



# Adaptive Immune Response

## PART I

### Humoral Immune response

### B lymphocytes

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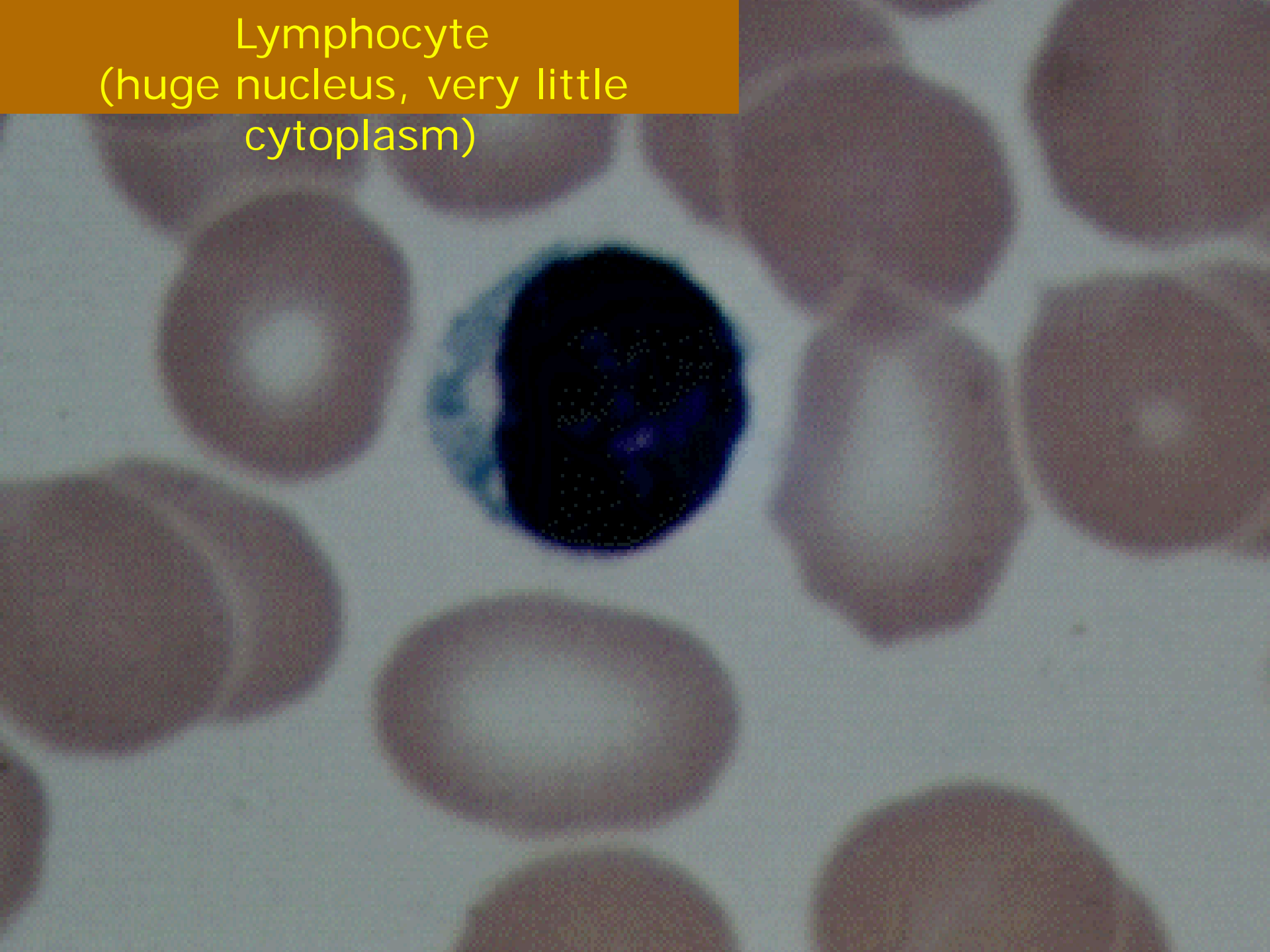
(Immunity)

College of Pharmacy-Dep. Of Clinical Laboratory Sciences

Lecture 2.

17 /3/ 2019

Lymphocyte  
(huge nucleus, very little  
cytoplasm)



# LYMPHOCYTES

**Lymphocytes are produced in the bone marrow before birth.**

**They then mature and travel around the body.**

**They are NOT phagocytic.**

# Lymphocytes

Are the principal cell players in the adaptive immune response.

- They represent 20% to 40% of circulating white blood cells and 99% of cells in the lymph.
- Lymphocytes can be broadly subdivided into three major populations on the basis of functional and phenotypic differences:
  - B lymphocytes (B cells), T lymphocytes (T cells), and natural killer (NK) cells.
- Surface proteins expressed by immune cells are often referred to by the cluster of differentiation (CD)

# The Specific Immune response

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graph TD; A[The Specific Immune response] --> B[Humoral response]; A --> C[Cell Mediated response]; B --> D[B Cells]; C --> E[T Cells];
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**Humoral response**

**B Cells**

**Cell Mediated response**

**T Cells**

These are 2 different types of lymphocytes that work in different ways and are matured in different areas of the body

