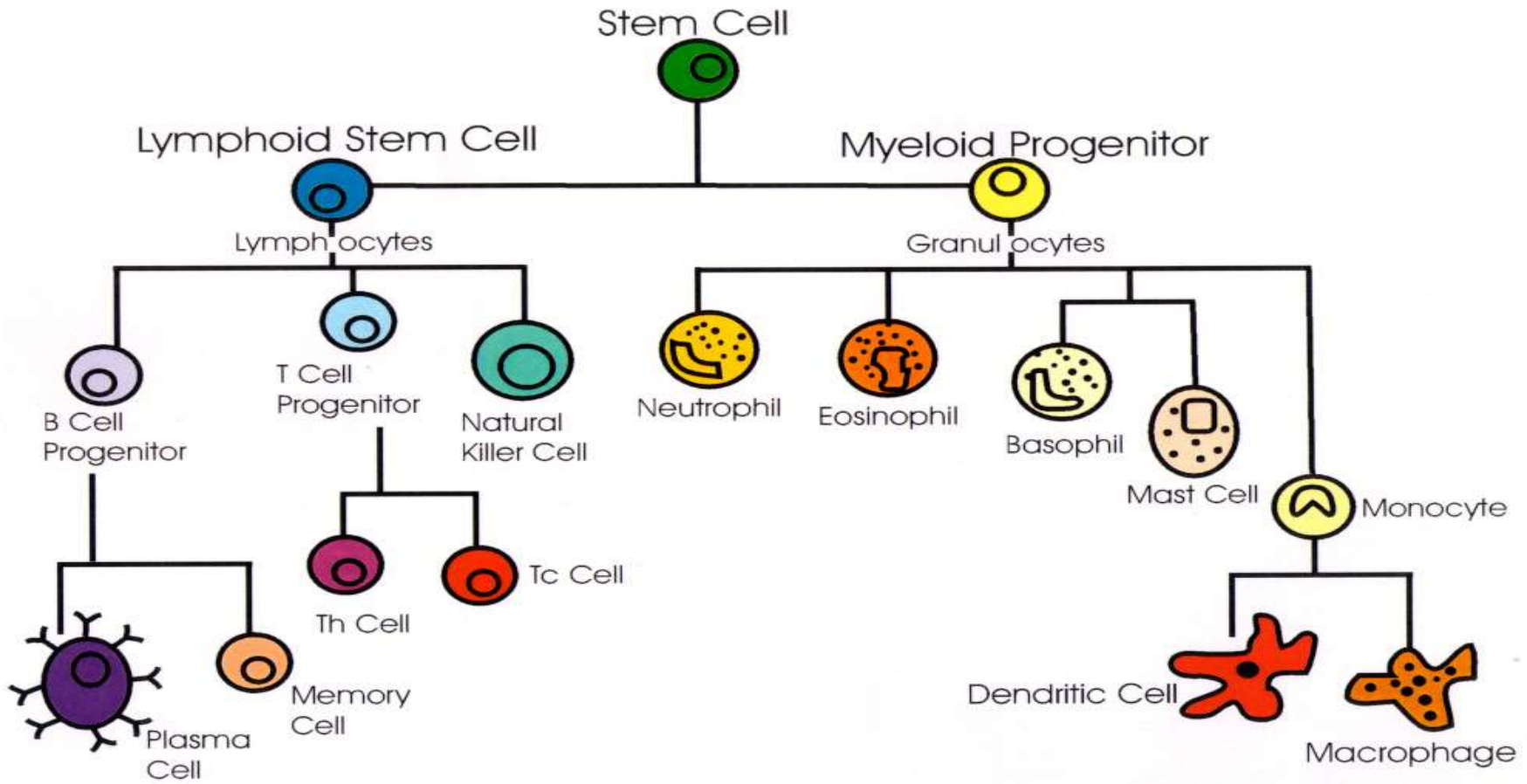
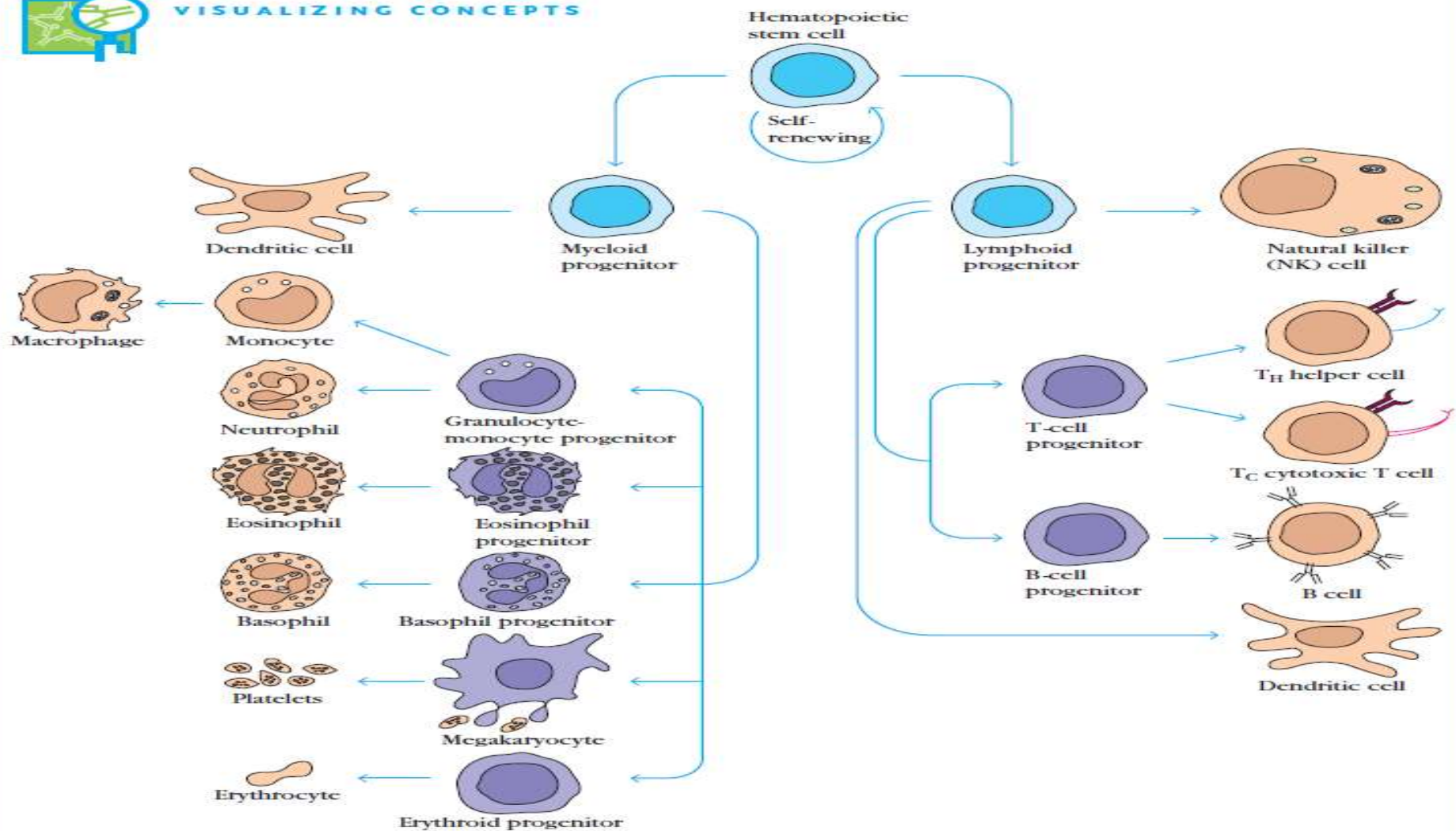


