

**CENTRAL TEXAS COLLEGE
SYLLABUS FOR MLAB 1415
HEMATOLOGY**

Semester Hours Credit: 4

INSTRUCTOR: Luci Hansen

OFFICE HOURS: TBA

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

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 stainers, microhematocrit 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 of 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 70 percent is earned on each written examination covering the material.

III. INSTRUCTIONAL MATERIALS

- A. Required Texts:
 - 1. McKenzie, Shirlyn B., Clinical Laboratory Hematology. 1st ed. New Jersey: Pearson Prentice Hall, 2004. (ISBN: 0-13-019996-6)
 - 2. Diggs, Sturm, and Bell, The Morphology of Human Blood Cells. 6th ed. Tennessee: Abbott Laboratories, 2003.
- B. References:
 - 1. Turgeon, Mary Louise, Clinical Hematology Theory and Procedures. 3rd ed. Pennsylvania: Lippencott, 1999. (ISBN: 0-316-85623-1)
 - 2. Brown, Barbara A. Hematology Principles & Procedures, 6th ed. Pennsylvania: Lea & Febiger, 1993. (ISBN: 0-8121-1643-7)
 - 3. Henry, John Bernard. Clinical Diagnosis and Management by Laboratory Methods: 20th ed. Pennsylvania: W.B. Saunders Co, 2001. (ISBN: 0-7216-6030-4)

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. Students are expected to attend all lectures/labs diligently and comply with college attendance rules as published in the Student Handbook.

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. Make-up examinations will not be given unless approved by the instructor. If given, make-up examinations may be 50% essay.
- C. Quizzes may be given at the discretion of the instructor.

VI. SEMESTER GRADE COMPUTATION

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|----|--|---------------|
| A. | Lecture Examinations | <u>Points</u> |
| | Lecture 1 | 100 |
| | Lecture 2 | 100 |
| | Lecture 3 | 100 |
| | Lecture 4 | 100 |
| | Lecture 5 | 100 |
| | Comprehensive Final | <u>200</u> |
| | TOTAL LECTURE EXAM POINTS | 700 |
| B. | Hematology and Coagulation Laboratory | <u>Points</u> |
| | Exam 1: Blood Cell ID: Maturation series, Blood Smear, Manual testing: WBC & Platelet counts, ESR | 100 |
| | Exam 2: Manual testing: Hct, Hgb, Retic, Osmotic Fragility, Sickle Cell Screening, RBC morphology and inclusions, RBC Pathology: cell ID | 100 |
| | Exam 3: WBC Pathology: cell ID Body Fluids, WBC & Plt estimates, Automation, Coag testing | 100 |
| | TOTAL LAB EXAM POINTS | <u>300</u> |
| C. | Laboratory Assessment Points: Lab testing, Article Summaries, Case Studies, Quizzes, Math problems | <u>100</u> |
| | TOTAL LAB ASSESSMENT POINTS | 100 |

TOTAL LABORATORY POINTS FOR SEMESTER: 400

D. Total Possible Points for course: 1100

990 - 1100 points = **A**
880 - 989 points = **B**
770 - 879 points = **C**
660 - 769 points = **D**
< 660 points = **F**

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 8 th week |
| 8-week session | Friday of the 6 th week |
| 5-week session | Friday of the 4 th 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): Students requiring accommodations for disabilities are responsible for notifying the instructor. Reasonable accommodations will be granted in full compliance with federal and state law and Central Texas College policy.
- 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. **Section One: Introduction to Hematopoiesis, Erythrocytic Series, Hemoglobin Development, and Leukocytic Series**

