
Immune system
م. م. سرى صباح ناجي
المرحلة / الثالثة

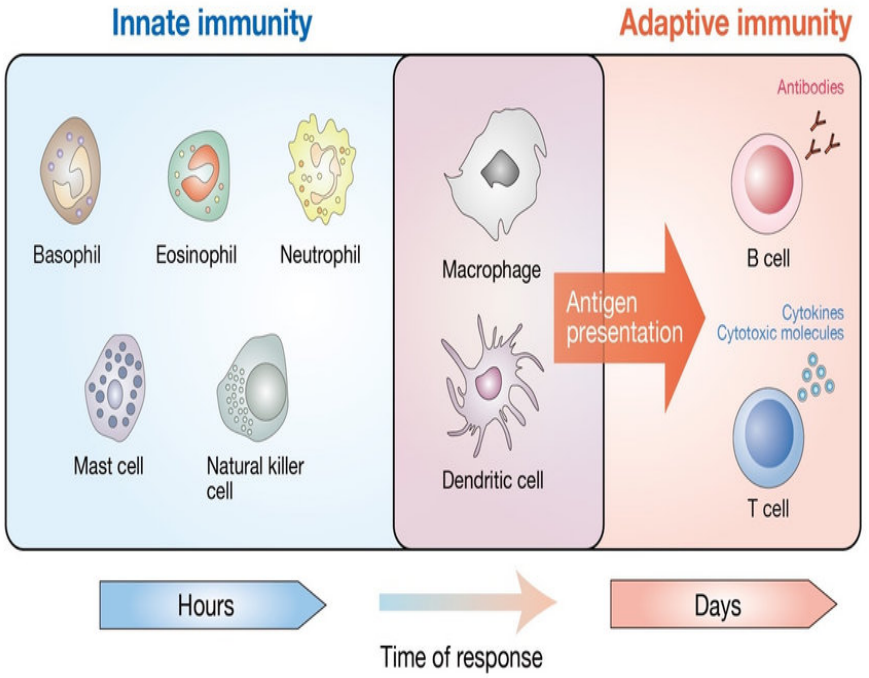
Immunity: It is protection against infections.

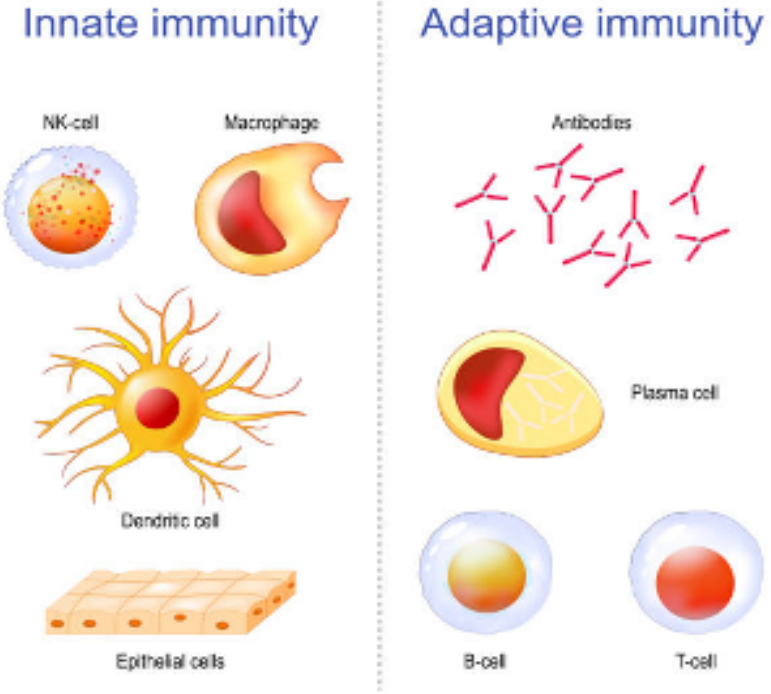
The immune system is the collection of cells and molecules that are responsible for:

1- Defending our body against pathogenic microbes in our environment.
2- Prevent the proliferation of cancer cells.
3- Mediate the healing of damaged tissue.

Defense against microbes consists of two types of reactions:

1- Innate immunity (natural or native immunity).
2- Adaptive immunity (acquired or specific immunity)





1- Innate immunity :

It is mediated by cells and proteins that are **always present** and act **immediately** against any infection.

