



## 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**

**Class section meeting time:** This is an online lecture course with face to face labs that meet on three pre-designated Saturdays during the semester.

**Alternate Operations During Campus Closure:** In the event of an emergency or announced campus closure due to a natural disaster or pandemic, it may be necessary for Panola College to move to altered operations. During this time, Panola College may opt to continue delivery of instruction through methods that include but are not limited to: online learning management system (CANVAS), online conferencing, email messaging, and/or an alternate schedule. It is the responsibility of the student to monitor Panola College's website ([www.panola.edu](http://www.panola.edu)) for instructions about continuing courses remotely, CANVAS for each class for course-specific communication, and Panola College email for important general information.

**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. Select appropriate method of water purification: distilled, deionized, reverse osmosis.
- b. Explain types of (CLSI) reagent grade water.

- c. Identify attributes, advantages, disadvantages and disadvantages of specific type of glassware
- d. Define:
  - i. units of systems of measurement (Metric and SI)
  - ii. dilutions (serial and ratio),
- e. Describe basic mechanisms and types of balances.
- f. Define balancing terminology: capacity, sensitivity, precision, readability, tare
- g. Operate balances: leveling, handling weights, pan and/or beam arrest, weight paper or boats, cleanliness, temperature, elimination of drafts, vibrations, etc
- h. Calibrate balances following established laboratory procedure.
- i. Perform routine maintenance checks on all balances.
- j. Perform basic calculations:
  - i. Exponents
  - ii. Molarity
  - iii. Percentage
  - iv. ratios and proportions
  - v. unit conversions (concentration relationships)
  - vi. percent to molarity
  - vii. molarity to percent
  - viii. standard solutions
- k. Perform temperature conversion ( $F^{\circ}$  to  $C^{\circ}$ ), ( $C^{\circ}$  to  $F^{\circ}$ ).
- l. Perform conversion between and among systems of measurement- metric to SI and SI to metric.
- m. Calculate and perform dilutions (serial and ratio)
- n. Explain basic concepts of centrifugation- principles of centrifugal force, tachometer, relative centrifugal force
- o. Identify basic components of a centrifuge
  - i. head/rotor
  - ii. bowl and cover
  - iii. shields/cups
  - iv. brushes
  - v. cushion
- p. Describe operation of centrifuge- function controls, balancing
- q. Operate centrifuges- load and balance, lock head, select appropriate speed and temp, follow safety precautions.
- r. Perform routine maintenance checks on all centrifuges.
- s. Perform routine maintenance checks on heating units following established laboratory procedure.
- t. Check/calibrate temperature setting of heating units.
- u. Correct malfunction according manufacturer's manual.

## 2. Chapter 2- Safety in the Clinical Chemistry Laboratory

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

- a. Apply OSHA Standards
- b. Outline fire safety guidelines: Fire protocol (RACE), Classes of fire extinguishers, Fire evacuation plan, Fire Extinguisher protocol (PASS)
- c. Identify potential sources of lab hazards (Biological/Bioterrorism)
- d. List five examples of personal protective equipment (PPE) and engineered controls used to protect laboratory staff
- e. Identify elements of an exposure control plan.
- f. Describe the purpose of a chemical hygiene plan.
- g. Apply ergonomic practices to laboratory tasks
- h. Follow a disaster preparedness program

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

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

- a. Define statistical data for quality control and statistical analyses
- b. Define type of laboratory errors and biases: Preanalytical, Analytical (Random, Systematic), Postanalytical.
- c. Assess pre-analytic and analytic factors that can affect patient results:
  - i. Sample integrity

