I. INTRODUCTION

A. The purpose of this course is to provide practical general training and experience in the workplace. The college with the employer develops and documents an individualized plan for the student. The plan relates the workplace training and experiences to the student’s general and technical course of study. The guided external experiences are unpaid. This course may be repeated if topics and learning outcomes vary.

B. There are three clinical courses in the Medical Laboratory Technician Program. These courses are designed to fulfill the clinical requirements set forth by the National Accrediting Agency for Clinical Laboratory Sciences.

C. The course is occupationally related and serves as the preparation course in clinical medical laboratory techniques.

D. Prerequisites: Refer to the CTC Catalog.

II. LEARNING OUTCOMES

Upon successful completion of this course, Clinical I, II, and III, the student will be able to:

A. Collect and process biological specimens for analysis.

B. Comply with biosafety regulations by practicing proper disposal of bio-hazardous material, as evidenced by complying with established safety regulations.

C. Accurately perform analytical tests on body fluids, cells, and products.

D. Exhibit interest in the clinical laboratory by having participated in lecture discussions and clinical laboratory assignments.

E. Recognize factors that affect procedures and results, and take appropriate actions within predetermined limits when corrections are indicated.

F. Help maintain a neat, clean, and orderly work area in all the laboratories without
being asked.

G. Interpret quality control values within predetermined limits.

H. Demonstrate proper use and care of laboratory equipment, as evidenced by lack of breakage.

I. Perform preventive and corrective maintenance of laboratory instruments.

J. Cooperate by communicating with and helping other students.

K. Attend clinical laboratory assignments and lectures regularly and punctually.

L. Demonstrate professional conduct and interpersonal communication skills with patients, laboratory personnel and other health professionals.

M. Exhibit assurance and confidence in performing laboratory tests.

N. Demonstrate integrity by recognizing and repeating questionable tests.

O. Accept instruction and constructive criticism maturely.

P. Comply with the stated dress code of each clinical affiliate.

Q. Relate the clinical significance of laboratory procedures to the appropriate disease process.

R. Demonstrate proper use of each laboratory information system.

S. 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 each of the written examinations covering the material.

III. INSTRUCTIONAL MATERIALS
A. Text:
   The instructional materials identified for this course are viewable through www.ctcd.edu/books
   Access to online Allied Health Professionals database is available through CTC website. Go to CTC homepage then click library on the left. Choose eBooks (available from any location c internet capability)
   All courses.
   Professionalism Grade: 50 Points (This grade cannot be replaced by final)
   Grading for Professionalism Grade: Subtract 2 pts per tardy or absence, 1 pt for other infractions
   Includes:
Preparation for Class
Completion of assignments (Homework assignments: Full credit at start of class, half points at end of day, 0 points after 1st day. See attendance below.)
Attendance (Must bring a doctor’s note for each absence due to illness to accept assignments the following day)
Tardies
Unlawful Use of electronics (cell phones, etc)
Observation (Team player, Participation, Stay on Task –minimal Distractions, cheating, plagiarism, talking)

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.

Testing: If professor elects to use testing center, tests will only be available on Tues-Thursday only. No exceptions. Tests will only be for same time period as the class. Class must meet during original scheduled class time for extra lectures and/or labs. Professor will take test on Monday, pick up tests on Friday to be able to grade by next class period.

The following texts will be used for MLAB 2462 Clinical I.

Required Texts:


IV. COURSE REQUIREMENTS

A. To receive transferrable credit for this course, you must earn a grade of "75" or better.

MLAB 2460, 2461 2462
B. You must keep up with the material on a day by day basis. The material must be learned in sequential order.

C. Students will be dismissed from the program if they make less than 75 on any exit exam.

D. Students will attend lectures on a weekly basis while assigned to clinical facilities.

E. You will be expected to attend all clinical experiences assigned. Absences in the clinical portion of the program must be made up before a grade will be given for the clinical portion of the course.

F. Each student is required to teach one lesson on a subject assigned by the instructor and/or one laboratory procedure. This lesson will be taught to the lower MLT classmen and evaluated by the instructor and/or the student.

V. EXAMINATIONS

A. Students in clinical courses must take Exit examinations. A grade of 75 or above is required on each exam. Exit examinations successfully completed will constitute 30% of the student’s grade for each clinical course. Each semester, a student will be allowed to retake only one of the exit tests with the approval of the instructor and program director. If a student requires a retake exit test, he or she will lose an overall letter grade for the course for not meeting the overall requirement of completing classes with a 75 on each exit test. A student may be dismissed from the program when an exit exam is not passed with a grade of 75 or above on the second attempt. If the student is dismissed from the program, each student has a one-time readmission to the program for the entire time they are in the MLT program. The program must be completed within a maximum 4 year period. If the student is seeking readmission during a clinical rotation class, the student will have to reapply to be in clinicals and start with Clinical I. MLT’s must meet these mandatory requirements to evaluate and diagnose by use of critical thinking in order to graduate from this program.