The major components :

a. Epithelial barriers.
b. Phagocytic leukocytes (neutrophils and macrophages).
c. natural killer cells
d. plasma proteins. the complement system

2- Adaptive immunity:

- It is normally silent and responds (or "adapts") to the presence of an infectious microbes by becoming active for neutralizing and eliminating the microbes.
- The terms "immune system" and "immune response" refer to adaptive immunity.

Types of adaptive immunity:

1- Humeral immunity.

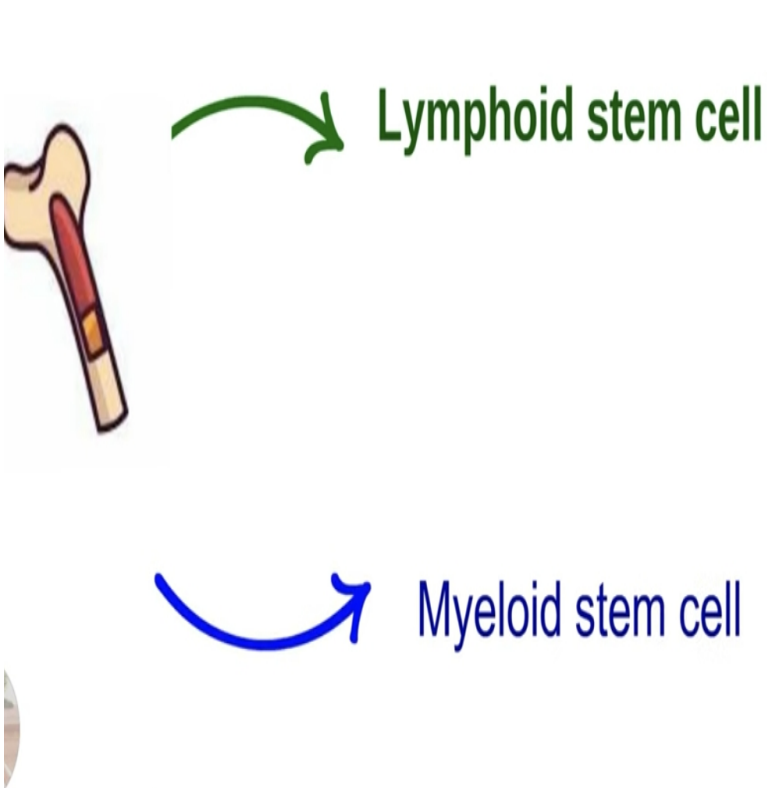
2- Cell-mediated (or cellular) immunity.

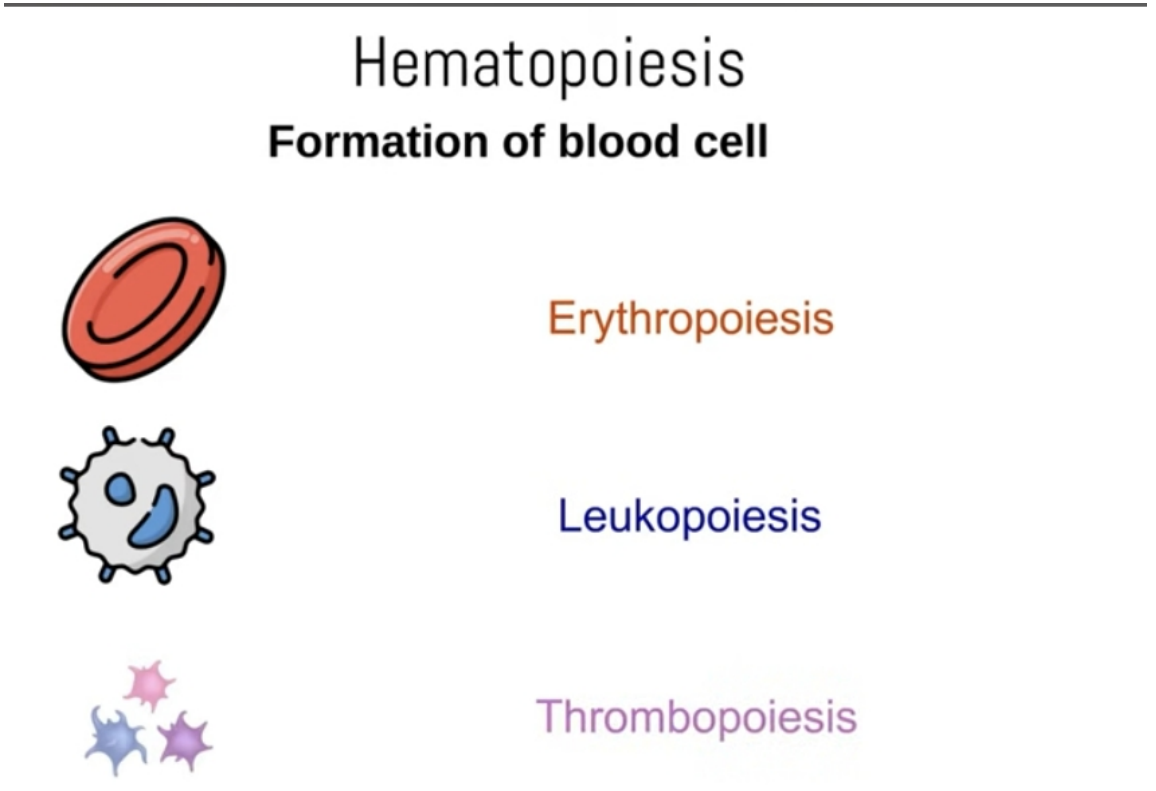
Origin in of Immune system:

the bone marrow ➡️hematopoietic stem cells.

Bone marrow ➡️ It results in:

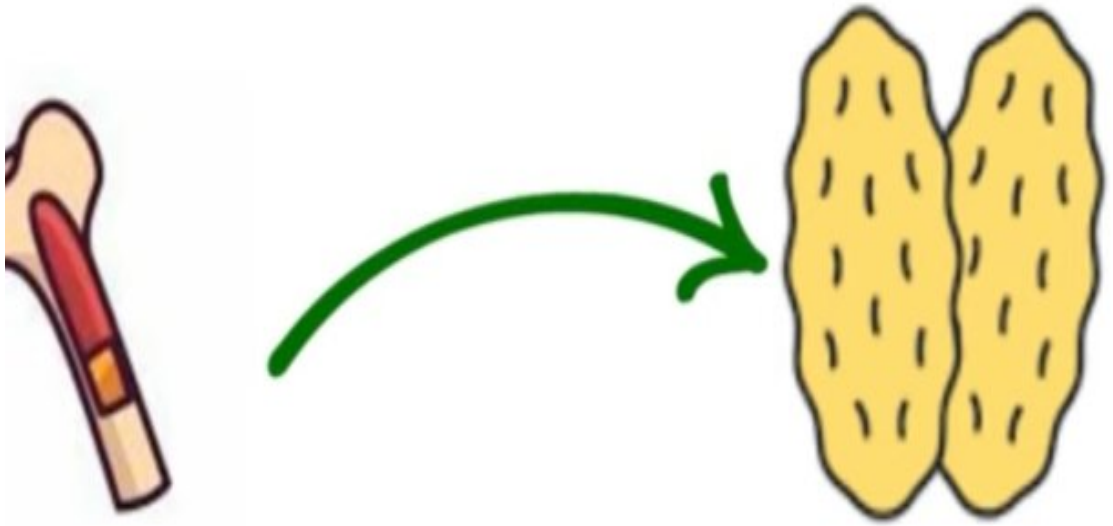
1. Lymphoid stem cells
2. myeliod stem cells





T -cell

Maturation



T helper CD4+

Cytotoxic T cell CD8+

Cells of the immune system:

Lymphocytes

present in the circulation and in various lymphoid organs as two types:

- T lymphocytes(mature in the thymus).
- B lymphocytes(mature in the bone marrow).

