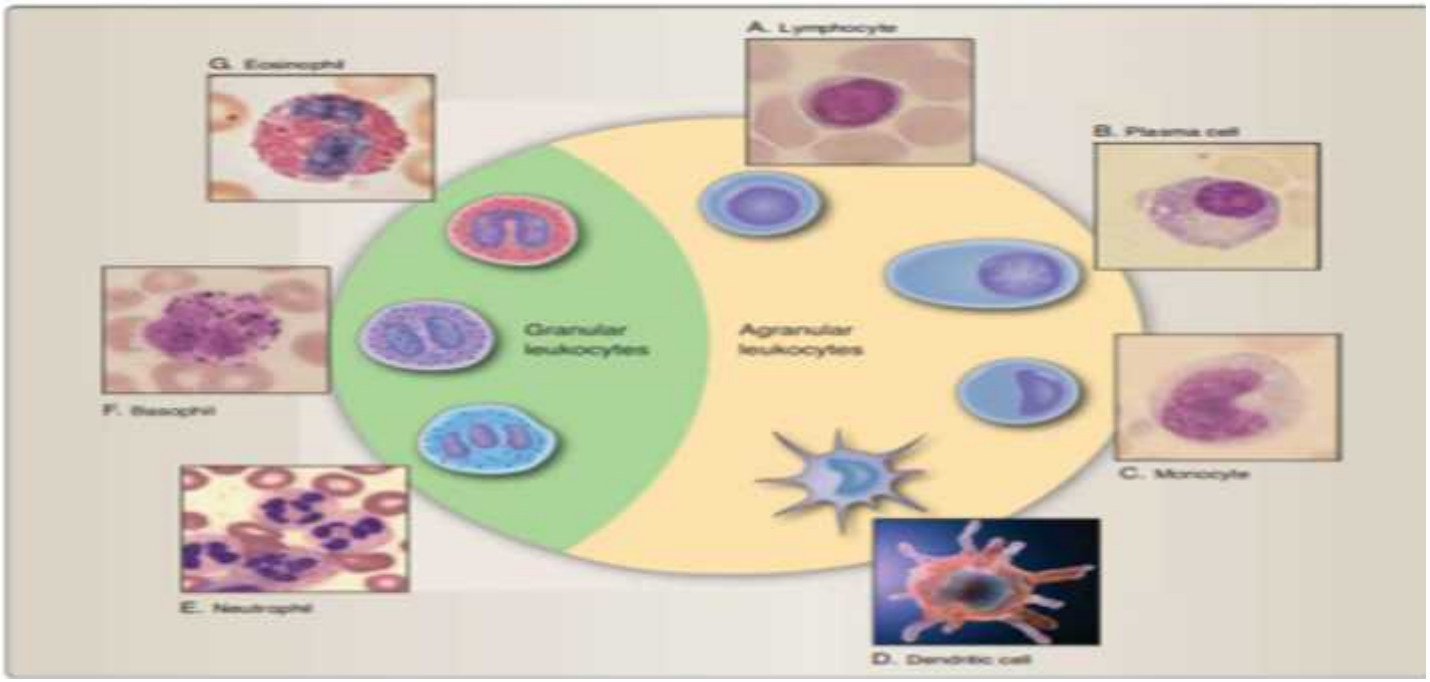
Lecture …… 2

Components of immune system

[Cells of immune system]



By T.A. Noor AL-huda

content the lecture:

1-Origin of immune system cells

2-Myeloid progenitor cells .

3-Lymphoid progenitor cells.

4-major histocompatibility complex (MHC) .

Origin of immune system cells

All components of the blood, including immune cells are originated from hematopoietic stem cells derived from bone marrow; these cells are highly differentiated into progenitor cells to give different blood cells. The formation and development of hematopoietic stem cells begins in the early embryonic stages, lately these cells migration to liver, spleen, and differentiated in bone marrow in one of two pathways as shown that in the **figure (1)**.

