



**Immunology Course
Faculty of Medicine**

Lecture 3

2025-2026

Cells of the Immune System

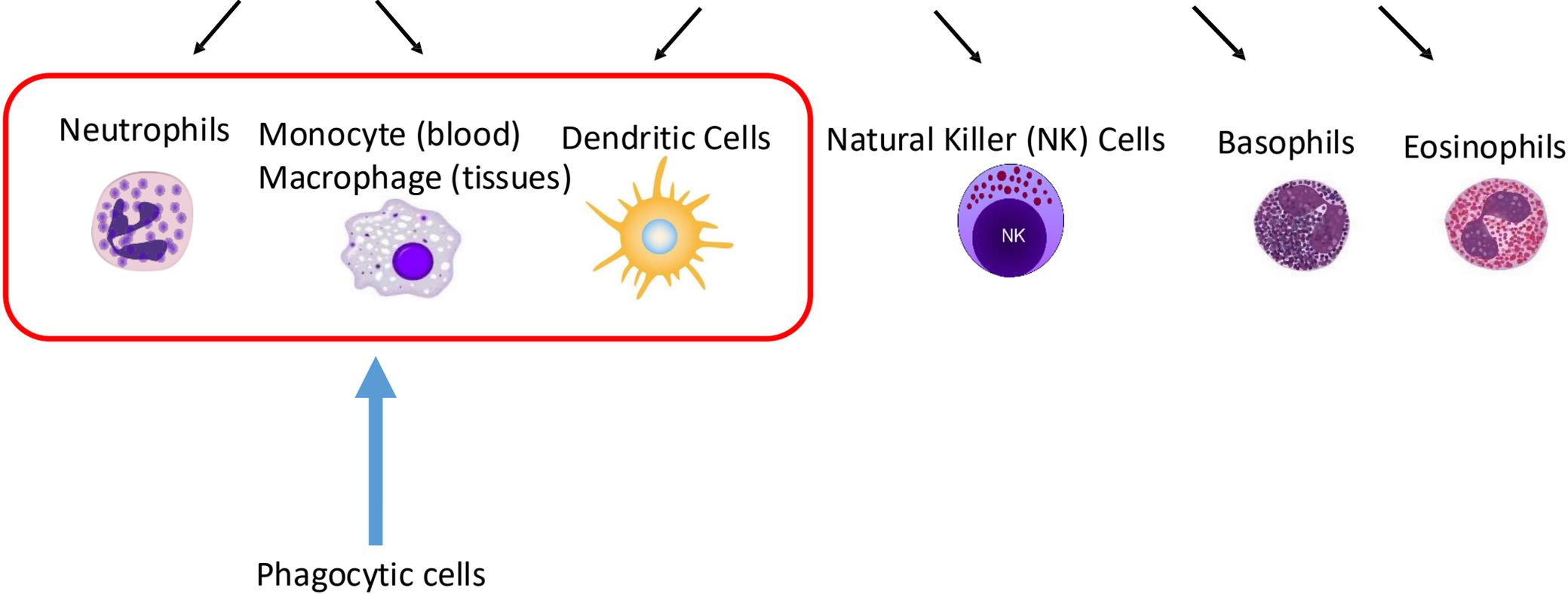
Dr. Mohammad Odaibat

Objectives

- To study the different types of immune cells.
- To know the surface makers of immune cells.
- To be familiar with the function of each type of immune cell.
- To know briefly the lymphoid organs.

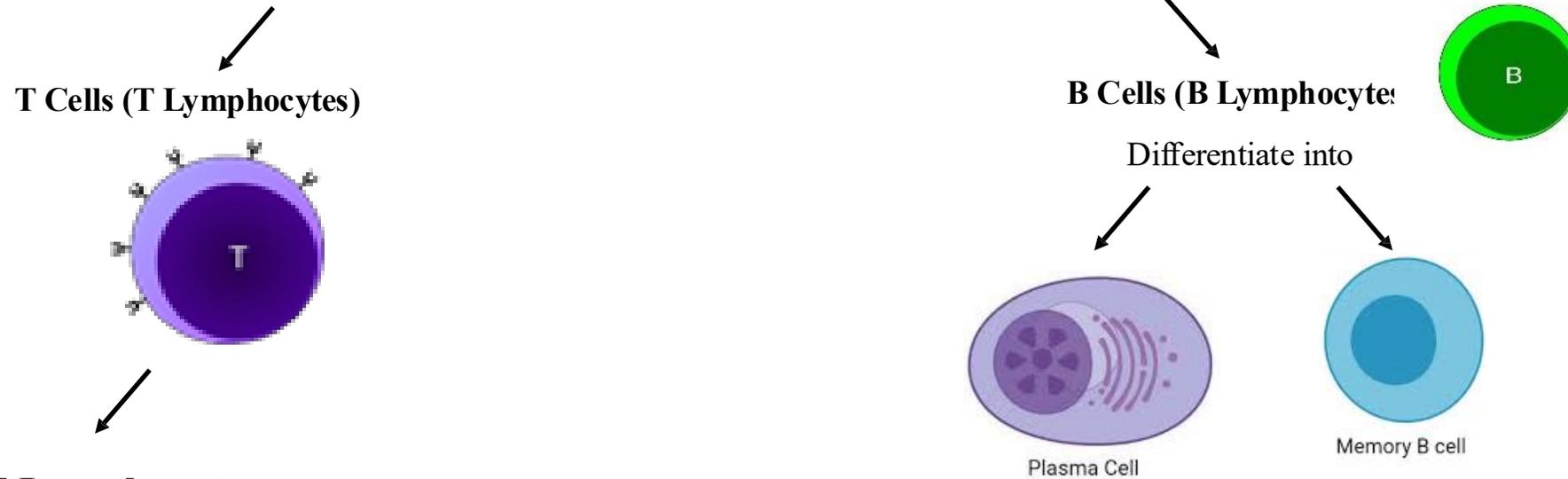
Immune Cells

Innate Immune Cells (First Line of Defense – Fast but Non-Specific)



Lymphocytes

Adaptive Immune Cells (Targeted, Long-Lasting Defense – Slower but Specific)

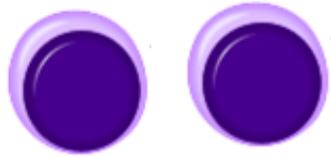


Types of T Lymphocytes

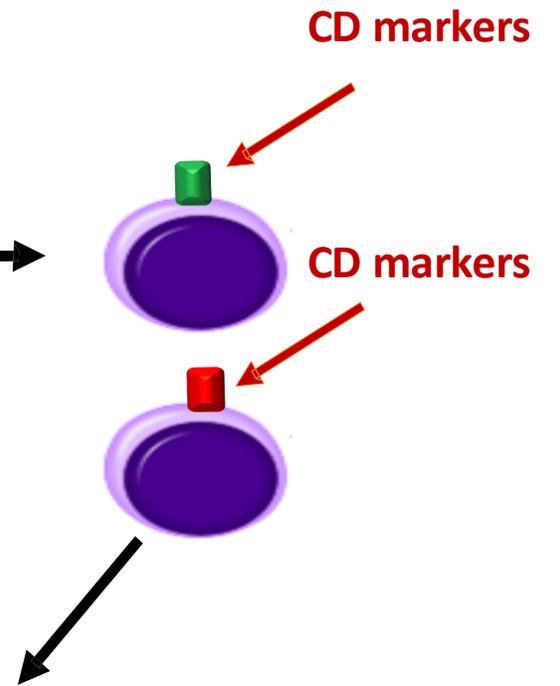
- **Helper T Cells (CD4⁺):** Activate other immune cells
 - Th1
 - Th2
 - T-regulatory Cells
- **Cytotoxic T Cells (CD8⁺):** Kill infected or cancerous cells
- **Memory T Cells:** “Remember” past infections for faster response

Immune Cells Surface Markers

Immune cells cannot always be distinguished based on their morphology.