Each T or B lymphocyte expresses receptors for a *single antigen*, and the total population of lymphocytes (numbering about 10^{12} in humans) is capable of recognizing *tens or hundreds* of millions of antigens

T Lymphocytes:

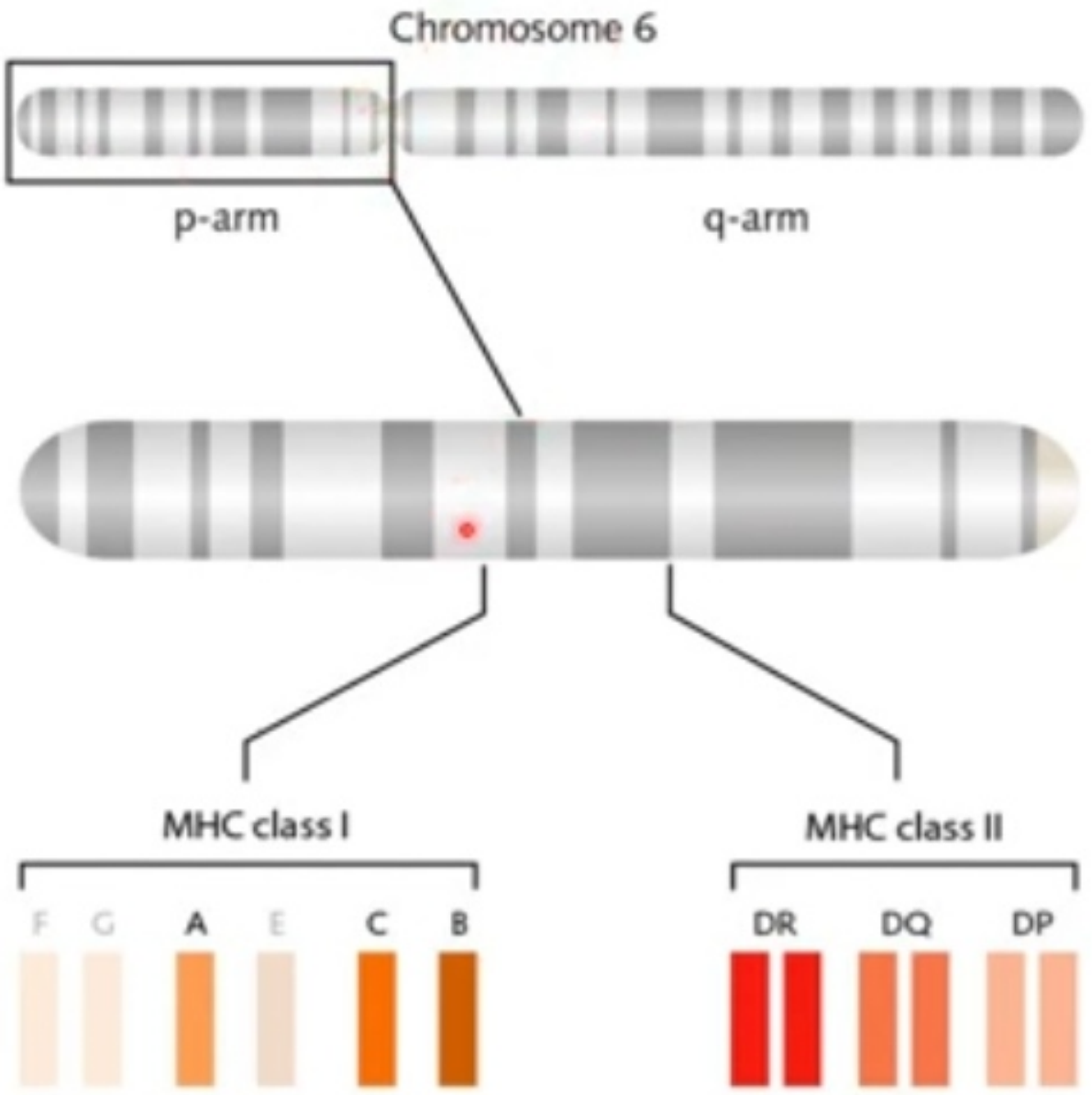
- Effector cells of cellular immunity.
- Provide important stimuli for antibody responses to protein antigens.
- T cells do not detect free or circulating antigens. Instead, the vast majority (>95%) express antigen receptors called T cell receptors (TCRs) that recognize only protein antigens that are displayed on other cells bound to proteins of the major histocompatibility complex (MHC; or human leukocyte antigen [HLA] complex).

- The normal function of **MHC** molecules is to display protein for recognition by T lymphocytes thus perform their function of killing infected cells or activating phagocytes or B lymphocytes that have ingested protein antigens.

