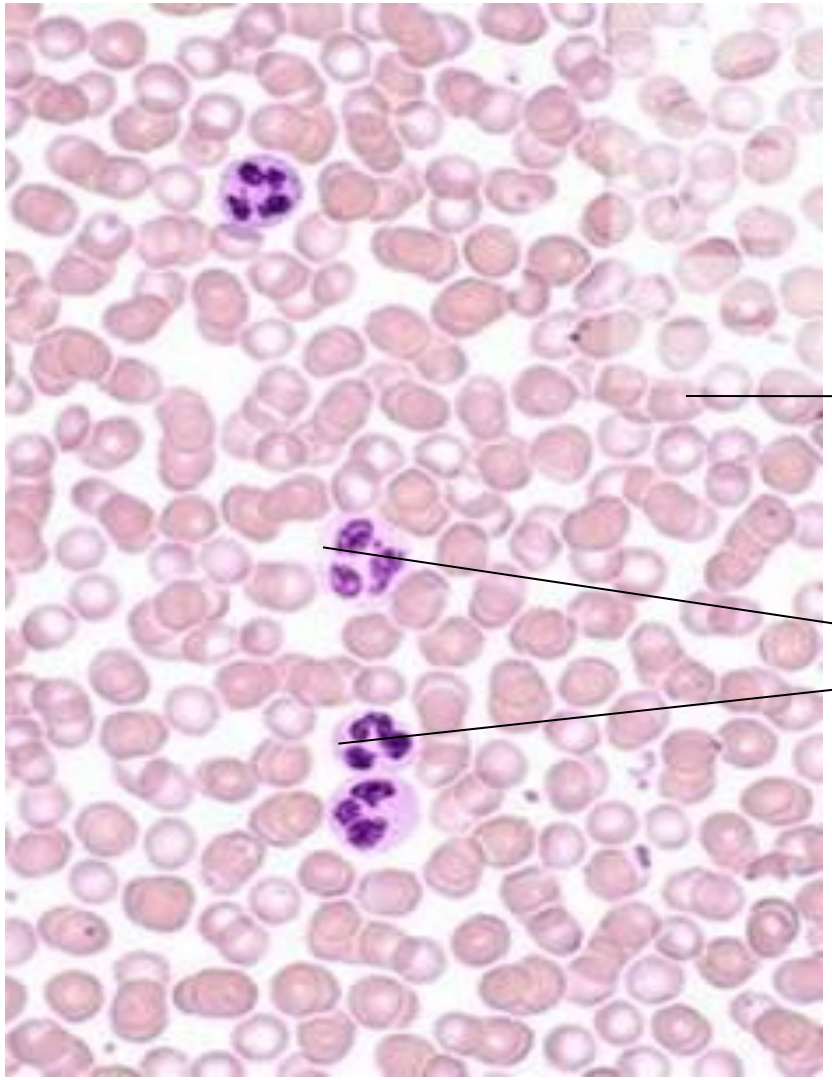
BLOOD PHYSIOLOGY

White Blood Cells

Dr Sitelbanat

Lecture content

1. Formation of WBC
2. Types of WBC
3. Genesis, sites of formation and life span of WBC
4. Neutrophils formation, maturation and function
5. Phagocytosis



red blood cells
(5-6-million /ml)

white blood cells
(5000/ml)

White Blood Cells Leucocytes

- Formed in bone marrow, lymph tissue
- Protection against infection by:
  - Phagocytosis
  - Secretion of antibodies
- WBC = 4000—11000/ml

Types of WBC

1. **Granular (polymorphnuclear PMN):**
   - **Neutrophil 62%.**
     - **10-16um, lobulated nucleus 2-5, purple cytoplasmic granules**
   - **Eosinophil 2.3%.**
     - **12-18um, 2 lobe nucleus, coarse red granules**
   - **Basophil .4%.**
     - **10-14um, rarely segmented nucleus, nucleus hidden by large round bluish granules**

