

قَالَ اللَّهُ تَبَّ
عَلَى الْعِبَادِ
مَنْ كَفَرَ
بِأَيِّدِي اللَّهِ
وَأَقْرَبِهِمْ
وَأَقْرَبِهِمْ
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٤٢

RETICULOENDOTHELIAL SYSTEM AND FUNCTION OF THE SPLEEN

Nonspecific Host Defenses

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OBJECTIVES

At the end of this lecture you should be able to:

- ▶ **Classify immune systems**
- ▶ **Describe Monocyte macrophage system**
- ▶ **Functions of monocytes/macrophages in different tissues**
- ▶ **Mechanism of chemotaxis, phagocytosis and microbial killing**
- ▶ **Know the feedback control of macrophages & neutrophils and Pus formation**
- ▶ **Explain functions of spleen**

IMMUNITY

```
graph TD; A[IMMUNITY] --> B["Innate immunity  
(non specific)"]; A --> C["Acquired immunity  
(specific, adaptive)"]; B --> D["• Phagocytes  
• Complement  
• Barriers"]; C --> E["Cell mediated  
T lymphocytes"]; C --> F["Humoral  
Antibody mediated  
B lymphocytes"]; G["Note: Macrophages are key components of the innate immunity and activate adaptive immunity by transforming into Antigen Presenting Cells"]
```

Innate immunity (non specific)

Examples:

- Phagocytes
- Complement
- Barriers

Acquired immunity (specific, adaptive)

Cell mediated
T lymphocytes

Humoral
Antibody mediated
B lymphocytes

Note: Macrophages are key components of the innate immunity and activate adaptive immunity by transforming into Antigen Presenting Cells

BARRIERS

(Chemical barriers)

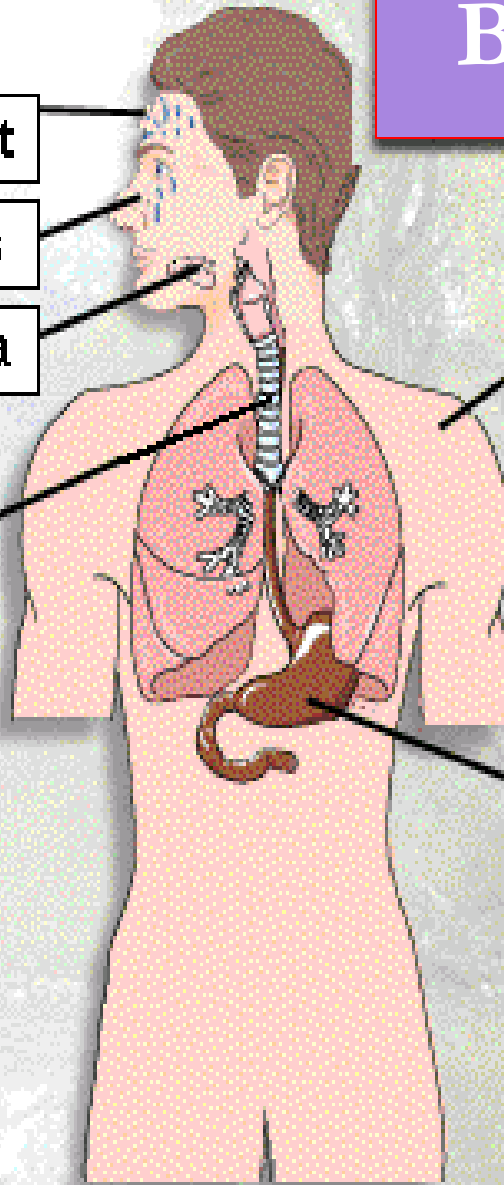
Sweat

Tears

Saliva



Trachea / Cilia
(Physical barrier)



Skin

(Physical barrier)

Stomach acid

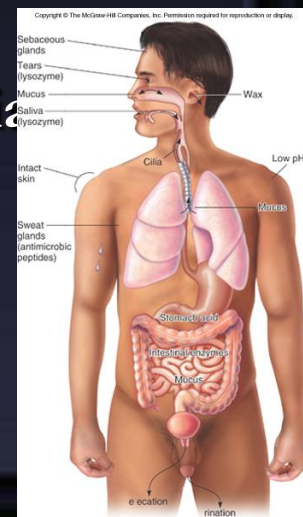
(Chemical barrier)

Physical or Anatomical Barriers:

First Line of Defense

Skin and mucous membranes of respiratory, urogenital, eyes and digestive tracts;

- outermost layer of **skin** is composed of epithelial cells compacted, cemented together and impregnated with keratin; few pathogens can penetrate if intact
- flushing effect of **sweat glands**
- damaged cells are rapidly **replaced**
- **mucous coat** impedes attachment & entry of bacteria
- blinking and **tear** production
- stomach **acid**
- **nasal hair** traps larger particles



Nonspecific Chemical Defenses

- Sebaceous secretions
- Lysozyme, an enzyme that hydrolyzes the cell wall of bacteria, in tears
- High lactic acid and electrolyte concentration in sweat
- Skin's acidic pH
- Hydrochloric acid in stomach
- Digestive juices and bile of intestines
- Semen contains antimicrobial chemical.
- Vagina has acidic pH.

RETICULOENDOTHELIAL SYSTEM

- Monocytes transform themselves into macrophages in tissue these macrophages are mononuclear cells, & this system of phagocytes is called as **Monocyte-Macrophage Cell System**
- This system of cells was known as reticuloendothelial system although neither they are reticular in appearance nor they have endothelial origin
- Therefore, the term reticuloendothelial system is obsolete.

Reticuloendothelial System

Monocyte/Macrophage System

TISSUE MACROPHAGE SYSTEM

- Monocytes
- Mobile macrophages
- Fixed tissue macrophages
- Specialized endothelial cells in bone marrow, spleen and lymph nodes

WBC TYPES (CLASSIFICATION)

■ Granulocytes

- Polymorphonuclear leukocytes (PMNs)
- Neutrophils
- Eosinophils
- Basophils




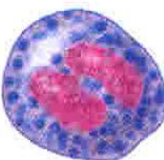



■ Agranulocytes

- Lymphocytes
 - T lymphocyte
 - B lymphocyte
- Monocytes → macrophage system

CLASSIFICATION

GRANULOCYTES

AGRANULOCYTES

Erythrocytes	Leukocytes					Platelets
	Polymorphonuclear granulocytes			Monocytes	Lymphocytes	
	Neutrophils	Eosinophils	Basophils			
						

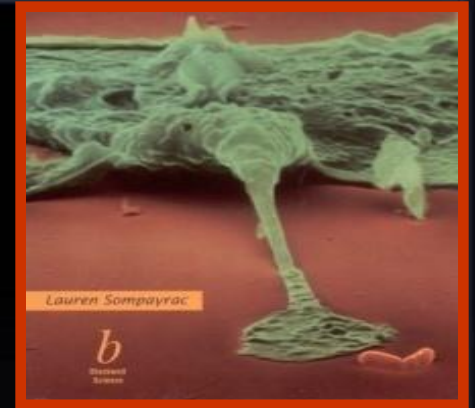
Concentration (Normal Counts)

Cells	Approximate Normal range (/μL)	Percentage of Total WBC	Life Span
Total WBC	4000-11000	- - -	
Granulocytes • Neutrophils • Eosinophils • Basophils	3000-6000 150-300 0-100	50-70 1-4 0.4	4-8 hours in blood and 4-5 days in tissues
Lymphocytes	1500-4000	20-40	Weeks-months
Monocytes (macrophages)	300-600	2-8	10-20 hours (months)

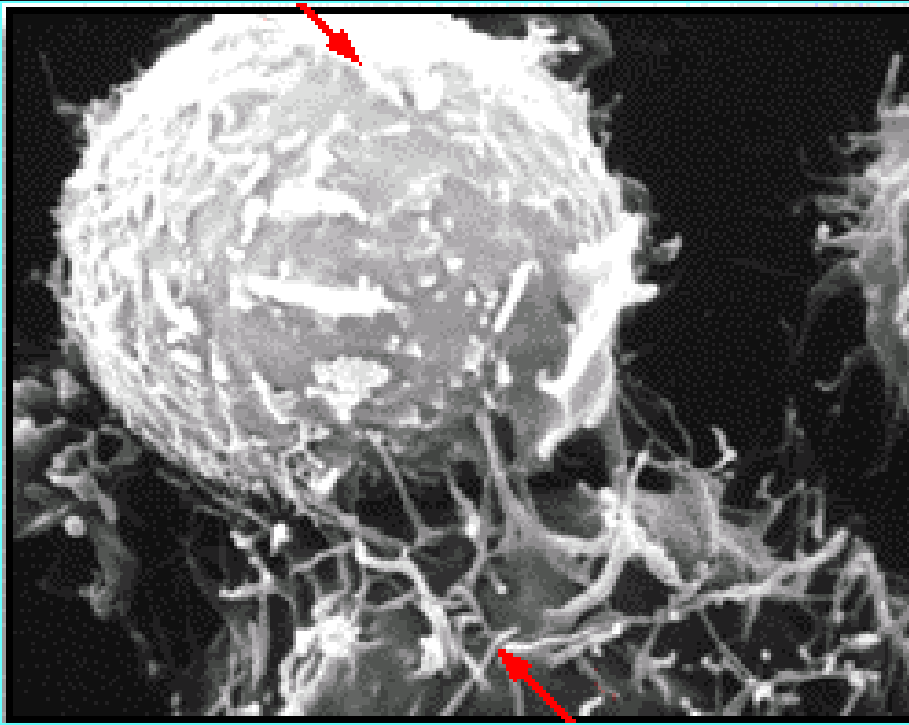
Macrophage and Neutrophil Responses During Inflammation