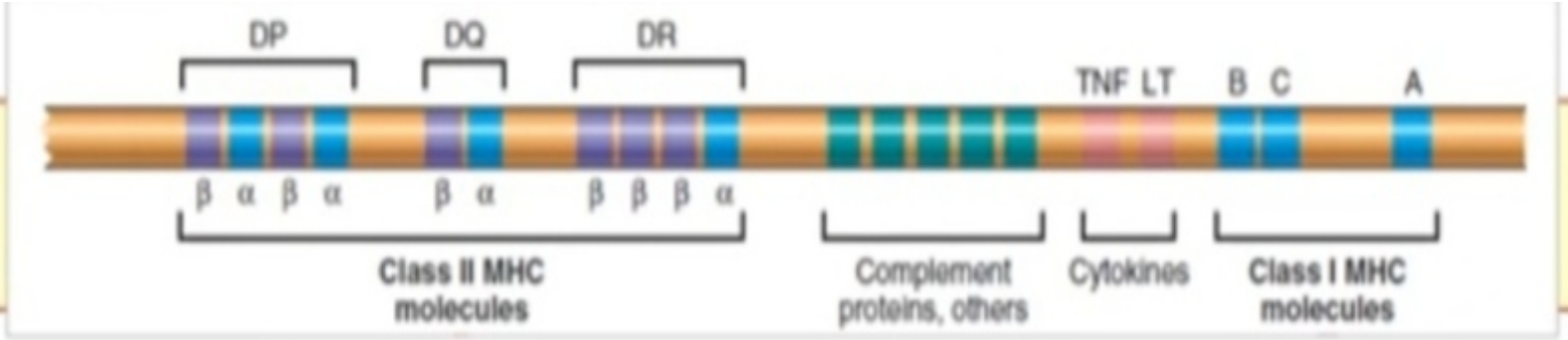
MHC = Major Histocompatibility Complex

- ..was **discovered** on the basis of studies of graft rejection and acceptance (tissue, or "histo-" compatibility).
- In humans, it is called HLA (Human Leukocyte Antigen)

- **Structure**: protein molecules..
- The **function** of HLA (MHC) molecules is to display peptides for recognition by CD4+ and CD8+ T lymphocytes.

