MEDICAL LABORATORY TECHNOLOGY
HEMATOLOGY I
MLTC 1170

Semester: Spring 2009
Credit: 3
Laboratory: 3 hours – W – 8:00 – 10:50
Lecture: 2 hours – T – 8:00 – 9:50

Instructor: Marla Thoroughman
Office No.: Health Science 214
Office Phone: (740) 351-3388
Office Hours: Posted on door

Course Description:
An introduction to the basic laboratory methods in hematology, including the origin, formation, differentiation, and cell morphology of blood formed elements. Study includes detailed material regarding all components of a complete blood count. General information of coagulation processes and laboratory tests.

Objectives:
Upon completion of this course, the competent student should be able to:

1. Demonstrate safe and accountable behaviors within the laboratory setting.

2. Describe the origin, development and function of blood and blood forming organs including the identification of the cells in all stages of hematopoiesis.

3. Perform routine hematologic tests with emphasis on blood collection, enumeration and identification of cellular components in blood.

4. Identify erythrocyte and leukocyte abnormalities from a stained smear, photograph, and/or Kodachrome, listing the name and origin of all inclusion bodies and the conditions in which each is typically found.

5. Give the normal values and outline the principles of routine tests employed in the hematology lab, and those discussed in lecture, including but not limited to CBC, hemoglobin, hematocrit, WBC count, RBC count, MCV, MCH, MCHC, RDW, WBC differential, platelet count, retic count, eosinophil count, sedimentation rate, as well as those performed in the student lab.

6. Point out and correct possible sources of error encountered in hematology lab tests.

7. Compare and contrast the reference methods of the above hematology tests.

8. Apply and evaluate quality control in the hematology lab.

9. Perform routine test procedures, exhibiting proper technique and obtain acceptable results based on previous analyses and control values using both manual and automated procedures.

10. List common disease states that alter the normal hematologic values and outline the associated physiology.
11. Describe the process of coagulation and the screening tests (bleeding time, clotting time, thrombin time, PT, APTT, fibrinogen, D-dimer) to assess the process.

12. Demonstrate achievement of the above objectives by obtaining a grade of C or better in the lecture and lab portion of this course.

Specific objectives for each topic will be given and are listed at the end of syllabus.

**Textbooks:**

**References:**


**Methods of Instruction:**
A. Lecture and Lab  B. Demonstration and discussion  C. Audio – visual aids

**Grading Policy:**
Lecture Exams 40%  (Coursebook to be added)
Lab practicals/ quizzes/ lab evaluations 40%
Final Exam 20%

The following grading scale is based on the total possible points in the course:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>93-100</td>
<td>A</td>
</tr>
<tr>
<td>90-92</td>
<td>A-</td>
</tr>
<tr>
<td>87-89</td>
<td>B+</td>
</tr>
<tr>
<td>83-86</td>
<td>B</td>
</tr>
<tr>
<td>80-82</td>
<td>B-</td>
</tr>
<tr>
<td>77-79</td>
<td>C+</td>
</tr>
<tr>
<td>73-76</td>
<td>C</td>
</tr>
<tr>
<td>70-72</td>
<td>C-</td>
</tr>
<tr>
<td>67-69</td>
<td>D+</td>
</tr>
<tr>
<td>63-66</td>
<td>D</td>
</tr>
<tr>
<td>60-62</td>
<td>D-</td>
</tr>
<tr>
<td>Below 60</td>
<td>F</td>
</tr>
</tbody>
</table>

**Competency:**
Students must obtain a “C” grade (73%) or above in both the lecture and laboratory portion of the course to continue in the Medical Laboratory Program. If the student fails to achieve a 73% in either the lab or lecture, the student will receive the lesser of the two as the final grade. If the student achieves at least a 73% in both the lab and lecture portion of the course, the final grade will be determined based on the established grading policy as stated above.

Further explanation of this policy is as follows:
- A minimum average of 73% is required in both lecture and laboratory for all MLTC courses.
  a. For lecture, the average to determine minimal competency will be assessed on lecture exams only. It will not include the coursebook grade or the final exam grade.
b. For laboratory, the average to determine minimal competency will include laboratory exam scores, lab reports, and quizzes.
c. The final overall course grade (which will include the final exam score) must be 73% or better.