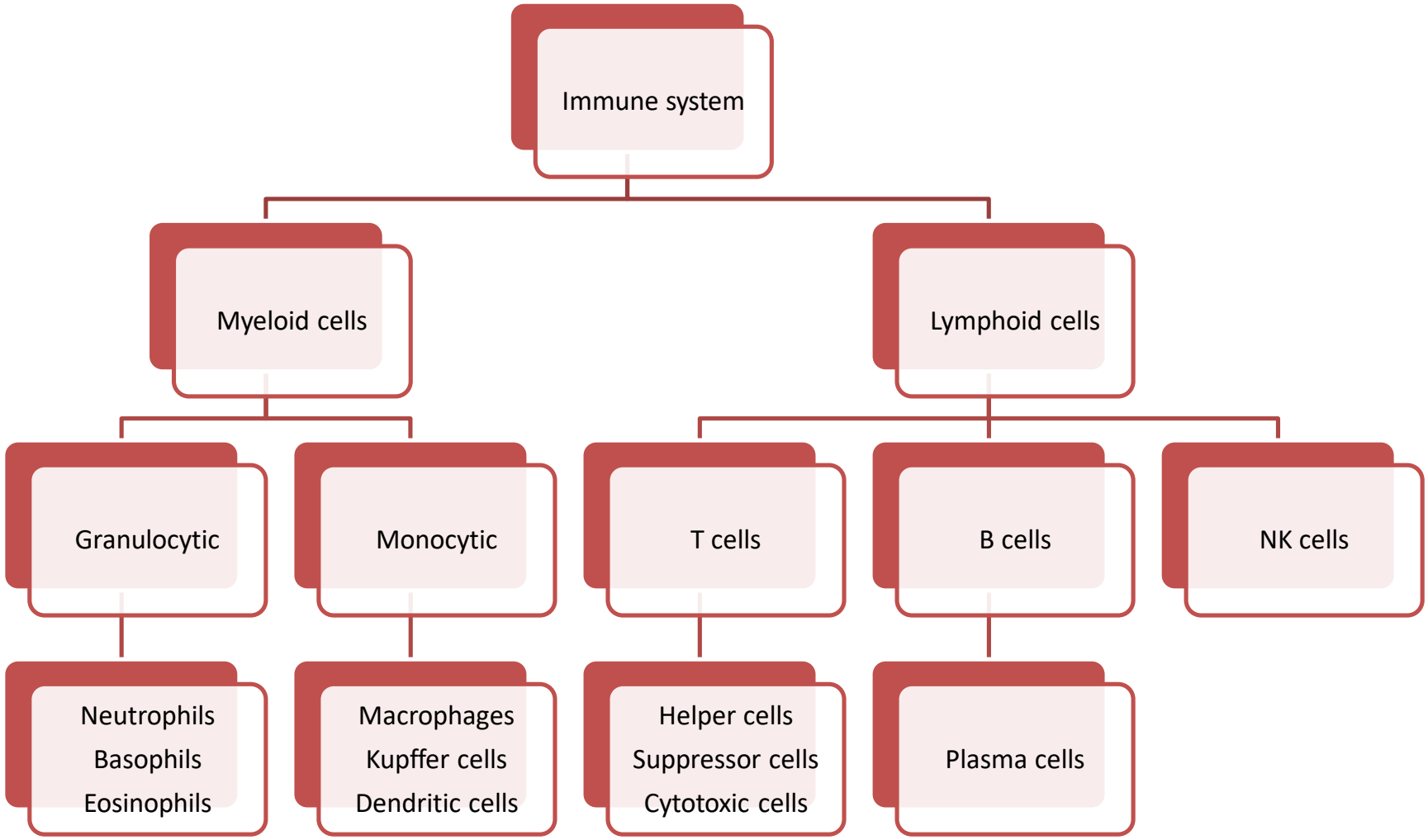
Cells of Immune System

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Cells of the Immune System





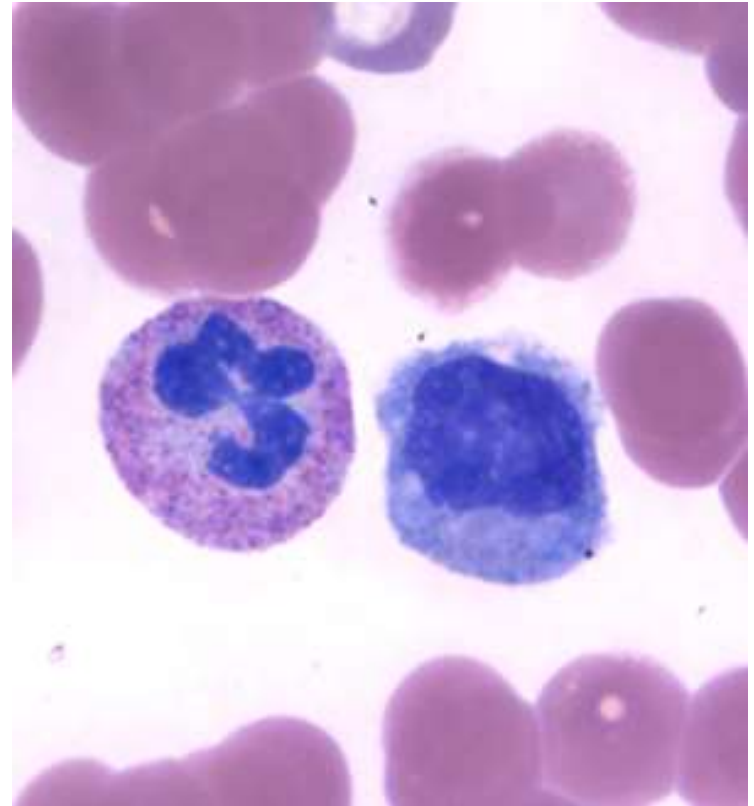


Cells of Innate Immune System

- Phagocytes
 - PMNs/neutrophils
 - Monocytes/macrophages
- NK cells
- Basophils and mast cells
- Eosinophils
- Platelets

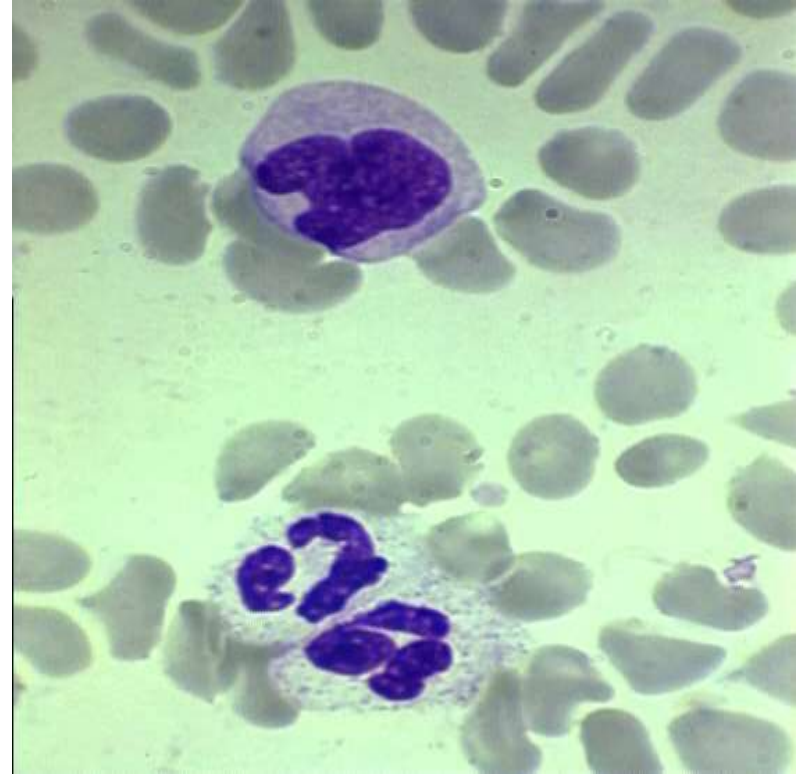
Neutrophils

- Most abundant type of white blood corpuscles in mammals.
- Characteristic polymorphic nucleus and cytoplasm
- Neutrophils are phagocytic cells
- In the beginning of bacterial infection, neutrophils are one of the first to migrate towards the site of inflammation.
- Forms first line of defense.