B. Make-up examinations will be given only by director approval. Documentation of illness or absence may be requested. The student will be evaluated by the director based on other grades, professionalism in the classroom and affiliate sites, to include parameters such as attendance, tardies, coming to class prepared, etc. prior to allowing the make-up test to be given. **Make-up tests are not guaranteed.** The student must meet evaluation process by the director prior to administering the exam.

C. Each clinical rotation must be successfully completed with a 2.5 (75) or above. Any clinical rotation receiving a grade of 2.4 or lower will result in a grade of F recorded for the course and the student will be withdrawn from the program.
VI. SEMESTER GRADE COMPUTATIONS

A. Clinical - 70% of semester grade for MLAB 2561 and 2460. It will be 65% for MLAB 2461.

B. Exit Examinations- 30% of semester grade

<table>
<thead>
<tr>
<th>Grade</th>
<th>3.5</th>
<th>3.0</th>
<th>2.5</th>
<th>1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0</td>
<td>3.4</td>
<td>2.9</td>
<td>2.4</td>
</tr>
</tbody>
</table>

C. Mock BOC- 5% of semester grade for MLAB 2461.

D. Clinical I Exit Examinations: Urinalysis (1), Coagulation (1), Hematology (2).

E. Clinical II Exit Examinations: Serology (1), Microbiology (2).

F. Clinical III Exit Examinations: Immunohematology (2), Clinical Chemistry (3).

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM COURSE INSTRUCTOR

A. Course Withdrawal: It is the student's responsibility to officially withdraw from a course 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 withdrawal form must be signed by the student.

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 as follows:

- 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 session 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 are 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 not be brought into the classroom or laboratory. Students wishing to record lectures should bring alternate devices for this purpose.

E. **Americans with Disabilities Act (ADA):** Disability Support Services provides 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 (DSS) located on the central campus. This service is available to all students, regardless of location. Review 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. **LESSON ONE:** Review of Urinalysis, Coagulation and Hematology Procedures

1. **Learning Outcomes:** upon successful completion of this lesson, the student will be able to:
   a. Successfully complete Exit exam in Urinalysis, Coagulation and Serology with a minimum of 75%.
   b. Describe laboratory experiences from the clinical site rotation
   c. Demonstrate a sense of professionalism by exhibiting the following characteristics: attends lecture and clinical site sessions regularly and punctually, seeks activities which further learning, admits mistakes and takes steps to correct them, repeats procedures when test results is in doubt, cooperates with lecture and clinical site
instructor, takes pride in laboratory medicine, complies with the
stated dress code of the student and clinical laboratory and
participates in continuing education activities.

d. Accurately perform clinical laboratory procedures as designed by
the clinical laboratory site rotation
e. 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

Exit Exam: Urinalysis, Coagulation and Hematology

B. Lesson Two: Review of Serology and Microbiology Procedures

1. Learning Outcomes: Upon successful completion of this lesson, the student
will be able to:

a. Successfully complete Exit exam in Urinalysis, Coagulation and
Serology with a minimum of 75 %.
b. Describe laboratory experiences from the clinical site rotation
c. Demonstrate a sense of professionalism by exhibiting the following
characteristics: attends lecture and clinical site sessions regularly
and punctually, seeks activities which further learning, admits
mistakes and takes steps to correct them, repeats procedures when test
results is in doubt, cooperates with lecture and clinical site
instructor, takes pride in laboratory medicine, complies with the
stated dress code of the student and clinical laboratory and
participates in continuing education activities.
d. Accurately perform clinical laboratory procedures as designed by
the clinical laboratory site rotation
e. 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

Exit Exam: Serology, Microbiology

C. Lesson Three: Review of Blood Bank and Clinical Chemistry Procedures

1. Learning Outcomes: Upon successful completion of this lesson, the student
will be able to:

a. Successfully complete Exit exam in Urinalysis, Coagulation and
Serology with a minimum of 75 %.
b. Describe laboratory experiences from the clinical site rotation
c. Demonstrate a sense of professionalism by exhibiting the following
characteristics: attends lecture and clinical site sessions regularly
and punctually, seeks activities which further learning, admits mistakes and takes steps to correct them, repeats procedures when test results is in doubt, cooperates with lecture and clinical site instructor, takes pride in laboratory medicine, complies with the stated dress code of the student and clinical laboratory and participates in continuing education activities.

