I. INTRODUCTION

A. The purpose of this course is an introduction to the theory and practical application of routine and special hematology procedures, both manual and automated; red blood cell and white blood cell maturation sequences, normal and abnormal morphology and associated diseases.

B. This course is designed to meet curriculum requirements for the Medical Laboratory Technician Program, but may also be of assistance to pre-med or other allied health curricula.

C. The course is occupationally related and serves as preparation for a career in medical laboratory technology.

D. Prerequisites: MLAB 1201 - Introduction to Clinical Laboratory Science and MLAB 1211 - Urinalysis and Body Fluids
   BIOL 2401 - Anatomy and Physiology I is recommended

II. LEARNING OUTCOMES

Upon successful completion of this course, Hematology, the student will be able to:

A. Demonstrate knowledge of required terminology, relating the terms to hematological procedures.

B. Relate normal and abnormal values with appropriate disease processes.

C. Describe the vascular system.

D. Describe the characteristics, formation, and morphology of erythrocyte, leukocyte, and megakaryocytic cells.

E. Identify normal and abnormal cells in peripheral blood smears.

F. Accomplish the following for each of these procedures: hemoglobin, hematocrit, erythrocyte count, leukocyte count, platelet count, sedimentation rate, red cell indices, peripheral blood smear differential with morphology and WBC and platelet estimates, and reticulocyte count:
   1. Describe specimen collection, handling, storage, and preparation
   2. Examine physiologic theory
   3. Explain the principle of method(s)
4. List normal and abnormal values
5. Recognize common abnormalities
6. Relate common disease manifestation with basic clinical correlation
7. Differentiates/resolves common technical, instrument, physiologic causes of problems or unexpected test results
8. Perform and evaluate manual testing for hemoglobin, hematocrit, WBC count, platelet count, ESR, differential, and reticulocyte count.

G. Accomplish the following for special procedures: RBC morphology, RBC inclusions, WBC artifacts and inclusions, sickle cell studies, special stains for abnormal cells, and sugar water test:
1. Describe specimen collection, handling, storage, and preparation
2. Examine physiologic theory
3. Explain the principle of method(s)
4. List normal and abnormal values
5. Recognize common abnormalities
6. Relate common disease manifestation with basic clinical correlation
7. Perform and evaluate sickle cell testing
8. Distinguish and evaluate morphology and inclusions for both RBC and WBC on a differential

H. Evaluate the following for body fluids: cerebral spinal fluid, synovial fluid, serous fluid, and seminal fluid:
1. Describe specimen collection, handling, storage, and preparation
2. Examine physiologic theory
3. Explain the principle of method(s)
4. Relate disease manifestation to clinical correlation

I. Define coagulation.
J. Evaluate the coagulation mechanism.
K. Accomplish the same objectives as F 1 through 7 for the following: prothrombin time and activated partial thromboplastin time.
L. Accomplish the same objectives as G 1 through 6 for the following: thrombin clotting time, fibrinogen, fibrin degradation products, D-dimer, bleeding time, clot retraction, factor assays, and mixing studies.
M. Examine the following for each of these instruments/methods: automated strainers, micro hematocrit centrifuge, automated cell counters, automated WBC differential, photo optical coagulation, and fibrometer:
1. Describe essential components
2. Examine principles of operation
3. Assess preventative maintenance
4. Recognize unexpected test results and corrective action to take for routine or frequently encountered problems
5. Prepare PT and APTT reagents
6. Determine PT and APTT values and evaluate acceptability
N. Recognize and use safety procedures required in the clinical laboratory, including the handling and disposal of specimens, personal protective equipment, flammable materials, and sharps disposal.

O. Explain the importance of quality assurance in the clinical laboratory. Define, apply and evaluate quality control, reference range, Levey Jennings charts, and Westgard rules.

P. Perform routine phlebotomy for Hematology specimens.

Q. Exhibit attitudes consistent with professionalism and concern for high quality health care by:
   1. Performing analysis with care, adhering strictly to written procedure
   2. Demonstrating flexibility by accepting and implementing approved changes to procedures
   3. Attending scheduled lecture and lab regularly and punctually
   4. Completing assigned tasks with minimal guidance
   5. Maintains confidentiality of patient results
   6. Seeks activities which further assists learning
   7. Admits mistakes and take steps to correct them
   8. Repeats procedures when test results are in doubt
   9. Responds appropriately to authority
  10. Takes pride in role in laboratory medicine
  11. Complies with the stated dress code for laboratory exercises
  12. Recognize the value of continuing education activities

R. At the conclusion of each lecture series, the learner will have achieved the following:
   Achievement will be met when a minimum score of 75 percent is earned on each written examination covering the material.

III. INSTRUCTIONAL MATERIALS
The instructional materials identified for this course are viewable through www.ctcd.edu/books.