Introduction to the Study of Hematopoiesis

- 1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. Demonstrate a basic knowledge of the following terms:

| | |
|---------------------|------------------|
| (1) Hematology | (5) Whole blood |
| (2) Vascular system | (6) Erythrocytes |
| (3) Hematopoiesis | (7) Leukocytes |
| (4) Plasma | (8) Thrombocytes |
 - b. Describe the physiology of the vascular system and blood constituents
 - c. Accomplish the following with regard to the composition of blood:
 - (1) List the cellular components and the normal values
 - (2) List the liquid components and their normal percentages
 - d. Accomplish the following with regard to blood formation:
 - (1) Describe extramedullary and medullary hematopoiesis
 - (2) Demonstrate knowledge of the following:
 - (a) Synchronism
 - (b) Asynchronism
 - (c) Cytoplasmic differentiation
 - (d) Nuclear maturation
 - (e) Reduction in cell size
 - e. Describe normal maturation stages for the erythrocytic series:
 - (1) List sequential steps
 - (2) Compare the stages with regard to:
 - (a) Cell size
 - (b) Shape of cell and nucleus

- (c) Ratio of nucleus to cytoplasm
 - (d) Cytoplasmic stain characteristics
 - (e) Chromatin pattern
 - (f) Hemoglobin content
- f. Describe the normal maturation stages for the granulocytic series:
- (1) List sequential stages
 - (2) Compare the stages with regard to:
 - (a) Cell size
 - (b) Shape of cell and nucleus
 - (c) Ratio of nucleus to cytoplasm
 - (d) Stain characteristics of granules
 - (e) Chromatin pattern
- g. Describe the normal maturation stages for the lymphocytic series:
- (1) List sequential steps
 - (2) Compare the stages using same criteria as in "f"
- h. Describe the normal maturation stages for the monocytic series:
- (1) List sequential steps
 - (2) Compare the stages using the same criteria as in "f"
- i. Describe the normal maturation stages for the plasmacytic series:
- (1) List the sequential steps
 - (2) Compare the stages using the same criteria as in "f"
- j. Describe the normal maturation stages for the megakaryocytic series:
- (1) List the sequential steps
 - (2) Compare the stages using the same criteria as in "f"
- k. Demonstrate knowledge of the following cells:
- | | |
|-----------------|-------------------|
| (1) Erythrocyte | (5) Lymphocyte |
| (2) Neutrophil | (6) Monocyte |
| (3) Eosinophil | (7) Megakaryocyte |
| (4) Basophil | (8) Plasma cell |
- l. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.

2. Learning Activities:

- a. Classroom lecture and discussion
- b. Reading assignment: McKenzie-Chapters 1-6
- c. Laboratory exercises

3. Equipment and Materials:

- a. Microscope
- b. Prepared peripheral smears
- c. Immersion oil

4. Audio-Visual Aids and Computer Technology:

- a. 35mm Kodachromes of blood cells and projector
- b. Overhead transparencies and projector

5. Lesson Outline:
 - a. Terminology
 - b. Cell maturation stages
 - c. Cellular recognition

LECTURE EXAM #1

B. Section Two: Routine Hematology Procedures, Special Hematology Procedures, Blood Smears, Bone Marrow, Automation, and Body Fluids

Routine Hematology Procedures: Blood Cell Counts: WBC, RBC, and Platelets

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. Accomplish the following for leukocyte counts:
 - (1) State the principle for the hemacytometer method
 - (2) Describe the areas of the chamber used for WBC counts using:
 - (a) WBC pipette
 - (b) Unopette
 - (3) List WBC dilution fluids that may be used
 - (4) Perform and calculate results according to method used
 - (5) List sources of error
 - (6) List the normal values for adults
 - b. Accomplish the following for RBC counts:
 - (1) State the principle for the hemacytometer method
 - (2) Describe the areas of the chamber used for RBC counts using Unopette
 - (3) List the normal values for adults
 - c. Accomplish the following for platelet counts:
 - (1) State the principle for the hemacytometer method
 - (2) Describe the areas of the chamber used for plt counts using Unopette
 - (3) List plt dilution fluids that may be used
 - (4) Perform and calculate results according to method used
 - (5) List sources of error
 - (6) List the normal values for adults
 - (7) Interpret results using correct terminology
 - d. Accomplish the following for peripheral blood smear differentials:
 - (1) Describe and correctly perform a peripheral blood smear
 - (2) Identify correct area of smear for reading
 - (3) Describe and perform a WBC differential
 - (4) Correlate relative vs. absolute values
 - (5) List normal values
 - (6) Interpret results using terms such as leukopenia, lymphopenia, neutrophilia, and leukocytosis
 - e. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of

70 percent is earned on the written examination covering the material.