Macrophages

- Literally, “large eaters.”
- These are large, long-lived phagocytes
- In this manner, they present the antigens to the T cells.
- Macrophages are strategically located in lymphoid tissues, connective tissues and body cavities, where they are likely to encounter antigens.
- They also act as effector cells in cell-mediated immunity.
- Act as Antigen Presenting Cells (APCs).



Tissue specific differentiation:

- Alveolar macrophages : lung
- Histiocytes : connective tissues
- **Kupffer cells** : **liver**
- Mesangial cells : kidney
- Microglial cells : brain
- Osteoclasts : bone

TABLE 2-6**Mediators of antimicrobial and cytotoxic activity of macrophages and neutrophils****Oxygen-dependent killing**

Reactive oxygen intermediates

 $O_2^{\cdot -}$ (superoxide anion) OH^{\cdot} (hydroxyl radicals) H_2O_2 (hydrogen peroxide) ClO^- (hypochlorite anion)

Reactive nitrogen intermediates

NO (nitric oxide)

 NO_2 (nitrogen dioxide) HNO_2 (nitrous acid)

Others

 NH_2CL (monochloramine)**Oxygen-independent killing**

Defensins

Tumor necrosis factor α
(macrophage only)

Lysozyme

Hydrolytic enzymes

NK cells

- T lymphocytes which do not have/ bear either CD 4 or CD 8 markers are called NK cells.
- Also known as large granular lymphocytes (LGL).
- Kill virus-infected or transformed cells.
- Identified by the CD56+/CD16+/CD3-
- Activated by IL-2 and IFN- γ to become **lymphokine activated killer (LAK) cells**.

