



Cihan University/ Sulaymaniyah

College of Health Science

Medical Laboratory Analysis

4th Stage- 1st Semester

Pr. Clinical Immunology

Lecture- 3: Specific Immunity

Third line of defense: An Overview of Specific Immunity (Part-2)

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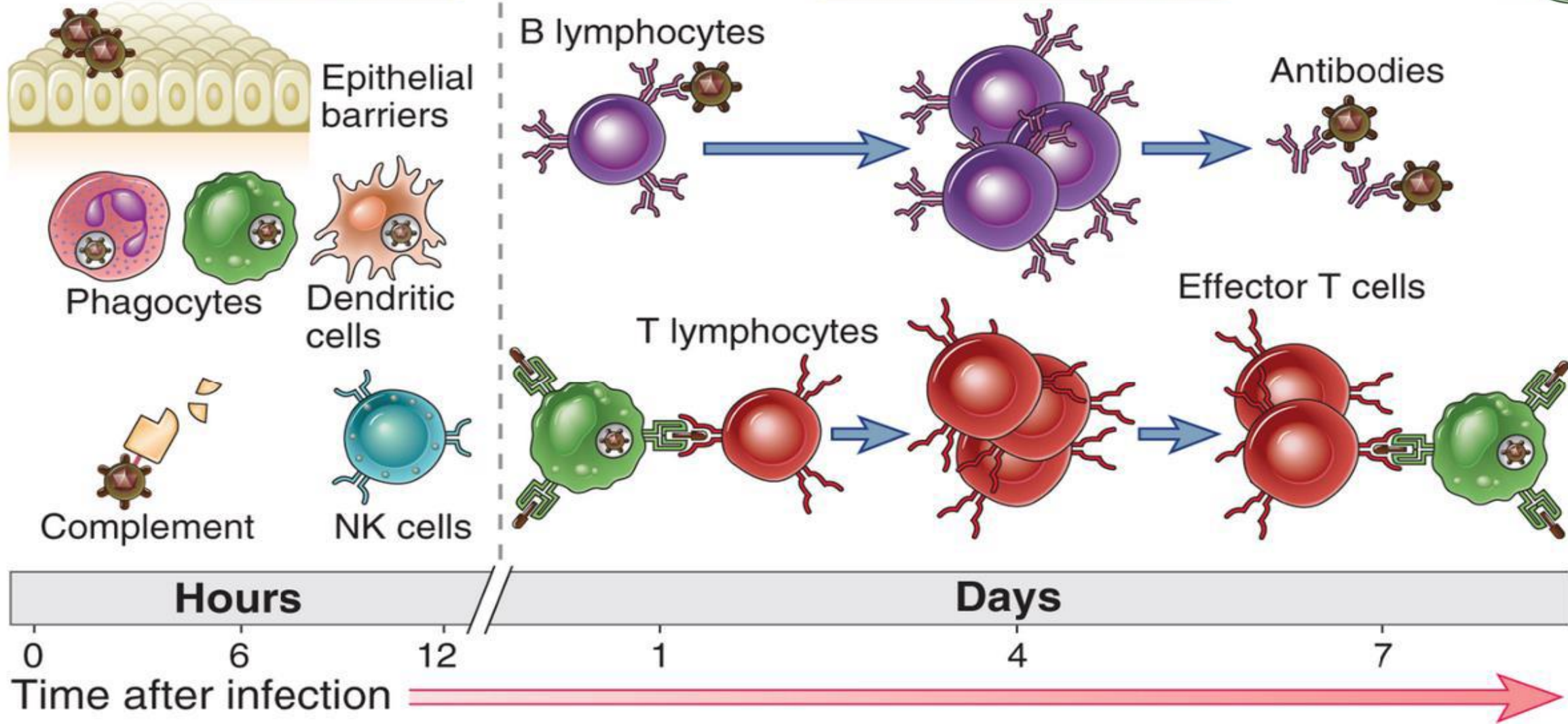
The adaptive (Acquired) immune system

- The adaptive immune system consists of **lymphocytes** and **their products, such as antibodies**.
- **Lymphocytes** are the cells of adaptive immunity that **express receptors** that **specifically recognize a much wider variety of molecules** produced by **microbes** as well as **noninfectious substances**.
- Any substance that is **specifically recognized** by **lymphocytes** or **antibodies** is called an **antigen**.
- **The resistance** that human acquires during life is known as **acquired immunity** is more specialized than other mechanisms of immunity.