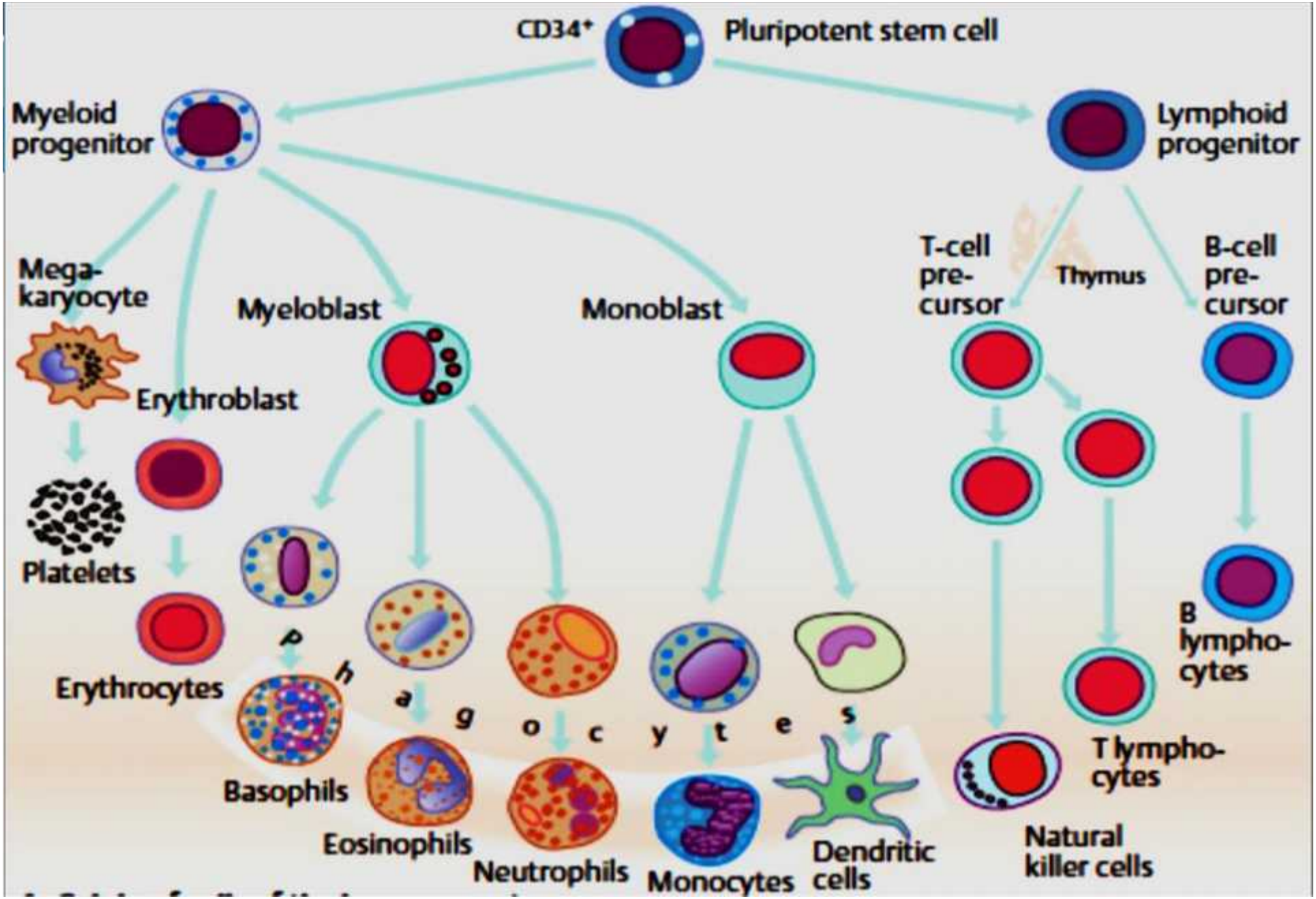

CD34+
Pluripotent stem cell
Myeloid progenitor
Lymphoid progenitor
Mega-karyocyte
Erythroblast
Myeloblast
Monoblast
T-cell pre-cursor
Thymus
B-cell pre-cursor
Platelets
Erythrocytes
Basophils
Eosinophils
Neutrophils
Monocytes
Dendritic cells
Natural killer cells
T lympho-cytes
B lympho-cytes

figure (1)

1- Myeloid progenitor cells can differentiate into:

- Megakaryocytes, which are differentiated into platelets involved in blood clotting(also called thrombocytes).
- Erythroblasts, which are multiply and differentiated into.

erythrocytes - red blood cell (RBCs), carry oxygen & carbon dioxide in the blood .

- **Myeloid cells are development into two kinds of phagocyte cells:**

1. Myeloblasts, which can differentiate into Granulocytes cells (PMNs) can be divided into neutrophils, basophils, and eosinophils according to cytoplasmic granules respond to different dyes.

Granulocytes

Leukocytes that contain cytoplasmic granules are known as granulocytes.

