

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



WBCs and immunity

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LEUKOCYTES

Granulocytes (65%)

Neutrophils, Eosinophils, Basophils formed in bone marrow

Monocytes (5%)

tissue macrophages formed in bone marrow

Lymphocytes (30%)

formed in bone marrow and differentiated in the lymph tissue

Leukocytes Classification

- **Granulocytes**

- Neutrophils
- Eosinophils
- Basophils

- **Polymorphonuclear**

- Neutrophils
- Eosinophils
- Basophils

- **Phagocytes**

- Neutrophils, Monocytes
- Macrophages, Eosinophils

- **Non- Granulocytes**

- Monocytes
- Lymphocytes

- **Mononuclear**

- Monocytes
- Lymphocytes

- **Non-phagocytes**

- Lymphocytes
- Basophils

PHAGOCYTYIC CELLS

Polymorphonuclear Neutrophils

non-dividing, short-lived

dominant number in bloodstream

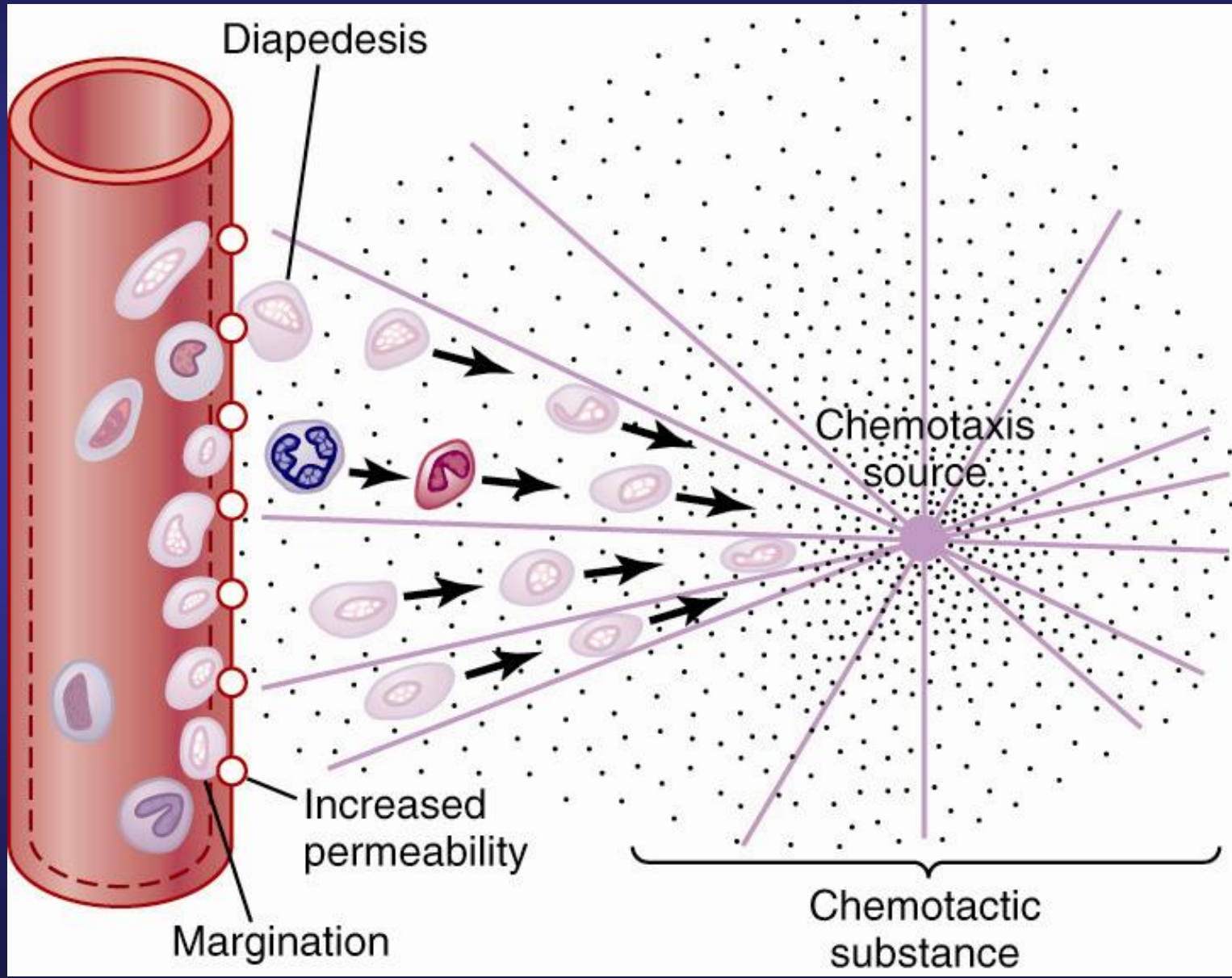
Monocytes/Macrophages

- long-lived cells
- do not circulate
- present in tissue, particularly in lungs,
- spleen, liver, lymph nodes
- tissue macrophage system

ACTIONS OF PHAGOCYTOTIC CELLS

1. Margination
2. Diapedesis
3. Ameboid Motion
4. Chemotaxis
5. Phagocytosis

ACTIONS OF PHAGOCYTOTIC CELLS



EOSINOPHILS

- ~ 2% of total white blood cells
- active against parasites, skin diseases, chronic infections
- phagocytic and immunomodulatory, decrease inflammation

BASOPHILS

- ~ 0.5% of total white blood cells
- Basophils similar to mast cells
- release primarily histamine, some bradykinin
- release due to binding of IgE

Important terms

- **Leukopenia** : decrease in the number of white blood cells.
example: bone marrow suppression
- **Leukocytosis** : increase in the number of white blood cells.
example : bacterial infections
- **Leukemia** : (cancerous) uncontrolled production of white blood cells

Neutropenia

Neutropenia:

decreased number of neutrophils

Decreased production

Increased neutrophil destruction (chronic infections)

Agranulocytosis:

severe neutropenia due to production failure

due to irradiation, exposure to chemicals, drugs

The Immune Response

Immunity: “Free from burden”. Ability of an organism to recognize and defend itself against *specific* pathogens or antigens.

Immune Response: Third line of defense. Involves production of antibodies and generation of specialized lymphocytes against specific antigens.

Antigen: Molecules from a pathogen or foreign organism that provoke a specific immune response. Usually have a molecular wt. of more than 8000 D.

Immunity -- Types

1. Innate immunity

Non-specific: Examples:

- Ingestion of invading organisms (phagocytosis)
- Stomach acidity
- Skin barrier
- Lysozyme
- Natural killer lymphocytes