Microbe

Innate immunity

Adaptive immunity



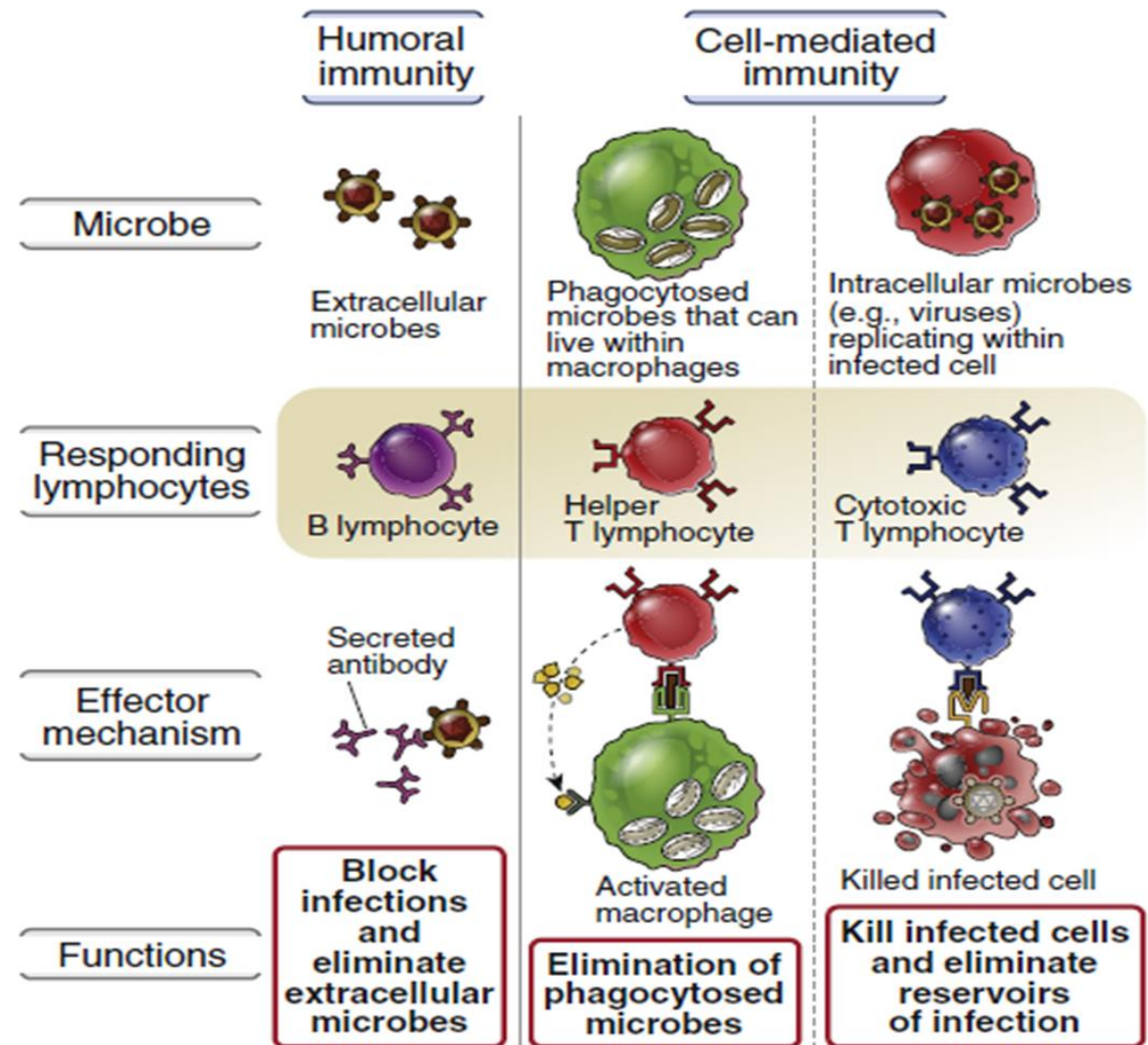


Types of Adaptive Immunity

- There are two types of adaptive immunity, called **humoral immunity** and **cell-mediated immunity**.
- Humoral immunity is mediated by proteins called antibodies, which are produced by cells called B lymphocytes and provide defense against extracellular microbes.
- **Cell-mediated immunity** mediated by different **cells** which are called **T lymphocytes** and provide defense against intracellular microbes.

1- The Humoral Immune Response

- Antibodies are produced by B- lymphocytes,
- Antibodies have the ability to recognize and bind to the specific antigens that caused their formation,
- Defense against extracellular microbe,



Properties of Adaptive Immune Responses



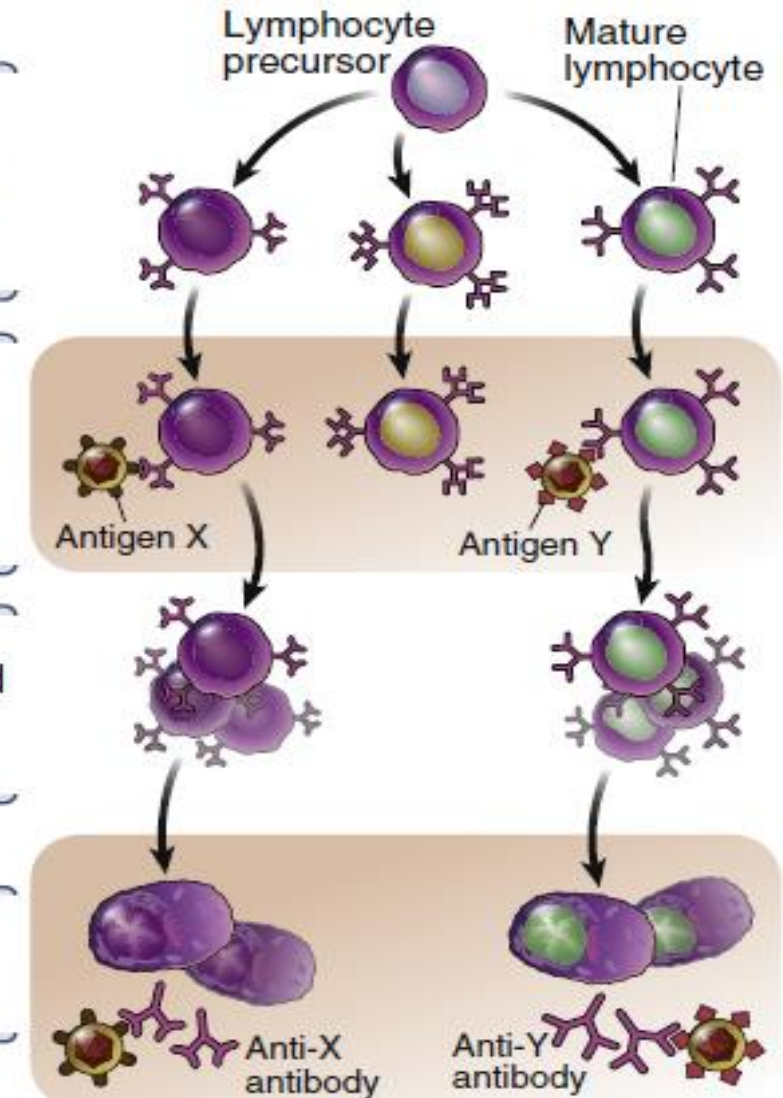
Feature	Functional significance
1 Specificity	Ensures that distinct antigens elicit specific responses
2 Diversity	Enables immune system to respond to a large variety of antigens
3 Memory	Leads to enhanced responses to repeated exposures to the same antigens
4 Clonal expansion	Increases number of antigen-specific lymphocytes from a small number of naive lymphocytes
5 Specialization	Generates responses that are optimal for defense against different types of microbes
6 Contraction and homeostasis	Allows immune system to respond to newly encountered antigens
7 Nonreactivity to self	Prevents injury to the host during responses to foreign antigens