2. Learning Activities:
 - a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie-Chapter 7
 - c. Laboratory exercises

3. Equipment and Materials:
 - a. Microscope
 - b. Hemacytometer
 - c. WBC and plt Unopettes
 - d. Glass slides
 - e. Plain microhematocrit tubes
 - f. Wrights stain

4. Audio-Visual Aids and Computer Technology
 - a. Computer program: Peripheral Blood Tutor

5. Lesson Outline:
 - a. WBC counts
 - b. RBC counts
 - c. Platelet counts
 - d. Peripheral blood smear differentials

Special Hematology Procedures: Reticulocyte Count, ESR, Osmotic Fragility Testing, and Sickle Cell Testing

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. Accomplish the following in regard to reticulocyte counts:
 - (1) Describe the difference between retics and mature RBCs
 - (2) State the principle
 - (3) List the steps of the procedure
 - (4) List the sources of error
 - (5) State the normal values for adults
 - (6) Relate the significance of abnormal values to disease states
 - (7) Describe automated retic counts
 - (8) Perform a reticulocyte count and calculate the relative, absolute, and corrected values

 - b. Accomplish the following in regard to the sedimentation rate:
 - (1) Using the Westergren method:
 - (a) State the principle
 - (b) List the steps and perform the procedure
 - (c) Describe sources of error
 - (d) List the normal values for adults

- (e) Relate the significance of abnormal values to disease states
- (2) Describe automated ESR
- c. Accomplish the following in regard to osmotic fragility testing:
 - (1) State the principle
 - (2) List the steps and perform the procedure
 - (3) List the sources of error
 - (4) State the normal values for initial and complete hemolysis
 - (5) Explain the effects of variations in shape and erythrocyte size
 - (6) Describe results obtained in regard to different anemias
- d. Accomplish the following in regard to sickle cell testing:
 - (1) State the principle of the following tests for sickle cell:
 - (a) Dithionite solubility test
 - (b) Hemoglobin electrophoresis
 - (2) List the reagents used in above procedures
 - (3) List the steps and perform the procedures
 - (4) Describe the difference in results obtained from normal, HbS trait, and HbS disease patients
 - (5) State the method used to report procedures in 1
 - (6) Describe the advantages and disadvantages of each of these methods
 - (7) Relate the significance of abnormal values to disease states
- e. Describe the sucrose hemolysis test
- f. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.

2. Learning Activities:

- a. Classroom lecture and discussion
- b. Reading assignment: McKenzie – Chapter 7 & 40

3. Equipment and Materials:

- a. Osmotic fragility Unopette kit
- b. Glass slides
- c. Microscopes
- d. Hand Tally
- e. Timer
- f. Test tubes and rack
- g. Pipettes
- h. Spectrophotometer
- i. Sicklequick test kit
- j. Westergren ESR tubes
- k. Retic stain
- l. Immersion oil

4. Audio-Visual Aids and Computer Technology:

- a. Transparencies
 - b. Projector
5. Lesson Outline:
- a. Reticulocyte counts
 - b. ESR testing
 - c. Osmotic fragility
 - d. Sickle cell testing

Hemoglobin, Hematocrit, and RBC Indices

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
- a. Accomplish the following in regard to hemoglobin determination:
 - (1) Define and describe significance of the following plasma hemoglobins:
 - (a) Oxyhemoglobin
 - (b) Reduced hemoglobin
 - (c) Carboxyhemoglobin
 - (d) Cyanmethemoglobin
 - b. Accomplish the following for Unopette method of hemoglobin determination:
 - (1) Describe the principle
 - (2) List and perform the sequential procedural steps
 - (3) Describe the advantages and disadvantages
 - (4) List sources of error
 - (5) List normal values for adults
 - (6) Relate the significance of abnormal values to disease states
 - c. Accomplish the following in regard to preparation of a standard curve:
 - (1) State the principle
 - (2) Describe and perform the procedure
 - (3) Evaluate the results
 - d. Accomplish the following in regard to the hematocrit:
 - (1) Using the microhematocrit method:
 - (a) State the principle
 - (b) List and perform the steps
 - (c) Describe sources of error
 - (d) List normal values for adults
 - (e) Explain the significance of abnormal values
 - e. Accomplish the following in regard to RBC indices:
 - (1) Define the terms
 - (2) Perform the calculations
 - (3) List the normal values
 - (4) Explain the significance of abnormal values to disease states
 - f. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of