Different cells can be identified and distinguished by the molecules they express on the cell surface or in the cytoplasm



A Cluster of Differentiation (CD) markers

Or called Cellular Differentiation markers:

Definition: is a cell surface molecule used to identify and classify different cell types, particularly immune cells.

Identification: by specific monoclonal antibodies, with each unique molecule assigned a specific numerical designation (e.g., CD3, CD4).

Immune Cells Surface Markers

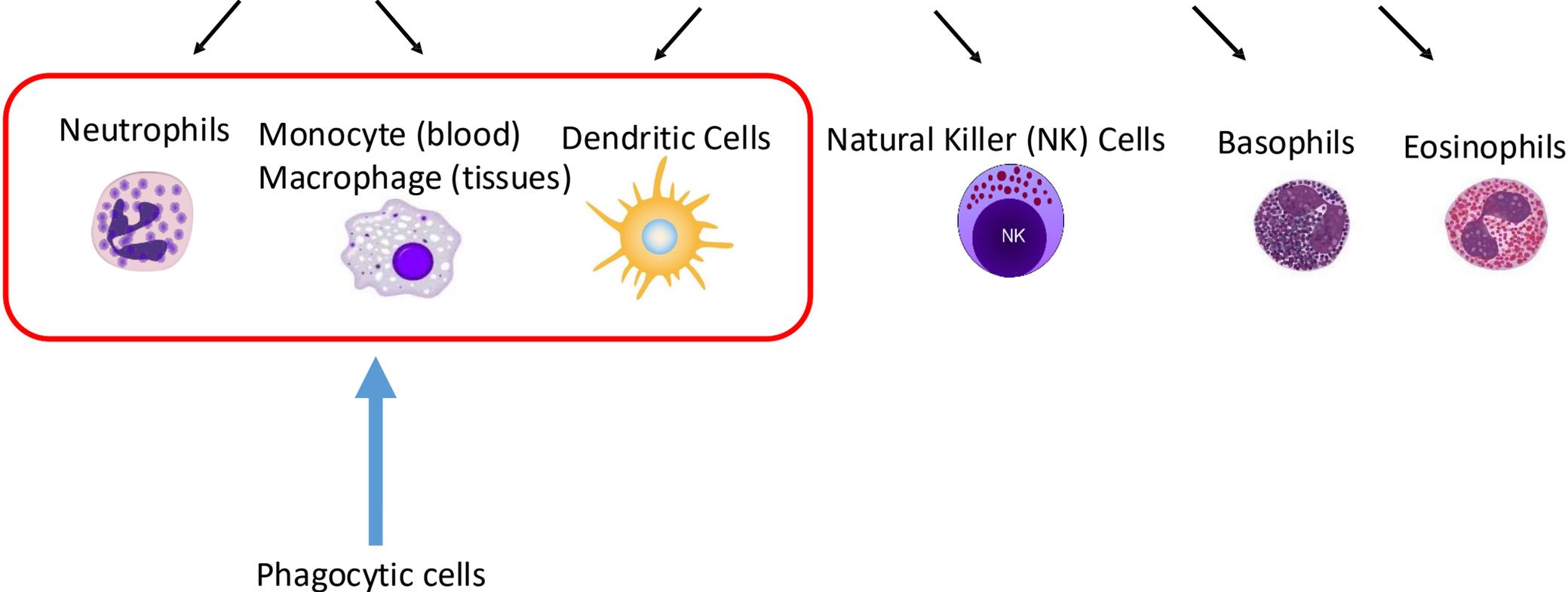
Functions of CD:

1. Ligands (the molecule that activates a receptor) important to the cell.
2. Adhesion molecules .

Type of cell	CD markers
stem cells	CD34+
all leukocyte groups	CD45+
Granulocyte	CD45+, CD15+
Monocyte	CD45+, CD14+
T lymphocyte	CD45+, CD3+
T helper cell	CD45+, CD3+, CD4+
Cytotoxic T cell	CD45+, CD3+, CD8+
B lymphocyte	CD45+, CD19+ or CD45+, CD20+
Natural killer cell	CD16+, CD56+

Immune Cells

Innate Immune Cells (First Line of Defense – Fast but Non-Specific)



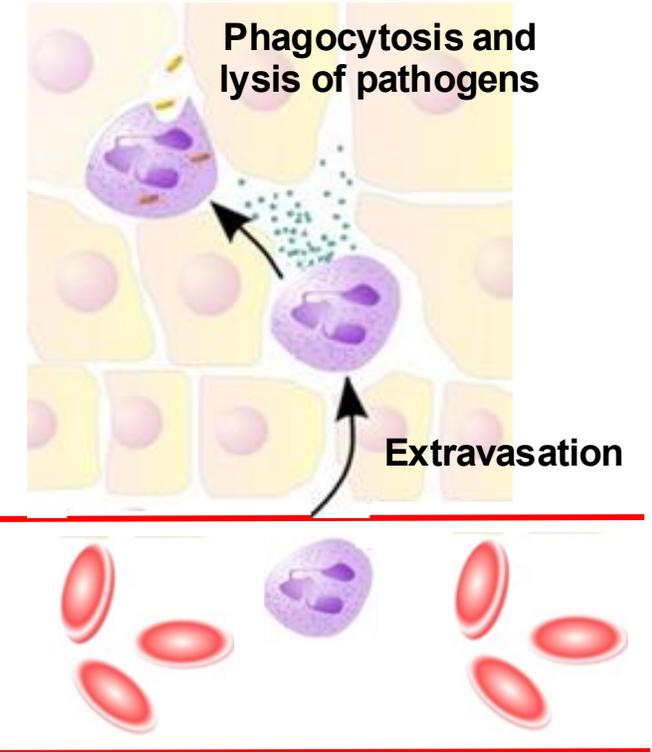
Neutrophil

Leukocyte %	55-70
Main function:	Elimination of pathogens, removal of tissue debris
Recognition:	PRR, Antibody and Complement receptor (facilitate phagocytosis)
Content of granules:	Digesting enzymes
Elimination of pathogens:	Phagocytosis, respiratory burst, degranulation
Produced mediators:	Inflammatory cytokines
Fc receptor:	FcγR (binds IgG)
Role in diseases	Inflammatory reactions

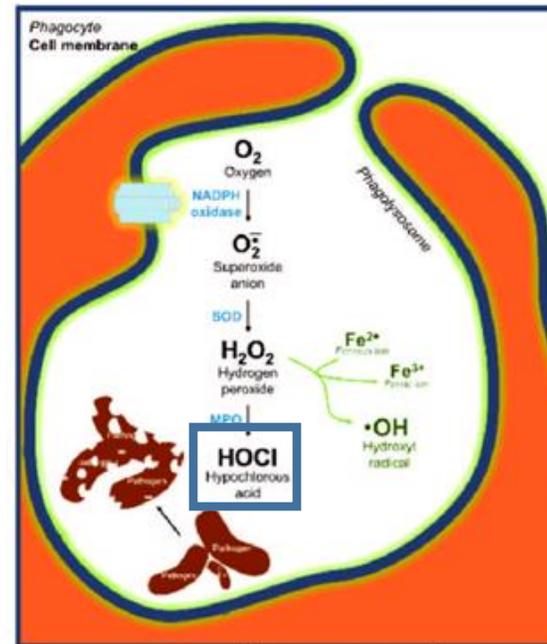
Red: Only possible after the activation of the adaptive immunity



No antigen presentation



Respiratory burst



Monocyte, macrophage

Leukocyte %:	2-8
Main function:	Phagocytosis, Antigen presentation, Cytokine production,
Site of antigen presentation:	Locally, in the tissues
Recognition:	PRR, Fc receptor, Complement receptor
Elimination of pathogens:	Phagocytosis, Respiratory burst
Produced mediators:	Cytokines
Fc receptor:	FcγR (binds IgG)

Red: Only possible after the activation of the adaptive immunity



A macrophage ingesting (phagocytosing) bacteria (SEM image)