Lymphocyte clones with diverse receptors arise in generative lymphoid organs

Clones of mature lymphocytes specific for many antigens enter lymphoid tissues

Antigen-specific clones are activated ("selected") by antigens

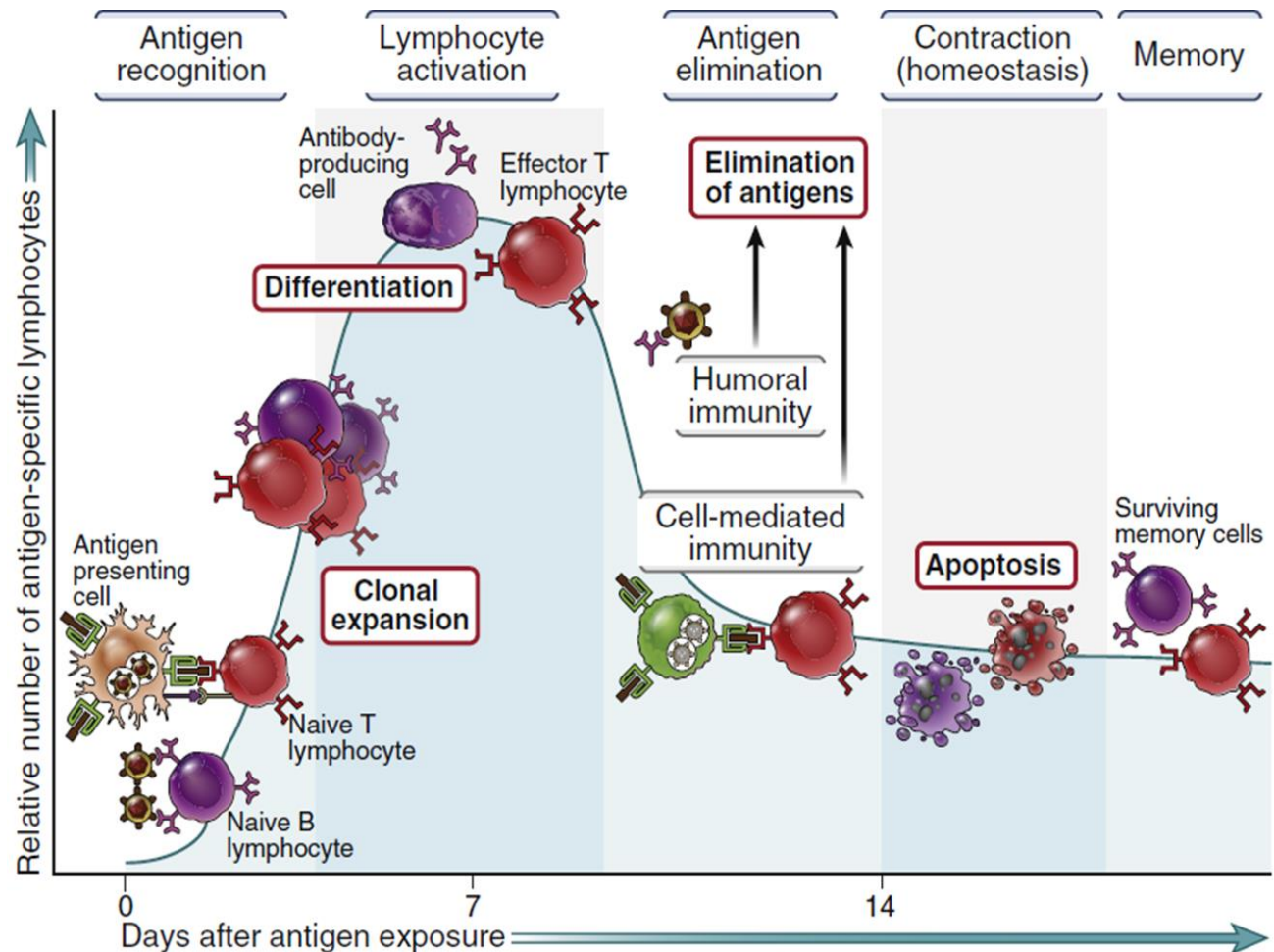
Antigen-specific immune responses occur



Phases of Adaptive Immune Response

Acquired immune response is initiated by:

1. Recognition of an antigen by certain lymphocytes,
2. Activation of these lymphocytes,
3. Differentiation and proliferation into effector cells,
4. Effector cells eliminate antigen,
5. Development of memory cells,
6. Memory cells elicit a rapid and long-term response to re-exposure.

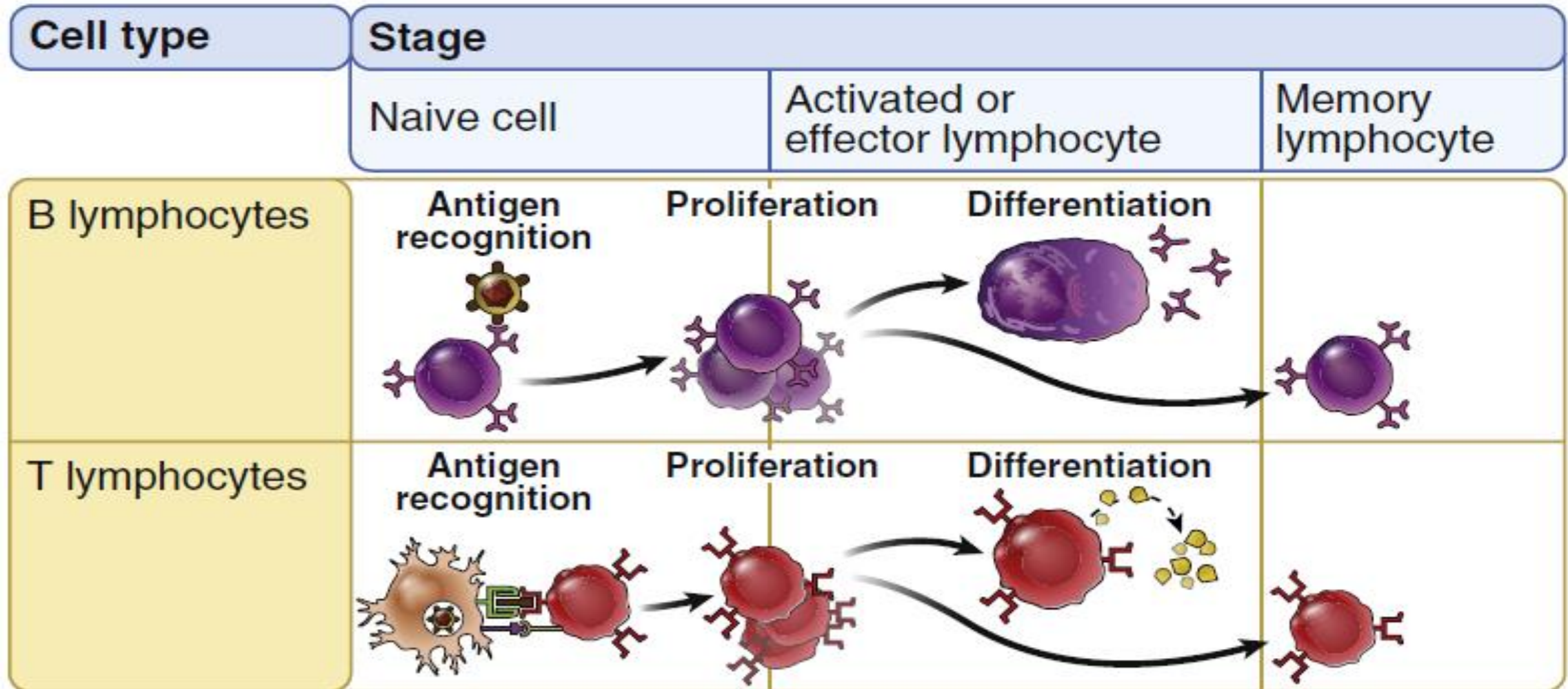




Lymphocytes

- All lymphocytes arise from **stem cells in the bone marrow**.
- **Naive lymphocytes** express **receptors for antigens** but do not perform the functions that are required to eliminate antigens.
- These cells **reside in** and **circulate** between **peripheral lymphoid organs** and **survive for several weeks or months**, waiting to find and respond to antigen.
- **Naive lymphocytes** recognize foreign antigens **to initiate adaptive immune responses**.
- **Naive lymphocytes** need **signals** in addition to antigens to proliferate and differentiate into effector cells.