d. Accurately perform clinical laboratory procedures as designed by the clinical laboratory site rotation

e. 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

Exit Exam: Blood Bank and Clinical Chemistry
## LECTURE SCHEDULE-CLINICAL I

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture</th>
<th>Exam</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>June 1</td>
<td>Review for UA Exit Exam</td>
<td></td>
<td>Complete the UA review and be ready to give answers in class.</td>
</tr>
<tr>
<td>2</td>
<td>June 8</td>
<td>Review for UA Exit Exam</td>
<td></td>
<td>Continue discussion of the UA review.</td>
</tr>
<tr>
<td>3</td>
<td>June 15</td>
<td>UA EXIT EXAM Review for Coag Exit Exam</td>
<td>UA EXIT EXAM</td>
<td>Start answering the review for Coag in class after the UA exit exam.</td>
</tr>
<tr>
<td>4</td>
<td>June 22</td>
<td>Review for Coag Exit Exam</td>
<td></td>
<td>Be ready for discussion of the review for Coagulation.</td>
</tr>
<tr>
<td>5</td>
<td>June 29</td>
<td>COAG EXIT EXAM Review for Hema I Exit Exam</td>
<td>COAG EXIT EXAM</td>
<td>Start answering the review for Hematology in class after the Coag exit exam.</td>
</tr>
<tr>
<td>6</td>
<td>July 6</td>
<td>Review for Hema I Exit Exam</td>
<td></td>
<td>Complete the Hema I review and be ready to give answers in class.</td>
</tr>
<tr>
<td>7</td>
<td>July 13</td>
<td>HEME EXIT EXAM I Review for Hema II Exit Exam</td>
<td>HEME EXIT EXAM I</td>
<td>Continue discussion of the review.</td>
</tr>
<tr>
<td>8</td>
<td>July 20</td>
<td>Review for Hema II Exit Exam</td>
<td></td>
<td>Start answering the review for Hema II in class after the Hema I Exam.</td>
</tr>
<tr>
<td>9</td>
<td>July 27</td>
<td>EXAM HEMA EXIT EXAM II Review for Mock BOC</td>
<td>HEME EXIT EXAM II</td>
<td>Start answering Mock BOC questions.</td>
</tr>
<tr>
<td>10</td>
<td>Aug 3</td>
<td>Mock BOC</td>
<td>MOCK BOC</td>
<td>Class will end after exams have been graded and exam has been discussed.</td>
</tr>
</tbody>
</table>

### VIII. LABORATORY SCHEDULE

To be arranged with the various clinical facilities- Tuesday through Friday starting as early as 6:00 am.
LECTURE SCHEDULE-CLINICAL II

WEEK 1-Serology Procedure
WEEK 2-Serology Procedure
WEEK 3-Serology Procedure
WEEK 4-Serology Procedure, Computer Laboratory-Immunology
WEEK 5-Serology Exit Exam I
WEEK 6-Microbiology Procedures-Staph and Strep sp.
WEEK 7-Microbiology Procedures-Continue from week 6 Neisseria and Moraxella sp.
WEEK 8-Microbiology Procedures-Enterobacteriaceae sp., Pseudomonas, Haemophilus, Vibrio’s
WEEK 9-Continue from week 8
WEEK 10-Microbiology Procedures- Campylobacter sp., Corynebacterium sp. Msc. Bacteria
WEEK 11-Microbiology exit Exam I
WEEK 12-Anaerobes, Spirochetes, Chlamydia, Mycobacterium
WEEK 13-Continue from week 12
WEEK 14-Microbiology Exit Exam II
WEEK 15-Clinical Site Evaluations

LABORATORY SCHEDULE
To be arranged with the various clinical facilities- Thursday and Friday from 6:00 am to 5:00 pm
LECTURE SCHEDULE-CLINICAL III

WEEK 1-Blood Bank Procedures

WEEK 2-Blood Bank Procedures

WEEK 3-Blood Bank Exit Exam I
   Donor Procedures and Components

WEEK 4-Continue Donor Procedures and Components

WEEK 5-Blood Bank Exit Exam II
   Clinical Chemistry – Specimen Collection Procedures

WEEK 6-Clinical Chemistry-Specimen Collection Procedures

WEEK 7-Clinical Chemistry Specimen Collection Procedure

WEEK 8-Clinical Chemistry Automation Procedures

WEEK 9-Clinical Chemistry Automation Exit Exam
   Clinical Chemistry Analysis and Disease Processes