**Attendance:**
Since the lecture and lab experience is interrelated, absences from either will impair the student’s performance in the clinical setting. Therefore students are responsible for being present for all lectures and lab sessions.
1. 3% will be deducted from the final average for every unexcused absence. More than 1 unexcused absence in an MLTC course may result in the student’s removal from that course. A conference with the instructor, chairperson, and student will be necessary if the student has more than 1 unexcused absence.
2. Notice of the absence should be given to the instructor, chairperson, or secretary of the department before class time if possible.
3. Excused absences will be given for legitimate reasons only, and will be approved by the chairperson.
4. All absences will be documented and become part of the student’s permanent file.
5. Students are expected to be present throughout the entire lab or lecture section. They should not come to class after the door has been closed and they should not leave class prematurely without the consent of the instructor.
6. It is the responsibility of the students to complete a Student Absence Form and give it to the instructor as soon as possible.

**Tardiness:**
1. Tardiness is not acceptable. If a student is late for more than ½ hour of lecture or lab, he/she will be counted absent.
2. All tardiness will be documented, reported to the program chairperson, and become a part of the student’s permanent file.
3. A. First tardy – will be reported to the program chair and considered an isolated incident.
   B. Second tardy – verbal warning from the program chair.
   C. Third tardy – written warning from the program chair
   D. Fourth tardy – unexcused absence – 3% deducted from final grade of that particular course.
4. It is the students responsibility to complete a Student Tardiness Form and submit it to their instructor the same day they are tardy.

**Make-up Policy:**
1. Students are responsible for all information presented in lecture and lab. The instructor is not responsible to supply lecture notes and information for a student who is absent. These must be obtained from classmates.
2. If a student misses a lecture exam and the absence is excused, the exam must be made up within one week of the time it was originally given otherwise, it cannot be made up.
3. If a student misses a laboratory activity, the activity cannot be made up except with instructor approval.
4. Assignments will not be accepted after the specified date.
5. Laboratory reports must be turned in the same day they are done and will not be accepted at a later date unless there is prior approval.
ADA Compliance Statement
Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 require Shawnee State University to provide reasonable academic adjustments or accommodations for students with documented disabilities which would not compromise the integrity of the academic program. Examples of documented disabilities include physical, psychiatric, and/or learning impairments that substantially limit one or more major life activities of the student. Students seeking academic adjustments or accommodations must self-identify with the Coordinator of Disability Services, Student Success Center, Massie Hall, 740-351-3276. After meeting with the Coordinator, students are encouraged to meet with their instructors to discuss their needs, and if applicable, any lab safety concerns related to their disabilities.

Topics to be included:
Phlebotomy/Blood Collection
Microscopy
Introduction to Hematology
Routine Hematology Procedures
  Hemoglobin
  Hematocrit
  RBC count
  WBC count
  Calculation of RBC Indicies
  Platelet count
  Reticulocyte count
  Sedimentation Rate
  Eosinophil count
  WBC Differential
Hematology math
Hematopoiesis and Development
Erythrocyte Morphology
Hemostasis

Lecture Specific Objectives
OBJECTIVES: Upon completion of this course of study, the student should be able to:

Introduction to Hematology and Review of Basic Lab Skills

1. Define universal precautions.
2. Discuss the composition of blood.
3. List the tests that are generally included in a CBC.
4. Very generally outline the flow of blood through the body using terms as, artery, vein, capillary, etc.
5. Discuss and successfully perform the collection of blood including micro- and macro sampling techniques.

6. Discuss complications from blood collection and properly negotiate with a disagreeable patient in the lab setting for the collection of blood.