A. Required Texts:

B. References:
IV. COURSE REQUIREMENTS

A. To receive transferable credit for this course, you must earn a grade of "C" or better.
B. You must keep up with the material on a day-to-day basis because the material is technical. In order to understand the material, it must be learned in a sequential order. A good set of notes will be important. The majority of exam material will be taken from your notes and handouts; the rest will be taken from the text.
C. You are expected to read all assigned materials and to bring textbooks to class and laboratory. All written assignments given by the instructor are to be completed and handed in as required.
D. Students with a grade of "D" or less are expected to make an appointment with the instructor to discuss the reason for their low performance. Any material not understood by the student in lecture or lab can be discussed with the instructor privately. On the office door will be a list of office hours for conferences. Please try to make an appointment at your convenience.
E. Class attendance is mandatory. A student who is late for 15 minutes or more will be marked absent. A student who is late for less than 15 minutes late will be marked tardy. Two tardy will count as an absence. Three absences result in loss of a letter grade for the course. Four absences will disqualify a student from the MLT program and the student will be required to meet with the program director for readmission.

V. EXAMINATIONS

A. Five lecture examinations; three laboratory examinations and a comprehensive final will be given. Examinations will be primarily of the objective type.
B. Makeup examinations will not be given. If you must miss an exam, you can use your final exam grade to replace your missed exam grade. Any additional missed exams would result in a “0” and cannot be made up.
C. Quizzes may be given at the discretion of the instructor.
D. Testing: If the professor elects to use the testing center, tests will only be available on Tuesday through Thursday. No Exceptions. The time given to complete the Exam will be the same as the duration of the class period. Class must meet during the original scheduled class time for extra lectures and/or labs. The professor will deliver the exam to the testing center on Monday and pick up completed exams on Friday to be able to grade them prior to the next class period. The final exam will be given in the classroom.

VI. SEMESTER GRADE COMPUTATION

A. Lecture Exams

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture 1</td>
<td>100</td>
</tr>
<tr>
<td>Lecture 2</td>
<td>100</td>
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<tr>
<td>Lecture 3</td>
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<tr>
<td>Lecture 4</td>
<td>100</td>
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<tr>
<td>Lecture 5</td>
<td>100</td>
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</tbody>
</table>

MLAB 1415
TOTAL LECTURE EXAM POINTS 700

B. Lecture Homework  Points
   Homework assignments 100

C. Professionalism Grade:  Points
   Students are expected to be attend all class periods, arrive on time, come to class prepared, turn in completed assignments on time, and refrain from unauthorized use of electronic devices.
   Grading of the Professionalism component cannot be replaced by the final exam.
   Grading of the Professionalism component will follow the following guidelines:
   2 points will be subtracted per tardy or absence, 1 point will be subtracted for each of the following infractions:
   Preparation for Class
   Completion of Assignments: Homework/assignments: Full credit will be given if the assignment is turned in at the start of class or the stated due date and time; Half of the point value will be given if the assignment is turned in at the end of the work day or more than 8 hours after the stated due date and time; 0 points will be given if assignment is turned in after the 1st day or more than 24 hours after the stated due date and time.
   Attendance (must bring a doctor’s note for each absence due to illness for assignments to be accepted and credit given the following day.
   Tardies
   Unlawful use of electronics, (cell phones, tablets, computers)
   Observation of Behavior: Team player, Participation, Stay on Task-minimal distractions, Talking, Cheating, Plagiarism.

D. Extra Credit: Extra credit can only be given toward the lecture grade. Lab has participation points. No extra assignments will be assigned without the approval of the professor for lecture. The maximum allowed extra credit is 3% of the total grade.

E. Hematology and Coagulation Laboratory  Points
   Lab Exam 1 100
   Lab Exam 2 100
   Lab Exam 3 100

TOTAL LAB EXAM POINTS 300

F. Laboratory Assessment Points:
   10 Lab Assignments (10 points each)

TOTAL LAB ASSESSMENT POINTS 100

TOTAL LABORATORY POINTS FOR SEMESTER: 400
MLAB 1415
G. Total Possible Points for course: 1250

   1250 - 1125  A
   1124 - 1000  B
   999 – 937.5   C
   936.5 - 750   D
   749 - Below   F

A minimum score of 75% is required to pass the course. A minimum score of 75% is required to pass each exam.

NOTE: Plagiarism in any form will not be tolerated. A student who chooses to plagiarize will be given a zero on the assignment. A formal charge may be made to the College Disciplinary Board.

*Eleven clean AS100 scan Tron answer sheets will be required for lecture, lab, and final exams. Those will be given to the instructor during the 1st week of classes.

NOTE: Cheating in any form will not be tolerated. A student observed cheating will be given a zero on the test. A formal charge may be made to the College Disciplinary Board.

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM COURSE INSTRUCTOR

A. Course Withdrawal: It is the student's responsibility to officially withdraw from a class if circumstances prevent attendance. Any student who desires to, or must, officially withdraw from a course after the first scheduled class meeting must file a Central Texas College Application for Withdrawal (CTC Form 59). The student must sign the withdrawal form.

