Immunology:

Definition, Classification, and innate immunity

Lecture 1

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Definition of immunology:

- The science of Immunology encompasses studying the development, anatomy, functions, and malfunctions of the immune system, all of which are of fundamental importance to understanding human disease.

Immune System

- The immune system is the group of organs, molecules, and special cells that are distributed in every tissue of the body, which acts in a coordinated manner to provide non-specific and specific protection against:
    - Microorganisms
    - Microbial toxins
    - Tumor cells
  - Crucial to human survival

The immune system (IS)

- From the morphological point of view, the immune system is a diffuse organ; it weights app. 1 kg in adults
- Primary and secondary lymphoid organs
- Numerous leucocytes, macrophages, dendritic cells etc., all to gather are their app. 10^{12} cells
- Billions of molecules (antibodies, cytokines, regulatory, anti-microbial, transport molecules, etc.) – 10^{20}

- **Immune system consists of the following activities:**
  - Defense against invading pathogens (viruses & bacteria)
  - Removal of 'worn-out' cells (e.g., old RBCs) & tissue debris (e.g., from injury or disease)
  - Identification & destruction of abnormal or mutant cells (primary defense against cancer)
  - Rejection of 'foreign' cells (e.g., organ transplant)
  - Inappropriate responses:
    - **Allergies - response to normally harmless substances**
    - **Autoimmune diseases**

- The immune system normally recognizes and responds to foreign molecules or damaged self cells, but not healthy host cells and tissues.

- That is, the immune system must be able to **distinguish** what is **non-self** (foreign) from what is **self**. The immune system can make this distinction because all **cells** have identification molecules (antigens) on their surface. Microorganisms are recognized because the identification molecules on their surface are foreign.

Definition of immunity (immune response):

- It is the state (process) of protection against foreign organisms or substances (antigens)

