



Course Syllabus

MLAB 2401 -Clinical Chemistry

Catalog Description: An introduction to the principles, procedures, physiological basis, and significance of testing performed in Clinical Chemistry. Includes quality control, reference values, and safety.

Lecture hours = 4, Lab hours = 1

Prerequisites: Enrollment in this course and the Medical Laboratory Technology Program requires department head approval and successful completion of the admissions process. Students must be accepted into the MLT program.

Semester Credit Hours: 4

Lecture Hours per Week: 4

Lab Hours per Week: 1

Contact Hours per Semester: 128

State Approval Code: 5110040000

Instructional Goals and Purposes: The purpose of this course is to provide basic understanding of medical laboratory clinical chemistry from the sophomore level MLT. Students are reintroduced to safety and quality control procedures covered in previous MLAB and PLAB courses.

Learning Outcomes:

1. Apply principles of safety, quality assurance and quality control in Clinical Chemistry.
2. Evaluate specimen acceptability for chemical analysis.
3. Compare and contrast human body chemistry levels under normal and abnormal conditions
4. Explain, perform and evaluate clinical chemistry procedures and correlate test results with patient conditions.

Specific Course Objectives (includes SCANS):

After studying all materials and resources presented in the course, the student will be able to:

1. Chapter 1-Laboratory Basics

(1a-iii, b-ii, iii, iv, v, vi. 2a-i,ii,iii. 2c-i, iii..)

- a. Identify two methods used to produce clinical laboratory-grade water for use in the clinical laboratory.
- b. List three items that should be monitored during the water-purification process.
- c. Identify four types of glassware available for laboratory use.
- d. Identify four types of plastics used in laboratory plasticware.
- e. Define the following terms: to contain (TC) and to deliver (TD) in reference to types of pipettes, molarity, molality, normality, thermocouple, percent solution, and hydrates.
- f. Cite three types of balances used to weigh substances in the laboratory.
- g. Complete the mathematical calculations presented in this chapter correctly.
- h. Convert results from one unit format to another.
- i. Calculate the volumes required to prepare a 1:2, 1:5, and 1:10 dilution.

2. Chapter 2- Safety in the Clinical Chemistry Laboratory

(1a-i,ii, b-ii,iv,v, 2c-i,iii, d-i.)

- a. Provide the correct words that correspond to the following abbreviations: OSHA, SDS, NFPA, HEPA, RACE, PASS, and CFR.
- b. Identify the source of the OSHA standards.
- c. List several responsibilities of employers and employees in maintaining a safe work environment.
- d. Identify the classes of fires and the appropriate type of fire extinguisher to use.
- e. List five important safety procedures to follow when handling electrical equipment.
- f. Identify three hazards related to handling biological specimens.
- g. List five examples of personal protective equipment (PPE) and engineered controls used to protect laboratory staff.
- h. Define teratogens, carcinogens, and transplacental carcinogenesis.
- i. List five examples of risk factors for cumulative trauma disorders.
- j. Identify elements of an exposure control plan.
- k. Describe the purpose of a chemical hygiene plan.
- l. Explain the proper way to store compressed gas cylinders and what may happen if the cylinders fall to the floor.
- m. Identify three types of waste generated by a clinical laboratory and identify an agency that may provide information on safe disposal.
- n. Discuss the significant aspects of selected workplace safety issues.
- o. List five examples of potentially infectious body fluids and provide examples of what contaminants may be present.
- p. Identify equipment in a laboratory and administrative areas that may emit harmful radiation.

3. Chapter 3- Laboratory Statistics, Method Development, and Quality Control

(1a-i,ii, 1b-ii, iv, 2c-iii, d-i.)

- a. Compare and contrast descriptive statistics and inferential statistics.
- b. Explain a Gaussian distribution.
- c. Define accuracy and precision.
- d. Identify three types of errors.
- e. Identify five factors to consider when selecting quality-control material.
- f. Explain the characteristics of a Levey–Jennings chart and include x- and y-axis labels.
- g. Explain each Westgard rule violation.
- h. Characterize proportional and systematic error.

4. Chapter 4- Instrumentation, Laboratory Automation, and Informatics

(1a-i, ii, b-i, ii, v, 2c-i, iii)

- a. Identify two physical properties of light.
- b. Define the following wave parameters: amplitude, period, and frequency.
- c. Define the factors that characterize the energy of a photon.
- d. Identify three types of light scatter.
- e. List several major instrument components for the following analyzers:
- f. Spectrophotometer
 - i. Fluorometer
 - ii. Nephelometer
 - iii. Mass spectrometer
 - iv. Gas chromatograph
 - v. Densitometer
- g. Identify the significant regions of the electromagnetic spectrum (EMS) from lowest energy to highest energy levels.
- h. List four spectrophotometric function checks.
- i. Define the following terms associated with electrochemical methods: potentiometer, amperometry, colometry, conductance, resistivity, and voltammetry.
- j. Write the Nernst equation.
- k. Write the chemical reactions for the PO₂ and PCO₂ electrode.
- l. Identify four examples of separation techniques used in the clinical laboratory.