- ii. draw time
  - iii. preservation or storage
  - iv. Age
  - v. Gender
  - vi. Ethnicity
  - vii. Diet,
  - viii. nutritional status
  - ix. fasting
  - x. post prandial
  - xi. Exercise
  - xii. Position
  - xiii. Posture
  - xiv. Sample processing
  - xv. identification
  - xvi. Method
  - xvii. interfering substances/sources of error
  - xviii. Recording of results
- d. Report results according to laboratory protocol: Routine, STAT, Action limits (critical values)
  - e. Correlate all patient test data for acceptability: Review normal physiology and function (liver, cardiac, kidney, etc.)
  - f. Interpret patient test results using reference intervals and previous patient data
  - g. Recognize pathophysiology of abnormal results
  - h. Define:
    - i. Mean
    - ii. Mode
    - iii. Median
    - iv. Standard Deviation
    - v. Coefficient of variation
    - vi. Reference intervals
    - vii. Variance
    - viii. linear regression
    - ix. correlation coefficient
    - x. Gaussian distribution
    - xi. scales/graphs/charts
    - xii. Levey-Jennings charts
    - xiii. Westgard Multirule system

**4. Chapter 4- Instrumentation, Laboratory Automation, and Informatics**  
**(1a-i, ii, b-i, ii, v. 2c-i, iii)**

- a. State basic concepts of atomic absorption spectrophotometry: Principles of light absorption, Generation of atoms from molecules
- b. Describe unique components relative to Osmometry:
  - i. Principles of osmolality (colligative properties)
  - ii. Definition
  - iii. Calculations
- c. Identify basic concepts of spectrophotometry:
  - i. Principles of light absorption
  - ii. Wavelength
  - iii. Spectrum
  - iv. Beer's law
  - v. Complementary spectra
- d. Identify spectrophotometer components:
  - i. Light Source
  - ii. Monochromator
  - iii. Cuvettes
  - iv. Light Detectors
  - v. Read-out systems
- e. State basic concepts of fluorometry:

- i. Principles of light absorption and emission by molecules
  - ii. Absorption and emission spectrum
- f. State basic concepts of turbidimetry and nephelometry:
  - i. Principles of absorption
  - ii. light scatter
  - iii. Reflectance
- g. State basic concepts of mass spectrophotometry
- h. State basic concepts of chromatography:
  - i. Separation mechanisms (partition, absorption)
- i. Define basic chromatography techniques:
  - i. Column
  - ii. Thin layer (TLC)
  - iii. Liquid (HPLC)
  - iv. Gas (GLC)
- j. Describe the basic components of a chromatography system:
  - i. Flow regulation
  - ii. Mobile phase
  - iii. Stationary phase
  - iv. Column Detectors
- k. Explain basic concepts of electrochemistry:
  - i. Principles of electrochemistry
  - ii. Potentiometry
  - iii. Electrodes
- l. Describe the basic concepts of Ion-selective electrodes:
  - i. Glass
  - ii. Solid state
  - iii. Liquid membrane
- m. Describe the basic components of electrochemistry:
  - i. Reference electrode
  - ii. Indicator electrode
  - iii. Salt bridge
- n. State basic concepts of luminescence.
- o. Describe the basic components of an automated system:
  - i. Sample/reagent pick-up/dilution
  - ii. Transfer module/mechanism
  - iii. Spectrophotometer module
  - iv. Control/calibration module
  - v. Readout/recorder
  - vi. Operation/calibration
  - vii. Maintenance/quality assurance
  - viii. Troubleshooting
- p. Describe operations and principles of the automated systems.
- q. State basic concepts of automated analyzers:
  - i. Discrete sample systems
  - ii. self-contained
  - iii. special purpose (POC)

## 5. Chapter 6- Molecular Diagnostics

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

- a. Discuss Mendelian and non-Mendelian genetics
- b. Define mutation and polymorphism
- c. Discuss the basic functions of DNA
- d. Discuss Nucleic acid electrophoresis:
  - i. Role of size
  - ii. Charge
  - iii. shape
  - iv. conformation in migration/movement

