BLOOD

OBJECTIVES/RATIONALE

To pursue a career in health care, proficiency in anatomy and physiology is vital. The student will describe biological and chemical processes that maintain homeostasis; analyze forces and the effects of movement, torque, tension, and elasticity on the human body; associate the disease process with changes in homeostasis; identify changes in structure and function due to trauma and disease; and identify normal and abnormal anatomy and physiology.

TEKS: 121.3 (c)(1)(F)(H),
121.4 (c)(1)(G)(H)(I),
121.5 (c)(1)(E)(F)(G)

TAKS: ELA 1, 4
Mathematics 8, 9, 10
Science 1, 2, 4

KEY POINTS

Powerpoint

I. Introduction
   A. Essential Life Supportive Fluid
   B. Transported Throughout Body Through Blood Vessels
   C. Does Not Leave Vessels to Flow Among Tissues
   D. Remains Inside Vessels as Closed System
   E. Connective Tissue (Cells + Matrix)

II. Functions
   A. Transportation
      1. Delivers O_2 from Lungs and nutrients from digestive tract to all body cells
      2. Transports the oxygen as oxyhemoglobin and carbon dioxide as carboxyhemoglobin, carbonic acid, and bicarbonate
      3. Transports metabolic waste from cells to elimination sites (lungs, kidneys)
      4. Transports hormones
   B. Regulation
      1. Maintains appropriate body temperature
      2. Maintains normal pH
      3. Maintains adequate fluid volume with NaCl and other salts acting with blood proteins (albumin) to prevent excessive fluid loss
   C. Protection
      1. Prevents blood loss through clotting mechanism
      2. Prevents infection through immunity (phagocytosis and antibody production)

III. General Characteristics

A. Formed Elements: Living Blood Cells
    1. 2 out of 3 are NOT true cells
    2. Most are short lived
    3. Most do not divide
    4. Hematopoiesis occurs in liver, spleen, thymus, and bone marrow
    5. Erythrocytes
        a. 45% (Hematocrit)
        b. RBCs transport oxygen
    6. Leukocytes and platelets
        a. <1%
        b. Buffy Coat

B. Plasma
    1. Fluid matrix with fibrous proteins (fibrin)

C. Physical Characteristics
    1. Viscous
    2. pH 7.35 – 7.45
    3. Temperature: 38 ^{o}C or 100.4 ^{o}F
    4. 7% - 8% of total body weight
    5. Males: 5 – 6 liters
    6. Females: 4 – 5 liters

IV. Plasma

A. Liquid Portion: 90% - 92% Water

B. Straw Colored Sticky Fluid

C. 8% Proteins
    1. Albumin (60%)
    2. Globulins (36%): alpha, beta, gamma (antibodies)
    3. Clotting proteins: fibrinogen, Prothrombin
    4. Others: metabolic enzymes, antibacterial proteins, hormones

D. Nonprotein Nitrogenous Substances
    1. Lactic acid
    2. Urea
    3. Creatinine
    4. Ammonium salts

E. Nutrients

F. Electrolytes: Na, K, Ca, Mg, Cl, phosphate, sulfate, bicarbonate

G. Respiratory Gases: O_2 and CO_2

H. Functions
    1. Suspends blood cells and transports blood cells
    2. Carries metabolic wastes and nutrients
    3. Circulates hormones to regulate body functions
    4. Maintains water content and body temperature
    5. Maintains acid-base balance of blood