A. Neutrophils are a very important component of our innate host defenses, and severe bacterial infections occur if they are too few in number (neutropenia) or are deficient in function, as in chronic granulomatous disease. neutrophils are the most numerous leukocyte population. They are also called polymorph nuclear (PMN) cells because of their variable number of nuclear segments (two to five) .

With a half-life of approximately 7 hours.

Neutrophils are very effective at killing bacteria. An increase in the number of peripheral blood neutrophils is often an indication of acute infection.

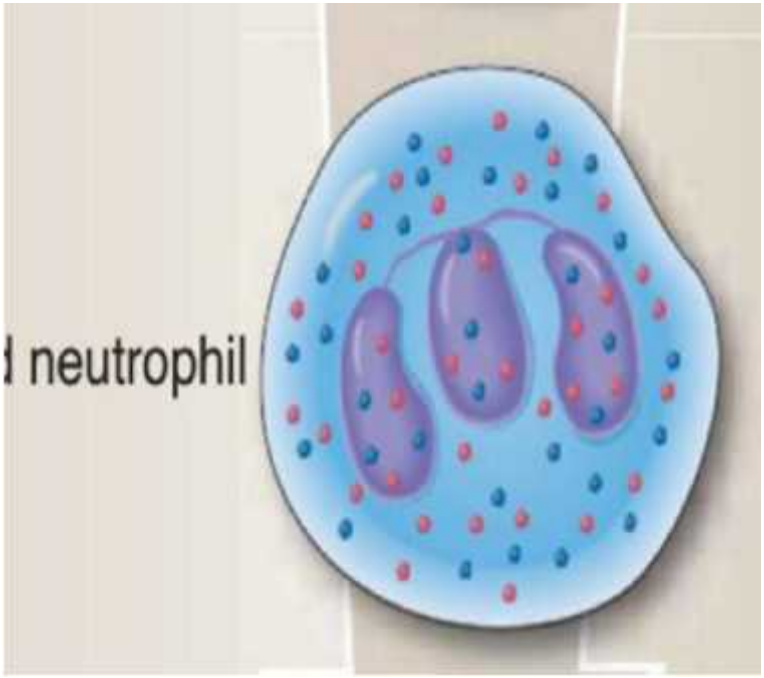


Figure2 : Neutrophils are the most numerous leukocytes and play a vital role in policing the body against microbial invasion.

B. Basophils and mast cells The acidic cytoplasmic granules of basophils contain vasoactive amines (e.g., histamine) that cause smooth muscle contraction and appear blue when stained with Wright stain. The blue color is caused by the positively charged methylene blue dye binding to several negatively charged molecules in the granules. Basophils circulate in the bloodstream, whereas mast cells, which are similar to basophils in many ways, are fixed in tissue, especially under the skin and in the mucosa of the respiratory and GI tracts. Both basophils and mast cells are important in allergic reactions of the adaptive immune response .

C. Eosinophils Eosinophils are white blood cells with cytoplasmic "eosin-loving" granules that appear red when stained with(eosin is a dye used in histology). The red color is caused by the negatively charged eosin dye binding to the positively charged major basic protein in the granules.

The eosinophil count is elevated in two medically important types of diseases: parasitic diseases, especially those caused by nematodes ,and hypersensitivity diseases, such as asthma .Diseases caused by protozoa are typically not characterized by eosinophilia.

Figure 3 Basophils. Release of their cytoplasmic granules (degranulation) disseminates vasoactive amines and other molecules associated with allergic reactions.

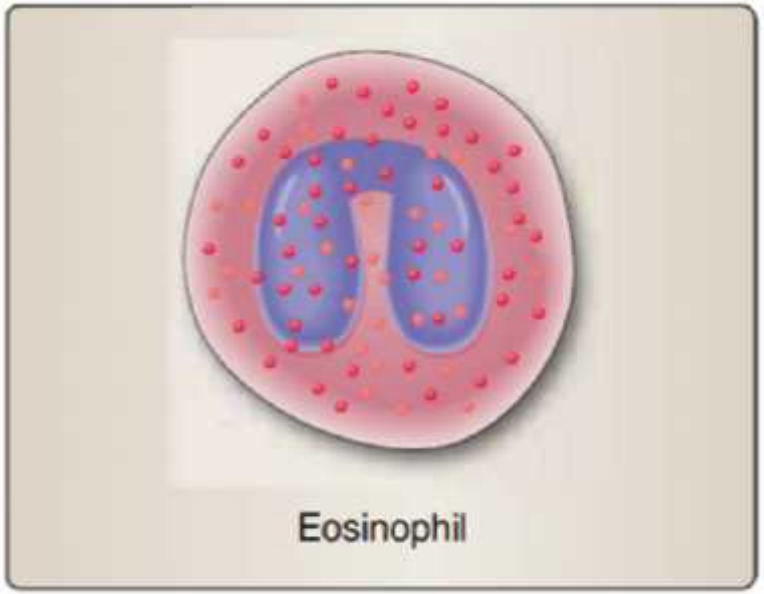


Figure 4 Eosinophils. Release of cytoplasmic granules by eosinophils provides molecules that are potent weapons against parasitic worms.