- m. List four examples of transducers used in biosensor devices.
- n. Identify three factors that affect chromatographic resolution.
- o. Define the following terms: diffuse reflection, retention time, R_f, fluorescence, and chemiluminescence.
- p. Identify four colligative properties of solutions.
- q. Identify specific analyte(s) that are measured by each device or instrument.
- r. List four advantages of automated chemical analysis.
- s. Define the following terms: throughput, test menu, carryover, discrete testing, random-access testing, open-reagent analyzer, and closed-reagent analyzer.
- t. Identify five laboratory tasks associated with the preanalytical stages of laboratory testing.
- u. Identify three reasons why automation is necessary.
- v. Give examples of how an automated analyzer performs the following functions:
 - i. mixing
 - ii. incubating
 - iii. transferring reagents
- w. List four tasks associated with the analytical stage of laboratory testing.
- x. Identify five demands placed on the laboratory that serve to drive automation.
- y. List three techniques used to mix samples and reagents in an automated system.
- z. Identify three techniques used to incubate samples and reagents.
- aa. List three drawbacks of total laboratory automation.
- bb. Identify three tasks associated with the postanalytical stage of laboratory testing.
- cc. State the two items required to interface computers.
- dd. State two ways of entering laboratory data into a computer.

5. Chapter 5- Immunoassays

(1a-i, ii, v, b-v, 2c-i, iii)

- a. Explain the fundamental differences among enzyme immunoassays, fluorescent immunoassays, and chemiluminescent immunoassays.
- b. Identify five specific examples of labels used in immunoassays.
- c. Identify five specific examples of solid-phase material used to bind antibodies.
- d. Identify three advantages of monoclonal antibodies used in immunoassay systems.
- e. Define the terms antigen, antibody, immunogen, and hapten.

6. Chapter 6- Molecular Diagnostics

(1a-i, ii, b-i, ii, v, 2c-i, iii)

- a. List the three components of a nucleotide.
- b. Describe the basic steps of transcription and translation.
- c. Using absorbance values, calculate the DNA purity and yield of a sample.
- d. Discuss the basic principles of gel electrophoresis of DNA.
- e. Define the basic principles of restriction endonucleases.
- f. Determine the melting temperature of a short DNA sequence.
- g. Explain the basic principles of the following techniques: liquid-phase hybridization, in situ hybridization, fluorescent in situ hybridization (FISH), Western blot, traditional polymerase chain reaction (PCR), real-time qPCR, and the Sanger method of DNA sequencing.
- h. List clinical applications of the methods mentioned in objective 7.

7. Chapter 7- Carbohydrates

(1a-i, ii, b-i, ii, v, 2c-i, iii)

- a. List and define the major classes of carbohydrates and give examples of each.
- b. Recognize the structure of the common stereoisomers of carbohydrates.
- c. Review the digestion of carbohydrates from the role of salivary amylase to the final CO₂ and H₂O. Define the most common terms associated with carbohydrate metabolism.
- d. Briefly summarize the three major biochemical pathways associated with carbohydrate metabolism.
- e. List the various hormones that affect carbohydrate metabolism and summarize their functions (gland and action).
- f. Compare and contrast the main characteristics of the two major types of diabetes mellitus (DM) (type 1 and type 2).
- g. Review other carbohydrate disorders, including

- i. Gestational diabetes
 - ii. Other types of diabetes (secondary diabetes mellitus)
 - iii. Impaired glucose tolerance
- h. List and explain the changes that occur in the body with hyperglycemia (complications of DM).
- i. List the American Diabetes Association criteria for the diagnosis of DM, impaired glucose tolerance, and impaired fasting glucose.
- j. Define hypoglycemia and discuss the common causes of drug-induced, reactive, and fasting hypoglycemia.
- k. List the three factors in Whipple's triad.
- l. Summarize the common enzymatic glucose methodologies: glucose oxidase and hexokinase.
- m. Review urine and cerebrospinal fluid glucose clinical significance and methodologies.

8. Chapter 8- Lipids and Lipoproteins

(1a-i, ii, v, b-i, ii, v, vi, c-ii, iii, v. 2c-i, ii, iii)

- a. Review cholesterol metabolism, absorption, synthesis, and catabolism.
- b. Outline and describe classes of clinically significant lipids.
- c. Define unsaturated and saturated fatty acids.
- d. List and explain the role of the major apolipoproteins.
- e. Summarize lipid metabolism, including exogenous, endogenous, and reverse cholesterol pathways.
- f. List the major components and the percentage composition of the major lipoproteins—for example, apoproteins, cholesterol, and triglycerides.
- g. Review the four major lipoproteins and their density and function.
- h. List conditions associated with hypercholesterolemia and hypocholesterolemia.
- i. Summarize the major cholesterol methodologies.
- j. Identify causes of hypertriglyceridemia and hypotriglyceridemia.
- k. Review triglyceride methodologies.
- l. Summarize HDL-C methodologies.
- m. Calculate LDL-C using the Friedewald formula.
- n. Examine Lipoprotein (a) [Lp(a)] and its clinical significance.