- ❑ **1st** line of defense – Tissue macrophages & Physical Barriers
- ❑ **2nd** line of defense – Neutrophil Invasion of the inflamed area
- ❑ **3rd** line of defense – Monocytes –macrophage invasion of inflamed area
- ❑ **4th** line of defense – Increased production of granulocytes and Monocytes by Bone marrow

MONOCYTES

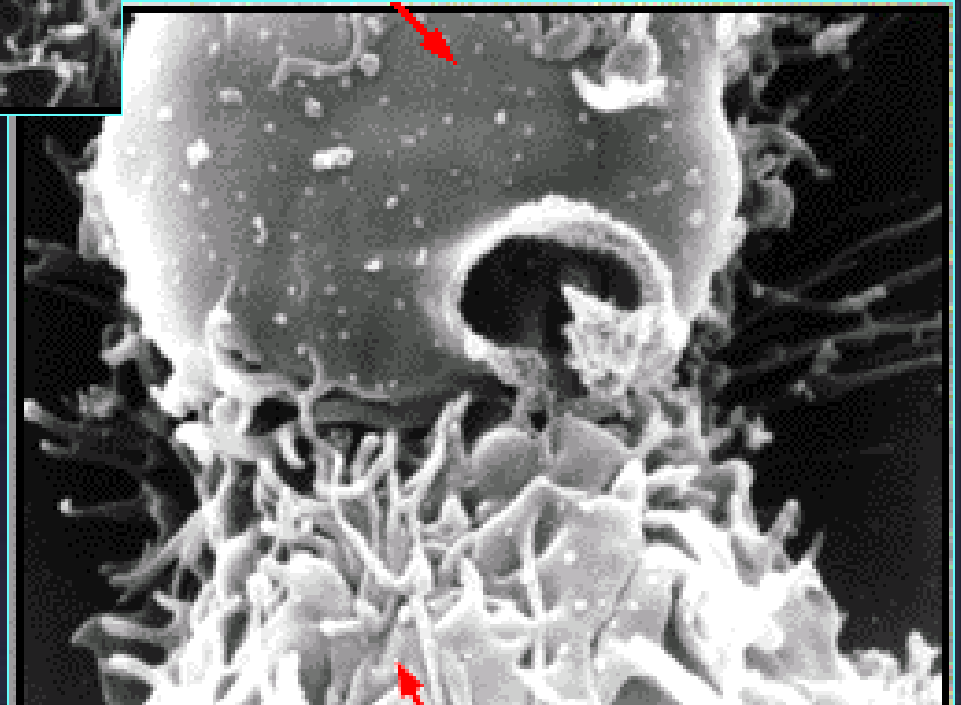


- No Granules but Vacoules
- Size: 15-20 μm (active cells 60-80 μm)
- More Efficient than Neutrophils (100 bacteria vs 3-20 by Neutr, larger particles like RBCs & malarial parasites)
- Life span: 10-20 hours in blood
- Two types: Mobile & Fixed
- Lysosomes contain lipases unlike Neut.



**RESTING
MACROPHAGE**

**ACTIVATED
MACROPHAGE**



A fluorescence micrograph showing a large, green, irregularly shaped cell with a prominent, long, thin protrusion extending downwards. The cell has a textured, ruffled appearance. The background is a dark, reddish-brown color. In the bottom right corner, there is a small, bright, elongated object. The entire image is framed by a dark blue border with a thin orange inner line.

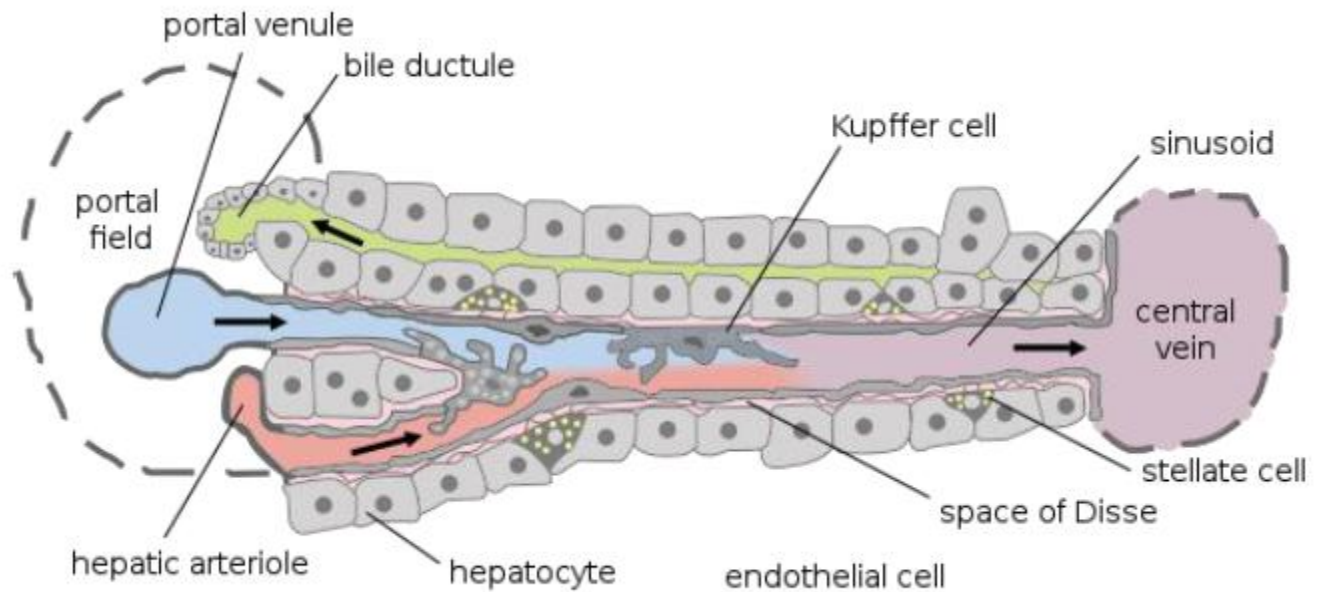
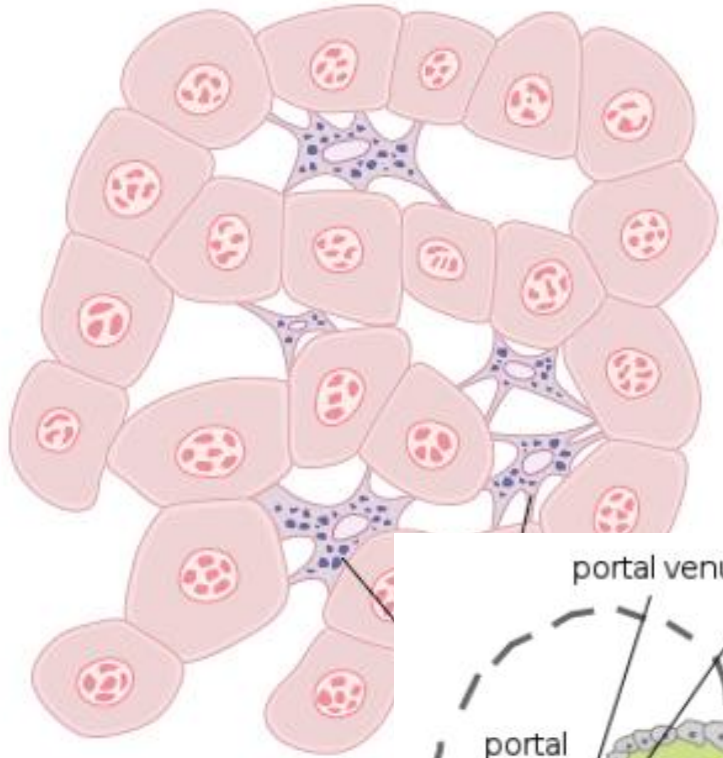
**ACTIVATED
MACROPHAGE**

