جامعة المستقبل
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IMMUNE SYSTEM

lecture two

cells of Immune system

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cells of Immune system

- The immune system consists of several different types of cells, which work together to defend the body against pathogens (like bacteria, viruses, and fungi). All immune system cells originate from the bone marrow in Hematopoietic Stem cell.
- Here are some of the key types of cells in the immune system:

- **1. White Blood Cells (Leukocytes)**
- These are the cells responsible for fighting infections and foreign invaders. They can be divided into two main categories: **innate** and **adaptive** immune cells.
- **Innate Immune Cells:**
- These cells provide the first line of defense and respond quickly to pathogens.
- **1-Neutrophils:**

  Role; Neutrophils are part of the granulocyte family and are the first responders to sites of infection or injury. They're the most abundant type of white blood cell in circulation.

  Mechanism: They patrol the bloodstream and migrate to infection sites in response to signals released by infected tissues. Upon arrival, they use processes like phagocytosis (engulfing pathogens) and release antimicrobial molecules stored in granules.

  Key Characteristics:

  They have a short lifespan (a few hours to a few days) and typically die after fighting infection, forming pus.

  They're primarily effective against **bacterial infections**.

2-Macrophages:

Role: Macrophages are large, long-lived immune cells that are part of the monocyte lineage. They act as both defenders and regulators of the immune response.

Mechanism:

Like neutrophils, macrophages engage in phagocytosis, but they are also capable of processing and presenting antigens to T-cells, which triggers the adaptive immune response.

Macrophages can recognize pathogens via pattern recognition receptors (PRRs), which detect common molecular patterns found on pathogens (like bacteria, fungi, or viruses).

They can secrete a wide range of cytokines that coordinate the immune response, promote inflammation, and recruit other immune cells to the site of infection.

Key Characteristics:

They can adapt to various functional states (e.g., pro-inflammatory or tissue repair roles) depending on the needs of the body.

3-Dendritic Cells

Role: Dendritic cells act as the bridge between **innate** and **adaptive** immunity.

Mechanism: They are the most potent **antigen-presenting cells (APCs)** in the body. Dendritic cells capture pathogens and process them into fragments (antigens), which they present on their surface to **T-cells** to initiate the adaptive immune response. This process is essential for **immune surveillance**.

Once they capture antigens, dendritic cells migrate to lymph nodes where they present the antigens to naïve T-cells.

Key Characteristics:

They can take many forms (like **conventional dendritic cells** or **plasmacytoid dendritic cells**) and are particularly important in **viral immunity**.

4-Natural Killer (NK) Cells

Role: NK cells are part of the **innate immune system** and play a critical role in **killing** infected or abnormal cells (such as tumor cells).

Mechanism: Unlike T-cells, NK cells do not require antigen presentation to identify target cells. They use a combination of **activating** and **inhibitory receptors** to detect cells that are stressed or infected (especially with viruses).

When NK cells recognize these abnormal cells, they release **cytotoxic granules** (e.g., perforin and granzymes) that induce apoptosis (programmed cell death) in the target cell.

Key Characteristics:

They can also produce **cytokines** such as **IFN-gamma**, which helps shape the immune response by influencing other cells like macrophages.

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Adaptive Immune Cells:

These cells are more specialized and adapt to recognize specific pathogens.

- **T-cells** (T-lymphocytes):

  Role: T-cells are key players in the adaptive immune system and are responsible for targeting and eliminating specific pathogens.

  Mechanism:

  - Helper T-cells (CD4+ T-cells): These cells do not kill pathogens directly. Instead, they coordinate the immune response by releasing cytokines that activate other immune cells, including B-cells, cytotoxic T-cells, and macrophages. They are essential for both humoral (antibody-mediated) and cell-mediated immunity.
  - Cytotoxic T-cells (CD8+ T-cells): These directly kill infected or tumor cells by recognizing foreign antigens presented by MHC I molecules. They release toxic molecules like perforin and granzymes to induce apoptosis in infected cells.
  - Regulatory T-cells: These cells help maintain immune tolerance by preventing the immune system from attacking the body's own tissues (autoimmunity). They suppress the activity of other T-cells that might respond to self-antigens.
  - Memory T-cells: After an infection is cleared, memory T-cells persist in the body for faster and more efficient responses if the same pathogen is encountered again.