2. Acquired immunity:

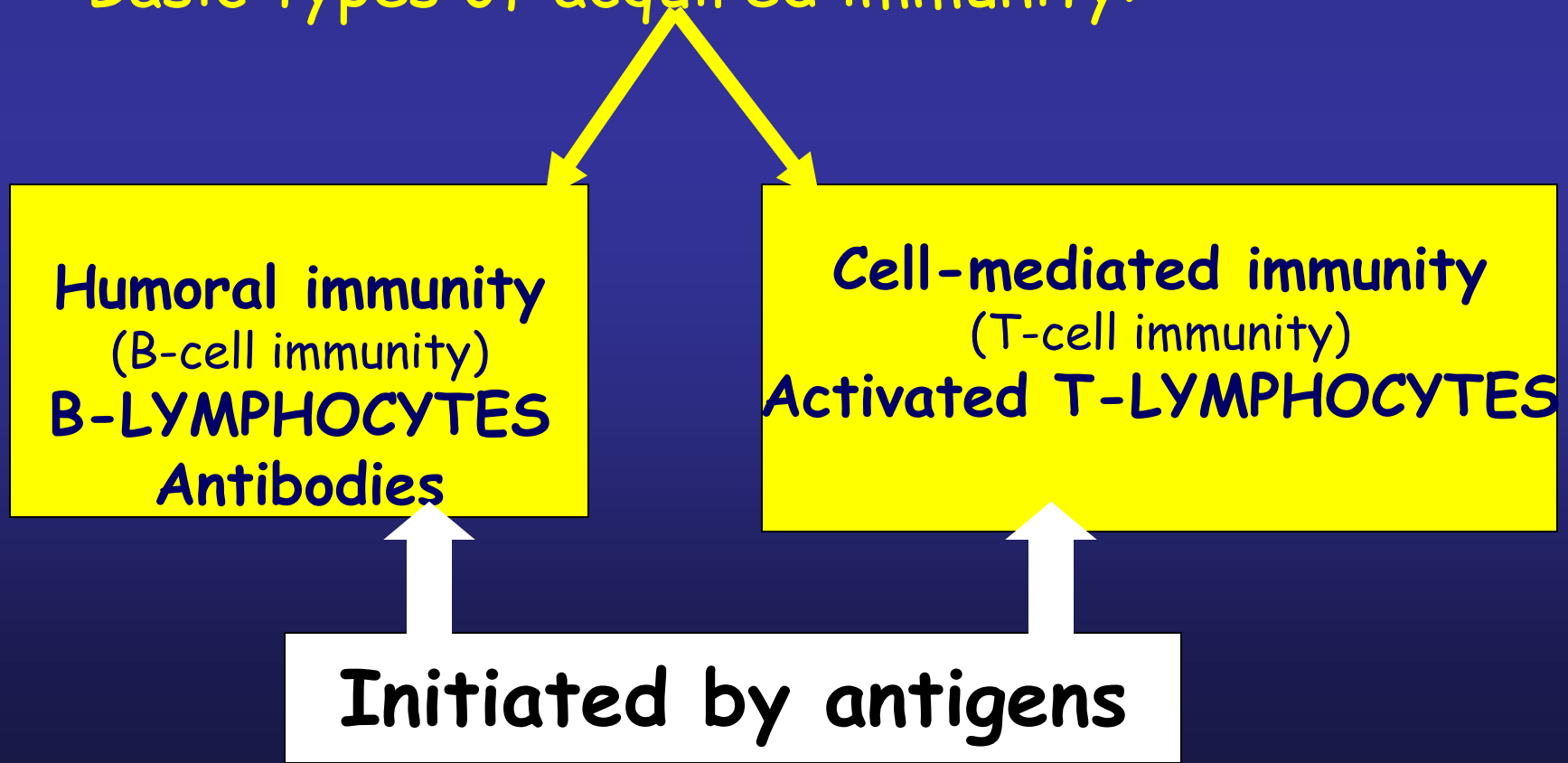
the result of attack by bacteria, viruses etc

- e.g. Vaccination
- Long lasting (Memory)

Immunity -- Types

Acquired immunity:

- Specific against individual bacteria, virus, toxin, foreign tissues
- Basic types of acquired immunity:



Antigens

- ◆ Most are **proteins** or large **polysaccharides** from a foreign organism.
 - ◆ **Microbes**: Capsules, cell walls, toxins, viral capsids, flagella, etc.
 - ◆ **Nonmicrobes**: Pollen, egg white, red blood cell surface molecules, serum proteins, and surface molecules from transplanted tissue.
- ◆ Lipids and nucleic acids are only antigenic when **combined** with proteins or polysaccharides.
- ◆ Molecular weight of **8,000** or higher.
 - ◆ **Hapten**: Small foreign molecule that is not antigenic. Must be coupled to a **carrier** molecule to be antigenic. Once antibodies are formed they will recognize hapten.

Antibodies

- ◆ **Proteins** that recognize and bind to a particular antigen with very high *specificity*.
- ◆ Made in response to exposure to the antigen.
- ◆ One virus or microbe may have several *antigenic determinant sites*, to which different antibodies may bind.
- ◆ Each antibody has at least two identical sites that bind antigen: *Antigen binding sites*.
- ◆ **Valence of an antibody**: Number of antigen binding sites. Most are **bivalent**.
- ◆ Belong to a group of serum proteins called **immunoglobulins (Igs)**.

Types of Acquired Immunity

I. Naturally Acquired Immunity: Obtained in the course of daily life.

A. Naturally Acquired ACTIVE Immunity:

- ◆ *Antigens* or pathogens enter body naturally.
- ◆ Body generates an immune response to antigens.
- ◆ Immunity may be lifelong (chickenpox or mumps) or temporary (influenza or intestinal infections).

B. Naturally Acquired PASSIVE Immunity:

- ◆ *Antibodies* pass from mother to fetus via placenta or breast feeding (**colostrum**).
- ◆ No immune response to antigens.
- ◆ Immunity is usually **short-lived** (weeks to months).
- ◆ Protection until child's immune system develops.

Types of Acquired Immunity (Continued)

II. Artificially Acquired Immunity: Obtained by receiving a vaccine or immune serum.

1. Artificially Acquired ACTIVE Immunity:

- ◆ *Antigens* are introduced in vaccines (immunization).
- ◆ Body generates an immune response to antigens.
- ◆ Immunity can be lifelong (oral polio vaccine) or temporary (tetanus toxoid).

2. Artificially Acquired PASSIVE Immunity:

- ◆ Preformed *antibodies* (antiserum) are introduced into body by injection.
 - ☞ Snake antivenom injection from horses or rabbits.
- ◆ Immunity is short lived (half life three weeks).
- ◆ Host immune system does not respond to antigens.

The bases of
Acquired Immunity
are Lymphocytes

Immune cells

Two types:

1. B-Lymphocytes

(Thymus independent, B-lymphocytes)

Produce antibodies

(Humoral Immunity)

2. T- lymphocytes

(Thymus dependent, T-lymphocytes)

Cellular mechanisms

(Cellular Immunity)