- e. Discuss PCR:
  - i. Amplification Reaction
  - ii. the cycle (denature, anneal, extend)
  - iii. components
- f. Explain florescence in situ hybridization (FISH)
- g. Describe DNA:
  - i. Central dogma
  - ii. Transcription
  - iii. Translation (codons/anticodons, ribosomes, genetic code/degeneration)
  - iv. Extrachromosomal (plasmid, mitochondrial transmission)
- h. Describe nucleic acid extraction/isolation/quantitation/purification techniques:
  - i. Purpose of technique
  - ii. Reagents and purpose
  - iii. Acceptable sample types
- i. Differentiate PCR modifications techniques:
  - i. Real time PCR
  - ii. nested PCR
  - iii. Multiplex PCR
  - iv. Reverse Transcriptionase PCR.
- j. Define the basic principles of restriction endonucleases.
- k. List the different types of amplification assays.
- l. Compare blotting techniques: Western, Northern, Southern
- m. Consider the following variables with performing various blotting techniques:
  - i. RFLP
  - ii. Stringency
  - iii. Hybridization

**6. Chapter 7- Carbohydrates**  
**(1a-i, ii, b-i, ii, v. 2c-i, iii)**

- a. Define the following terms:
  - i. Monosaccharide
  - ii. Disaccharide
  - iii. Polysaccharide
  - iv. Glycosidic linkage
  - v. Aldose
  - vi. Ketose
  - vii. Hexose
  - viii. Pentose
  - ix. Isomer
- b. State the components of the disaccharides:
  - i. Lactose
  - ii. Maltose
  - iii. Sucrose
- c. State the composition and function of each of the following polysaccharides:
  - i. Starch
  - ii. Glycogen
- d. Discuss carbohydrate metabolism:
  - i. State the purpose of digestion and absorption of dietary carbohydrates
  - ii. State how glucose is transported in the blood
  - iii. State the main physiologic functions of carbohydrates
  - iv. State the purpose of the following glucose pathways:
    - a) Glycolysis
    - b) Gluconeogenesis
    - c) Glycogenesis
    - d) Glycogenolysis
- e. State whether the following hormones increase or decrease blood glucose levels:
  - i. Insulin

- ii. Glucagon
  - iii. Cortisol
  - iv. Adrenocorticotropic hormone (ACTH)
  - v. Epinephrine
  - vi. Thyroxine
  - vii. Growth hormone (GH)
  - viii. Human placental lactogen (HPL)
- f. Discuss the maintenance of blood glucose levels in the fed state (parenteral) and the fasting state
- g. List disease states and disorders associated with carbohydrate metabolism
- h. Explain etiology, symptoms, and effects of GDM
- i. Explain etiology, symptoms, and effects of Type 1 and Type 2 Diabetes
- j. Explain etiology, symptoms, and effects of Cushing's Syndrome
- k. Explain the diagnostic criteria for Type 1, 2 (impaired glucose tolerance and provisional diabetes mellitus), and GDM
- l. Explain etiology, symptoms, and effects of hypoglycemia:
  - i. Induced
  - ii. Fasting Reactive
- m. State the principle of the chemical reaction, sample types required, reference interval, most common interfering substances/sources of error, and the usefulness of each:
  - i. Glucose oxidase
  - ii. Hexokinase
  - iii. Glycated hemoglobin (A1C)
- n. State the qualitative or quantitative method used for detection:
  - i. Other reducing substances
  - ii. Ketones
  - iii. Urinary sugars
  - iv. Cerebrospinal fluid (CSF) glucose
- o. Explain the usefulness of, patient preparation, and the procedure for a glucose tolerance test; include normal and diagnostic levels
- p. Correlate all patient results and patient outcomes with disease state or disorder
- q. Explain the usefulness of insulin and C-peptide
- r. State the usefulness of bedside or at-home glucose monitoring devices; compare results to non-POC analyzer results.

