

## **Blood**

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## **Functions of Blood**

- **Transporting**
  - **nutrients**
  - **respiratory gases**
  - **waste products**
- **Distributing body heat**

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## **Components of Blood**

**A type of connective tissue**

- **Formed elements**
  - **Living blood cells**
- **Plasma**
  - **Nonliving fluid matrix**

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## 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

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## Composition of Plasma

Sylvia S. Mader, Human Biology, 5th edition, Copyright © 1997 The McGraw-Hill Companies, Inc. All rights reserved.

Water (90-92% of plasma)
Plasma proteins (7-8% of plasma) Albumin Fibrinogen Immunoglobulins
Salts (less than 1% of plasma)
Gases Oxygen Carbon dioxide
Nutrients Fats Glucose Amino acids
Nitrogenous waste Urea Uric acid
Other Hormones, vitamins, etc.

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## 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
- Volume 5 - 6 liters

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## Formed Elements of the Blood

- **45% of blood volume**
  - **Erythrocytes or red blood cells (RBCs)**
  - **Leukocytes or white blood cells (WBCs)**
  - **Thrombocytes or platelets**

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## Formed Elements in Blood

- Sylvia S. Mader, Human Biology, 5th edition. Copyright © 1997 The McGraw-Hill Companies, Inc. All rights reserved.
- Red Blood Cells (erythrocytes)
    - 4 million–6 million per mm<sup>3</sup> blood
  - White Blood Cells (leukocytes)
    - Granular leukocytes
      - Basophil
        - 20–50 per mm<sup>3</sup> blood
      - Eosinophil
        - 100–400 per mm<sup>3</sup> blood
      - Neutrophil
        - 3,000–7,000 per mm<sup>3</sup> blood
    - Agranular leukocytes
      - Lymphocyte
        - 1,500–3,000 per mm<sup>3</sup> blood
      - Monocyte
        - 100–700 per mm<sup>3</sup> blood
  - Platelets (thrombocytes)
    - 150,000–300,000 per mm<sup>3</sup> blood

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## Erythrocytes

- **Function - carry oxygen to all body cells**
- **Structure**
  - **Biconcave disk shape**
  - **Lacks nucleus (anucleate)**
  - **Contains hemoglobin**
    - **12 - 18 grams per 100 milliliters of blood**
- **4.5 - 5.5 million cells per cubic millimeter**
- **Lifespan 100 - 120 days**

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## Red Blood Cells — Erythrocytes

	Function/Description	Source
 <p>4 million-6 million per mm<sup>3</sup> blood</p>	Transport O <sub>2</sub> and help transport CO <sub>2</sub>  7-8 μm in diameter Bright-red to dark-purple biconcave disks without nuclei	Red bone marrow

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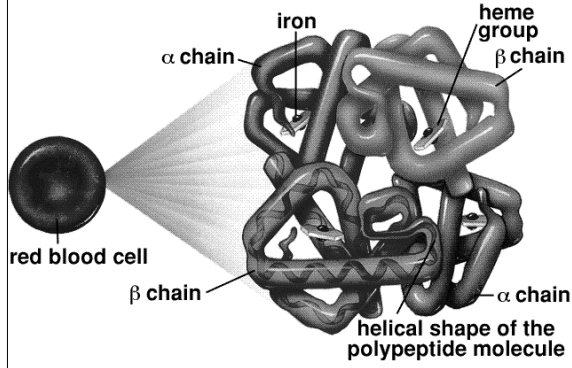
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## Hemoglobin Molecule



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## Anemia

**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

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## Leukocytes

**Function - crucial in body's defense against disease**

- **4000 - 11,000 WBCs per cubic millimeter**
- **Classification**
  - Granulocytes
  - Agranulocytes

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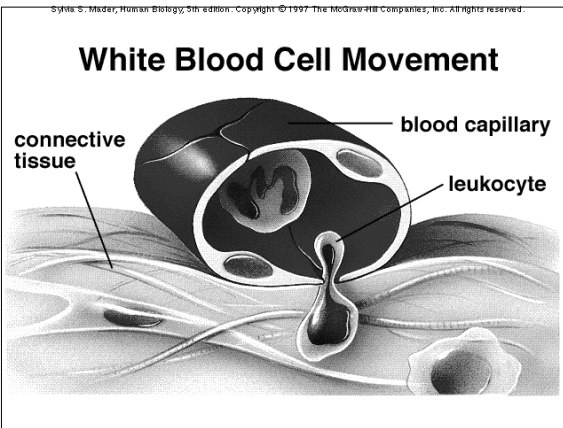
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## Granulocytes

- **Granule-containing WBCs**
- **Lobed nuclei**
- **Types**
  - Neutrophils
  - Eosinophils
  - Basophils