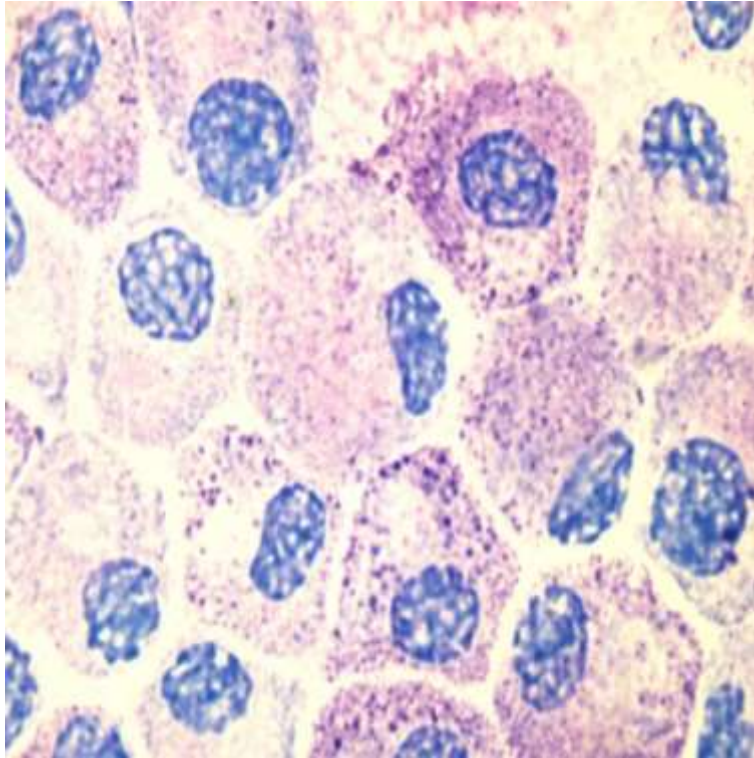


Eosinophils



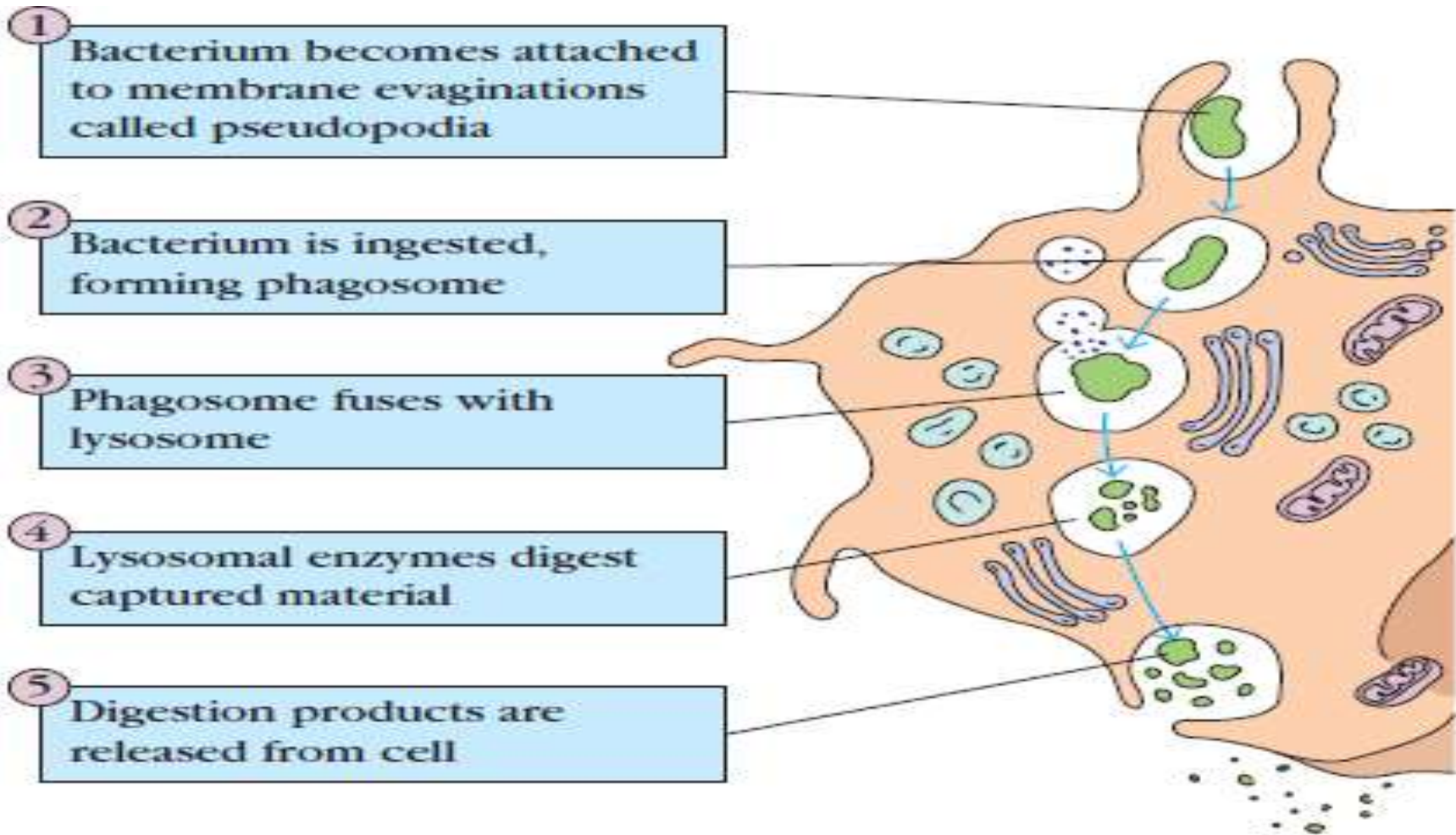
- Have characteristic bi-lobed nucleus.
- Cytoplasmic granules, stain with acidic dyes (eosin), contains
 - Major basic protein (MBP)
 - Potent toxin for helminths
- Kill parasitic worms

Mast Cell



- Large number of mast cells are present within the respiratory and gastrointestinal tracts
- Also within the deep layers of the skin
- Release **histamine** upon encountering certain antigens, thereby triggering an allergic reaction.
- Role in immunity against parasites