V. Erythrocytes (RBCs)

A. Biconcave Disc Shape: Spectrin (Fibrous Protein) - Flexibility to Change Shape

B. Mature - Anucleate

C. 4 to 5.5 million per mm^3
D. Hemoglobin (97% of RBC) – protein that binds to oxygen
    1. O_2 transport as oxyhemoglobin
    2. CO_2 transport as carbaminohemoglobin
    3. Deoxyhemoglobin - O_2 detaches
    4. Heme = red, iron (Fe) pigment, combined with O_2 gives blood its red color
E. Lifespan: 100 - 120 Days
    1. Spleen: RBC "graveyard"
    2. Heme: Fe recycled, remainder becomes bilirubin (yellow pigment) in liver then excreted as bile into the intestines
F. Erythropoiesis – red blood cell production
    1. Erythropoietin: Hormone to Stimulate RBC Formation
        a. Tissue demand for O_2 and the RBCs ability to deliver it regulates RBC production
        b. Reduced #s (numbers) of RBCs due to hemorrhage or excess RBC destruction
        c. Reduced availability of O_2 i.e. high altitudes or pneumonia
        d. Increased tissue demands for O_2
        e. Hypoxia (oxygen deprivation) stimulates kidneys to increases erythropoietin production activates bone marrow to produce RBCs = erythropoiesis
    2. Dietary Requirements for development of RBCs
        a. Fe (Iron)
        b. B_{12}
        c. Folic Acid

VI. Leukocytes: WBCs
A. General Characteristics
    1. Less than 1% of total blood volume
    2. Normal: 4,000 – 11,000 WBCs per mm^3
    3. Function: protect against disease by engulfing bacteria and other foreign matter by phagocytosis
    4. Diapedesis: process of WBCs slipping out of capillaries into mainly loose connective tissue
    5. Leukocytosis: WBC count > 11,000 - indicates bacterial or viral infection (homeostatic response)
    6. Two classifications of White Blood Cells
        a. Granulocytes
            a. Contains granules in cytoplasm
            b. Live only a few hours
        b. Agranulocytes
            a. Cytoplasm lacks granules
            b. Live for a few days
    7. Five (5) types (most abundant to least abundant)
        a. **N**eutrophils: Granulocyte
        b. **L**ymphocytes: Agranulocyte

c. **M**onocytes: Agranulocyte
d. **E**osinophils: Granulocyte
e. **B**asophils: Granulocyte
f. **(N**ever **L**et **M**onkeys **E**at **B**ananas! -How to remember most to least)

B. Neutrophils
1. Nuclei: 3 –6 lobes: polymorphonuclear leukocytes (polys) or segmented neutrophils (segs)
2. Increase in % indicates bacterial or some fungal infections
3. Destroy bacteria by phagocytosis
4. Life span: 0.5 – 9 days

C. Lymphocytes
1. Large, dark purple spherical nucleus
2. Increase in % indicates possible viral infection
3. T and B cells
4. Produce antibodies
5. T cells act directly against virus infected cells and tumor cells
6. B cells create plasma cells which produce antibodies (immunoglobulins)
7. Life span: a few days to decades

D. Monocytes
1. Gray blue cytoplasm with dark purple kidney or U-shaped nucleus
2. In tissues → become macrophages
3. Increase in % indicates possible chronic infections i.e. TB and certain viruses, intracellular parasites
4. Activate lymphocytes immune response
5. Life span: several months

E. Eosinophils
1. 2 lobes in nucleus
2. Large red granules
3. 1% - 4% of all WBCs
4. Participate in allergic reactions
5. Increase in % indicates possible parasitic worm infection (i.e. flatworms → tapeworms, flukes; roundworms → pinworms, hookworms) or allergic response to antigen-antibody complex
6. Life span: 0.5 – 9 days

F. Basophils
1. Large, coarse purple granules with histamine (inflammatory chemical that acts as a vasodilator and attracts other WBCs to the inflamed site)
2. Mast cells are similar
3. Release heparin and histamine
4. Life span: 0.5 – 9 days

VII. Platelets: Thrombocytes
A. Small cytoplasmic fragments from a megakaryocyte

B. 250,000 to 400,000 per microliter
C. Responsible for blood clotting
D. Life span: live only 10 days (aspirin inactivates the platelets)

