Rationale

Disease can be identified and diagnosed by an alteration in cell structure and function.

Objectives

Upon completion of this lesson, the student will be able to

- Analyze diseases and disorders of the blood
- Differentiate normocytic from dysmorphic blood cells on a blood smear

Engage

In the US in 1846, a paper entitled "Case of Absence of the Spleen" (from the *Southern Journal of Medical Pharmacology*), was probably the first to describe sickle cell disease. It discusses the case of a runaway slave who was executed. His body was autopsied and found to have "the strange phenomenon of a man having lived without a spleen." Although the slave's condition was typical, the doctor had no way of knowing this because the disease had not yet been discovered. The first formal report of sickle cell disease came out of Chicago about 50 years later, in 1910. In 1922, after three more cases were reported, the disease was named "sickle cell anemia."

Excerpt from: http://www.innvista.com/health/ailments/anemias/sickhist.htm

Key Points

Blood Disorders Power Point Presentation

I. Blood

- A. Blood picks up nutrients and oxygen from the digestive and respiratory systems, and delivers them to the body cells; then blood picks up the waste products from the cells to elimination sites
- B. Blood transports hormones, enzymes, antibodies, buffers, and other critical biochemical substances
- C. Blood helps regulate heat in the body
- D. There are four components of the blood:
 - 1. Erythrocytes (Red Blood Cells) responsible for transporting both oxygen and carbon dioxide
 - Leukocytes (White Blood Cells) nucleated cells capable of dividing and living for years
 - Thrombocytes (platelets) assist in hemostasis and blood clotting
 - 4. Plasma the fluid portion of blood consisting mostly of water; carries dissolved substances such as electrolytes, hormones, gases, and organic compounds

Course Pathophysiology

Unit V

Process of Pathology

Essential Question

How do blood cells look when they are diseased?

TEKS

§130.208.(c) (6A, B)

Prior Student Learning

Review the lesson on Blood and Microscopy.

Estimated time

2-5 hours

- II. Functions
 - A. Transportation
 - 1. Delivers O₂ from the lungs and nutrients from the digestive tract to all body cells
 - 2. Transports the oxygen as oxyhemoglobin, carbon dioxide as carboxyhemoglobin, carbonic acid, and bicarbonate
 - 3. Transports metabolic waste from the cells to elimination sites (lungs and 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 excess fluid loss
 - C. Protection
 - 1. Prevents blood loss through the clotting mechanism
 - 2. Prevents infection through immunity (phagocytosis and antibody production)
- III. Red Blood Cell Disorders
 - A. Iron-deficiency anemia caused by insufficient iron in the blood, affecting the production of hemoglobin, and resulting in an inability to carry enough oxygen. The patient feels tired and lethargic. This is the most common type of anemia. Cells will show microcytic and hypochromic morphology
 - B. Aplastic anemia caused by a failure of the bone marrow to produce enough of any type of blood cell. Blood smears will show a lack of circulating blood cells with marked dysmorphic blood cells showing aniso-, poikilo- and schistocytosis
 - C. Pernicious anemia a condition showing marked megalocytes (large blood cells) caused by a lack of production of intrinsic factor resulting in the inability to absorb vitamin B12. This is primarily found in the elderly
 - D. Sickle cell anemia
 - History first observed in 1910 by James Herrick. It was observed in a West Indian student suffering from anemia. In 1917, it was recorded that red blood cells were found sickled in a patient not suffering from anemia. In 1949, it was discovered that Hemoglobin S when electrophoresed, migrates differently that Hemoglobin A, and this difference was caused by an amino acid substitution in the globin chain of the hemoglobin molecule
 - 2. Two different states
 - a. Hemoglobin AS patients have both HgbA and HgbS, the heterozygous state. These patients are known to be

carrying the sickle cell trait. The morbidity and mortality of patients in this state is not affected. The trait occurs in approximately 8% of American Blacks. In electrophoresis, the patient with the sickle cell trait has 20-40% of HgbS and 60% or more of HgbA