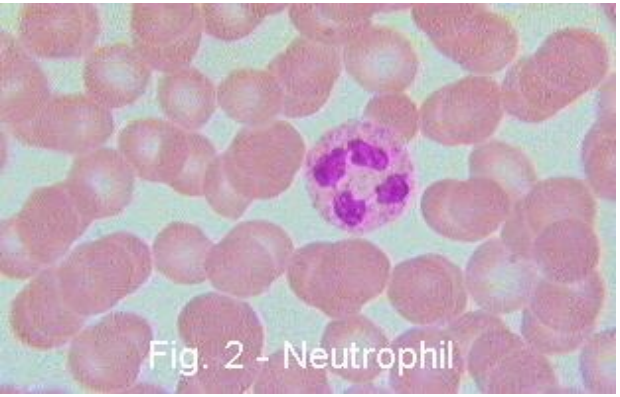


Fig. 2 - Neutrophil

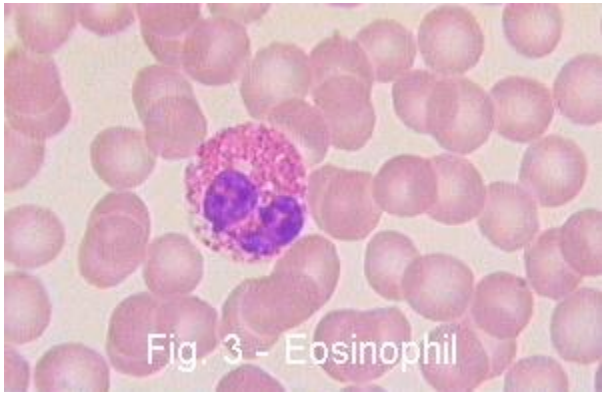


Fig. 3 - Eosinophil

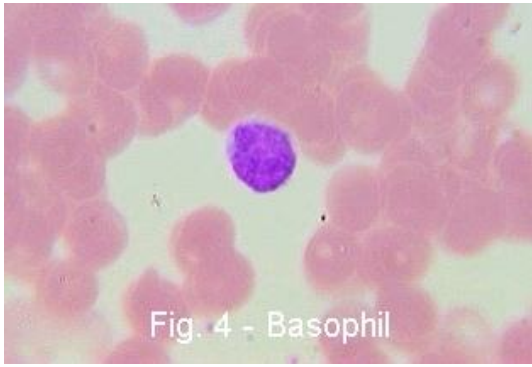


Fig. 4 - Basophil

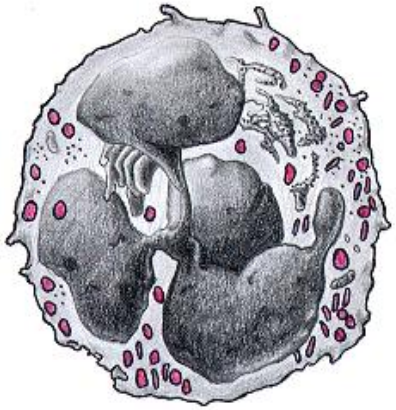


Fig. 8 - Neutrophil

Fig. 9 - Eosinophil

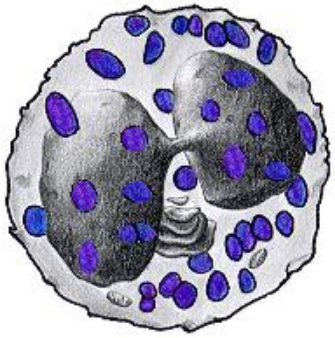


fig. 10 - Basophil

Types of WBC *cont.*

2. A granular

- **Monocytes 5.3%**
  - **15-20um, kidney shape nucleus**
- **Lymphocyte 30%**
  - **round nucleus**
    - **small (5-8um)**
    - **large (9-15um)**