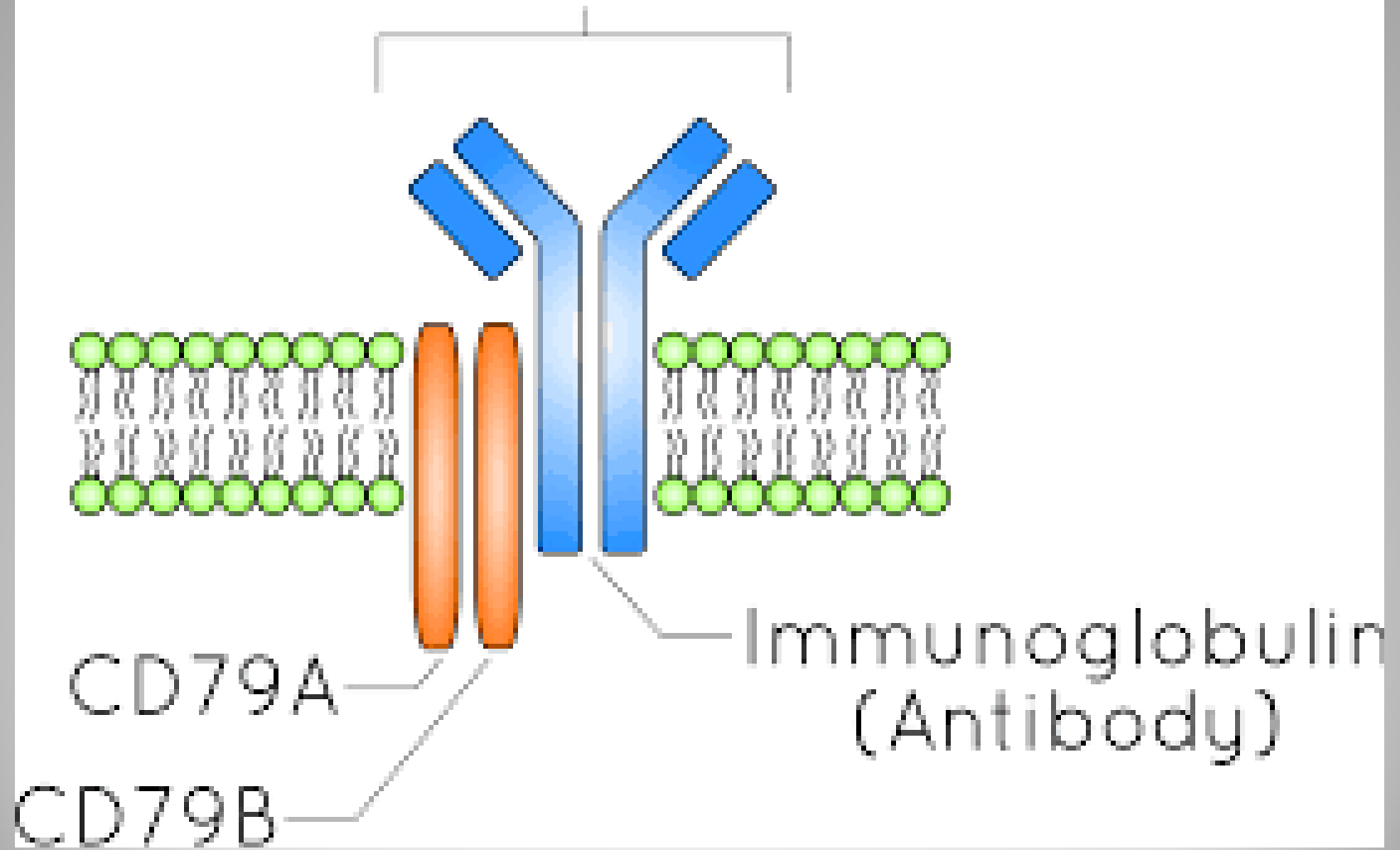
# Overview of humoral Immune Response

- Mediated by B lymphocytes
  - B cells
- Develops in bone marrow
- B cells may be triggered to proliferate into plasma cells
  - Plasma cells produce antibodies
    - Antibodies produce when antigen bonds B cell receptor
- Some B cells produce memory cells

# B Lymphocytes

- ❑ **B cells**, also known as **B lymphocytes**, are a type of WBC of the lymphocyte subtype.
- ❑ They function in the immunity component of the adaptive immune system by secreting antibodies
- ❑ In mammals, B cells mature in the bone marrow, which is at the core of most bones
- ❑ B cells, unlike the other two classes of lymphocytes, T cells and natural killer cells.
- ❑ Express B cell receptors (BCR) on their cell membrane.
- ❑ BCRs allow the B cell to bind to a specific antigen, against which it will initiate an antibody response.