Lymphocytes

B-lymphocytes

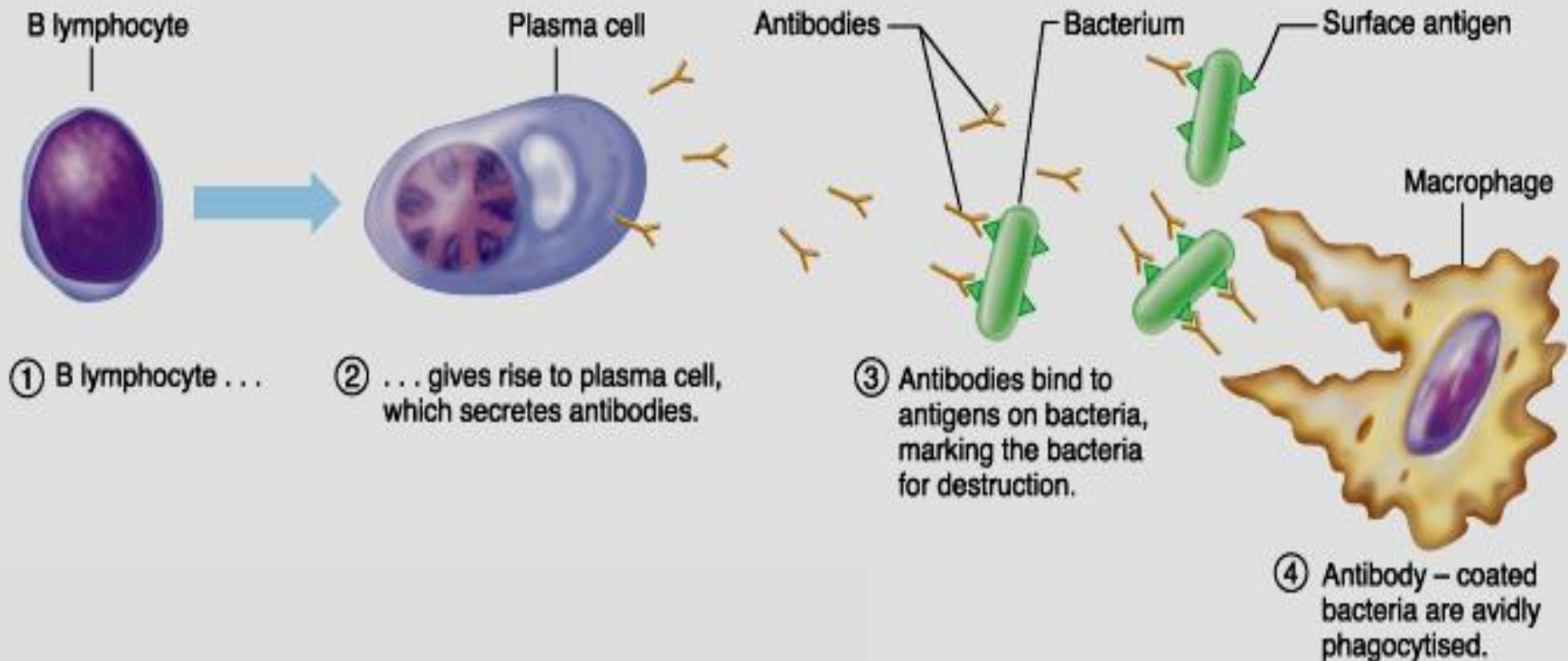
- Develop in the lymph nodes and spleen.
- **Life span:** 2-7 days (short lived lymphocyte).
- Principal mediators of **humoral immune** responses.
- These produce **antibodies** that are capable of attacking the invading agent.
- This type of immunity is called "**humoral immunity**".

T-lymphocytes

- Originate in the thymus or bone marrow.
- **Life span:** 100-300 days (long lived lymphocytes).
- Principal mediators of **cellular immune responses**.
- They are specifically designed to destroy the foreign agent.
- This type of immunity is called "**cell-mediated immunity**".

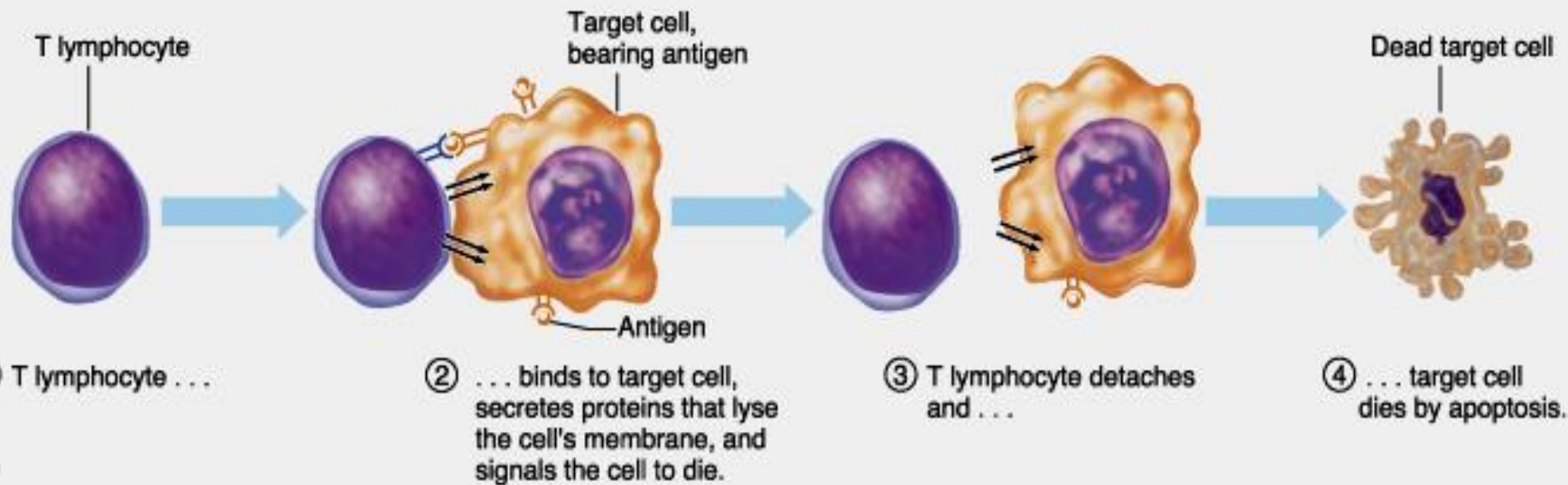
B-Lymphocytes

- B lymphocytes transform into plasma cells and secrete antibodies



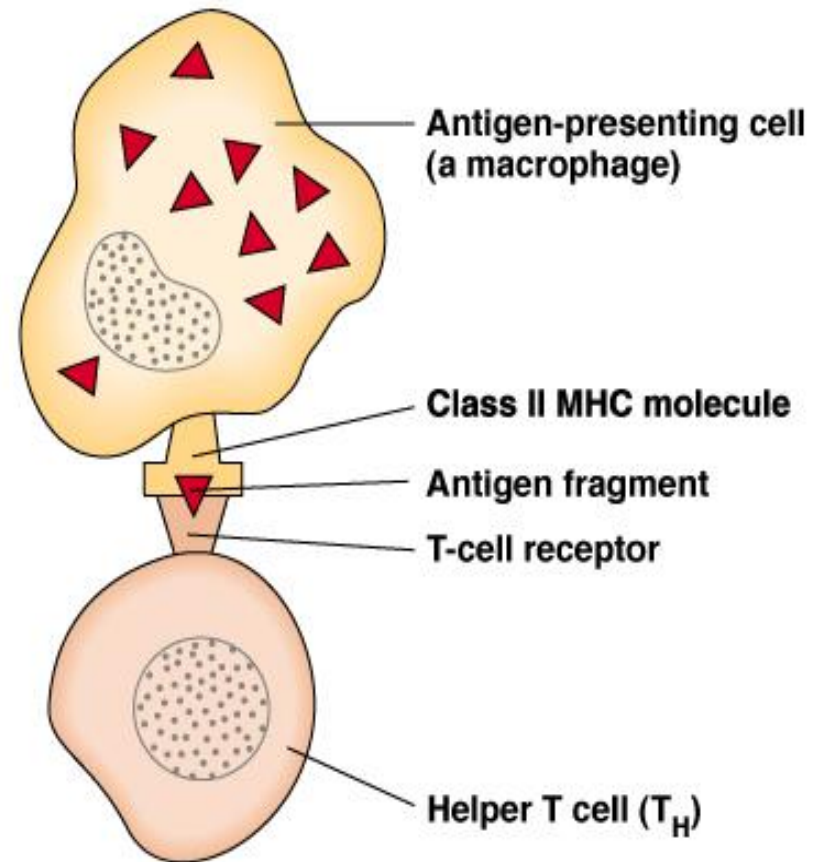
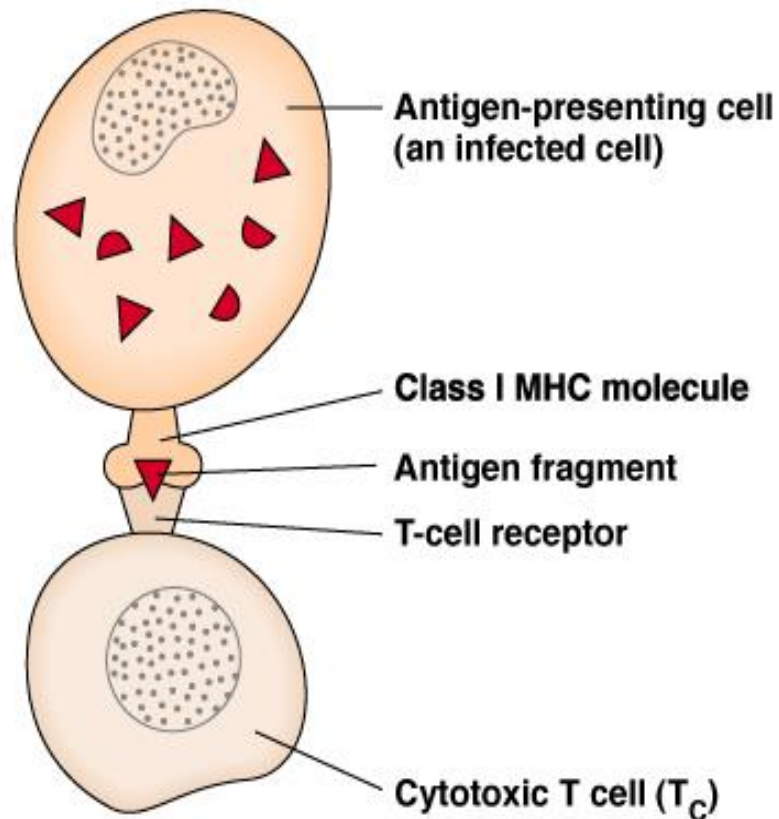
T-Lymphocytes