WEEK 10-Clinical chemistry Analysis and Disease Processes

WEEK 11-Clinical Chemistry Analysis and Disease Processes

WEEK 12-Clinical Chemistry Analysis and Disease Processes
   Exit Exam

WEEK 13-Computer Laboratory-Clinical Laboratory Science Review

WEEK 14-Clinical Chemistry Analysis and Disease Processes
   Exit Exam II

WEEK 15-Clinical Site Evaluation

LABORATORY SCHEDULE

To be arranged with the various clinical facilities- Thursday and Friday from 6:00 am to 5:00 pm
CLINICAL LABORATORY OBJECTIVES
Phlebotomy, Laboratory Safety, and Specimen Handling

Objectives

1. Apply clinical phlebotomy theory.
2. Learn and practice skills by performing techniques with organization, precision, and accuracy.
3. Keep accurate quality control (QC) records, and adhere to quality control standards to assure test reliability.
4. Recognize safety and precaution labels and signs.
5. Locate safety equipment.
6. Disinfect work area.
7. Adhere to the clinical facility’s safety policies.
8. Assume responsibility for patient work and prompt response to stat request and abnormal results.
9. Learn principles of procedures selection and evaluation.
10. Demonstrate professional attitude in relationships with patients, laboratories, and other hospital personnel.
11. Observe supervisory and managerial responsibilities.
12. Communicate effectively with patients, laboratories, and other hospital personnel.
13. Recognize the significance of continued professional development by participating in professional development when available at the clinical site.

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.
Clinical Chemistry

1. Objectives

At the end of the chemistry rotation, each student should be able to complete the following task:

1. Using established laboratory specimen management criteria identify and evaluate a patient specimen as acceptable or unacceptable for chemical analyses.

2. Evaluate patient chemistry results according to established clinical chemistry laboratory, understand how quality control (QC) is monitored using multi-rules, correctly record QC data in terms of chemistry department protocol, evaluate QC records, and take appropriate corrective actions should QC values fall outside established limits. Understand the related terminology: Calibration and Standards, NIST, reference range, Levy Jennings graph, trend and shift, Beer’s law. Know characteristics of quality control.

3. Define and differentiate the following terms: quality assurance, quality control, accuracy, precision, reliability, descriptive statistics, reference interval, random error, sensitivity, specificity, systematic error, confidence intervals, standard deviation, coefficient of variation, Gaussian distribution, Six-Sigma performance.

4. Describe and evaluate the pre-analytic, analytic, post-analytical phases of quality assurance. Be able to demonstrate and differentiate carry-over, thru-put. Understand how to handle critical values.

5. Calculate percent solutions using weight per volume (w/v): g/dl, mg/dL (mg %), and percent solutions using volume per unit volume (v/v): ml/dL (%). Calculate dilutions.

Be able to do conversions: ex. from grams to milligrams, milliliters to microliters, mg/dl to mmol/L etc.

6. Calculate the following: sensitivity, specificity, efficiency, predictive value, mean, medium, mode, range, coefficient of variation, and standard deviation.

7. Classify the type of pipet (TD, TC) when given an actual pipet or its description. Describe two ways of calibrating a pipetting device.

8. Discuss safety awareness for clinical laboratory personnel and identify agencies that regulate safety in the laboratory. Identify and demonstrate the various types of safety equipment available in the student laboratory. Identify hazards relating to chemicals, biologic specimens, and radiologic materials. Identify the classes of fires and the type of fire extinguishers to use for each.

9. For each chemistry instrument used to perform chemical analyses, identify
the primary operating components; explain the function of each component, and advantages and disadvantages of each methodology.

10. For each chemistry instrument or piece of equipment used, explain and demonstrate competency of use by:
   a. Describing the reagent(s) used, including reagent blanks if necessary
   b. Describing reagent function(s)
   c. Demonstrating reagent handling
   d. Demonstrating sample processing for chemical analyses
   e. Programming or calibrating the instrument or equipment
   f. Producing valid patient results

11. Validate instrument performance through calibration, performance checks and quality control.

12. Perform basic troubleshooting on each chemistry instrument and preventive maintenance.

13. Perform the chemical analyses of cerebrospinal fluid (CSF) and other fluids (including plasma and serum), evaluate the results, and correlate the results with patient medical conditions.