Types of Immunity

There are two types of immunity

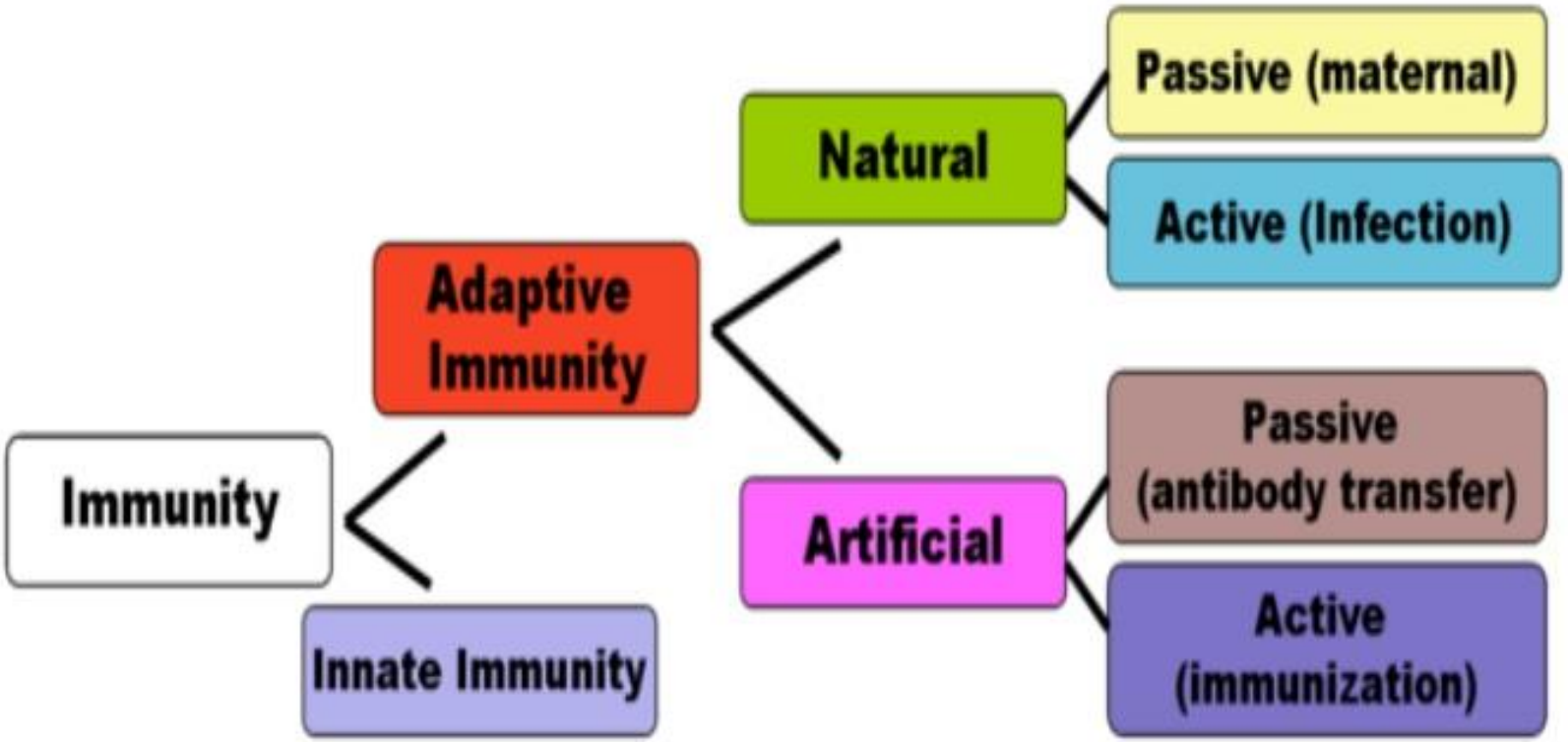
I. Innate Immunity

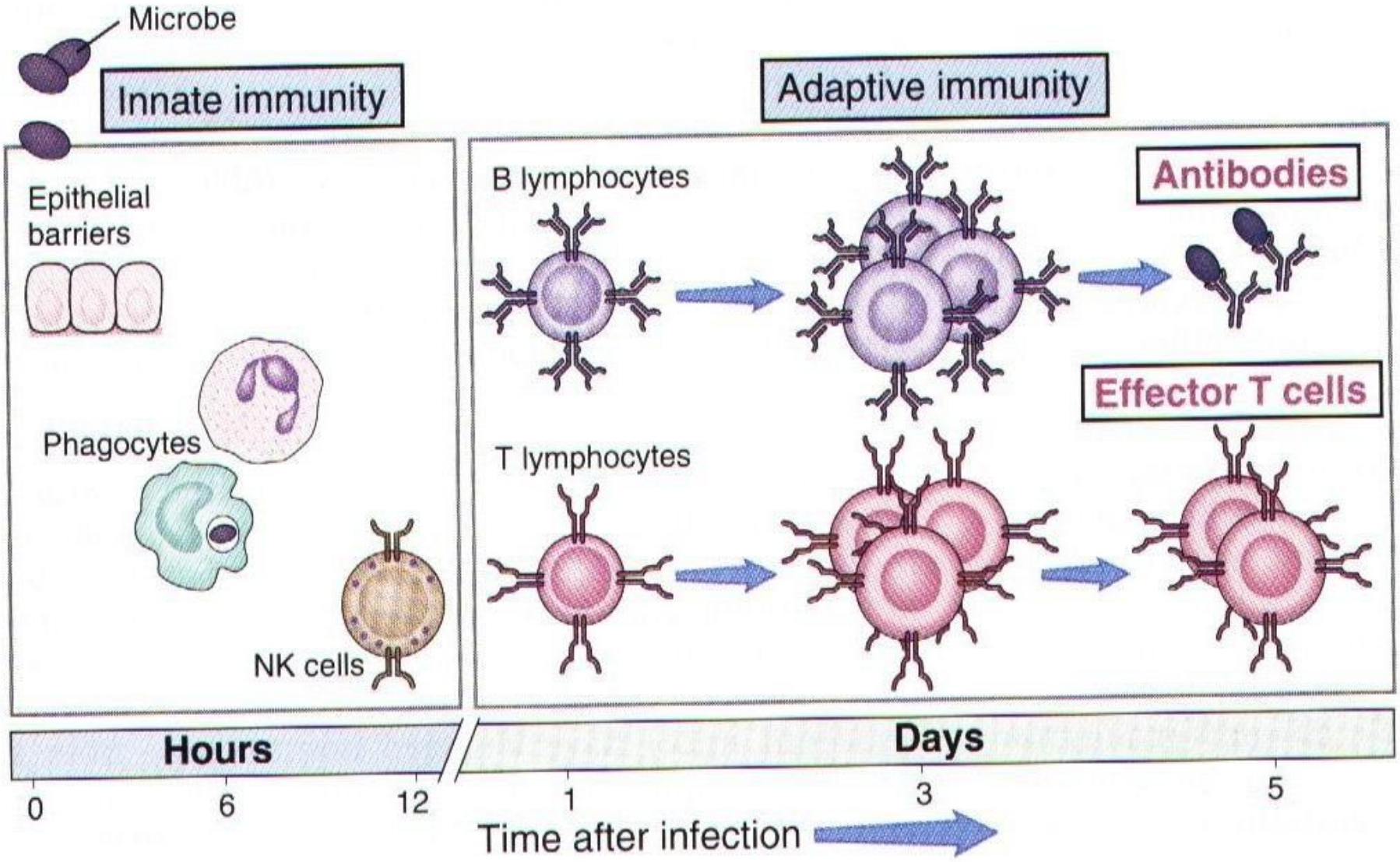
(or native immunity/ non-specific immunity/congenital immunity)