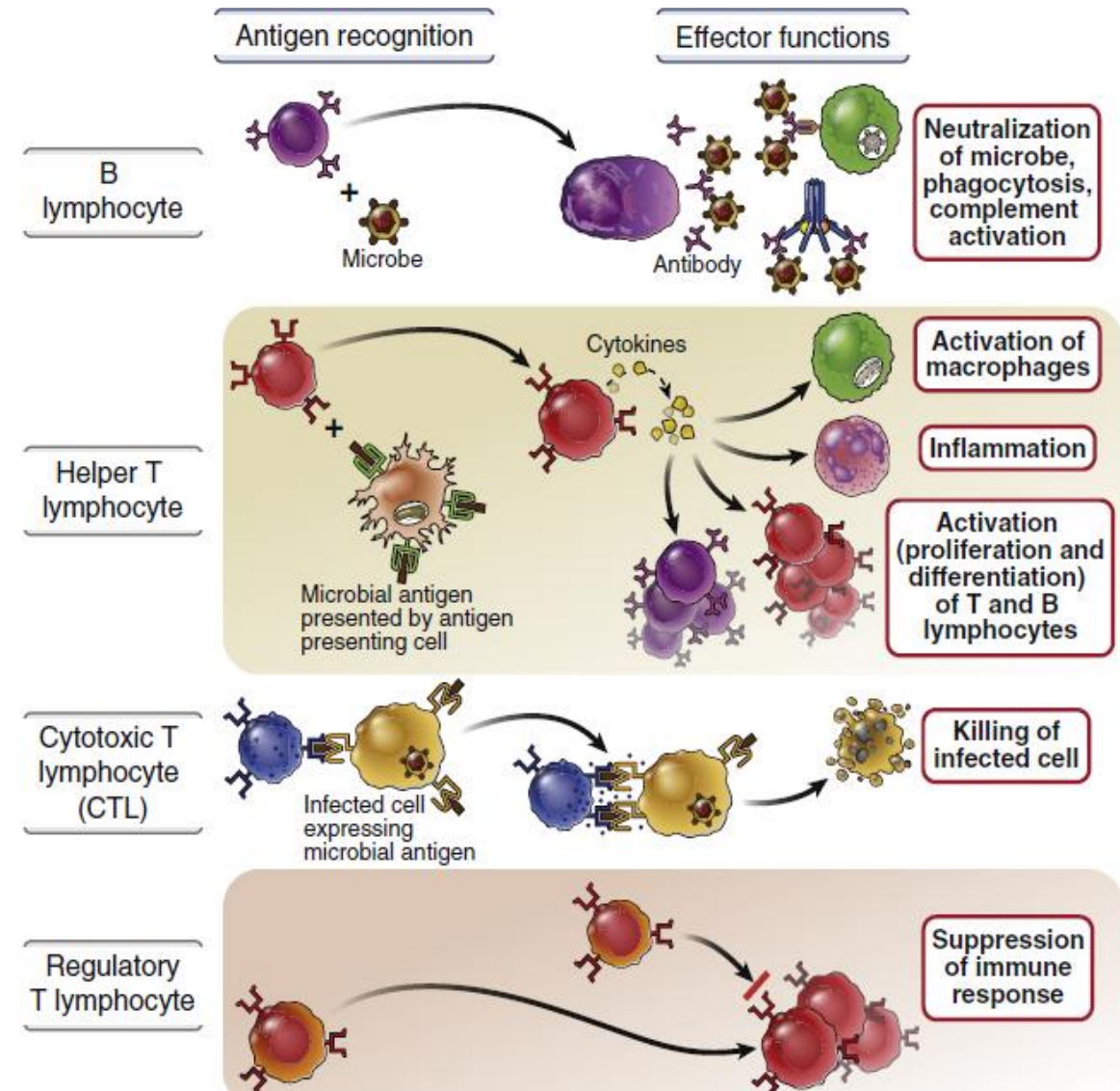
Stages in the Life History of Lymphocytes



Classes of Lymphocytes

Different classes of lymphocytes in the adaptive immune system recognize distinct types of antigens and differentiate into effector cells whose function is to eliminate the antigens.

- B lymphocytes** recognize soluble or cell surface antigens and differentiate into antibody-secreting cells.
- Helper T lymphocytes** recognize antigens on the surfaces of antigen-presenting cells and secrete cytokines, which stimulate different mechanisms of immunity and inflammation.
- Cytotoxic T lymphocytes** recognize antigens in infected cells and kill these cells. T lymphocytes recognize peptides that are displayed by MHC molecules.
- Regulatory T cells** limit the activation of other lymphocytes, especially of T cells, and prevent autoimmunity.



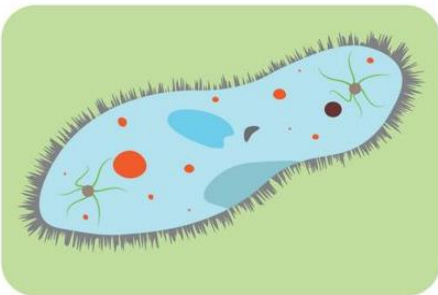
Acquired Immunity

Immunity that develops during your lifetime

Active Immunity

Natural

Antibodies developed in response to an infection



Artificial

Antibodies developed in response to a vaccination



Passive Immunity

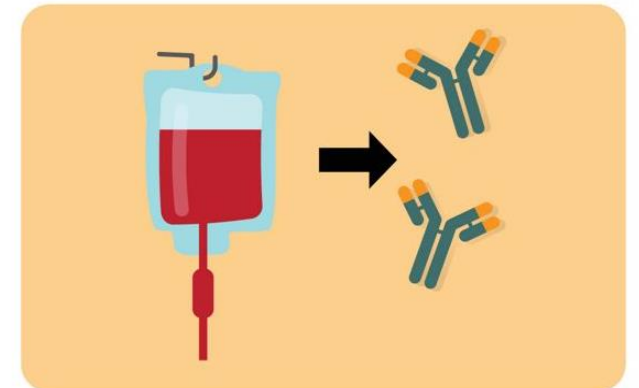
Natural

Antibodies received from mother, through breast milk



Artificial

Antibodies received from a medicine, from a gamma globulin injection or infusion



Immune organs

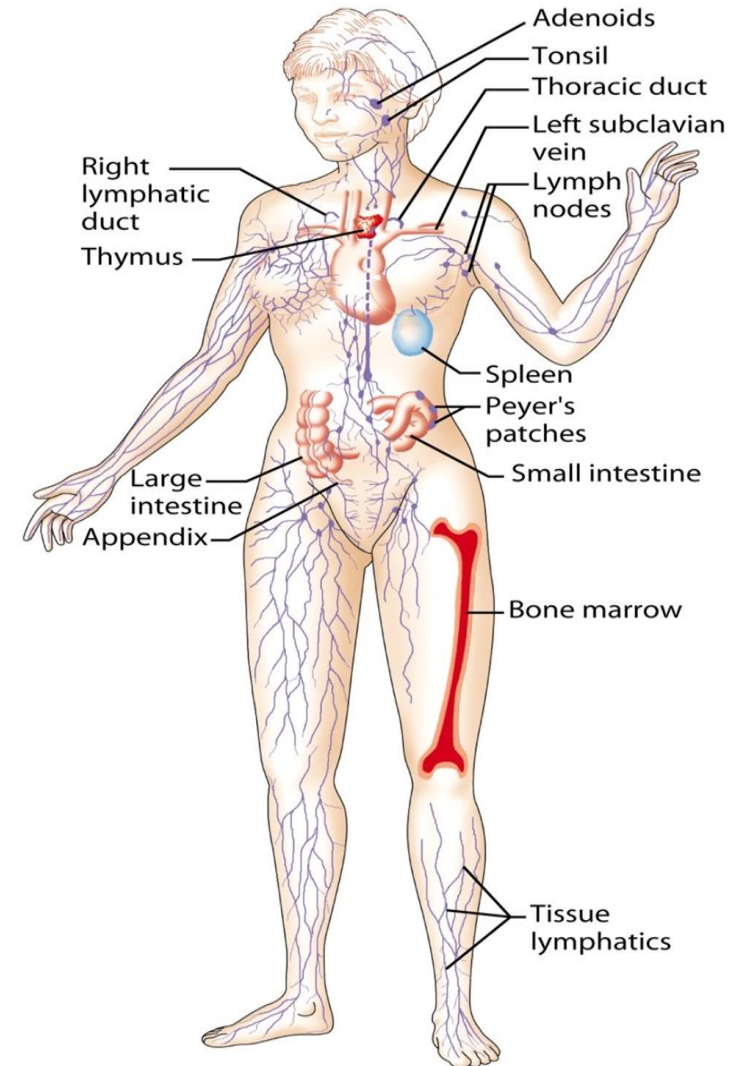


1. Central immune organs or primary lymphoid organs: The site that lymphocytes **generate** and **mature** into functional cells.