- T lymphocytes can attack foreign cells directly



(a)

T Cells Only Recognize Antigen Associated with MHC Molecules on Cell Surfaces

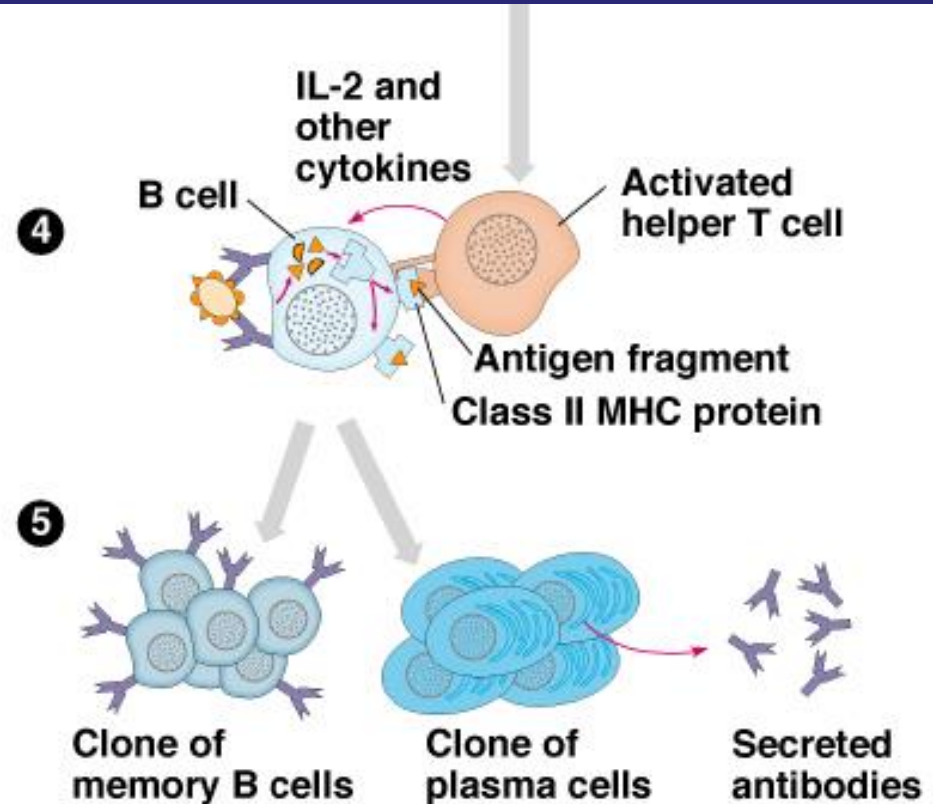
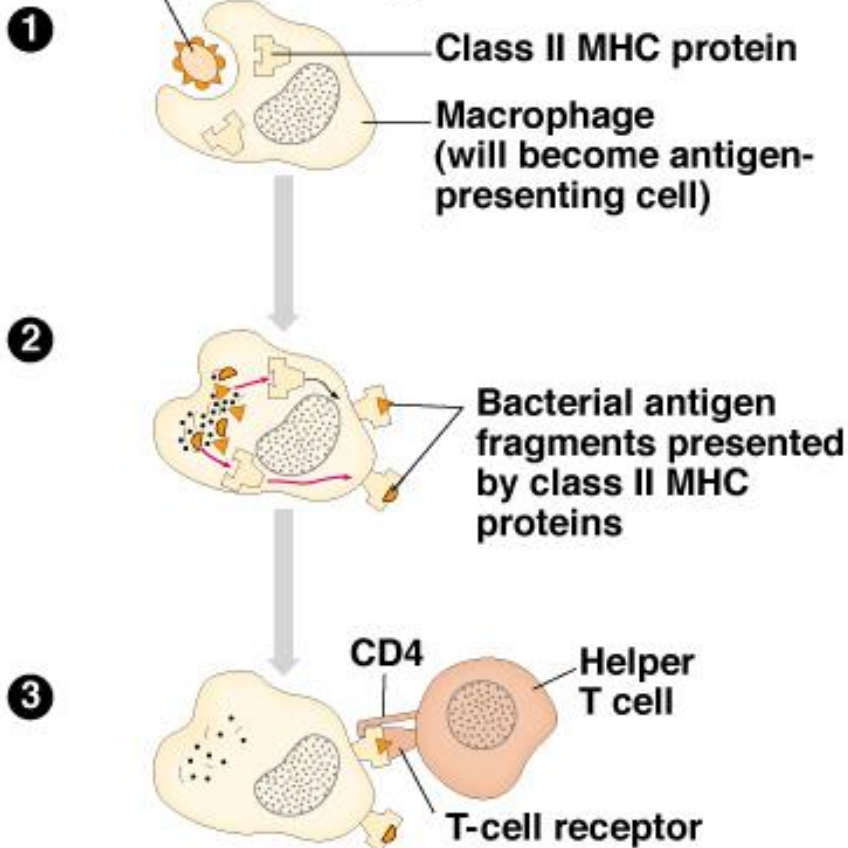


(a)

