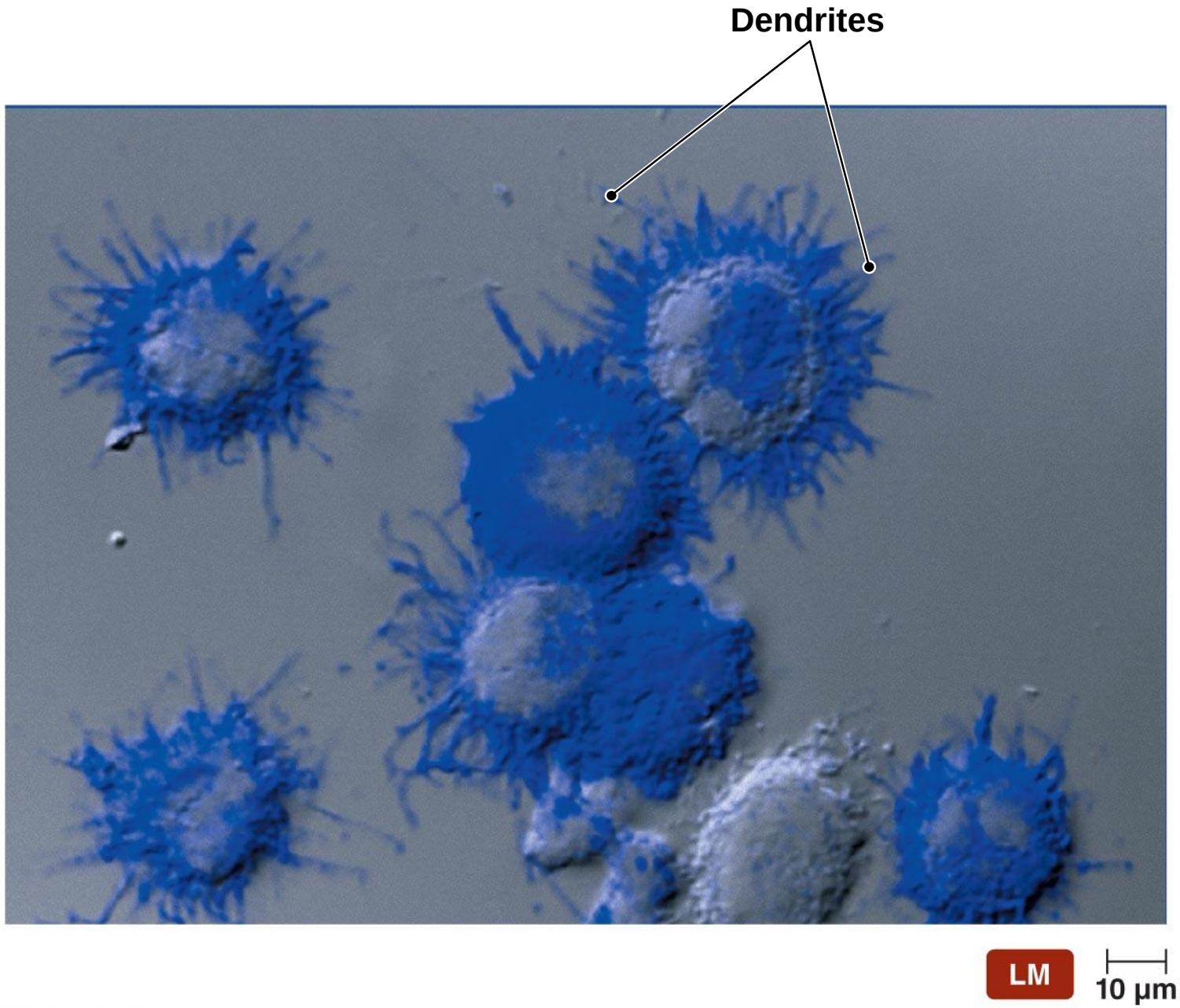