CTC Form 59 will be accepted at any time prior to Friday of the 12th week of classes during the 16-week fall and spring semesters. The deadline for sessions of other lengths is:

- 10-week session: Friday of the 8th week
- 8-week session: Friday of the 6th week
- 5-week session: Friday of the 4th week

The equivalent date (75% of the semester) will be used for sessions of other lengths. The specific last day to withdraw is published each semester in the Schedule Bulletin.

A student who officially withdraws will be awarded the grade of "W", provided the student's attendance and academic performance is satisfactory at the time of official withdrawal. Students must file a withdrawal application with the college before they may be considered for withdrawal.

A student may not withdraw from a class for which the instructor has previously issued the student a grade of "F" or "FN" for nonattendance.
B. **Administrative Withdrawal**: An administrative withdrawal may be initiated when the student fails to meet College attendance requirements. The instructor will assign the appropriate grade on CTC Form 59 for submission to the registrar.

C. **Incomplete Grade**: The College catalog states, “An incomplete grade may be given in those cases where the student has completed the majority of the course work but, because of personal illness, death in the immediate family, or military orders, the student is unable to complete the requirements for a course..." Prior approval from the instructor is required before the grade of "I" is recorded. A student who merely fails to show for the final examination will receive a zero for the final and an "F" for the course.

D. **Cellular Phones and Beepers**: Cellular phones and beepers will be turned off while the student is in the classroom or laboratory.

E. **American’s With Disabilities Act (ADA)**: Disability Support Services provide services to students who have appropriate documentation of a disability. Students requiring accommodations for class are responsible for contacting the Office of Disability Support Services (DDS) located on the central campus. This service is available to all students, regardless of the location. Explore the website at [www.ctcd.edu/disability-support](http://www.ctcd.edu/disability-support) for further information. Reasonable accommodations will be given in accordance with the federal and state laws through the DSS office.

F. **Instructor Discretion**: The instructor reserves the right of final decision in course requirements.

G. **Civility**: Individuals are expected to be cognizant of what a constructive educational experience is and respectful of those participating in a learning environment. Failure to do so can result in disciplinary action up to and including expulsion.

VIII. **COURSE OUTLINE**

A. **Unit one**: Hematopoiesis, Hemostasis, Erythrocytes, Hemoglobin

1. **Lesson one**: Introduction to the Study of Hematopoiesis and Homeostasis  
   (McKenzie Ch.1-4; 38)

2. **Learning Outcomes**: Upon successful completion of this lesson, the student will be able to:
   
a. Define the following terms:  
   Hematology, Whole blood, Vascular system, Erythrocytes, Hemostasis,  
   Hematopoiesis, Leukocytes, Plasma, Thrombocytes, Apoptosis,  
   Synchronism, A synchronism, CBC, Differential, Buffy Coat, Senescence,

b. Describe the physiology of the vascular system and blood constituents.

c. List the cellular components of normal whole blood and the normal values.
d. List the liquid components of normal whole blood and their normal percentages.

e. Describe extramedullary and medullary hematopoiesis

f. Describe the basic concepts of cell differentiation and maturation.

g. Compare and contrast each cell line (Erythrocyte, Lymphocyte, Plasma cell, Neutrophil, Monocyte, Eosinophil, Basophil, Megakaryocyte,): hematopoietic stem cells, hematopoietic progenitor cells, and maturing cells, including proliferation and differentiation potential, morphology, and population size.

h. List and describe basic structures in the cell.

i. Explain the cycle of the cell: Mitosis, Differentiation, Maturation, and Cell Regulation.

j. Identify the sites of hematopoiesis during embryonic and fetal development as well as in childhood and adulthood.

k. Identify organ/tissue sites in which each hematopoietic cell type differentiates.

l. Identify the sites for obtaining bone marrow samples.

m. Define myeloid to erythroid (M:E) ratio.

3. **Lesson two: Erythrocyte: Structure and Function (McKenzie Ch 5)**

4. **Learning outcomes:** Upon successful completion of this lesson, students will be able to:

   a. Define:
      Erythrocyte, Bilirubin, Hypoxia, Cyanosis, Erythropoiesis, Glycolysis, Haptoglobin, Heinz bodies, Hemosiderin, Polychromasia, Erythropoietin, Transferrin, Deformability
   
   b. List and describe the stages of erythrocyte maturation from youngest to the most mature cells including hemoglobin synthesis.
   
   c. List the structural components of the cell membrane and correlate poikilocytes with variations in membrane composition.
   
   d. Compare and contrast the following erythrocyte metabolic pathways: Embden-Meyerhof Pathway, Hexose Monophosphate Shunt, Methemoglobin Reductase Pathway, Rapoport-Leubering Shunt
   
   e. Demonstrate an understanding of the intravascular/extravascular hemoglobin degradation process.
   