II. Adaptive Immunity

(or acquired immunity/specific immunity)

Basic classification of Immunity




Microbe
Innate immunity
Adaptive immunity
Epithelial barriers
Phagocytes
NK cells
B lymphocytes
Antibodies
T lymphocytes
Effector T cells
Hours
Days
0
6
12
1
3
5
Time after infection

Naturally Acquired Immunity

- Active
  - Antigens enter the body naturally with the response of
    - Innate and adaptive immune systems
  - Provides long-term protection

- Passive
  - Antibodies pass from mother to
    - Fetus across the placenta
    - Infant in breast milk
  - Provides immediate short-term protection

Artificially Acquired Immunity

- Active
  - Antigens enter body through vaccination with response of
    - Innate and adaptive immune systems
  - Provides long term protection

- Passive
  - Antibodies from immune individuals injected into body
    - Referred to as
      - Immune serum globulins (ISG)
      - Immune globulins (IG)
      - Gamma globulins
  - Provides immediate short term protection

The innate (non-specific, non-adaptive, non-acquired) immune system:

- Refers to nonspecific defense mechanisms (**first responders)** that come into play immediately or within hours (**fast)** of an antigen's appearance in the body.
- Exists at birth
- Be the first line of defense against infection

The innate (non-specific, non-adaptive, non-acquired) immune system:

- The mechanisms of innate immunity present as normal components and are **not induced by exposure to infectious agents**, although their numbers might increase upon exposure like increase in WBCs during acute phase of many infections.

The innate (non-specific, non-adaptive, non-acquired) immune system:

- Innate immunity refers to **pre-existing nonspecific** defense mechanisms that come into play **immediately or within hours** of an antigen (non-self) appearance in the body.

- is a multi-layer system of physical, chemical, and cellular defenses that are ready for immediate activation by a pathogen.

Innate immunity……..continue

Characteristics

- Exists naturally
- Non–specific
- No immune memory (innate immunity can't be enhanced by the second stimulation of the same antigen)

Immune memory: Exposure of the immune system to a foreign antigen enhances its ability to respond again to that antigen.