Reticuloendothelial System Monocytes/Macrophage System

Examples are: -

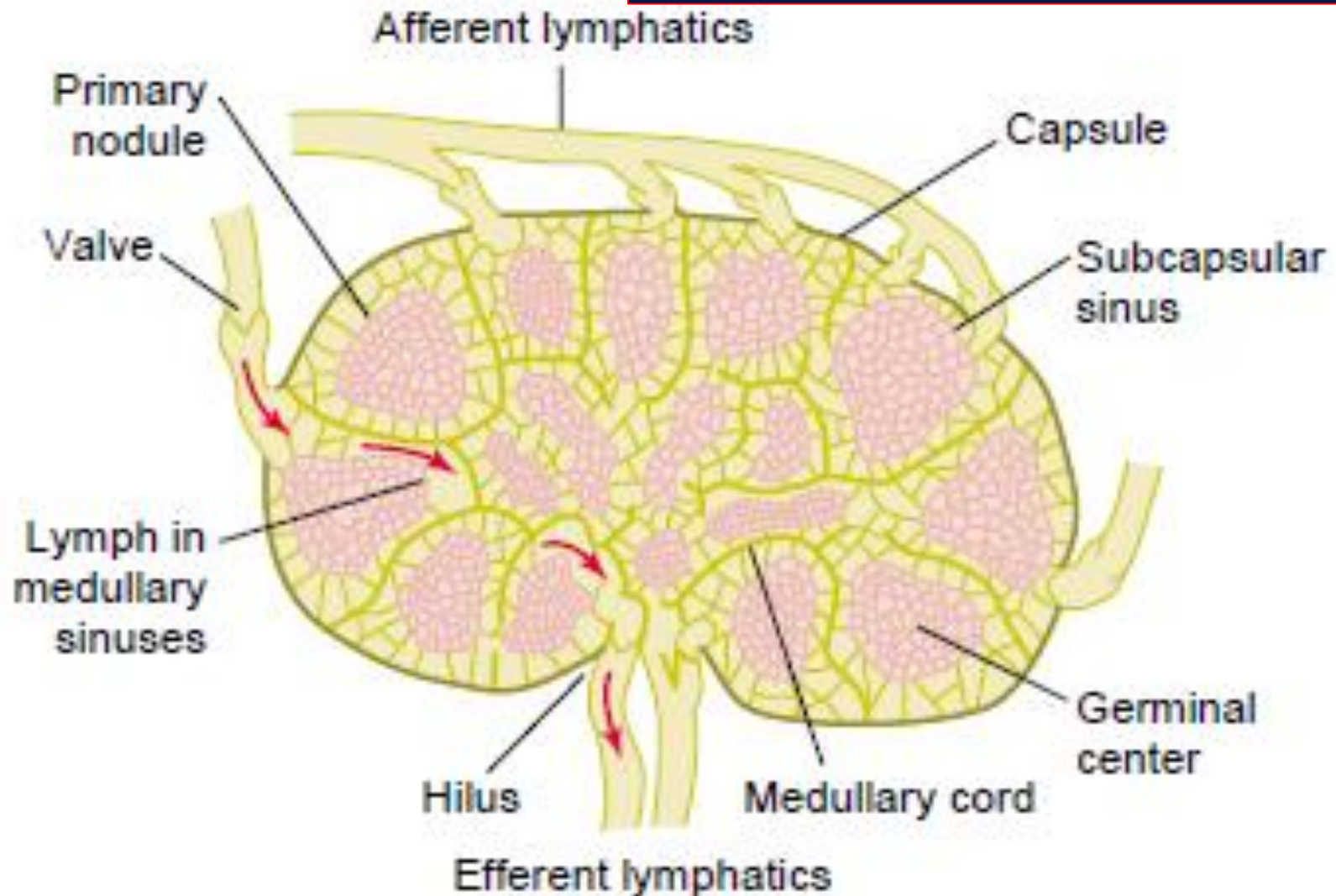
- 1. Skin and Subc tissues (Histiocytes)**
- 2. Lymph Nodes**
- 3. Alveolar macrophages**
- 4. Liver sinuses (Kupffer Cells)**
- 5. Spleen & Bone marrow**
- 6. Microglia in Brain**

Tissue macrophages in Liver sinuses



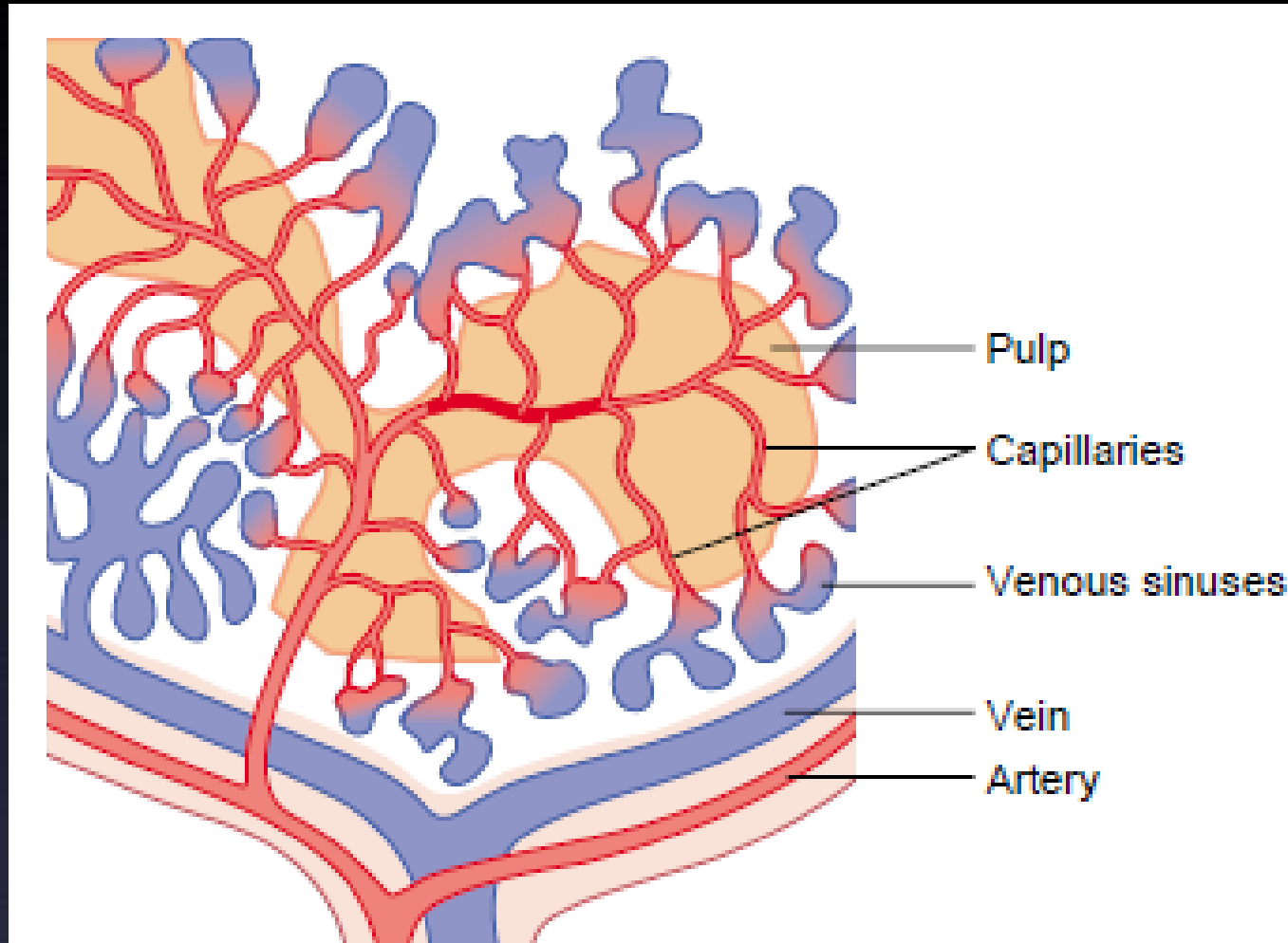
Tissue macrophages in Lymph Nodes

Macrophages line nodal medullary sinuses



Tissue macrophages in Spleen

The blood squeezes through the trabecular cords meshwork of red pulp.



FUNCTIONS OF SPLEEN

•Formation of blood cells

- play in important role in the hemopoietic function in embryo
- during the hepatic stage, spleen produces the blood cells along with liver

•Destruction of blood cells

- the older RBCs, lymphocytes & thrombocytes are destroyed in spleen

•Reservoir function

- a large number of RBCs are stored in spleen
- RBCs are released from spleen into circulation during the emergency conditions like hypoxia & hemorrhage