## 7. Chapter 8- Lipids and Lipoproteins

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

- a. Define the lipid associated terminology:
  - i. Lipid / Lipase
  - ii. Simple /Complex lipid
  - iii. Lipemia
  - iv. Lecithin
  - v. Sphingomyelin
  - vi. Glycolipid
  - vii. Lipoprotein
  - viii. Apoprotein
  - ix. Esterification
  - x. Saturated/Unsaturated
- b. State structural characteristics of lipids:
  - i. Cholesterol
  - ii. Fatty Acids T
  - iii. Triglycerides
  - iv. Phospholipids
- c. Discuss lipid metabolism
- d. State the main physiologic functions of lipids
- e. State the main transport route of dietary lipids
- f. State the origin, main function of each lipoprotein; include apoprotein(s) required for normal function
- g. Explain the lipid pathways; include exogenous, endogenous, reverse

- h. Compare the lipoproteins using the difference in lipid and protein composition:
  - i. Chylomicron
  - ii. Very low density lipoproteins (VLDL)
  - iii. Low density lipoproteins (LDL)
  - iv. High density lipoproteins (HDL)
- i. Correlate disease states and disorders associated with hyperlipidemias: Hyperglycemia/Hypoglycemia
- j. List methodologies for lipid determinations, state the principle of the chemical reaction, reference interval, most common interfering substances/sources of error, and the usefulness:
  - i. Cholesterol
  - ii. Triglycerides
  - iii. LDL
  - iv. HDL
- k. Explain the calculation for LDL
- l. List the usefulness of apolipoprotein measurements
- m. List the lipid levels associated with hereditary disorders:
  - i. abetalipoproteinemia
  - ii. hypobetalipoproteinemia
  - iii. Tangier disease
- n. Explain recommended patient preparation protocol, specimen requirements, and abnormal serum appearance when collecting or handling specimens for lipid analysis
- o. Correlate patient results with disease state or disorder
- p. State the disorders/conditions associated with lipid imbalances:
  - i. Atherosclerosis
  - ii. Malabsorption states
  - iii. Biliary obstruction
  - iv. Pregnancy
  - v. Post menopause
  - vi. Ketosis
  - vii. Fatty liver
  - viii. Lipid storage diseases
  - ix. Hyaline membrane disease/Respiratory Distress Syndrome

## 8. Chapter 9- Amino Acids and Proteins

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

- a. State the reference range for serum total protein and albumin
- b. Define protein-associated terminology:
  - i. Isoelectric point
  - ii. Amino acid
  - iii. Peptide bond
  - iv. Complex or conjugated protein
- c. State protein structures and classifications
- d. Contrast protein structures:
  - i. Primary
  - ii. Secondary
  - iii. Tertiary
  - iv. Quaternary.
- e. State protein metabolism
- f. State the main transport route of dietary amino acids
- g. State the main physiologic functions of plasma proteins
- h. Discuss synthesis:
  - i. Non-essential amino acids
  - ii. Cellular proteins; include DNA and RNA
- i. State the main site of synthesis for plasma proteins
- j. State the principle of the chemical reaction, sample types required, reference interval, most common interfering substances/sources of error, and the usefulness:
  - i. Biuret
  - ii. Turbidimetry/nephelometry

- iii. Dye binding
- iv. Protein electrophoresis
- k. List the cause for elevated urine levels:
  - i. Albumin (microalbumin)
  - ii. Immunoglobulin
  - iii. Immunoglobulin light chains (Bence-Jones protein)
  - iv. Beta-2-microglobulin
- l. Correlate disease states and disorders associated with total protein levels and other test results:
  - i. Dehydration
  - ii. Multiple myeloma
  - iii. Nephrotic syndrome
  - iv. Malabsorption
  - v. Liver disease
  - vi. Hemolytic anemia
  - vii. Acute phase reaction
  - viii. Hypogammaglobinemia
  - ix. Congestive heart failure (beta-natriuretic peptide)
- m. Discuss methodologies for protein determinations
- n. State the property of proteins that allows separation or classification:
  - i. Electrophoresis
  - ii. Isoelectric focusing
  - iii. Ion exchange chromatography
  - iv. Ultracentrifugation
  - v. Immunochemical assay
- o. State the electrophoretic fraction in which each is located, the normal function, and disease states associated with abnormal levels:
  - i. Albumin
  - ii. Alpha-1-antitrypsin
  - iii. Fetal fibronectin
  - iv. Alpha-2-macroglobulin
  - v. Haptoglobin
  - vi. Ceruloplasmin
  - vii. Transferrin
  - viii. Fibrinogen
  - ix. C-reactive protein Immunoglobulins
- p. Correlate the serum protein electrophoresis pattern with disorders:
  - i. Nephrotic syndrome
  - ii. Monoclonal gammopathy
  - iii. Hypogammaglobinemia L
  - iv. liver cirrhosis
  - v. Acute phase reaction
  - vi. Polyclonal gammopathy/inflammation
- q. State the regulation of Copper:
  - i. Absorption
  - ii. Ceruloplasmin

