MLT 110L - Clinical Hematology Lab

Approval Date:  Effective Term:
Department: MEDICAL LABORATORY TECHNICIAN
Division: Allied Health/Public Safety
Units: 1.00
Grading Option: Letter Grade
Transferability: CSU Transferable
Course is: AA/AS Degree
Repeatability:  
Contact Hours per Term:
    Lab: 4.00
Associate Degree GE Applicability: No
Recommended Class Size: 15
-Rationale: Station limitations.

Discipline/Minimum Qualifications:

Catalog Description:
Introduces the instruments and techniques used for hematology testing, including calibration and interpretation of results. Emphasizes the morphology and identification of common human blood cells.

Schedule Description:
Introduces the instruments and techniques used for hematology testing, including calibration and interpretation of results. Emphasizes the morphology and identification of common human blood cells.

Student Learning Outcome:
1. Explain the criteria of an acceptable specimen including all preanalytical variables that could affect the results.
2. Perform differential cell counts on normal and abnormal specimens.

Course Objectives:
1. Practice the use of Standard Precautions as they apply in the clinical Hematology laboratory according to Occupational Safety and Health Administration (OSHA) mandates.
2. Demonstrate safe use and disposal of biohazardous materials.
3. Demonstrate proper technique in applying differential stains to blood smears.
4. Critique and practice hematocrit testing using both fingerstick and anticoagulated blood samples, compare and contrast normal range for adult males and females as well as infants.
5. Calculate three RBC indices and interpret the significance of their changes in the various anemias.
6. Demonstrate the use of an automated Hematology analyzer from start-up, routine operation, and maintenance.
7. Perform, review, and critique quality control testing on an automated analyzer.
8. Set up and read test results from an Erythrocyte Sedimentation Rate (ESR) test, compare and contrast normal ranges for males and females.
9. Set up and read Erythrocyte Sedimentation Rates (ESR), compare and contrast normal ranges for adult males and females.
10. Set up and interpret test results for the Sickle Cell screen with interpretation.
11. Demonstrate proper use of the microscope including routine maintenance.
12. Compare and contrast cell counts performed on a hemacytometer with those from an automated hematology instrument. Compare and contrast normal ranges for adult males and females as well as infants and adolescents (referring to Red Blood Cell Count).
13. Prepare peripheral blood smears and perform differential cell counts on normal and abnormal specimens.
14. Prepare slides for and perform reticulocyte counts, compare and contrast normal ranges for males and females.

Course Content Outline:

A. Standard Precautions as they apply in the clinical hematology laboratory according to Occupational Safety and Health Administration (OSHA) mandates.
   1. Basic aspects of infection control policies, including how and when to use personal protective equipment (PPE) or devices (gown, gloves, and goggles).
   2. Use of PPE in hematology laboratory.
   3. Safety program defined in the Safety Manual
   4. Pre and post exposure prophylactic measures for handling potentially occupational transmission of certain pathogens.
   5. Disinfectants used to decontaminate the work area when a hazardous spill has occurred or when beginning or ending a laboratory session.
B. Safe use and Disposal of biohazardous materials.
   1. Segregation and disposal of various types of waste products generated in the clinical laboratory including the use of sharps containers for needles, lancets and/or other sharps.
   2. Disposal of biological samples
C. Technique in applying differential stains to blood smears.
   1. Technique for making peripheral blood smears
   2. Technique for staining peripheral blood smears.
   3. Types of stains used in the clinical hematology lab: Wrights-Giemsa, Methylene Blue, Stains for Bone Marrows, Cytospin's.
   5. Staining characteristics of the formed elements in the blood, stain verification
      a. Lymphocyte nuclei & cytoplasm
      b. Monocyte nuclei & cytoplasm
      c. Neutrophil nuclei, cytoplasm & granules
      d. Eosinophils nuclei, cytoplasm & granules
      e. Basophil nuclei, cytoplasm & granules
      f. Importance of pH in the staining process
D. Hematocrit testing using both fingerstick and anticoagulated blood samples, normal ranges for adult males, females and infants.
   1. Layers obtained on a spun hematocrit and their clinical relevance: plasma, buffy coat, red blood cells.
2. Normal hematocrit ranges for adult males, females and infants
   a. Adult males: 42-52%
   b. Adult females: 37-47%
   c. Newborn: 53-65%
   d. Infants: 31-43%
3. Quality control associated with spun hematocrits.
   Common causes of error in manual hematocrit techniques and how these errors are corrected and resolved.
   a. Improper sample collection
      1. Incorrect anticoagulant-collect blood sample in tube containing EDTA as an anticoagulant.
      2. Clotted blood-redraw specimen assuring sample is well mixed after collection
      3. Hemolyzed specimen-redraw specimen avoiding unnecessary trauma to the RBC's.
   b. Improper sample processing
      1. Insufficient centrifugation-follow manufacturer’s instructions for the particular microhematocrit centrifuge being used.
      2. Insufficient seal-blood sample will be lost during centrifugation if the microhematocrit tube is not sealed correctly.
E. Three RBC indices and the significance of their changes in the various anemias.
   1. Definition of the three RBC indices, values and calculation of the indices.
      a. Mean Corpuscular Volume (MCV)=[Hematocrit/RBC(in millions)] X 10
      b. Mean Corpuscular Hemoglobin (MCH)=[Hemoglobin(g)/RBC(in millions)]X10
      c. Mean Corpuscular Hemoglobin Concentration (MCHC)=[Hemoglobin(g)/Hematocrit]X10
   2. Clinical significance of RBC indices, interpretation of calculation results and relation to physiological conditions.
   3. Anemia and aplastic anemia correlated to laboratory tests associated with anemia.
      a. anemia-a condition in which there is reduced oxygen carrying capacity of the blood and separation of slides for and performance of reticulocyte counts, normal values for adult males and females.
         1. Maturation of the reticulocyte
         2. The use of the reticulocyte count in the diagnosis of anemias.
         3. Use of Methylene blue stain on slides for manual reticulocyte counts.
         4. Using the Miller disc to calculate reticulocyte counts.
         5. Comparison of manual reticulocyte count with that from an automated hematology analyzer.
         6. Comparison of normal ranges of reticulocyte counts for adult males and females
            a. Adult males: 1.1-2.1%
            b. Adult females 0.9-1.9%
   herefore a reduced amount of oxygen reaching the tissues and organs.
   b. aplastic anemia-failure of the bone marrow to produce blood cells.
   c. Laboratory tests for anemia: CBC, reticulocyte count, peripheral blood smear and bone marrow examination.
F. Use of the automated hematology analyzer including start-up, routine operation and maintenance.
   1. Daily start-up of the automated hematology analyzer
   2. Daily maintenance and documentation on the automated hematology analyzer.
   3. Weekly, monthly and as needed maintenance and documentation on automated hematology analyzer.
   4. Analysis of patient samples on the automated hematology analyzer.
G. Performing, reviewing and critiquing quality control test on an automated hematology analyzer.
1. Analysis of controls
2. Troubleshooting out of control results
3. Documentation/storage of results.

H. Erythrocyte Sedimentation Rate (ESR) test set up, test results and normal ranges for adult males and females.

1. Factors that can affect the accuracy of the ESR
   a. Improper sample collection
      1. Use EDTA anticoagulated blood collection tube and obtain a proper "fill".
      2. Hemolysis affects testing—obtain a blood sample without unnecessary trauma.
      3. Fibrin affects testing—ensure that immediately after collection blood specimen has been properly mixed.
   b. Technical Factors
      1. Tube must remain exactly vertical during the one-hour test time
      2. Test must be read at exactly 60 minutes
      3. The counter on which the rack is placed must be level and free of vibrations.
      4. Test should be conducted at room temperature.
      5. Tube should not be placed in a draft, and should not be exposed to direct sunlight.
   2. Quality Control procedures necessary for ESR.