Process of Phagocytosis



Cells of Adaptive Immune Response

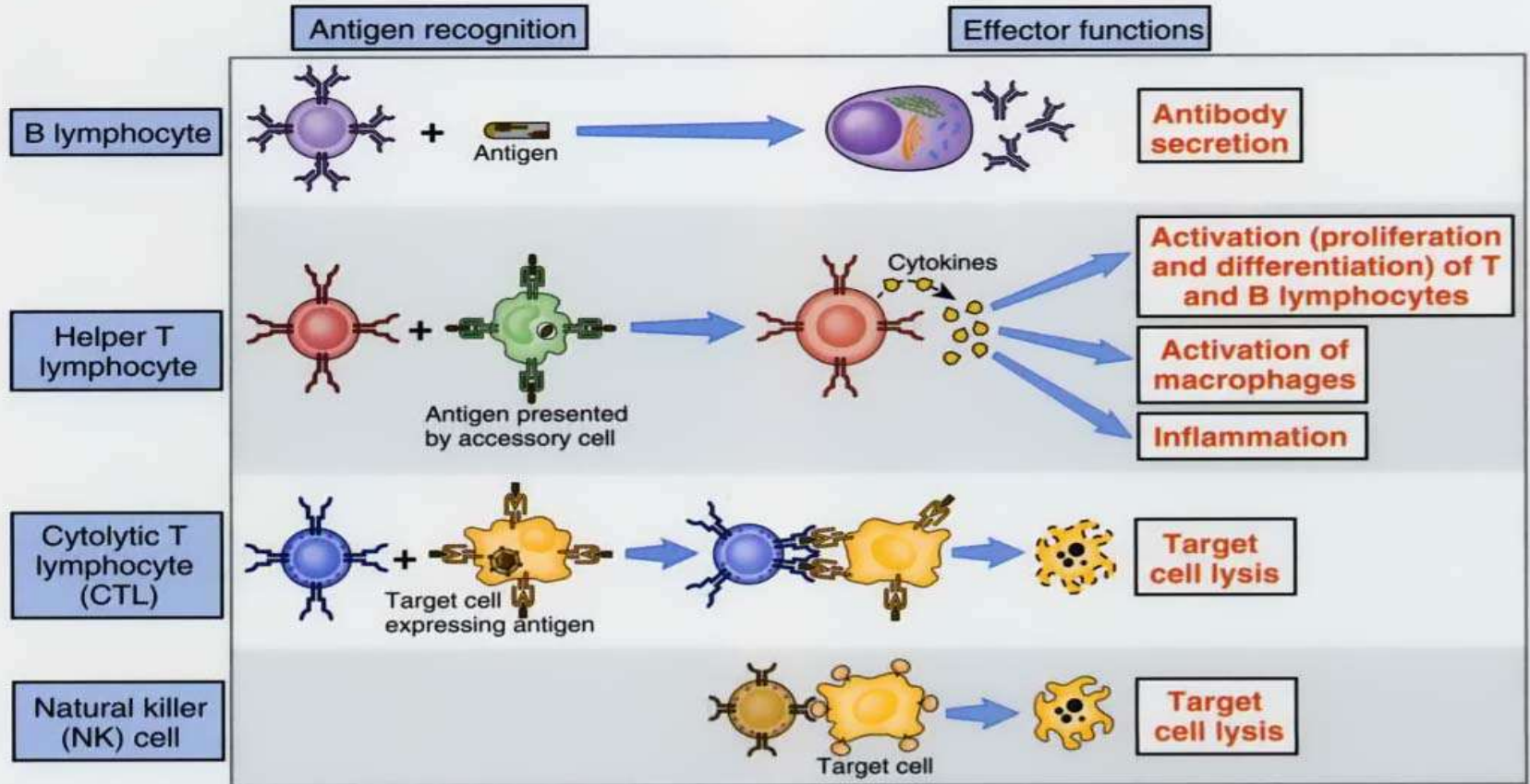
Cells of adaptive immune response

- Lymphocytes
 - B cells
 - Plasma cells (Ab producing)
 - B-memory Cells
 - T cells
 - Cytotoxic (CTL)
 - Helper (Th)
 - Th1
 - Th2

Lymphocytes

- Mature lymphocytes are small cells with a large nucleus and scanty cytoplasm.
- There are two broad sub-types of lymphocyte known as **B cells** and **T cells**.
- All of them are derived from the bone marrow.
- In most of the mammals, B cells mature in Bone marrow itself whereas T cells undergo a process of maturation in the thymus .