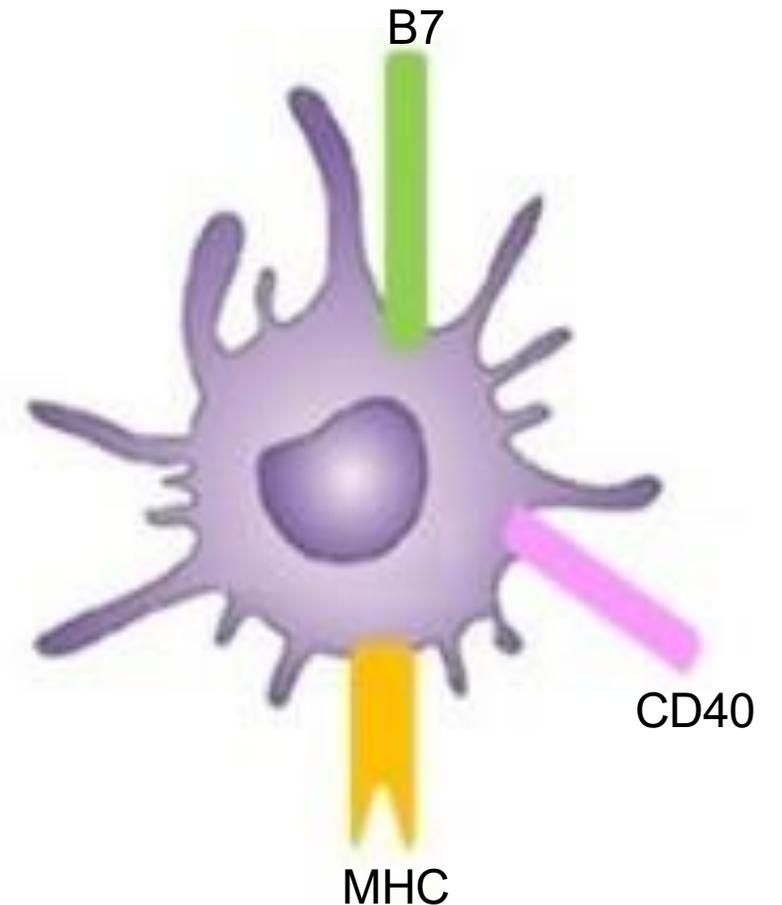


A monocyte in a blood smear

Dendritic cell (DC)

Found in:	Tissues
Main function:	Antigen presentation
Site of antigen presentation:	In the secondary lymphoid organs
Recognition:	PRR, Fc receptor
Produced mediators:	Cytokines
Fc receptor:	FcγR (binds IgG)

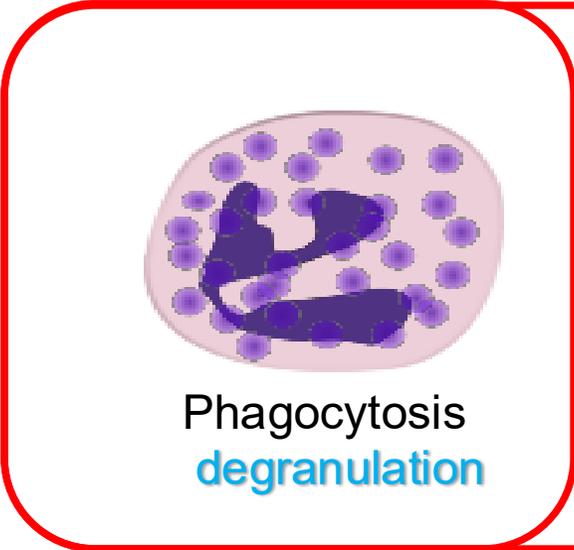
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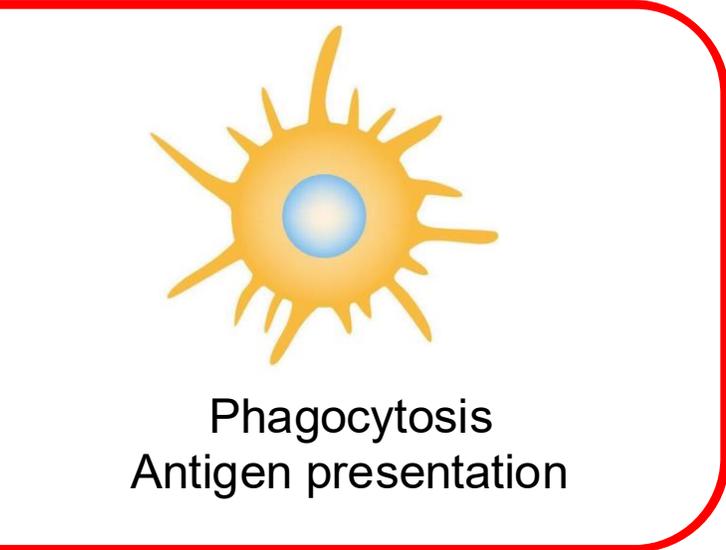
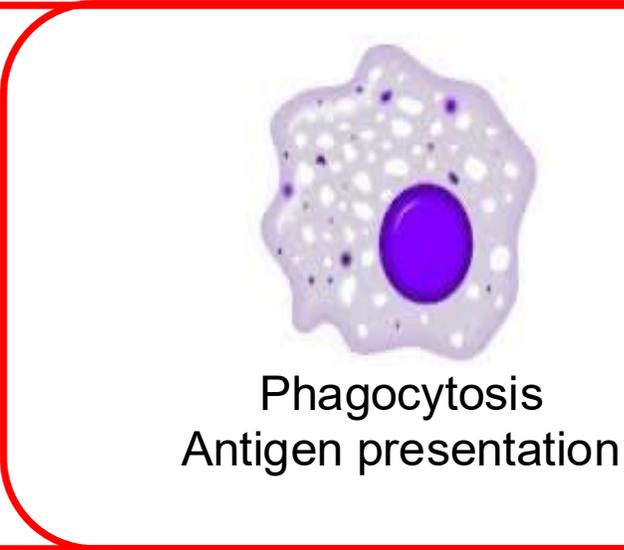
Immune Cells

Innate Immune Cells (First Line of Defense – Fast but Non-Specific)

Non-Professional Phagocyte



Professional Phagocytes



All have
PRR,
IgG Receptor

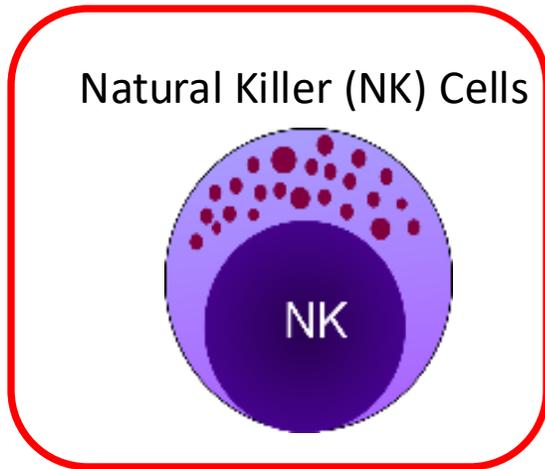
Immune Cells

Innate Immune Cells (First Line of Defense – Fast but Non-Specific)