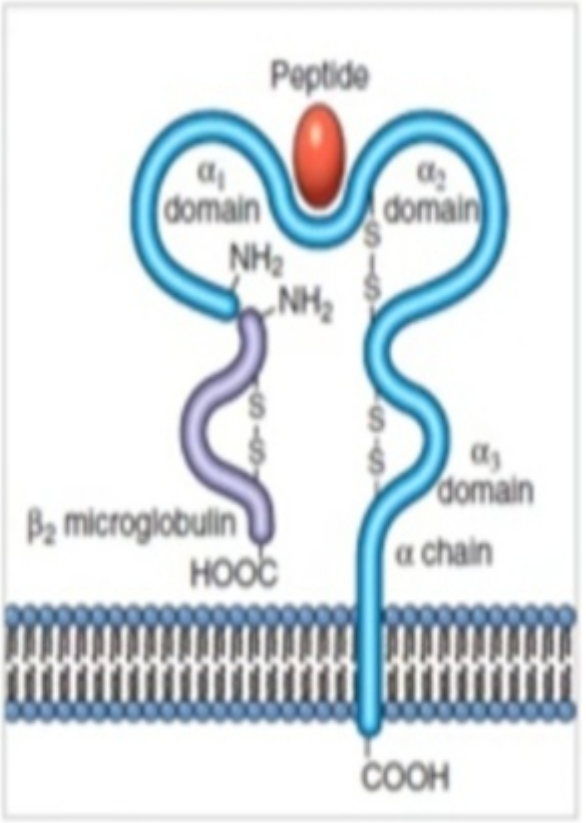

Chromosome 6
p-arm
q-arm
MHC class I
F
G
A
E
C
B
MHC class II
DR
DQ
DP

MHC

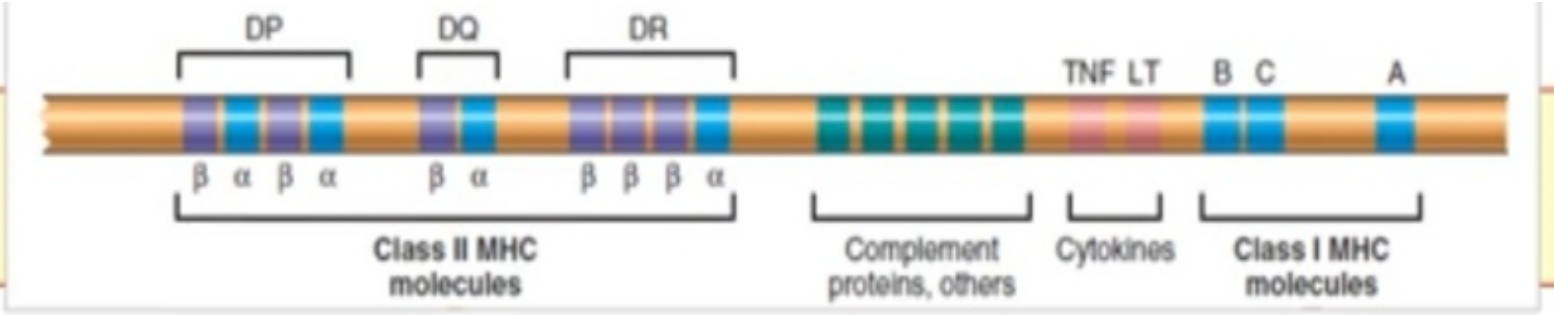


MHC gene products fall into **two main categories**:

- **Class I MHC** molecules are expressed on **all nucleated cells** and are HLA-A, HLA-B, and HLA-C.
- The extracellular portion binds CD8, ensuring that only CD8+ T cells can respond to peptides displayed by class I molecules.
- ..**bind** peptides derived from protein antigens present in the cytosol of the cell (e.g., viral and tumor antigens).

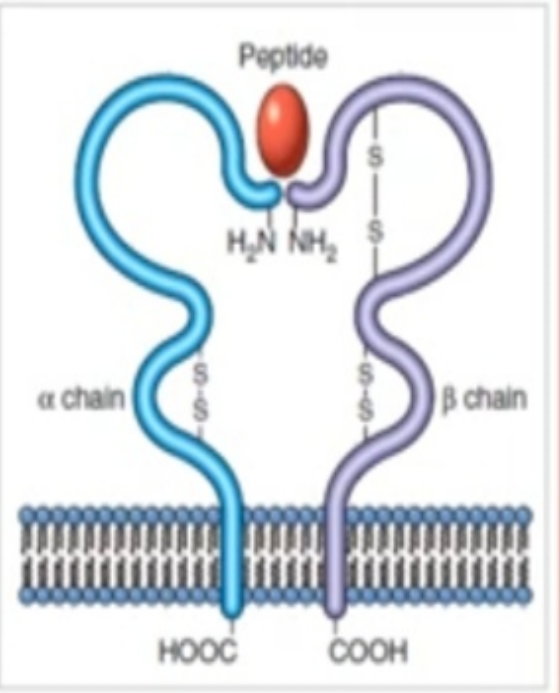


MHC



MHC gene products fall into **two main categories**:

- **Class II MHC** molecules contains three subregions: DP, DQ, and DR.
- Expression is by **APCs** (notably, dendritic cells), **macrophages**, and **B cells**.
- The extracellular portion binds CD4.
- ..**bind** peptides derived from proteins synthesized outside the cell, for example, from microbes that are ingested and then broken down inside the cell.



Class I : 1*8 = 8

Class II : 2*4 = 8

Differences between MHC Class I and Class II

MHC class I	MHC class II
Comprised of MHC-encoded a chain and a b2-microglobulin chain	Comprised of an MHC-encoded a and b chain
Present on most cells	Present only on antigen-presenting cells
Bind endogenous antigens synthesized in a cell	Binds exogenous antigens
Present antigen to cytotoxic T cell lymphocytes	Present antigen to helper T cell lymphocytes
Bind CD8 adhesion molecules on cytotoxic T cells	Bind CD4 adhesion molecules on helper T cell
Presence of foreign or over-abundant antigens targets cell for destruction	Presence of foreign antigens induces antibody production, and attracts immune cells to area of infection

Depending on the presence of a specific membrane glycoprotein receptors on T cell surface, they are subdivided into:

1. CD4+ T cells (T helper cells)

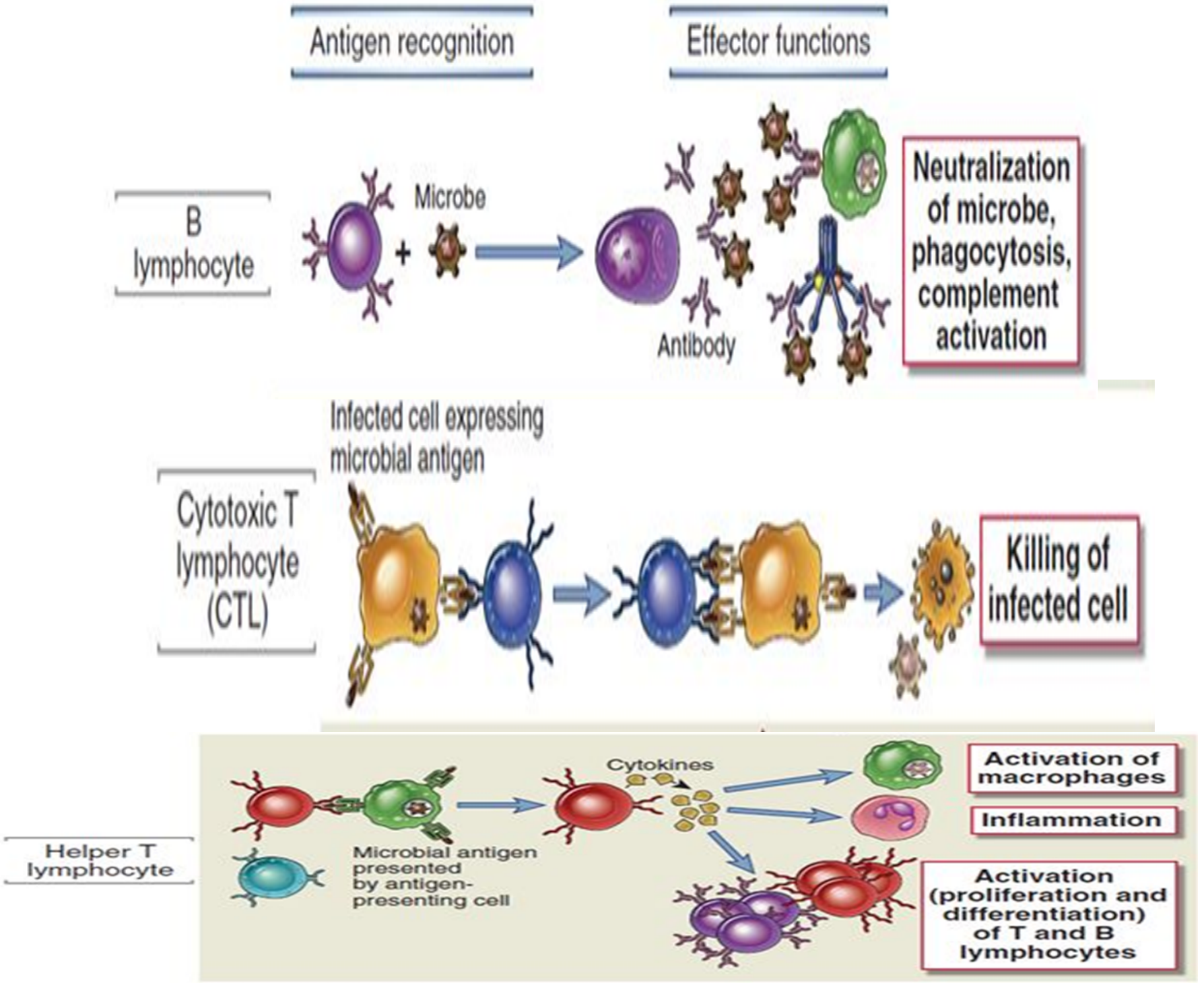
- Constitute **60%** of T cells.
- Express **CD4+** molecule on cell surface.
- Binds to **class II MHC** on the surface of antigen presenting cell.
- "helper" T cells because they secrete soluble molecules (cytokines) that help B cells to produce antibodies, and also help NK cells and macrophages to destroy phagocytized microbes.