1. Thymus
2. Bone marrow

2. Peripheral immune organs or secondary lymphoid organs and tissues: The sites that T and B lymphocytes **reside in** and **respond to antigens**.

1. Spleen,
2. Lymph nodes,
3. Tonsils
4. Appendix
5. MALT (mucosal associated lymphatic tissue)





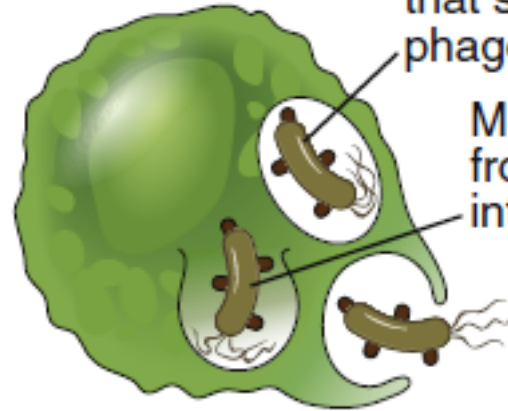
2- Cell-Mediated Immune Response

- Accomplished by T cells to protect against viruses, tumors, and pathogens resistant to phagocytosis.
- There are several types of mature T cells:
 - ✓ Cytotoxic T cells (Tc),
 - ✓ T-helper (Th)
 - ✓ Regulatory T cells including T-helper (Th) and T-suppressor (Ts) cells,
 - ✓ Memory cells.

Intracellular microbes

Examples

A Phagocyte



Phagocytosed microbes that survive within phagolysosomes

Microbes that escape from phagolysosomes into cytoplasm

Intracellular bacteria:

Mycobacteria

Listeria monocytogenes

Legionella pneumophila

Fungi:

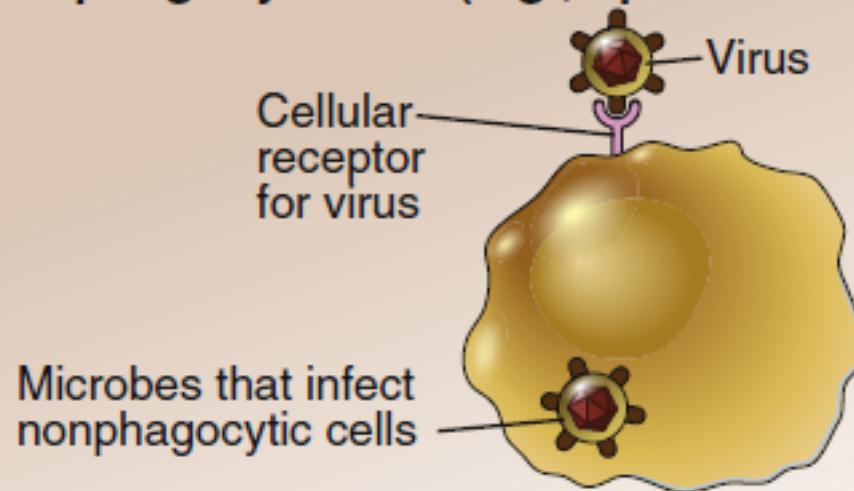
Cryptococcus neoformans

Protozoa:

Leishmania

Trypanosoma cruzi

B Nonphagocytic cell (e.g., epithelial cell)



Virus

Cellular receptor for virus

Microbes that infect nonphagocytic cells

Viruses:

All

Rickettsiae:

All

Protozoa:

Plasmodium falciparum

Cryptosporidium parvum

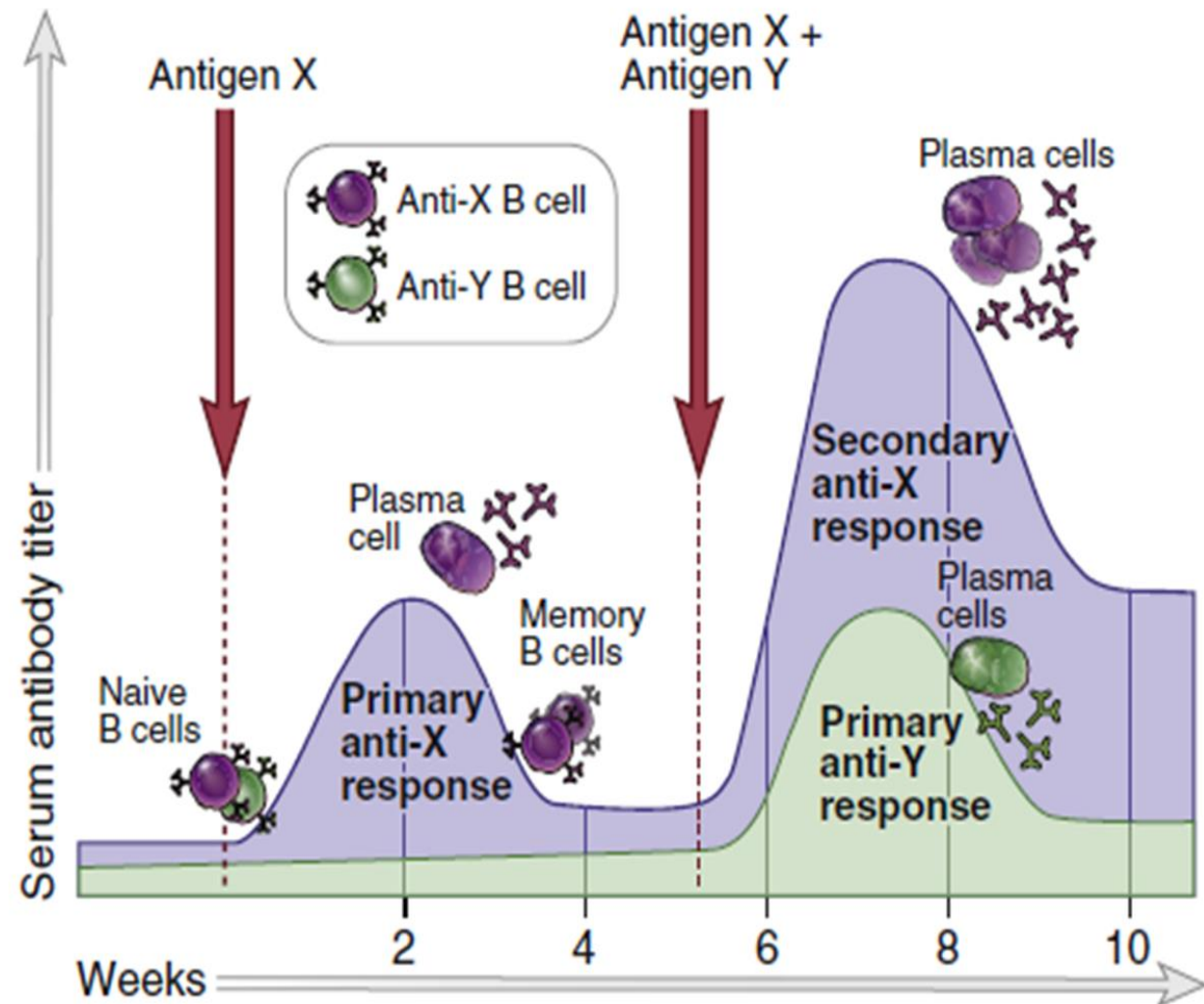
Immunologic Memory

❖ Primary Response:

- Occurs the first time the body is exposed to a particular antigen.
- A latent period of 5-7 days occurs during which B cell clonal selection occurs.
- Activated by Th2 cells (T-helper cells, type 2).
- IgM is detected in blood first, followed by IgG.
- Memory B cells form.