## 9. Chapter 10- Enzymes

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

- a. State the chemical composition of an enzyme
- b. Give the basic function of Ligases
- c. List types of inhibitors (reversible/ irreversible)
- d. Define enzyme-associated terminology:
  - i. Enzyme
  - ii. Catalyst
  - iii. Cofactor
  - iv. Apoenzyme
  - v. Coenzyme
  - vi. Prosthetic Group



- vii. Active Site
  - viii. Substrate
  - ix. Product
  - x. inhibitor
  - xi. Kinetic
  - xii. International Unit
  - xiii. Isoenzyme
  - xiv.  $V_{max}$
  - xv.  $K_m$
  - xvi. Energy of Activation (EA)
  - xvii. Michaelis-Menten Constant
  - xviii. First-Order Kinetics
  - xix. Zero-Order Kinetics
- e. Discuss the usefulness of measuring enzymes
  - f. State enzyme classification, nomenclature, and structure
  - g. List types of activators
  - h. State the most common physiologic functions of enzymes
  - i. Explain theories of substrate binding by enzymes:
    - i. Lock and key
    - ii. Induced fit
  - j. State the kinetic measurement (first order, zero order) that is preferred for use in an analytical method
  - k. List factors affecting enzyme reaction rates:
    - i. Temperature
    - ii. Substrate
    - iii. concentration
    - iv. pH
    - v. Enzyme concentration
    - vi. Time
    - vii. Isoenzymes
    - viii. Substrate specificity
  - l. Contrast endpoint and continuous monitoring kinetic methods
  - m. List clinically significant enzymes:
    - i. Lactate dehydrogenase (LD)
    - ii. Creatine kinase (CK)
    - iii. CK-MB
    - iv. Aspartate amino transferase (AST)
    - v. Alanine amino transferase (ALT)
    - vi. Gamma glutamyl transferase (GGT)
    - vii. Alkaline phosphatase (ALP)
    - viii. Amylase (AMY)
    - ix. Lipase (LIP)
    - x. Cholinesterase/pseudocholinesterase
  - n. State the primary tissue source(s) of clinically significant enzymes
  - o. Explain the significance of abnormal serum levels and correlate with specific disease states or disorders:
    - i. Myocardial infarction
    - ii. Liver disease
    - iii. Muscle disease
    - iv. Bone disease
    - v. Malignancy
    - vi. Hematological disorders
    - vii. Pancreatitis
  - p. List examples of the use of enzymes as analytical reagents
  - q. State the chemical principle and reaction of the most commonly used methods for determining levels of the clinically significant enzymes