14. Evaluate the chemical principles underlying the following special chemistry procedures, explain the reagents used, identify and special sample types, reagent requirements, or handling procedures to be used, identify the appropriateness of ordering the test(s), and the pathophysiological significance of results obtained using these chemical testing procedures:
   a. Electrophoresis
   b. Fluorometer
   c. EIA
   d. Electrochemistry
   e. Turbidimetry
   f. Radioimmunoassay
   g. Immunoassay
   h. Atomic Absorption Spectrophotometer
   i. Scintillation counter
   j. Colorimetry
   k. Nephelometry
   l. Potentiometry
   m. pH meter
   n. Ion-selective electrodes
   o. Freezing Point Depression
   p. Chromatography
   q. Sweat electrolyte
   r. Amniocentesis fluid analysis
   s. Blood Gas Instruments
   t. Automated discrete analyzer
   u. Continuous flow analyzer
   v. POC
15. Evaluate the clinical usefulness of underlying chemistry profiles/assays/categories, identify the chemical tests composing the following profiles/assays, describe methodologies for each, proper specimen collection, perform these profiles/assays, and discuss/evaluate the pathophysiological significance of performing the following profiles/assays, define their physiology, metabolism and function, signs and symptoms, and relate their clinical significance, and correlation in diagnosing disease, toxic states, as well as knowing reference, normal ranges for each:
   a. Liver
   b. Carbohydrates, including differentiation of types of diabetes, mode of action or effects of hormones on metabolism and glucose values, Hemoglobin (Hgb) A1C testing
   c. Lipids and Lipoproteins
   d. Cardiac, including risk factors
   e. Amino Acids
   f. Proteins
   g. Enzymes: fixed time vs. kinetic methods, isoenzymes
   h. Hormones
   i. Renal function-including assessing and calculating of 24 hour urine specimens, and differentiation between prerenal, renal, and post renal phases and testing
   j. Iron studies including total iron-binding capacity (TIBC), % saturation (iron), ferritin, transferrin
   k. Trace Elements
   l. Porphyrins and Hemoglobin
   m. Endocrine studies (e.g., thyroid profiles, free thyroxine index)
   n. Non-Protein Nitrogen Compounds, including Blood urea nitrogen (BUN), creatinine,
   o. Electrolytes, include calculation for anion gap
   p. Acid-Base Balance: (metabolic acidosis and alkalosis, respiratory acidosis and alkalosis-how to compensate); Blood Gases
   q. Pancreatic and Gastrin
   r. Therapeutic Drug Monitoring
   s. Toxicology, including Chain of Command
   t. Body Fluid Analysis, including Fetal monitoring, and Lecithin/sphingomyelin (L/S) ratio
   u. Tumor Markers
   v. Nutritional Assessment, including vitamins

16. Under supervision, utilizing the LIS (if available), know how to report test results to the physician.

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 may be covered on Exams.
Hematology Rotation

1. Objectives:
At the end of the hematology rotation, each student should be able to complete the following tasks:

1. Using established criteria including collection sites based on age or disease, identify and evaluate patient specimens for acceptability, and take necessary actions if specimens are unacceptable.
2. Evaluate how quality control (QC) is monitored for the different procedures and instrumentation in the hematology laboratory, correctly record QC data in terms of hematology department protocol, evaluate QC records, and take appropriate corrective actions should QC values fall outside established limits.
3. Know how to calculate SD
4. Operate each piece of hematology instrumentation, producing accurate patient and QC results. Be able to recognize irregularities on any of these results.
5. Locate and explain the major components and functions of each piece of hematology and coagulation instrumentation and the blood parameters or values that each provides.
6. Validate instrument performance through calibration, performance checks and quality control.
7. Perform basic troubleshooting on each instrument and preventive maintenance.
8. Recognize each parameter of a complete blood count.
9. Perform a complete slide differential on a Wright’s-stained blood smear, and correctly identify any abnormal white blood cell or maturation stage, as well as all forms of abnormal red blood cell morphology.
10. Perform and evaluate an abnormal blood smear differential, and recognize possible pathological relationships of the abnormal cell type. Recognize a shift to the left and its significance.
11. Recognize histogram results, and what interferences can affect actual results.
12. Be able to troubleshoot Wright-stained blood smears, and remedy any problems.
13. Be able to identify inclusion bodies. If required, know measures to confirm diagnosis.
14. Given CBC data, be able to calculate a total lymphocyte count, absolute eosinophil count. Know formula for an absolute cell count.
15. Identify, compare, and contrast diseases, abnormalities based on CBC, cell indices, platelets, blood smears and other lab results.
16. Evaluate cell histograms, and predict pathophysiology; and explain the principle of test, the reagents involved, and the proper interpretation of results:
   a. Osmotic fragility
   b. Pyruvate kinase screen
   c. G-6-PD
   d. Sickle cell preps
   e. Test for abnormal hemoglobin
17. List the principle of the erythrocyte sedimentation rate and factors that might interfere with an accurate result.