•Role in defense of body

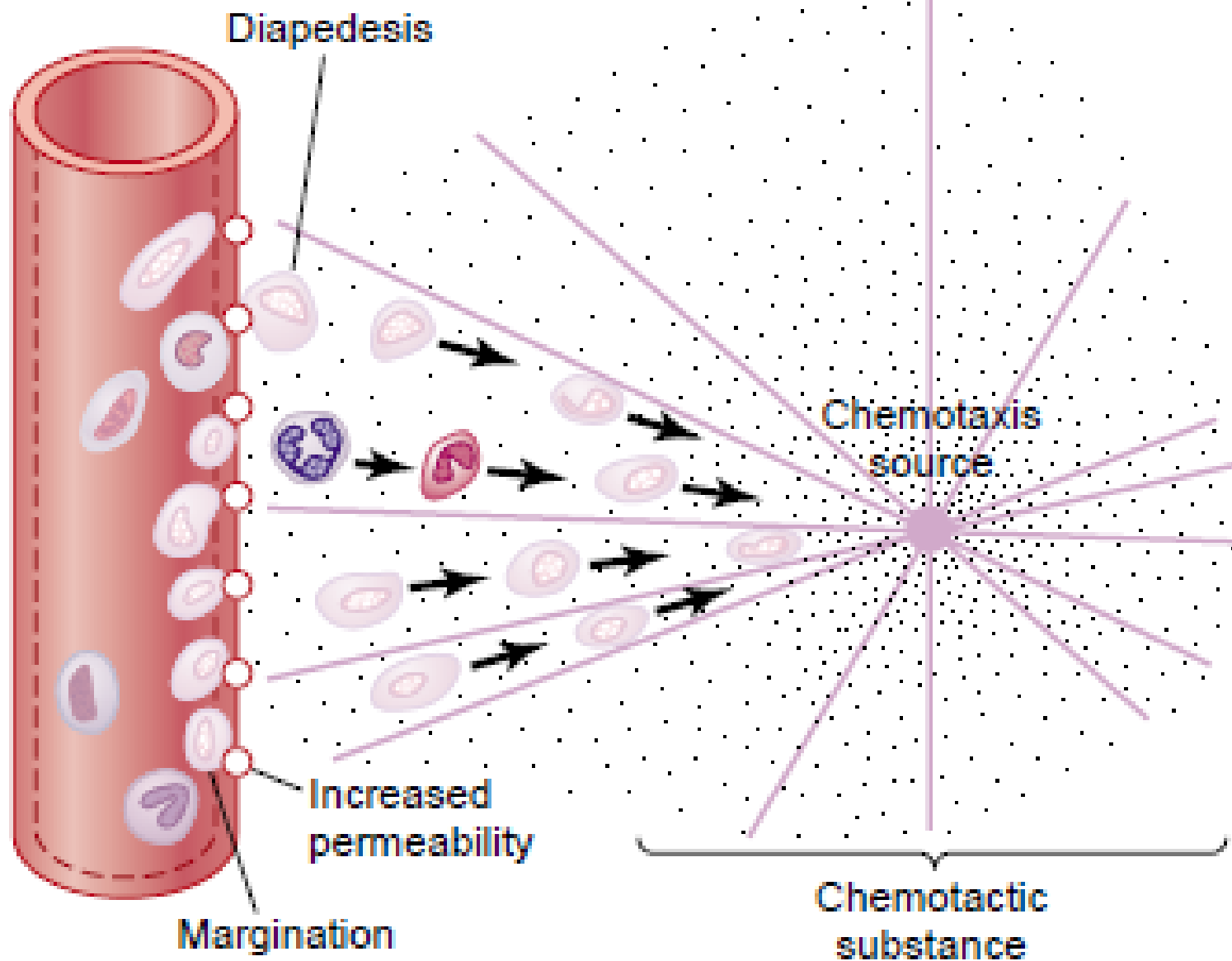
- spleen filters the blood by removing the microorganism
- macrophages in splenic pulp phagocytose microorganisms & foreign bodies
- spleen contains about 25% of T lymphocytes & 15% of B lymphocytes & form the site of antibody production

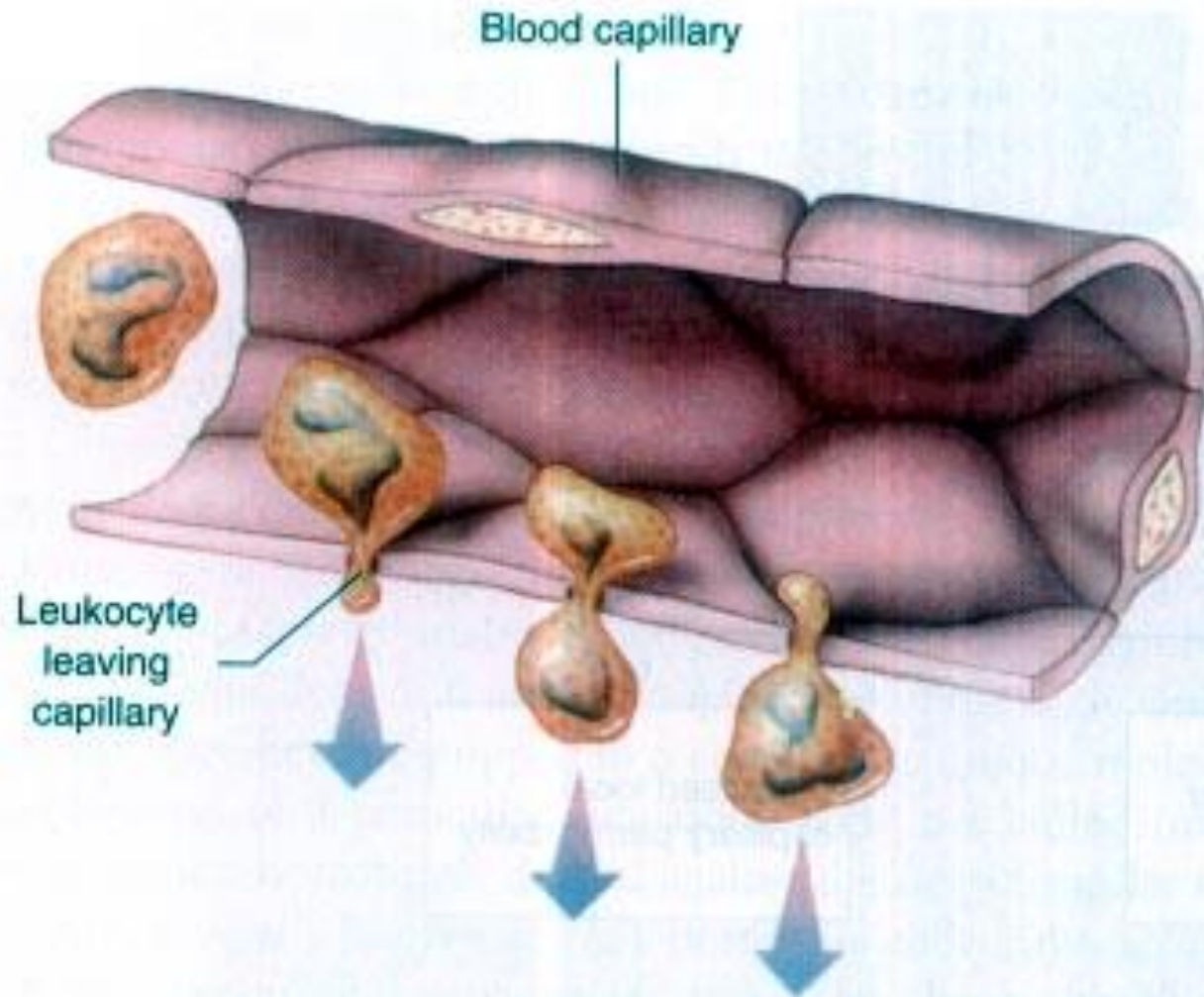
NEUTROPHILS

- Most Abundant WBCs 60-70 %
- Size: 15-20 μm
- Nucleus: Multilobed 2-5 lobes
- Life span: 6-8 hours

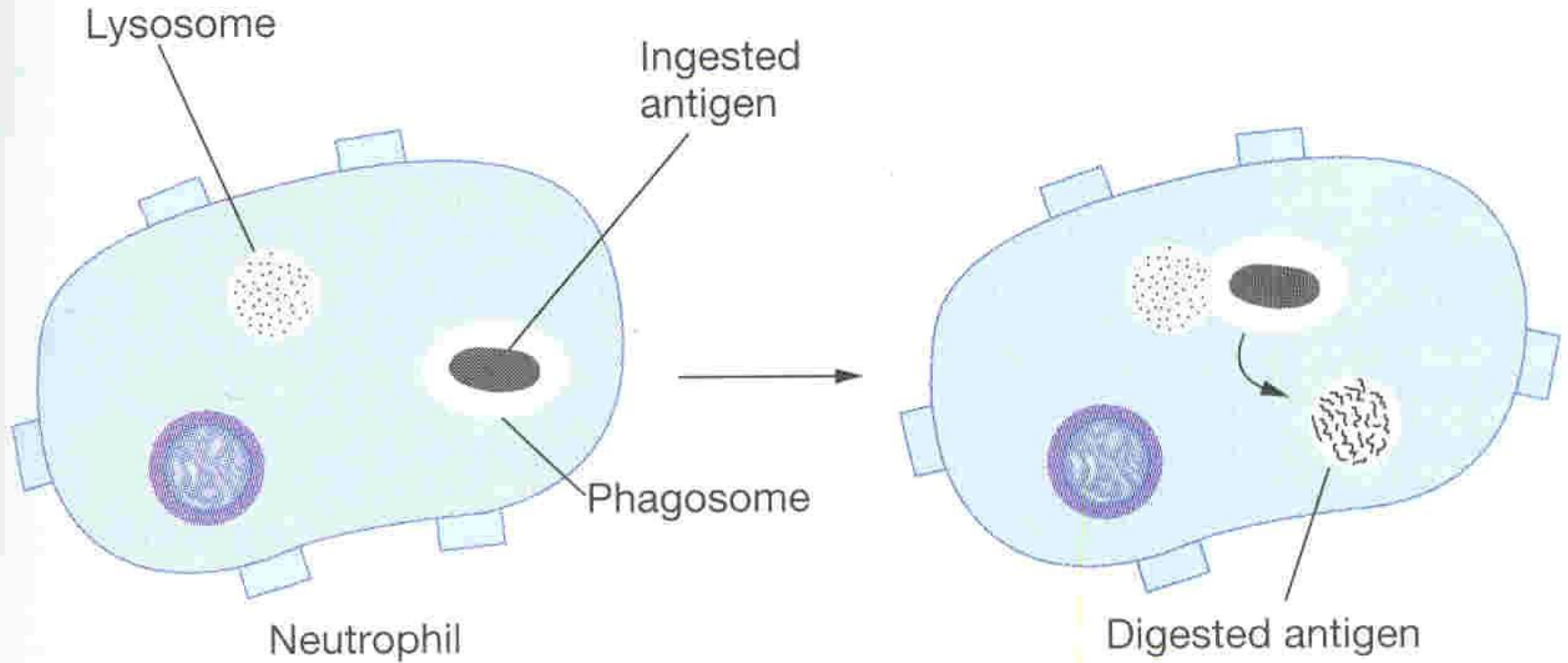
DEFENSIVE PROPERTIES OF MACROPHAGES & NEUTROPHILS

