Class 8:

White blood cells (granulocytes, monocytes)

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Objectives for this lecture

- Discuss the structure and functions of White blood cells.
- understand the abnormalities in white blood cells.

White blood cells *(leukocytes)*

- Protecting the body against infection.
- Two broad groups:
  - *Phagocytes* cells of **innate** immune system.
    granulocytes *(neutrophils, eosinophils, basophils, monocytes)*.
  - *Lymphocytes* **adaptive** immune response.
    develop immunological memory.

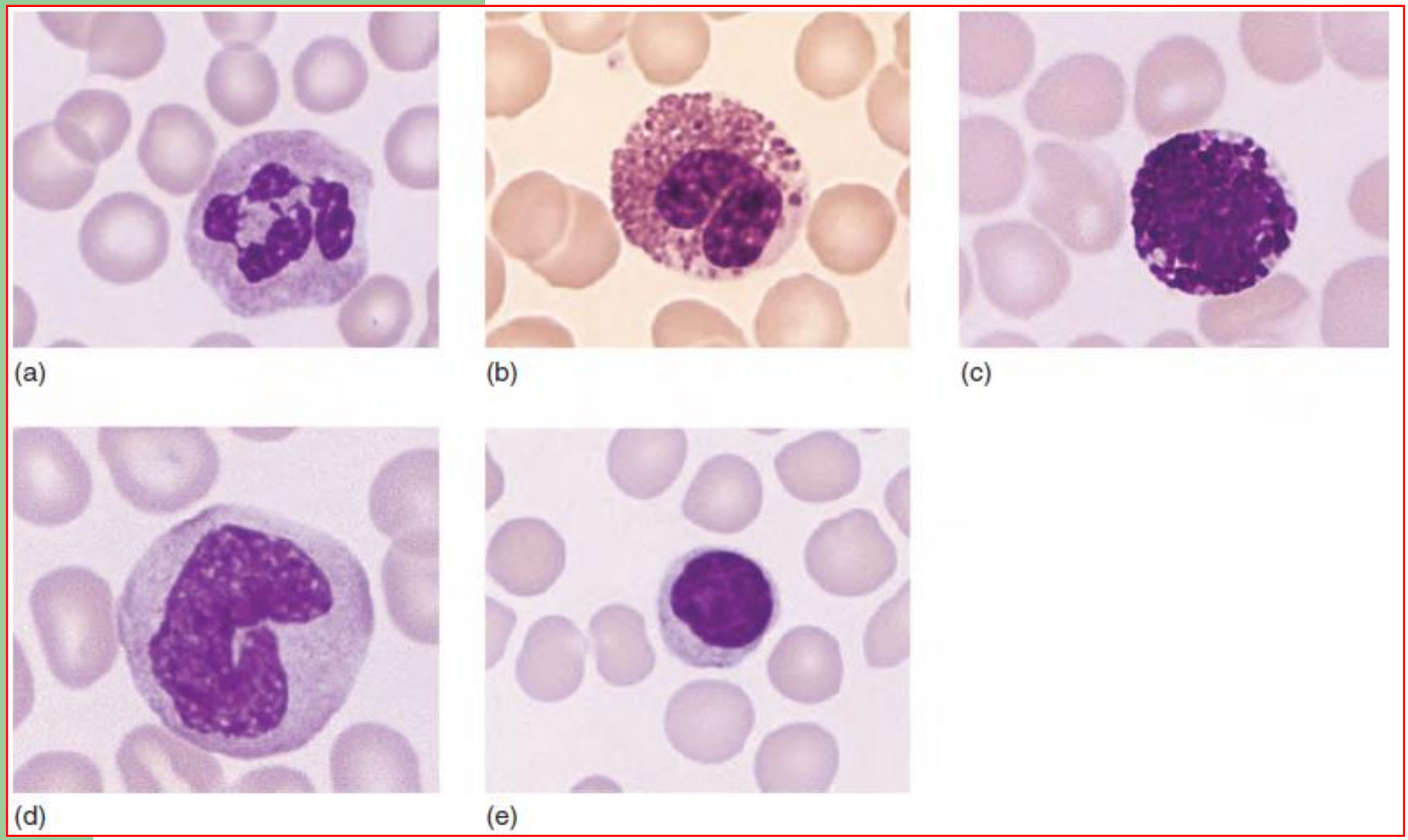
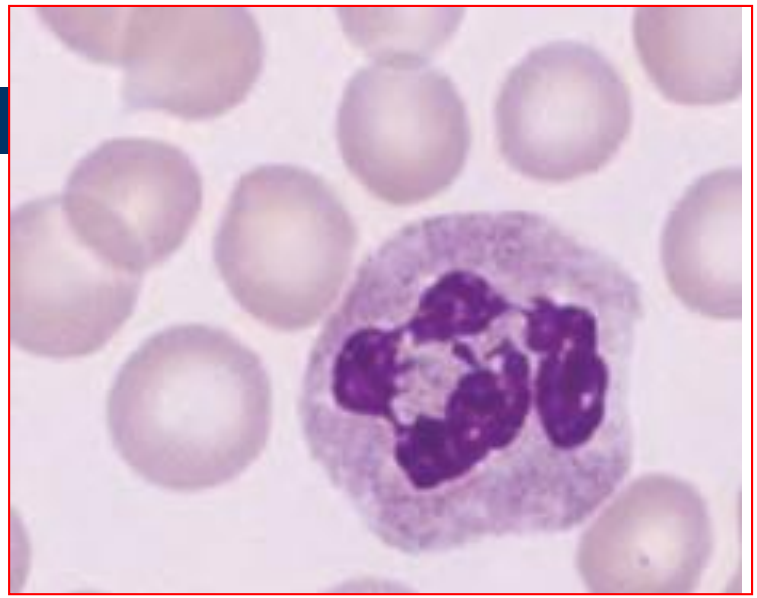