VIII. Blood Clotting Process
A. Cut Occurs
B. Injury to Lining of Blood Vessel Exposes Collagen Fibers
C. Platelets Adhere - Platelet Plug Forms
D. Platelets Release Chemicals That Make Other Platelets Sticky
E. PF_3 From Platelets and Thromboplastin From Damaged Cells + Calcium and Other Clotting Factors in the Plasma - Initiate Coagulation Sequence
F. Prothrombin Activator (Thrombokinase) - Prothrombin (Plasma Protein That Needs Vitamin K)- Thrombin - Fibrinogen (Soluble) - Fibrin (Insoluble)
G. Fibrin Clot With Trapped RBCs Infiltrates Platelet Plug
H. Serum = watery portion of the blood after coagulation

IX. Accessory Components
A. Bone Marrow
1. Manufactures RBCs, WBCs, and Platelets
2. Iliac crest and sternum preferred site for biopsy (bone marrow aspiration)
B. Spleen
1. Provides reservoir for blood cells
2. Active in destroying bacteria in the blood
3. Found in LUQ behind and below the stomach
C. Liver
1. Produces plasma proteins, heparin, antibodies
2. Serves as a filter for blood
D. Kidneys
1. Filters blood and excretes waste as urine
2. Produce erythropoitin

X. Blood Groups/Types
A. Antigens: chemical structures imparting specific properties to the surface of the red cell
B. Antibody: protein substance developed in response to foreign body substances
C. Blood Group Systems
1. Detected on the basis of specific reaction with corresponding antibody (either agglutination, lysis, or hemolysis) as a result of the presence or absence of the blood protein antigens on the RBC surface
2. Inherited according to Mendelian laws
3. Fully formed either at birth or in early postnatal life and persist throughout life
D. ABO System
1. Discovered by Landsteiner in 1900
2. Type A = 41% of population

a. Has A antigens on RBC surface
b. Has anti-B antibodies in plasma

3. Type B = 10% of population
   a. Has B antigens on RBC surface
   b. Has anti-A antibodies in plasma
4. Type AB = 4% of population
   a. Has A and B antigens on RBC surface
   b. Has NO antibodies in plasma
5. Type O = 45% of population
   a. Has No antigens on the RBC surface
   b. Has anti-A and anti-B antibodies in plasma
6. Type O is the Universal Donor (can be given to Type A, B, AB, and O) because it has No antigens on the RBC surface
7. Type AB is the Universal Recipient (can receive Type A, B, AB, and O) because it has NO antibodies in the plasma
8. Genotypes/Phenotypes
   a. AA and AO are both Type A blood
   b. BB and BO are both Type B blood
   c. AB is Type AB blood
   d. OO is Type O blood

E. Rh System

1. Discovered by Landsteiner and Wiener in 1937
2. Discovered in the Rhesus monkey
3. Rh is an antigen on the RBC
   a. Rh+ has the antigens (85% of the population)
   b. Rh- does NOT have the Rh antigens
   c. Rh+ can accept Rh+ or Rh- blood
   d. Rh- can accept ONLY Rh- blood
4. Rh Incompatibility
   a. When Rh- person receives Rh+ blood in a transfusion, person develops antibodies against the Rh+ factor.
   b. This becomes a clinical problem if they receive a second transfusion of Rh+ blood - Rh antibodies will clump with the Rh antigens.
   c. Rh- mother and Rh+ father can also develop Rh problems with having children. If the mother has a baby that is Rh+, her body will develop antibodies to the Rh antigen so that a second pregnancy with a Rh+ baby will result in the mother's antibodies attacking the unborn child's RBCs. To prevent this a shot of Rhogam is given shortly after birth to block the development of antibodies.
   d. Symptoms of transfusion reaction: chills and fever, rash, itching, SOB, nausea, nephralgia, hematuria, shock and death