1. Diapedesis
2. Chemotaxis
3. Opsonization
4. Degranulation
5. Phagocytosis & Digestion

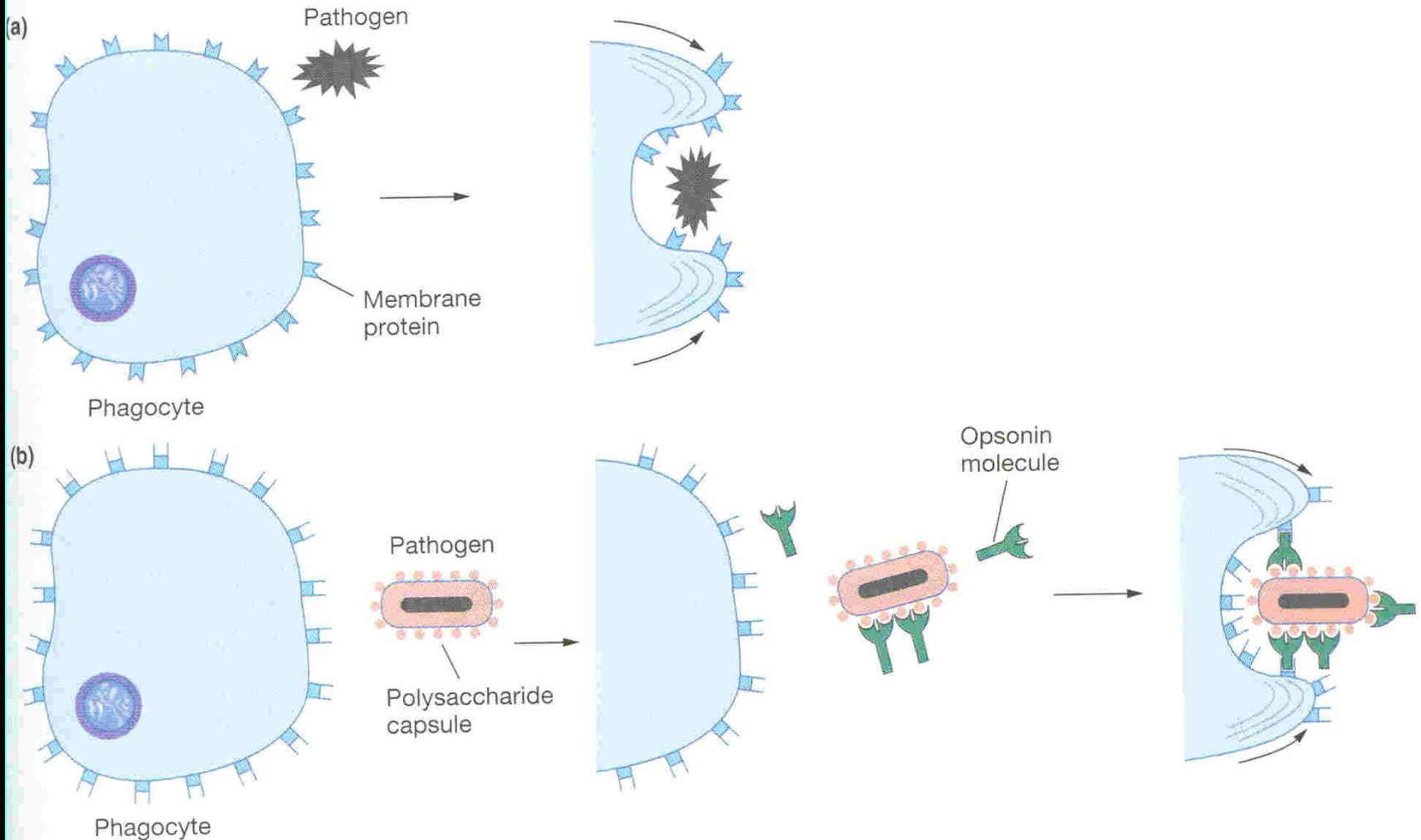




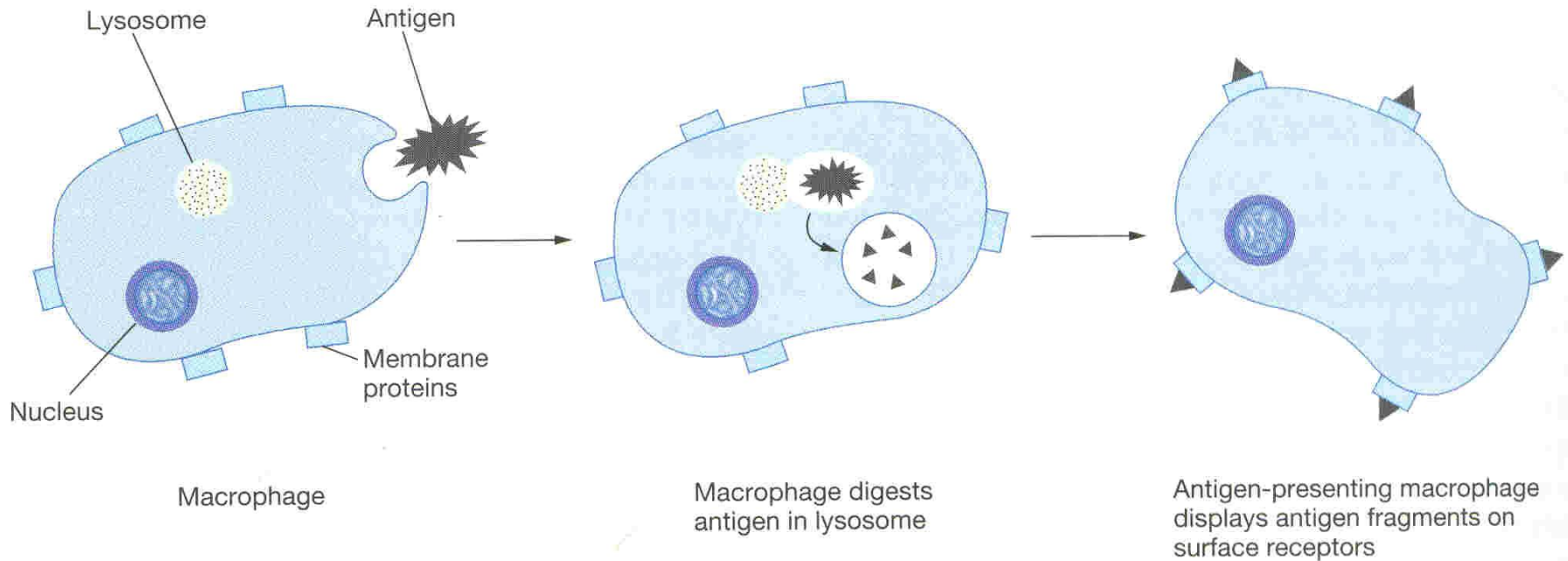
Phagocytosis & Digestion



Opsonization & Phagocytosis

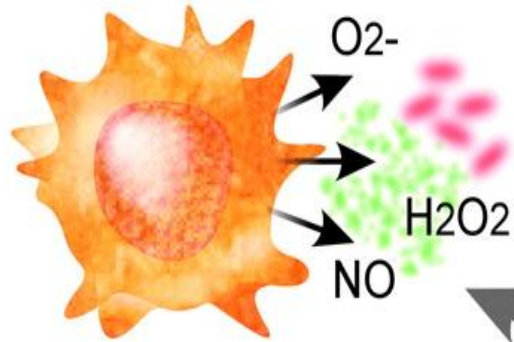


Antigen Presenting Cells

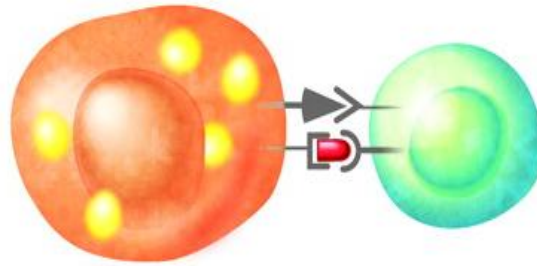


Antimicrobial
Actions

**Respiratory
Burst**



Antigen Presentation



**Activate adaptive
immunity**

Antigen/Antibody
Uptake



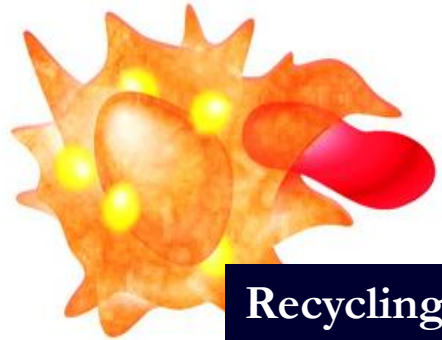
**Clearing
immune
complexes**

Monocyte

Bone remodeling

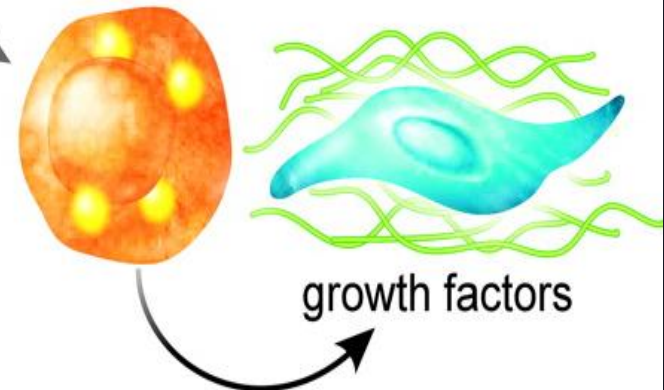


Bone Resorbtion



Recycling RBCs

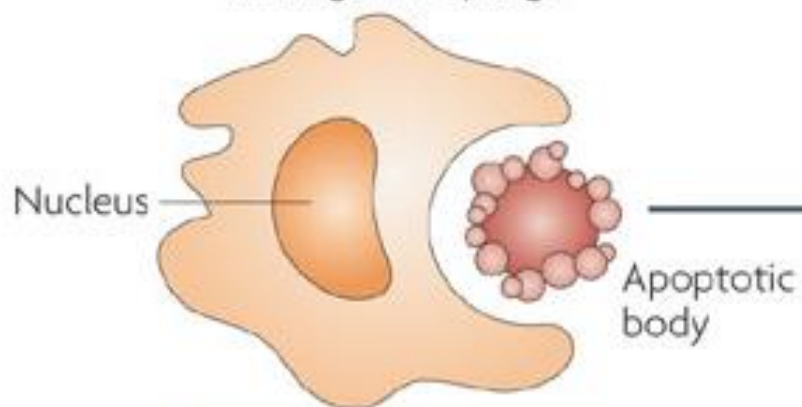