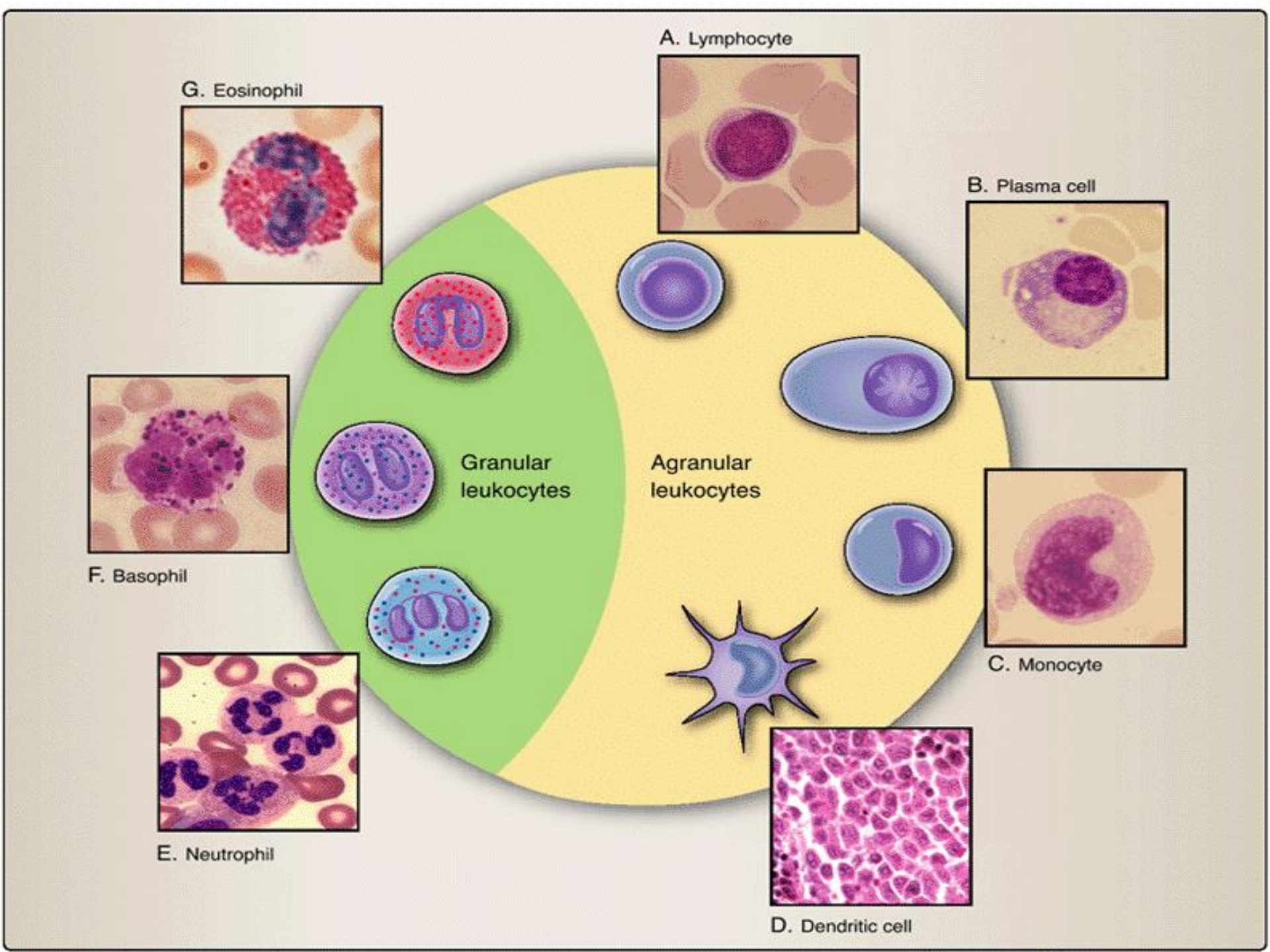
- No MHC (Major Histocompatibility Complex) restricted.
- Have receptors called **pattern recognition receptors (PRR).**
- Hereditable
- No racial difference

