Blood

Physical Characteristics of Blood

- Sticky, opaque fluid
- Metallic taste
- Color - scarlet (oxygen-rich) - dull red (oxygen poor)
- Density - 5 times denser than water
- pH 7.35 - 7.45
- Temperature 37°C (100.4°F)
- Volume: 5 - 6 liters in adult males
  4 - 5 liters in adult females

Functions of Blood

1. Transporting
   - Ex: nutrients, respiratory gases, waste products and hormones
2. Distribution & regulation of body heat
3. Protection
Components of Blood

A type of connective tissue (liquid CT)

2 Parts

1. Formed elements
   - Living blood cells & cell fragments
2. Plasma
   - Nonliving fluid matrix

Plasma

Liquid part of blood -
- 55% of blood volume
- 90% water
- 100+ substances dissolved in plasma
  - Nutrients
  - Metal ions (salts)
  - Respiratory gases
  - Hormones
  - Plasma proteins**
  - Waste products of cell metabolism
Formed Elements of Blood

- 45% of blood volume
  - Erythrocytes or red blood cells (RBCs) \( \rightarrow 99\% \)
  - Leukocytes or white blood cells (WBCs) \( \rightarrow <1\% \)
  - Thrombocytes or platelets \( \rightarrow <1\% \)
- Red bone marrow

### Slide 8

**Red Blood Cells**  
(erythrocytes)  
- 4 million–6 million per mm\(^3\) blood

**White Blood Cells**  
(leukocytes)
  - Granular leukocytes  
    - Basophil  
      - 20–50 per mm\(^3\) blood  
    - Eosinophil  
      - 100–400 per mm\(^3\) blood  
    - Neutrophil  
      - 3,000–7,000 per mm\(^3\) blood
  - Agranular leukocytes  
    - Lymphocyte  
      - 1,500–3,000 per mm\(^3\) blood  
    - Monocyte  
      - 100–700 per mm\(^3\) blood
  - Platelets  
    - (thrombocytes)  
      - 150,000–300,000 per mm\(^3\) blood

### Slide 9

**Erythrocytes**  
(RBCs)

- Function - carry oxygen to all body cells
- Structure
  - Biconcave disk shape
  - Lacks nucleus (anucleate)
  - Contains hemoglobin, PM and cytosol
- 4.5 - 5.5 million cells per cubic millimeter
- Lifespan 100 - 120 days
**Red Blood Cells — Erythrocytes**

<table>
<thead>
<tr>
<th>Function/Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport O₂ and help transport CO₂</td>
<td>Red bone marrow</td>
</tr>
<tr>
<td>7-8 μm in diameter Bright-red to dark-purple biconcave disks without nuclei</td>
<td></td>
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<tr>
<td>4 million-6 million per mm³ blood</td>
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</tbody>
</table>

**Hemoglobin**

- Iron-containing protein
- Oxygen from lungs binds to iron ion
  - Transport
  - One RBC has 250 million hemoglobin molecules
  - One hemoglobin molecule combines with 4 O₂ molecules
Anemia

Def: A decrease in the oxygen-carrying ability of blood

- Causes:
  - Lower than normal number of RBCs
  - Abnormal/deficient hemoglobin content of RBCs
- Examples:
  - Sickle-cell anemia
  - Polycythemia

Leukocytes (WBCs)

Function - crucial in body's defense against disease

- 4000 - 11,000 WBCs per cubic millimeter
- <1% of blood volume
- 2 Types:
  1. Granulocytes
  2. Agranulocytes

White Blood Cell Movement

connective tissue  blood capillary  leukocyte
RBC & WBC Movement

RBC movement
- confined to blood vessel

WBC movement
- capable of exiting and re-entering BV
- transported to site of action by circulatory system
- Amoeboid movement

Granulocytes

- Granule-containing WBCs
- Lobed nuclei
- Types
  - Neutrophils
  - Eosinophils
  - Basophils
**Neutrophil**  
*(polymorphonuclear leukocyte)*

- **Cytoplasm** - stains pale pink and contains fine granules
- **Nucleus** - stains deep purple with 3-5 lobes
- **Function** - phagocytic; increases during acute infections