   f. Explain the function of erythropoietin; include the origin of production, bone marrow effects, and normal values.
   
   g. Predict the effects of increased and decreased erythropoietin levels in the blood.
   
   h. Describe the function of the erythrocyte membrane.
   
   i. Diagram the mechanism of extravascular erythrocyte destruction and hemoglobin catabolism.
   
   j. Diagram the mechanism of intravascular erythrocyte destruction and
hemoglobin catabolism.

k. Compare and contrast erythrocyte extravascular destruction and intravascular destruction and identify laboratory tests to evaluate hemolysis.

l. Explain the role of the spleen in erythrocyte homeostasis.

m. State the average dimensions and life span of the normal erythrocyte.

n. Describe the function of 2,3-BPG and its relationship to the erythrocyte.

o. Explain the maturation process of reticulocytes and the cellular changes that take place.

p. Given a reticulocyte count predict the differential smear results.

5. **Lesson three: Hemoglobin (McKenzie Ch. 6)**

6. **Learning outcomes:** Upon successful completion of this lesson, the student will be able to:

   a. Diagram the quaternary structure of a molecule of hemoglobin identifying the heme ring, globin chains, and iron.

   b. List the types of hemoglobin normally found in adults and newborns and give their approximate concentration.

   c. Summarize hemoglobin’s function in gaseous transport.

   d. Define normal hemoglobin values.

   e. Explain how the fine balance of hemoglobin concentration is maintained.

   f. Compare HbA with HbA1c and explain what an increased concentration of HbA1c means.

   g. Construct a diagram to show the synthesis of a hemoglobin molecule.

   h. Describe the ontogeny of hemoglobin types; contrast differences in oxygen affinity of HbF and HbA, and relate them to the structure of the molecule.

   i. Define and describe significance of the following plasma hemoglobins: Oxyhemoglobin, Reduced hemoglobin, Carboxyhemoglobin, Cyan methemoglobin

   j. Explain the principle of the hemoglobin procedure. List and perform the sequential procedural steps. Describe the advantages and disadvantages, list sources of error.

   k. Relate the significance of abnormal hemoglobin values to disease states.

   l. Accomplish the following in regard to preparation of a standard curve: State the principle, describe the procedure, and evaluate the results.

   m. Explain the principle of the Romanowsky staining technique.

   n. Explain how pH, temperature, 2,3-BPG, and PO₂ affect the oxygen dissociation curve (ODC).

   o. Identify Heinz bodies and explain the mechanism of their formation.
Learning Activities: Methods of Teaching and Learning

Students will be taught using various learning methods and activities which includes lectures, demonstrations including hands on with microscope preserved slides, practice sessions, case studies, projects, laboratory experiences, Internet exercises, quizzes, exams, and recordings. All material covered by these methods may be covered on Exams.

Lecture Exam 1

B. Unit Two: Leukocytes, Hematology Procedures, Introduction to Anemia

In addition to the following objectives, students are responsible for all information covered in Unit One.

1. Lesson one: Leukocytes: (McKenzie, Ch7, 8)

2. Learning outcomes: Upon successful completion of this lesson, the student will be able to:
   a. Describe the hierarchy of hematopoietic precursor cells and the relationships of the various blood cell lineages to each other (including the concept of colony-forming units/CFUs).
   b. Describe the basic concepts of leukocyte differentiation and maturation.
   c. Compare and contrast the development including distinguishing maturation and cell features of the granulocytic, monocytic-macrophage, and lymphocytic cell lineages.
   d. Compare and contrast the morphologic and other distinguishing cell features of each of the leukocytes found in the peripheral blood. List CD markers for specific cells.
   e. Compare and contrast the function of each of the leukocytes found in the peripheral blood.
   f. Compare and contrast the immunologic features and functions of each of the leukocytes found in the peripheral blood. List the four steps of phagocytosis in the innate immune response.
   g. Summarize the process of neutrophil migration and phagocytosis.
   h. List the adult reference ranges for the leukocytes found in the peripheral blood.
   i. List the contents of granules in granulocytic cell lines along with their function.
   j. Recall the specific names of macrophages according to their location in the tissues.
   k. List causes/conditions that increase or decrease absolute numbers of individual leukocytes found in the peripheral blood.