- B and T cells circulate in the blood and through body tissues.

Lymphocyte Classes



Lymphocytes

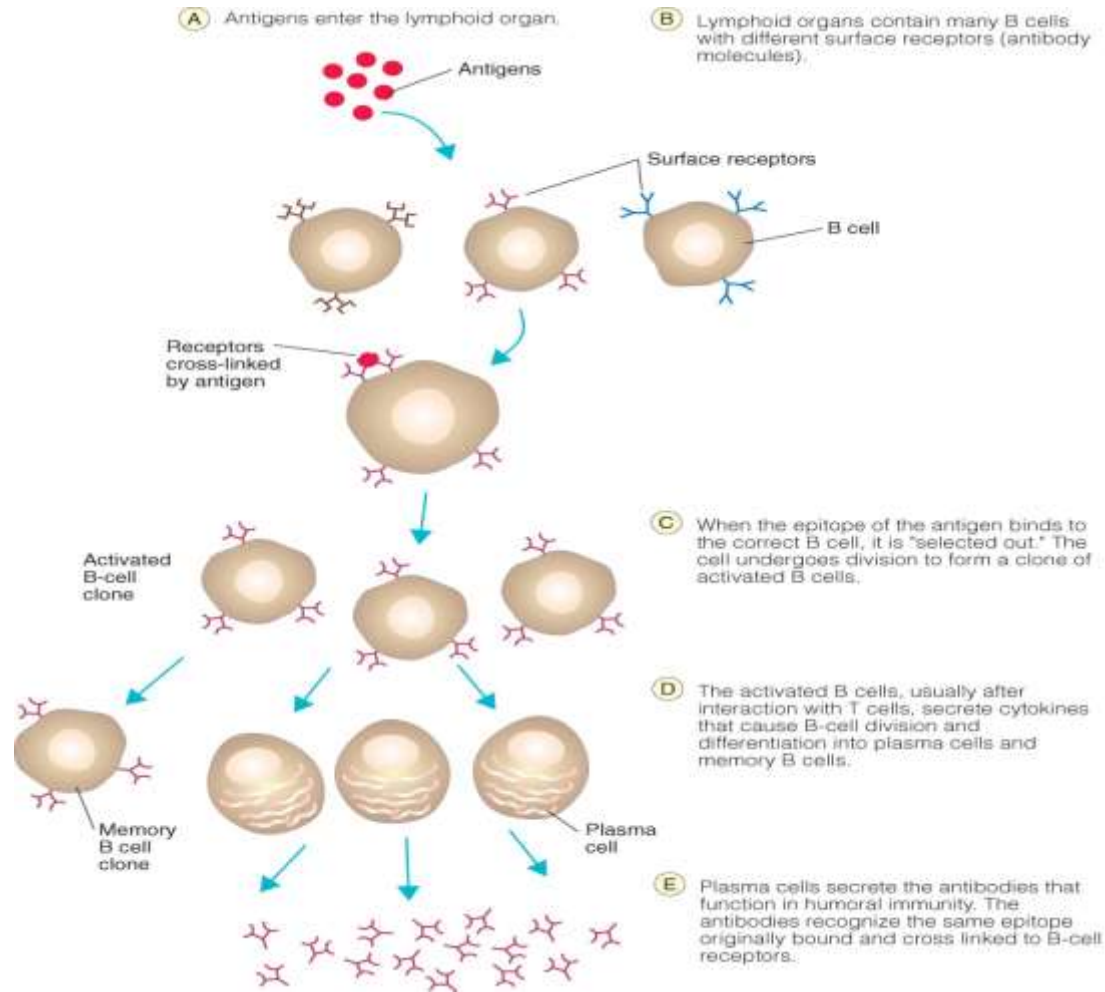
- B cells give rise to PLASMA CELLS which secrete immunoglobulins (antibodies). Thus, responsible for humoral immunity.
- T- cells take part in cell mediated immunity.
- However, a sub-population of T cells called T helper cells (CD4+) cells secrete cytokines and thereby help in both cellular and humoral immune responses.
- CD8+ T cells are cytotoxic cells and main mediator of cell mediated immune response (CMI).
- CD8+ cells are able to cause lysis of infected cells.

