

Lecture 9 BLOOD

Provides a mechanism for rapid transport of nutrients, waste products, respiratory gases and cells. Powered by the pumping action of the heart.

Introduction

Cardiovascular System

System made up of blood vessels, blood and heart. Major function is to transport nutrients, gases and hormones to the cells and pick up wastes from cells to transport them to areas of body where they are excreted

Lymphatic System

Network of vessels that return the fluid escaped from blood vessels back to the bloodstream

Includes lymphocytes, lymphoid tissue and lymphoid organs which fight infections and give immunity to disease

Circulatory System

Together the cardiovascular system and lymphatic system make up the circulatory system.

Functions of Blood

- **Transportation** - the blood transports dissolved gases, nutrients, hormones and metabolic wastes.
- **Protection** - the blood restricts fluid losses through damaged vessels. Platelets in the blood and clotting proteins minimize blood loss when a blood vessel is damaged.
- **Regulation**
 - Blood regulates the pH and electrolyte composition of the interstitial fluids.
 - Blood regulates body temperature.

Composition of Blood

- Contains cellular and liquid components
- A specialized connective tissue
 - Blood cells – formed elements

- Plasma – fluid portion and fibrinogen
- Blood volume
 - Males: 5 – 6 liters
 - Females: 4 – 5 liters
- The pH of blood is about 7.35-7.45

Formed Elements

Blood cells (Erythrocytes, leukocytes, and platelets)

Blood Plasma (Straw-colored, sticky fluid portion of blood)

Approximately 90% water, contains:

- Ions – Na⁺ and Cl⁻
- Nutrients – sugars, amino acids, lipids, cholesterol, vitamins and trace elements
- Three main proteins - Albumin (60%), globulin (35%), fibrinogen (4%)
- Dissolved Gasses – including O₂ and CO₂
- Waste Products – other protein wastes such as urea and bilirubin

Overview: Composition of Blood

Erythrocytes – Red Blood Cells (RBCs) Oxygen-transporting cells
7.5 μm in diameter (diameter of capillary 8 – 10μm). Most numerous of the formed elements

- Females: 4.3 – 5.2 million cells/cubic millimeter
- Males: 5.2 – 5.8 million cells/cubic millimeter

Made in the red bone marrow in long bones, cranial bones, ribs, sternum, and vertebrae. Average lifespan 100 – 120 days

RBC Structure and Function

Have no organelles or nuclei, contain hemoglobin (oxygen carrying protein (Each RBC has about 280 million hemoglobin molecules). Biconcave shape.

Leukocytes – White Blood Cells (WBCs)

- Protect the body from infectious microorganisms
- 4,800 – 11,000/cubic millimeter
- Function outside the bloodstream in loose connective tissue
- Diapedesis (circulating leukocytes leave the capillaries)

- WBCs have a nucleus and are larger than RBCs
- Most produced in bone marrow
- Lifespan of 12 hours to several years
- Two types of leukocytes
 - Granulocytes
 - Agranulocytes

White Blood Cells

Type Of White Blood Cells	% By Volume Of WBC	Description	Function
Neutrophils	60 – 70 %	Nucleus has many interconnected lobes; blue granules	Phagocytize and destroy bacteria; most numerous WBC
Eosinophils	2 – 4 %	Nucleus has bilobed nuclei; red or yellow granules containing digestive enzymes	Play a role in ending allergic reactions
Basophils	< 1 %	Bilobed nuclei hidden by large purple granules full of chemical mediators of inflammation	Function in inflammation medication; similar in function to mast cells
Lymphocytes (B Cells and T Cells)	20 – 25 %	Dense, purple staining, round nucleus; little cytoplasm	the most important cells of the immune system; effective in fighting infectious organisms; act against a specific foreign molecule (antigen)

Monocytes	4 – 8 %	Largest leukocyte; kidney shaped nucleus	Transform into macrophages; phagocytic cells
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Granulocytes

Neutrophils: most numerous WBC, Phagocytize and destroy bacteria. Nucleus – has two to six lobes. Granules pick up acidic and basic stains.

Eosinophils: compose 1 – 4% of all WBCs). Play roles in ending allergic reactions, parasitic infections.

Basophils: about 0.5% of all leukocytes. Nucleus – usually two lobes. Granules secrete histamines. Function in inflammation mediation, similar in function to mast cells

Agranulocytes

Lymphocytes: compose 20 – 45% of WBCs. The most important cells of the immune system. Nucleus – stains dark purple. Effective in fighting infectious organisms. Act against a specific foreign molecule (antigen). Two main classes of lymphocyte

- T cells (attack foreign cells directly)
- B cells (multiply to become plasma cells that secrete antibodies)

Monocytes: compose 4–8% of WBCs. The largest leukocytes. Nucleus – kidney shaped. Transform into macrophages. Phagocytic cells.

Platelets

Small cellular fragments; originate in bone marrow from giant cell megakaryocyte. Contain several clotting factors (calcium ions, ADP, serotonin). Involved in stopping bleeding when a blood vessel is damaged; Process is called hemostasis.

Blood Cell Formation

- Hematopoiesis – process by which blood cells are formed
- 100 billion new blood cells formed each day

- Takes place in the red bone marrow of the humerus, femur, sternum, ribs, vertebra and pelvis
 - Red marrow – actively generates new blood cells
 - Contains immature erythrocytes
 - Remains in epiphyses, girdles, and axial skeleton
 - Yellow marrow – dormant
 - Contains many fat cells
 - Located in the long bones of adults
 - Tissue framework for red marrow
 - Reticular connective tissue