All are non-phagocytic cells

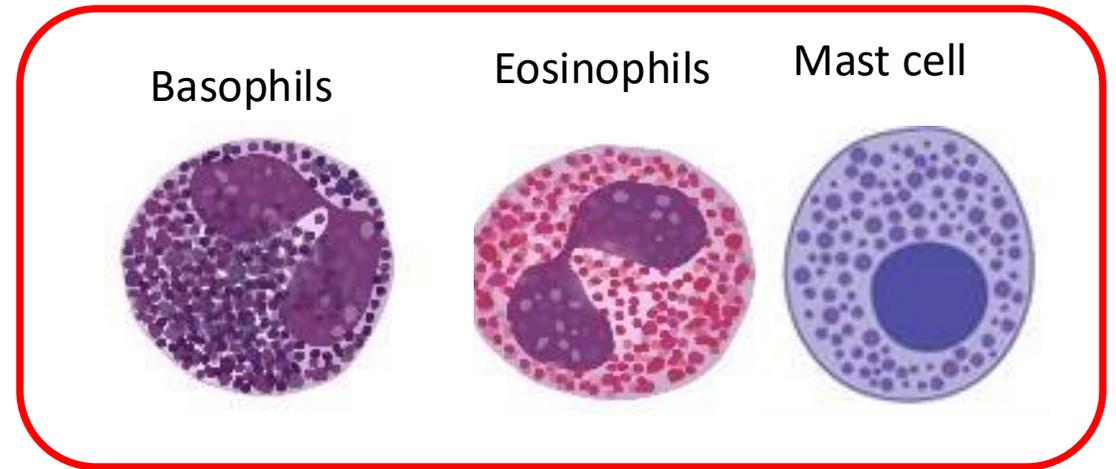


IgG Receptor



Defense against intracellular pathogens,
Killing cancer cells

IgE Receptor

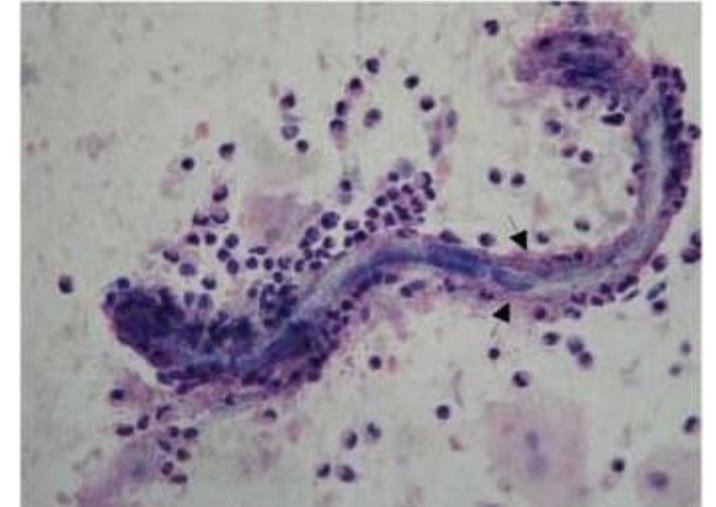


Defense against multicellular parasites

Eosinophil

Leukocyte %	2-4
Main function:	Defense against multicellular parasites
Recognition:	PRR, Fc receptor
Content of granules:	Toxic proteins, enzymes
Elimination of pathogens:	Degranulation
Produced mediators:	Prostaglandins, Leukotrienes, Inflammatory cytokines
Fc receptor:	Fc ϵ R (binds IgE)
Role in diseases:	Allergic reactions

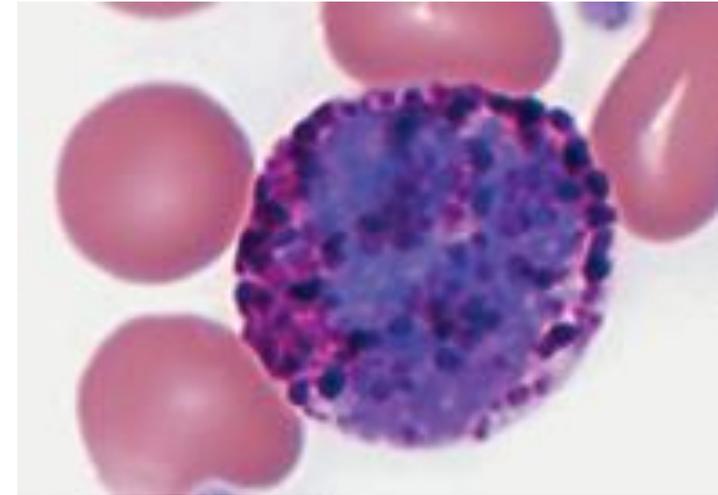
Red: Only possible after the activation of the adaptive immunity



Eosinophils surrounding a worm larva.
(sputum from a parasitic pneumonia case)

Basophil

Leukocyte %	0-1
Main function:	Defense against multicellular parasites
Recognition:	PRR, Fc receptor
Content of granules:	Histamine, heparin, proteases, and eosinophil chemotactic factors (ECF-A)
Elimination of pathogens:	Degranulation
Produced mediators:	Leukotrienes
Fc receptor:	FcεR (binds IgE)
Role in diseases:	Allergic reactions



Leukotrienes are potent lipid molecules that act as inflammatory mediators in the body, synthesized by white blood cells (leukocytes) from arachidonic acid

Red: Only possible after the activation of the adaptive immunity



The immune response to **helminth (worm) infections**

Type 2 immune response



production of different cytokines



activation of eosinophils, mast cells, basophils



Eosinophils and basophils



degranulation



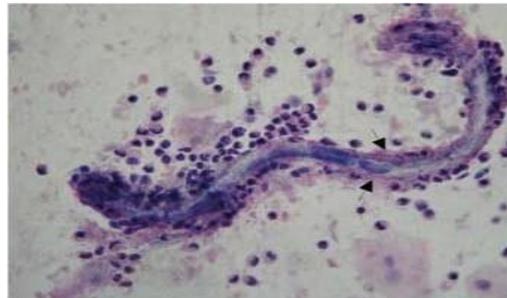
Lysis



mast cells



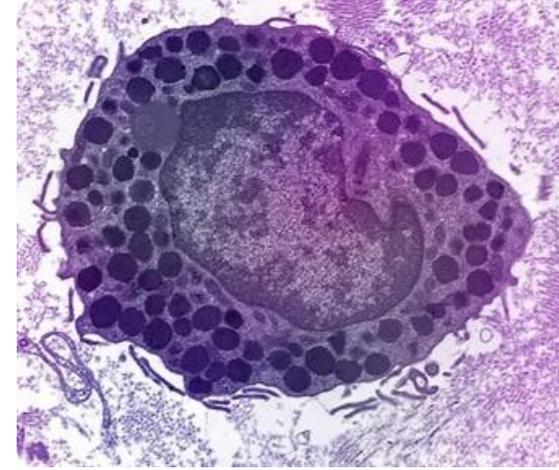
increase paracellular permeability in the intestinal epithelium and contractions of the intestinal smooth muscle, which causes expulsion of intestinal worms.



Mast cell (mastocyte)

Found in:	Tissues
Main function:	Defense against multicellular parasites
Recognition:	PRR, Fc receptor
Content of granules:	Histamine, heparin, enzymes
Elimination of pathogens:	Degranulation
Produced mediators:	Cytokines, Leukotrienes
Fc receptor:	FcεR (binds IgE)
Role in diseases:	Allergic reactions

Red: Only possible after the activation of the adaptive immunity

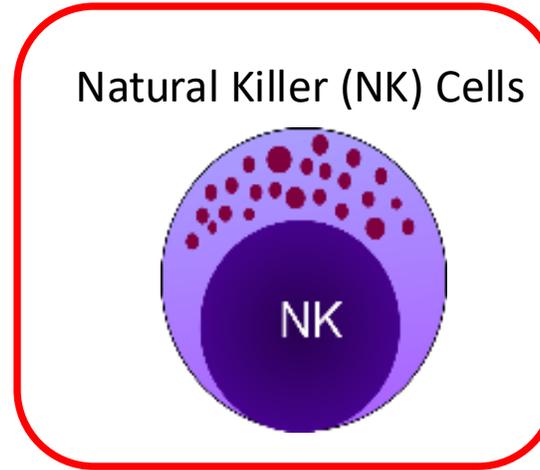


Mast cell (electron microscopy image)

Immune Cells

Innate Immune Cells (First Line of Defense – Fast but Non-Specific)