## 10. Chapter 11- Nonprotein Nitrogen and Renal Function

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

- a. Describe renal function tests:
  - i. Creatinine Clearance
  - ii. Estimated Glomerular Filtration
  - iii. Cystatin C
  - iv. Beta2Microglobulin
- b. List methodologies for urea nitrogen: State the principle of the chemical reaction, sample types required, reference interval, most common interfering substances/sources of error, and the usefulness.
- c. Differentiate the advantage and disadvantages of substances for determination of renal clearance:
  - i. Creatinine
  - ii. Inulin
  - iii. Cystatin
- d. State the usefulness of creatinine measurement
- e. Explain creatinine synthesis and mode of excretion
- f. List methodologies for creatinine: For the most common methods, state the principle of the chemical reaction, sample type, reference interval, most common interfering substances/sources of error.
- g. Discuss disease states and disorders associated with creatinine measurement:
  - i. Renal disease
  - ii. Muscle wasting disease
- h. State the reference range and explain the usefulness of the BUN/creatinine ratio
- i. Explain uric acid synthesis and mode of excretion
- j. List methodologies for uric acid
- k. List disease states and disorders associated with uric acid measurement:
  - i. Renal disease
  - ii. Gout
  - iii. Increased cell turnover (Leukemia, Chemotherapy)
  - iv. Liver Disease I
  - v. inborn Errors of metabolism
- l. List factors that can influence creatinine clearance results (timing, complete collection, body size)
- m. Differentiate eGFR and GFR
- n. Calculate creatinine clearance results using body surface area normalization
- o. List disease states and disorders associated with urea measurement:
  - i. Pre-renal causes
  - ii. Renal causes
  - iii. Post-renal causes
    - a) Decreased formation (liver disease)
    - b) Over-hydration; dilution
  - iv. End stage renal disease

**11. Chapter 12**

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

- a. Define electrolyte-associated terminology:
  - i. Electrolyte
  - ii. Anion
  - iii. Cation
  - iv. Intracellular/extracellular
  - v. Anion Gap
  - vi. Trace element
- b. State the significance of results: Reflection of electrolyte-fluid balance Assessment of renal concentrating ability
- c. Discuss electrolyte metabolism
- d. State the physiologic function and distribution of the following electrolytes:
  - i. Sodium
  - ii. Potassium

- iii. Chloride
- iv. Bicarbonate
- v. Calcium
- vi. Magnesium
- vii. Phosphate
- e. Define and explain the usefulness of the Anion Gap
- f. Given electrolyte data, calculate the Anion gap
- g. Correlate an increased or decreased Anion gap with specific disorders or conditions
- h. Utilize the Anion gap as a quality control measure when performing electrolyte analyses
- i. Describe water regulation:
  - i. Anti-diuretic hormone (ADH) (vasopressin)
  - ii. Renin-angiotensin-aldosterone system
  - iii. Thirst center
- j. Explain water movement and metabolism:
  - i. Intracellular
  - ii. Extracellular
  - iii. Osmosis
  - iv. Maintenance of electrical equilibrium
  - v. Effect of macromolecules
- k. State the regulation of Bicarbonate:
  - i. Blood
  - ii. pH
  - iii. Kidney function
- l. State the regulation of Potassium:
  - i. Dietary intake
  - ii. Blood
  - iii. pH
  - iv. Kidney function
- m. State the regulation of Sodium:
  - i. Dietary intake
  - ii. Aldosterone
  - iii. Renin
  - iv. Kidney function
- n. State the regulation of Chloride:
  - i. Follows sodium
  - ii. Blood pH
- o. State the difference between a direct and indirect ISE: State electrolyte specimen requirements and most common sources of error
- p. State the basic concepts in the measurement of osmolality:
  - i. Definition
  - ii. Colligative properties of solutions
- q. Discuss disease states and disorders associated with electrolyte metabolism
- r. State reference intervals and critical values:
  - i. Sodium
  - ii. Potassium
  - iii. Chloride
  - iv. Bicarbonate
- s. Define by including the diagnostic level and list causes and symptoms:
  - i. Hyponatremia
  - ii. Hypernatremia
  - iii. Hypokalemia
  - iv. Hyperkalemia
  - v. Hypochloremia
  - vi. Hyperchloremia
  - vii. Increased levels of bicarbonate Decreased levels of bicarbonate