9. Chapter 9- Amino Acids and Proteins

(1a-i, ii, b-i, ii, v. 2c-i, iii)

- a. Describe protein structure.
- b. List the major functions of protein.
- c. Discuss clinically significant proteins, including function, clinical significance, and protein band in electrophoresis.
- d. Discuss causes of hyperproteinemia.
- e. Discuss causes of hypoproteinemia.
- f. Explain the principle of major protein methodologies.
- g. Describe urinary protein screening, clinical significance, and methodologies.
- h. Describe cerebrospinal fluid protein, clinical significance, and methodologies.
 - i. List major functions of albumin.
 - j. List causes of hypoalbuminemia.
 - k. Discuss the major cause of hyperalbuminemia: dehydration.
 - l. Explain major albumin methodologies.
- m. Discuss the major components of protein electrophoresis.
- n. List in order the protein electrophoresis bands and approximate percentages of total protein.
- o. Explain changes in the protein electrophoresis associated with the more common causes of abnormal patterns.
- p. Calculate A/G ratio.

10. Chapter 10- Enzymes

(1a-ii, iii, b-iii. 2c-i, ii, iii)

- a. Define enzyme and list general functions of enzymes.
- b. Write the formula for enzyme-catalyzed reactions.

- c. List the six major groups of enzymes and the reactions catalyzed by each group.
- d. Review enzyme catalysis, including the role of enzymes in decreasing activation energy.
- e. Define apoenzyme, prosthetic groups, and holoenzyme.
- f. Define cofactor, coenzyme, and metalloenzyme and give examples of each.
- g. Interpret the formula $Q = K \times E \times t$ and define first-order and zero-order reactions.
- h. Explain how various factors affect enzyme reactions—for example, pH, temperature, and substrate concentration.
- i. Examine the differences among competitive, noncompetitive, and uncompetitive inhibition.
- j. Summarize the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for the following cardiac enzymes: creatine kinase (CK), creatine kinase isoenzymes, and lactate dehydrogenase (LD).
- k. Review the clinical significance of the three major CK isoenzymes (heart, muscle, and brain), including their dimeric composition and major sources.
- l. Identify a normal CK isoenzyme pattern and the typical pattern following a myocardial infarction (MI).
- m. Briefly examine other CK isoenzyme procedures—for example, electrophoresis and immunoinhibition.
- n. Summarize the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for the following liver enzymes: aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatases (ALP).
- o. Differentiate the five major LD isoenzymes, including their tetrameric composition and the major tissue(s) involved.
- p. Summarize the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for the following biliary tract enzymes: gammaglutamyl transferase (GGT) and 5'-nucleotidase (5'-NT).
- q. Relate the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for the following pancreatic and liver enzymes: amylase (AMY), lipase (LPS), trypsin (TRY), and chymotrypsin (CHY).

11. Chapter 11- Nonprotein Nitrogen and Renal Function

(1a-ii, iii, b-iii. 2c-i, ii, iii)

- a. List and briefly describe the major parts of the urinary system.
- b. Trace the ultrafiltrate (urine) flow through the major parts of the nephron.
- c. Trace the blood flow in the kidney from the renal artery to the renal vein.
- d. Summarize the three major renal processes; glomerular filtration, tubular reabsorption, and tubular secretion, including where they occur in the nephron and constituents involved.
- e. Explain the difference between active transport and passive transport in relation to renal concentration.
- f. List the major components of nonprotein nitrogen (NPN).
- g. Identify the source of blood urea nitrogen (BUN) and the major organ of the urea cycle.
- h. Review the most common BUN methodologies including chemical reactions and specificity.
- i. State the reference range for BUN.
- j. Convert BUN to urea and urea to BUN.
- k. Define azotemia and uremia.
- l. Outline common causes of prerenal, renal, and postrenal azotemia.
- m. Identify causes of a decreased BUN.
- n. Explain the source of creatinine (CR).
- o. Review the Jaffe reaction and creatinase procedures.
- p. Cite the reference range for creatinine.
- q. Classify sources of increased creatinine.
- r. Calculate the BUN:CR ratio and discuss its clinical significance.
- s. Summarize the formation and excretion of uric acid.
- t. Review the major uric acid methodologies.
- u. Explain primary hyperuricemia (gout), including causes (precipitating factors) and treatment.
- v. Outline causes of secondary hyperuricemia.

- w. Review the renal clearance tests, including creatinine, the protein:creatinine ratio, and inulin clearance.
- x. Calculate a creatinine clearance given the relevant data.
- y. Summarize the etiology and clinically significant laboratory findings of major renal diseases.

12. Chapter 12

(1b-ii, iv. 2c-iii, d-i.)