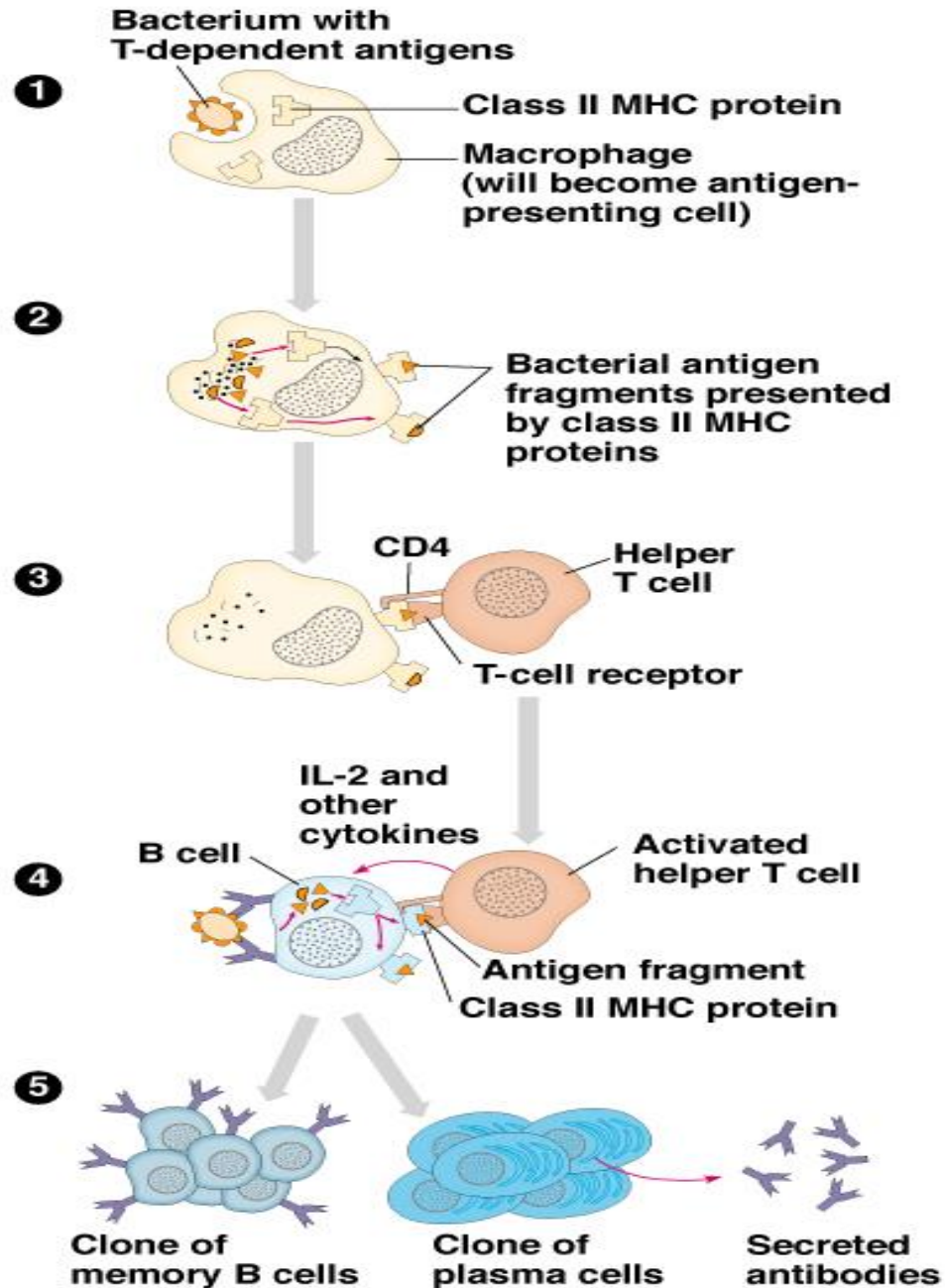
(b)

Humoral Response to T Dependent Antigens

Bacterium with T-dependent antigens



Humoral Response to T Dependent



T-Lymphocytes

(thymus dependent)