Phagocytosis



Wound Healing

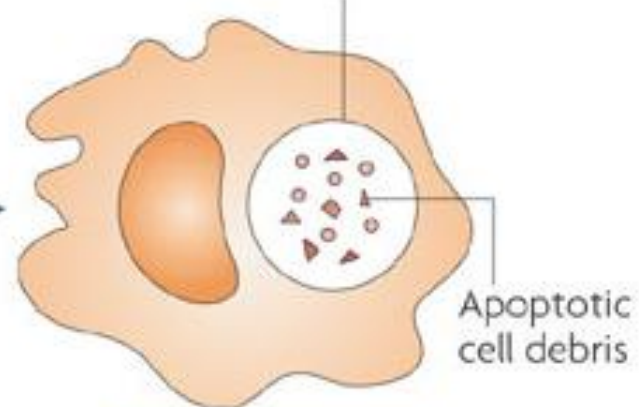
a

Resting macrophage

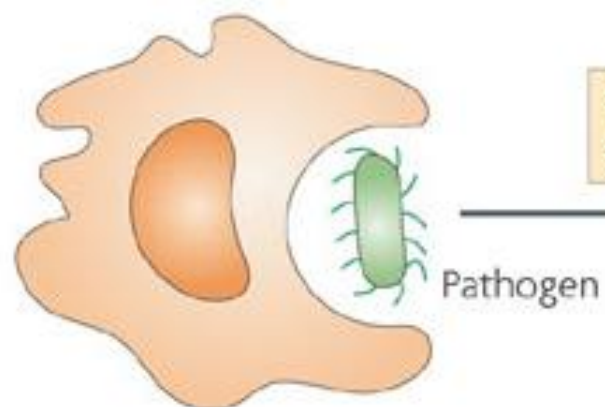


No inflammatory signals

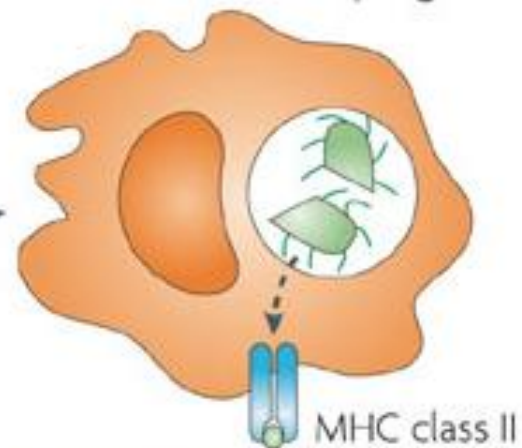
Highly degradative phagosome



No inflammation

bInflammatory signals
such as LPS and IFN γ \uparrow Superoxide burst
 \downarrow Proteolysis

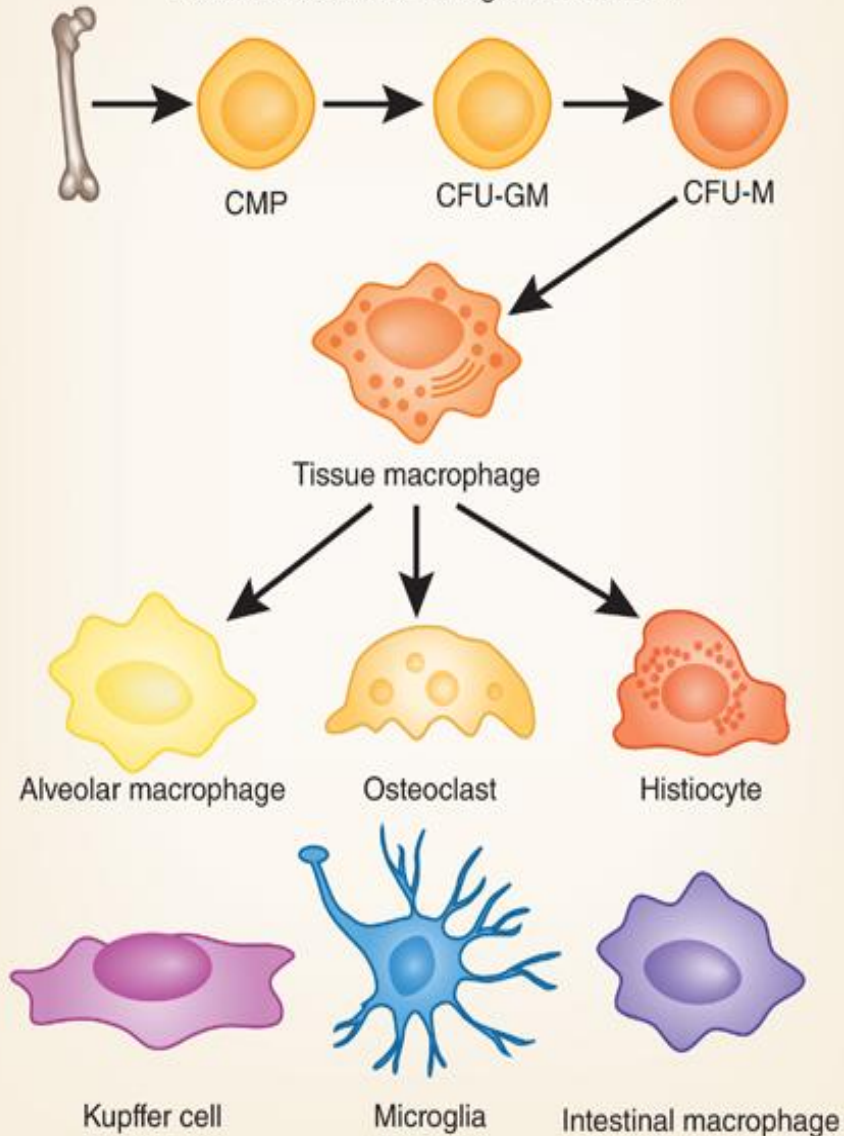
Activated macrophage

Inflammation and enhanced
antigen presentation

Macrophage populations

Less-flexible programming—determined during ontogeny

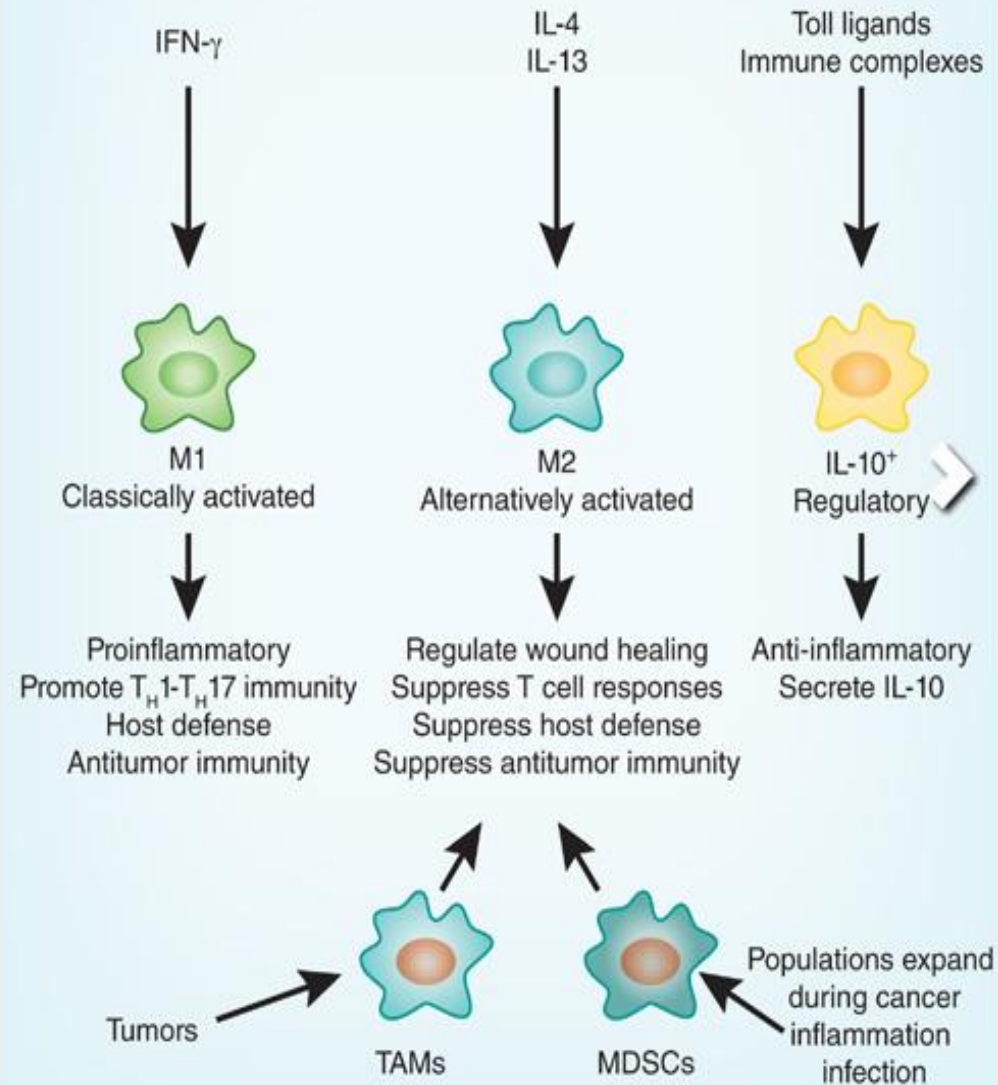
Specific transcription factors and epigenetic modifications direct lineage commitment