- a. List examples of electrolytes found in plasma water, interstitial fluid, and intracellular water.
- b. Identify the analytes required to calculate anion gap and osmolality.
- c. State the specific fluid compartments that make up total body water.
- d. Distinguish between serum and plasma.
- e. State the principle differences between interstitial fluid and plasma.
- f. List five examples of body fluids that are assayed for electrolyte composition.
- g. Select the electrolyte associated with each of the following:
 - h. major intracellular cation
 - i. major extracellular cation
 - j. major extracellular anion
- k. Identify four methods used to measure chloride in sweat.
- l. Identify methods and instrument techniques used to measure electrolytes in body fluids.
- m. Name the four colligative properties of solutions.

13. Chapter 13- Blood Gases, pH, and Acid–Base Balance

(1b-ii, iv. 2c-iii, d-i.)

- a. State the Henderson–Hasselbalch equation and identify the respiratory and metabolic components.
- b. Calculate various blood gas parameters given the appropriate equation(s).
- c. Identify the four major body buffer systems.
- d. Identify the five ways in which carbon dioxide is carried in blood.
- e. Identify appropriate calibration materials to use for pH, PCO₂, and PO₂ measurements.
- f. Describe the proper control material to use for blood pH, PCO₂, and PO₂ measurements.
- g. Identify preanalytical sources of errors in blood-gas analysis.
- h. Identify the specimen of choice discuss the proper handling of specimen for blood-gas analysis

14. Chapter 14- Mineral and Bone Metabolism

(1a-i, ii, v, b-v. 2c-i, iii. d-i)

- a. Identify three forms of calcium as they exist in circulation.
- b. List three distinct methods for measuring total serum calcium.
- c. Identify two chemical compounds used to measure inorganic phosphate in serum.
- d. Identify three compounds used to measure magnesium in serum.
- e. Identify two main causes of hypercalcemia.
- f. Indicate the source of parathyroid hormone.
- g. Discuss the feedback effects of PTH on calcium and phosphorus levels in circulation.
- h. List three functions of vitamin D in humans.
- i. Describe the structure, tissue source(s), and function of calcitonin.
- j. Identify biochemical markers specific for bone formation and resorption.
- k. List several methods used to measure biochemical markers for bone.

15. Chapter 15- The Endocrine System

(1b-ii, iv. 2c-iii, d-i.)

- a. Identify three major types of hormones.
- b. State which of the three classes of hormones characterizes the following compounds:
 - i. thyroxine
 - ii. cortisol
 - iii. parathyroid hormone
 - iv. epinephrine
 - v. estrogen
- c. Define negative feedback.
- d. List five examples of hormones found in the anterior pituitary gland.
- e. List two examples of hormones found in the posterior pituitary gland.

- f. Know the location of the thyroid gland, adrenal glands, pituitary, and hypothalamus.
- g. Identify the hormones released by the thyroid gland.
- h. Identify the mineralocorticoids and the glucocorticoids.
- i. Identify the hormones produced by the adrenal medulla.
- j. List example(s) of target tissues for each of the following hormones:
 - i. thyroxine
 - ii. prolactin
 - iii. testosterone
 - iv. antidiuretic hormone
 - v. oxytocin
 - vi. growth hormone
 - vii. aldosterone
 - viii. cortisol
 - ix. epinephrine
 - x. luteinizing hormone
- k. Associate abnormal laboratory results with a disease or syndrome.
- l. Know the functions of the hormones presented.
- m. State the methods used to quantitate the amount of hormones in blood.

16. Chapter 16- Gastrointestinal Function

(1a-i, ii, v, b-v. 2c-i, iii)

- a. Review the gross anatomy of the gastrointestinal (GI) tract from the mouth to the anus.
- b. Outline the functions of each significant component of the GI tract.
- c. Identify three examples of GI regulatory peptides.
- d. Define the following terms: peptic ulcer, gastrinoma, and protein-losing enteropathy.
- e. Explain the principal pathological condition associated with each of the following GI tract disorders: Zollinger–Ellison’s syndrome, peptic ulcer, celiac disease, protein-losing enteropathy, lactase deficiency, and carcinoid tumors.
- f. Identify five nonclinical laboratory diagnostic tests or procedures used to assess patients with disorders of the GI tract.

17. Chapter 17- Pancreas

(1a-i, ii, v, b-v. 2c-i, iii)

- a. Review the location and anatomy of the pancreas.
- b. Identify the islets of Langerhans and the major cells found in the islets of Langerhans.
- c. Summarize the endocrine and exocrine functions of the pancreas.
- d. Explain the major invasive test for assessing exocrine pancreatic function secretin–cholecystokinin (CCK).
- e. Summarize the most common noninvasive tests for assessing pancreatic exocrine insufficiency: pancreatic elastase-1, pancreatic chymotrypsin, pancreatic serum enzymes, breath test (C-mixed triglyceride test), urinary amylase, fecal fat, phospholipase A2, NBT-PABA, and fecal elastase.
- f. Review the two major tests for monitoring the endocrine function of the pancreas: insulin and C-peptide.
- g. Summarize briefly diabetes mellitus, the major endocrine pancreatic disease.
- h. List the two primary causes of acute pancreatitis.
- i. Outline Ranson’s indicators of severity in acute pancreatitis.
- j. Briefly review the etiology and prognosis of chronic pancreatitis.
- k. Summarize the etiology of cystic fibrosis.