3. Lesson two: Peripheral Blood Smear Evaluation and Hematology Procedures: (McKenzie, Ch10, 37; 38)
4. **Learning objectives:** Upon successful completion of this lesson, students will be able to:

   a. Define:
      Peripheral Blood Smear, Cellular Morphology, Complete Blood Count, Rodaleas, Delta Checks, Point of Care Testing, Anticoagulant, Hemoconcentration, Turn Around Time, Supravital Stain, Refractive Index, Acute Phase Reactant.

   b. Describe the peripheral blood smear staining method. Identify the characteristics of an optimally prepared smear. Explain the procedure and correctly evaluate the peripheral blood smear of an unknown.

   c. Recognize each parameter of a Complete Blood Count and explain what each one measures. Calculate absolute values given Total count and relative value. Evaluate CBC results to determine clinical significance.

   d. Interpret RDW results.

   e. Correlate CBC results with findings on a blood smear and troubleshoot discrepancies. Evaluate hemoglobin and Hematocrit using the “rule of three.”

   f. Identify the three anticoagulants used in the hematology laboratory and give examples of laboratory tests that should be performed on blood anticoagulated with each.

   g. Determine sequence of draw of phlebotomy collection tubes and correlate the collection technique of a blood sample with potential problems in sample analysis.

   h. Describe proper disposal of contaminated equipment and supplies.

   i. Identify the component parts of a microscope and explain their functions.

   j. List factors affecting the collection of a blood sample.

   k. State the principle, describe the procedure, identify potential sources of error, determine appropriateness of use including reflex testing, calculate and interpret results, and explain the clinical significance of each test: cell enumeration by Hemacytometer, hemoglobin concentration, Hematocrit, erythrocyte sedimentation rate, Reticulocyte count, solubility test for hemoglobin S, hemoglobin electrophoresis, acid elution for hemoglobin F, osmotic fragility.

   l. Discuss the microscope’s preventative maintenance procedures.

   m. Describe OSHA Blood-borne Pathogens standards as it relates to phlebotomy, processing and testing Hematology specimens.

   n. Recognize the types of fire extinguishers classify fires and recall fire safety as it relates to the Hematology Lab.

   o. Recall appropriate electrical safety measures as they relate to the Hematology Lab.

   p. Explain good work practices.

   q. Summarize the usefulness of the MSDS in the Hematology Lab.

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**Lab Exam 1**
5. **Lesson three : Introduction to Anemia (McKenzie, Ch 11)**

6. **Learning Objectives:** Upon successful completion of this lesson, students will be able to:

   
   b. Calculate erythrocyte indices, classify and describe erythrocytes based on erythrocyte indices.
   
   c. Calculate absolute reticulocyte count, corrected reticulocyte count and reticulocyte production index from reticulocyte results, hematocrit, and RBC count. Recall normal values and evaluate results. Correlate clinical significance.
   
   d. Interpret RPI results.

**Learning Activities: Methods of Teaching and Learning**

Students will be taught using various learning methods and activities which includes lectures, demonstrations including hands on with microscope preserved slides, practice sessions, case studies, projects, laboratory experiences, Internet exercises, quizzes, exams, and recordings. All material covered by these methods maybe covered on Exams.

**Lecture Exam 2**

C. **Unit Three: Anemia**

In addition to the following objectives, students are responsible for all information covered in Units One and Two.

**Anemia: (McKenzie, Ch 12-20)**

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

1. **Lesson Outcomes:**

   a. Describe and identify specific anisocytoses and poikilocytes.
   
   b. Classify and describe erythrocytes based on erythrocyte indices.
   
   c. Describe and identify erythrocyte inclusions including staining characteristics.
   
   d. Correlate poikilocytes with the mechanism of formation and assess their clinical significance.
   
   e. Determine the clinical significance of erythrocyte inclusions and select methods to differentiate the inclusions.
Given CBC and RPI results, categorize an anemia according to morphologic classification.

Compare the morphologic and functional classification of anemia.

Given laboratory results, classify anemia in terms of morphology and pathophysiologic mechanism (function).

Correlate the following laboratory features with iron deficiency anemia and sideroblastic anemia: erythrocyte morphology and protoporphyrin studies, iron studies, and bone marrow.

Choose appropriate follow-up tests to determine anemia classification and evaluate the results.

Define the M:E ratio, and explain what can cause an increase or decrease in it.

Correlate patient history and clinical symptoms with laboratory results in anemia.

Interpret RDW results.

Correlate polychromasia on a blood smear with other laboratory results of erythrocyte production and destruction.

Diagram the transport of iron from ingestion to incorporation into heme.

Define the following terms and explain their role in iron metabolism: transferrin, hemosiderin, ferritin, TIBC.

Explain the etiology and pathophysiology of iron deficiency anemia, anemia of chronic disease, sideroblastic anemia, hemochromatosis and porphyries.

Define hemosiderosis.

List the three stages of iron deficiency and define characteristic RBC morphology of each stage.

Compare and contrast iron stores, hemoglobin, serum iron, TIBC, saturation, serum ferritin, and RBC morphology in the three stages of iron deficiency.

Define hemoglobinopathy.

Explain the basis of defects resulting in the production of abnormal hemoglobins.

Explain the basis of the hemoglobin electrophoresis method in identifying abnormal hemoglobins.

Describe the epidemiology of sickle cell anemia (SCA) and other hemoglobinopathies.

Identify the globin chain defects causing SCA and hemoglobin C disease.

Associate laboratory analyses with their use in detecting and identifying hemoglobinopathies.