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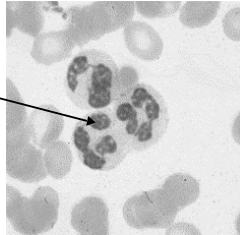
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## Neutrophil

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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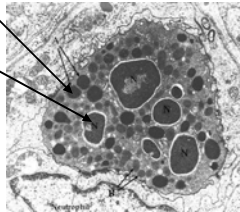
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## Neutrophil

electronmicrograph - 10,000X

granules

nucleus (N)



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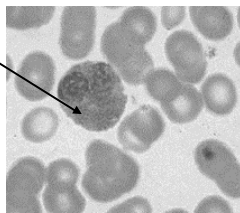
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## Eosinophil

Cytoplasm -  
has coarse red-  
orange granules

Nucleus -  
stains blue-red;  
figure-8 or bilobed  
shaped

Function -  
kills parasitic worms



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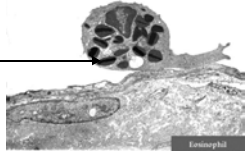
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**Eosinophil**  
electronmicrograph - 10,000X

granules



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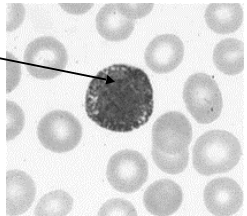
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**Basophil**

Cytoplasm -  
has few large blue-  
purple granules

Nucleus -  
U or S shaped; stains  
dark blue

Function -  
histamine discharged  
during inflammation



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**Agranulocytes**

- Lack visible granules
- Nuclei spherical, oval or kidney-shaped
- Types
  - Lymphocytes
  - Monocytes

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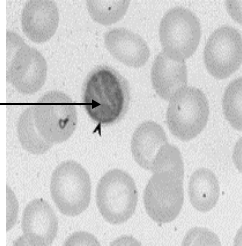
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## Lymphocyte

Cytoplasm -  
stains pale blue; thin rim  
around nucleus

Nucleus -  
spherical; stains dark  
purple

Function -  
part of immune system



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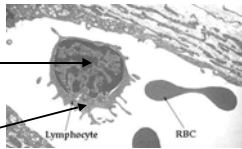
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## Lymphocyte

electronmicrograph - 10,000X

nucleus

cytoplasm



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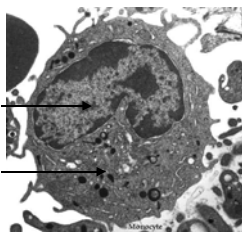
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## Monocyte

electronmicrograph - 10,000X

nucleus

cytoplasm



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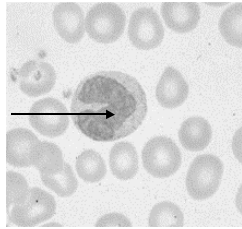


## Monocyte

Cytoplasm -  
**abundant; stains gray-blue**

Nucleus -  
**"U" or kidney shaped**

Function -  
**phagocytic; increases during chronic infection**



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## 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

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## Platelets

- **Function - aid in blood clotting**
- **Fragments of cells - megakaryocytes**
- **250,000 - 500,000 per cubic millimeter of blood**

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## Platelets — Thrombocytes

	Function/Discription	Source
 150,000-300,000 per mm <sup>3</sup> blood	<b>Aid clotting</b>  2-4 $\mu\text{m}$ in diameter Disk-shaped cell fragments with no nuclei; purple granules in cytoplasm	<b>Red bone marrow</b>

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## Hematopoiesis - Blood Cell Formation

- **Occurs in red bone marrow**
- **All blood cells arise from common stem cell - hemocytoblast**
- **RBCs eliminated in spleen, liver**
- **RBC rate of production controlled by the hormone erythropoietin - released by kidneys**

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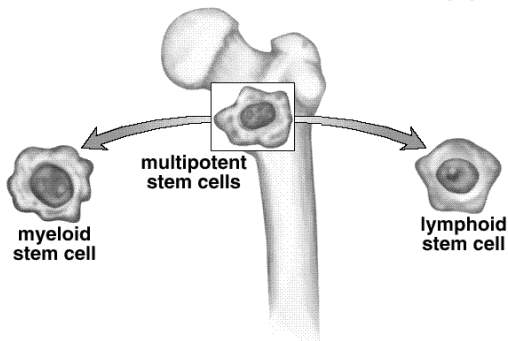
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## Red Blood Cell Formation (1)