# B cell Receptor

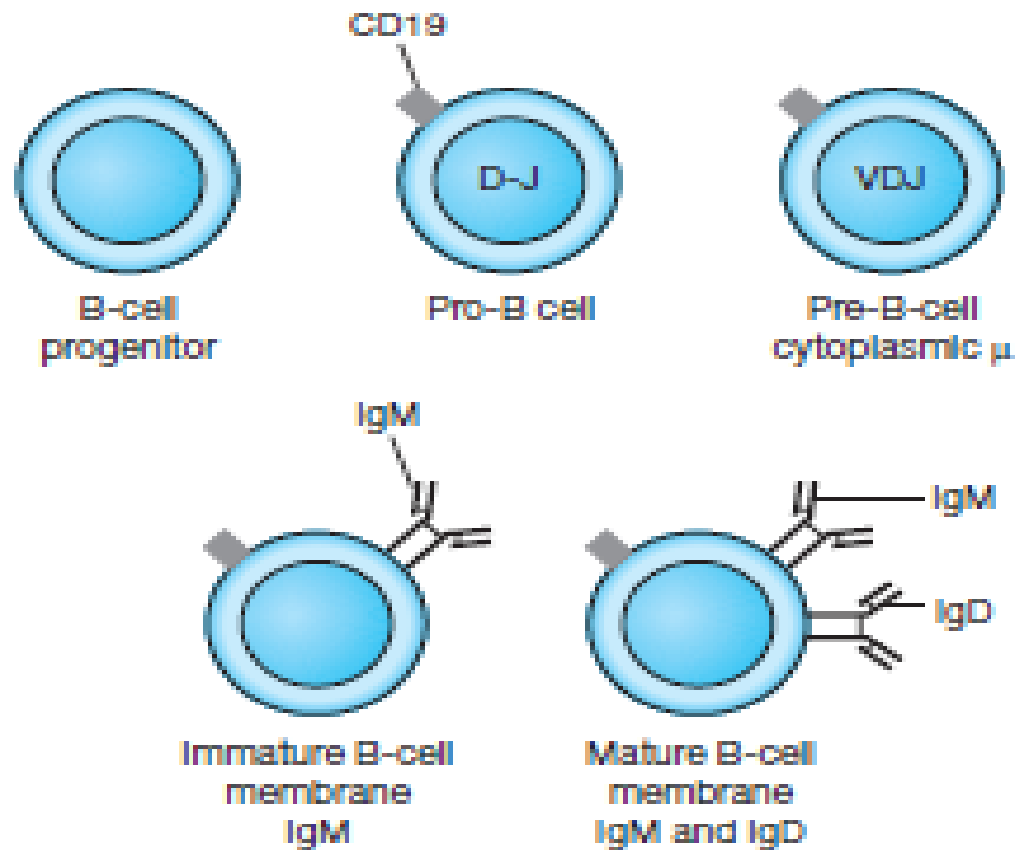




## Production of B lymphocytes

B lymphocytes are produced in the bone marrow.

1. The first stage in B cell development is a rearrangement of D to J in the Ig heavy chain gene, involving D rearranging to J . Cells that successfully rearrange D to J are known as **pro-B cells**. These cells also express a molecule called CD19 on their cell surface, which identifies them as cells of the B lymphocyte lineage.
2. The next stage of B cell development is rearrangement of an Ig heavy chain V segment to the rearranged DJ gene. Cells that have successfully completed both the D to J and the V to DJ rearrangements are allowed to continue their development and are called **pre-B cells**. Cells that do not successfully rearrange their heavy chain genes die .
3. The next stage of B cell development is rearrangement of the Ig light chain genes. If the rearrangement of V to J is successful the cell can make an Ig light chain that associates with the Ig heavy chain and the B lymphocyte will express IgM on its cell surface. This cell is now known as an **immature B cell**.
4. Finally the B cell will also express IgD on its surface, at which point it has completed the antigen-independent stage of maturation .



**Figure 11.4 B cell development.** The pro-B cell expresses CD19 on its cell surface and rearranges the IgH D gene to the J gene. The pre-B cell rearranges its V gene to the DJ and expresses the Ig  $\mu$ -chain in its cytoplasm. Immature B cells express IgM but not IgD on their cell surface while mature B cells express both IgM and IgD.

This cell is called a 'naive' or 'virgin' B cell because it has never experienced antigen.

-Naive B cells are exported to the peripheral lymphoid tissue where they will circulate through blood and lymphoid tissue and wait to encounter the antigen for which their Ig is specific.

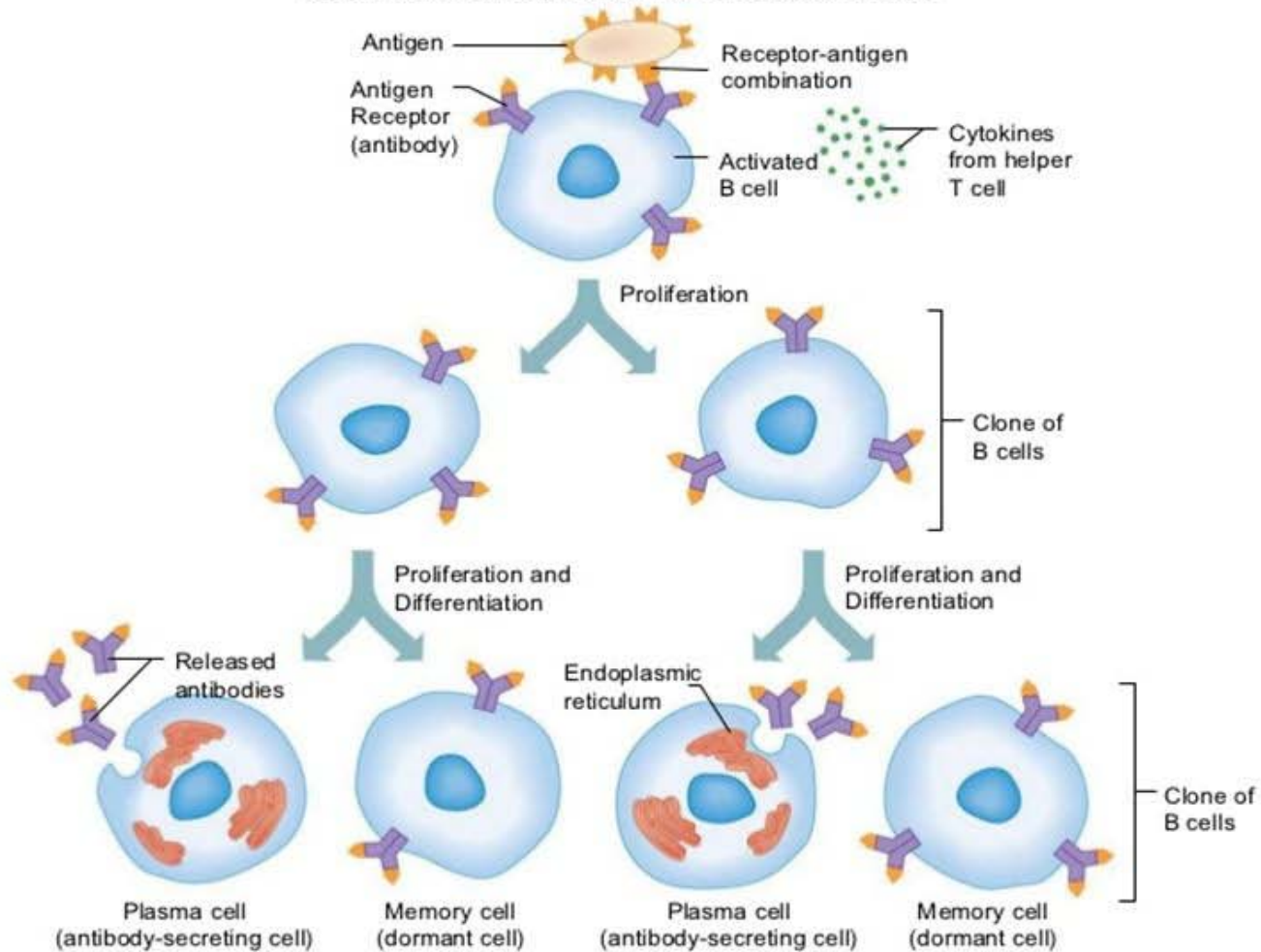
If they encounter antigen in the presence of appropriate T cell help they will undergo antigen-dependent maturation and differentiate into plasma or memory cells.