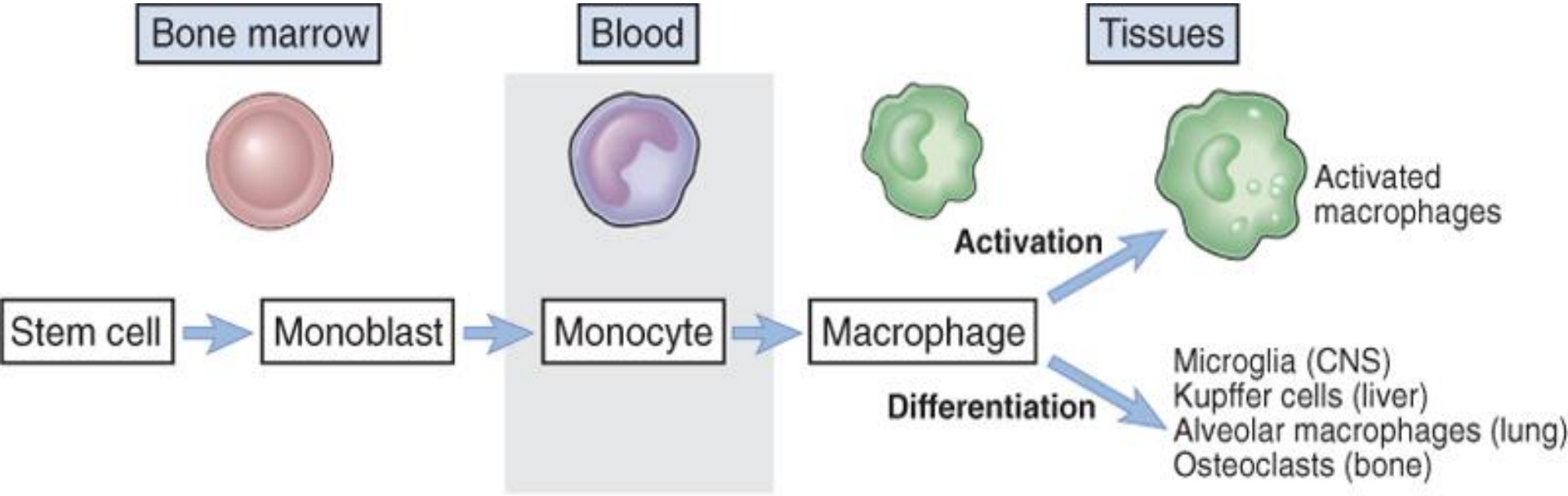
Innate immunity vs Adaptive Immunity

Innate Immunity (first line of defense)	Adaptive Immunity (second line of defense)
No time lag	A lag period
Not antigen specific	Antigen specific
No memory	Development of memory