Non-phagocytic cell

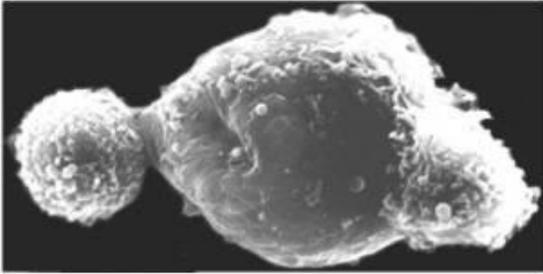


Defense against

intracellular pathogens

Killing cancer cells

Natural killer cells (NK cells)



Two NK cells kill a cancerous cell. (Scanning electron microscopy image)

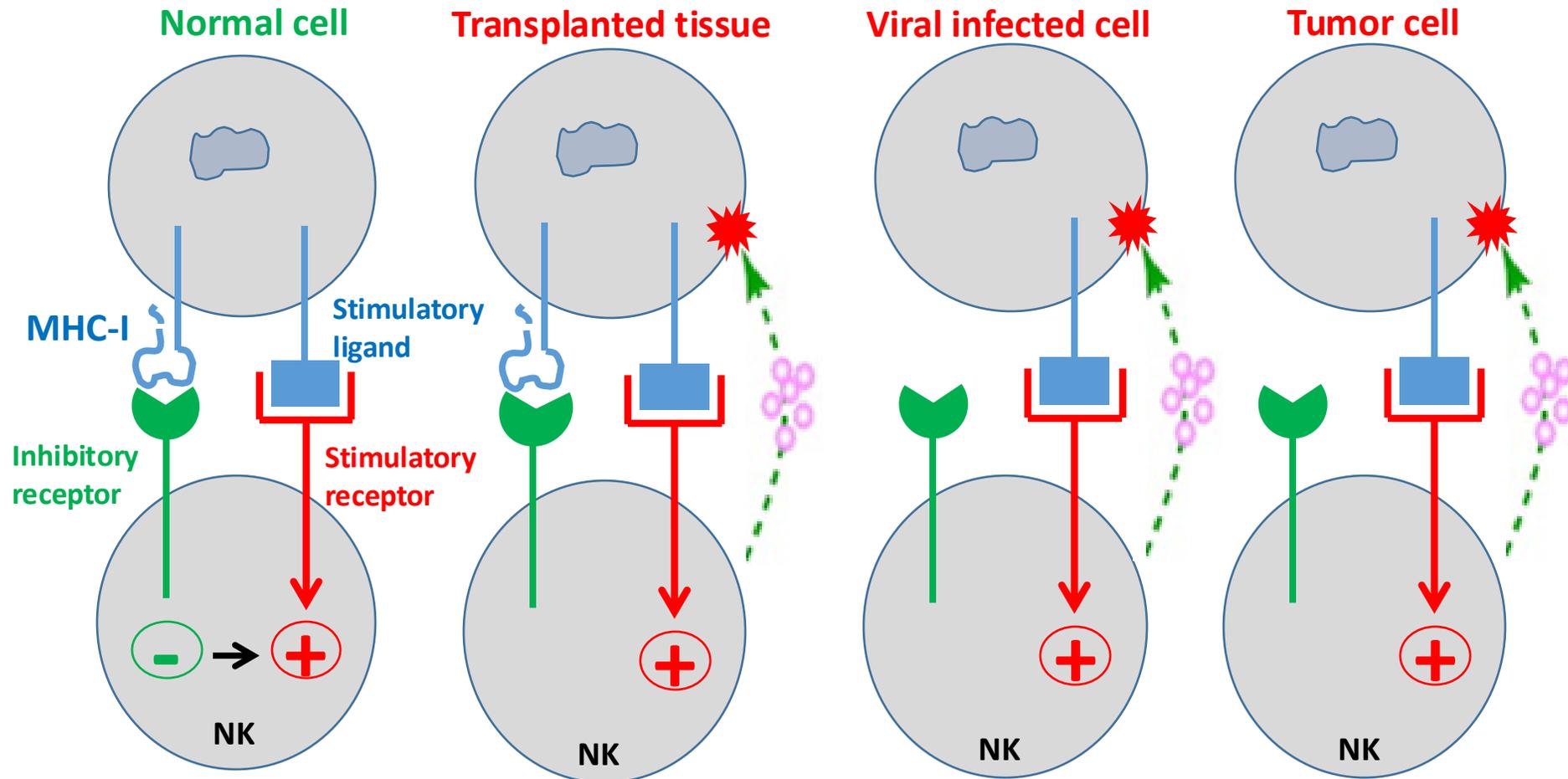


NK cells sense self MHC molecules

Blood lymphoid cells:	≈ 10%
Main function:	Killing cells infected with intracellular pathogens, Killing cancer cells
Recognition:	KAR → killing the target (stimulatory) KIR → sparing the target (inhibitory) Fc receptor, Complement receptor
Cytotoxicity:	Perforin, Granzymes
Produced mediators:	Cytokines
Fc receptor:	FcyR (binds IgG)

Red: Only possible after the activation of the adaptive immunity

NK Cells can sense normal, abnormal, and downregulated MHC-I molecules



NK cells do not respond to normal cells expressed normal MHC-I molecules.

NK will not recognize the new MHC-I and it will mount a destructive immune response

NK recognizes and destroyed cells lack or have downregulated MHC-I molecules

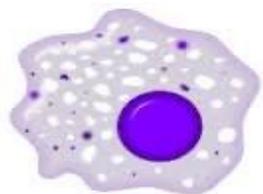
NK recognize tumor cells lack MHC-I molecules and mount destructive immune response

Innate Immune Cells

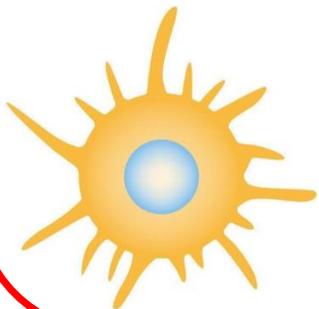
Neutrophils



Monocyte (blood)
macrophage (tissues)