B-Cells

- B cells are produced in bone marrow.
- In most of the mammals, they also mature and acquire immune competence in Bone marrow itself.
- In mammals like ruminants, B cells mature in Peyer's patches and in birds they mature in "Bursa of Fabricius" (Hence the name "B cells").
- A mature B cells bear IgM and IgD antibodies on their surface which act as B cell receptors (BCRs).
- All the antibody molecule present on the surface of B cells have single specificity i.e., specificity for any single epitope.
- Upon maturity, B cells keep on circulating throughout the blood and lymph looking for antigens.

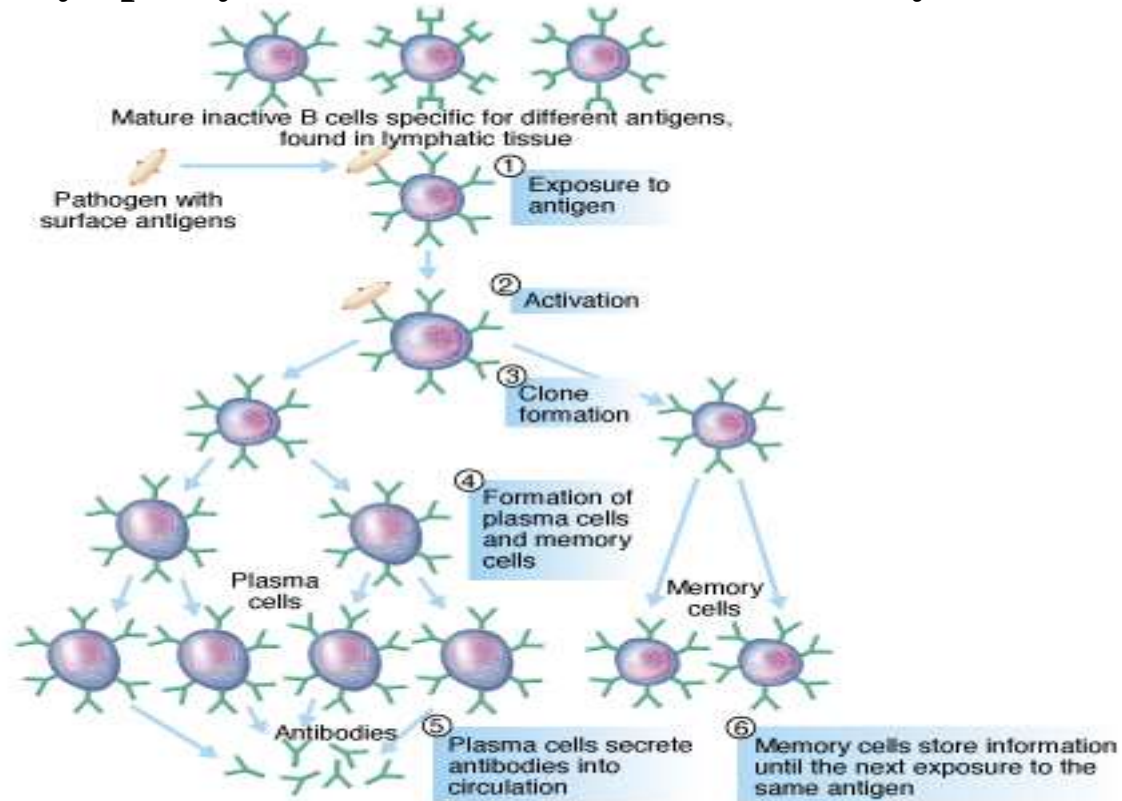
B-Cells

- Once a B cell has identified an antigen / epitope, it starts replicating (*Clonal selection theory*).
- The B cells produced in response to antigen stimulation will finally differentiate into two types:
 - a) Plasma Cells
 - b) Memory Cells
- ***Plasma cells***: Specialized B cells which produce antibodies—more than two thousand per second.
- ***Memory cells***: Some of the B cells differentiate into Memory cells. Memory cells are long-lived cells which are capable of mounting immediate response when they encounter same antigen again.