❖ Secondary Response:

- Occurs each **successive time** that the **body encounters this antigen**.
- **Memory B** cells are **rapidly activated** and produce large **amounts of IgG** very quickly.





Specific immunity

Humoral Immunity, Antigen, Antibody & Cytokines.

Antigen (Ag):

- Is a foreign substances usually **protein** and sometimes **polysaccharide**.
- Generates a specific immune response and induces the formation of a **specific antibody** or **T cells response** or **both**.
- **Antigens** react with the **products of a specific immune response (Ab)**.



Substances that Act as Antigens

1. Infectious materials:

- a. Microbial structures (cell walls, capsules, flagella, pili, viral capsids, envelope associated glycoproteins, etc).
- b. Microbial toxins.

2. Noninfectious materials:

- a. Allergens (dust, pollen, hair, foods, drugs, and other agents causing allergic reactions);
- b. Foreign tissues and cells (from transplants and transfusions); and
- c. The body's own cells that the body fails to recognize as "normal self" (cancer cells, infected cells, cells involved in autoimmune diseases).



Structure of Antigen (Ag)

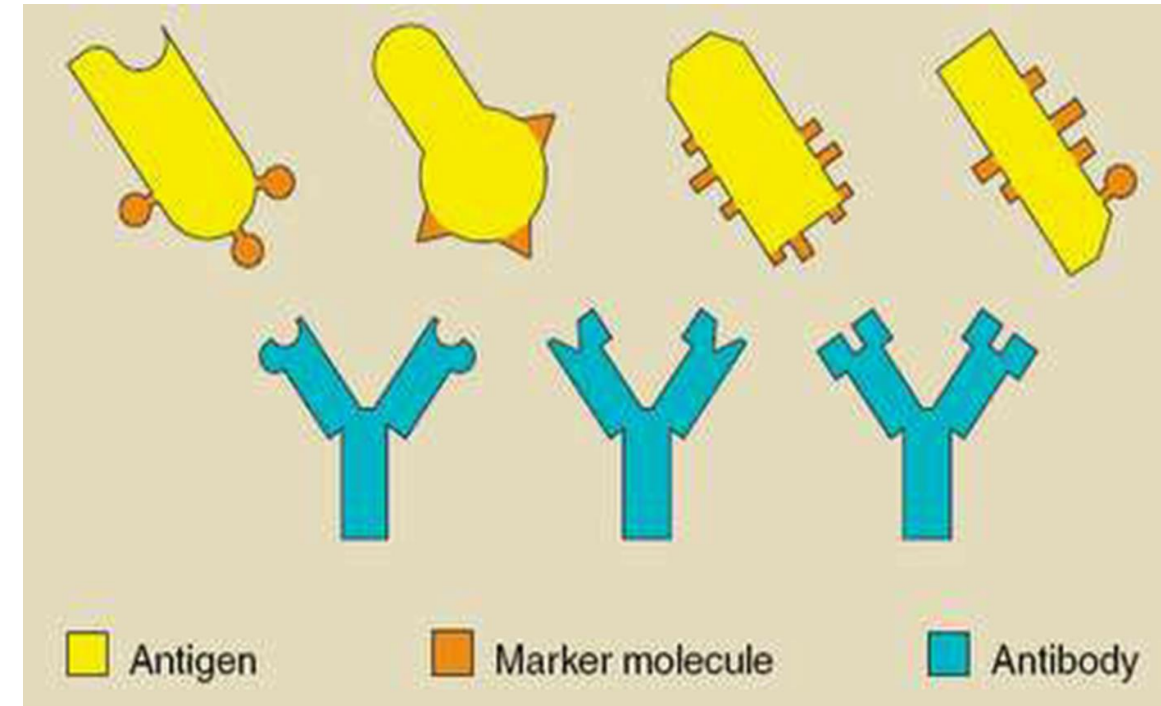
- **Antigenic determinants or epitopes are components of antigen.**
- Each antigen carries many **epitopes**.
- Each **Y-shaped antibody molecule** has at least **two binding sites** that can attach to a **specific epitope on an antigen**.
- An antibody can also bind to **identical epitopes of two different cells at the same time** which can cause neighboring cells to **aggregate**.
- Antigens combine with the antibody. The combination is very much like the **lock and key** analogy.

Epitope (Antigenic Determinant)

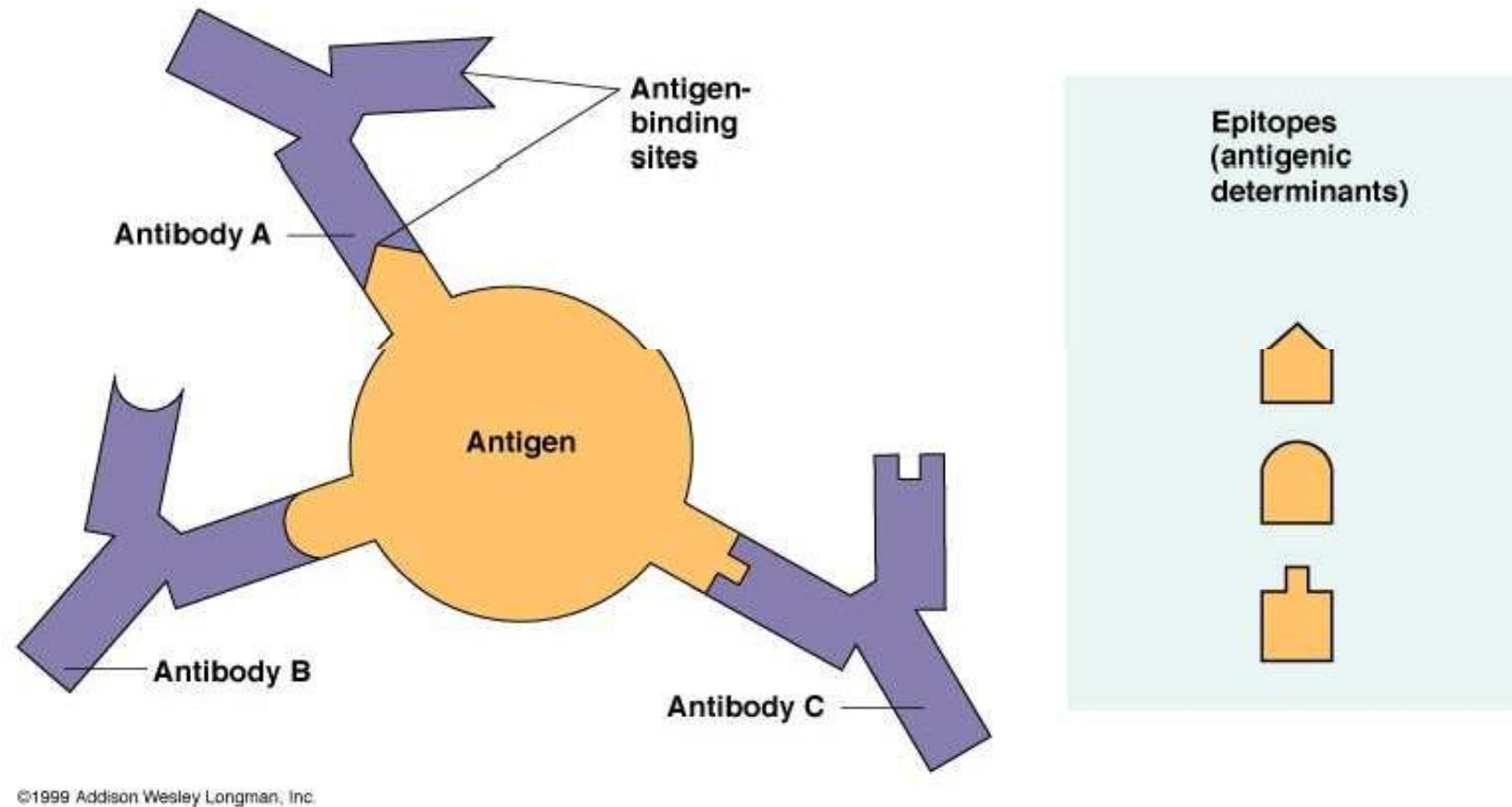
❖ **Epitope (antigenic determinant);** active regions of an immunogen (or antigen) that binds to antigen-specific receptors on lymphocytes or to secreted antibodies.