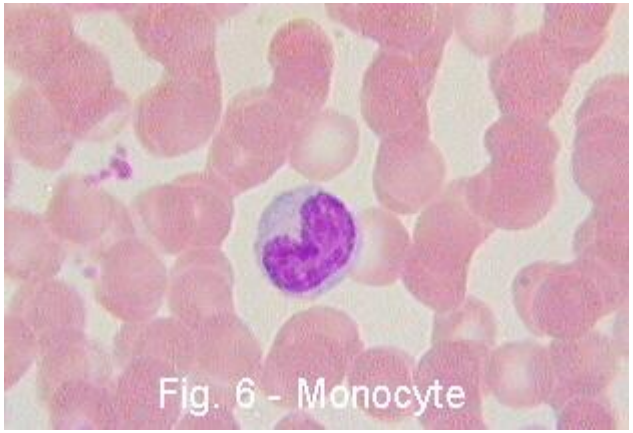


Fig. 6 - Monocyte

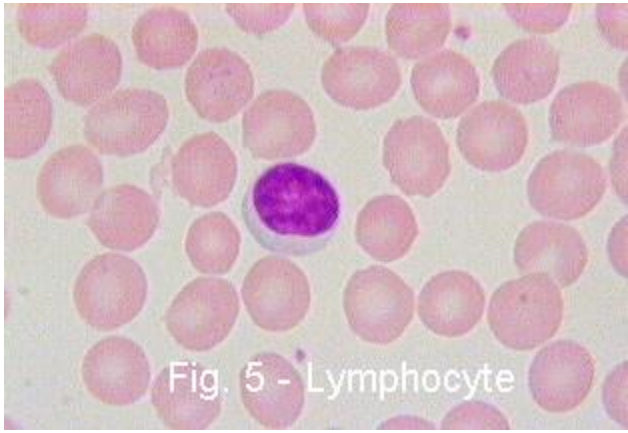


Fig. 5 - Lymphocyte

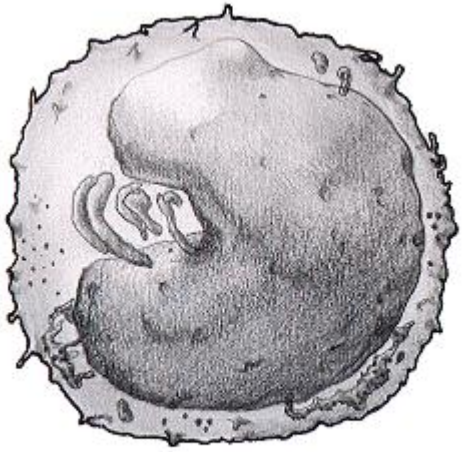


Fig. 12 - Monocyte

Fig. 11 - Lymphocyte

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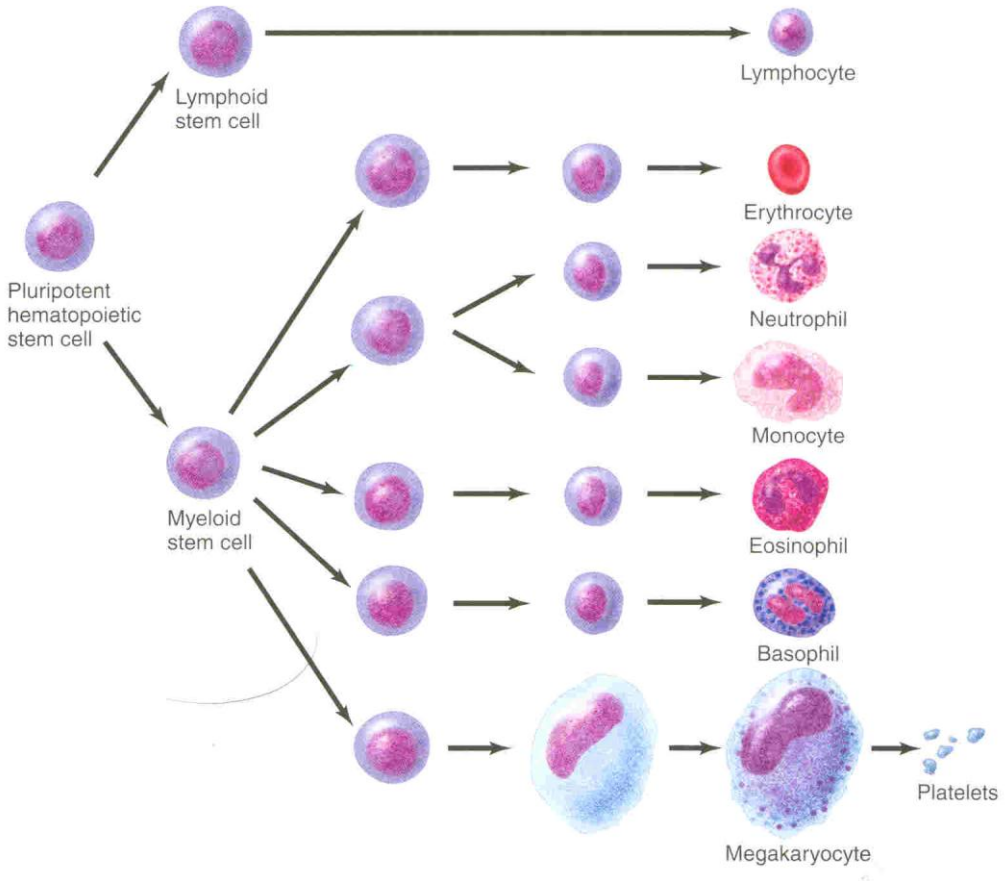
Genesis of WBC

Two major lineage of WBC are formed:

1. **Myelocytic: granular,monocytes**
2. **Lymphocytic: lymphocytes**

Genesis of WBC



Sites of WBC Formation

sites of WBC formation

- **Granulocytes (neutrophil, basophil, eosinophil) in bone marrow**
- **Monocytes- bone marrow**
- **lymphocytes- bone marrow, thymus, lymphoid tissues**