Macrophage activation phenotypes

Flexible programming—driven by microenvironmental signals

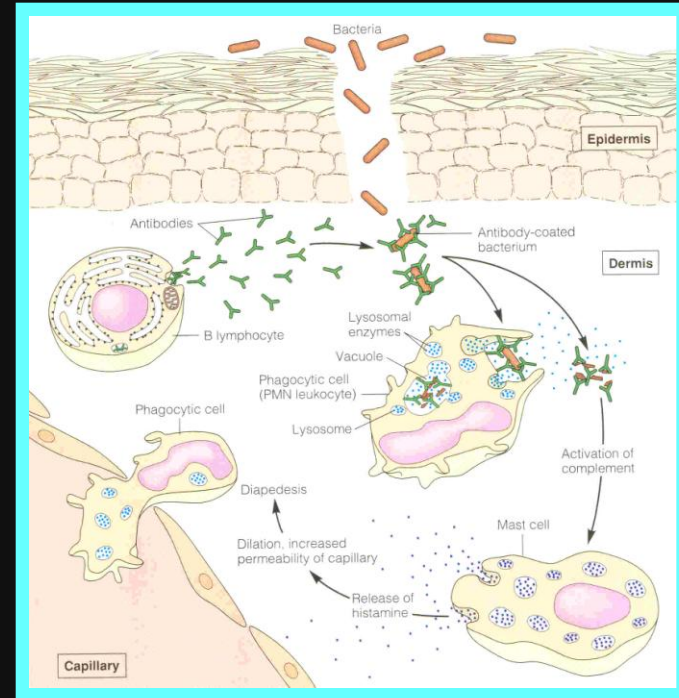
Cytokines, transcription factors and epigenetic changes modulate phenotypic and functional plasticity



PMNs Digestive System (Antimicrobial system)

ENZYMATIC Granules

- Heparin
- Histamine
- Bradykinin
- Serotonin
- Defensins
- Lysosomal enzymes
- Slow reacting substance of anaphylaxis



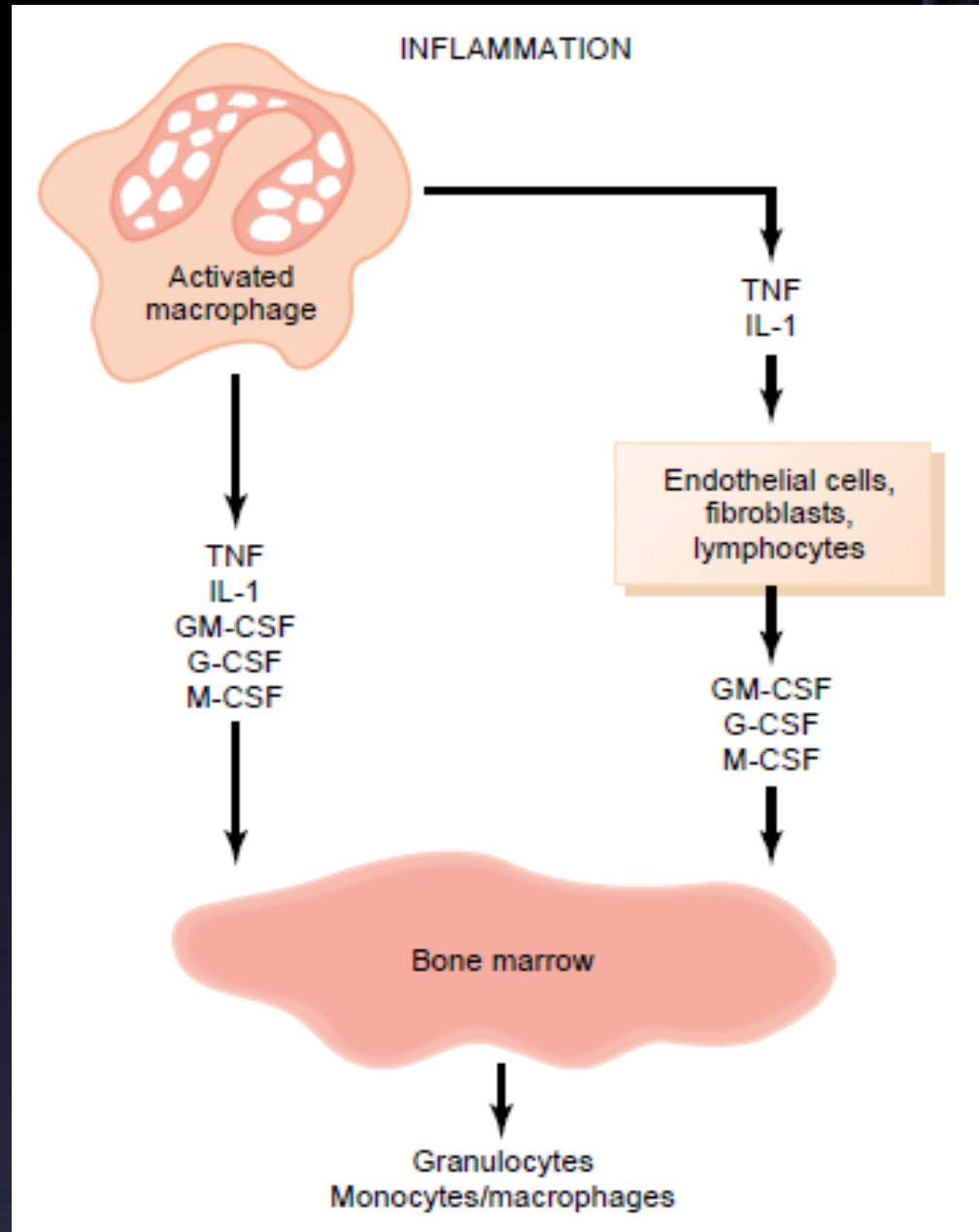
PMNs Digestive System (Antimicrobial system)

NON ENZYMATIC

respiratory burst

- O₂ Free Radicals (O⁻², H₂O₂, -OH)
- NADPH-oxidase
- Myeloperoxidase
- Cl⁻ → HOCl
- Hypochlorous acid “very toxic”

Feed Back Control of Macrophage & Neutrophil response



IMPORTANT TERMS

- **Pus** (necrotic tissue, dead neutrophils, dead macrophages and tissue fluid → Autolyze)
- **Leukocytosis**
- **Neutrophilia**
- **Leukopenia**
- **Leukemias**