**12. Chapter 13- Blood Gases, pH, and Acid–Base Balance**  
**(1b-ii, iv. 2c-iii, d-i.)**

- a. State basic concepts of blood gas analyzers
- b. Describe basic components of blood gas analyzers:
  - i. pCO<sub>2</sub> electrode
  - ii. pO<sub>2</sub> electrode
  - iii. pH electrode
  - iv. ISE electrode
  - v. Cooximetry
  - vi. Sample chamber
- c. Describe operation of blood gas analyzers:
  - i. Function controls
  - ii. Sample handling
- d. Define blood gas analysis terminology:
  - i. Acid
  - ii. Acidosis
  - iii. acidemia
  - iv. Base
  - v. Alkalosis
  - vi. Alkalemia
  - vii. base excess
  - viii. Buffer
  - ix. pH
  - x. Partial pressure
  - xi. Oxygen saturation
  - xii. P50
  - xiii. oxygen capacity
  - xiv. Hypoxia
  - xv. hypoxemia
  - xvi. Henderson-Hasselbalch equation
- e. List the mechanisms of bicarbonate reabsorption by the renal tubules:
  - i. Sodium-hydrogen exchange/H<sup>+</sup> secretion
  - ii. Sodium-potassium exchange/secretion of K<sup>+</sup>
  - iii. Secretion of ammonia
- f. Explain the application of the Henderson-Hasselbalch equation
- g. Explain compensatory mechanisms:
  - i. Pulmonary compensation with primary metabolic change (change in HCO<sub>3</sub>)
  - ii. Hypoventilation if bicarbonate increased (increased pCO<sub>2</sub> if increased HCO<sub>3</sub>)
  - iii. Hyperventilation if bicarbonate decreased (decreased pCO<sub>2</sub> if decreased HCO<sub>3</sub>)
  - iv. Renal compensation with primary respiratory change (change in CO<sub>2</sub>)
  - v. Retention of bicarbonate, if CO<sub>2</sub> is retained
  - vi. Excretion of bicarbonate, if CO<sub>2</sub> is blown off
- h. Identify the four major body buffer systems.
- i. State the mechanisms of carbon dioxide excretion via the lungs:
  - i. Mechanism for expiration of CO<sub>2</sub>
  - ii. Factors affecting pCO<sub>2</sub> or H<sub>2</sub>CO<sub>3</sub>
- j. Perform routine maintenance/quality assurance of blood gas analyzers:
  - i. Standard gases
  - ii. Electrode and membrane care
  - iii. Interference
- k. Perform test procedures on standards, controls, and unknowns:
  - i. Evaluate quality control data (QC)
  - ii. Accept/reject results
  - iii. Take appropriate corrective action, if necessary
  - iv. Report results, if acceptable
- l. Correlate test results with other laboratory tests and patient diagnosis.
- m. Discuss blood gas analysis.
- n. List causes for:
  - i. metabolic acidosis (= bicarbonate deficit)

- ii. metabolic alkalosis (= bicarbonate excess)
- iii. respiratory alkalosis (= decreased carbonic acid)
- iv. respiratory acidosis (= increased carbonic acid)
- o. Evaluate blood gas results to determine defect.
- p. Discuss oxygen metabolism.
- q. Define hemoglobin oxygen saturation.
- r. List factors that affect oxygen dissociation from hemoglobin:
  - i. 2,3-diphosphoglycerate (DPG)
  - ii. pH
  - iii. Temperature
  - iv. Carbon monoxide (CO)
- s. State causes of:
  - i. shift to the left
  - ii. shift to the right

**13. Chapter 14- Mineral and Bone Metabolism**  
(1a-i, ii, v, b-v. 2c-i, iii. d-i)

- a. State the regulation of Calcium:
  - i. Parathyroid hormone (PTH)
  - ii. Calcitonin
  - iii. Protein affects
  - iv. total calcium
  - v. Blood pH
  - vi. Vitamin D
- b. State the regulation of Magnesium: Aldosterone PTH
- c. State the regulation of Phosphate:
  - i. PTH
  - ii. Calcitonin
  - iii. Vitamin D
- d. Define by including the diagnostic level and list causes and symptoms:
  - i. Hypocalcemia
  - ii. Hypercalcemia
- e. Define by including the diagnostic level and list causes and symptoms:
  - i. Hypophosphatemia
  - ii. Hyperphosphatemia