Life span of WBCs

- **Granulocytes= 4-5 days in tissues, During infection life span only few hours because they die after ingesting bacteria.**
- **Monocytes = 10-20- hours then they leave blood to tissues transform into macrophage, its life span goes up to months.**
- **Lymphocytes = weeks to months according to its type**

White Blood Cells

NEUTROPHILLS

Formation and Maturation of Neutrohils

Formed in Bone Marrow

1. **Stem cells →**
2. **Myeloblast →**
3. **Promyelocytes →**
4. **Neutrophil myelocytes →**
5. **Young neutrophil metamyelocytes →**
6. **Band neutrophil →**
7. **Polymorphnuclear neutrophil (Mature Neutrphils released to blood)**

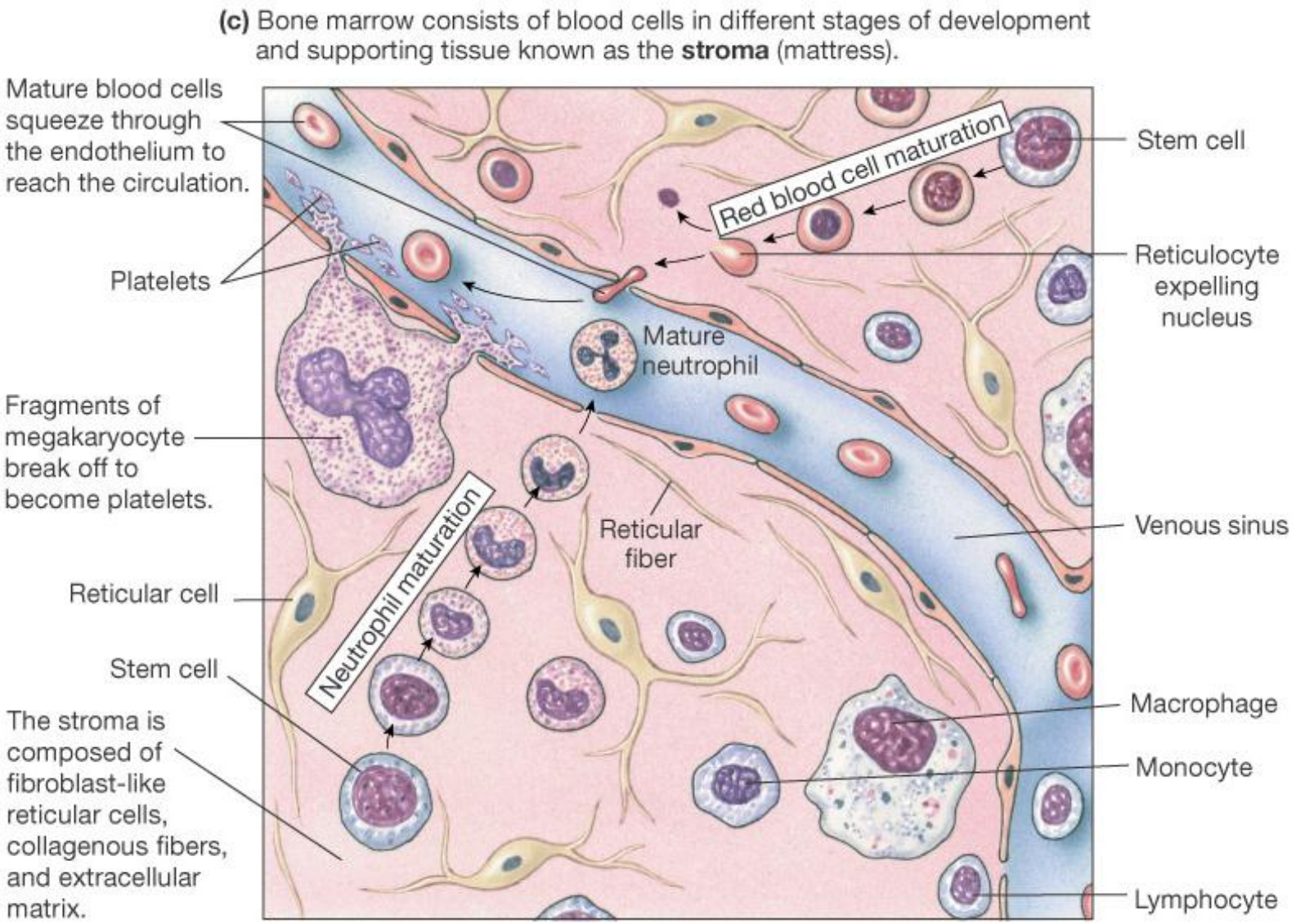


Figure 16-5c: Bone marrow

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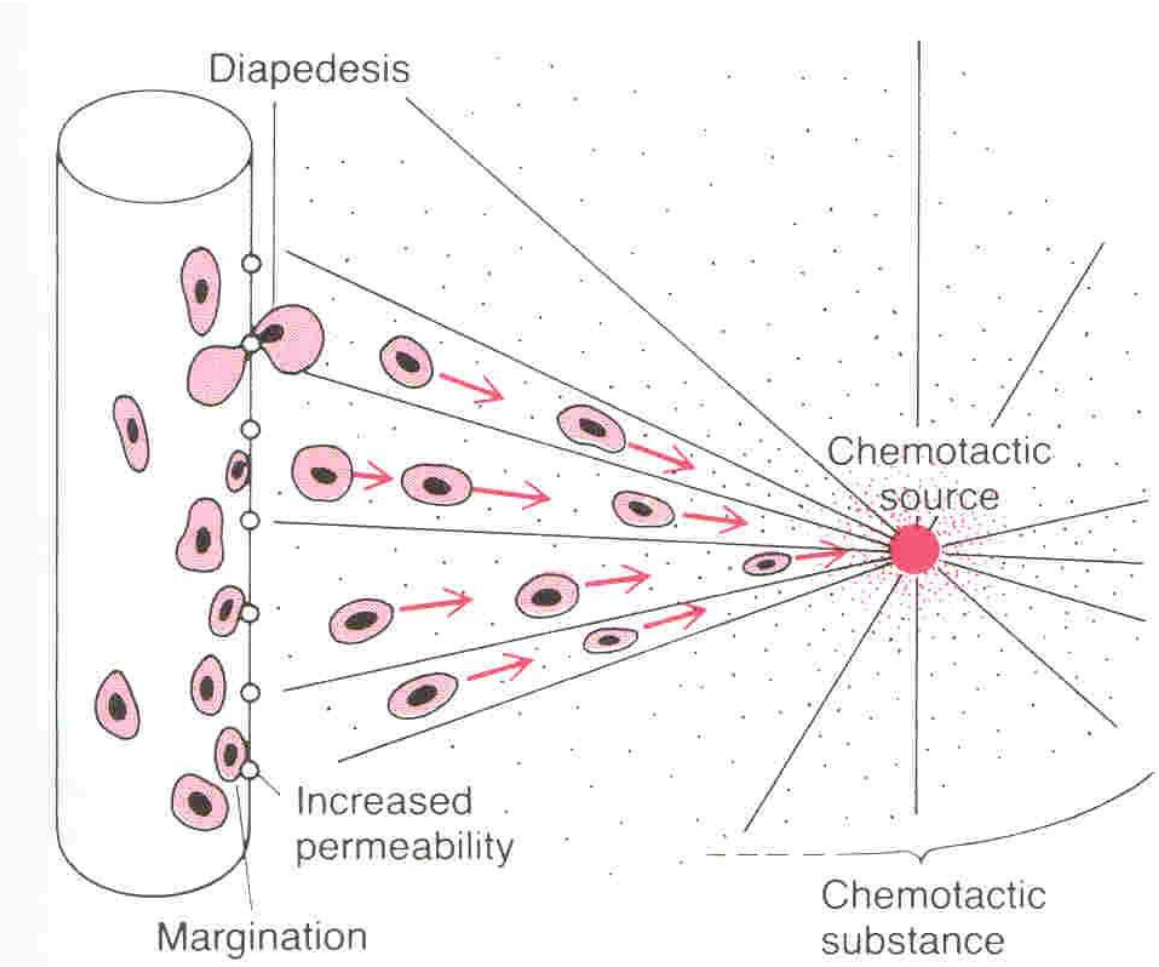
Neutrophil Function

Defense against infection: Neutrophil has the ability of engulfing bacteria or organism by a process of phyagocytosis

Steps of Phygocytosis

1. **Chemotaxis**
2. **Margination**
3. **Diapedesis**
4. **Ameoboid movement**
5. **Engulfing and killing of a microbe**