  Key Characteristics:

  T-cells mature in the thymus and undergo a selection process to ensure they only respond to foreign invaders or infected cells, not the body's own tissues.

B-cells (B-Lymphocytes)

•**Role**: B-cells are responsible for **antibody production** and are central to the humoral immune response.

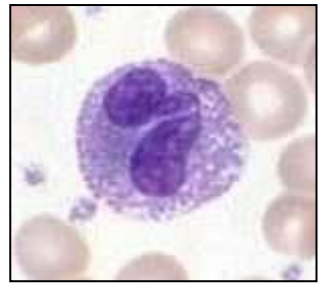
•**Mechanism**:

- **Naïve B-cells** express unique receptors on their surface that can bind to specific antigens. Upon activation (usually by Helper T-cells), B-cells differentiate into **plasma cells** that secrete large amounts of **antibodies** (also called immunoglobulins).
- Antibodies bind to pathogens and neutralize them or mark them for destruction by other immune cells (such as macrophages or neutrophils).
- Some B-cells become **memory B-cells**, which "remember" pathogens and can respond more rapidly if the pathogen is encountered again.

•**Key Characteristics**:

- B-cells can differentiate into **different types of antibodies** (IgM, IgG, IgA, IgE, and IgD), each of which has a specific function in defending against infections.

Other Important Cells:



1-Eosinophils:

•**Role**: Eosinophils are primarily involved in combating **parasites** (like worms) and are also implicated in allergic reactions.

•**Mechanism**:

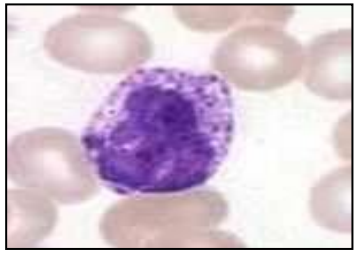
- They contain granules filled with enzymes and toxic proteins (such as **peroxidase** and **major basic protein**) that are released to kill larger parasites.
- In allergic reactions, eosinophils can contribute to tissue damage and inflammation by releasing their toxic contents in response to IgE antibodies.

•**Key Characteristics**:

- Elevated eosinophil counts are often associated with allergies, asthma, and parasitic infections.

2-Basophils

- **Role**: Basophils are involved in inflammatory and allergic responses, particularly in reaction to things like pollen or food allergens.
- **Mechanism:**
- Basophils release histamine and other chemicals stored in their granules in response to signals from IgE antibodies. This triggers inflammation and plays a role in hypersensitivity reactions.
- **Key Characteristics:**
- They’re less abundant than other immune cells but can cause significant symptoms during allergic reactions (such as anaphylaxis).



3-Mast Cells

- **Role**: Similar to basophils, mast cells are involved in allergic responses and defense against parasites.
- **Mechanism**:
  - They reside in tissues (like skin, lungs, and mucous membranes) and release **histamine** and other inflammatory mediators upon activation by allergens or pathogens.
  - In **allergic reactions**, mast cells play a key role in triggering symptoms such as swelling, itching, and airway constriction.
- **Key Characteristics**:
  - Mast cells are especially important in **chronic inflammation** and **autoimmune diseases**.

