**Foundation Block 2010**

**White Blood Cells (Leucocytes)**

**Lecture 3 and 4**

**Objectives of lecture 3**

The student should

1. Recognize WBC formation
2. Identify the different types of WBC
3. Recognize the WBC genesis and the sites of formation
4. Recognize life span of different types of WBC
5. Recognize Neutrophils formation, maturation and function
6. Recognize steps of phagocytosis

WBC are Formed in bone marrow, lymph tissue, and their main function is to protect us against infection by phagocytosis and antibodies secretion.

WBC count between 4000—11000/ml

**Types of WBC**:

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

1. **A granular**
   * Monocytes 5.3% of WBC; 15-20um in size, kidney shape nucleus
     + - Lymphocyte 30% of WBC; round nucleus; small size(5-8um); large size(9-15um)

**Genesis of WBC**

Two major lineage of WBC are formed:

1. Myelocytic lineage give rise to granular cells and monocytes
2. Lymphocytic lineage give rise to lymphocytes cells

**Sites of WBC formation**

* Granulocytes (neutrophil, basophil, eosinophil) formed in bone marrow
* Monocytes in bone marrow
* Lymphocytes in bone marrow, thymus, lymphoid tissues

**Life span of WBCs:**

* Granulocytes live for 4-5 days in tissues, while during infection their life span is reduced to few hours as they die after ingesting bacteria.
* Monocytes = 10-20- hours then they leave blood to tissues transform into macrophage with a life span that goes up to months.
* Lymphocytes = weeks to months according to its type

**Neutrophil:**

**Formation**: Formed in Bone Marrow: Stem cells → Myeloblast → Promyelocytes → Neutrophil myelocytes → Young neutrophil metamyelocytes → Band neutrophil → Polymorphnuclear neutrophil (Mature Neutrphils released to blood)

**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**

* 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

**Phagocytosis**

Selective process by which foreign substance is recognized 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

**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

**Objectives of Lecture 4**

The student should

1. Recognize the formation, maturation and function of eosinophils and Basophilophils
2. Recognize the formation, maturation and function of monocytes and macrophage
3. Identify the component and function of reticuloendothelial system
4. Recognize the formation, maturation and function of lymphocytes
5. Recognize definition of leucocytosis, leucopenia and leukemia

**Formation and Maturation of Eosinophils**

Formed in Bone Marrow: Stem cells → Myeloblast→ Promyelocytes → Eosinophil myelocytes → Eosinophil metamyelocytes → polymorphnuclear eosinophil (Mature Eosinophil released to blood)

**Function**:

1. Phagocytosis
2. Eosinophil attach themselves to parasites and releases substances (hydrolytic anzymes, superoxide) to kill it

**High eosinophil count** is detected in:

* 1. Parasitic infection such as hook worm, ascaris, bilharzia
  2. Allergic condition such as asthma, rhinitis, drug reaction

**Basophils**

* Formed in Bone Marrow: Stem cells → Myeloblast→ Promyelocytes → Basophil myelocytes → Polymorphnuclear Basophil (Mature Basophils released to blood)
* Similar to mast cells both secrets:
* Heparin to prevent clotting,
* Histamine , bradykinin & serotinin contribute to inflammation response
* The release of those substances cause local and vascular reactions characteristic of allergic manifestation

**Monocyte**

* Formed in Bone Marrow: Stem cell → monoblast → promonocyte → mature monocytes released into blood
* Stay for 10-20 hours in circulation, then leave blood to tissues transforming into larger cells macrophage,
* Macrophage has a longer life span up to few months

**Function of Monocytes and Macrophages**

* Macrophages are a powerful phagocytic cells; first line of defense
  + Ingest up to 100 bacteria,
  + Ingest larger particles as old RBC
  + Get rid of waste and survive
* Functions: anti-inflamatory
  + Directly: phygocytosis of bacteria, dead cells
  + Indirectly cooperating with lymphocytes by recognizing foreign body (take in foreign body process it and present it to lymphocytes)
* **Reticuloendothelial system**
* Consist of: Monocytes; macrophages; Endothelial cells in bone marrow, spleen and lymph nodes
* Located in all tissues especially skin (histocytes), lymph nodes, lung, liver (kupffer), spleen & bone marrow
* **Functions of Reticuloendothelial system**
* Phagocytosis: Bacterial, dead cells, foreign particles
* Breakdown of Hb
* Immune function: processing antigen and antibodies production
* Storage of iron

**Lymphocytes**

* Formed in bone marrow, thymus, lymphoid tissues
* Stem cell (thymus, lymphoid tissue & bone marrow) → lymphoblast → intermediate pyronophilic blast cell → lymphocytes
* Life Span Of Lymphocytes range from weeks to months according to its type
* **Function**: Immunity
* **Types:**
  + Thymus dependent (T-lymphocytes)
  + Thymus independent (B-lymphocytes)
  + **T-Lymphocytes (thymus dependent)**
* Formed in bone marrow or lymphoid tissue migrate to thymus
* Life spans 100-130 days.
* Circulate between blood, tissues, lymph.
* Types of T-lymphocytes
  + T-helper
  + T-cytotoxic
  + Natural killer
* Functions
  + Cellular immunity (graft rejection, delayed hypersensitivity).
  + Role in antibody secretion.
  + **B- Lymphocytes**  (thymus-independents)
* First found in bird Bursa
* Formed in bone marrow, germinal layer of lymph node, red pulp of spleen
* Life span 2-7 days
* Stimulated by antigen → large plasma cell ( produce antibody)
* Function: Humoral immunity production of antibodies.
* **Leucocytosis**
* Increased WBC count
  + Physiological
    - Diurnal ↓ morning ↑ evening
    - After physical exercise
    - Stress or Adrenaline injection
  + Pathological
    - Bacterial infection (tonsillitis, appendicitis
    - Worm infection
    - **Leucopenia**
    - Decreased WBC count
  + Malnutrition
  + Depressed bone marrow
  + Deficient Vitamin B12 or folic acid

* **Leukaemia**
* Cancer of white cells due to chromosomal abnormality results from exposure to certain chemical, radiation, and viruses
* WBC count is more than 50x103
* Types of leukaemia
  + Myeloblast leukaemia → myeloid cells
  + Lymphoblast leukaemia → lymphocytic cells
* Acute or chronic
* Accompanied with anaemia, bleeding