- b. Hemoglobin SS patients are homozygous for HgbS and have sickle cell anemia. The anemia of sickle cell patients is a chronic hemolytic anemia that is normochromic and normocytic. A blood smear will show sickled cells, target cells, and nucleated red cells. There is no cure for sickle cell anemia. Life expectancy varies so much that an accurate estimate is not known. Clinical features of sickle cell anemia include hemolytic crisis, vaso-occlusive crisis, bone and joint abnormalities, enlarged heart, heart murmurs, retinal hemorrhage, and autosplenectomy. A sickle cell crisis is any new sickness that comes on fast in patients with sickle cells anemia. A crisis may be a vaso-occlusive crisis or hemolytic crisis, just to mention a few
- E. Diamond Blackfan anemia (DBA) is a rare blood disorder that is also associated with birth defects or abnormal features. In DBA, the bone marrow (the center of the bone where blood cells are made) does not make enough red blood cells to carry oxygen throughout the body
- IV. White Blood Cell Disorders
 - A. Leukemia is a type of blood cancer of the white blood cells or the bone marrow. More than half of the cases of leukemia are diagnosed in adults. Leukemia is divided into two main categories: acute versus chronic, and are then subcategorized as either myelogenous or lymphocytic
 - 1. Acute Leukemia characterized by a large spike in the production of immature white blood cells
 - 2. Chronic Leukemia characterized by a large spike in the production of mature, but still abnormal, white blood cells
 - 3. Lymphocytic Leukemia a type of blood cancer affecting the bone marrow cells that produce lymphocytes
 - Myelogenous Leukemia a type of blood cancer affecting the bone marrow cells that produce all other types of blood cells, including red blood cells, platelets, and white blood cells other than lymphocytes
 - B. Acute lymphoblastic leukemia (ALL) the most common type of leukemia found in young children. This disease can also affect adults, especially those aged 65 and older
 - C. **Chronic lymphocytic leukemia** (CLL) most often affects adults over the age of 55. It sometimes occurs in younger adults, but it

almost never affects children

- D. Acute myelogenous leukemia (AML) occurs more commonly in adults than in children. This disease is more common in men than in women
- E. **Chronic myelogenous leukemia** (CML) occurs mainly in adults. It is rare for children to develop this disease
- V. Platelets/Thrombocytes
 - A. Thrombocytes are actually nuclear fragments born from a megakaryoblast; when activated by clotting proteins found in plasma, they will form a fibrous plug to stop bleeding
 - B. Diseases result from the bone marrow producing too many or too few platelets. Also platelet diseases could cause normal platelet counts with abnormal behavior
 - 1. Thromobocytopenia an abnormally low platelet production
 - Clotting disorders petechiae, bruising, deep vein thrombisis, ecchymosis
 - a. Deep Vein Thrombosis and Pulmonary Embolism (DVT/PE) – often underdiagnosed and serious, but preventable, medical conditions. Deep vein thrombosis (DVT) is a medical condition that occurs when a blood clot forms in a deep vein. These clots usually develop in the lower leg, thigh, or pelvis, but they can also occur in the arm. The most serious complication of DVT happens when a part of the clot breaks off and travels through the bloodstream to the lungs, causing a blockage called a pulmonary embolism (PE)
- VI. Other Blood Disorders
 - A. Hemochromatosis (called iron storage disease) occurs when the body absorbs too much iron from foods and other sources, such as vitamins containing iron. This disease causes extra iron to gradually build up in the body's tissues and organs, a term called iron overload. If this iron buildup is not treated, it can, over many years, damage the body's organs
 - B. Bleeding and clotting disorders pose important problems for women because of the relationship of these disorders to reproductive issues
 - 1. Heavy menstrual bleeding (menorrhagia)
 - 2. Bleeding and clotting complications of pregnancy
 - 3. Recurrent fetal loss
 - C. Hemophilia is an inherited bleeding disorder in which the blood does not clot properly. Blood contains many proteins, called clotting factors, that help stop bleeding. These factors are numbered from 1 through 13, using roman numerals (such as I, IV, or X). People with hemophilia have either a low level of these clotting factors or none at all. The lower the level, the more serious the hemophilia, and

problems such as bleeding without obvious cause, bleeding following injuries, and surgery are more likely

- D. Hemolytic disease of the newborn is also known as erythroblastosis fetalis. This disease occurs in the fetus if the fetus is Rh+ while the mother is Rh-. During the first pregnancy, the mother will form antibodies against the Rh+ blood. Since the antibodies have only formed, they do not cross the placenta and harm the fetus' blood. If a second Rh+ pregnancy occurs, the antibodies that have already been made cross through the placenta and begin to destroy the Rh+ red blood cells. The result is a reduction in the number of circulating red blood cells in the fetus as well as jaundice due to the accumulation of bilirubin in the skin. The Rh mother must receive an injection of Rhogam after every Rh+ pregnancy in order to destroy the antibodies that have been made against the Rh+ blood. The fetus may require transfusions and light therapy
- E. Mononucleosis, or infectious mononucleosis, is a noncancerous leukocyte disorder caused by a virus. This virus is typically transmitted in the saliva and is nicknamed the "kissing disease." Unlike its name seems to suggest, the affected leukocyte is actually a lymphocyte.
 - 1. Signs and symptoms include
 - a. Extreme fatigue
 - b. Sore throat
 - c. Rash
 - d. Enlargement of the cervical lymph nodes
 - e. Splenomegaly
 - 2. It typically resolves itself in four to six weeks

Activity

I. Complete the Blood Disorders Laboratory Investigation

Assessment

Laboratory Investigation Rubric

Materials

<u>Blood Disorders PowerPoint Presentation</u> <u>Blood Disorders Laboratory Investigation</u> Handout

Prepared abnormal blood cell smears with coverslips

- Normal erythrocyte slides
- Normal (neutrophil, eosinophil, basophil, monocyte, lymphocyte) slides
- Normal thrombocyte/platelets slides
- Sickle cell anemia slide
- Pernicious anemia slide
- Aplastic anemia slide

