Leukocytes (WBC’s)
Two major components of blood: liquid phase and formed elements

- **Plasma (55 - 60%)**
  - Fluid portion of blood
  - Contains:
    - 91 - 92% of water
    - Albumin & globulin
    - Crucial hormones & clotting factors

- **Red Cells (40 - 45%)**
  - Transports oxygen from the lungs to all tissues of the body and returns carbon dioxide back to the lungs

- **White Cells**
  - Protect against diseases & infections

- **Platelets**
  - Small plate-shaped cells that cluster together to help form blood clots when bleeding occurs
Blood Cell Origin and Production

- All new WBCs except for lymphocytes are produced in the bone marrow (that also give rise to erythrocytes and platelets). Most new lymphocytes are produced by colonies of cells in lymphoid tissues, such as lymph nodes.
Leukocytes (WBC’s)

Mobile units of body’s defense system:

- “Seek and Destroy” Functions:
  - Destroy invading microorganisms
  - Destroy abnormal cells (ie: cancer)

- Clean up cellular debris (phagocytosis)
  - Assist in injury repair

- Each WBC has a specific function
### Leukocytes (WBC’s) (Cont...)

<table>
<thead>
<tr>
<th>Leukocyte group</th>
<th>Subgroup</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>granulocytes</td>
<td>neutrophils</td>
<td>destroy small organisms</td>
</tr>
<tr>
<td></td>
<td>basophils</td>
<td>secrete histamine, mediating inflammatory response, and platelet activating factor</td>
</tr>
<tr>
<td></td>
<td>eosinophils</td>
<td>destroy parasites allergic reaction</td>
</tr>
<tr>
<td>lymphocytes</td>
<td>B lymphocytes</td>
<td>synthesize antibody</td>
</tr>
<tr>
<td></td>
<td>T lymphocytes</td>
<td>participate in the specific immune response</td>
</tr>
<tr>
<td>monocytes</td>
<td>macrophages</td>
<td>destroy invading organisms</td>
</tr>
</tbody>
</table>
Leukocytes (WBC’s) (Cont...)

- Five Types
- Classified according to the presence or absence of granules and the staining characteristics of their cytoplasm.
- Leukocytes appear brightly colored in stained preparations, they have a nuclei and are generally larger in size than RBC’s.
Types of WBC’s

Are classified in 3 main classes

Agranulocytes

Lymphocyte
Monocyte

Granulocytes

Eosinophil
Basophil
Neutrophil
Type of WBC’s

- **Granulocytes (Polymorphonuclear leukocytes):** have 2 types of granules in their cytoplasm:
  - **the specific granules** (specific functions) and **azurophilic granules** (lysosomes)
    - Neutrophils
    - Eosinophils
    - Basophils
Types of WBC’s (cont...)

- **Agranulocytes**: do not have specific granules, but they do contain azurophilic granules in their cytoplasm
  - Lymphocytes
  - Monocytes
Granuloctyes

1. Neutrophils (cond...)

- Constitute 60-70% of circulating WBC’s
- Have an average diameter of 12-15 µm
- Several lobes in nucleus (2-5 segments) linked by fine threads chromatin
- Also contain glycogen (source of energy)
- Stain light purple with neutral dyes
Granuloctyes (cont...)  

1. Neutrophils (cond...)  

- Granules are small and numerous  
- Highly mobile/very active  
- **Diapedesis**: Can leave blood vessels and enter tissue space  
- Short lived cells: life span of 6-7h in blood and 1-4 days in connective tissues  
- **Function**: Phagocytosis (contain several lysosomes) and play a major role of acute inflammation
2. Eosinophils

- 2-4% in normal blood
- Large, numerous granules
- Typical bilobed nuclei
- Are about 12-17 µm in size, pale blue colour
- Found in lining of respiratory and digestive tracts
Granuloctyes (cont...)

2. Eosinophils (cont...)

- Persist in the circulation for 8–12 hours
- **Functions:**
  - Important functions involve protections against infections caused by parasitic worms and involvement in allergic reactions
  - Secrete anti-inflammatory substances in allergic reactions
Granulocytes (cont...)

3. Basophils

- Least numerous, less than 1% of blood WBC’s
- They are about 12-15 µm diameter
- They contain many large, rounded, dark purplish black granules
- Their nucleus is divided into irregular lobes
Granulocytes (cont...)

3. Basophils (cont...)

- Diapedesis
- Contain histamine and heparin (inflammatory chemical)
- **Function:** Like eosinophils, basophils play a role in both parasitic infections and allergies
Agranulocytes

1. Lymphocytes

- Constitute 28% of WBC’s
- Small lymphocytes (6-8 µm); medium-sized lymphocytes (small number) and large lymphocytes (18 µm)
- Large nuclei/small amount of cytoplasm
- Color pale-blue
Agranulocytes (cont...)

1. Lymphocytes (cont...)

- Only type of WBC’s that return from the tissue back to blood after diapedesis
- Vary in life span: some live only a few days (~3 days), others survive in circulating blood for many years (4-5 years)
Agranulocytes (cont...)

1. Lymphocytes (cont...)

- **Function**: immune responses and memory, mainly found in lymph tissue

- Two types:
  - **T lymphocytes** attack an infect or cancerous cell
  - **B lymphocytes** produce antibodies against specific antigens (foreign body)
Agranulocytes (cont...)

2. Monocytes

- Largest of WBCs (12-20μm)
- Dark kidney bean shaped nuclei
- Cytoplasm is basophilic and frequently contain very fine azurophilic granules
- In tissues differentiate into macrophages
Agranulocytes (cont...)

2. Monocytes (cont...)

- **Function:** phagocytosis
  - evident in chronic infections – Tuberculosis
  - defense vs. viruses and certain bacteria
  - activate lymphocytes
WBC Numbers

- Doctors look at WBC numbers.
- Clinics will count the number of WBC’s in a blood sample, this is called differential count.
- A decrease in the number of white blood cells is **leukopenia**.
- An increase in the number of white blood cells is **leukocytosis**.
Metabolism of leukocytes

- They have aerobic glycolysis and active pentose phosphate pathway (NADPH)

- During phagocytosis of bacteria, there is an increase of O₂ consumption (respiratory burst: the rapid release of reactive oxygen species) and superoxide radical O₂⁻ (involved in killing the bacteria) is formed.
Phagocytic leukocytes use NADPH as a substrate for the NADPH-oxidase enzyme, which contributes to the killing of ingested microorganisms.

\[
\text{NADPH} + \text{A} + \text{O}_2 \xrightarrow{\text{NADPH oxidase}} \text{NADP}^+ + \text{AH} + \text{O}_2^- \\
2\text{H}^+ + 2\text{O}_2^- \xrightarrow{\text{Acidic pH}} 2\text{H}_2\text{O}_2 + \text{AH} + \text{O}_2^- \\
\text{Helps to kill microorganisms}
\]
Metabolism of leukocytes (cont...)

- Active leukocytes release $O_2^-$ ions and $H_2O_2$ to surrounding tissues in areas of inflammations

- Superoxide dismutase, catalase and glutathione peroxidase are normal antioxidant enzymes that help to protect the body against the toxic effect of $O_2$ ions and $H_2O_2$
THANK YOU!

Take a break!!
Have a cup of........