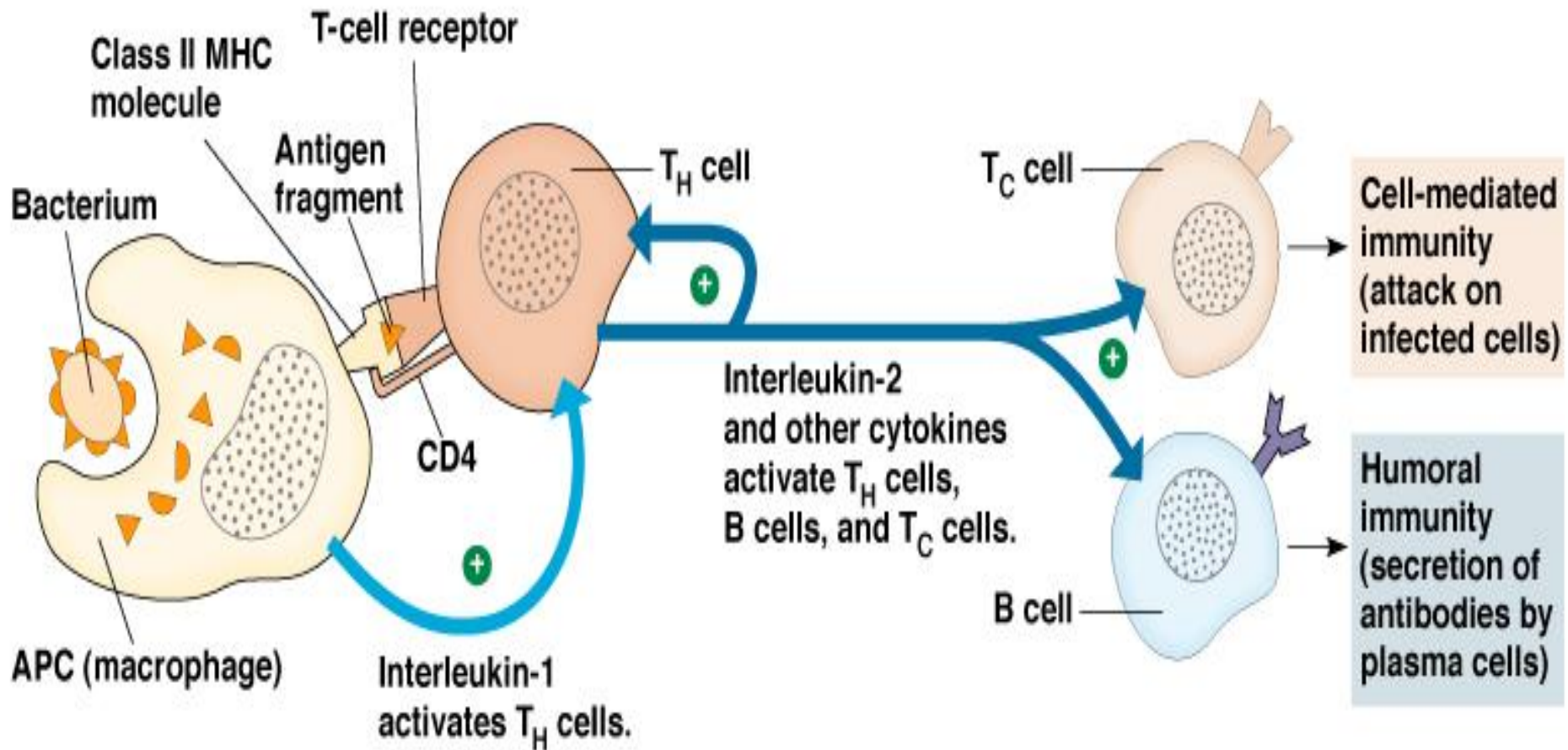
Types of T-lymphocytes

- T-helper
- T-cytotoxic
- Natural killer

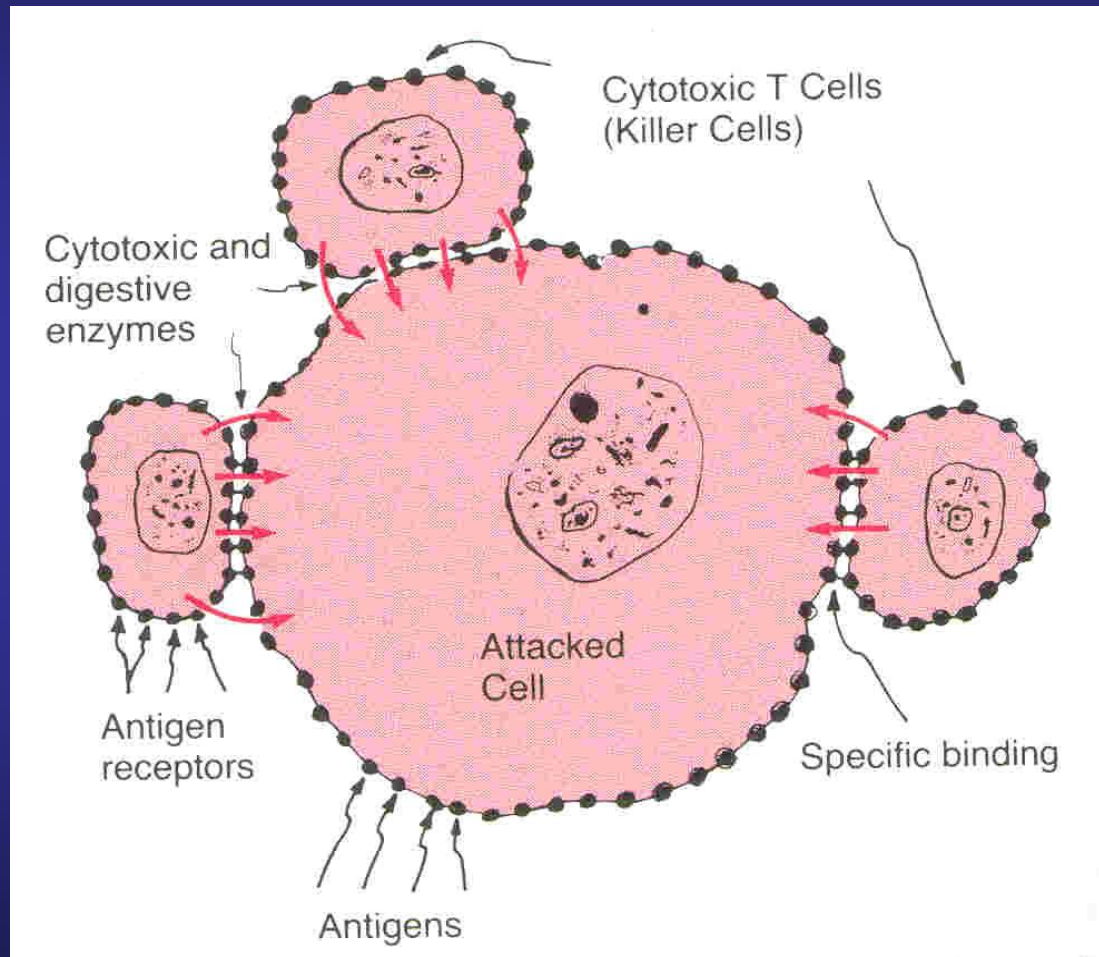
Functions

- Cellular immunity
 - graft rejection
 - delayed hypersensitivity.
- Help in antibody secretion.