Figure 8.1 White blood cells (leucocytes): **(a)** neutrophil (polymorph); **(b)** eosinophil; **(c)** basophil; **(d)** monocyte; **(e)** lymphocyte.

Granulocytes



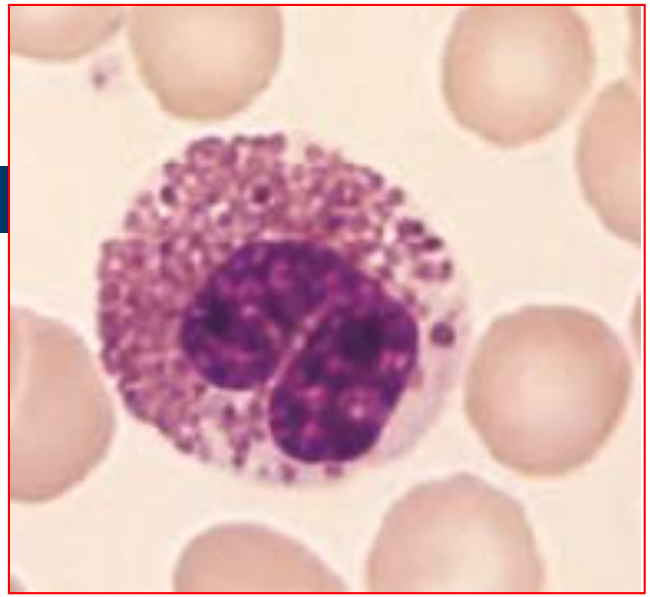
- *Neutrophil (polymorph)*
  - Blood count =

    $1.8–7.5 \times 10^9/L$

    (in normal pregnancy=

    $11 \times 10^9/L$)
  - nucleus of between two and five lobes.
  - Have granule of lysozyme.
  - lifespan is only 6–10 hours.