-Most B cells that do not encounter antigen within a week of leaving the bone marrow die.

- Ultimately, activated B cells differentiate into effector cells known as **plasma cells**.
- Plasma cells lose expression of surface immunoglobulin and become highly specialized for secretion of antibody.
- A single cell is capable of secreting from a few hundred to more than a thousand molecules of antibody per second.
- Plasma cells do not divide and, although some long-lived populations of plasma cells are found in bone marrow, many die within 1 or 2 weeks.

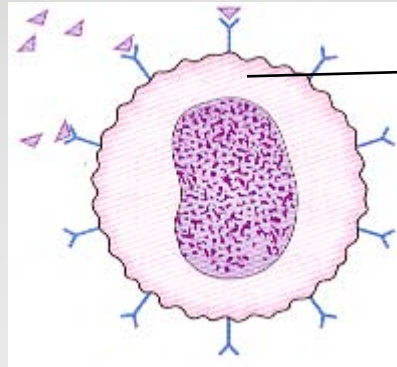
# B-Lymphocytes activation

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# B CELL ACTIVATION

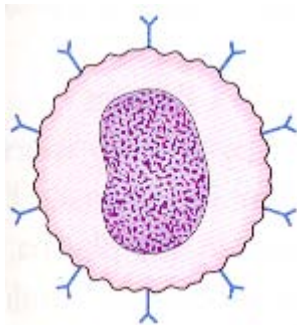
B cell receptor binds to specific antigen