70 percent is earned on the written examination covering the material.

2. Learning Activities:
 - a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie-Chapter 7
 - c. Laboratory exercises

3. Equipment and Materials:
 - a. Spectrophotometer
 - b. Unopettes for hemoglobin determination
 - c. Cuvettes
 - d. Graph paper
 - e. Microhematocrit centrifuge
 - f. Microhematocrit tubes
 - g. Critoseal
 - h. Disposable tubes and rack
 - i. Timer

4. Audio-Visual Aids and Computer Technology:
 - a. Overhead transparencies
 - b. Projector

5. Lesson Outline:
 - a. Hemoglobin determination
 - b. Unopette hemoglobin determination
 - c. Preparation of a standard curve
 - d. Hematocrit determination
 - e. RBC indices

Lab Exam 1

Automation in Hematology

1. Lesson Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. Discuss basic principle of hematological analyzers
 1. Light scattering
 2. Laser
 3. Flow cytometry
 - b. Give examples of the equipment which utilize the principles above
 - c. Recognize unexpected test results and corrective action to take for routine or frequently encountered problems
 - d. Describe essential components of analyzers
 - e. Describe preventative maintenance
 - f. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of

70 percent is earned on the written examination covering the material.

2. Learning Activities:
 - a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie-Chapter 41
 - c. Laboratory exercises
3. Equipment and Materials:
 - a. Coulter S Plus
 - b. Mino-STX
4. Audio-Visual Aids and Computer Technology:
 - a. VHS tape: Automation in Hematology
 - b. Overhead transparencies and projector
 - c. Computer program: Management in Hematology
5. Lesson Outline
 - a. Principle of hematological analyzers
 - b. Procedures for hematological analyzers
 - c. Troubleshooting for hematological analyzers
 - d. Preventative maintenance for hematology analyzers

Body Fluids

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. List the characteristics of normal cerebral, synovial, serous, and seminal fluid
 - b. Relate the effect of disease states upon cellular content of these fluids
 - c. Describe the formation of these fluids and their function
 - d. Accomplish the following in regard to these fluids
 - (1) State the principle of methods
 - (2) Describe specimen handling and distribution
 - (3) Describe the gross examination
 - (4) Describe how to perform dilutions, if necessary
 - (5) List the steps for the procedure
 - (6) Identify area of the hemacytometer used
 - (7) Perform calculations and report results
 - (8) Name the normal values for adults
 - e. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.
2. Learning Activities:
 - a. Classroom lecture and discussion

- b. Reading assignment: McKenzie-Chapter 33
- 3. Equipment and Materials:
 - a. Unopettes
 - b. Microscopes
 - c. Hemacytometer
 - d. Tally counter
- 4. Audio-Visual Aids and Computer Technology:
 - a. 35mm Kodachromes and projector
 - b. Overhead transparencies and projector
- 5. Lesson Outline:
 - a. Characteristics of body fluids
 - b. Correlate disease states to body fluids
 - c. Laboratory examination of body fluids

LECTURE EXAM #2

D. Section Three: Anemias

Abnormal Erythrocyte Morphology and Inclusions

- 1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. Demonstrate knowledge of the following abnormalities:
 - (1) Microcytosis
 - (2) Macrocytosis
 - (3) Anisocytosis
 - (4) Hypochromia
 - (5) Polychromasia
 - (6) Poikilocytosis
 - (7) Codocyte (target cell)
 - (8) Stomatocyte
 - (9) Elliptocyte/ovalocyte
 - (10) Spherocyte
 - (11) Dacryocyte (teardrop)
 - (12) Echinocyte (crenated/burr cells)
 - (13) Bite cell
 - (14) Schistocyte
 - (15) Acanthocyte
 - (16) Drepanocyte (sickle cell)
 - b. Give examples of disease states showing 1-16
 - c. State the composition, explain the clinical significance, and list the method for identification for the following inclusions:
 - (1) Basophilic stippling
 - (2) Howell-Jolly bodies