XI. Diseases and Disorders of Blood

A. Anemia: deficiency in the numbers of functional RBCs; symptoms = dyspnea, fatigue, muscle weakness
    1. Iron deficiency: not enough iron (leafy green vegetables); inability of the body to use iron
    2. Aplastic: failure of the bone marrow to produce RBCs due to poisoning, drugs, radiation
    3. Pernicious: RBCs inadequate due to decreased gastric secretion and vitamin B_{12} malabsorption; must take B_{12} shots forever; untreated - certain death; S & S = weakness, sore tongue, numbness and tingling in arms and legs
    4. Sickle cell: inherited trait of defective hemoglobin molecule; abnormal sickle shaped RBCs, cells carry less oxygen, break easily, clog vessels; primarily in Black population; homozygous - severe disease; heterozygous - asymptomatic
    5. Thalassemia: defective synthesis of protein for hemoglobin production; hereditary; several types
B. Polycythemia Vera: too many RBCs and platelets; thickens blood and increases BP; periodic removal of a unit of blood to thin the blood
C. Leukemia
    1. Increased number of WBCs but they are nonfunctional
    2. WBCs take over RBCs, therefore there are not enough RBCs to circulate oxygen
    3. S & S: fever, joint pains, swollen lymph nodes, anemia
    4. Four types of leukemia
    5. Treatment: bone marrow transplant and/or chemotherapy
D. Thrombocytopenia purpura
    1. Decrease in production of platelets in the bone marrow
    2. Causes bleeding into the tissues (petechiae)
E. Hemophilia
    1. X-linked recessive bleeding disorder of males
    2. Females are the carriers
    3. Clotting factor deficiencies
F. Von Willebrand's Disease
    1. Hereditary bleeding disorder of males and females
    2. Clotting factor deficiency
G. Embolism: moving blood clot that becomes trapped in small vessels or capillaries and obstructs oxygen to that part
H. Thrombosis: stationary blood clot in a larger vessel that obstructs the vessel
I. Infectious Mononucleosis
    1. Caused by the Epstein-Barr virus
    2. Causes atypical lymphocytes with increased number
    3. S & S: fever, sore throat, enlarged spleen, enlarged lymph nodes, headache, malaise
J. Multiple Myeloma

1. Plasmacytoma infiltrates bone to produce osteolytic lesions, bone marrow failure, renal failure
2. S & S: bone pain, hypercalcemia

K. Hodgkins Disease
1. Macrophages increase in size and number → replace lymphocytes
2. Lymphoma begins in one node, usually cervical and spreads
3. More common in men
4. S & S: recent URI, night sweats, anorexia, N&V, cough, dyspnea, nephralgia

L. Erythroblastosis Fetalis
1. Antigen-antibody reaction due to mixing of Rh+ blood of fetus with Rh- blood of mother during a second Rh+ pregnancy
2. Prevented with shot of Rhogam at birth of first Rh+ baby

M. AIDS
1. Acquired immune deficiency syndrome
2. Defect in T-cell immunity caused by the HIV virus (human immunodeficiency virus)
3. Opportunistic infections: Pneumocystic pneumonia, Kaposi's sarcoma (vascular tumors)
4. ELISA test: enzyme-linked immunosorbent assay; detects antibody to the AIDS virus
5. Western blot test: more sophisticated, more specific, more expensive; used to confirm positive ELISA test

ACTIVITIES

I. Complete Study Questions over video: "Blood The River of Life".
II. Complete Study Questions over video: " The Body Against Disease"
III. Complete Simulated Blood Typing.

MATERIALS NEEDED

Blood Typing Kits from Carolina Biologicals, Ward, etc
Videos
Guest Speakers: Hematologist, Blood Bank Specialist or Representative

ASSESSMENT

Blood Test

ACCOMMODATIONS

For reinforcement, the student will develop flashcards of the terms

For enrichment, the student will organize a blood drive in community.

REFLECTIONS

“Blood the River of Life” Video Questions

1. How much blood is found in the average human?

2. How often does the total volume of blood circulate?

3. Name two major waste products that the blood transports.

4. List other materials transported by the blood.

5. List the two major components of blood.

6. What is the lifespan of the RBC? Of the WBC?

7. List the two major functions of blood.

8. List the 2 events that occur with clotting.

9. Name the major clotting disease and list what factor is missing.

10. Explain how th blood and blood vessels help maintain temperature.

11. What is a CBC? What does and increase in WBCs indicate? What does a decrease in WBCs indicate? What does a decrease in RBCs indicate? What does a decrease in platelets indicate?