7. List ways in which pediatric collection differs from adult collection of blood.

8. Identify the purpose and action of various anticoagulants.

9. Identify various and pertinent parts of the microscope and their purpose.

10. Demonstrate proper use of the microscope by demonstrating ability to focus, clean, and care.

11. Discuss the theory and use of the microscope.

12. Differentiate between light microscopy, phase microscopy, and electron microscopy.

13. Demonstrate knowledge of terms associated with microscopy as numerical aperature, resolving power, and aberrations.

14. Discuss the theory of spectrophotometry.

15. Recall the basic part of a spectrophotometer.

16. Produce a standard curve given the concentration and absorbance of standards.

17. Determine values for any given set of data from a standard curve.

18. Discuss essential elements and theory of centrifugation, recognizing the different types of centrifuges.


20. Perform all laboratory procedures by following directions given by the instructor.

21. Demonstrate proper disposal of biohazardous material in both hard side and soft side biohazard containers.

22. Demonstrate proper care of equipment and safe handling of all biological specimens.

23. Apply knowledge of quality control in test processes and procedures for every test performed in the hematology laboratory.

24. Identify values that are accepted and those that are outside the acceptable limits, being able to outline corrective measures when necessary.

25. Comply with the dress code, acting responsible, and demonstrate confidence in performing all lab tasks.
Normal Hemoglobin and Variants

26. Outline how the hemoglobin molecule is made.

27. List the normal and panic values for hemoglobin in adults, children and infants.

28. Discuss the oxygen saturation curve and its role in health and disease.

29. List the variant forms of hemoglobin.

30. List the symbols and abbreviations for variant forms of hemoglobin used.

31. Differentiate in chronic vs. acute states of elevated HbCO.

32. Site reasons why HbCO normals vary between individuals in the city vs rural communities.

33. Explain the definition and cause of individuals with elevated methemoglobin levels.

34. Name the typical cause of elevated methemoglobin levels.

35. List various treatments of methemoglobinemia.

36. List the normal values for hemoglobin variants in health and disease.

37. Suggest reasons one might have elevated forms of each of the variant types of hemoglobin.

38. List multiple methods that can be used to measure hemoglobin.

39. Outline in detail the HiCN hemoglobin determination.

40. Perform the HiCN hemoglobin determination in the laboratory.

41. Describe the CuSO₄ method for hemoglobin determination and list when it is commonly used.

42. Outline in detail the Hemocue method of hemoglobin determination.

43. Perform the Hemocue method of hemoglobin determination in the laboratory.

44. Perform all laboratory procedures by following directions, demonstrating proper disposal of biohazardous material, demonstrating proper care of equipment, safely handling all biological specimens, complying with the dress code, acting responsible, and demonstrating confidence in performing all lab tasks.
Hematocrit and routine cell counting (RBCs, WBCs and platelets) in the laboratory

Hemacytometer

45. Define hematocrit.

46. Provide alternate names for hematocrit.

47. Explain the normal and panic values for hematocrits in adults, children and infants.

48. Given samples of blood, perform a microhematocrit on several patients.

49. Correlate hemoglobin and hematocrit values.

50. List reasons WBC counts may be elevated or decreased.

51. List sources of error in performing WBC, RBC and platelet counts.

52. Sketch a Neubauer hemacytometer, listing all dimensions of the counting area.

53. Explain the ‘line rules’ in using a hemacytometer.

54. Sketch a blood diluting pipet used for both WBC and RBC dilutions.

55. List the appropriate diluting fluids used for diluting blood for RBC, WBC and platelet counts.

56. Describe the unopette mechanism used for cell counting.

57. List the dilutions and diluents used for RBC, WBC and platelet counts with the unopette system.

58. List the optimum type of microscope used for each of the counts.

59. Describe the act of performing manual counts for WBC’s, RBC’s, and platelets,

60. Calculate the dilution factor, depth factor, area factor, volume factor and final dilution factor for a set of data.

61. Write out the formula for cell counts and give variations of the formula demonstrating knowledge of formula variations.

62. Perform a manual WBC count within acceptable limits.

63. Perform a manual RBC count within acceptable limits.

64. Perform a manual platelet count within acceptable limits.

65. Perform an automated CBC.
66. Perform a cell count from a body fluid (semen, CSF, synovial fluid) within acceptable limits. (Theory, principles, normal ranges, etc. of these counts will be taught in Urinalysis and body fluids.)