A granulocytes –Monocytes-Lymphocytes -

2.Monoblasts, which can differentiate into monocyte and dendritic cells.

Mononuclear cells that differentiate from myeloid precursors are known as monocytes in the circulation or macrophages once they leave the circulation and enter the tissues. These cells are the scavengers of the body. They **phagocytize** cellular debris, foreign cells, and particles and degrade them enzymatically. Another group of phagocytic cells with both myeloid and lymphoid origins is collectively known as dendritic cells.

1. Monocytes and macrophages: Monocytes are large mononuclear cells and account for approximately 5% to 7% of the leukocytes in the peripheral blood .Monocytes spend 1 to 2 days in the circulation (their half-life is approximately 8.4 hours) , then cross the endothelium to enter tissues throughout the body, where they reside for up to several months as macrophages. Both monocytes and macrophages actively sample their environment by phagocytosis and serve as scavengers to remove cellular debris. Ingested materials are enzymatically degraded.

2. Dendritic cells: Found throughout the body but predominantly in potential portals of microbial entry (e.g., skin, lung, gastrointestinal tract), these cells are named for their branchlike cytoplasmic projections .Like other phagocytes, dendritic cells actively engulf cells and particles in their environment by phagocytosis. As actively phagocytic cells, dendritic cells are important in innate immune defenses.

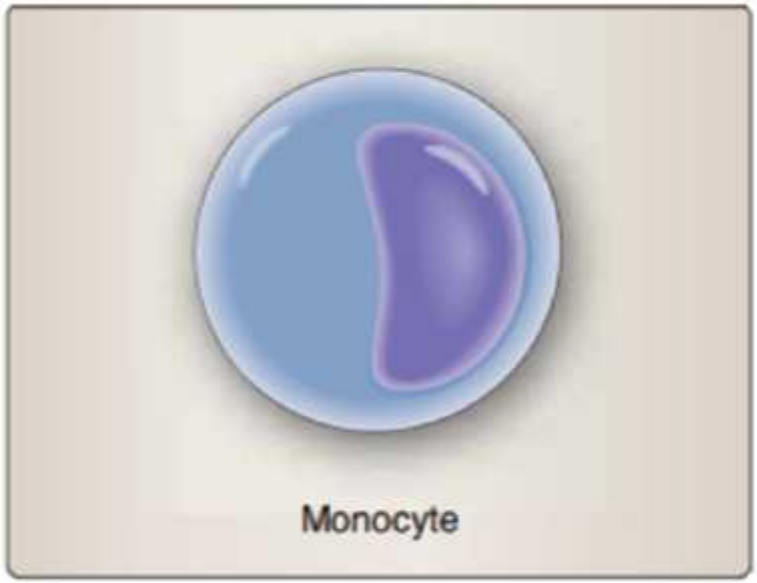


Figure 5 :Monocytes. Circulating mononuclear phagocy1es are called monocy1es. When they leave the circulation and enter tissues they are called macrophages.

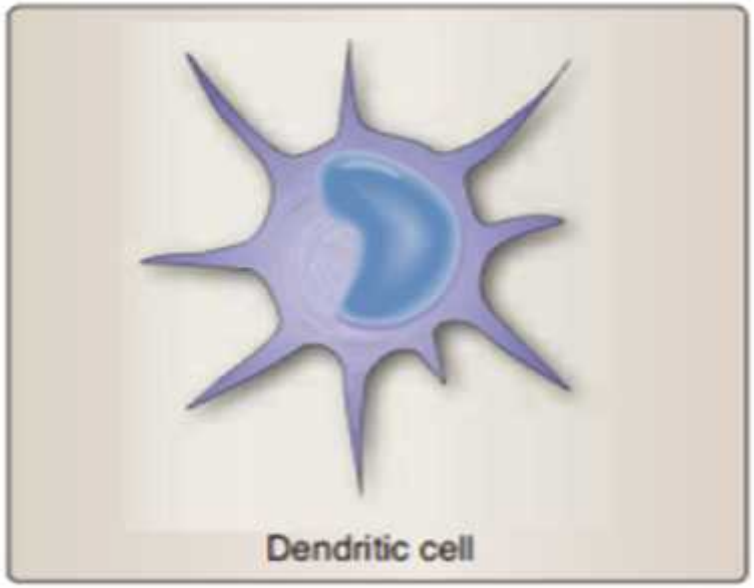


Figure 6 :Dendritic cells. As professional phagocytes, dendritic cells use their cytoplasmic extensions to sample their environment.