Chemotaxis, margination & diapedesis



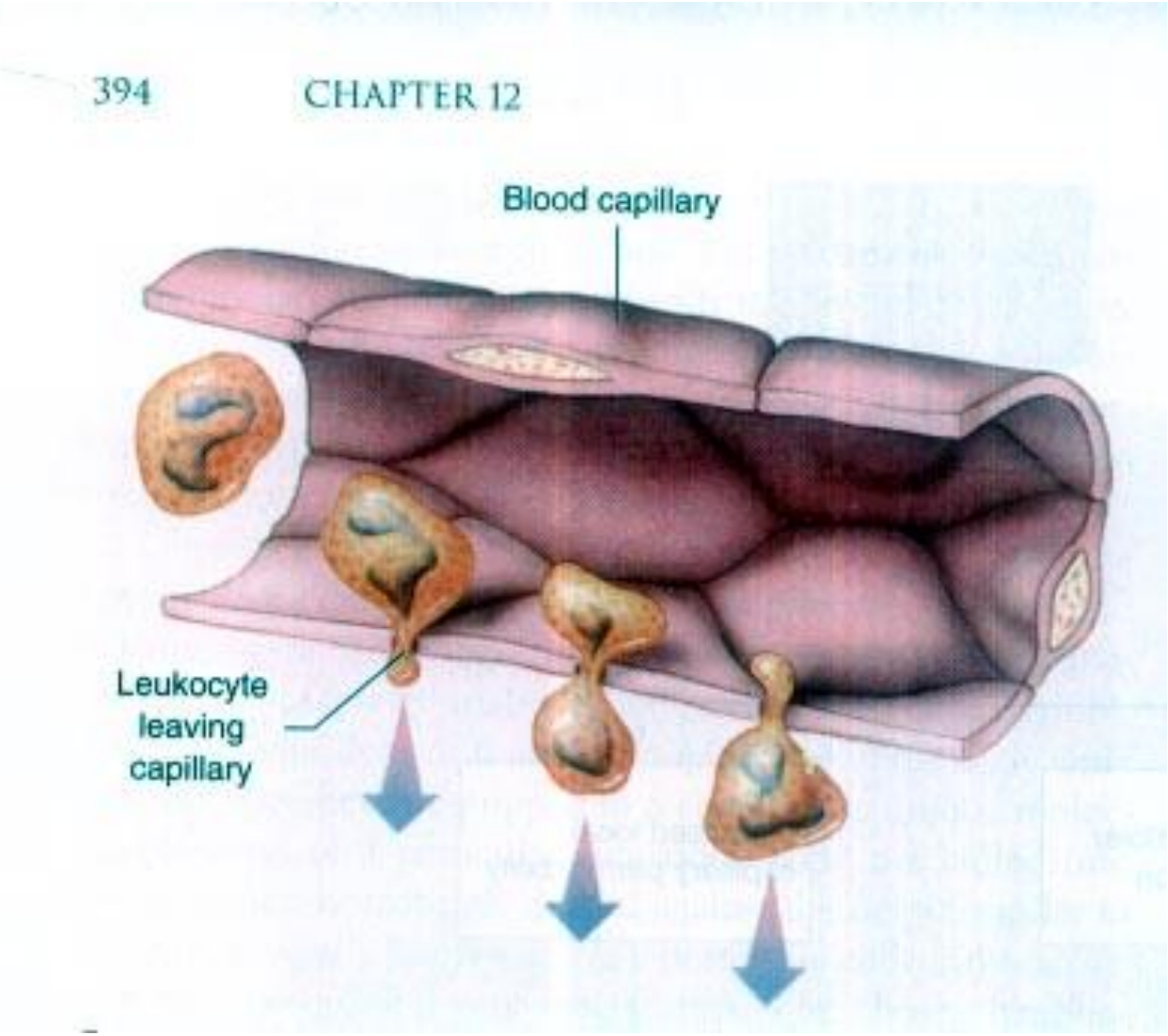
Chemotaxis

- **The attraction of the neutrophils to inflamed area following chemotactic substances release from infected site:**

- **Chemotactic substances:**
  - **Bacterial toxin**
  - **Degenerative products of inflamed tissue**
  - **Complement system**
  - **Reaction product of plasma clotting**

Margination & Diapedesis

- **WBC marginate along the wall of blood capillaries**
- **WBC squeezes itself through endothelial holes leaving blood capillaries (diapedesis)**
- **WBC move by amoeboid motion towards inflammation area following chemotactic substance released from site of infection**
- **Upon reaching the site of infection neutrophils start to engulf infecting organism**


Blood capillary
Leukocyte leaving capillary

Phagocytosis

Selective process: foreign substance recognize by:

1. **Rough surface**
2. **No protective protein coat, which prevents phagocytosis**
3. **Marked by certain substance e.g Complement 3 or antibodies making them ready for killing a process known as opsonization**

Neutrophils encircled the bacteria with pseudopodia and engulf it inside into a vacuole (phagosome), takes 3-20 bacteria