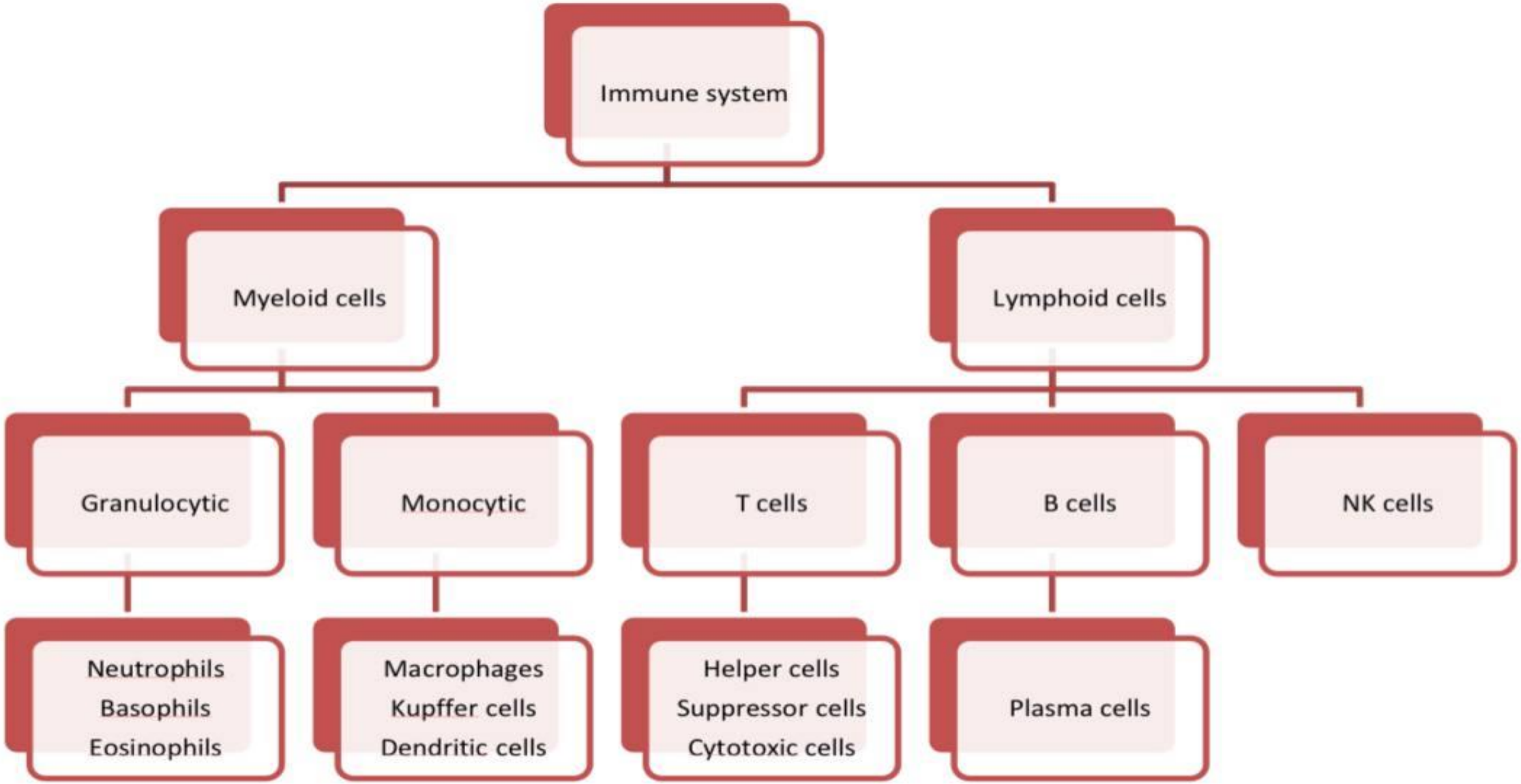


Fig. Cells of the immune system

		Characteristics	Key Functions	Interaction with Adaptive Immunity
Macrophage		Large phagocytes, located in all tissues, class II MHC expression	Engulfs and kills many classes of microbes, removal of debris, tissue repair	Possess surface IgG receptors that facilitate phagocytosis (opsonization), activated by IFN-γ, TNF-α from T cells. Professional APC expressing class II MHC
Dendritic cell		Sentinel cells with long branches; reside in epithelial barriers and secondary lymphoid organs, class II MHC expression	Antigen uptake and presentation including cross-presentation	Professional APC expressing class II MHC, responsible for priming of naive T cells
Neutrophil		Most common leukocyte in blood, first responder in inflamed or necrotic tissue	Engulfs and kills bacteria and fungi, digests cellular debris	Attracted into tissues by chemokines, which are increased by T cell-derived IL-17
Eosinophil		Eosinophili granules contain major basic protein; recruited into inflamed tissue by eotaxin	Granule proteins are toxic to cells; involved in asthma and allergic diseases, and protective against invasive helminth infections	Surface IgE receptors; maturation and survival supported by IL-5 from T cells
Basophil		Present at low frequency in the blood	Release histamine, proteases, chemokines, and cytokines; contribute to allergic disease and anaphylaxis	IgE receptors hold IgE molecules that survey for antigen
Mast cell		Distributed throughout the tissues around the vasculature		


THANK YOU