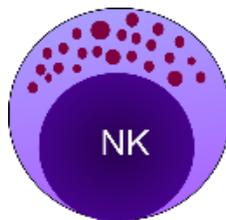
Dendritic Cells



Phagocytic cells

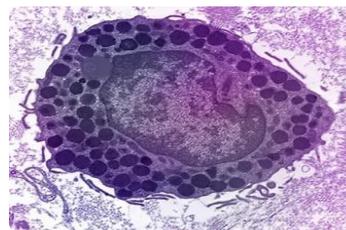
Non-phagocytic cells

Natural Killer (NK) Cells

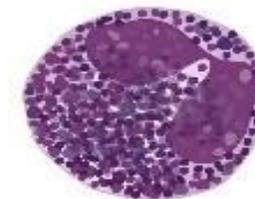


intracellular pathogens
Killing cancer cells

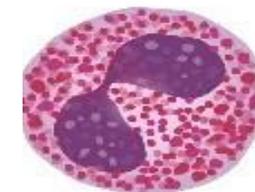
Mast cell



Basophils

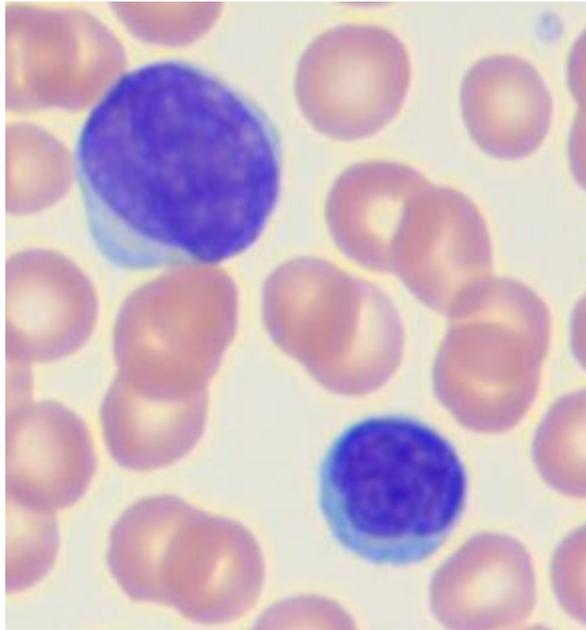


Eosinophils



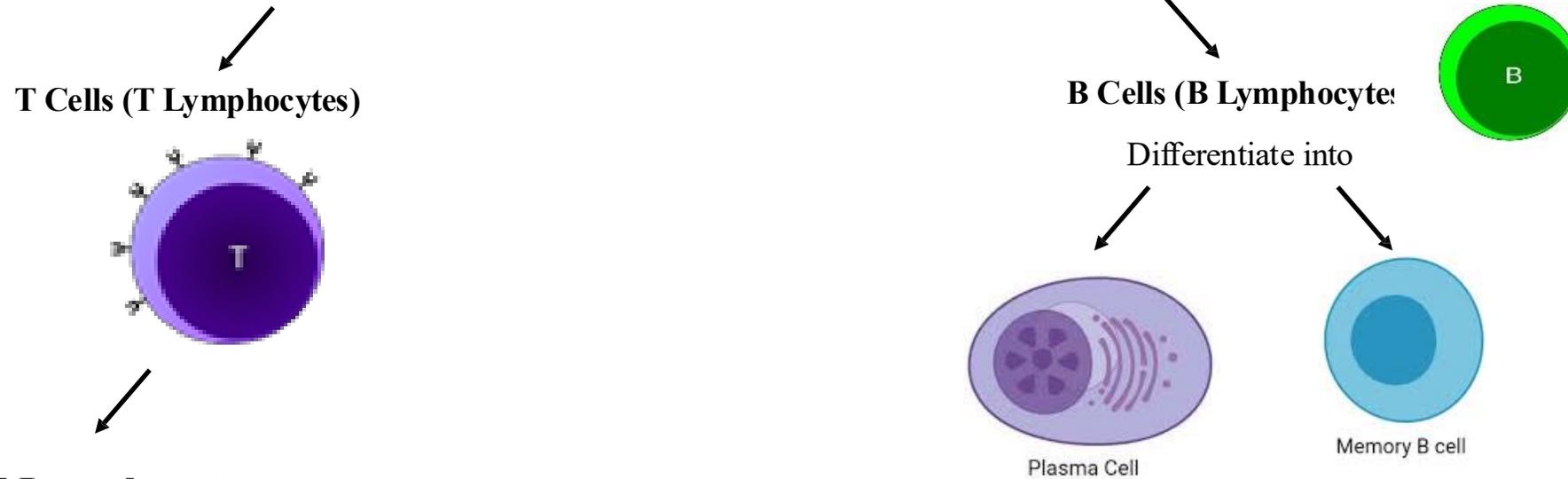
helminth (worm) infections

Lymphocytes



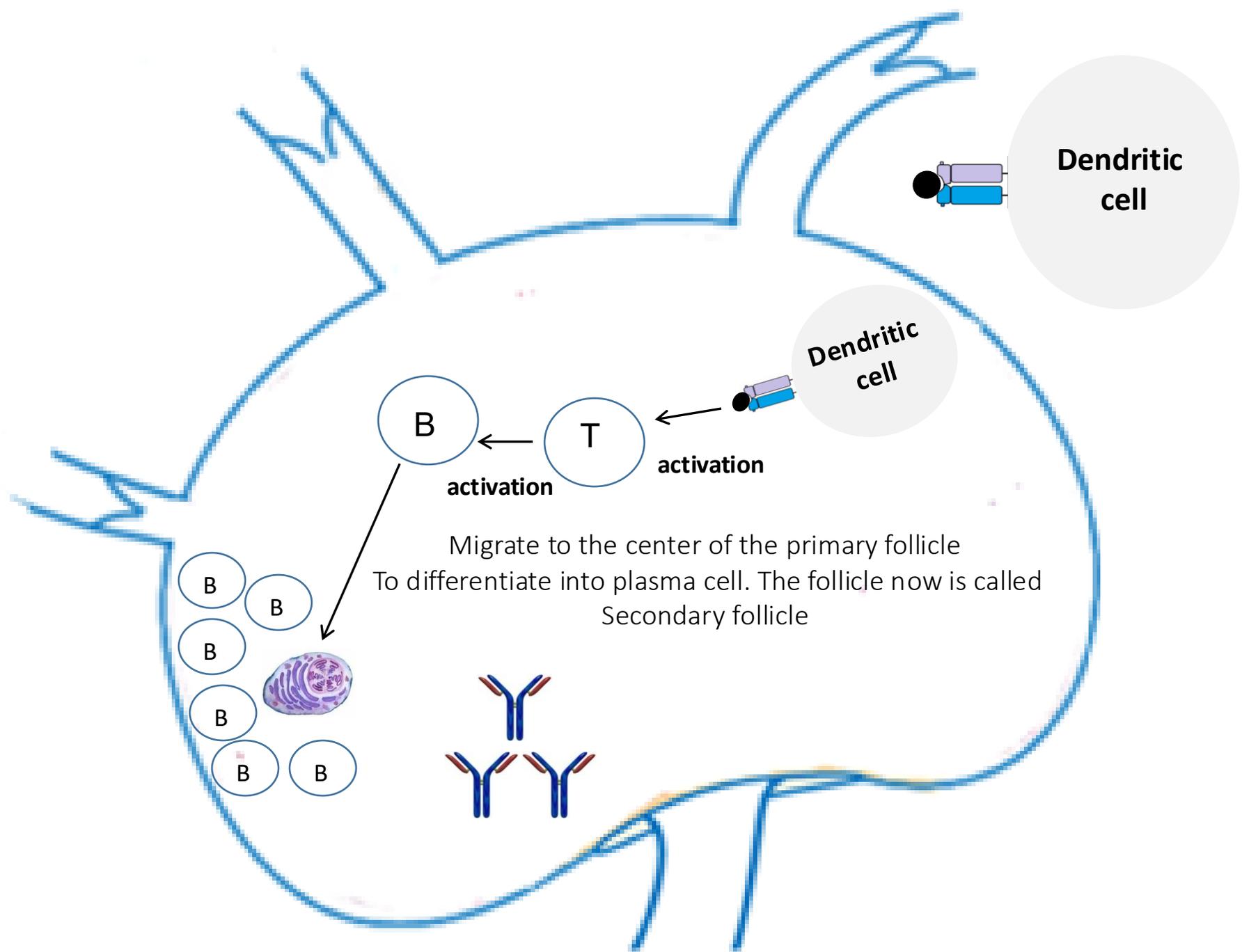
Lymphocytes

Adaptive Immune Cells (Targeted, Long-Lasting Defense – Slower but Specific)



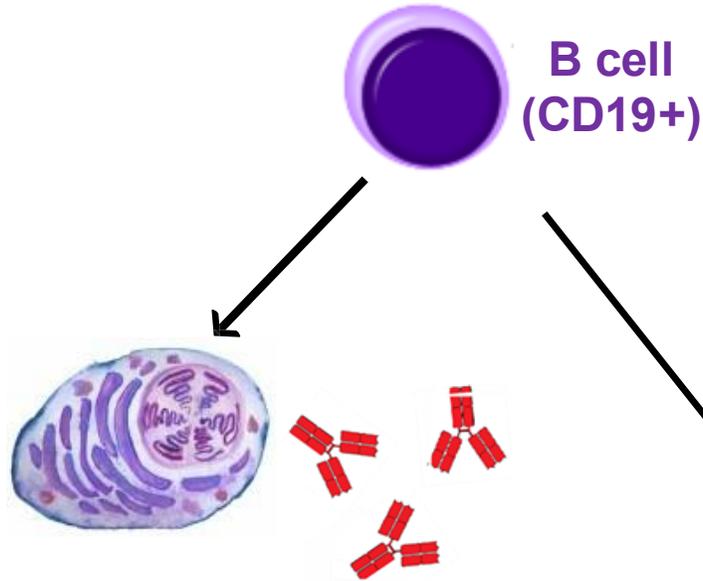
Types of T Lymphocytes

- **Helper T Cells (CD4⁺):** Activate other immune cells
 - Th1
 - Th2
 - T-regulatory Cells
- **Cytotoxic T Cells (CD8⁺):** Kill infected or cancerous cells
- **Memory T Cells:** “Remember” past infections for faster response