2- Lymphoid progenitor can be differentiating into:

- T-lymphocytes, which are responsible for the cellular immune response.
- B-lymphocytes, which produce antibodies (humoral immune response).
- Natural killer cells (NKs).

The Lymphocytes cells

Lymphocytes are one of white blood cells classes; derived from stems cells and maturate either in the bone marrow or thymus; comprise 20-40% of all leukocytes, distributed into blood, lymph and lymphoid organs. Typically, it divide in three major types of lymphocyte, B lymphocyte, T lymphocyte and NK cells. Different lymphocytes are identified by protein markers on their surface called "cluster of differentiation" or "CD".

1-T- Lymphocyte:

- "T-cell" is an abbreviation of "thymus dependent lymphocyte". it arise in the bone marrow as T-cell precursors, then migrate and passage through the thymus as pre thymocytes to complete their maturation which includes rearrangements and coding of the variable part of the TCR (T Cell Receptor) by enzymes and hormones activity.
- TCRs are dividing into CD8 or CD4 surface molecules. It require to react with many receptors include antigens receptors, Fc fragment of antibodies, and Virus receptor.

There are two major types of T cells:

Helper T cells (TH):

1- Are identified by the presence of CD4 marker.

2-They recognize antigen when presented along with Class II MHC molecules.

3- They are subdivided into the TH1 and TH2 subsets on the basis of the kinds of cytokines they produce. TH1 cells produce interleukin-2 (IL-2), interferon-gamma (IFNγ), and tumor necrosis factor-beta (TNF-β) while TH2 cells produce IL-4, IL-5, IL6, IL-10 and TGF-β.

4- They are promotes differentiation of B-cells and cytotoxic T-cells, Activates macrophages, and secrete cytokines.

Cytotoxic/Suppressor T cells (TC):

1- Are identified by the presence of CD8 marker.

2- They recognize antigen when presented along with Class I MHC molecules.

3- They have a role in down regulation of immune response, and Kill infected cells.

B - Lymphocyte:

- Naming and maturation: They are called B cells; because they were found in bursa of birds. But in human, they are developed and mature occurs in bone marrow that equivalent to bursa.

The early stages of B cell maturation occur in the fetal liver and continue in the bone marrow throughout life. The stages in B cell development in the bone marrow are:

Stem cell → pro-B cell → pre-B cell → immature B cell → mature B cell.

•Surface markers: The most important surface markers on the surface of mature B cell are: CD32 (receptor of Immunoglobulin), CD35 (Receptor for complement component), and markers that distinguish B cells such as CD20, CD21 and CD22.

•Functions of B-cells:

1- Direct recognition and presentation of antigen.

2- Secrete large amounts of antibodies after differentiation into plasma cells.

C-Natural Killer cells

NK cells are lymphocytes with some T-cell markers, but they do not have to pass through the thymus in order to mature. They have no immunologic memory and, unlike cytotoxic T cells, have no TCR; also, killing does not require recognition of MHC proteins. In fact, NK cells have receptors that detect the presence of class I MHC proteins on the cell surface.

NK cells play two important roles in our innate host defenses: (1) they kill virus-infected cells, and (2) they produce gamma interferon that activates macrophages to kill bacteria ingested by the macrophage

major histocompatibility complex (MHC)