67. Report answers in terms of cells/mm$^3$, cells/µL and cells/L and convert back and forth.

68. List the normal ranges for RBC, WBC and platelet counts for adults, children and neonates.

69. Correlate RBC, WBC and platelet values to disease states associated with a variety of anemia and leukemia types.

70. Perform the math for correction of a WBC count for the number of nucleated RBCs.

71. Perform all laboratory procedures by following directions, demonstrating proper disposal of biohazardous material, demonstrating proper care of equipment, safely handling all biological specimens, complying with the dress code, acting responsible, and demonstrating confidence in performing all lab tasks.

Red Blood Cell Indices

72. Define MCV, MCH and MCHC.

73. Write the formula for MCV, MCH, and MCHC.

74. Give the units for MCV, MCH and MCHC.

75. Perform sample problems, being able to calculate the RBC indices from a set of data.

76. Explain the descriptive terms microcytic, normocytic and macrocytic and how these terms correlated to MCV.

77. Explain the descriptive terms normochromic and hypochromic and how these terms correlate to MCH and MCHC.

78. List normals for MCV, MCH and MCHC.

79. Relate MCV, MCH, and MCHC to disease states.

Erythrocyte Sedimentation Rate

80. Define erythrocyte sedimentation rate.

81. Write the abbreviations for erythrocyte sedimentation rate.

82. List the three general factors that affect the erythrocyte sedimentation rate.

83. Discuss the erythrocytic factors that have the ability to alter the erythrocyte sedimentation rate.
84. Explain the charge on the perimeter of the RBC.

85. Use terms including rouleaux, agglutination, and macrocytes in a discussion regarding an increased erythrocyte sedimentation rate.

86. Use terms including microcytes, anisocytosis, poikilocytosis and spherocytosis in a discussion regarding decreased erythrocyte sedimentation rate.

87. Include fibrinogen, viscosity, and albumin in a discussion of plasma factors that influence the erythrocyte sedimentation rate.

88. Use terms as tilt of tube, vibrations, temperature, length of tube, and diameter of tube in a discussion regarding the technical and mechanical factors of the erythrocyte sedimentation rate.

89. Write the significance of the erythrocyte sedimentation rate.

90. Give principle, procedure, source of error and normals for the Winthrobe, Westergren and automated methods of the erythrocyte sedimentation rate.

91. Perform an erythrocyte sedimentation rate with limits established by the instructor.

**Eosinophil Counts**

92. List the normal range for eosinophils in the blood.

93. Cite the most common reasons eosinophils are elevated, decreased in the blood.

94. Define eosinophilia and eosinopenia.

95. List the diluents that are most often used to perform direct eosinophil counts including, phloxine B, Pilot’s solution, and Randolph’s solution, being able to give differences and similarities of each.

96. List the three counting chambers most commonly used to perform direct eosinophil counts, including the Neubauer, Fuchs-Rosenthal, and Spiers Levy.

97. Give the general dimensions of each of the 3 counting chambers.

98. Be able to perform an eosinophil count with the unopette method, within acceptable limits, as defined by the instructor.

**Differential WBC Counts**


100. Name the three kinds of smears that can be used to perform a differential.

101. Prepare acceptable wedge smears as defined by the instructor.
102. Define what is meant by a buffy coat smear.

103. Properly use terms like Romanovsky and polychromatic when discussing stains for differentials.

104. List the primary stains used in Wright’s stain.

105. Describe what RBCs, lymphocytes, neutrophils, eosinophils, basophils, monocytes and platelets look like in a properly stained Wright’s stained smear.

106. Give reasons that smears could be too pink or too blue.

107. Discuss the proper technique for scanning and observing cells and be able to perform the normal differential within limits set by the instructor.