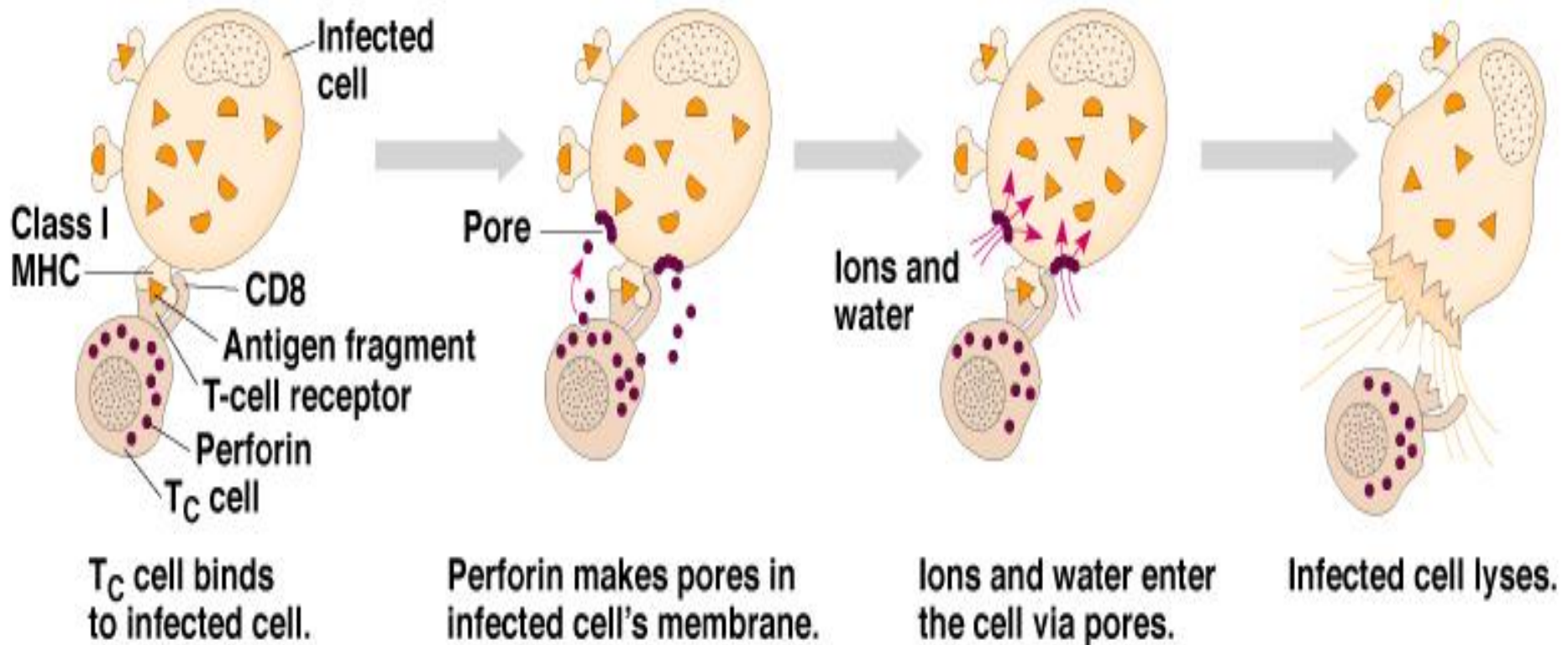
Central Role of Helper T Cells



Cytotoxic T cells



Cytotoxic T Cells Lyse Infected Cells



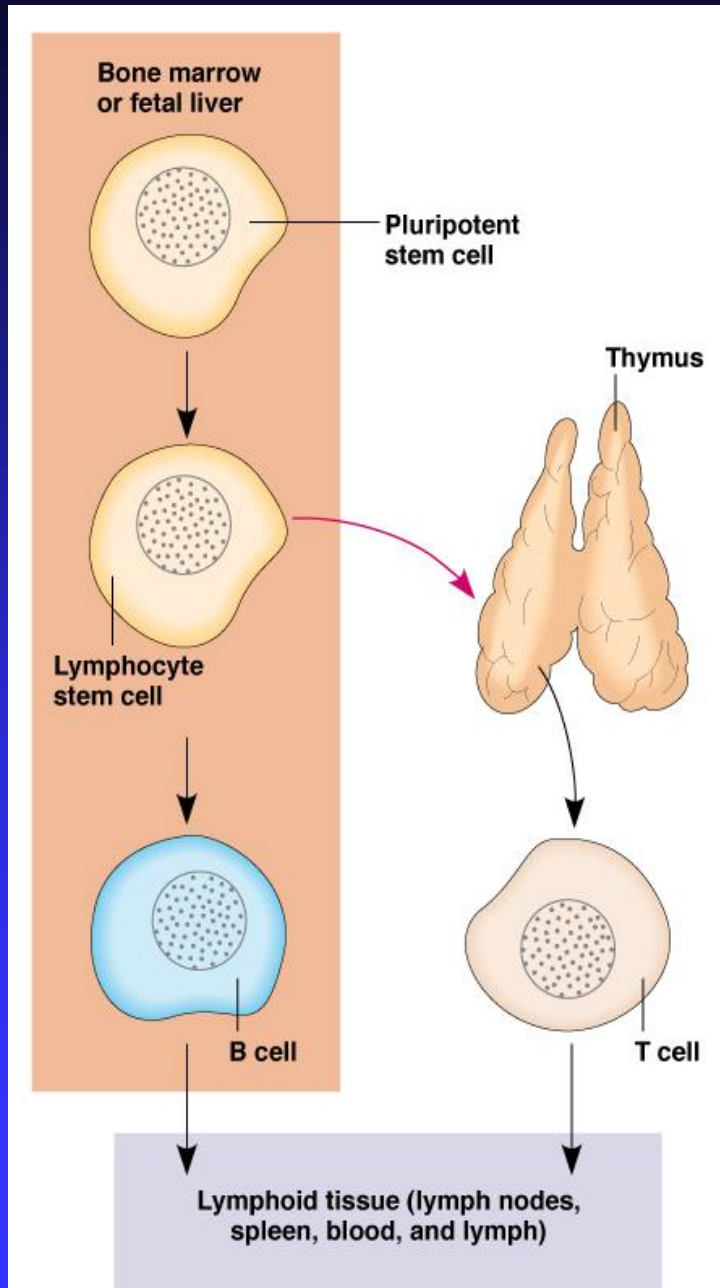
(a)

Duality of Immune System

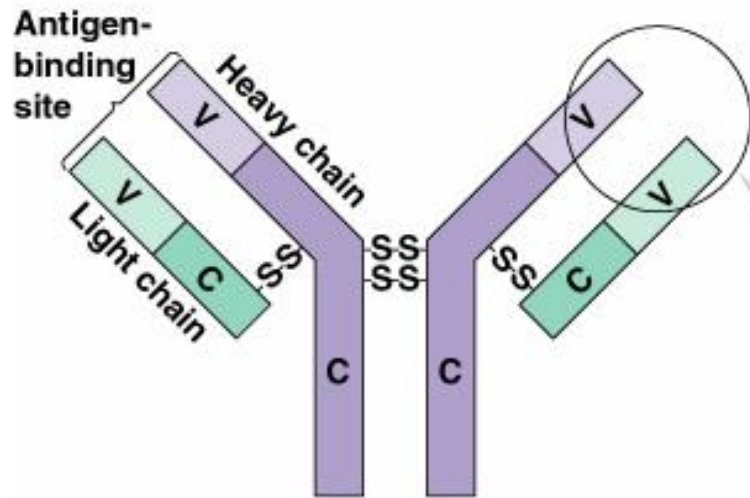
I. Humoral (Antibody-Mediated) Immunity

- ◆ Antibodies are produced by a subset of lymphocytes called **B cells**.
- ◆ Involves production of antibodies against foreign antigens.
- ◆ B cells that are stimulated will actively secrete antibodies and are called *plasma cells*.
- ◆ Antibodies are found in **extracellular fluids** (blood plasma, lymph, mucus, etc.) and the surface of B cells.
- ◆ Defense against bacteria, bacterial toxins, and viruses that circulate freely in body fluids, *before* they enter cells.
- ◆ Also cause certain reactions against transplanted tissue.

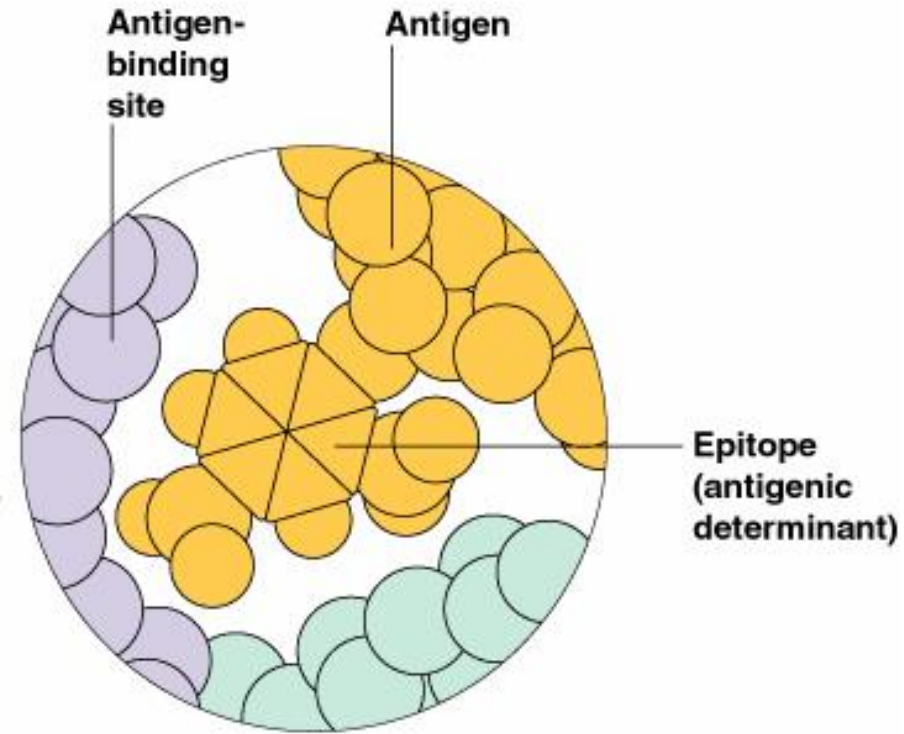
Antibodies are Produced by B Lymphocytes



