

Blood Lecture for Anatomy

Adapted from Marieb's Human Anatomy & Physiology

Blood

- The only fluid tissue in the human body
- Classified as a connective tissue
 - Living cells = formed elements
 - Non-living matrix = plasma

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Slide 10.1a

Blood

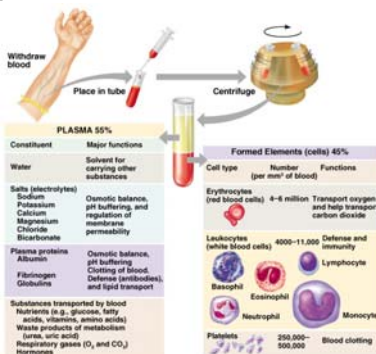


Figure 10.1

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Physical Characteristics of Blood

- Color range
 - Oxygen-rich blood is scarlet red
 - Oxygen-poor blood is dull red
- pH must remain between 7.35–7.45
- Blood temperature is slightly higher than body temperature

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Blood Plasma

- Composed of approximately 90 percent water
- Includes many dissolved substances
 - Nutrients
 - Salts (metal ions)
 - Respiratory gases
 - Hormones
 - Proteins
 - Waste products

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Plasma Proteins

- Albumin – regulates osmotic pressure
- Clotting proteins – help to stem blood loss when a blood vessel is injured
- Antibodies – help protect the body from antigens

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Formed Elements

- Erythrocytes = red blood cells
- Leukocytes = white blood cells
- Platelets = cell fragments

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Table 10.2 Characteristics of Formed Elements of the Blood

Cell type	Occurrence in blood (per mm ³)	Cell anatomy*	Function
Erythrocytes (red blood cells, or RBCs)	4-6 million	Salmon-colored biconcave disks; anucleate; lateral sacs of hemoglobin; most organelles have been ejected	Transport oxygen bound to hemoglobin molecules; also transport small amount of carbon dioxide
Leukocytes (white blood cells, or WBCs)	4000-11,000		
Granulocyte			
• Neutrophils	3000-7000 40-70% of WBCs	Cytoplasm stains pale pink and contains fine granules, which are difficult to see; deep purple nucleus consists of three to seven lobes connected by thin strands of nucleoplasm	Active phagocytes; number increases rapidly during short-term or acute infections
• Eosinophils	100-400 (1-4% of WBCs)	Red coarse cytoplasmic granules; figure-8 or bilobed nucleus stains blue-red	Kill parasitic worms; increase during allergy attacks; might phagocytose antigen-antibody complexes and inactivate some inflammatory chemicals

*Appearance when stained with Wright

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10.5b

Table 10.2 Characteristics of Formed Elements of the Blood

Cell type	Occurrence in blood (per mm ³)	Cell anatomy*	Function
• Basophils	20-60 (0-1% of WBCs)	Cytoplasm has a few large blue-purple granules; U- or S-shaped nucleus with constrictions; stains dark blue	Granules contain histamine (vasodilator chemical), which is discharged at sites of inflammation
Agranulocyte			
• Lymphocytes	1500-3000 (20-45% of WBCs)	Cytoplasm pale blue and appears as thin rim around nucleus; spherical or slightly indented dark purple-blue nucleus	Part of immune system; one group (B lymphocytes) produces antibodies; other group (T lymphocytes) involved in graft rejection, fighting tumors and viruses, and activating B lymphocytes
• Monocytes	100-700 (4-8% of WBCs)	Abundant gray-blue cytoplasm; dark blue-purple nucleus often kidney-shaped	Active phagocytes that become macrophages in the tissues; long-term "cleanup team"; increase in number during chronic infections such as tuberculosis
Platelets	250,000-500,000	Essentially irregularly shaped cell fragments; stain deep purple	Needed for normal blood clotting; initiate clotting cascade by clinging to broken area; help to control blood loss from broken blood vessels

*Appearance when stained with Wright

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Erythrocytes (Red Blood Cells)

- The main function is to carry oxygen
- Anatomy of circulating erythrocytes
 - Biconcave disks
 - Essentially bags of hemoglobin
 - Anucleate (no nucleus)
 - Contain very few organelles
- Outnumber white blood cells 1000:1

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Hemoglobin

- Iron-containing protein
- Binds strongly, but reversibly, to oxygen
- Each hemoglobin molecule has four oxygen binding sites
- Each erythrocyte has 250 million hemoglobin molecules