- (3) Cabot rings
 - (4) Siderotic granules
 - (5) Heinz bodies
 - (6) Pappenheimer bodies
 - (7) Hemoglobin C crystals
 - (8) Malarial parasites
 - d. Identify common artifacts: platelet on rbc, air holes, and stain precipitin
 - e. Identify abnormal platelet morphology and describe causes
 - (1) Platelet clumping
 - (2) Platelet satellitism
 - (3) Giant platelets
 - f. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.
2. Learning Activities:
- a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie-Chapter 10
 - c. Laboratory exercises
3. Equipment and Materials:
- a. Microscope
 - b. Prepared peripheral smears
 - c. Immersion oil
4. Audio-Visual Aids and Computer Technology:
- a. 35mm Kodachromes of blood cells and projector
 - b. Overhead transparencies and projector
 - c. VHS tape: "Hematology of Dogs & Cats"
 - d. Computer program: Peripheral Blood Tutor
5. Lesson Outline:
- a. Recognize abnormal cells
 - b. Correlate disease states to abnormal cells
 - c. Identify artifacts
 - d. Identify abnormal platelets and causes

Anemias and Hemoglobinopathies

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
- a. Describe anemia classification by morphology and according to cause
 - b. Describe the following anemias by listing lab findings:
 - (1) Iron deficiency

- (2) Sideroblastic
 - (3) Porphyria
 - (4) Aplastic
 - (5) Pernicious
 - (6) Vitamin B12 deficiency
 - (7) Folate deficiency
 - (8) Blood loss
 - (9) Hereditary spherocytosis
 - (10) Paroxysmal Nocturnal Hemoglobinuria
 - (11) G-6-PD deficiency
 - (12) Paroxysmal Cold Hemoglobinuria
 - (13) Sickle cell disease
 - (14) Hemoglobin C disease
 - (15) Thalassemia major and minor
- c. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.
2. Learning Activities:
- a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie - Chapters 10 - 20
 - c. Laboratory exercises
3. Equipment and Materials:
- a. Microscope
 - b. Prepared peripheral smears
 - c. Immersion oil
4. Audio-Visual Aids and Computer Technology:
- a. 35mm Kodachromes and projector
 - b. Overhead transparencies and projector
5. Lesson Outline:
- a. Anemia classification
 - b. Identify anemias by lab findings

LECTURE EXAM #3

D. Section Four: Leukocyte Pathology

Pathology of the Leukocytes and Related Disorders

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
- a. Define leukocytosis
 - (1) Explain the difference between relative and absolute

- (2) List causes for neutrophilic, eosinophilic, monocytic, and lymphocytic leukocytosis
- b. Define and list causes for leukemoid reactions
- c. Describe the following WBC morphology and inclusions and relate them to disease states:
 - (1) Hypersegmented neutrophil
 - (2) Toxic granulation
 - (3) Dohle body
 - (4) Vacuoles
 - (5) Atypical lymphocytes
 - (6) Auer rod
 - (7) Smudge cell
 - (8) Necrobiotic cell
- d. Describe the following WBC disorders:
 - (1) Pelger-Huet Anomaly
 - (2) May-Hegglin Anomaly
 - (3) Chediak-Higashi Anomaly
 - (4) Alder-Reilly Anomaly
 - (5) The leukemias
 - (6) Myelofibrosis
 - (7) Polycythemia
 - (8) Infectious mononucleosis
 - (9) The lymphomas:
 - (a) Non-Hodgkin's
 - (b) Hodgkin's
 - (10) Multiple myeloma
 - (11) Lupus erythematosus
 - (12) Sezary syndrome
 - (13) Gaucher syndrome
 - (14) Niemann-Pick
- e. Bone marrow studies
- f. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.