3. Clinical factors that can increase or decrease an ESR
   a. Increased ESR
      1. Bacterial infection
      2. Acute Pelvic Inflammatory Disease
      3. Ruptured ectopic pregnancy
      4. Myocardial Infarction
      5. Rheumatic fever, Rheumatoid arthritis
      6. Pyogenic arthritis
      7. Increased fibrinogen and immunoglobulin
      8. Rouleaux formation
      9. Heparin anticoagulant
      10. Menstruation and pregnancy
      11. Multiple myeloma
      13. Anemia
   b. Decreased ESR
      1. Extreme increases in plasma viscosity
      2. Sickle cell anemia
      3. Spherocytes
      4. Microcytes
      5. Polycythemia
   5. Normal ranges of the ESR for adult males and females
      a. Adult men=0-15 mm/hr
      b. Adult women=0-20 mm/hr

I. Sickle cell disease and sickle cell trait, test results and prevalence among the African and Mediterranean cultures.
1. Setting up, incubating and interpreting results of a sickle cell prep.
2. Genetic abnormalities that make up sickle cell disease and sickle cell trait.
   a. HbSS vs. HbS
   b. Prevalence of sickle cell disease and sickle cell trait among the African and Mediterranean cultures.
3. Limitations of the sickle cell prep test and ways to correct or resolve.
a. Severe anemia can cause false negatives-if total hemoglobin is <8g/dL, double the sample volume to 100uL.
b. Patients with multiple myeloma, cryoglobuineamia and other dysglobulinemias may give false positive results. Place patient red blood cells in physiologic saline to minimize these problems.
c. Elevated levels of Hemoglobin F can cause false negative results-Do not test infants less than 6 months of age.
d. Recent transfusion can cause false positive or false negative results-ensure patient has not been transfused recently.
e. Some rare hemoglobin variants such as Hemoglobin C Harlem or C Georgetown may give a positive reaction.
f. This test is a screening procedure only. All positive or questionable results should be further evaluated with hemoglobin electrophoresis.

J. Proper use of the microscope including routine maintenance
1. Support systems of the microscope
   a. Frame
   b. Stage
   c. Light source
   d. Condenser
   e. Diaphragm
   f. Body tube
   g. Adjustment knobs
2. Defining and identifying the optical system
   a. Eyepiece (monocular or binocular)
   b. Objective lens
   c. Low power and high power
   d. Oil immersion lens
3. How to focus on an object under low, high dry and oil immersion lens
4. Proper cleaning supplies and methods to clean microscopes.
5. Rotation of the objective to ensure it does not contaminate the "dry" lens
6. Increasing and decreasing the light intensity.
7. Identifying points which correlate with the proper care of a microscope.

K. Comparing and contrasting cell counts performed on a hemacytometer with those from an automated hematology instrument. Normal ranges for adults, adult females, infants and adolescents (referring to Red Blood Cell Count, RBC)
1. Proper technique for filling an unopette from an EDTA tube or capillary puncture.
2. Charging a hemacytometer
3. How to focus on the grid of the microscope
4. Hemacytometer Counting "Rules"
   a. When counting cells on a grid, cells lying on the top and left borders are counted.
   b. Cells on the right and bottom borders are not counted.
5. The routine "red cell counting area", white cell counting area" and "platelet counting area" of the grid.
7. Errors inherent in the performance of manual counts
   a. Sample size
   b. Nature of the sample - must be free of clots
   c. Faulty laboratory equipment
   d. Inherent error of cell distribution in the counting chamber
   e. Comparison of manual count to an automated platelet count.
f. Differences between capillary and automated platelet counts
g. Clinical significance of decreased and increased cell counts.
h. Comparison of platelet counts to different disorders associated with platelet dysfunction.
i. Correcting for "in vitro" platelet aggregation
j. Accuracy vs. precision

9. Comparison of manual counts with those from the automated hematology analyzer.
10. Comparison of normal ranges for adult males, adult females, infants and adolescents (referring to platelet count)
a. Adult male: 4.7–6.1 X 10^11/uL
b. Adult female: 4.2–5.4 X 10^11/uL