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Leukocytes (White Blood Cells)

- Crucial in the body's defense against disease
- These are complete cells, with a nucleus and organelles
- Able to move into and out of blood vessels (diapedesis)
- Can move by ameboid motion
- Can respond to chemicals released by damaged tissues

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Leukocyte Levels in the Blood

- Normal levels are between 4,000 and 11,000 cells per millimeter
- Abnormal leukocyte levels
 - Leukocytosis
 - Above 11,000 leukocytes/ml
 - Generally indicates an infection
 - Leukopenia
 - Abnormally low leukocyte level
 - Commonly caused by certain drugs

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Types of Leukocytes

- Granulocytes
 - Granules in their cytoplasm can be stained
 - Include neutrophils, eosinophils, and basophils

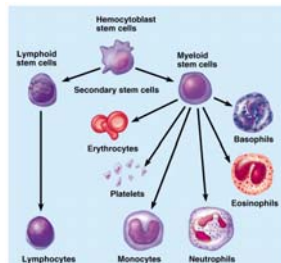


Figure 10.4

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Types of Leukocytes

- Agranulocytes
 - Lack visible cytoplasmic granules
 - Include lymphocytes and monocytes

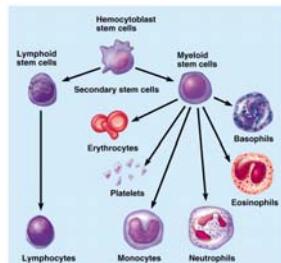


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Granulocytes

- Neutrophils
 - Multilobed nucleus with fine granules
 - Act as phagocytes at active sites of infection
- Eosinophils
 - Large brick-red cytoplasmic granules
 - Found in response to allergies and parasitic worms

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Granulocytes

- Basophils
 - Have histamine-containing granules
 - Initiate inflammation

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Agranulocytes

- Lymphocytes
 - Nucleus fills most of the cell
 - Play an important role in the immune response
- Monocytes
 - Largest of the white blood cells
 - Function as macrophages
 - Important in fighting chronic infection

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Platelets

- Derived from ruptured multinucleate cells (megakaryocytes)
- Needed for the clotting process
- Normal platelet count = 300,000/mm³

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Blood Groups and Transfusions

- Large losses of blood have serious consequences
 - Loss of 15 to 30 percent causes weakness
 - Loss of over 30 percent causes shock, which can be fatal
- Transfusions are the only way to replace blood quickly
- Transfused blood must be of the same blood group

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Human Blood Groups

- Blood contains genetically determined proteins
- A foreign protein (antigen) may be attacked by the immune system
- Blood is “typed” by using antibodies that will cause blood with certain proteins to clump (agglutination)

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Human Blood Groups

- There are over 30 common red blood cell antigens
- The most vigorous transfusion reactions are caused by ABO and Rh blood group antigens

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ABO Blood Groups

- Based on the presence or absence of two antigens
 - Type A
 - Type B
- The lack of these antigens is called type O

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ABO Blood Groups

- The presence of both A and B is called type AB
- The presence of either A or B is called types A and B, respectively

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Rh Blood Groups

- Named because of the presence or absence of one of eight Rh antigens (agglutinin D)
- Most Americans are Rh⁺
- Problems can occur in mixing Rh⁺ blood into a body with Rh⁻ blood

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Rh Dangers During Pregnancy

- Danger is only when the mother is Rh⁻ and the father is Rh⁺, and the child inherits the Rh⁺ factor

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Rh Dangers During Pregnancy

- The mismatch of an Rh⁻ mother carrying an Rh⁺ baby can cause problems for the unborn child
 - The first pregnancy usually proceeds without problems
 - The immune system is sensitized after the first pregnancy
 - In a second pregnancy, the mother's immune system produces antibodies to attack the Rh⁺ blood (hemolytic disease of the newborn)

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Blood Typing

- Blood samples are mixed with anti-A and anti-B serum
- Coagulation or no coagulation leads to determining blood type
- Typing for ABO and Rh factors is done in the same manner
- Cross matching – testing for agglutination of donor RBCs by the recipient's serum, and vice versa

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Developmental Aspects of Blood

- Sites of blood cell formation
 - The fetal liver and spleen are early sites of blood cell formation
 - Bone marrow takes over hematopoiesis by the seventh month
- Fetal hemoglobin differs from hemoglobin produced after birth

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