12. List two methods of determining the oxygen carrying capacity of blood.

13. List two clotting tests using plasma.

14. List three major chemicals measured in the blood and explain what abnormal levels of the chemicals indicate.

“The Body Against Disease” Video Questions

A.Section One

1. What are microbes? Where do they live? What are their effects on human beings?

2. How do pathogens cause disease?

3. What are 2 different types of pathogens? How does each cause a disease?

4. How do pathogens enter the body to transmit disease?

5. What are some ways in which the spread of disease may be controlled?

6. What are some of the body’s initial defenses against disease?

7. Suppose bacteria enters the body through a cut in the skin. What happens then?

8. What happens if phagocytes fail to destroy enough of the invaders?

9. What happens when a bacterial infection spreads?

B.Section Two

1. What is combined immunodeficiency disease?

2. What is the immune system?

3. How do the components of the immune system work?

4. How does the immune system know what cells to accept or reject?

5. How does the immune system react to foreign cells?

6. How do antibodies destroy foreign cells?

7. What is natural immunity? How can a person become immune to a disease? What is the risk in developing natural immunity?

8. What is immunization? How does it work? How does it avoid the risks of natural immunity?

9. Why does immunization continue to be important, even though no cases of a particular disease may have been reported in years?

10. Antibiotics are very successful in treating some illnesses. What are their drawbacks?

C. Section Three

1. What are autoimmune diseases?

2. What may cause the immune system to turn against the body?

3. What treatments are available for individuals with autoimmune diseases?

4. What are the risks in using immunosuppressive drugs to suppress the immune response?

5. What is cancer?

6. What do some scientists believe about the relationship of cancer and the immune system?

7. What causes cancer?

What is interferon? How is it related to cancer?

Blood Unit Test

Multiple Choice. Choose the best answer.

_____1. What is the average normal pH of blood?
a. 8.4
b. 7.8
c. 7.4
d. 4.7

_____2. Which of the following is a regulatory function of blood?
a. delivery of oxygen to body cells
b. transport of metabolic wastes from cells
c. maintenance of normal pH in body tissues
d. prevention of blood loss

_____3. Which of the following is a protective function of blood?
a. maintenance of normal pH in body tissues
b. maintenance of adequate fluid volume
c. prevention of blood loss
d. maintenance of body temperature

_____4. Which of the following is a function of blood?
a. transport metabolic wastes **to** the cells of the body
b. maintain the proper body temperature
c. protect the body against hormones
d. eliminate the buffy coat from leukocytes

_____5. The normal range of blood volume for males is
a. 5 – 6 milliliters
b. 4 – 5 liters
c. 5 – 6 cups
d. 5 – 6 liters

_____6. The molecule in RBCs used to transport O_2 and CO_2 is
a. hemoglobin
b. cholesterol
c. calcium oxalate
d. folic acid

_____7. The hormone that stimulates RBC production is
a. testosterone
b. erythropoietin
c. estrogen
d. thyroxin

_____8. The oxygen deprivation that stimulates the kidneys to increase production of hormone that stimulates RBC production is called
a. hyperoxia
b. hyperglycemia
c. hypoxia
d. hyperventilation

_____9. The “RBC graveyard” is the
a. thyroid gland
b. pancreas

c. spleen
d. gallbladder

_____10. Which of the following might trigger erythropoiesis?
a. decreased tissue demand for oxygen
b. increased tissue demand for oxygen
c. an increased number of RBCs
d. moving from a high altitude to a low altitude

_____11. All of the following can be expected with polycythemia except:
a. low blood viscosity
b. high hematocrit
c. increased blood volume
d. high blood pressure

_____12. Aplastic anemia is caused by
a. blood loss
b. lysing of RBCs prematurely
c. destruction or inhibition of hematopoietic components in red marrow
d. lack of B_{12}