Antibodies are Proteins that Recognize Specific Antigens



(a) Antibody molecule



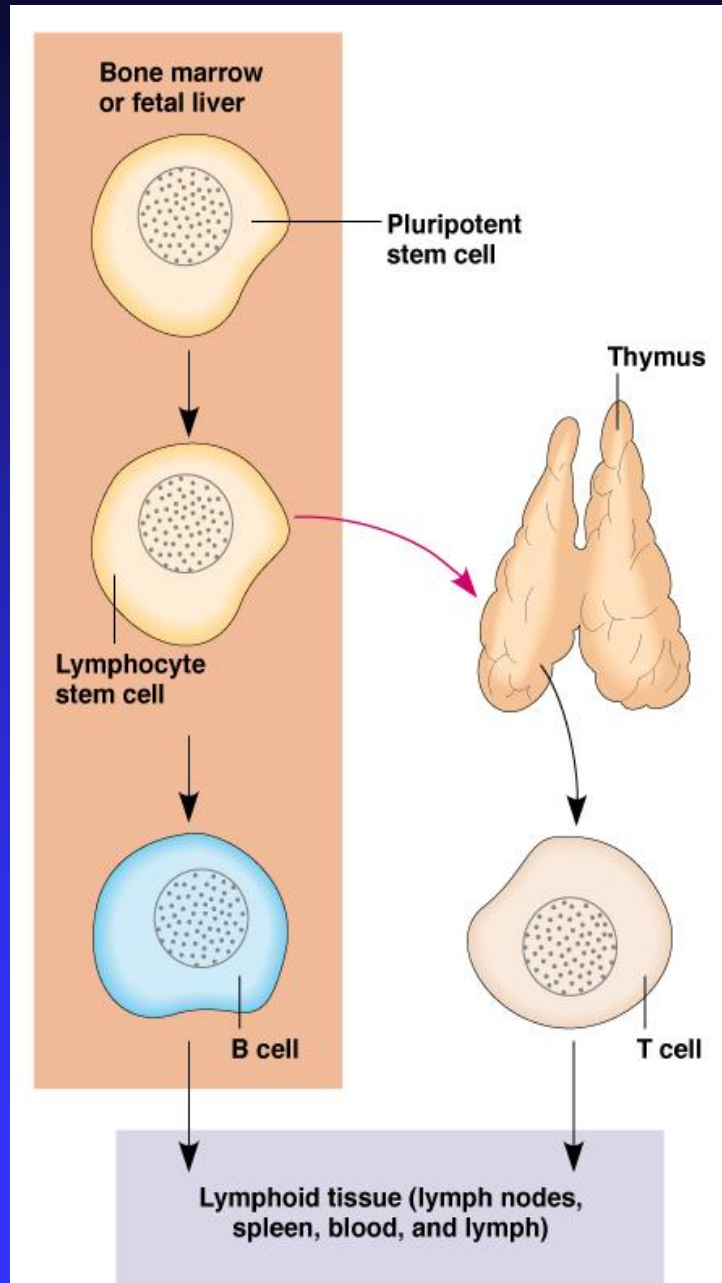
(b) Enlarged antigen-binding site

Duality of Immune System (Continued)

II. Cell Mediated Immunity

- ◆ Involves specialized set of lymphocytes called **T cells** that recognize foreign antigens on the surface of cells, organisms, or tissues:
 - ☞ Helper T cells
 - ☞ Cytotoxic T cells
- ◆ T cells **regulate** proliferation and activity of other cells of the immune system: B cells, macrophages, Neutrophils, etc.
- ◆ Defense against:
 - ☞ Bacteria and viruses that are inside host cells and are inaccessible to antibodies.
 - ☞ Fungi, protozoa, and helminths
 - ☞ Cancer cells
 - ☞ Transplanted tissue

Cell Mediated Immunity is Carried Out by T Lymphocytes



Immunological Memory

Pattern of Antibody Levels During Infection

Primary Response:

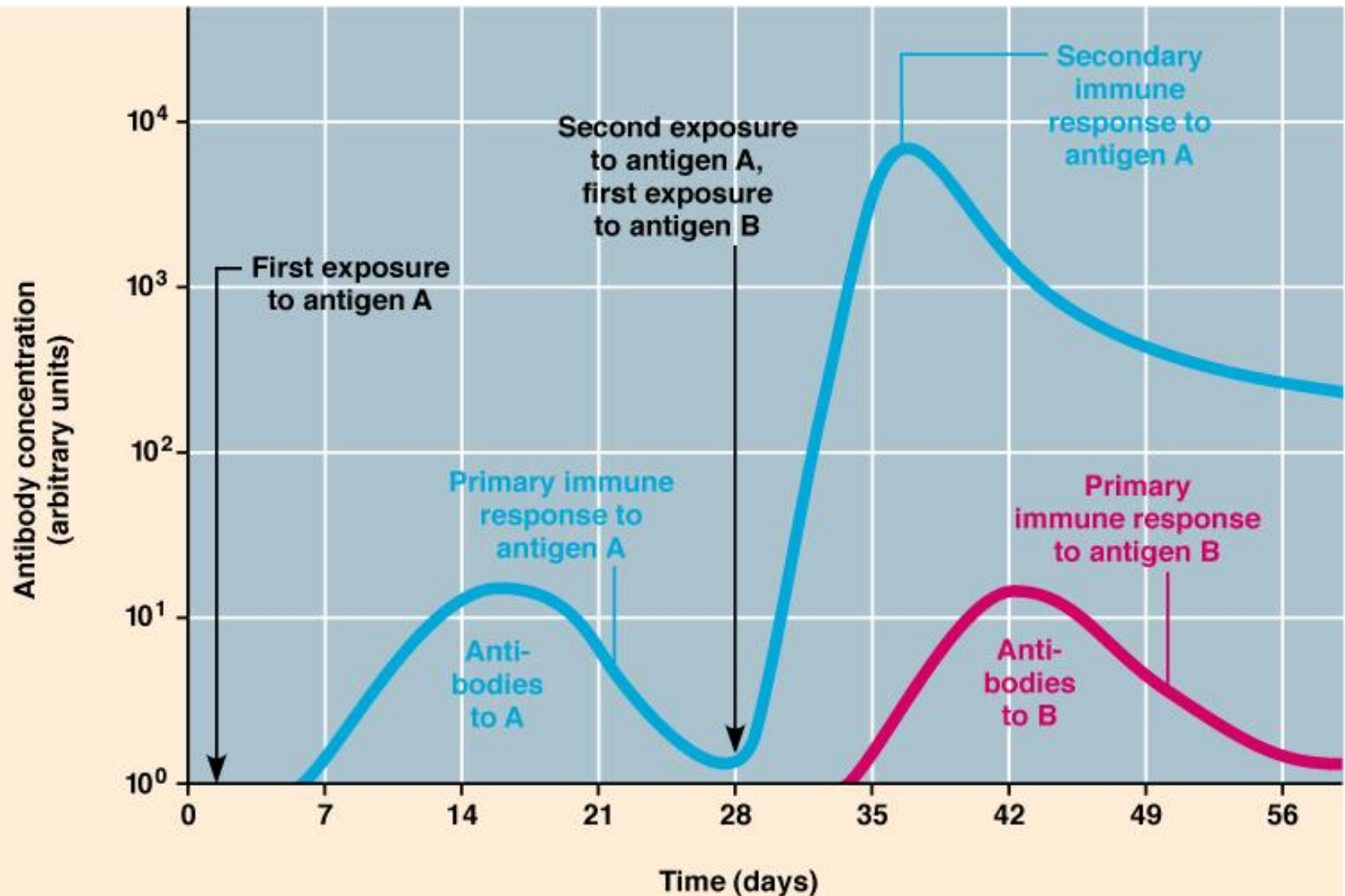
- ◆ After *initial* exposure to antigen, no antibodies are found in serum for several days.
- ◆ A gradual increase in titer, first of IgM and then of IgG is observed.
- ◆ Most B cells become plasma cells, but some B cells become long living *memory cells*.
- ◆ Gradual decline of antibodies follows.

Immunological Memory (Continued)

Secondary Response:

- ◆ Subsequent exposure to the same antigen displays a faster and more intense antibody response.
- ◆ Increased antibody response is due to the existence of memory cells, which rapidly produce plasma cells upon antigen stimulation.

Antibody Response After Exposure to Antigen



THANK YOU