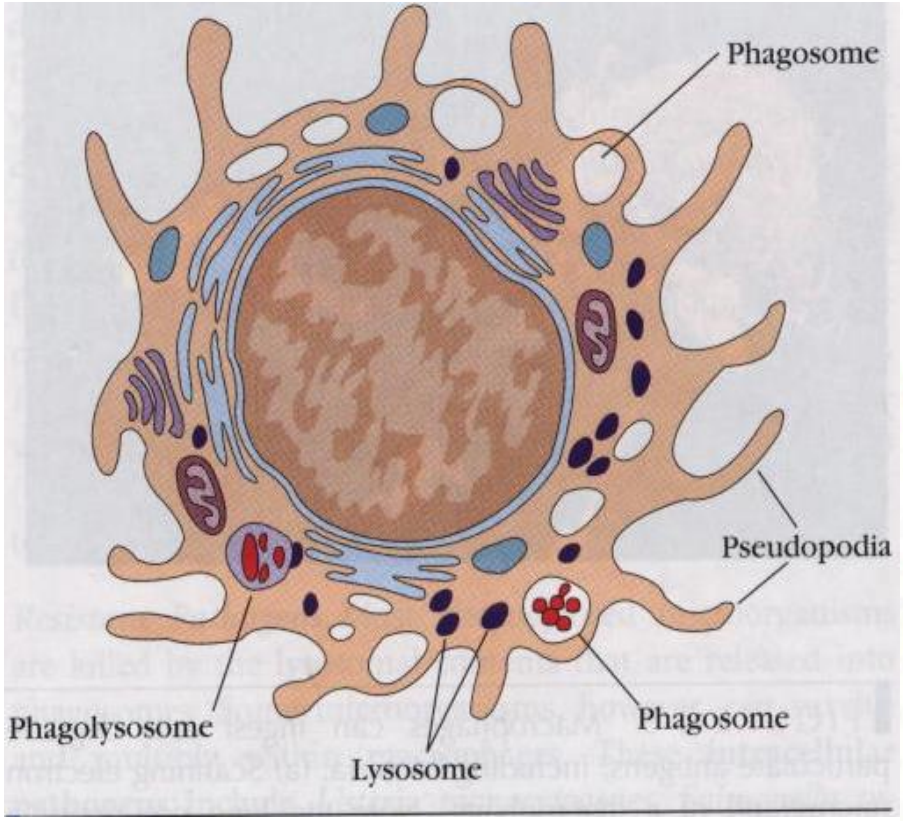
Cells of the innate immunity

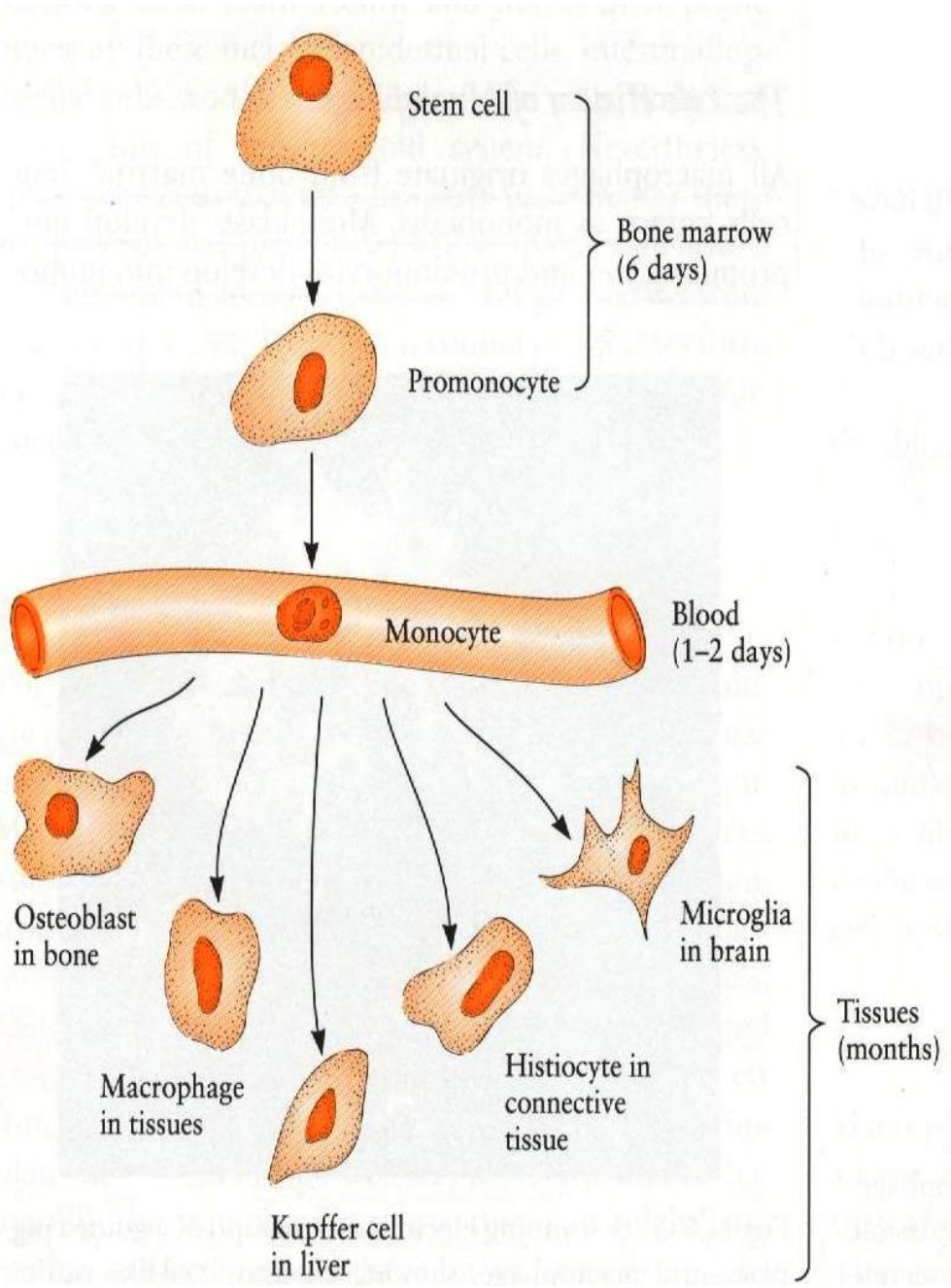
Phagocytes	Neutrophils
	Eosinophils
	Monocytes
	Macrophages
Cytotoxic cells	NK-cells
Mediator cells	Basophils
	Mast cells