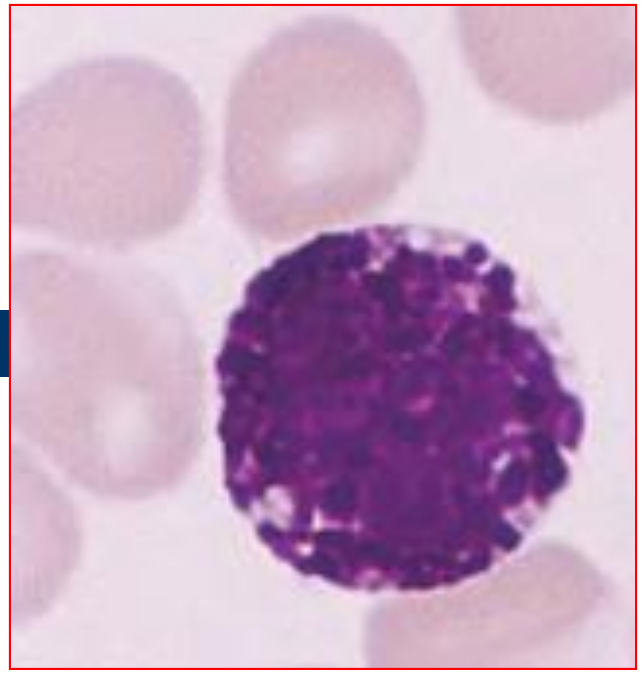
Granulocytes



- *Eosinophils:*
  - Blood count =

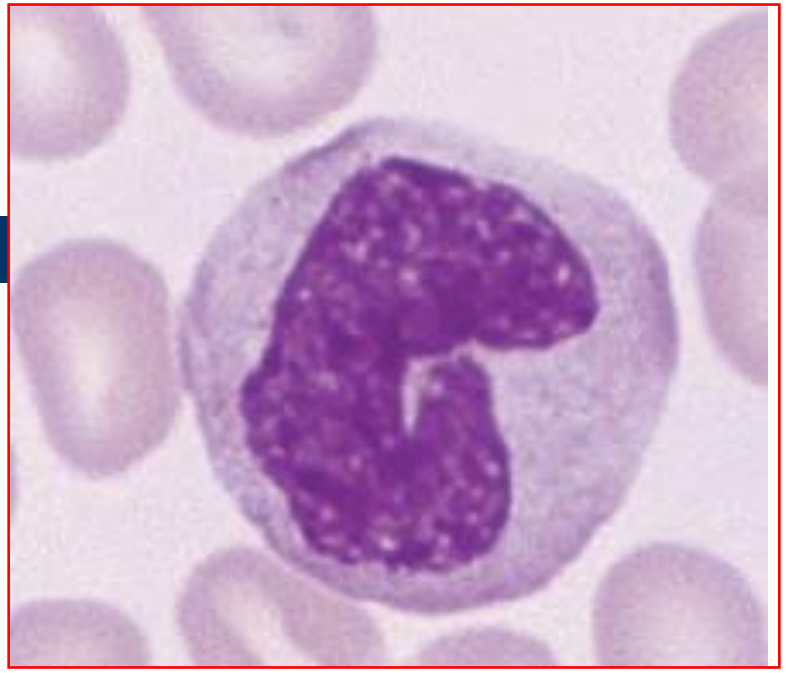
    $0.04–0.4 \times 10^9/L$
  - more than three nuclear lobes.
  - in allergic responses, defence against parasites and removal of fibrin formed during inflammation.

Granulocytes



- *Basophils*
  - Blood count = 0.01–0.1 × 10^9/L
  - contain heparin and histamine.
  - Have IgE attachment sites.
  - their degranulation is associated with histamine release.

Granulocytes



- *Monocytes*
  - Blood count =

    $0.2–0.8 \times 10^9/L$
  - Large cell, large nucleus, contains many fine vacuoles.

Granulopoiesis

- Granulocytes and monocytes are formed in the bone marrow.
- Large numbers of *neutrophils* (10–15 times than in the blood) are held in the marrow.
- After being released, they pend only 6–10 hours in the circulation, then enter tissues to perform phagocytic function.
- After 4–5 days in the tissues they are destroyed during defensive action.