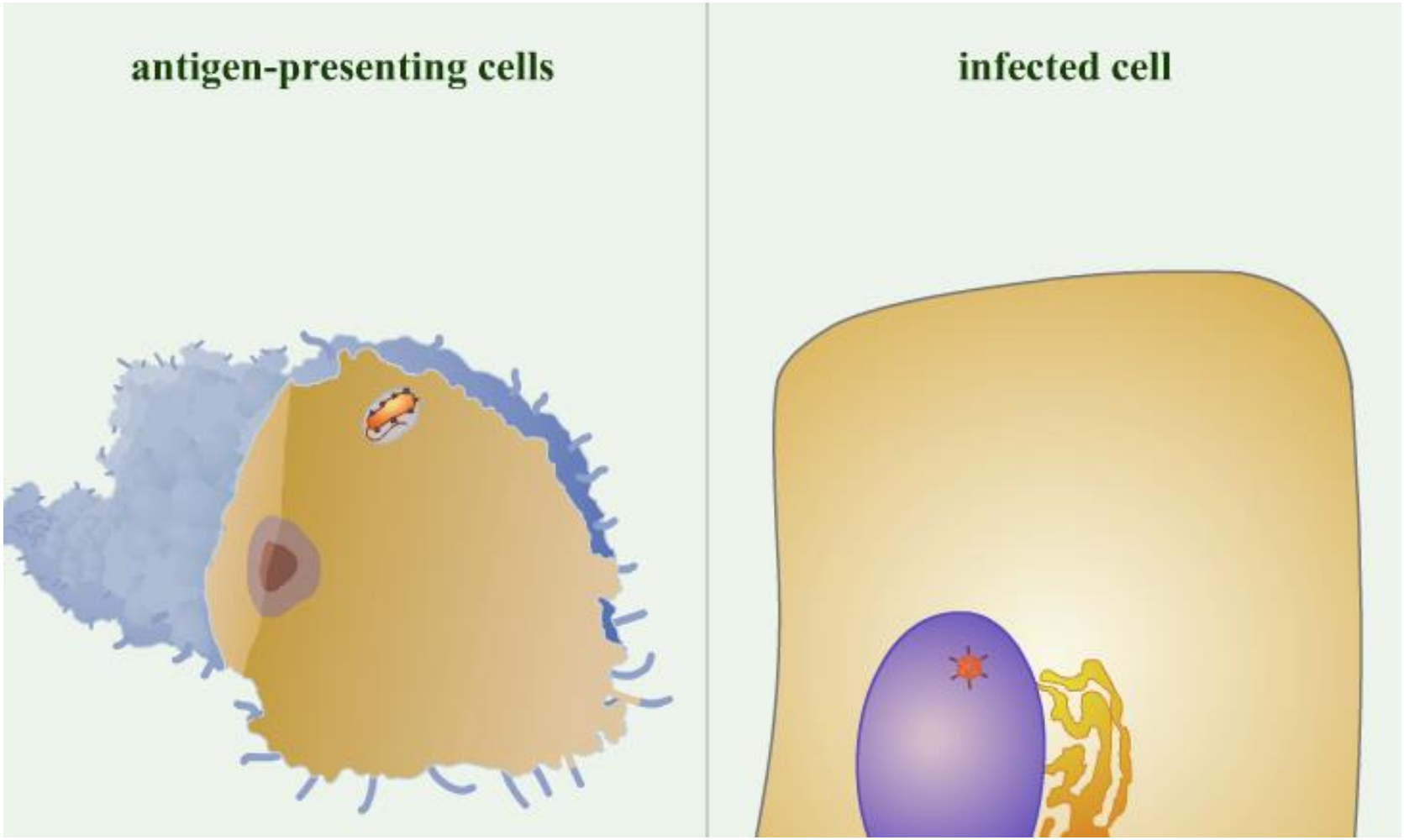
Figure 16.5 Dendritic cells.