B-Lymphocytes

B cells makes infection-fighting proteins called antibodies in response to **antigens** (**anti**body **gen**erators)



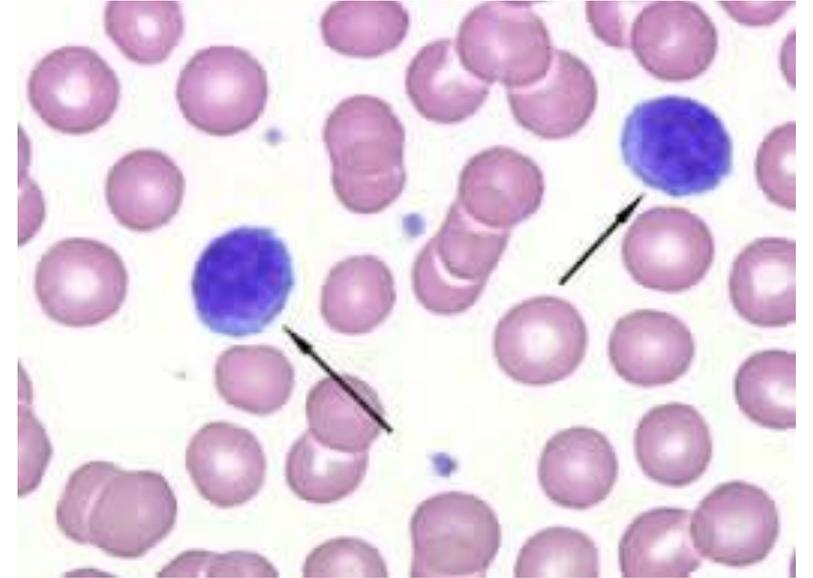
Plasma cells: Once a B cell becomes a mature plasma cell, it can release up to 2,000 antibodies per second

Blood lymphoid cells %:	10-15
Main functions:	Antibody production, Antigen presentation
Recognition:	antigen-specific B cell receptor BCR
Site of production:	Bone marrow
Characteristic marker:	CD19 (makes a complex with BCR)

Memory cells: Memory cells remember particular antigens so, if they appear in your body in the future, your immune system can mount a defense quickly.. For example vaccines.

T- Lymphocytes

Leukocyte %:	25-40*
Main function:	ADAPTIVE IMMUNITY
Recognition	Antigen-specific receptors (TCR)



**Cytotoxic T cell
(CD8+)**



**Direct killing of
target cell
(infected or
cancerous)**



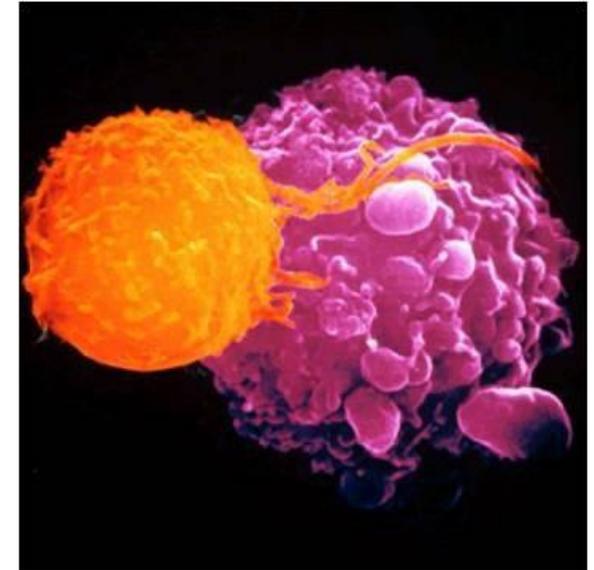
**Helper T cell
(CD4+)**



**Regulation of
the immune
response**

Cytotoxic T cells (Tc or CTL)

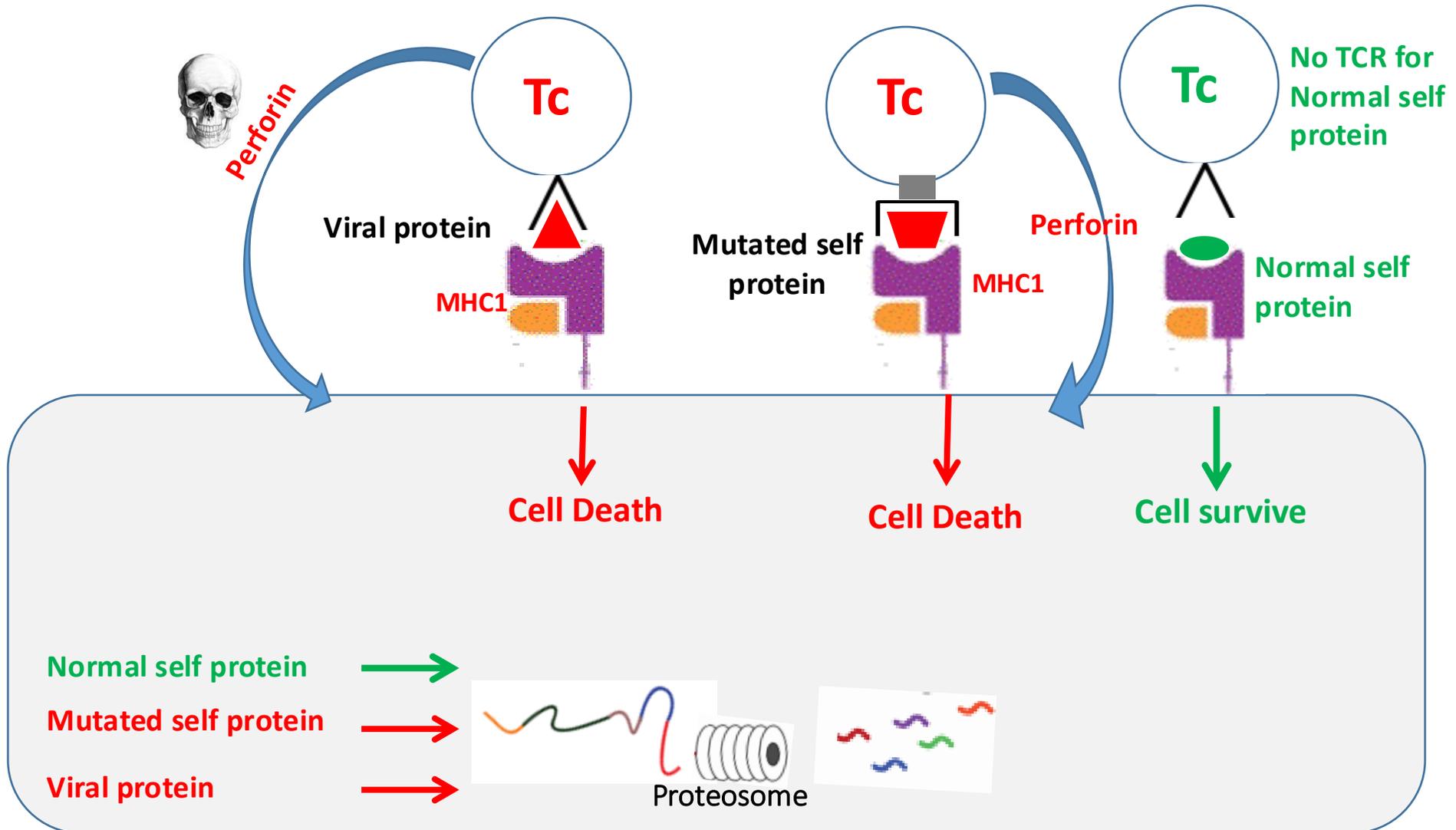
Blood T cells:	1/3
Main function:	Effector cell of the cellular immunity
Recognition:	Through MHC I, antigen- specific TCR
Target cells to kill:	Infected with intracellular pathogens, Cancerous, Foreign (transplantations!)
Recognized antigens:	Endogenous (from the cytoplasm of the target cell)
Cytotoxicity:	Perforin, Granzyme
Immunophenotype:	CD3+/CD8+/CD4-