Antigen

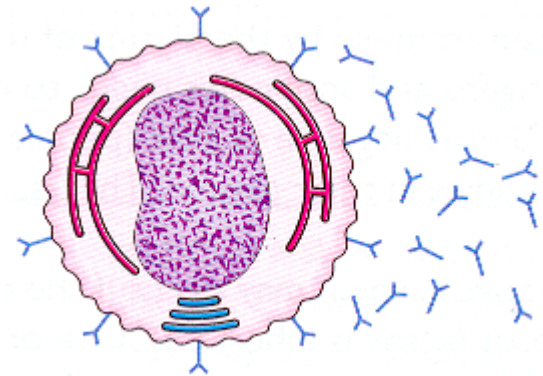
Memory cell

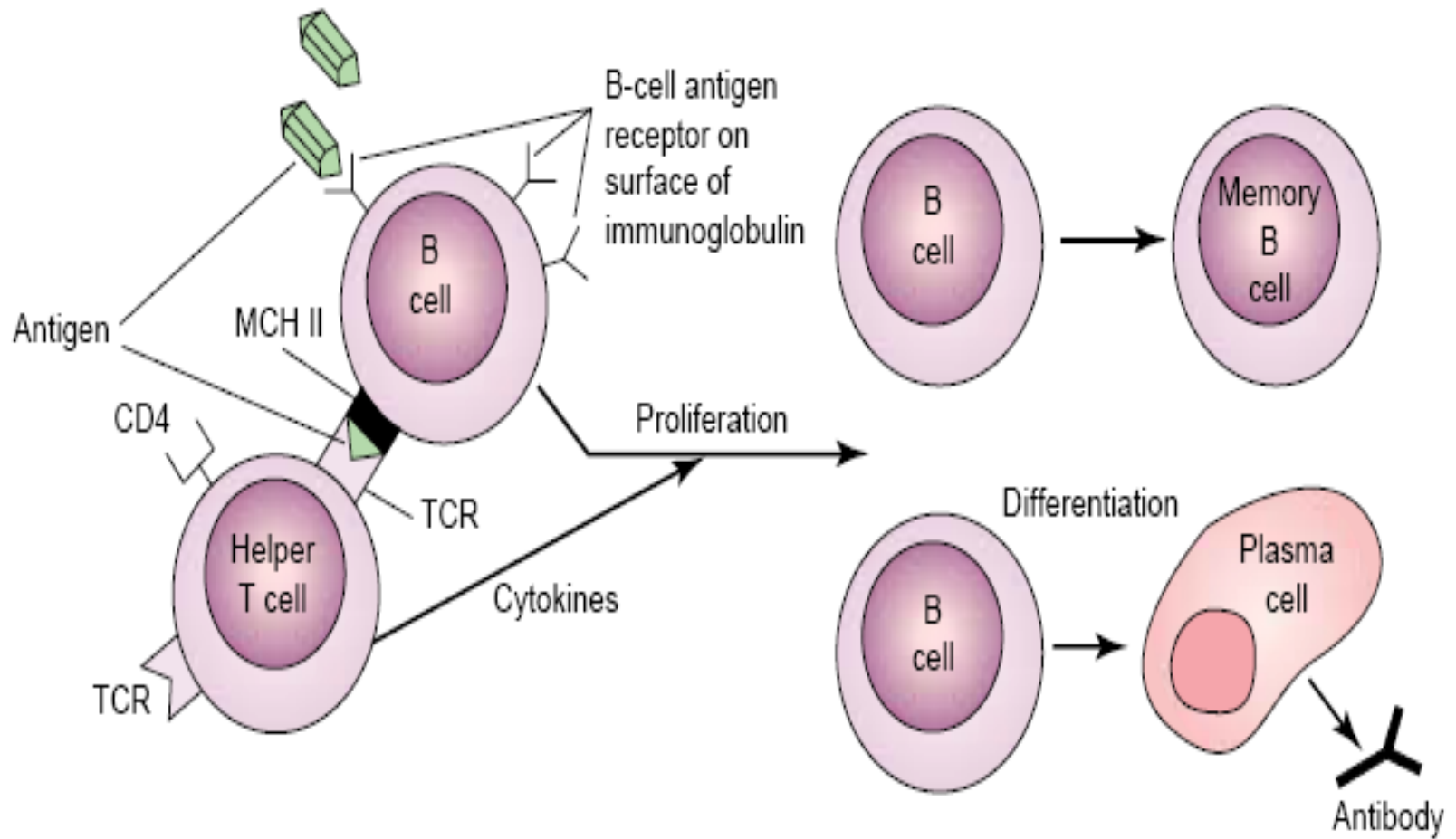
remains in lymph nodes



Plasma cells

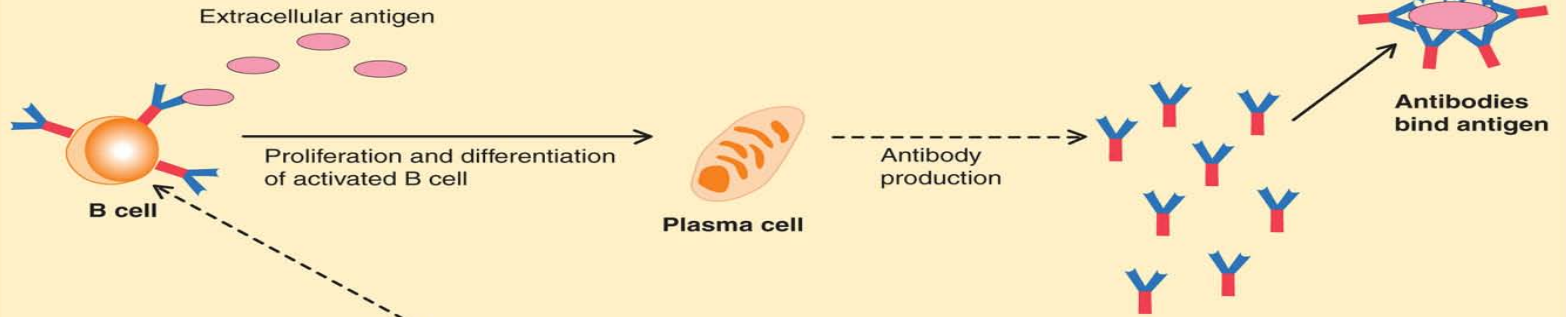
divide and release antibodies to the antigen



