

Lecture Outline for Integrated Basic Health Sciences for Pharmacy

Physiology Component of Module : Cardiovascular

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I. Overview: Blood Composition and Functions (pp. 635–636; Fig. 17.1)

A. Components (p. 635; Fig. 17.1)

1. Blood is a specialized connective tissue consisting of living cells, called formed elements, suspended in a nonliving fluid matrix, blood plasma.
2. Blood that has been centrifuged separates into three layers: erythrocytes, the buffy coat, and plasma.
3. The blood hematocrit represents the percentage of erythrocytes in whole blood.

B. Physical Characteristics and Volume (p. 635)

1. Blood is a slightly basic (pH = 7.35–7.45) fluid that has a higher density and viscosity than water, due to the presence of formed elements.
2. Normal blood volume in males is 5–6 liters, and 4–5 liters for females.

C. Functions (pp. 635–636)

1. Blood is the medium for delivery of oxygen and nutrients, removal of metabolic wastes to elimination sites, and distribution of hormones.
2. Blood aids in regulating body temperature, body fluid pH, and fluid volume within fluid compartments.
3. Blood protects against excessive blood loss through the clotting mechanism, and from infection through the immune system.

II. Blood Plasma (p. 636; Table 17.1)

- A. Blood plasma consists of mostly water (90%), and solutes including nutrients, gases, hormones, wastes, products of cell activity, ions, and proteins (p. 636; Table 17.1).
- B. Plasma proteins account for 8% of plasma solutes, mostly albumin, which function as carriers (p. 636).

III. Formed Elements (pp. 637–643; Figs. 17.2–17.8; Table 17.2)

(N.B. Be aware of types of Leukocytes, but details to be addressed in another course.)

- A. Erythrocytes (pp. 637–643; Figs. 17.2–17.8)
1. Erythrocytes, or red blood cells, are small cells that are biconcave in shape. They lack nuclei and most organelles, and contain mostly hemoglobin.
 - a. Hemoglobin is an oxygen-binding pigment that is responsible for the transport of most of the oxygen in the blood.
 - b. Hemoglobin is made up of the protein globin bound to the red heme pigment.
 2. Production of Erythrocytes
 - a. Hematopoiesis, or blood cell formation, occurs in the red bone marrow.
 - b. Erythropoiesis, the formation of erythrocytes, begins when a myeloid stem cell is transformed to a proerythroblast, which develops into mature erythrocytes.
 - c. Erythrocyte production is controlled by the hormone erythropoietin.
 - d. Dietary requirements for erythrocyte formation include iron, vitamin B₁₂, and folic acid, as well as proteins, lipids, and carbohydrates.
 - e. Blood cells have a short life span due to the lack of nuclei and organelles; destruction of dead or dying blood cells is accomplished by macrophages.
 3. Erythrocyte Disorders
 - a. Anemias are characterized by a deficiency in RBCs.
 - b. Polycythemia is characterized by an abnormal excess of RBCs.
- C. Platelets (pp. 648–649; Fig. 17.12)
1. Platelets are not complete cells, but fragments of large cells called megakaryocytes.
 2. Platelets are critical to the clotting process, forming the temporary seal when a blood vessel breaks.
 3. Formation of platelets involves repeated mitoses of megakaryocytes without cytokinesis.

IV. Hemostasis (pp. 649–654; Figs. 17.13–17.14; Table 17.3)

- A. A break in a blood vessel stimulates hemostasis, a **fast, localized response** to reduce blood loss through clotting (p. 649).
- B. Vascular spasms are the immediate vasoconstriction response to blood vessel injury (p. 649).
- C. Platelet Plug Formation (pp. 649–650; Fig. 17.13)
 1. When endothelium is damaged, platelets become sticky and spiky, adhering to each other and the damaged vessel wall.
 2. Once attached, other platelets are attracted to the site of injury, activating a positive feedback loop for clot formation.

- D. Coagulation, or blood clotting, is a multistep process in which blood is transformed from a liquid to a gel (pp. 650–652; Figs. 17.13–17.14; Table 17.3).
1. Factors that promote clotting are called clotting factors, or procoagulants; those that inhibit clot formation are called anticoagulants.
 2. The clotting process involves three phases: formation of prothrombin activator, conversion of prothrombin to thrombin, and the formation of fibrin mesh from fibrinogen in the plasma.
 - a. The intrinsic pathway of clotting is so named because all factors necessary are present within the blood. It is a slower clotting pathway, and may be triggered by negatively charged surfaces, such as activated platelets, collagen, or glass.
 - b. The extrinsic pathway is triggered through an endothelium-derived protein factor, called tissue factor (TF) or factor III, and can occur very rapidly.
- E. Clot Retraction and Repair (p. 652)
1. Clot retraction is a process in which the contractile proteins within platelets contract and pull on neighboring fibrin strands, squeezing plasma from the clot and pulling damaged tissue edges together.
 2. Repair is stimulated by platelet-derived growth factor (PDGF).
- F. Fibrinolysis removes unneeded clots through the action of the fibrin-digesting enzyme plasmin (p. 652).
- G. Factors Limiting Clot Growth or Formation (pp. 652–653)
1. Rapidly moving blood disseminates clotting factors before they can initiate a clotting cascade.
 2. Thrombin that is not bound to fibrin is inactivated by antithrombin III and protein C, as well as heparin.
- H. Disorders of Hemostasis (pp. 653–654)
1. Thromboembolytic disorders result from conditions that cause undesirable clotting, such as roughening of vessel endothelium, slow-flowing blood, or blood stasis.
 2. Disseminated intravascular coagulation is a situation leading to widespread clotting throughout intact vessels, and may occur as a complication of pregnancy, septicemia, or incompatible blood transfusions.
 3. Bleeding disorders arise from abnormalities that prevent normal clot formation, such as a deficiency in circulating platelets, lack of synthesis of procoagulants, or hemophilia.

V. Transfusion and Blood Replacement (pp. 654–657; Fig. 17.15; Table 17.4)

- A. Transfusion of whole blood is routine when blood loss is substantial, or when treating thrombocytopenia (pp. 654–656; Fig. 17.15; Table 17.4).
1. Humans have different blood types based on specific antigens on RBC membranes.

2. ABO blood groups are based on the presence or absence of two types of agglutinogens.
 3. Preformed antibodies (agglutinins) are present in blood plasma and do not match the individual's blood.
 4. The Rh factor is a group of red blood cell antigens that are either present in Rh⁺ blood, or absent in Rh⁻ blood.
 5. A transfusion reaction occurs if the **infused donor blood antigens (agglutinogens)** is attacked by the **recipient's blood plasma antibodies (agglutinins)**, resulting in agglutination and hemolysis of the donor cells.
- B. Plasma and blood volume expanders are given in cases of extremely low blood volume (pp. 656–657).

END OF OUTLINE

References

Marieb, E. N. & Hoehn K (2010). Human Anatomy and Physiology. 8th Edition, Pearson, Benjamin Cummings.