

CH 11 Blood

OUTLINE:

- Functions of Blood
- Composition of Blood
- Blood Cell Disorders
- Blood Types
- Blood Clotting

Functions of Blood

- Transportation
- Protection
- Regulation
 - pH
 - Temperature

Composition of Blood

- Plasma: liquid that makes up about 55% of blood
 - Composition of plasma
 - About 93% water
 - 7% consists of dissolved substances: ions, dissolved gases, hormones, plasma proteins, and waste products
- Formed elements
 - Cellular components of blood
 - Make up about 45% of blood

Plasma

- Plasma proteins
 - Help balance water flow between blood and cells
 - General categories
 - Albumins
 - Important for blood's water-balancing ability
 - Globulins
 - Transport lipids and fat-soluble vitamins
 - Some are antibodies
 - Clotting proteins
 - Example: fibrinogen

Formed Elements and Platelets

- Stem cells within red bone marrow give rise to the formed elements
 - Platelets
 - White blood cells
 - Red blood cells
- Platelets
 - Sometimes called thrombocytes
 - Fragments of larger precursor cells called megakaryocytes
 - Essential to blood clotting

White Blood Cells and Defense Against Disease

- Also called leukocytes (leuko: white, cytes: cells)
- Have a nucleus
- One type is produced in lymph nodes and other lymphoid tissue

White Blood Cells and Defense Against Disease

- General functions

- Remove wastes, toxins, and damaged and abnormal cells
- Help defend the body against disease
 - Can leave the circulatory system and move to the site of infection or tissue damage
 - Some are capable of phagocytosis

White Blood Cells and Defense Against Disease

- Two groups based on the presence or absence of granules in the cytoplasm
 - **Granulocytes (possess granules)**
 - Classified based on how they stain
 - Neutrophils do not stain
 - Basophils stain purple
 - Eosinophils stain pink
 - **Agranulocytes (lack visible granules)**

Granulocytes

- Neutrophils (most abundant of the WBCs)
 - Engulf microbes by phagocytosis, thus curbing the spread of infection
 - Component of pus (liquid associated with infection):
 - Dead neutrophils, bacteria and cellular debris

Granulocytes

- Eosinophils
 - Defend against parasitic worms
 - Lessen the severity of allergies
- Basophils
 - Release histamine that attracts other white blood cells and causes the blood vessels to dilate
 - Also play a role in some allergic reactions

Agranulocytes

- Monocytes
 - Largest of the formed elements
 - Develop into macrophages: phagocytic cells that engulf invading microbes, dead cells, and cellular debris
- Lymphocytes
 - B lymphocytes
 - T lymphocytes

Agranulocytes

- B lymphocytes
 - Give rise to plasma cells, which produce antibodies
 - Antibodies are proteins that recognize specific molecules (antigens) on the surface of invading microbes or other foreign cells
- T lymphocytes
 - Specialized white blood cells
 - Kills cells not recognized as coming from the body, or cells that are cancerous

Red Blood Cells and Transport of Oxygen

- Also called erythrocytes
- Transport oxygen to the cells
- Carry about 23% of the blood's total carbon dioxide
- Shaped like biconcave disks and are very flexible
- No nucleus when mature

- Contain hemoglobin

Red Blood Cells and Hemoglobin

- Oxygen-binding pigment in RBCs
- Structure
 - Each molecule has four subunits
 - Each subunit has a polypeptide chain and a heme group
 - The iron ion of the heme group binds to oxygen

Red Blood Cells and Hemoglobin

- Oxyhemoglobin: hemoglobin bound with oxygen
- Hemoglobin has a much greater affinity for carbon monoxide than for oxygen
 - Odorless and tasteless
 - An insidious poison

Life Cycle of Red Blood Cells

- Produced in the red bone marrow
- Live about 120 days
- Undergo phagocytosis in the liver and spleen
 - Hemoglobin is degraded into its protein component (globin) and heme component
 - The iron from the heme is sent to the bone marrow for recycling
 - The remaining portions of heme are degraded to bilirubin, which the liver releases in bile

Life Cycle of Red Blood Cells

- Production of red blood cells
 - Regulated by a negative feedback mechanism
 - Production typically matches destruction
 - In the case of blood loss, the rate of RBC production is increased
 - Kidney cells sense reduced oxygen and produce the hormone erythropoietin
 - Erythropoietin stimulates the red bone marrow to produce more RBCs
 - The increased oxygen-carrying capacity of the blood inhibits production of erythropoietin

Disorders of Red Blood Cells

- Anemia
 - The blood's ability to carry oxygen is reduced
 - Can result from too little hemoglobin, too few red blood cells, or both
 - Symptoms include fatigue, headaches, dizziness, paleness, breathlessness, and heart palpitations
 - Types of anemias
 - Iron-deficiency anemia
 - Hemolytic anemia: sickle-cell anemia
 - Pernicious anemia

Disorders of Red Blood Cells

- Anemia (cont'd)
 - Iron-deficiency anemia (most common form, leads to inadequate hemoglobin production)
 - Causes:
 - A diet that contains too little iron
 - An inability to absorb iron
 - Blood loss