2. Learning Activities:

- a. Classroom lecture and discussion
- b. Reading assignment: McKenzie-Chapters 21, 22, 26-31
- c. Laboratory exercises

3. Equipment and Materials:

- a. Microscope

- b. Prepared peripheral smears
 - c. Immersion oil
4. Audio-Visual Aids and Computer Technology:
- a. 35mm Kodachromes and projector
 - b. Overhead transparencies and projector
 - c. VHS tape: Differentials
5. Lesson Outline:
- a. Leukocytosis
 - b. WBC morphology and inclusions
 - c. WBC disorders
 - d. Bone marrow studies

LECTURE EXAM #4

E. Section Five: Hemostasis and Coagulation Testing

Thrombocytes, Hemostasis, and Blood Coagulation

1. Learning Outcomes: Upon successful completion of this lesson, the student will be able to:
- a. Accomplish the following with regard to thrombocytes:
 - (1) Describe the normal platelet and its function
 - (2) State the normal value for adults
 - (3) Explain the following with regard to platelet counts:
 - (a) State the principle
 - (b) List the steps of procedure for Unopette counts
 - 1 list sources of error
 - 2 state the area of the hemacytometer used
 - 3 calculate and report results
 - (c) Describe automated platelet counts
 - b. Accomplish the following with regard to hemostasis:
 - (1) Define hemostasis
 - (2) List the factors involved in hemostasis
 - (3) Describe the extravascular, intravascular, and vascular controls
 - c. Accomplish the following with regard to blood coagulation:
 - (1) Describe the stages of blood coagulation
 - (2) List the factors involved in the stages of blood coagulation
 - (3) Recognize the international factor nomenclature and synonyms
 - (4) Explain role of each coagulation factor
 - (5) Apply this knowledge to explain hemorrhagic disorders
 - (6) List some of the inhibitors
 - (7) Describe the inhibitory action of commonly used anticoagulants

- d. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.
- 2. Learning Activities:
 - a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie-Chapters 34-38
 - c. Laboratory exercises
- 3. Equipment and Materials:
 - a. Centrifuge
 - b. Micropipettes
 - c. Coag reagents
 - d. Fibrometer
 - e. Coag-a-mate XM
- 4. Audio-Visual Aids and Computer Technology:
 - a. 35mm Kodachromes and projector
 - b. Overhead transparencies and projector
- 5. Lesson Outline:
 - a. Platelet function
 - b. Platelet counts
 - c. Hemostasis
 - d. Blood coagulation

Coagulation Testing

- 1. Lesson Outcomes: Upon successful completion of this lesson, the student will be able to:
 - a. Properly prepare lab reagents and collect specimens for coagulation testing
 - b. Apply the following to the tests listed below:
 - (1) State the principle
 - (2) List the steps of the procedure
 - (3) State sources of error
 - (4) State the normal range
 - (5) Relate significance of abnormal results to disease states
 - (6) Report and evaluate results correctly
 - (7) Tests:
 - (a) Prothrombin time
 - (b) Activated partial thromboplastin time
 - (c) Thrombin time
 - (d) Fibrinogen assay
 - (e) Bleeding time

- (f) Fibrin degradation products
 - (g) D-dimer
 - c. Describe the following procedures:
 - (1) Factor assays
 - (2) Mixing studies
 - d. At the conclusion of this lecture series, the learner will have achieved the following: Achievement will be met when a minimum score of 70 percent is earned on the written examination covering the material.
- 2. Learning Activities:
 - a. Classroom lecture and discussion
 - b. Reading assignment: McKenzie-Chapter 39
 - c. Laboratory exercises
- 3. Equipment and Materials:
 - a. Fibrometer
 - b. Coag-a-mate
 - c. Centrifuge
 - d. Micropipettes
 - e. Coag reagents
- 4. Audio-Visual Aids and Computer Technology:
 - a. Overhead transparencies
 - b. Projector
- 5. Lesson Outline:
 - a. Specimens for coagulation testing
 - b. Coagulation testing procedures