108. List the normals for each cell in a normal differential.

109. Recognize abnormal RBC morphology.

110. Make estimates of platelets and WBCs from a stained smear.

111. Calculate absolute white counts for all cell types.

112. State reasons that there may be increases or decreases in any cell line.

113. List criteria when it necessary for the differential to be reviewed by a pathologist.

Reticulocyte Count

114. Define and discuss the reticulocyte.

115. Discuss the principle of the reticulocyte procedure.

116. Recognize a reticulocyte on a properly stained smear.

117. Outline the procedure used to perform a reticulocyte count.

118. Relate the reticulocyte count value to normal and disease states.

119. Perform a reticulocyte count within an acceptable range as determined by the instructor.

Hematopoiesis (Erythropoiesis and Leukopoiesis)

120. Define the terms hematopoiesis, erythropoiesis, and leukopoiesis.

121. Discuss when and where blood cells are produced.
122. Discuss the origin and interrelationship of blood cells.

123. Discuss the criteria used to identify the normal maturation sequence of blood cells including both nuclear and cytoplasmic morphologic changes.

124. Name, discuss and identify all white blood cells from the hematopoietic stem cell through maturity.

125. Discuss the cellular kinetics, physiology, and function of neutrophils, eosinophils, basophils, monocytes, and lymphocytes.

126. Name, discuss and identify red blood cells from origination through maturity.

127. Discuss erythropoiesis and name all of the stages in the development of a red cell.

128. Discuss the morphologic changes in both cytoplasm and nucleus during the development of an erythrocyte.

129. Describe the structure and synthesis of hemoglobin including organelles of the cell where each stage of the process takes place.

130. Discuss the function of hemoglobin.

131. Describe the red cell membrane and the metabolism and catabolism of the red cell.

132. Differentiate between normal and abnormal red cell morphology.

133. Identify, describe and recognize from a properly stained blood smear or a kodachrome the following:
Red blood cells – normal, microcytic, and macrocytic
Anisocytosis
Poikilocytosis
Hypochromia
Polychromasia
Spherocytes
Target cells
Stomatocytes
Elliptocytes
Ovalocytes
Teardrop cells
Crenated RBC
Burr Cells
Schistocytes
Acanthocytes
Sickle Cells
Basophilic stippling
Siderocytes
Pappenheimer bodies
Howell jolly bodies
134. Correlate all of the terms in the above objective with normal and disease states.

135. Be familiar with the greek terminology associated with target cells, sickle cells, and teardrop cells.

136. Explain the basic physiological composition and how each of the following is stained:
- Basophilic stippling
- Siderocytes
- Pappenheimer bodies
- Howell jolly bodies
- Heinz bodies
- Cabot rings

137. Define M:E ratio.

138. Calculate M:E ratio from a set of data.

139. Define shift to the left.

140. Describe the normal development of megakaryocytes and platelets.

141. Discuss the physiology and biology of the megakaryocyte.

142. Discuss platelet production, structure, function and life span.

143. List the components of the intrinsic and extrinsic pathways of coagulation.

144. List the normal and panic values for the tests performed in the laboratory to assess coagulation including but not limited to: Bleeding time, Clotting time, PT, APTT, thrombin time, fibrinogen, D-dimer, FDP.

145. Discuss the primary function of lymphocytes, monocytes, neutrophils, eosinophils, and basophils.

146. List the components that make up a WBC including specific enzymes.

147. Describe the specific staining properties of each WBC.

148. Discuss the band vs. seg issue and be able to differentiate in bands and segs on a smear or kodochrome.

149. Compare the granules in WBCs as to contents, definition, specific, non-specific and azurophilic.
150. Discuss the physiology of leukocyte life spans, total blood pool, and control of release.

151. Discuss the specific function of neutrophils including but not limited to terms as: chemotaxis, opsonization, ingestion, degranulation, metabolic sequelae, and exocytosis.

152. Discuss the specific function of eosinophils and basophils.

153. Discuss the specific function of lymphocytes and monocytes.

154. Discuss leukocytosis including but not limited to terms as: early infection, established infection, recovery, and exhaustion.

155. List the inclusions that can be found in WBCs, including but not limited to:
   - Dohle bodies
   - Toxic granulation

156. Outline the composition of each inclusion and how it is stained.