18. Chapter 18- Cardiac Function

(1a-i, ii, v, b-v. 2c-i, iii)

- a. Explain the inflammatory response associated with atherosclerosis.
- b. Define acute coronary syndrome (ACS).
- c. List five factors that define an ideal cardiac biomarker.
- d. Identify two biomarkers used to evaluate each of the following events associated with vascular inflammation:
 - i. Proinflammatory cytokine release
 - ii. Plaque destabilization

- iii. Plaque rupture
- iv. Acute-phase reactant response
- v. Ischemia
- vi. Necrosis
- e. Define hs-CRP relative to cardiac usefulness.
- f. Identify the clinical usefulness of the following cardiac biomarkers:
 - i. Lipoprotein (a)
 - ii. Lipoprotein-associated phospholipase A2
 - iii. Glycogen phosphorylase isoenzyme BB
 - iv. Omega-3 fatty acids
 - v. Matrix metalloproteinases
 - vi. Placental growth factor
 - vii. Oxidized low-density lipoprotein (LDL)
 - viii. Myeloperoxidase
 - ix. Cardiac troponin I and T
 - x. Brain-type natriuretic peptide and NT-proBNP
 - xi. Ischemia-modified albumin (IMA)
- g. Discuss the advantages of point-of-care testing (POCT) for cardiac biomarkers.
- h. Discuss the temporal relationship and concentration of each the following relevant to acute myocardial infarction (AMI):
 - i. Myoglobin
 - ii. CK-MB
 - iii. Cardiac troponin I

**19. Chapter 19- Liver Function
(1a-i,ii, 1b-ii, iv, 2c-iii, d-i.)**

- a. Diagram a hepatic lobule and identify the major vessels and cell types.
- b. Review major liver functions and list examples of each category.
- c. Summarize the main steps of bilirubin metabolism from the breakdown of hemoglobin to excretion as urobilin.
- d. Differentiate conjugated and unconjugated bilirubin, including composition and solubility in water and alcohol.
- e. Review the clinical significance of bilirubin, including levels of total, direct, and indirect bilirubin.
- f. Define jaundice, and identify and list examples of the three major categories of jaundice.
- g. Explain the enzyme deficiency or metabolic defect involved in Crigler–Najjar, Gilbert, Dubin–Johnson, and Rotor syndromes.
- h. Identify type of virus, route of transmission, at risk populations, incubation period, and recovery rate for the following types of viral hepatitis: A, B, C, and D.
- i. Briefly examine the progression in alcoholics from alcoholic fatty liver to alcoholic hepatitis to alcoholic cirrhosis.
- j. Review the Jendrassik–Grof methodology, including reagents and the direct bilirubin procedure.
- k. Summarize the clinical significance of increased ammonia.
- l. Briefly outline other liver function tests: enzymes, albumin, urinary and fecal urobilinogen, and prothrombin time.
- m. Review common ammonia methodologies.

**20. Chapter 20- Iron, Porphyrins, and Hemoglobin
(1a-i, ii, v, b-v, 2c-i, iii)**

- a. Explain the biochemistry of iron in humans.
- b. Explain how iron is transported in the human body.
- c. Outline the metabolism of iron and iron-containing compounds.
- d. Cite examples of specific diseases associated with iron deficiency and iron overload.
- e. Identify methods used to measure iron in serum or plasma.
- f. Identify types of instrumentation used to measure iron, porphyrins, and porphobilinogen.
- g. Identify examples of types of specimens used for laboratory assessment of iron, porphyrins, and hemoglobin.

- h. List the two classes of porphyrias and outline specific porphyrias within each class.
- i. Diagram the metabolic pathway of heme.
- j. Draw the basis structure of a porphyrin.
- k. Define the following terms: porphyrins, porphyrias, ferritin, transferrin, heme, hemin, hematin, and hemoglobin.

21. Chapter 21- Therapeutic Drug Monitoring

(1a-i, ii, v, b-v. 2c-i, iii.d-i)

- a. Identify the four principle biological events associated with pharmacokinetics.
- b. Identify the factors that influence drug absorption.
- c. List examples of conjugation compounds.
- d. Discuss two mechanisms associated with drug excretion.
- e. List four parameters that affect changes in dosage of drugs.
- f. List an example of a specific drug from a given therapeutic category.
- g. Identify examples of additional laboratory tests that may be requested to evaluate organ function(s) in patients taking prescribed medications.
- h. Contrast chemical, generic, and trade name nomenclature for drugs.
- i. Identify appropriate specimens for selected therapeutic drugs.
- j. Identify two factors that significantly affect steady state.
- k. Name the sources of selected drugs.

22. Chapter 22- Toxic Substances

(1b-ii, iv. 2c-iii, d-i.)