Recognize and identify abnormal laboratory test results, including peripheral blood findings and screening and confirmatory tests, typically associated with homozygous and heterozygous conditions involving HbS, HbC, HbD, HbE, and compound heterozygous conditions involving hemoglobin S and other abnormal hemoglobins.
aa. List major clinical findings typically associated with the hemoglobinopathies listed in Objective 7.

bb. Compare the prevalence of hemoglobins S, C, D, and E.

c. Evaluate laboratory test results and medical history of a clinical case for a patient with a hemoglobinopathy and suggest a possible diagnosis.

d. Define thalassemia.

ee. Differentiate thalassemias from hemoglobinopathies based on definition and basic pathophysiology.

ff. Describe the typical peripheral blood morphology associated with thalassemia.

gg. For each of the four genotypes of α-thalassemia describe the:
   a. Number of affected alleles
   b. Individuals affected
   c. Basic pathophysiology
   d. Symptoms
   e. Laboratory results including blood cell morphology and hemoglobin electrophoresis
   f. Geographic prevalence
   g. Diseases

hh. For each of the six genotypes of β-thalassemia describe the:
   a. Individuals affected
   b. Basic pathophysiology
   c. Symptoms
   d. Laboratory results including blood cell morphology and hemoglobin electrophoresis
   e. Geographic prevalence
   f. Diseases

ii. Explain the cause and process of megaloblastic maturation in the bone marrow.

jj. Describe the body’s requirements for vitamin $B_{12}$ and folate and their physiologic role.

kk. List the laboratory tests used to confirm a diagnosis of vitamin $B_{12}$ deficiency and give expected results.

ll. List the laboratory tests used to confirm a diagnosis of folic acid deficiency and give expected results.

mm. Recognize the six most common disorders that result in a macrocytic anemia.

nn. Summarize the common or typical blood picture seen with a folate or vitamin $B_{12}$ deficiency.

oo. Calculate the MCV, MCHC and MCH given the hemoglobin, Hematocrit and total RBC count.

pp. Correlate the indices with the peripheral smear results.

qq. Calculate absolute reticulocyte count, corrected reticulocyte count and reticulocyte production index from reticulocyte results, hematocrit, and RBC count.
rr. Define dimorphic.

2. **Learning Activities: Methods of Teaching and Learning**

Students will be taught using various learning methods and activities which includes lectures, demonstrations including hands on with microscope preserved slides, practice sessions, case studies, projects, laboratory experiences, Internet exercises, quizzes, exams, and recordings. All material covered by these methods maybe covered on Exams.

At the conclusion of this lecture series, the learner will have achieved the following:
Achievement will be met when a minimum score of 75 percent is earned on the written examination covering the material.

**Lecture Exam 3**  
**Lab Exam 2**

**Learning Objectives**

D. **Unit Four: Leukocyte Pathology**

In addition to the following objectives, students are responsible for all information covered in Units One, Two and Three.

**Pathology of the Leukocytes and Related Disorders (McKenzie Ch 21-28)**

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

1. **Learning outcomes**
   
   a. Define leukemic hiatus, CD marker, benign, malignant, neoplasm, lymphoma, leukemia  
   
   b. Explain the difference between absolute and relative leukocytosis  
   
   c. Define and list the causes of leukemoid reaction.  
   
   d. Describe the following WBC morphology and inclusions and relate them to disease states: hyper segmented neutrophil, toxic granulation, Dohlë bodies, vacuoles, atypical lymphocytosis, Auer rods, smudge cells, Reed-Sternberg cell, Faggot cell.  
   
   e. Compare and contrast the peripheral blood picture and lab findings of the following WBC disorders or abnormal WBC: Pelger-Huët anomaly, May-Hegglin anomaly, Chediak-Higashi anomaly, Alder- Reilly anomaly, The Leukemias including Hairy Cell Leukemia, Burkitt Lymphoma, Hodgkin’s and Non-Hodgkin’s Lymphoma, Myelofibrosis,
polycythemia, Infectious Mononucleosis, Multiple Myeloma, Sezary syndrome, Gaucher disease, Niemann-Pick disease, Myelodysplastic disease, Aplastic anemia.

f. Differentiate the subgroups of myeloproliferative disorders (MPD) from other reactive and neoplastic diseases based on laboratory findings in the peripheral blood, bone marrow, and other diagnostic laboratory tests.

g. Compare and contrast the various presentations of AML.

h. Predict the most likely leukemia type based on patient history, physical assessment, and laboratory findings.

i. Recognize the treatment for Polycythemia vera.

j. Describe and recognize the characteristic peripheral blood picture found in essential thrombocythemia (ET).

k. Differentiate MDS from myeloproliferative disorders, acute leukemia, and other hematologic abnormalities using peripheral blood, bone marrow, and cytogenetic characteristics.

l. Compare and contrast the FAB and the WHO systems of classification.

m. Evaluate a case study from a patient with a leukocyte disorder and conclude from the medical history and laboratory results the most likely diagnosis for the disorder.