MLAB 2460, 2461 2462
18. Correctly perform an erythrocyte sedimentation rate and factors that might interfere with an accurate result.
19. Determine diagnosis based on results of Schilling test.
20. Use criteria to be able to differentiate and diagnose platelet disorders.
21. Stain and count a blood specimen for reticulocytes.
22. Perform and explain the various procedures and calculations for the following manual cell counts:
   a. Platelets
   b. Eosinophil
23. List the principles of the procedures, the reagents used, and the pathophysiological significance of the following coagulation tests:
   a. PT
   b. APTT
   c. TT
   d. Quantitative fibrinogen
   e. Fibrin-split products
   f. D-dimer
   g. Factor assays
   h. PLT aggregation
   i. Lupus anticoagulant
   j. Chromogenic
24. Accurately perform the 10 procedures listed above; correctly evaluate the control and patient values. (This task may not be required at all affiliated sites.)
25. Evaluate the pathophysiological significance of results obtained when performing procedures in hematology and coagulation.
26. Under supervision, utilizing the LIS, report test results to the physician.
27. Perform and evaluate an abnormal blood smear differential, and recognize possible pathological relationships of the abnormal cell type.
28. Evaluate cell histograms, and predict pathophysiology; and explain the principle of test, the reagents involved, and the proper interpretation of results: osmotic fragility, pyruvate kinase screen, G-6-PD, Sickle Cell Preps, and Test for abnormal hemoglobin.
29. List the principle of the erythrocyte sedimentation rate and factors that might interfere with an accurate result.
30. 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.
31. 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.
32. Interpret RDW results.
33. Correlate CBC results with findings on a blood smear and troubleshoot discrepancies. Evaluate hemoglobin and Hematocrit using the “rule of three.”
34. Explain the difference between absolute and relative leukocytosis and list diseases causing changes from normal.
35. Compare and contrast the epidemiology, disease, 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.

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

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

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

39. 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, clot lysis.

40. 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.

41. Compare the morphologic and functional classification of anemia.

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

43. 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.

44. Differentiate WBC using staining methods and use information to classify leukemia.

**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.
Urinalysis

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

1. State the primary function of the kidney
2. List and describe the basic anatomy of the renal system including the kidney, nephron, glomerulus, proximal tubule, loop of Henle, efferent and afferent arteriole, ureter, bladder, and urethra.
3. Discuss the urine components, urea and Creatinine as they relate to urine formation and glomerular filtration rate.
4. Describe the proper procedures for collecting the following urine specimens: random voided, midstream clean catch, first morning voided, 2 hour post prandial, and 24 hour urine collection. Explain diagnostic use of each.
5. Instruct patients/health care providers in the proper procedure for the collection of urine specimens
6. Differentiate urine specimen types
7. Evaluate acceptability of urine specimens
8. Determine if collection technique and specimen container is appropriate
9. Describe the factors that affect urine volume
10. Store specimens appropriately for testing
11. Explain the importance of using quality control
12. Perform and evaluate QC results. Identify and take corrective action when QC is not within predetermined limits
13. Prepare microscopic examination of urine specimens
14. Utilize physical and chemical means to evaluate a normal/or an abnormal urinalysis:
   a) Observe and record color, clarity, odor, and volume
   b) Perform and record qualitative/semi-quantitative reagent strip chemical tests
   c) Evaluate and correlate the results of macroscopic and microscopic urinalysis. Correlate values with given disease states, diagnosis, and treatment
15. Identify normal and abnormal cellular and formed elements in urine specimens. Identify crystals and indicate the pH at which they occur.
16. Evaluate specimens and determine integrity and appropriateness for specific tests required. Predict physical changes that occur when a specimen is incorrectly stored.
17. Explain the principle of each urine chemical test routinely performed by reagent strip method.
18. At the conclusion of this lecture series, the student 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.

Learning Activities: Methods of Teaching and Learning

MLAB 2460, 2461 2462
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.
Coagulation

**Hemostasis (McKenzie Ch. 29-33, 40)**

1. Distinguish the events that occur in primary hemostasis from those that occur in secondary hemostasis.
2. Describe the normal morphology and number of platelets on a peripheral blood smear and state the normal concentration in the blood.
3. Identify and define the steps in the normal sequence of events of platelet activation following injury to the endothelium.
4. 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.
5. Classify the coagulation factors into groups and discuss their characteristics.
6. Describe the mechanism of action of the coagulation proteins.
7. Explain the sequence of reactions and components in the coagulation cascade according to the historic concepts of intrinsic, extrinsic, and common pathways, and screening tests associated with each.
8. 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.
9. Define factor inhibitors and list characteristics of antithrombin and factor VIII inhibitor.
10. Cite the electrical impedance principle and the principles of light scatter for counting platelets.
11. Perform a platelet estimate and relate the usefulness of the result.
12. 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.
13. State the electromechanical principle of clot detection, and identify instruments that use this technology.
14. State the photo-optical principle of clot detection, identify instruments that use this technology and perform protime and activated partial thromboplastin time on patients and controls using this technology.
15. Describe special precautions to take regarding specimen collection and processing for platelet evaluation and coagulation studies, and determine specimen appropriateness.
16. 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.
17. 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.
18. Identify the appropriate laboratory procedure for monitoring heparin therapy and oral anticoagulant therapy.
19. 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.
20. 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), and associate results with diseases/deficiencies.