- a. List several examples of toxic substances measured in clinical laboratories.
- b. Identify methods used to measure selected toxic substances.
- c. Identify types of instrumentation used to measure toxic substances in clinical laboratories.
- d. List six substances that are frequently used as adulterants in urine specimens for drug abuse testing.
- e. List several examples of classes of drugs that are included in urine-drugs-of-abuse screening procedures.
- f. Identify several sources of lead that may result in high blood levels of lead.
- g. Identify the acidic or ketone metabolites of the following compounds:
 - i. Ethanol
 - ii. Methanol
 - iii. Ethylene glycol
 - iv. Isopropyl alcohol
 - v. Salicylate
- h. Indicate the appropriate specimen of choice for measuring selected toxic substances.
- i. Discuss specimen integrity issues associated with detecting and quantifying toxic substances.
- j. Cite biological uses of selected trace elements.
- k. State food and other sources of selected trace metals.
- l. Identify and distinguish essential, possibly essential, and not essential trace metals.
- m. Define the following terms: trace metal, ultra trace metal, chelating agents, and metalloprotein.
- n. Name specific organs affected by the presence of trace metals.
- o. Identify routes of exposure for selected trace metals.

23. Chapter 23- Nutrition and Vitamins

(1a-i, ii, v, b-v. 2c-i, iii)

- a. List the fat-soluble vitamins.
- b. Identify methods used to measure selected vitamins.
- c. Identify types of instrumentation used to measure vitamins.
- d. Cite biological uses of selected vitamins.
- e. State food sources of selected vitamins.
- f. Identify examples of types of specimens used for laboratory assessment of vitamins.
- g. Identify selected vitamins by both their common and trivial chemical names.
- h. Define the following terms: functional assay, direct assay, hypervitaminosis, and hypovitaminosis.

- i. Associate selected vitamins with disease.
 - j. Define the following terms: nutrition, nutrients, dietary reference intakes, anthropometry, enteral feeding, and parenteral feeding.
 - k. Identify four parameters that are a significant part of an individual's nutritional assessment.
 - l. Name six clinical laboratory tests that may yield significant information for a health-care provider to properly assess the nutritional status of a patient.
 - m. Name five high-risk factors associated with the development of nutritional deficiencies.
- 24. Chapter 24- Tumor Markers**
(1a-i, ii, v, b-v. 2c-i, iii)
- a. List five roles of tumor markers in the assessment of cancers.
 - b. Describe four different methodologies that may be used to detect markers associated with malignancy.
 - c. List commonly used tumor markers and state their clinical significance in relation to cancer.
 - d. Identify several laboratory tests used to evaluate the following:
 - i. Prostate disease
 - ii. Ovarian cancer
 - iii. Breast cancer
 - iv. Bladder cancer
 - v. Pancreatic cancer
- 25. Chapter 25- Geriatrics**
(1a-i, ii, v, b-v. 2c-i, iii)
- a. Discuss briefly the changing demographics of the geriatric population.
 - b. Summarize three changes that occur in the aging kidney.
 - c. Discuss the renal function tests and the age-related changes in these analytes.
 - d. Describe briefly the factors involved in age-related bone loss.
 - e. List five mechanisms of age-related bone loss.
 - f. Discuss four factors that may be a contributing cause of sarcopenia.
 - g. List five biological markers of sarcopenia.
 - h. Identify which hormones are increased, decreased, or show no change with aging.
 - i. Describe briefly the changes in the immune system with aging.
- 26. Chapter 26- Pediatrics**
(1a-i, ii, v, b-v. 2c-i, iii)
- a. Distinguish infant, child, and adolescent stages of life.
 - b. Describe the role of the pediatrician.
 - c. List five factors that should be considered when using peer review reference intervals.
 - d. Summarize the changes that occur in infants, children, and adolescents regarding disorders of respiratory, liver, kidney, thyroid, calcium, diabetes mellitus, inborn errors of metabolism, and nutrition.
 - e. Identify three key features of pediatric patients with hypothyroidism.
 - f. Define the following terms: jaundice, hematuria, proteinuria, and adolescence.
 - g. Identify specimen requirements and specimen integrity issues for selected laboratory tests.
- 27. Lab #1**
(1a-i, ii, v, b-v. 2c-i, iii)
- a. Define mean, standard deviation, coefficient of variation.
 - b. Distinguish between assayed and unassayed controls.
 - c. Read Levy-Jennings graphs to determine the analyte and the value of the mean.
 - d. Read Levy-Jennings graphs and be able to determine values outside of 2SD and 3SD.
 - e. Define precision and accuracy.
 - f. Describe the proper labeling when a reagent or control is opened and/or reconstituted in the lab.
 - g. Describe why controls are important in the clinical lab.
- 28. Lab #2**
(1a-i, ii, v, b-v. 2c-i, iii)
- a. Explain the purpose of the "blank" in spectrophotometry.
 - b. Discuss the importance and the reason we are required to run controls.

- c. Explain Beer's law as it relates to the activity performed today. (How the intensity of the observed color relates to concentration)
- d. Explain the difference in wavelengths used on spectrophotometer. List the wavelength used in today's procedures.
- e. Identify all parts of the spectrophotometer we used today (light source, monochromater, cuvette, photodetector, output).
- f. Discuss PHYSICAL factors of the patient that have an affect on the concentration of cholesterol in the blood.
- g. Discuss where cholesterol is found in the body.
- h. List common mistakes that can be made in spectrophotometry testing.