Granulopoiesis

- Monocytes spend a short time in the marrow.
- Circulate in blood for 20–40 hours, then enter the tissues.
- In tissues they mature and carry out their functions.
- Lifespan may be several months or even years.
- *Involved in antigen presentation to T cells.*

Control of granulopoiesis

- *myeloid growth factors*
  - e.g. interleukin-1, granulocyte–macrophage colony-stimulating factor (GM-CSF), granulocyte CSF (G-CSF).
  - Stimulate proliferation and differentiation, function. And also inhibit apoptosis.
  - Growth factors are produced from stromal cells and T lymphocytes.

Normal function of neutrophil and monocyte

1. ***Chemotaxis (cell mobilization and migration)***
   - chemotactic substances released from damaged tissues.
   - interaction of leucocyte adhesion molecules with ligands on the damaged tissues.

Normal function of neutrophil and monocyte

2. **Phagocytosis**
   - The foreign material (e.g. bacteria, fungi) or dead or damaged cells of the host are phagocytosed.
   - Recognition of a foreign particle is aided by binding with immunoglobulin.
   - secrete growth factors and chemokines which regulate inflammation and immune responses.

Normal function of neutrophil and monocyte

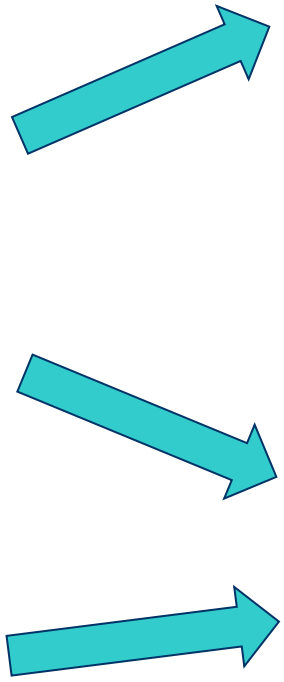
3. **Killing and digestion**
   - By oxygen-dependent reactions, superoxide (O^{2-}), hydrogen peroxide (H_2O_2) and other activated (O_2) species.
   - By oxygen-independent reactions, Nitric oxide (NO).
   - non-oxidative mechanisms, cathepsin G, lysozyme, elastase.

Defects of phagocytic cell function

- ***Chemotaxis***
  - ‘lazy leucocyte’ syndrome due to corticosteroid therapy or myeloid leukaemia, myelodysplasia.
- ***Phagocytosis***
  - lack of complement components.
- ***Killing***
  - abnormality affecting oxidase, so patients have recurring infections.

Causes of neutrophil leucocytosis

- levels greater than 7.5 × 109/L.
- *Causes:* - Bacterial infections
  - Inflammation and tissue necrosis
  - Metabolic disorders (uraemia, gout)
  - haemorrhage or haemolysis
  - Pregnancy
  - Neoplasms (carcinoma, leukaemia)
  - Drugs (corticosteroid therapy)



Neutropenia

- neutrophil level falls below 0.5 × 109/L
- patient will have recurrent infections.
- *Causes:* - Congenital
  - Drug-induced (Anti-inflammatory, Antibacterial drugs)
  - Autoimmune
  - Hypersensitivity
  - Infections (Viral (HIV), bacterial)