21. 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.

22. 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.

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

24. 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.

25. Compare and contrast the expected results of laboratory screening tests that detect abnormalities of the proteins of hemostasis.

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

27. Describe the role of heparin in the neutralization of activated coagulation factors by antithrombin.

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

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

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.

**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.
Immunohematology Rotation

Objectives
At the end of the immunohematology rotation, the student should be able to complete the following tasks:

1. Prepare a 2%, 5%, and 10% RBC suspension preparation
2. Reading and grading agglutination reactions and hemolysis
3. Evaluate the pathophysiological significance of results obtained when performing blood bank testing
4. ABO blood grouping (forward typing and reverse typing)
5. ABO discrepancy resolution
6. Rh₀ (Du) typing
7. Weak D (Du) typing
8. Direct and indirect antiglobulin tests
9. Prenatal testing on obstetrical patients
10. Postnatal testing (required if HDN is suspected)
11. Grouping, screening, and holding
12. Compatibility testing and antigen typing
13. Antibody identification, including the use of enhancement, absorption, elution, and neutralization techniques
14. Preparation of blood and blood components needed for infusion into adults and infants
15. Issuing of blood components, and RhIG
16. List how quality control (QC) is monitored for the different procedures and instruments in Immunohematology, correctly record QC data in terms of standard blood bank protocol, evaluate QC records, and take appropriate corrective actions should QC values fall outside established limits
17. Validate instrument performance through calibration, performance checks, and quality control.
18. Perform basic troubleshooting on each instrument and preventive maintenance
19. Under supervision, utilizing the LIS, report test to the physician.

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 may be covered on Exams.
Immunology and Serology Rotation

At the end of the immunology and serology rotation, the student should be able to complete the following task:

20. List how quality control (QC) is monitored for the different procedures and instruments in the immunology and serology laboratory; correctly record QC data in terms of department protocol, evaluate QC records, and take appropriate corrective actions should QC values fall outside established limits.

21. Perform immunology and serology assays using a variety of techniques (e.g., latex agglutination, precipitation, EIA, ELISA, enzyme inhibition, nephelometry, immunofluorescence where appropriate).

22. Validate instrument performance through calibration, performance checks and quality control.

23. Perform basic troubleshooting on instrument and preventive maintenance.

24. Under supervision, utilizing the LIS, report test results to the physician.

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 may be covered on Exams.
Microbiology Rotation

Objectives

At the end of the microbiology rotation, the student should be able to complete the following task:

1. List how to monitor quality control (QC) for the different procedures (media, bacterial identification, biochemical tests, etc.) and instruments in the microbiology laboratory; correctly record QC data in terms of department protocol, evaluate QC records, and take appropriate corrective actions should QC values fall outside established limits. Know which organisms need to be kept as stock QC cultures.

2. Recognize the colony characteristics of pathogens and normal flora from the various body-site specimens submitted for microbiological analysis.

3. Identify significant isolates from specimens, using the appropriate laboratory protocols. Under supervision, correctly report these results to the physician.

4. Examine types of specimens received in the microbiology laboratory to determine acceptability. Know collection and handling criteria for each specimen type.

5. Utilize proper safety procedures and equipment in the microbiology laboratory.

6. Differentiate proper sterilization, disinfection, and aseptic techniques.

7. Determine specific storage conditions for specimens prior to inoculation on appropriate media.

8. Select the media to be used, and perform proper inoculation and isolation procedures for specimens submitted for analysis. Compare and contrast media and its characteristics used in initial inoculation of specimens.

9. Demonstrate the correct procedure used in inoculating plate media, and its incubation. Discuss factors that will affect the viability and strength of the agar media.

10. Describe the gram stain principle used in the identification of bacteria. Understand each part. Interpret results and select appropriate media to isolate organisms (based on source of sample).

11. Perform the various staining procedures (e.g., Gram, acridine orange, fluorochrome, acid-fast, trichrome, India ink, Kenyon where appropriate), and correctly interpret the results.