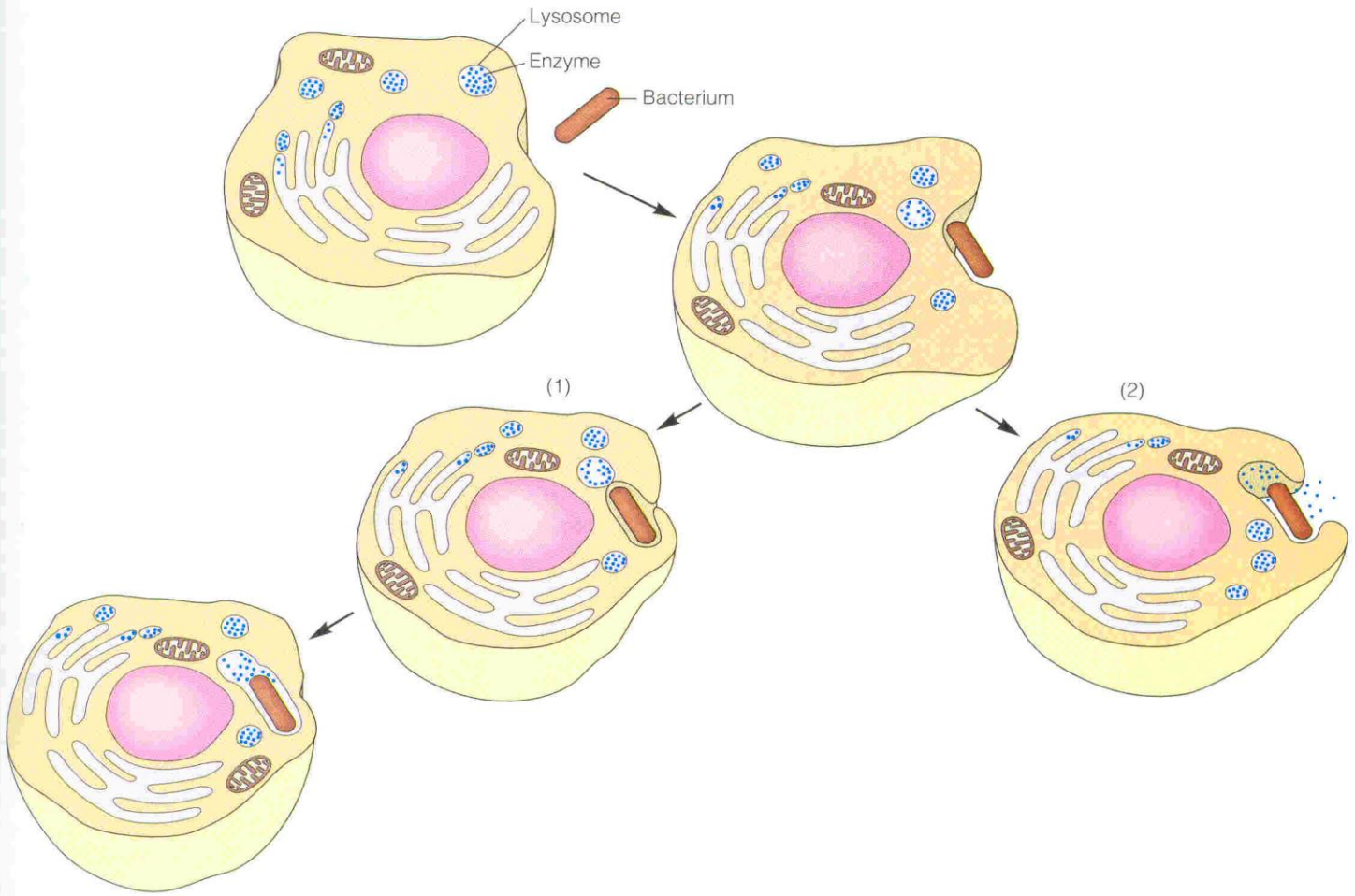


Figure 15.2

Phagocytosis by a neutrophil or macrophage. A phagocytic cell extends its pseudopods around the object to be engulfed (such as a bacterium). (Blue dots represent lysosomal enzymes.) (1) If the pseudopods fuse to form a complete food vacuole, lysosomal enzymes are restricted to the organelle formed by the lysosome and food vacuole. (2) If the lysosome fuses with the vacuole before fusion of the pseudopods is complete, lysosomal enzymes are released into the infected area of tissue.