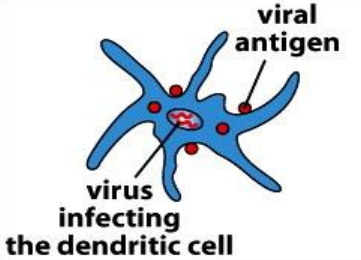
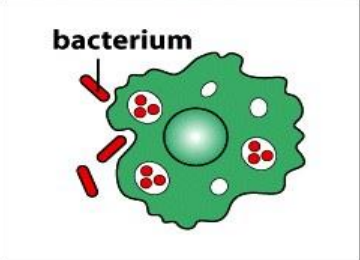
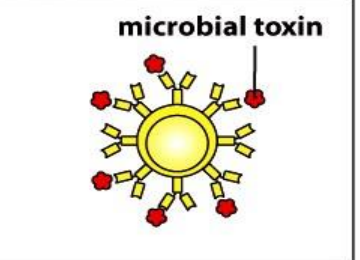
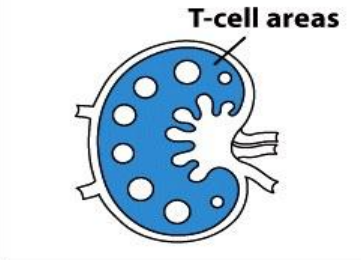
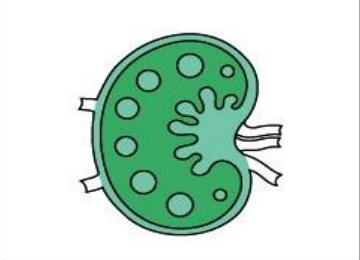
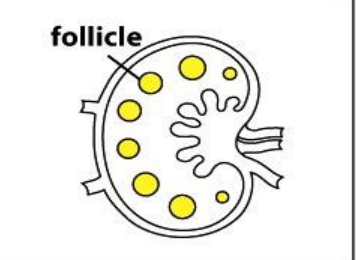
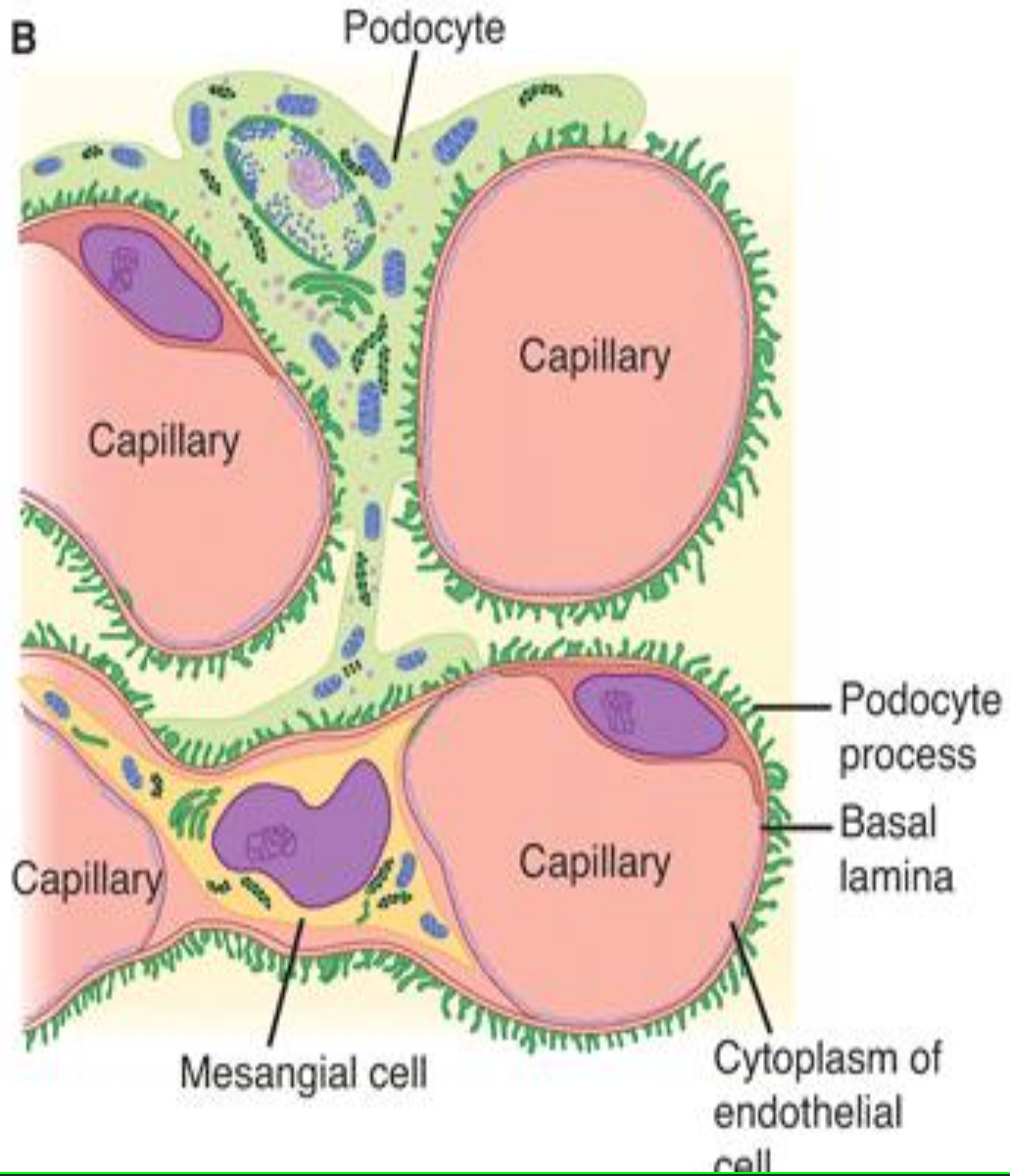
Professional antigen-presenting cells			
	Dendritic cell	Macrophage	B cell
Cell type			
Location in lymph node			
Antigen uptake	+++ Macropinocytosis and phagocytosis by tissue dendritic cells Viral infection	Phagocytosis +++	Antigen-specific receptor (Ig) ++++
MHC expression	Low on tissue dendritic cells High on dendritic cells in lymphoid tissues	Inducible by bacteria and cytokines - to +++	Constitutive Increases on activation +++ to ++++
Co-stimulator delivery	Constitutive by mature, nonphagocytic lymphoid dendritic cells ++++	Inducible - to +++	Inducible - to +++
Antigen presented	Peptides Viral antigens Allergens	Particulate antigens Intracellular and extracellular pathogens	Soluble antigens Toxins Viruses
Location	Ubiquitous throughout the body	Lymphoid tissue Connective tissue Body cavities	Lymphoid tissue Peripheral blood

Figure 8.11 The Immune System, 3ed. (© Garland Science 2009)

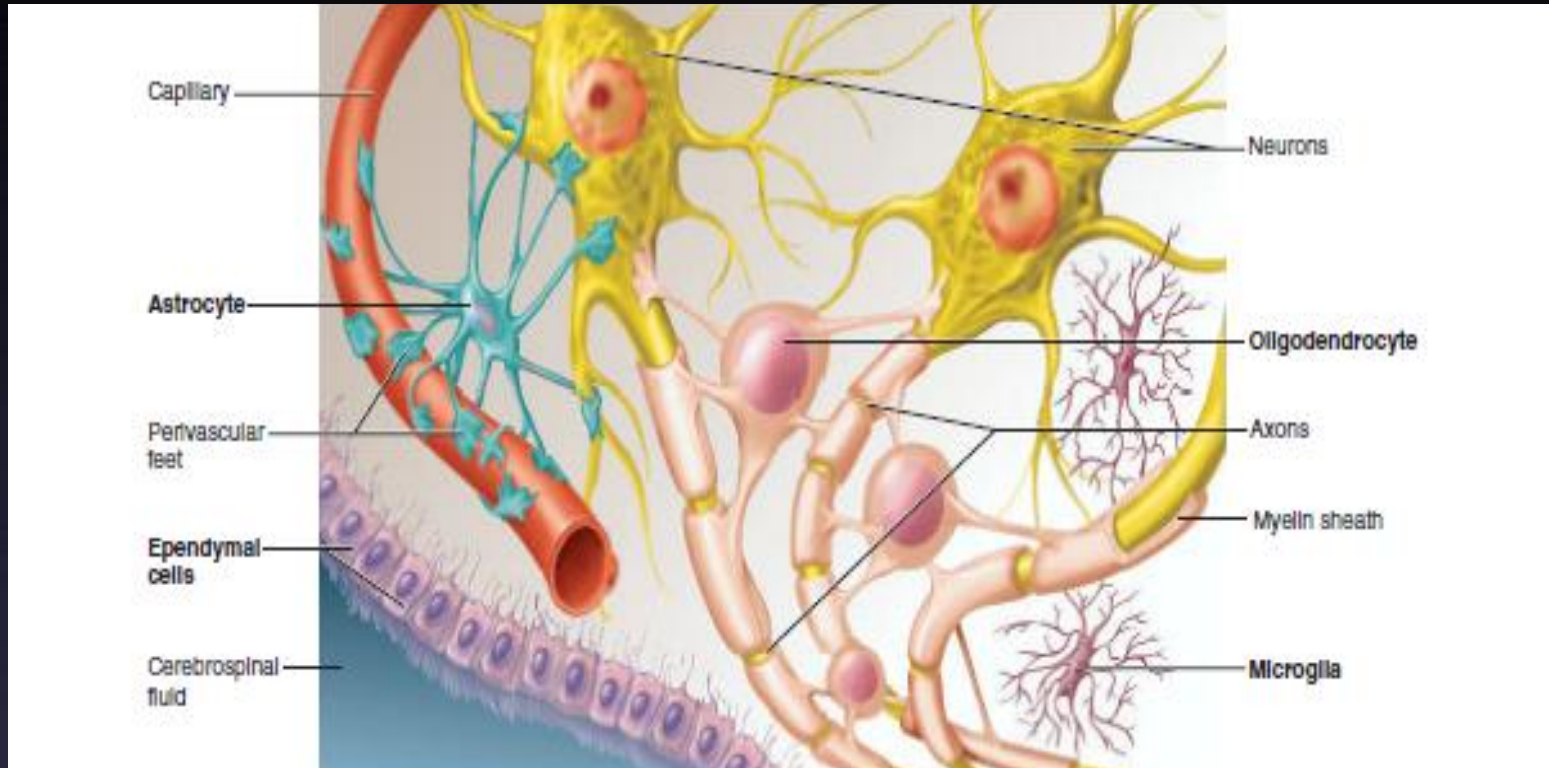
B



The different types of neuroglial cells

Myelin sheaths around axons are formed in the CNS by oligodendrocytes.

Astrocytes have extensions that surround both blood capillaries and neurons. Microglia are phagocytic, and ependymal cells line the brain ventricles and central canal of the spinal cord.



THANKS