❖ **Immunogen:** Molecule that stimulate a specific immune response.

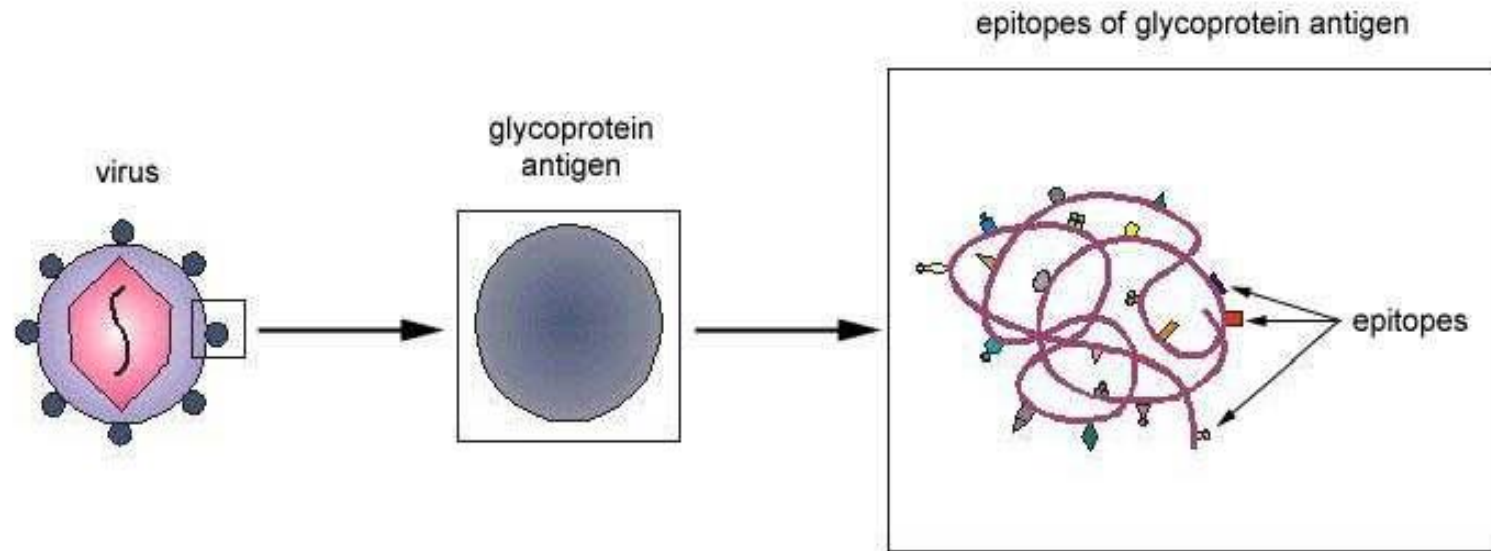
Epitopes: The Basic Recognition Unit



Epitopes: Antigen Regions that Interact with Antibodies



Antigens and Epitopes of a Virus



- ❖ Proteins have many epitopes of different specificities.
- ❖ Each different **protein and glycoprotein** of a virus constitutes a **different antigen**.
- ❖ Each **different antigen** contains a **number of different epitopes**.

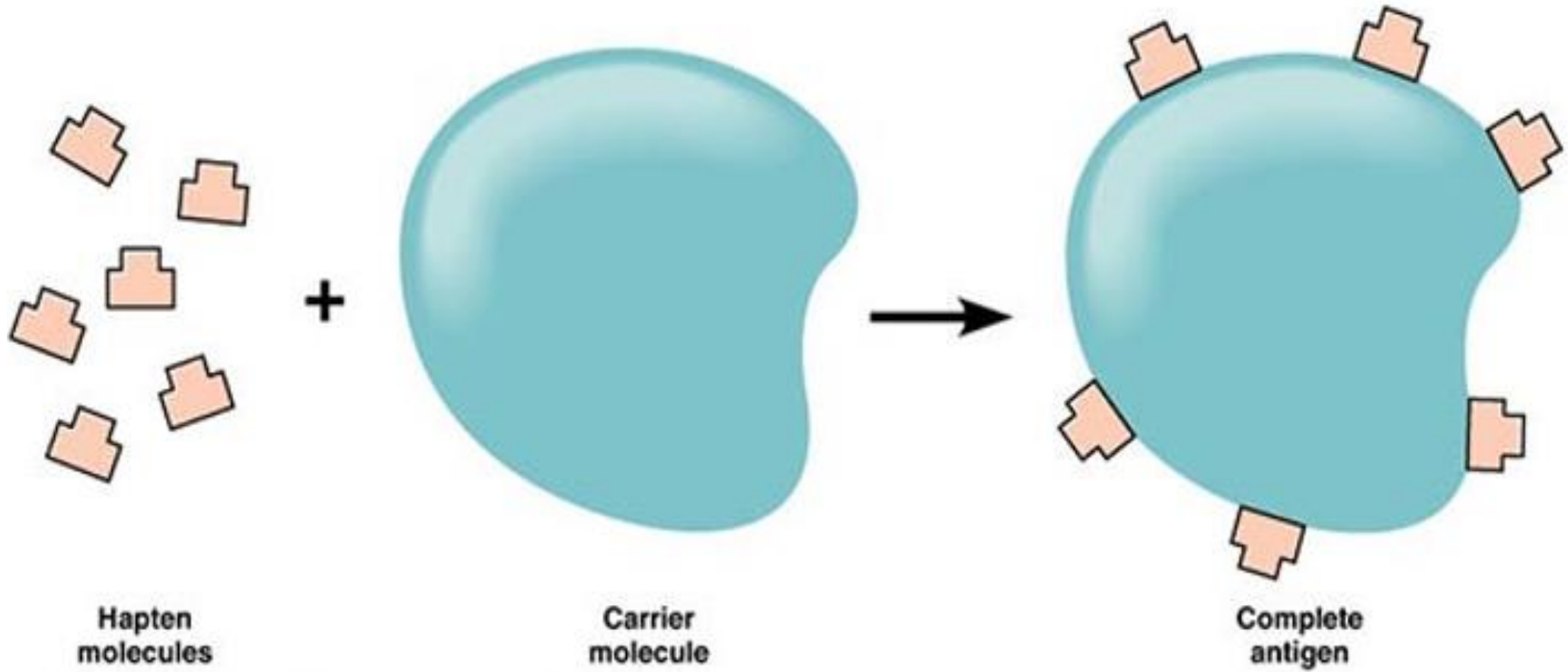


Types of Antigens

Based upon the **ability of antigens** to carry out their functions are two types:

1. A **complete antigen** is able to induce antibody formation and produce a specific and observable reaction with the antibody so produced.
2. Hapten (**incomplete antigens**): A substance that is non-immunogenic, it can react with the products of a specific immune response with **no antibodies formation**.
 - **It is small molecules with a low molecular weight** that could never induce an immune response when administered by themselves **unless it coupled to a carrier molecule**.