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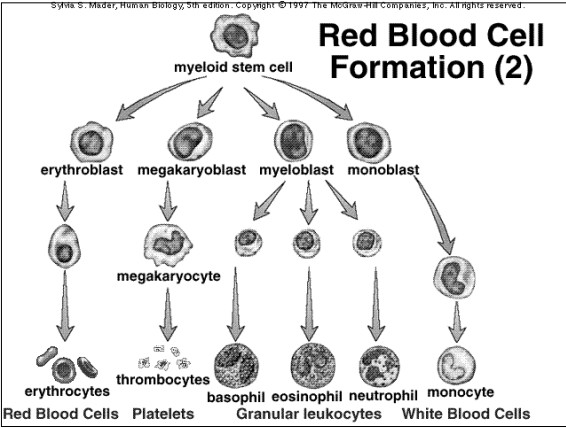
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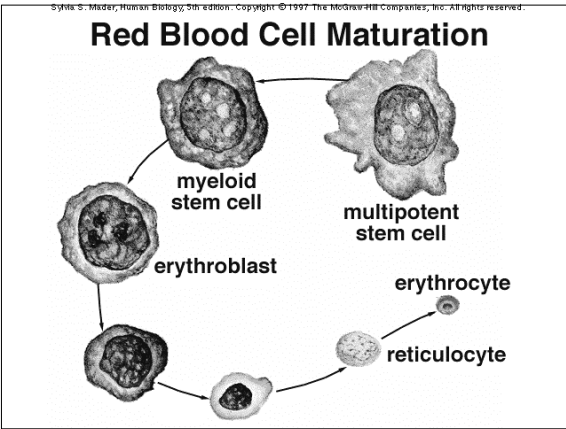
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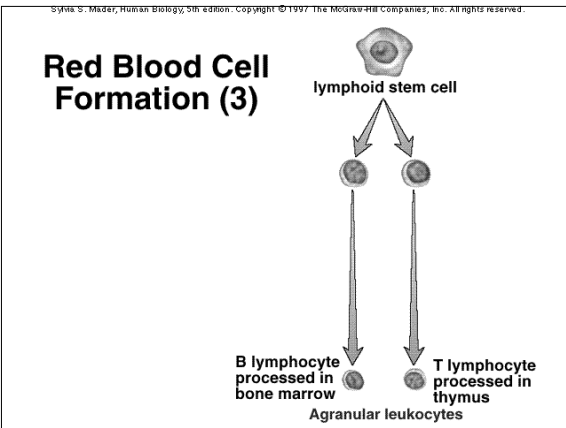
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## Hemostasis

### Stoppage of blood flow

- Phases
  - Vascular spasms
  - Platelet plug formation
  - Coagulation or blood clotting
    - Fibrinogen > fibrin

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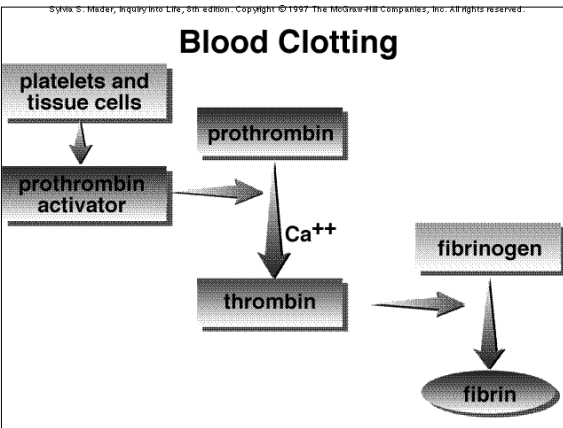
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## Disorders of Hemostasis

- Undesirable clotting
  - Thrombus
    - Clot develops in unbroken blood vessel
      - Eg coronary thrombosis
  - Embolus
    - Clot breaks away from vessel wall and float in bloodstream
      - Eg cerebral embolus

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## Disorders of Hemostasis

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

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## Blood Groups

- **Classified by proteins - antigens on RBC membrane**
- **ABO Group**
  - Type O - most common
  - Type AB - least common
- **Rh Group**
  - Rh<sup>+</sup> - most common

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## U.S. Blood-type Distribution

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

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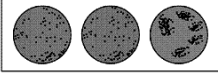
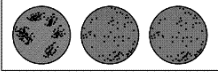


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### Blood Typing

	anti-A	anti-B	anti-Rh	type blood
				O <sup>+</sup>
				A <sup>-</sup>
				B <sup>+</sup>
				AB <sup>-</sup>

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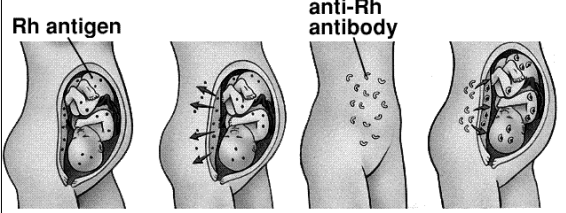
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### Development of Hemolytic Disease



**Rh antigen**  
Child is Rh-positive; mother is Rh negative

**Red blood cells leak across placenta**

**anti-Rh antibody**  
Mother makes anti-Rh antibodies

**Antibodies attack Rh-positive red blood cells in child**

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**The End**

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