Elements of Adaptive Immunity

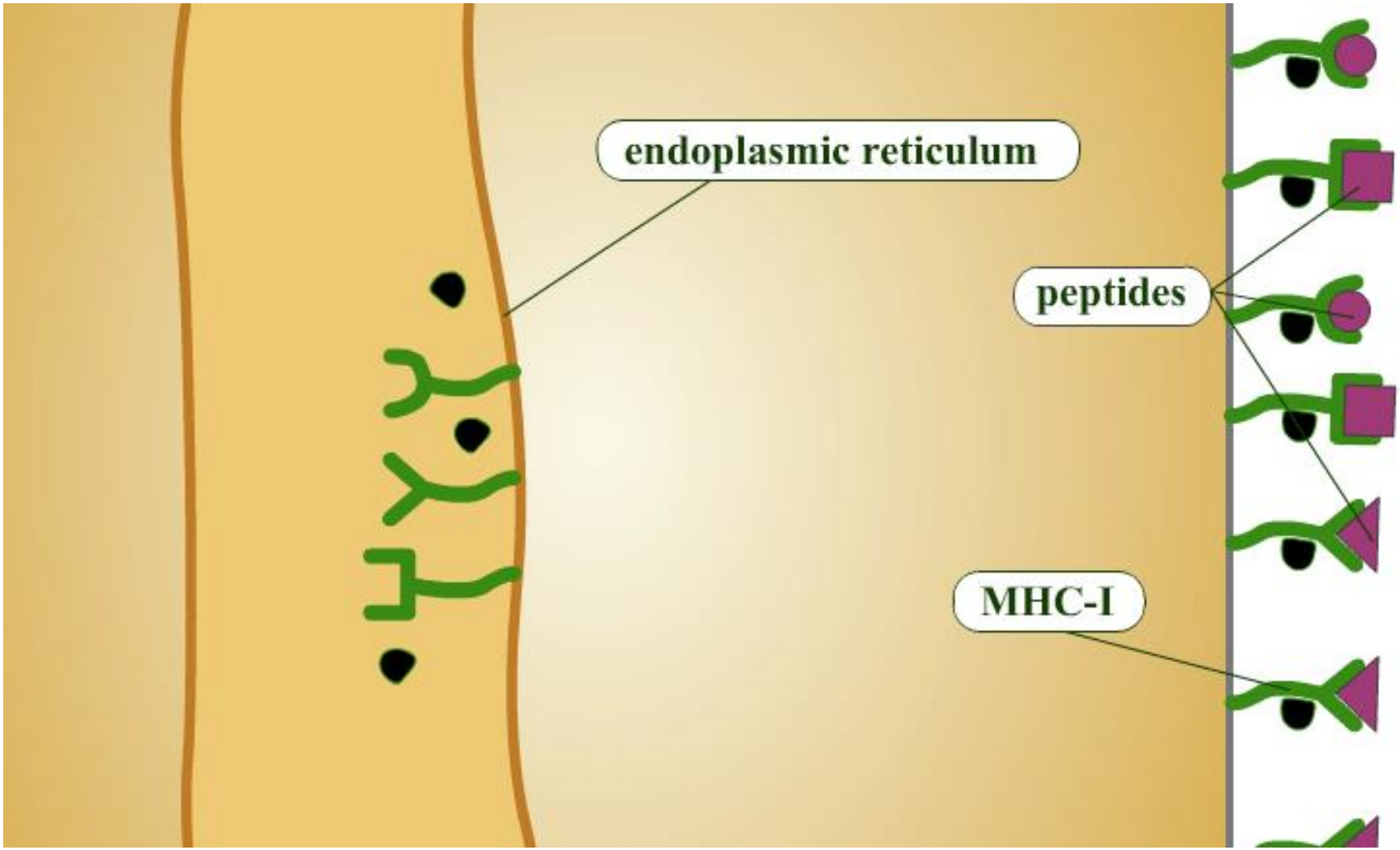
- **Preparation for an Adaptive Immune Response**
  - Antigen Processing
    - Antigens must be processed before MHC proteins can display epitopes
    - Different processes for endogenous and exogenous antigens