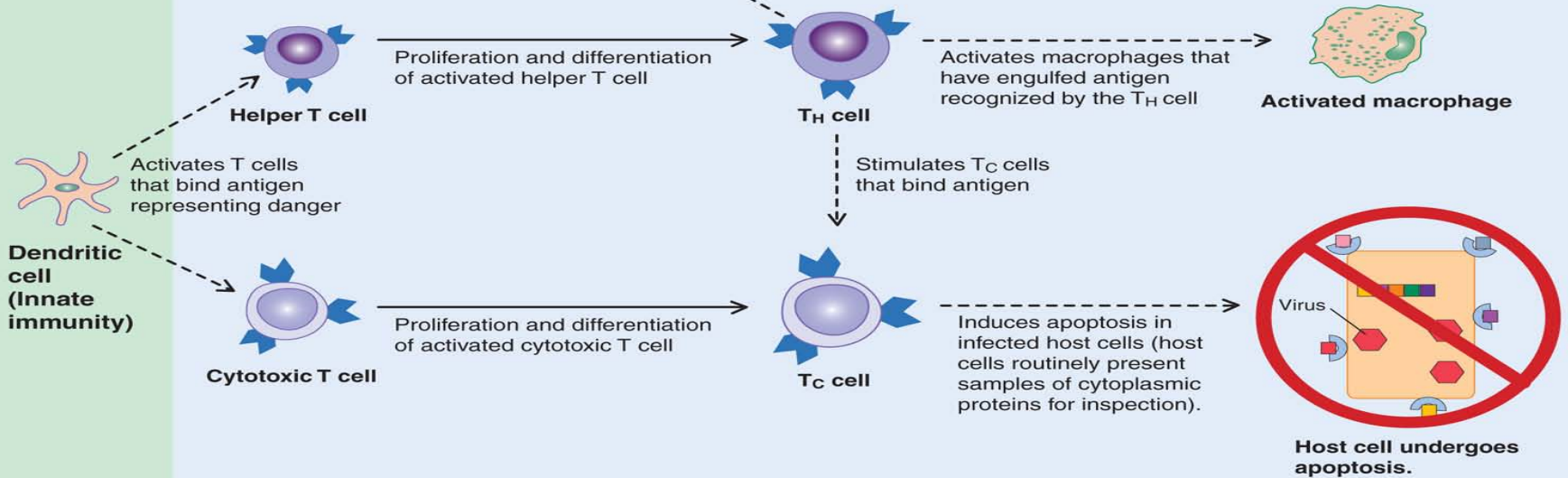


## **B cells Activation**

### Humoral Immunity (adaptive)



### Cellular Immunity (adaptive)



# Immune Response

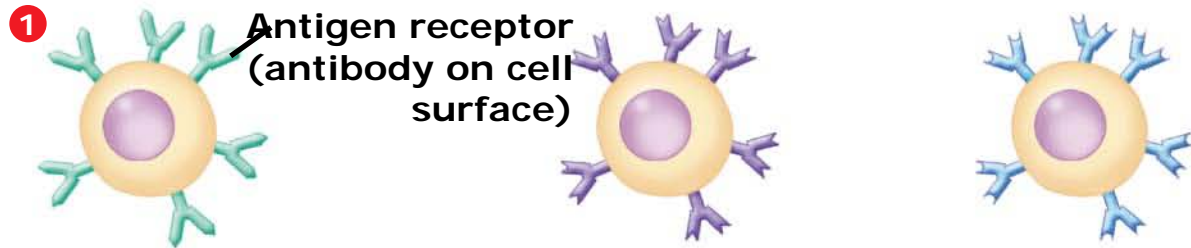
# B cells

- **The B-cell response to antigens has two stages:**
  - **Primary immune response:**
    - When B cells first encounter an antigen, the antigen attaches to a receptor, stimulating the B cells.
    - Some B cells change into memory cells, which remember that specific antigen, and others change into plasma cells. Helper T cells help B cells in this process.
    - Plasma cells produce antibodies that are specific to the antigen that stimulated their production. After the first encounter with an antigen, production of enough of the specific antibody takes several days. Thus, the primary immune response is slow.
  - **Secondary immune response**
    - Whenever B cells encounter the antigen again, memory B cells very rapidly recognize the antigen, multiply, change into plasma cells, and produce antibodies. This response is quick and very effective.



Primary immune response

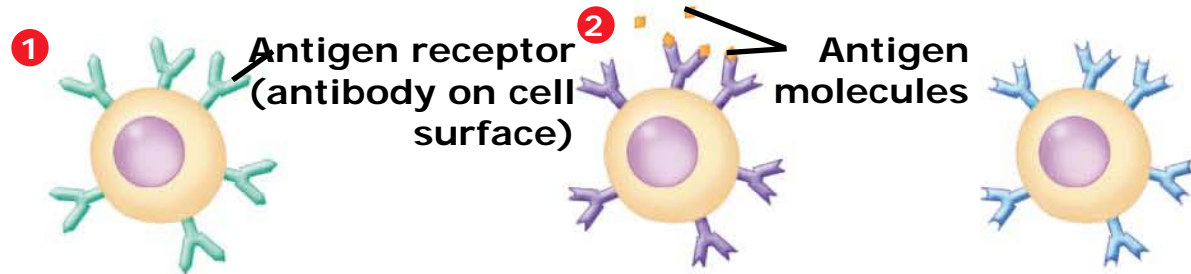
B cells with different antigen receptors