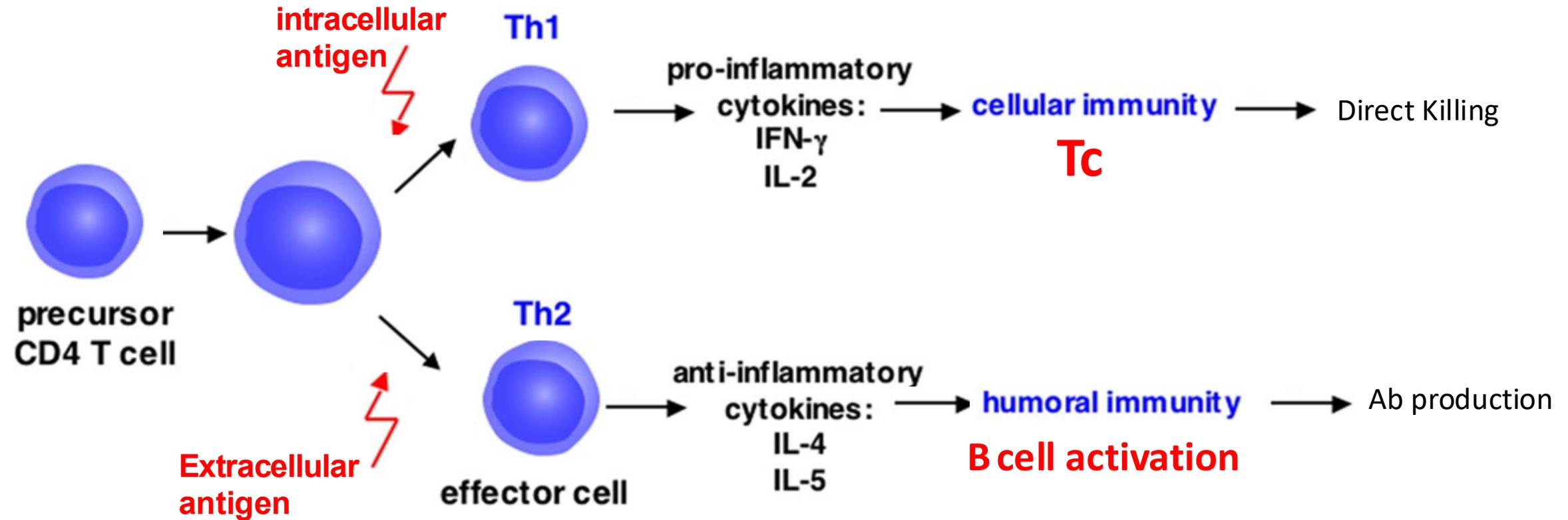
A cytotoxic T cell kills a cancer cell. (SEM image)

Cytotoxic T cells (Tc or CTL)

cellular proteins presentation by MHC1 to CTL to check their normality

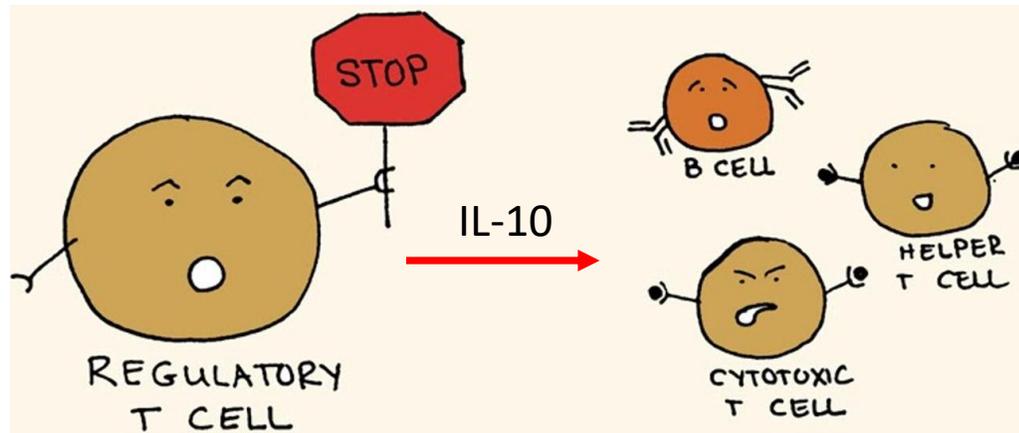
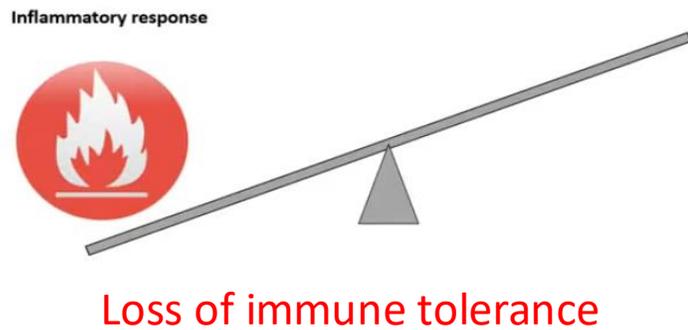
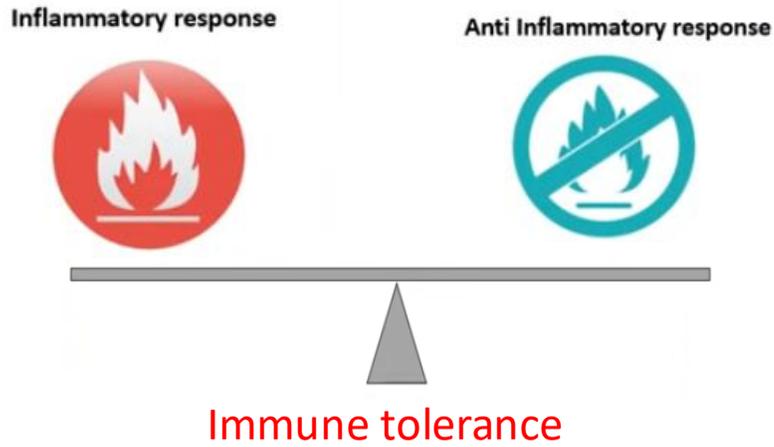


Lymphocytes



Regulatory T-cells

Regulatory T cells maintain homeostasis of immune response by regulating immune tolerance



Immune tolerance: regulatory T cells prevent the immune system from harming the body's own tissues.

The 2025 Nobel Prize in Physiology or Medicine



Mary E. Brunkow

Fred Ramsdell

Shimon Sakaguchi

Mary E. Brunkow, Fred Ramsdell and Shimon Sakaguchi are awarded the Nobel Prize in Physiology or Medicine 2025 for their groundbreaking discoveries concerning peripheral immune tolerance that prevents the immune system from harming the body.

WBCs percentages in blood

Never Let Monkeys Eat Bananas

- **N** – Neutrophils (~60%) ÷ 2
- **L** – Lymphocytes (~30%)
- **M** – Monocytes (~6%) ÷ 2
- **E** – Eosinophils (~3%) ÷ 2
- **B** – Basophils (~1%)

Lymphoid Organs

Lymphoid organs

Primary Lymphoid organs

Secondary Lymphoid organs