Antigen Processing and Presentation: Overview



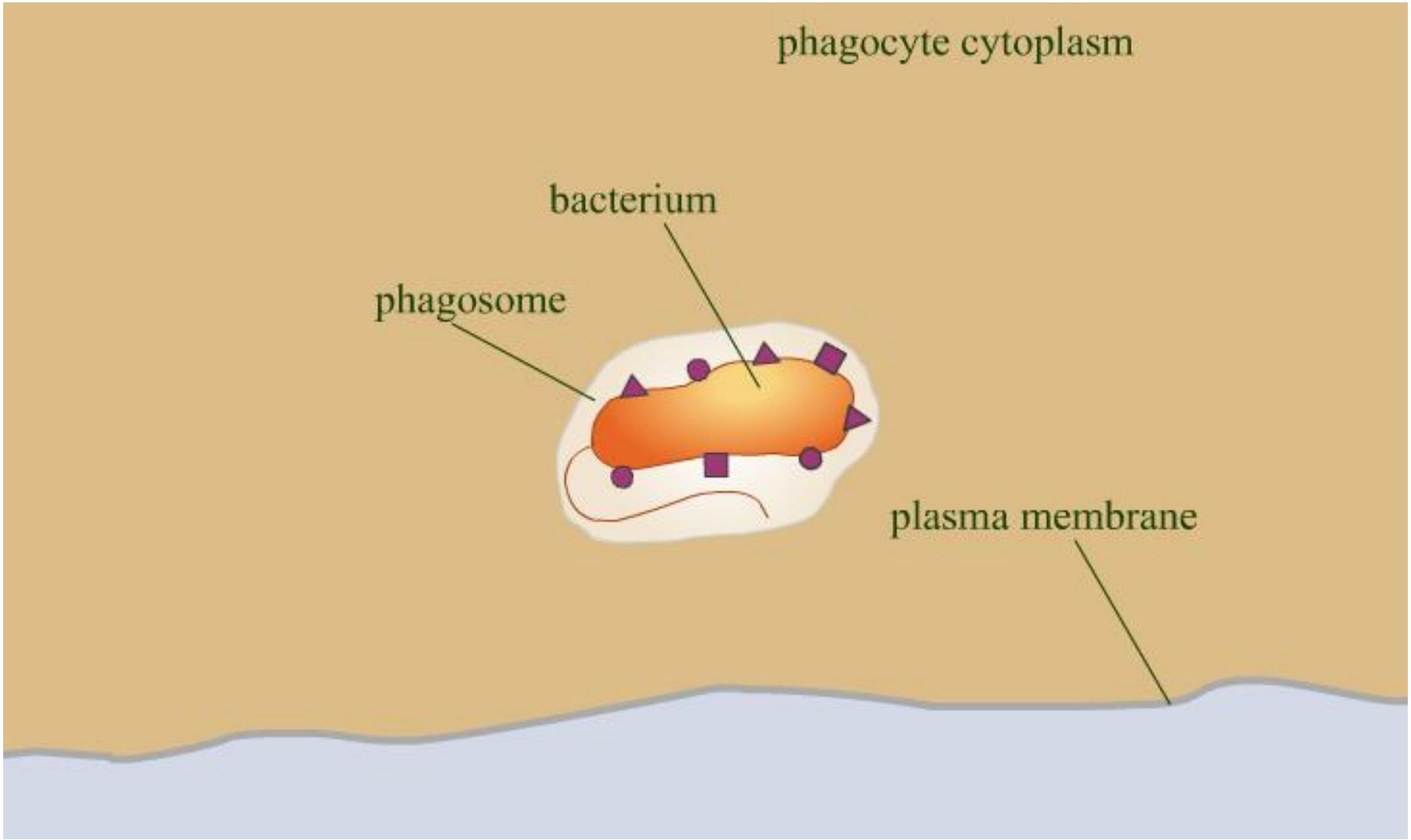
PLAY **Antigen Processing and Presentation: Overview**

Antigen Processing and Presentation: Steps



PLAY **Antigen Processing and Presentation: Steps**

Antigen Processing and Presentation: MHC



PLAY **Antigen Processing and Presentation: MHC**

Elements of Adaptive Immunity

- **T Lymphocytes (T Cells)**
  - Produced in the red bone marrow and mature in the thymus
  - Act against endogenous antigens, producing cell-mediated immune responses
  - Circulate in the lymph and blood
  - Migrate to the lymph nodes, spleen, and Peyer's patches
  - Have T cell receptors (TCRs) on their cytoplasmic membrane for every possible epitope