L. Preparation of peripheral blood smears and differential cell counts on normal and abnormal specimens.
1. Manual differentials
a. Identification of each cell type within the granulocytic and agranulocytic cell line.
b. Morphologic characteristics in each stage of normal granulocyte development as seen on the peripheral smear.
c. Types of inclusions seen in white blood cells and red blood cells, their composition and staining characteristics.
d. Identification of cells that are "not normal" as seen on the peripheral smear.
e. Estimating platelet counts and correlating them with automated counts.
f. Comparison of the different cell line maturation schemes of normal cells seen on a peripheral smear.
g. Key morphological factors, which aid in the cell identification and factors to the specific identification of specific cells.
   1. Nucleus to cytoplasm ratio
   2. Chromatin pattern of nucleus
   3. Presence/absence of granules
   4. Shape and size of nucleus
   5. Presence/absence of vacuoles
   6. Density of color
h. Identification from smears and a conditions that would cause:
   1. Neutrophilia
   2. Eosinophilia
   3. Infectious mononucleosis
   4. Leukemia
   5. Thrombocytosis
   6. Thrombocytopenia
   7. Neutropenia
   8. Myelodysplastic syndromes.
i. Identification of plasma cells and atypical lymphocytes from slides and their significance in the peripheral smear.
j. Comparison of the variations seen in the differential depending upon where the differential is performed on the smear (what part of the smear)

M. Pr

Methods of Instruction:

Lab:
Methods of Evaluation:
Exams/Tests/Quizzes
Skill Demonstrations
Writing Assignments

Typical Assignments:
Reading:
Textbook assignments Supplemental reference books Hand outs (lab procedures)

Writing, Problem Solving or Performance:
Problem solving for case studies Short essay answers for some exam questions Some calculations Written assignments: Laboratory worksheets to evaluate the student’s performance and understanding of the course material. Problem solving: Case studies and analyzing unknown samples will evaluate the student’s ability to apply critical thinking skills to a clinical situation. Skills demonstration: Laboratory practical exam demonstrating the student’s ability to integrate the knowledge acquired in the course with the technical skills necessary for the MLT profession.

Other:

Required Materials Examples:

Book 1
Author: Turgeon, Mary Louise
Title: Clinical Hematology, Theory and Procedures
Publication Date: 2005
Publisher: Lippincott, Williams & Wilkins
Edition: 4th

Book 2
Author: Carr, Jacqueline H.
Title: Clinical Hematology Atlas
Publication Date: 2008
Publisher: WB Saunders Co.
Edition: 3rd

Course Preparation:
Prerequisite(s): MLT 050
Co-Requisite(s): MLT 110
Recommended: None

Document Content Review

Target Course Skills
Condition on Enrollment
Established

Faculty
Sue Albert Donna Berardo

Basic Content Review
In MLT 050, Phlebotomy, the student learns to draw blood specimens. They learn the sites, the process, the correct tubes with substances in the tubes necessary to preserve the specimens. They learn problems associated with blood draws, possible complications and possible causes of inaccurate specimens. They learn the general criteria for suitability of a specimen for analysis. They learn the need for correct transport of the specimens. This is necessary for the student in MLT 110L, Clinical Hematology Laboratory, since in this course they will begin to look at the importance of an accurate specimen. They will be doing blood smears and it is important that they recognize that the specimens can be affected by the process of draw and how the specimen was transported. The obtaining of the specimen is important to quality control in the laboratory.

Condition on Enrollment
Established

Faculty
Donna Berardo Sue Albert

Basic Content Review
In MLT 110L, Clinical Hematology Laboratory, the student learns to do blood smears and to do hematocrit test. They learn the use of the automated hematology analyzer and to perform, review and interpret test results. They do differential cell counts. In MLT 110, Clinical Hematology Lecture the students learn cell morphology and the normal and abnormal development of cells that is necessary to know when doing the laboratory component. They apply their knowledge from MLT 110 to MLT 110L. Taking these courses together increases the likelihood of student success.