LECTURE EXAM #5

LAB EXAM #3

***Hematology Final is comprehensive
and will be administered as scheduled in the CTC bulletin.***

LABORATORY OBJECTIVES
MLAB 1415

**Week
One**

Lab Lesson 1: Safety, RBC and Platelet Blood Cell Maturation

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

1. Identify the following stages of cell maturation for the erythrocytic series: rubriblast, prorubricyte, rubricyte, metarubricyte, NRBC, reticulocyte, and mature RBC using the following criteria:
 - a. cell size
 - b. cell shape
 - c. nucleus
 - d. nucleus to cytoplasm ratio
 - e. staining reaction
 - f. chromatin structure
 - f. hemoglobin content
2. Identify the following stages of thrombocytic maturation: megakaryoblast, promegakaryocyte, megakaryocyte, and thrombocyte.
3. Identify and use safety procedures required in the student laboratory.
4. Demonstrate computer ability while developing peripheral blood smear skills

**Week
Two**

Lab Lesson 2: White Blood Cell Maturation

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

1. Identify the following stages of cell maturation for the granulocytic series: myeloblast, promyelocyte, myelocyte, metamyelocyte, band, mature neutrophil, eosinophil and basophil using the following criteria:
 - a. cell size
 - b. nucleus to cytoplasm ratio
 - c. nuclear pattern
 - d. shape and location of nucleus
 - e. presence or absence of nucleoli
 - f. cytoplasm staining reaction
2. Identify the following stages of lymphocytic maturation: lymphoblast, prolymphocyte, large lymphocyte, and small lymphocyte using the criteria in #2.
3. Identify the following stages of monocytic maturation: monoblast, promonocyte, and monocyte using the criteria listed in #2.
5. Identify the following stages of plasmacytic maturation: plasmablast, proplasmacyte, and plasma cell using the criteria listed in #2.

**Week
Three**

Lab Lesson 3: Intro to Hematology Procedures and Peripheral Smears

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

1. Recognize routine hematology procedures
2. Indicate correct areas of blood smear for differential
3. Obtain correct specimen for Hematology testing using appropriate venipuncture techniques
4. Perform basic blood smear WBC differential.

**Week
Four**

Lab Lesson 4: Manual Blood Cell Counts

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

1. Correctly fill a hemacytometer chamber
2. Identify the area of the chamber used for:
 - a. Manual WBC, RBC, and Platelet counts
 - b. Unopette WBC and Platelet counts
3. Perform WBC and Platelet counts using Unopette method of whole blood dilution
4. Calculate and evaluate the results of hemacytometer counts
5. List sources of error in chamber counting
6. Demonstrate the correct method of making a peripheral smear

Lab Lesson 5: Erythrocyte Sedimentation Rate

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

1. Perform Westergren sedimentation rate
2. Obtain, evaluate and compare results to normal values

**Week
Five**

LAB EXAM #1

Lab Lesson 6: Hemoglobin Determination

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

1. Prepare a standard curve for hemoglobin
2. Perform manual hemoglobin using Unopette method
3. Evaluate results and compare with normal values
3. Calculate hemoglobin values using both a standard curve and Beer's Law calculation.

Lab Lesson 7: Spun Hematocrit

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

1. Perform spun hematocrit testing and calculate results
2. Operate a microcentrifuge
3. Interpret spun microhematocrit result and compare with normal values
4. Calculate approximate hemoglobin value based on hematocrit result and correlate with previously determined hemoglobin value.

**Week
Six**

Lab Lesson 8: Body Fluids

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

1. Perform manual cell counts on body fluids
2. Demonstrate proper specimen handling of body fluids
3. Describe post-vas semen collection and analysis
4. Report, interpret and correlate results to disease states

Lab Lesson 9: Reticulocyte counts

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

1. Perform reticulocyte counts
2. Evaluate results and calculate values

**Week
Seven**

Lab Lesson 10: RBC Morphology and Inclusions

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

1. Identify abnormal red blood cell forms as listed in lecture outline (Unit II a. 1-16).
2. Identify abnormal red blood cell inclusions as listed in lecture outline (Unit II c. 1-8).
3. Identify correct area of smear for peripheral blood smear evaluation.
5. Apply appropriate criteria for quantitating RBC morphology and inclusions.