Hapten



Biological Type of Antigens

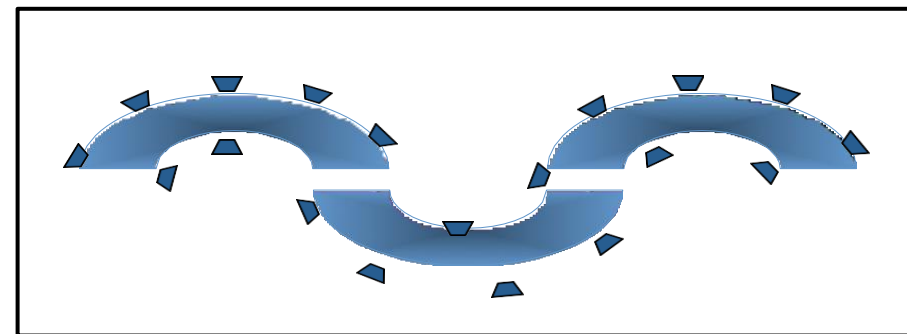


Depending on their **ability to induce antibody formation**, **antigens** are classified into:

1. **T-independent antigen**: are antigens which can directly stimulate the **B cells** to produce antibody without the requirement for T cell help In general, **polysaccharides** are T-independent antigens.

Examples:

- ✓ Pneumococcal
- ✓ polysaccharide,
- ✓ Lipopolysaccharide
- ✓ Flagella

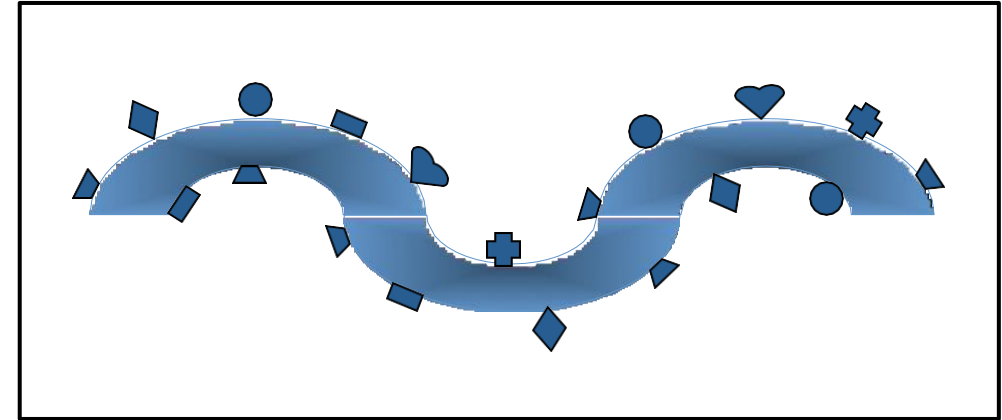


Biological Type of Antigens (Cont.)

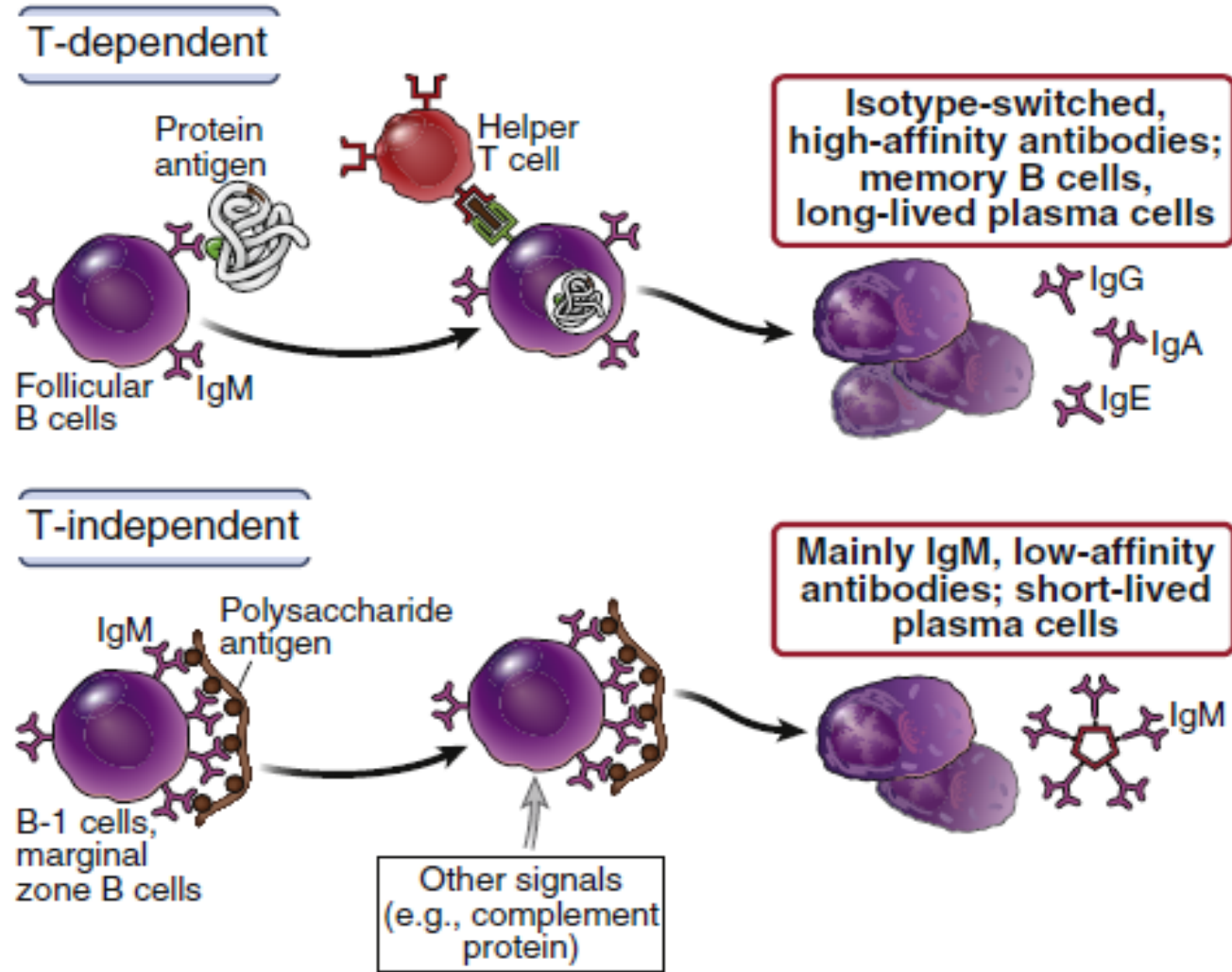
2- T-dependent antigen: are those that do not directly stimulate the production of antibody without the help of T cells. **Proteins** are T-dependent antigens.

Examples:

- ✓ Microbial Proteins



T-dependent and T-independent antibody responses





References

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