**Fig. 24-7aa-1**

**Primary immune response**

**B cells with different antigen receptors**

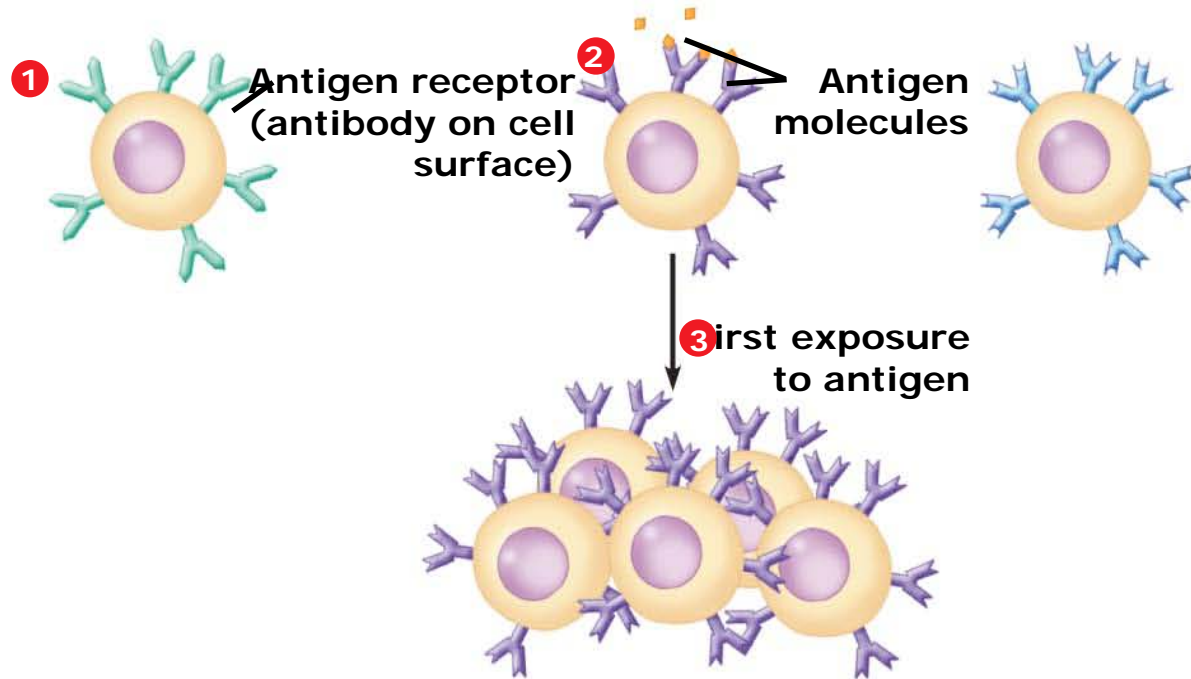


**Fig. 24-7aa-2**

Primary immune response

B cells with different antigen receptors

Cell activation: growth, division, and differentiation

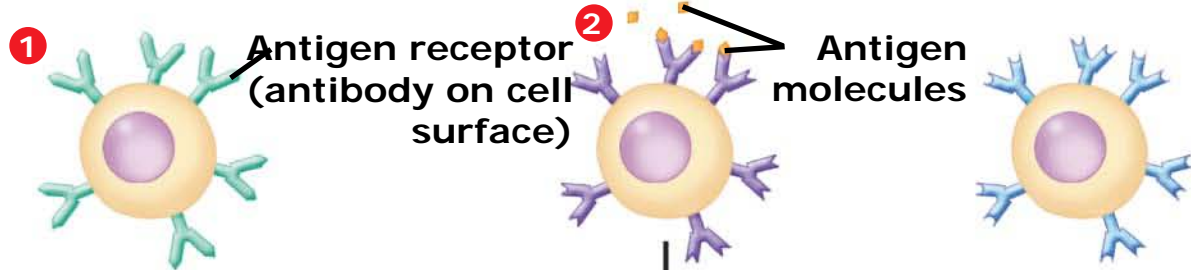


**Fig. 24-7aa-3**

Fig. 24-7aa-4

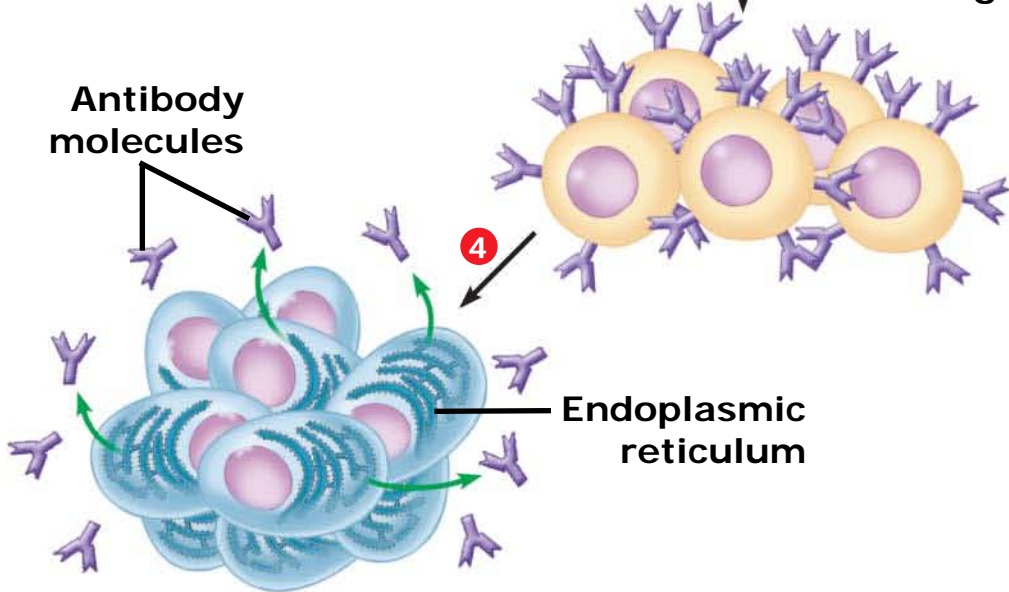
Primary immune response

B cells with different antigen receptors



3 first exposure to antigen

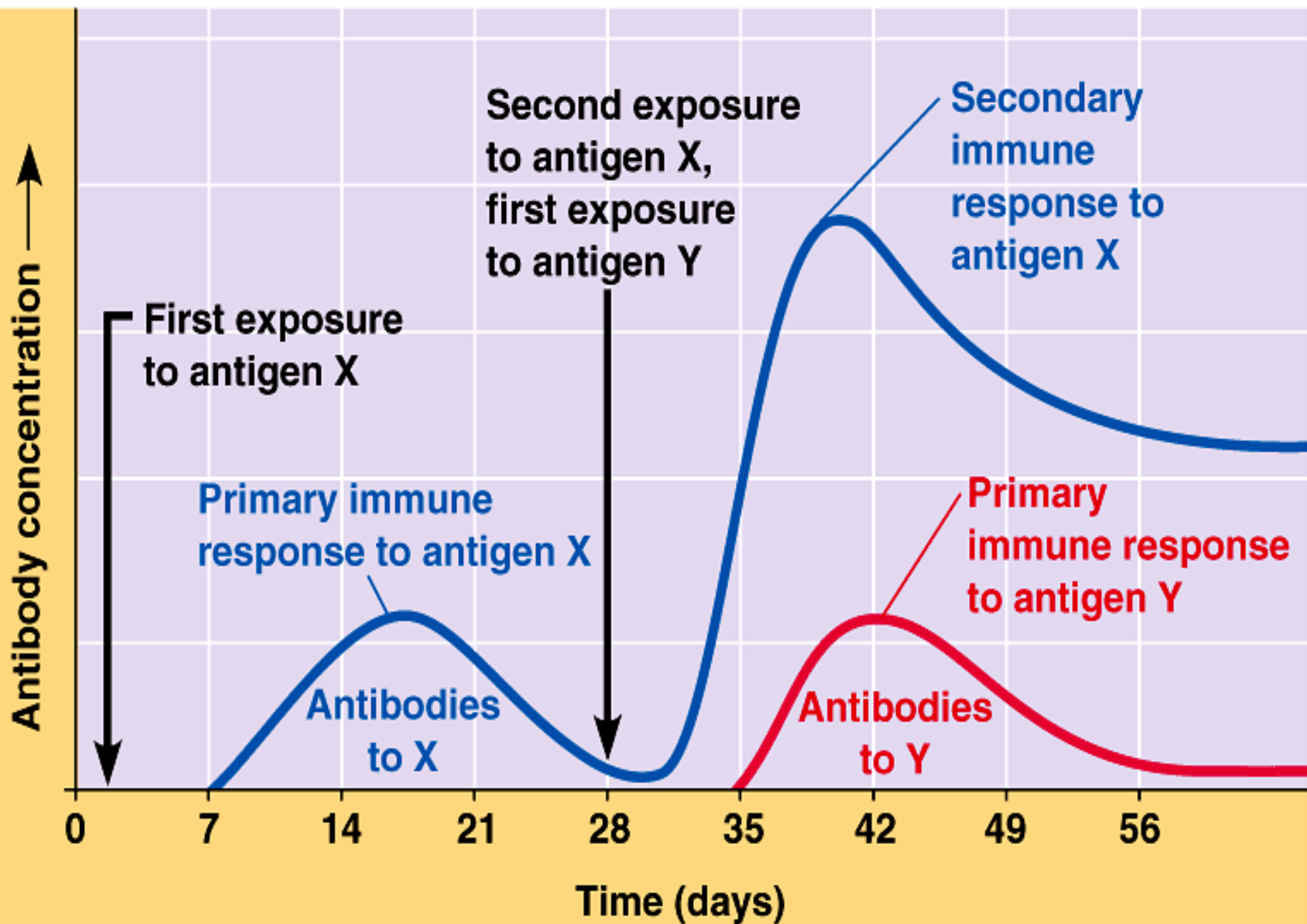
Cell activation: growth, division, and differentiation