2. Learning Activities: Methods of Teaching and Learning

Students will be taught using various learning methods and activities which includes lectures, demonstrations including hands on with microscope preserved slides, practice sessions, case studies, projects, laboratory exercises, clinical experiences, Internet exercises, quizzes, exams, and recordings. All material covered by these methods maybe covered on Exams.

Lecture Exam 4
Lab Exam 3

E. Learning Objectives

Unit Five: Hemostasis and Body Fluids

In addition to the following objectives, students are responsible for all information covered in Units One, Two, Three and Four.

Hemostasis (McKenzie Ch 9; 31-36; 30)

1. Learning outcomes
a. Distinguish the events that occur in primary hemostasis from those that occur in secondary hemostasis.
b. Describe the normal morphology and number of platelets on a peripheral blood smear and state the normal concentration in the blood.
c. Identify and define the steps in the normal sequence of events of platelet activation following injury to the endothelium.
d. List the coagulation factors using Roman numerals and common names and determine how each is evaluated in lab testing. List the source of each coagulation factor. Predict results of coagulation tests in a given disease.
e. Classify the coagulation factors into groups and discuss their characteristics.
f. Describe the mechanism of action of the coagulation proteins.
g. Explain the sequence of reactions in the coagulation cascade according to the historic concepts of intrinsic, extrinsic, and common pathways.
h. Define fibrinolysis. List the fragments resulting from fibrinolytic degradation; compare and contrast the fragments resulting from the degradation of fibrinogen and fibrin. Describe the significance and clinical implications of circulating fibrin degradation products.
i. Define factor inhibitors and list characteristics of antithrombin and factor VIII inhibitor.
j. Cite the electrical impedance principle and the principles of light scatter for counting platelets.
k. Perform a platelet estimate and relate the usefulness of the result.
l. Perform a manual platelet count using a Neubauer Hemacytometer, describe the procedure, identify potential sources of error, determine appropriateness of use, calculate and interpret results, explain the clinical significance of the test, report and evaluate the results.
m. State the electromechanical principle of clot detection, and identify instruments that use this technology.
n. State the photo-optical principle of clot detection, identify instruments that use this technology and perform proteome and activated partial thromboplastin time on patients and controls using this technology.
o. Describe special precautions to take regarding specimen collection and processing for platelet evaluation and coagulation studies, and determine specimen appropriateness.
p. Describe the procedure for determining the bleeding time (BT), prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT), Russell Viper Venom, fibrinogen assay, fibrin degradation products (FDP), fibrin split products (FSP) and D-dimer assay.
q. Explain the clinical significance of each test listed: bleeding time (BT), prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT), fibrinogen assay, factor assays, fibrin degradation products (FDP), fibrin split products (FSP), D-dimer assay, mixing studies.
r. Identify the appropriate laboratory procedure for monitoring heparin therapy and oral anticoagulant therapy.
s. Perform D-dimer assay using monoclonal antibody methodologies, describe the procedure, identify potential sources of error, determine appropriateness of use, interpret results, and explain the clinical significance of the test.

t. Interpret the results of routine coagulation testing (i.e., prothrombin time (PT), activated partial thromboplastin time (APTT), fibrinogen assay, thrombin time (TT), fibrinogen degradation products (FDP) and, D-dimer assay).

u. State the principle and determine the appropriate utilization for each of the following tests: platelet aggregation studies, reptilase time, prekallikrein screening test, F-XIII screening test, von Willebrand factor activity assay, von Willebrand factor antigen immunoassay, platelet neutralization procedure (PNP), dilute Russell’s viper venom time, Lupus anticoagulants, F-VIII inhibitor assay, euglobulin lysis, antithrombin (AT), protein C (PC), protein S (PS), plasminogen, antiplasmin, activated protein C resistance (APCR), and F-Xa inhibition.

v. Recognize hematologic disorders that are characterized by the presence of thrombocytopenia or thrombocytosis such as Fanconi anemia, Wiskott - Aldrich syndrome, Bernard -Soulier Syndrome, May-Hegglin anomaly.

w. Identify the cause and describe the clinical and laboratory features of hereditary disorders of platelet function.

x. Describe the hereditary and acquired qualitative platelet defects such at von Willebrand Disease, Bernard-Soulier syndrome, Glanzmann’s thrombasthenia by etiology and pathophysiology, and predict the clinical and laboratory features.

y. Describe the expected results of laboratory screening tests that detect abnormalities of the proteins of secondary hemostasis.

z. Identify hemostatic proteins that are deficient in hemophilias A and B.

aa. Describe the role of heparin in the neutralization of activated coagulation factors by anti-thrombin.

bb. Discuss how oral anticoagulants such as Coumadin decrease a person’s risk for thrombosis and describe the best way to monitor oral anticoagulation.