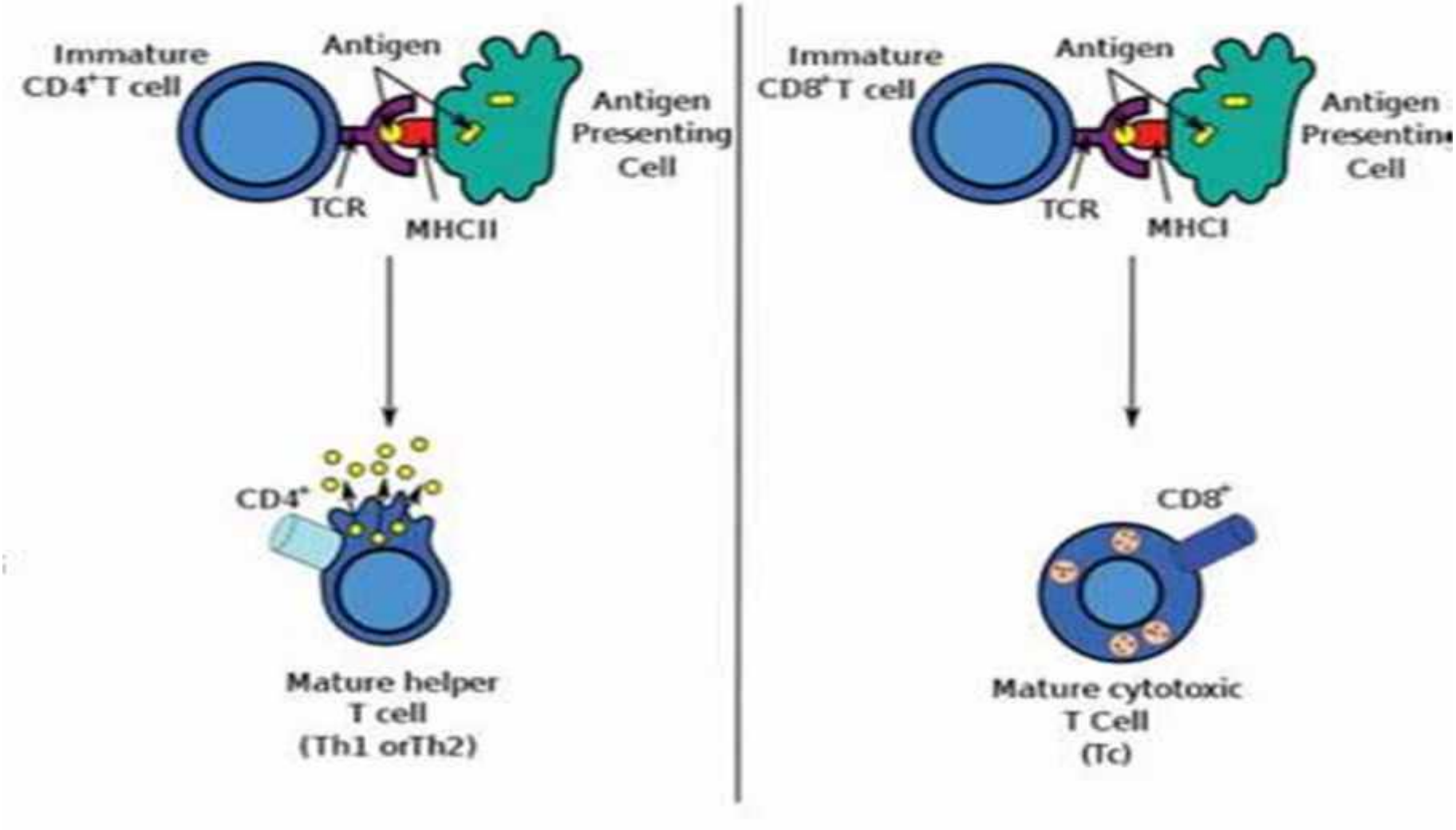
The major histocompatibility complex (MHC) is a set of cell surface proteins essential for the acquired immune system to recognize foreign molecules, which in turn determines histocompatibility.

The main function of MHC molecules is to :

- bind to Ag. derived from pathogens
- display them on the cell surface for recognition by the appropriate T cell
- Bind only to peptide Ag.

• MHC class II found on professional antigen-presenting cells (APCs): macrophages, B cells, and especially dendritic cells (DCs)

• MHC class I occurs on all nucleated cells . It presents epitopes to killer T cells, also called cytotoxic T lymphocytes (CTLs). A CTL expresses CD8 receptors, in addition to TCRs. When a CTL's CD8 receptor docks to a MHC class I molecule, if the CTL's TCR fits the epitope within the MHC class I molecule, the CTL triggers the cell to undergo programmed cell death by apoptosis.


Immature
CD4+T cell
Antigen
Antigen
Presenting
Cell
TCR
MHCII
CD4+
Mature helper
T cell
(Th1 orTh2)
Immature
CD8+T cell
Antigen
Antigen
Presentin
Cell
TCR
MHCI
CD8+
Mature cytotoxic
T Cell
(Tc)

Questions!

Thank You !