Disorders of Red Blood Cells

- Anemia (cont'd)
 - Hemolytic anemia: when red blood cell destruction exceeds production
 - Causes:
 - Infections
 - Defects in the membranes of RBCs
 - Transfusion of mismatched blood
 - Hemoglobin abnormalities

Disorders of Red Blood Cells

- Anemia (cont'd)
 - Sickle-cell anemia
 - An example of a hemolytic anemia
 - Caused by abnormal hemoglobin
 - RBCs form a sickle shape when the blood's oxygen content is low
 - Results in RBCs that are fragile and rupture easily, clogging small blood vessels and promoting clot formation

Disorders of Red Blood Cells

- Anemia (cont'd)
 - Pernicious anemia
 - Occurs when there is insufficient production of red blood cells
 - Production of RBCs depends on vitamin B₁₂
 - Intrinsic factor produced by the stomach lining helps the small intestine absorb vitamin B₁₂ from the diet
 - Caused by failure to produce intrinsic factor, which makes impossible the absorption of vitamin B₁₂

Disorders of White Blood Cells

- Infectious mononucleosis
 - Viral disease of the lymphocytes caused by the Epstein-Barr virus
 - Symptoms include fever, headache, sore throat, and swollen lymph nodes
 - There is no treatment

Disorders of White Blood Cells

- Leukemia
 - A cancer of the WBCs that causes the number of WBCs to greatly increase
 - These abnormal cells take over the bone marrow, preventing the development of normal RBCs, WBCs, and platelets
 - Symptoms include anemia and inadequate clotting and body defense mechanisms
 - Treatment typically involves radiation therapy, chemotherapy, and transfusions
 - Bone marrow transplants can help

Blood Types

- Named by the antigen (protein) found on the surface of RBCs
 - Type A has only the A antigen
 - Type B has only the B antigen
 - Type AB has both A and B antigens
 - Type O has neither A nor B antigens
- Agglutination (clumping)
 - Occurs when someone's antibodies contact a foreign cell
 - This response can be used to determine blood type

Blood Types

Rh Factor

- First discovered on the rhesus macaque (*Macaca mulatta*), also called the rhesus monkey
 - Another important antigen
 - Individuals who have Rh antigens on their RBCs are Rh-positive
 - Individuals who lack Rh antigens on their RBCs are Rh-negative
 - An Rh-negative person will not form anti-Rh antibodies unless he or she has been exposed to the Rh antigen
 - Transfusion
 - Having given birth to an Rh-positive baby

Rh Factor

- Hemolytic disease of the newborn
 - Anti-Rh antibodies can develop in the mother
 - They can cross the placenta, destroying the Rh-positive fetus's RBCs
 - The baby may die or be very anemic
 - RhoGAM
 - A serum containing antibodies against the Rh antigens
 - Given to an Rh-negative mother to destroy any Rh-positive fetal cells in her circulation and thereby prevent her production of anti-Rh antibodies

Blood Clotting

- Steps that occur once a blood vessel is cut
 - The vessel constricts
 - Platelets form a plug that seals the leak
 - Platelets cling to collagen and produce a chemical that attracts more platelets
 - Note: aspirin prevents the formation of this chemical and therefore inhibits clot formation
 - Formation of a blood clot

Blood Clotting

- The key events in clot formation are:
 - Clotting factors are released from injured tissue and platelets
 - These factors convert an inactive blood protein to prothrombin activator
 - Prothrombin activator converts prothrombin (a plasma protein produced by the liver) to thrombin, an active form
 - Thrombin causes fibrinogen (another plasma protein produced by the liver) to form long strands of fibrin
 - Fibrin strands form a web that traps blood cells and forms a clot
 - When the wound has healed, the enzyme plasmin, formed from plasminogen, digests the fibrin strands of the clot

Blood Clotting

- If even one of the clotting factors is lacking, the process can be slowed or completely blocked
- Vitamin K is needed to synthesize prothrombin in the liver
 - Clotting does not occur without it
 - Two sources of vitamin K are diet and intestinal bacteria (which can be killed by antibiotic therapy)

Blood Clotting

- Disorders
 - Hemophilia

- Inherited condition characterized by excessive bleeding
- Caused by faulty gene involved in the production of clotting factors
- Treatment involves restoration of the missing clotting factor

Blood Clotting

- Disorders (cont'd)
 - Formation of unnecessary blood clots can have immediate health consequences
 - Clots can disrupt blood flow and cause heart attack or stroke
 - A clot that continues to circulate is called an embolus
 - A clot that lodges in an unbroken blood vessel is called a thrombus

Blood Clotting

You Should Now Be Able To:

- Describe the functions of blood
- Describe the formation of blood
- Know the composition of blood:
 - Plasma
 - Platelets
 - White blood cells
 - Red blood cells
- Know the main blood cell disorders
- Know the blood types and Rh factor
- Understand blood clotting and blood clotting disorders