Lab Lesson 11: Osmotic Fragility Testing

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

1. Perform Osmotic Fragility testing using Unopette kit.
2. Operate spectrophotometer
3. Graph test results and interpret those results by comparing to normal curve

**Week
Eight**

Lab Lesson 12: RBC Pathology

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

1. Identify characteristics of the following anemias: iron deficiency, macrocytic, normocytic/ normochromic, aplastic, sickle cell, sideroblastic, AIHA, G6PD, hereditary spherocytosis, hereditary elliptocytosis, and physical trauma (burn)
2. Correlate results from hematologic studies for each anemia listed above

**Week
Nine**

Lab Lesson 13: Sickle Cell Testing

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

1. Perform dithionite solubility sickle cell testing.
2. Interpret test results and correlate to disease states
3. Observe hemoglobin electrophoresis equipment

**Week
Ten**

LAB EXAM #2

Lab Lesson 14: WBC Pathology

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

1. Identify cells associated with the following pathologic states:
 - a. Acute leukemias
 - b. Chronic leukemias
 - c. Myelofibrosis
 - d. Myelodysplastic syndrome
 - e. Sezary syndrome
 - f. Multiple myeloma
2. Identify WBC showing abnormal maturation processes
 - a. Congenital anomalies affecting nucleus
 - 1) Pelger-Huet
 - 2) Hypersegmentation
 - 3) LE cell
 - b. Congenital anomalies affecting the cytoplasm
 - 1) May-Hegglin
 - 2) Alder-Reilly
 - 3) Chediak-Hegashi
 - 4) Gaucher cell
 - 5) Niemann-Pick cell
3. Identify abnormal WBC morphology and correlate to disease states:
 - a. ATL
 - b. Smudge cell
 - c. Dohle body
 - d. Vacuolated
 - e. Toxic granulation

- f. Auer rod
- g. Necrobiotic

**Week
Eleven**

Lab Lesson 15: Abnormal Peripheral Blood Smear Differentials

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

1. Prepare acceptable blood smears
2. Stain peripheral blood smears demonstrating the qualities of a well stained peripheral smear
3. Perform differential to include: identification and enumeration (%) of WBC observed, WBC estimate, platelet estimate, RBC morphology and inclusions, WBC morphology and inclusions
4. Report, interpret and correlate results to disease states

**Week
Twelve**

Lab Lesson 16: Automation

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

1. Describe essential components of Hematology analyzers to include Beckman-Coulter ACT
2. Examine principles of operation for analyzers
3. Assess preventative maintenance for analyzers
4. Recognize unexpected test results and corrective action to take for routinely encountered problems

Lab Lesson 17: Quality Control in Hematology

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

1. Define Quality Control and reference range; determine their use in the clinical laboratory
2. Construct and interpret Levey-Jennings graph
3. Recognize and demonstrate the use of Westgard rules
4. Demonstrate computer ability while examining the management of a Hematology lab

**Week
Thirteen**

Lab Lesson 18: Coag Testing - Prothrombin Time

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

1. Prepare PT reagents
2. Operate Fibrometer for PT test
3. Operate Coag-a-Mate for PT test
4. Report, interpret and correlate PT values to disease states
5. Evaluate acceptability of results
6. Perform two levels of quality control for PT and evaluate QC results

**Week
Fourteen**

Lab Lesson 19: Coag Testing - Activated Partial Thromboplastin Time

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

1. Prepare APTT reagents
2. Operate Fibrometer for APTT test
3. Operate Coag-a-Mate for APTT test
4. Report, interpret and correlate APTT values to disease states
5. Evaluate acceptability of results
6. Perform two levels of quality control for APTT and evaluate QC results

**Week
Fifteen**

LAB EXAM #3

Lab Clean Up