A. Lymphocyte
G. Eosinophil
B. Plasma cell
Granular leukocytes
Agranular leukocytes
F. Basophil
C. Monocyte
E. Neutrophil
D. Dendritic cell



Macrophages





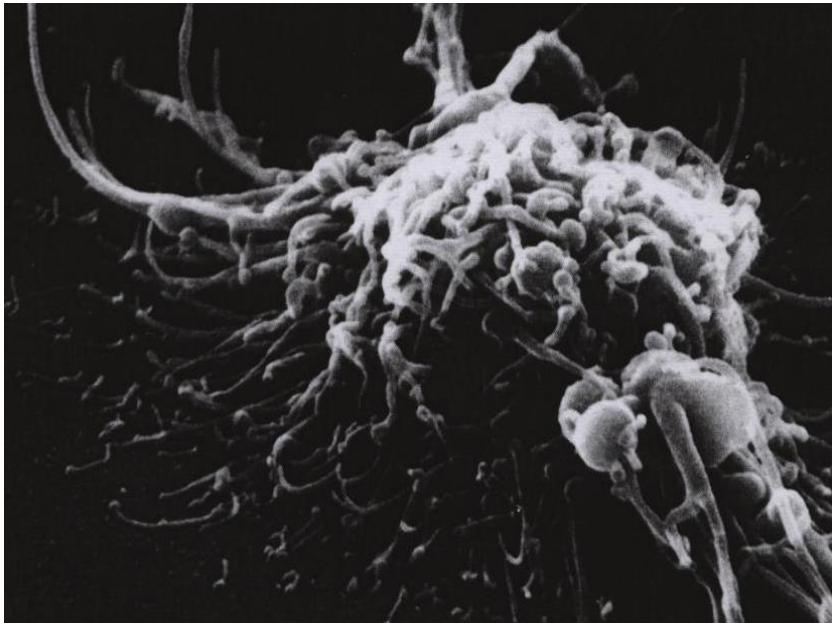
Dendritic cells (DC)

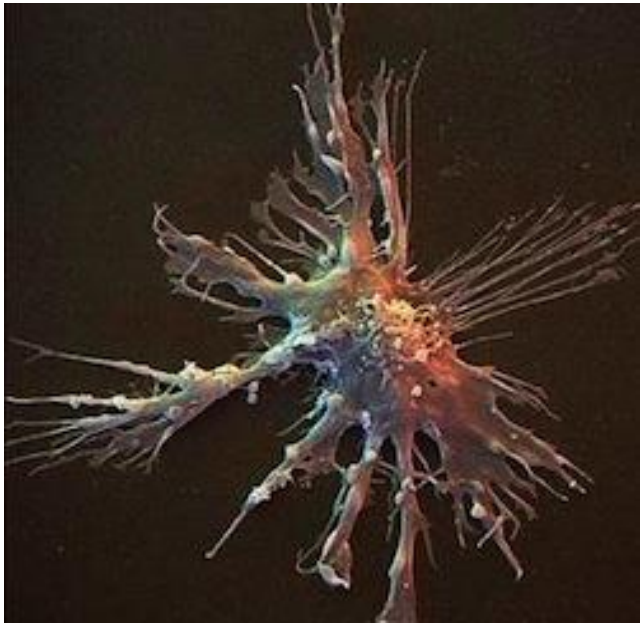
Myeloid DC (antigen processing)

Plasmacytoid DC (production of IFN-I)

Folicular DC (capture of immune complexes, i.e. complexes of antigens bound to its antibodies)

Myeloid dendritic cell





Follicular dendritic cells