cc. Evaluate a case study from a patient with a defect in hemostasis and, using the medical history and laboratory results, determine the diagnosis.

dd. Define the terms: Serous fluids, Pericardial, Peritoneal, Pleural, Cerebral Spinal Fluid, Xanthochromia, Synovial Fluid, Amniotic Fluid, and Birefringence.

ee. State the significance of the following findings on the cytospin prepared slide from body fluid samples: RBC, WBC (each type), lining cells, various microscopic organisms, and Crystals.
2. **Learning Activities: Methods of Teaching and Learning**

Students will be taught using various learning methods and activities which includes lectures, demonstrations including hands on with microscope preserved slides, practice sessions, case studies, projects, laboratory exercises, clinical experiences, Internet exercises, quizzes, exams, and recordings. All material covered by these methods maybe covered on Exams.

5. **Exhibit a sense of professionalism by demonstrating the following characteristics:**
   - attend class regularly and punctually,
   - seeks activities which further learning,
   - admits mistakes and takes steps to correct them,
   - cooperates with instructor, and
   - complies with the stated dress code of the student laboratory.

At the conclusion of this unit, the student will have achieved the following: Achievement will be met when a minimum score of 75 percent is earned on the material.

**Guidelines for MLAB Laboratory Exercises**

During all laboratory sessions the student will demonstrate attitudes consistent with professionalism and concern for high quality health care by:

- Performing analysis with care, adhering strictly to written procedure
- Demonstrating flexibility by accepting and implementing approved changes to procedures
- Attending scheduled lab regularly and punctually
- Completing assigned tasks with minimal guidance
- Maintaining confidentiality of patient results
- Seeking activities which further assists learning
- Admitting mistakes and taking steps to correct them
- Repeating procedures when test results are in doubt
- Responding appropriately to authority
- Taking pride in the student’s role in laboratory medicine
- Complying with the stated dress code for laboratory exercises
- Recognizing the value of continuing education activities

In order to obtain the maximum number of points awarded for each lab exercise, the student must:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comply with the stated dress code.</td>
<td></td>
</tr>
<tr>
<td>Wear appropriate PPE for the given task.</td>
<td></td>
</tr>
<tr>
<td>Clean the work area before lab with 10% bleach.</td>
<td></td>
</tr>
<tr>
<td>Obtain equipment and materials for testing.</td>
<td></td>
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</tbody>
</table>

MLAB 1415
- Maintain a safe, well organized, clean work area.
- Follow written procedures and all verbal directions.
- Use standard precautions in all lab work.
- Dispose of all waste properly.
- Store equipment in the proper storage area in clean, working condition.
- Put away all supplies and PPE.
- Clean work area with 10% bleach before leaving the lab.
- Submit completed lab reports on time, in ink using acceptable correction techniques if necessary.
- Wash hands before leaving the lab.

**Grading Criteria for Lab Exercises**

In order for a student to be awarded 100% of the total points for each lab exercise the following criteria must be accomplished:

1. Each lab assignment must be completed and the lab report must be submitted by the end of the lab period.
2. Patient and unknown lab results must be within 3% of the expected values or the instructor’s values.
3. Correctly answer each review question in complete sentences.
4. Successfully complete the case studies where appropriate.
5. Accomplishing all of the guidelines for lab exercises.

In order for a student to be awarded 90% of the total points for each lab exercise the following criteria must be accomplished:

1. Each lab assignment must be completed and the lab report must be submitted by the end of the lab period.
2. Patient and unknown lab results must be within 6% of the expected values or the instructor’s values.
3. Correctly answer each review question in complete sentences.
4. Successfully complete the case studies where appropriate.
5. Accomplishing all of the guidelines for lab exercises.

In order for a student to be awarded 80% of the total points for each lab exercise the following criteria must be accomplished:

1. Each lab assignment must be completed and the lab report must be submitted by the end of the lab period.
2. Patient and unknown lab results must be within 10% of the expected values or the instructor’s values.

MLAB 1415
3. Correctly answer each review question in complete sentences.
4. Successfully complete the case studies where appropriate.
5. Accomplishing all of the guidelines for lab exercises.

In order for a student to be awarded 75% of the total points for each lab exercise the following criteria must be accomplished:

1. Each lab assignment must be completed and the lab report must be submitted by the end of the lab period.
2. Patient and unknown lab results must be within 20% of the expected values or the instructor’s values.
3. Correctly answer each review question in complete sentences.
4. Successfully complete the case studies where appropriate.
5. Accomplishing all of the guidelines for lab exercises.

No points will be awarded for an incomplete or late laboratory exercise.

**Grading Criteria for Computer Modules**

1. The student must receive verbal approval from the instructor prior to proceeding to each file.
2. The student must complete the exam upon conclusion of the module with a score of 75%. Submit a copy of the exam to the instructor. For a score of less than 75%, the student must repeat the module and exam.