29. Lab #3

(1a-i, ii, v, b-v. 2c-i, iii)

- a. Explain the concept of electrophoresis.
- b. Describe the results of an electrophoresis gel, including what each "band" represents.
- c. State the function of the buffer in an electrophoresis system.
- d. List the different Hemoglobin fractions found in humans.
- e. Describe the purpose of staining electrophoresis gels.
- f. Explain tests that can be done using electrophoresis.
- g. Outline the symptoms of Sickle Cell Anemia.
- h. Interpret a completed electrophoresis gel.

Course Content:

A general description of lecture/discussion topics included in this course are listed in the Learning Objectives / Specific Course Objectives sections of this syllabus.

Students in all sections of this course will be required to do the following:

- 1. Chapter 1-26 Assignments
- 2. Chapter 1-26 Quizzes
- 3. Lab 1-3 pre and post quizzes
- 4. Lab 1-3 assignments

Methods of Instruction/Course Format/Delivery:

This is a mainly online course so it will require a lot of outside proactive work by the student. The instructor will provide guidance as needed. The student will be evaluated by assignments, quizzes, cases, and exams as assigned by the instructor outside of the classroom. The student will be required to come to a Panola College testing Center to take all major examinations. Laboratories will take place on three pre-determined Saturdays during the semester and will be mandatory. During the laboratories the students will be evaluated by case studies, in-lab assignments, and lab practicals as assigned by the instructor.

Major Assignments / Assessments:

The following items will be assigned and assessed during the semester and used to calculate the student's final grade.

Assignments

- 1. Chapters 1-7
- 2. Chapters 8-16
- 3. Chapters 17-26
- 4. Lab #1 in lab assignment
- 5. Lab #2 in lab assignment
- 6. Lab #3 in lab assignment

Assessment(s):

- 1. Chapter 1-26 quizzes
- 2. Lab 1-3 pre and post quizzes
- 3. 3 proctored exams

Course Grade:

The grading scale for this course is as follows:

Lecture Grade = 2/3 of grade**Lecture**

Major Exams 50%
Quizzes 15%
Homework Assignments 20%
Final Exam 15%

Lab Grade = 1/3 of grade**Laboratory**

Pre-Lab Quizzes 10%
Case Assignments 20%
In-Lab Assignments 20%
Practicals 50%

Texts, Materials, and Supplies:

- *textbook*
- other materials

Required Readings:

- Sunheimer, Robert. (2017). *Clinical Laboratory Chemistry*. Pearson 2nd edition. ISBN 9780134413327.
- Additional information given on Canvas

Recommended Readings:

- Medical Dictionary

Other:

- For current texts and materials, use the following link to access bookstore listings: <http://www.panolacollegestore.com>
- For testing services, use the following link: <http://www.panola.edu/elearning/testing.html>
- If any student in this class has special classroom or testing needs because of a physical learning or emotional condition, please contact the ADA Student Coordinator in Support Services located in the Administration Building or go to <http://www.panola.edu/student-success/disability-support-services/> for more information.
- Withdrawing from a course is the student's responsibility. Students who do not attend class and who do not withdraw will receive the grade earned for the course.
- Student Handbook, *The Pathfinder*: <http://www.panola.edu/student-success/documents/pathfinder.pdf>

More Information:**Medical Technologies Student Handbook**

Medical Technologies students are subject to all rules and regulations outlined in the Panola College Medical Technologies Student Handbook.

Laboratory Dress Code

The student will be expected to attend class clean and neatly dressed in long pants or scrubs and wear **closed-toe shoes**. A laboratory coat will must be worn snapped or buttoned up during all laboratory sessions. Hair that is shoulder length or longer **must** be worn up or securely tied back. Gloves must be worn when handling biological materials.

Behavioral Conduct

While a student is representing Panola College as a Medical Laboratory Technology student, they will be expected to conduct themselves in such a manner as to reflect favorably on themselves and on the Program. If a student acts in such a manner as to reflect immature judgment or disrespect for others, the

student will be called before the MLT Department Chair for determination of their status in the Program. Inappropriate conduct is grounds discipline and may be cause for immediate probation or dismissal from the Program.

Academic Dishonesty

Under no circumstances shall a student submit work that is not their own. Copying answers for study questions, cheating on exams and/or submitting laboratory results which are not your own are expressly prohibited.