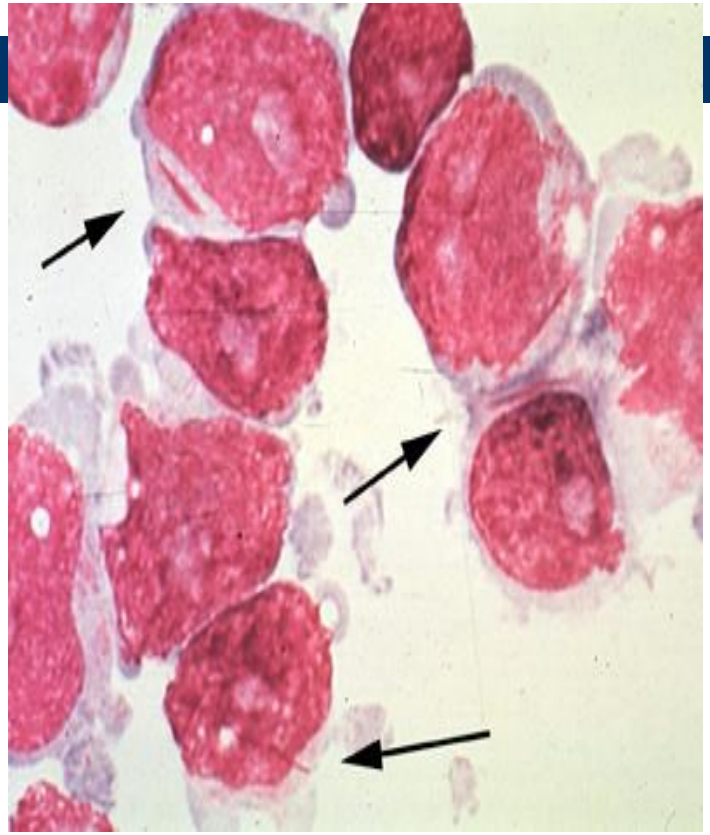
Leukemia

- *Uncontrolled* production of *abnormal* WBCs in the circulating blood.
- Caused by cancerous mutation of a myelogenous or lymphogenous cell.
- **Types :**
  - *Lymphocytic:* by cancerous production of lymphoid cells, in a lymph node.
  - *Myelogenous:* cancerous production of bone marrow, spreads to all body.

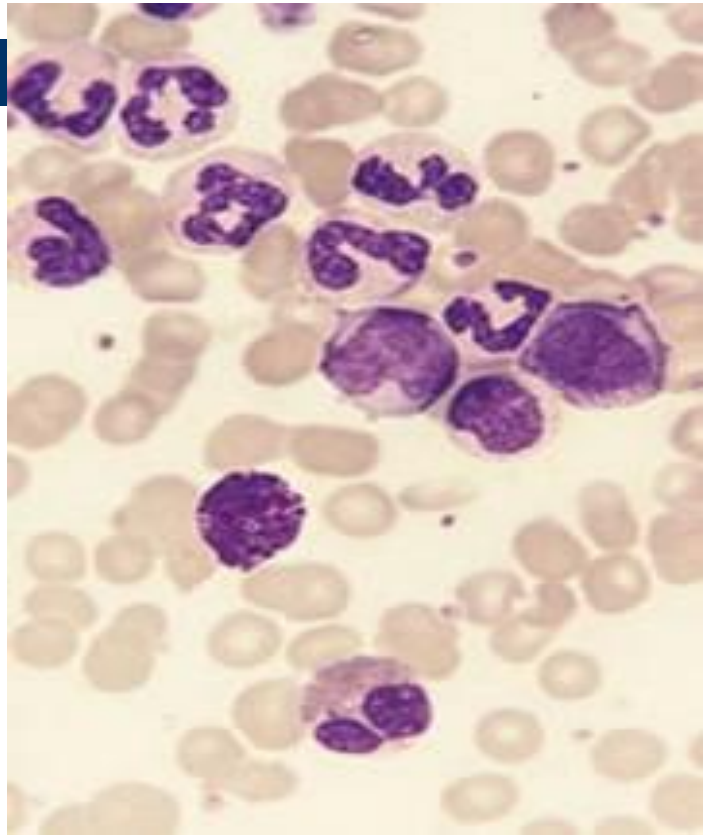
Leukemia

- *Acute* leukemia often lead to death within a few months if untreated.
- Leukemic cells, especially the undifferentiated cells, are nonfunctional for providing normal protection against infection.
- spread to the spleen, lymph nodes, liver, and other vascular regions.
- Develop infection, anemia, and a bleeding tendency caused by lack of platelets.

Myeloid malignancies



Acute Myeloid Leukaemia (AML M-3)



Chronic Myeloid Leukaemia

References

- Victor A Hoffbrand, Paul Moss, J Pettit; ***Essential Haematology***. Essentials Series Blackwell Science, New York; 2008.
- Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil. ***Harper's Illustrated Biochemistry.*** McGraw-Hill Ed, 31 ed, 2018.