- Antigen exposure activates only T and B cells with receptors that recognize specific epitopes on that antigen
- B and T cell clones contain lymphocytes that develop into:
 - Effector cells that which target pathogens
 - Memory cells are long-lived B and T cells
 - They are capable of division on short notice

B lymphocytes Make Antibodies and Memory B cells



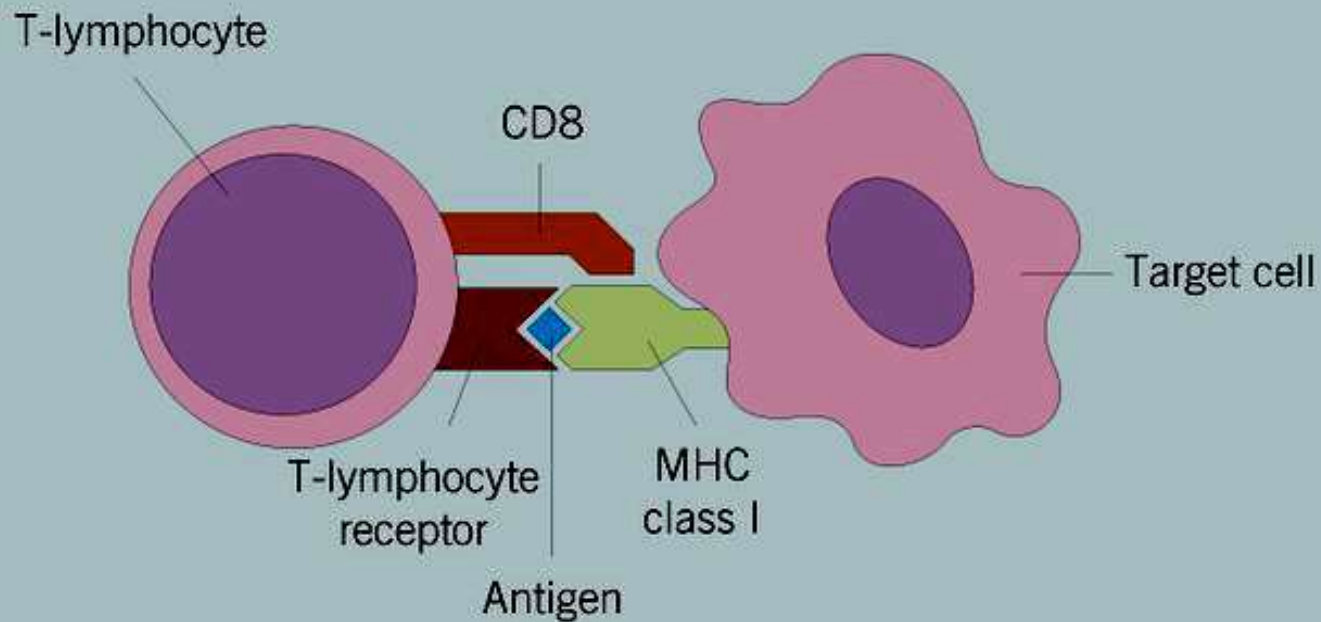
T-cells

- Unlike B cells, these cells leave the marrow at an early age and travel to the thymus, where they mature.
- During maturation T cells acquire T- cell receptors in thymus.
- The acquisition / generation of T cell receptors is a random phenomenon. Thus, these T cells receptors can recognize all sorts of antigen molecules.
- Here in thymus, T cells binding to the “self antigens” undergo “Negative selection” and eventually die.
- Thus, only those T cells that do not bind to self antigens are released in the circulation. This forms the basis of self –non self recognition.

T-cells

- T cells have two important sub populations called *helper T cells* (CD4+) and *cytotoxic (or killer) T cells* (CD8+).
- These cells travel through the blood and lymph, looking for antigens (such as those captured by *antigen-presenting cells*).
- It is interesting to note that T cells can recognize any antigen / epitope only when they are presented in association with “MHC molecule.”
- ***T helper cells***: These CD 4 + cells secretes cytokines which help both B and T cells to mount humoral and cellular immune response, respectively. T helper cells recognize antigen only in association with MHC II molecule.
- ***T cytotoxic cells***: These CD 8+ cells kill the cells exhibiting non self antigen on their surfaces in association with MHC I molecule.

CYTOTOXIC T-LYMPHOCYTE RESPONSE



Antigen Presenting Cells

- Cells that link the innate and adaptive arms
 - Antigen presenting cells (APCs)
 - Macrophages, Dendritic cells and B cells are considered as professional antigen presenting cells.
 - They expression MHC class II molecules.
 - In association with MHC II molecules APCs present antigenic peptides to T helper cells (CD 4+ cells).
 - T helper cells help in mounting both cell mediated and humoral immune response by adaptive arm.

Circulation of Immune cells

- Every B and T cells have predetermined specificity.
- For mounting immune response, specific B or T cell must come in contact with antigen molecule.
- To make it possible cells of immune system keep on circulating through blood and lymph.
- Mostly antigen inoculated through IV route is trapped in Spleen while through IM/SC routes are trapped in regional lymph nodes.

Important Markers on lymphocytes

Marker	B cell	T-cytotoxic cells	T-helper
Antigen R	BCR (surface Ig)	TCR	TCR
CD3	--	+	+
CD4	--	--	+
CD8	--	+	--
CD19/ CD20	+	--	--
CD40	+	--	--

THE END

The images for slides are taken from resources available on internet and used for the purpose of teaching students

THANKS