- Hemolytic anemia slide
- Acute Lymphocytic Leukemia slide
- Chronic Lymphocytic Leukemia slide
- Acute Myelogenous Leukemia slide
- Chronic Myelogenous Leukemia slide

Prepared normal red blood cell smears Microscope Oil for an oil-immersion lens Gloves Laboratory coat or apron Goggles Biohazard containers Surface disinfectant Paper towels

<u>http://medinfo.ufl.edu/other/histmed/streiff/slide13.html</u> is an excellent site for comparative blood morphologies.

http://www.cdc.gov/ncbddd/blooddisorders/index.html

Rodak, Bernadette F. <u>Diagnostic Hematology</u>. Philadelphia: W. B. Saunders Company, 1995. ISBN 0-7216-4727-8

Carr, Jacqueline H. and Rodak, Bernadette F. <u>Clinical Hematology Atlas</u>. Philadelphia: W.B. Saunders Company, 1999. ISBN 0-7216-4174-1

Accommodations for Learning Differences

For reinforcement, the student will review and repeat the laboratory investigation.

For enrichment, the student will research the incidence of sickle cell anemia.

National and State Education Standards

National Healthcare Foundation Standards and Accountability Criteria: Foundation Standard 1: Academic Foundation

1.2 Diseases and Disorders

1.21 Describe common diseases and disorders of each body system (prevention, pathology, diagnosis, and treatment).

1.22 Recognize emerging diseases and disorders.

1.23 Investigate biomedical therapies as they relate to the prevention, pathology, and treatment of disease

TEKS

§130.208. (c)(1) (F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures §130.208. (c)(5) (E) research stages in the progression of disease.

Texas College and Career Readiness Standards SCIENCE

1(D)(3) Demonstrate appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data
3 (B) (2) Set up apparatuses, carry out procedures, and collect specified data from a given set of appropriate instructions..
6 (A) (2) Know that although all cells share basic features, cells differentiate to carry out specialized functions.

BLOOD DISORDER LABORATORY INVESTIGATION

NAME: _____

DATE:

PURPOSE

In this laboratory investigation, the student will be able to differentiate normocytic from dysmorphic blood cells on a blood smear.

BACKGROUND INFORMATION

MATERIALS

Prepared abnormal blood cell smears with coverslips

- Normal erythrocyte slides
- Normal (neutrophil, eosinophil, basophil, monocyte, lymphocyte) slides
- Normal thrombocyte/platelet slides
- Sickle cell anemia slide
- Pernicious anemia slide
- Aplastic anemia slide
- Hemolytic anemia slide
- Acute Lymphocytic Leukemia slide
- Chronic Lymphocytic Leukemia slide
- Acute Myelogenous Leukemia slide
- Chronic Myelogenous Leukemia slide
- Prepared normal red blood cell smears

Microscope Oil for an oil-immersion lens

Gloves Laboratory coat or apron Goggles Biohazard containers Surface disinfectant Paper towels

PROCEDURE

- 1. Wash hands, and put on gloves and goggles.
- 2. Assemble equipment and materials.
- 3. Prepare work area.
- 4. Observe two microscopic slides and draw the red blood cells in the area provided.
- 5. Clean work area with a surface disinfectant. Remove goggles and gloves, and wash hands.

DATA



Slide 1- Normal BRC

Slide 2- Sickle cell anemia

Slide 3: Pernicious Anemia



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Slide 5: Acute Lymphocytic Leukemia

Slide 6: Chronic Myelogenous Leukemia





CONCLUSION

1. Define the following terms: anisocytosis, poikilocytosis, macrocytes, and microcytes.

- 2. Predict the effect of the sickle cell shape on the red blood cell's function.
- 3. Explain the difference between sickle cell anemia and sickle cell trait.
- 4. What are the signs and symptoms of sickle cell anemia?
- 5. What is a sickle cell crisis?

Laboratory Investigation Rubric

Student:_____ Date:_____

Scoring Criteria	4	3	2	1	N/A
	Excellent	Good	Needs Some Improvement	Needs Much Improvement	
Problem is					
appropriately					
identified.					
Problem is					
precise, clear.					
and relevant.					
Association					
between the					
problem and the					
predicted results					
is direct and					
relevant					
All variables are					
clearly					
operationalized					
Demonstrates					
comprehension of					
the use of					
contific					
conconte and					
VUCabulary.					
All Significant					
Data is measured.					
Data is recorded					
effectively and					
Data table is well					
designed to the					
task					
requirements.					
All graphs are					
appropriate.					
All data					
accurately					
plotted.					

Graph visually			
compelling,			
highlights			
conclusions of the			
study.			
Conclusion			
relates directly to			
hypothesis.			
Conclusion has			
relevancy in			
resolution of the			
original problem.			
Conclusion			
relates the study			
to general			
interest.			