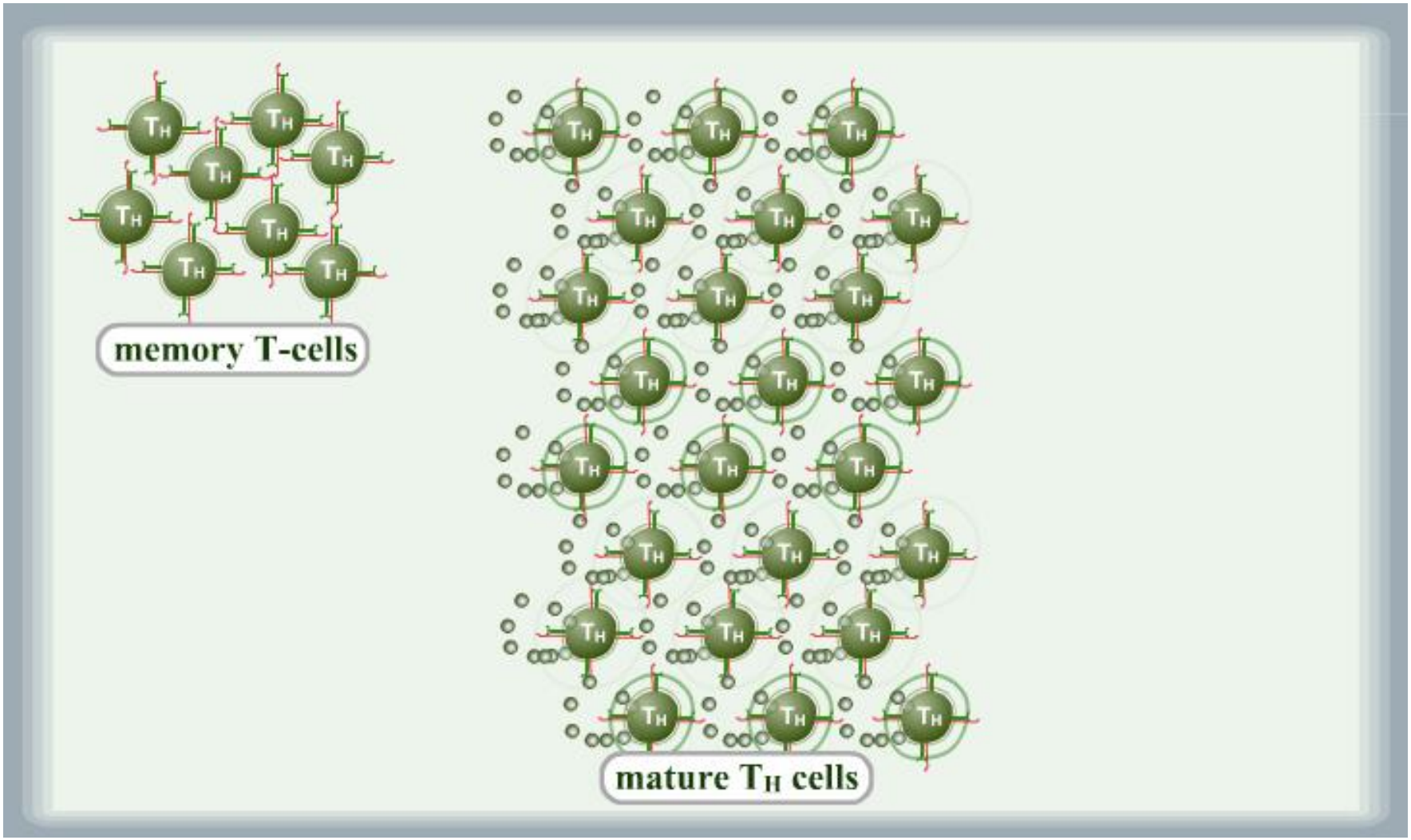
Elements of Adaptive Immunity

- **T Lymphocytes (T Cells)**
  - Specificity of the T Cell Receptor (TCR)
    - TCRs do not recognize epitopes directly
    - TCRs only bind epitopes associated with an MHC protein
    - T cells act primarily against cells that harbor intracellular pathogens
    - Some T cells act against body cells that produce abnormal cell-surface proteins

Elements of Adaptive Immunity

- **T Lymphocytes (T Cells)**
  - Types of T Lymphocytes
    - Based on surface glycoproteins and characteristic functions, three types:
      - **Cytotoxic T lymphocyte 9 (Tc or CD8 cells)**
        - Kill infected cells, as well as abnormal body cells such as cancer cells.
      - **Helper T lymphocyte (Th or CD4 cells)**
        - Helps regulate B cells and cytotoxic T cells
        - Includes type 1 and type 2 helper T cells
      - **Regulatory T lymphocyte (Tr cells or suppressor T cells)**
        - Represses adaptive immune responses

Cell-Mediated Immunity: Helper T Cells



PLAY **Cell-Mediated Immunity: Helper T Cells**

Elements of Adaptive Immunity

- **T Lymphocytes (T Cells)**
  - **Clonal Deletion of T Cells**
    - Vital that immune responses not be directed against autoantigens
    - Body eliminates self-reactive lymphocytes
    - Cells with receptors that respond to autoantigens are selectively eliminated via **apoptosis** in a process known as **clonal deletion** (because potential offspring—clones—are deleted)

Elements of Adaptive Immunity

- **T Lymphocytes (T Cells)**
  - **Clonal Deletion of T Cells**
    - Clonal deletion of T cells occurs in the thymus, where thymus cells process and present all the body's autoantigens to young T cells
    - T cells that do not recognize MHC are also deleted
    - Surviving lymphocytes and their descendants respond only to foreign antigens (except for a small number of regulatory T cells).
    - When self-tolerance is impaired, the result is an *autoimmune disease*

Elements of Adaptive Immunity

- **T Lymphocytes (T Cells)**
  - **Clonal Deletion of T Cells: Summary**
    - Immature T cells undergo one of four fates
      - T cells that do not recognize body's MHC protein undergo **apoptosis**
      - T cells that recognize autoantigen die by apoptosis
      - Some "self-recognizing" T cells become regulatory T cells
      - T cells that recognize MHC protein and foreign epitopes become repertoire of protective T cells

Figure 16.9 Clonal deletion of T cells.