12. Define taxonomy used in classifying bacteria. Match nickname of bacteria to scientific name.


14. Define physiological classification with regard to staining characteristics and biochemical reactions.

15. List the factors affecting bacterial growth with regard to nutrition and environment. Classify organisms based on optimal temperature, nutrition for growth. Differentiate obligate anaerobes, facultative anaerobes, microaerophilus, obligate aerobe, capnophilic bacteria.

16. Identify gram negative and gram positive cocci, bacilli, and coccobacillary terms on a gram stain and prepared smears. Correlate values with given disease states, diagnosis, and treatment.

17. Explain the need for sensitivity testing of bacteria.

MLAB 2460, 2461 2462
18. Discuss and define normal flora.
19. Perform a colony count, and know criteria to set up a culture.
20. Demonstrate the procedure for collecting a throat swab and performing a throat culture. Identify Streptococcus pyogenes using a Bacitracin disk.
21. List the major types of nosocomial infections and describe how such infections are acquired.
22. List tests to differentiate Staphylococcus and Streptococcus species.
23. Differentiate strains of Staphylococcus based on growth characteristics on media, coagulase testing. Discuss differences between tube and slide coagulase testing.
24. Differentiate Staphylococcus from Micrococcus species.
25. List the extracellular products produced by Staph aureus.
26. Discuss virulence factors.
27. Differentiate Staph. saprophyticus from other coagulase-negative Staphylococcus.
28. List the extracellular products produced by Strep pyogenes that enhance their virulence, and be able to differentiate Group A Streptococcus from other species of streptococcus.
29. Discuss and differentiate etiologic agents, biochemical tests associated with different diseases of Staphylococcus and Streptococcus.
30. Differentiate Strep pneumoniae from viridans strep. by colony morphology, optochin disk, hematology and chemistry tests, etc.
31. List different alpha hemolytic streptococcus.
32. Discuss testing to differentiate Enterococcus from non-enterococcus including concentration of sodium chloride.
33. List specific patterns of resistance to antimicrobial and current treatment for Staph, Strep. Describe the factors that are considered in the selection of an antimicrobial agent.
34. Predict what organisms are likely to cause urinary tract infections.
35. Describe the different types of urine specimens received in the lab and proper collections and storage methods.
36. List characteristics of Neisseria gonorrhoeae, meningitidis and Moraxella sp. Describe colony morphology, culture media, incubation temperature and growth factors for each. List immunoserological identification to differentiate Neisseria species.
37. Compare and contrast collection, transport, and culture techniques for Neisseria and Moraxella.
39. Explain factors that affect results of disk diffusion.
40. Describe reactions involved and products of metabolism in the biochemical tests, including TSI agar, indole test, bile solubility, CAMP, MRVP, nitrate reduction, citrate utilization, urease production, phenylalanine deaminase, decarboxylase test, lysine test, motility, ONPG. Understand false-positive, false-negative, and interferences of
each to be able to differentiate different bacteria.

41. Differentiate Pseudomonas aeruginosa from other fluorescent Pseudomonads by Morphology, biochemical tests, diseases.

42. Discuss O-F medium of High and Leifson to determine an unknown isolate(s) method of attack on glucose. Be able to list which organisms do not produce an acid reaction in O-F medium after 18-24 hours of inoculation.

43. Know characteristics of Chrysebacterium meningosepticum related to disease.

44. Determine appropriate blood to broth ratio for collection of blood cultures. Discuss collection techniques.

45. Summarize colonial similarities in Pasteurella and similar organisms, and recommend tests to help differentiate among the pathogens. Discuss their etiology.

46. Differentiate different species of Bacillus by characteristics, morphology, disease association.

47. Compare and contrast Bacillus and Clostridium.

48. Differentiate Klebsiella, Salmonella, Shigella, E. coli, Citrobacter, Campylobacter, Vibrio, Brucella species: cultures requirements, biochemical reactions, characteristics, diseases of each

49. Discuss organisms associated with enteric fever.

50. Differentiate species characteristics (media choices, etc.) of Haemophilus, Legionella and associated diseases.

51. Differentiate species, characteristics of Clostridium as well as from Pseudomonas, Peptostreptococcus, Stenotrophomonas, and Actinobacter. Know any diseases associated with above.

52. Differentiate Fusobacterium species from Bacteriodes species.

53. Differentiate species of Mycobacterium to include specimen of choice, media requirements, diseases, treatment.

54. Differentiate species of Corynebacterium to discuss colony morphology, characteristics

55. Demonstrate and explain rationale for special considerations associated with specimen collection and transport for anaerobic specimens, as well as knowing etiology.

56. Demonstrate appropriate specimen processing for anaerobic bacteria, including use of anaerobe jars or pouches, anaerobic chamber.

57. Define: hemolysis, lyophilization, exotoxin, halophilic, hyaluronidase

**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.