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**Agranulocytes**

- Lack visible granules
- **Nuclei** spherical, oval or kidney-shaped
- **2 Types**
  1. Lymphocytes
  2. Monocytes

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**Lymphocyte**

- **Cytoplasm** - stains pale blue; thin rim around nucleus
- **Nucleus** - spherical; stains dark purple
- **Function** - part of immune system
Monocyte

Cytoplasm - abundant; stains gray-blue
Nucleus - “U” or kidney shaped
Function - phagocytic; increases during chronic infection

Changes in Numbers of WBCs

- Leukocytosis - increase in number of WBCs
  - Normal - when body invaded by bacteria, viruses, or other foreign substances
  - Abnormal - infectious mononucleosis, leukemia
- Leukopenia - decrease in number of WBCs
  - Caused by certain drugs

Platelets — Thrombocytes

<table>
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<tbody>
<tr>
<td>Aid clotting</td>
<td>Red bone marrow</td>
</tr>
<tr>
<td>150,000-300,000 per mm³ blood</td>
<td></td>
</tr>
<tr>
<td>2-4 μm in diameter Disk-shaped cell fragments with no nuclei; purple granules in cytoplasm</td>
<td></td>
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</tbody>
</table>
Hematopoiesis - Blood Cell Formation

- Occurs in red bone marrow
- All blood cells arise from common stem cell - hemocytoblast in red bone marrow
- RBCs eliminated in spleen, liver
  - 100-120 day lifespan
- RBC rate of production controlled by the hormone erythropoietin (EPO) - released by kidneys

SPORTS AND DRUGS / CYCLE OF TRAGEDY / Baseball has BALCO, but Europe is plagued with its own sports drug scandal: EPO and bicycling.

Marco Pantani (right), who won a Tour de France stage in 2000, died this year, apparently of cocaine poisoning. Alex Zuelle (left) and other members of France's Festina team were banned from the 1998 Tour de France.

Lymphocyte Formation

Hemostasis

Stoppage of blood flow

- Phases
  - Vascular spasms
  - Platelets stick to injury site
  - Platelet plug formation
  - Coagulation or blood clotting
    - Fibrinogen → fibrin → clot
Disorders of Hemostasis 1

Causes:
- slow flowing blood
- damaged blood vessel endothelium

2 Categories
1. Undesirable clotting
2. Bleeding disorders
Disorders of Hemostasis 2

1. Undesirable clotting
   - Def: stoppage of blood flow in absence of BV break
   - Thrombus
     - Clot develops in unbroken blood vessel
     - Ex: coronary thrombosis → heart attack
   - Embolus
     - clot breaks away from vessel wall and float in bloodstream
     - mobile thrombus
     - fat or air bubble
     - Ex: cerebral embolus → stroke

Disorders of Hemostasis 3

2. Bleeding Disorders
   - Thrombocytopenia
     - Insufficient number of circulating platelets
   - Hemophilia
     - Hereditary
     - Lacks clotting factors

Blood Loss

- 15 – 30% blood loss
  - → pallor & weakness

- >30% blood loss
  - → severe shock → death
  - shock
    - state in which blood flow to peripheral tissues
      is inadequate to sustain life
Blood Groups

- Classified by proteins - antigens on RBC membrane
- ABO Group
  - Type O - most common
  - Type AB - least common
- Rh Group
  - Rh+ - most common

U.S. Blood-type Distribution

- O+ 38% of population
- A+ 34%
- B+ 9%
- O- 7%
- A- 6%
- AB+ 3%
- B- 2%
- AB- 1%

Blood Typing

<table>
<thead>
<tr>
<th>Blood Typing</th>
<th>anti-A</th>
<th>anti-B</th>
<th>anti-Rh</th>
<th>type blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>O+</td>
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<tr>
<td>A-</td>
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<td>B+</td>
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<td>B-</td>
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<tr>
<td>AB-</td>
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Transfusion

- **Def:** transfer of whole blood or blood components into the bloodstream

- **Transfusion with incompatible blood**
  - donor RBC antigens differ from recipient
  - Recipient antibodies attack donor blood
    - agglutination → blockages

The End