2. CD8+ T cells (Cytotoxic T cells)

- Constitute **40%** of T cells.
- They express **CD8+** molecule on their surface.
- Bind to **class I MHC** molecule.
- CD8+ T cells can also secrete cytokines, but they play a more important role in **directly killing virus infected or tumor cells**.

B Lymphocytes

- lymphocytes express membrane- bound antibodies that recognize a wide variety of antigens.
- B cells are activated to become plasma cells, which secrete antibodies or immunoglobulines=Ig = five classes: IgG, IgM, IgA, IgE and IgD.


Antigen recognition
Effector functions
B lymphocyte
Microbe
Antibody
Neutralization of microbe, phagocytosis, complement activation
Infected cell expressing microbial antigen
Cytotoxic T lymphocyte (CTL)
Killing of infected cell
Helper T lymphocyte
Cytokines
Microbial antigen presented by antigen-presenting cell
Activation of macrophages
Inflammation
Activation (proliferation and differentiation) of T and B lymphocytes

Natural Killer Cells

- Lymphocytes of innate immunity which have **limited set of activating receptors** so they do not have specificities as diverse as do T cells or B cells.
- They can recognize molecules expressed on **stressed** or **infected** cells or cells with **DNA damage**, and then kill these cells.
- NK cells express **inhibitory receptors** that recognize self class I MHC molecules, which are expressed on all healthy cells; so they avoid attacking normal host cells.
- Infections (especially viral infections) and stress are associated with loss of expression of class I MHC molecules so NK cells are released from their inhibition and destroy the unhealthy host cells.

B-Antigen-Presenting Cells

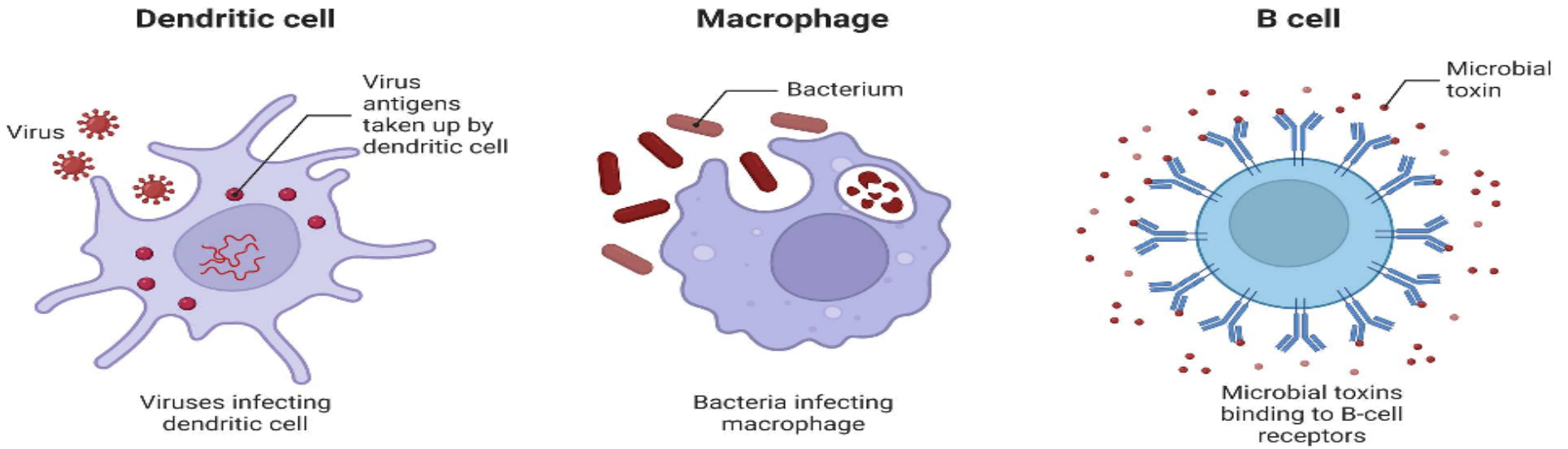
These cells are specialized to capture microbial antigens and display them to lymphocytes.

1-Dendritic Cells

Cells with fine dendritic cytoplasmic processes occur as two functionally distinct types.

2-Macrophages:

Ingest microbes and other particulate antigens and display them for recognition by T lymphocytes which in turn activate the macrophages to kill the microbes, the central reaction of cell- mediated immunity.



Thank you...