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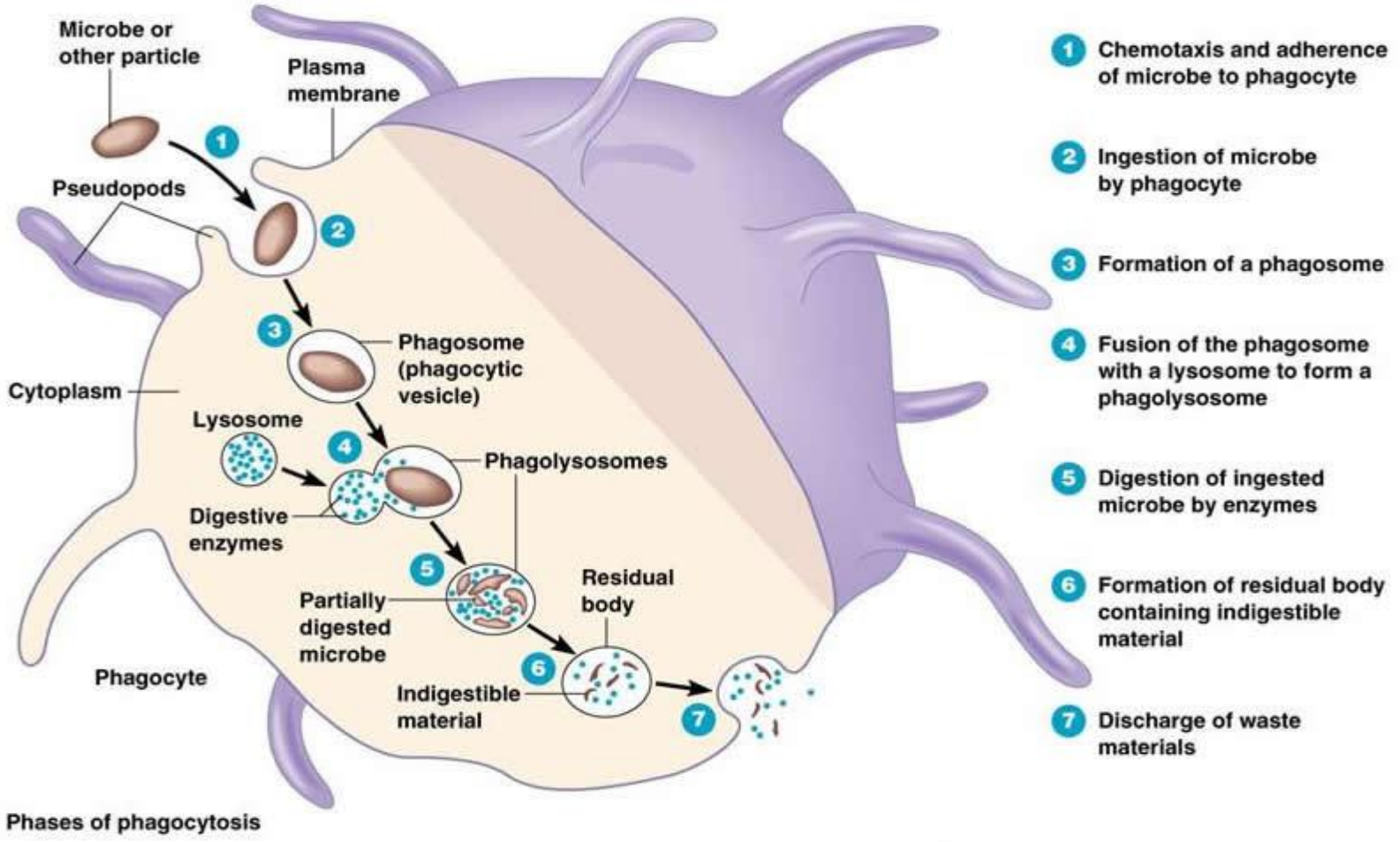
Microbial killing

- **Digestion of organism inside the phagosom**
  - **Fusion of intracellular lysosomes with phagosome vacuole**
  - **Lysosomes discharge its proteolytic enzymes such as myeloperoxidase, catalase into the vacuole, killing and digesting the engulfed bacteria.**

And or

  - **Release of bactericidal such as superoxide, hydrogen peroxide to kill the bacteria**

Microbial killing



Phases of phagocytosis

Objectives

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

1. **Describe different Types of WBC**
2. **Recognize the general functions of WBC**
3. **Describe genesis and site of formation of WBC.**

Objectives

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

4. **Describe stages of neutrophil formation**
5. **Describe the role of neutrophils in defending the body against infection**
6. **Describe the process of phagocytosis.**