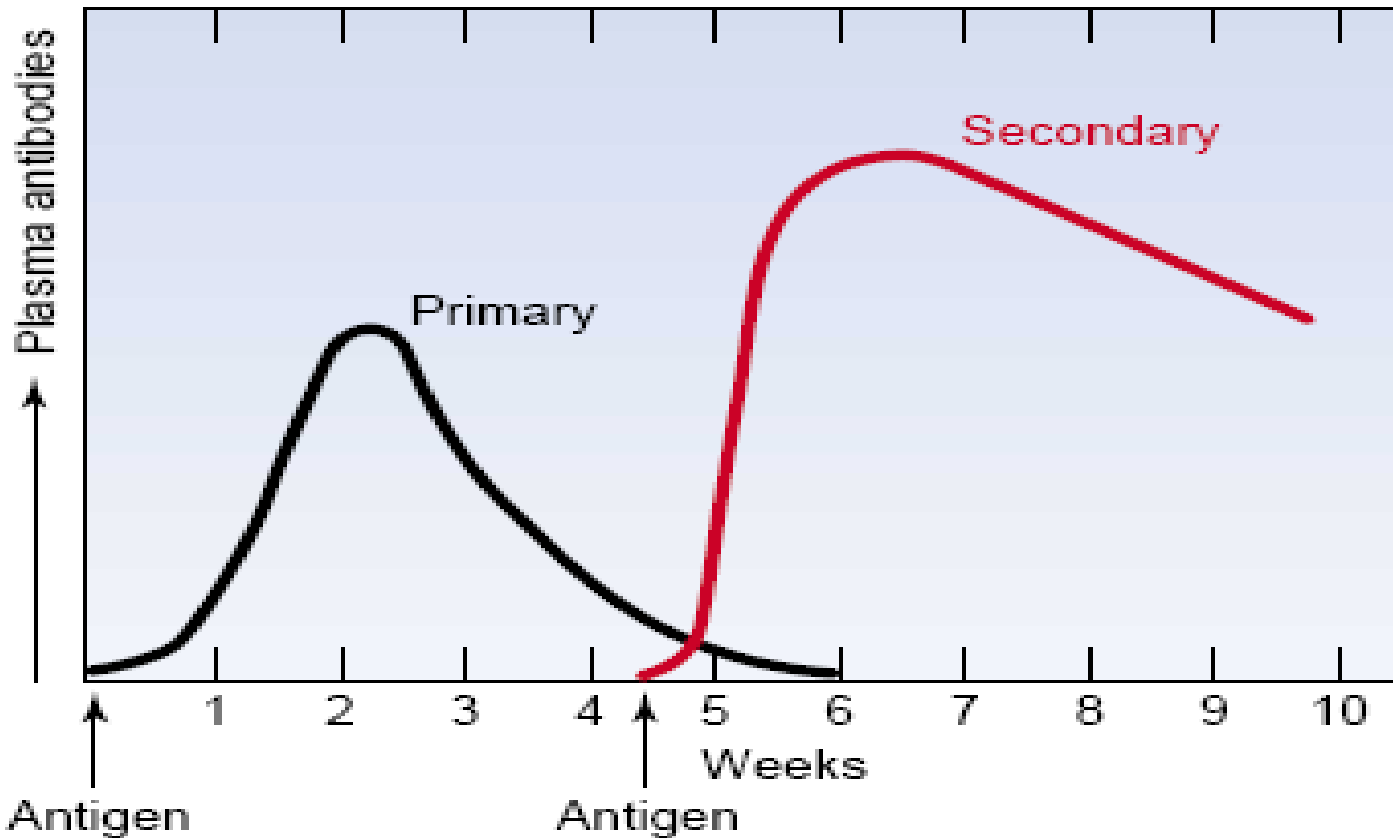


First clone

Endoplasmic reticulum

Plasma (effector) cells secreting antibodies





**Primary and secondary phases of the humoral immune response to the same antigen.**

# Two types of cell develop

## Plasma cells

- Secrete antibodies
- Survive a few days
- Make 2000 antibodies every second!
- Responsible for immediate defence

## **Primary immune response**

## Memory cells

- Live considerably longer than plasma cells (often decades!)
- Don't produce antibodies directly
- On contact with antigen, rapidly divide and develop into plasma and memory cells.

## **secondary immune response**

## **Immunological memory**

(Greater intensity and more rapid)

**THANK YOU FOR YOUR  
ATTENTION**

**Next lecture we will talking about the second type PART II :  
Cellular Immune Response**