_____13. Blood doping is
a. a cancer of the bone marrow
b. a type of anemia
c. a contagious infection of RBCs
d. secondary polycythemia

_____14. The process of WBCs slipping out of the capillaries into mainly loose CT is called
a. thrombocytopenia
b. diapedesis
c. leukopenia
d. leukocytosis

_____15. The condition in which there is a WBC count greater than 11,000 WBCs per cubic millimeter (an indication of infection) is called
a. leukocytosis
b. diapedesis
c. leukopenia
d. thrombocytopenia

_____16. Which of the following is a characteristic of all leukocytes?
a. They are phagocytic.
b. They have cytoplasmic granules.
c. They are nucleated.
d. They are the most numerous of the formed elements of the blood.

_____17. A differential cell count that shows an increase in the percentage of eosinophils present indicates a:
a. bacterial infection
b. parasitic infection or allergies
c. viral infection
d. chronic infection

_____18. A differential cell count that shows an increase in the percentage of lymphocytes indicates a
   a. bacterial infection
   b. parasitic infection or allergies
   c. viral infection
   d. chronic infection

_____19. A differential cell count which shows an increase in the percentage of neutrophils indicates a:
   a. bacterial infection
   b. parasitic infection or allergies
   c. viral infection
   d. chronic infection

_____20. Select the term that does **NOT** belong in the following group.
   a. erythrocyte
   b. lymphocyte
   c. monocyte
   d. eosinophil

_____21. Select the term that does NOT belong in the following group.
   a. neutrophil
   b. monocyte
   c. basophil
   d. eosinophil

_____22. What element of nutrition is necessary for the formation of the complex protein which carries O_2 in the RBC?
   a. Fe
   b. Ca^{++}
   c. Na^{++}
   d. Mg^{++}

_____23. Fragments of a megakaryocyte are called
   a. basophils
   b. platelets
   c. erythrocytes
   d. monocytes

_____24. Platelets:
   a. stick to the damaged area of a blood vessel and help seal the break
   b. have a life span of 120 days
   c. are the precursors of leukocytes
   d. have multiple nuclei

_____25. A clot that develops and persists in an unbroken blood vessel is called
   a. embolus
   b. infarct
   c. lack of Factor VIII
   d. thrombus

_____26. A decrease in the number of platelets is called
   a. leukocytosis
   b. thrombocytopenia
   c. leukopenia
   d. anemia

_____27. The sex-linked bleeding disorder is called
a. anemia
b. thrombocytopenia
c. hemophilia
d. leukemia

_____28. Which blood type is the universal donor?
a. A
b. B
c. AB
d. O

_____29. Which blood type is the universal recipient?
a. A
b. B
c. AB
d. O

_____30. Mr. Smith's blood was determined to be AB positive. What does this mean?
a. Antibodies to A and B are present in the red cells.
b. There are no antibodies to A, B, or Rh antigens in the plasma.
c. His blood lacks the Rh factor.
d. All of the above are correct.

_____31. An individual who is blood type AB negative
a. can receive any blood type in moderate amounts except that with the Rh antigen
b. can donate to all blood types in moderate amounts
c. can receive types A, B, and AB but not type O
d. can donate to types A, B, and AB but not type O

_____32. When can erythroblastosis fetalis not possibly happen in the child of an Rh negative mother?
a. if the child is type O positive
b. if the child is Rh positive
c. if the father is Rh positive
d. if the father is Rh negative

Extra Credit..

1. Explain why blood is classified as a connective tissue. (1 point)

2. What determines whether blood is bright red (scarlet) or dull brick-red (dark red)? (1 point)

3. Discuss the effect of a permanent move from sea level to a high-altitude area on RBC count. (2 points)

4. What is the normal (desirable) range for plasma cholesterol concentration (mg/100 ml)? Describe the relationship between high blood cholesterol levels and cardiovascular diseases such as hypertension, MIs, and strokes. (2 points)

5. List three blood tests that might be ordered if anemia is suspected. (2 points)