Time Commitment

According to "Hints on How to Succeed in College Classes"

<http://astrosociety.org/edu/resources/success.html> you should budget your time per week for this four-hour credit course as follows:

1. Reading assigned text 2 to 3 hours
2. Homework assignments 3 to 6 hours
3. Time for review and test preparation 3 hours
4. Total study time per week 10 to 15 hours **PER WEEK**

SCANS CRITERIA

- 1) **Foundation skills are defined in three areas: basic skills, thinking skills, and personal qualities.**
 - a) **Basic Skills:** A worker must read, write, perform arithmetic and mathematical operations, listen, and speak effectively. These skills include:
 - i) Reading: locate, understand, and interpret written information in prose and in documents such as manuals, graphs, and schedules.
 - ii) Writing: communicate thoughts, ideas, information, and messages in writing, and create documents such as letters, directions, manuals, reports, graphs, and flow charts.
 - iii) Arithmetic and Mathematical Operations: perform basic computations and approach practical problems by choosing appropriately from a variety of mathematical techniques.
 - iv) Listening: receive, attend to, interpret, and respond to verbal messages and other cues.
 - v) Speaking: Organize ideas and communicate orally.
 - b) **Thinking Skills:** A worker must think creatively, make decisions, solve problems, visualize, know how to learn, and reason effectively. These skills include:
 - i) Creative Thinking: generate new ideas.
 - ii) Decision Making: specify goals and constraints, generate alternatives, consider risks, and evaluate and choose the best alternative.
 - iii) Problem Solving: recognize problems and devise and implement plan of action.
 - iv) Visualize ("Seeing Things in the Mind's Eye"): organize and process symbols, pictures, graphs, objects, and other information.
 - v) Knowing How to Learn: use efficient learning techniques to acquire and apply new knowledge and skills.
 - vi) Reasoning: discover a rule or principle underlying the relationship between two or more objects and apply it when solving a problem.
 - c) **Personal Qualities:** A worker must display responsibility, self-esteem, sociability, self-management, integrity, and honesty.
 - i) Responsibility: exert a high level of effort and persevere toward goal attainment.
 - ii) Self-Esteem: believe in one's own self-worth and maintain a positive view of oneself.
 - iii) Sociability: demonstrate understanding, friendliness, adaptability, empathy, and politeness in group settings.
 - iv) Self-Management: assess oneself accurately, set personal goals, monitor progress, and exhibit self-control.
 - v) Integrity and Honesty: choose ethical courses of action.
- 2) **Workplace competencies are defined in five areas: resources, interpersonal skills, information, systems, and technology.**
 - a) **Resources:** A worker must identify, organize, plan, and allocate resources effectively.
 - i) Time: select goal-relevant activities, rank them, allocate time, and prepare and follow schedules.
 - ii) Money: Use or prepare budgets, make forecasts, keep records, and make adjustments to meet objectives.
 - iii) Material and Facilities: Acquire, store, allocate, and use materials or space efficiently. Examples: construct a decision time line chart; use computer software to plan a project; prepare a budget; conduct a cost/benefits analysis; design an RFP process; write a job description; develop a staffing plan.
 - b) **Interpersonal Skills:** A worker must work with others effectively.
 - i) Participate as a Member of a Team: contribute to group effort.
 - ii) Teach Others New Skills.
 - iii) Serve Clients/Customers: work to satisfy customer's expectations.

- iv) **Exercise Leadership:** communicate ideas to justify position, persuade and convince others, responsibly challenge existing procedures and policies.
- v) **Negotiate:** work toward agreements involving exchange of resources, resolve divergent interests.
- vi) **Work with Diversity:** work well with men and women from diverse backgrounds.
Examples: collaborate with a group member to solve a problem; work through a group conflict situation, train a colleague; deal with a dissatisfied customer in person; select and use appropriate leadership styles; use effective delegation techniques; conduct an individual or team negotiation; demonstrate an understanding of how people from different cultural backgrounds might behave in various situations.

c) **Information:** A worker must be able to acquire and use information.

- i) **Acquire and Evaluate Information.**
- ii) **Organize and Maintain Information.**
- iii) **Interpret and Communicate Information.**
- iv) **Use Computers to Process Information.**

Examples: research and collect data from various sources; develop a form to collect data; develop an inventory record-keeping system; produce a report using graphics; make an oral presentation using various media; use on-line computer data bases to research a report; use a computer spreadsheet to develop a budget.

d) **Systems:** A worker must understand complex interrelationships.

- i) **Understand Systems:** know how social, organizational, and technological systems work and operate effectively with them.
- ii) **Monitor and Correct Performance:** distinguish trends, predict impacts on system operations, diagnose deviations in systems' performance and correct malfunctions.
- iii) **Improve or Design Systems:** suggest modifications to existing systems and develop new or alternative systems to improve performance.

Examples: draw and interpret an organizational chart; develop a monitoring process; choose a situation needing improvement, break it down, examine it, propose an improvement, and implement it.

e) **Technology:** A worker must be able to work with a variety of technologies.

- i) **Select Technology:** choose procedures, tools or equipment including computers and related technologies.
- ii) **Apply Technologies to Task:** understand overall intent and proper procedures for setup and operation of equipment.
- iii) **Maintain and Troubleshoot Equipment:** Prevent, identify, or solve problems with equipment, including computers and other technologies.

Examples: read equipment descriptions and technical specifications to select equipment to meet needs; set up and assemble appropriate equipment from instructions; read and follow directions for troubleshooting and repairing equipment.