**14. Chapter 15- The Endocrine System**  
(1b-ii, iv. 2c-iii, d-i.)

- a. List factors that affect hormone levels other than endocrine diseases:
  - i. Emotional stress
  - ii. Time of day
  - iii. Menstrual cycle
  - iv. Menopause
  - v. Food intake/diet
  - vi. Hormone therapy
  - vii. Drugs
- b. Define endocrinology associated terminology:
  - i. Hormone
  - ii. Endocrine
  - iii. Releasing factor/hormone
  - iv. Tropic hormone
  - v. Effector (non-Tropic) hormone
  - vi. Glucocorticoid
  - vii. Mineralocorticoid
  - viii. Diurnal variation
- c. State the most common screening and diagnostic testing for hyperthyroid disorders: Grave's disease
- d. List relevant hormone and/or metabolite determinations in Thyroid Testing:
  - i. TSH

- ii. Free T4
  - iii. free T3
  - iv. reverse T3
  - v. TBG
  - vi. Antithyroid antibodies
- e. List relevant hormone and/or metabolite determinations in Adrenal Testing:
- i. Cortisol
  - ii. Urinary/primary free cortisol
  - iii. ACTH
  - iv. DHEA-S
  - v. Aldosterone
  - vi. Renin
  - vii. Catecholamines
  - viii. Vanillylmandelic acid (VMA)
  - ix. metanephrines
- f. List relevant hormone and/or metabolite determinations in Infertility Testing:
- i. FSH
  - ii. LH
  - iii. Testosterone
  - iv. Progesterone
  - v. Estrogens
- g. State the most common screening and diagnostic testing for hypothyroid disorders:
- i. Hashimoto's thyroiditis
  - ii. Myxedema
  - iii. Congenital
- h. State the source and intended effect of protein hormones: Growth hormone
- i. Adrenocorticotrophic hormone (ACTH)
  - ii. Thyroid stimulating hormone (TSH)
  - iii. Follicle stimulating hormone (FSH)
  - iv. Luteinizing hormone (LH)
  - v. Prolactin (PRL)
  - vi. Antidiuretic hormone (ADH)/vasopressin
  - vii. Calcitonin
  - viii. Parathyroid hormone (PTH)
  - ix. Insulin
  - x. Glucagon
  - xi. Human chorionic gonadotropin (HCG)
- i. State the source and intended effect of steroid hormones:
- i. Cortisol
  - ii. Aldosterone
  - iii. Androgens
  - iv. Testosterone
  - v. Dehydroepiandrosterone (DHEA)
  - vi. Dehydroepiandrosterone-sulfate (DHEA-S)
  - vii. Progesterone
  - viii. Estrogens/estradiol/estriol
- j. State the source and intended effect of amine hormones:
- i. Catecholamines
  - ii. Thyroxine (T4)
  - iii. Triiodothyronine (T3)
  - iv. Serotonin/5-hydroxyindolacetic acid (5-HIAA)
- k. List disease states and disorders associated with endocrine metabolism
- 15. Chapter 17- Pancreas**  
**(1a-i, ii, v, b-v. 2c-i, iii)**
- a. Summarize the most common noninvasive tests for assessing pancreatic exocrine insufficiency:
- i. pancreatic elastase-1

- ii. pancreatic chymotrypsin
- iii. pancreatic serum enzymes
- iv. breath test (C-mixed triglyceride test)
- v. urinary amylase
- vi. fecal fat
- vii. phospholipase A2
- viii. NBT-PABA
- ix. fecal elastase.

- b. Summarize briefly diabetes mellitus, the major endocrine pancreatic disease.
- c. Outline Ranson's indicators of severity in acute pancreatitis.
- d. Summarize the etiology of cystic fibrosis.

**16. Chapter 18- Cardiac Function**

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

- a. Identify a normal CK isoenzyme pattern and the typical pattern following a myocardial infarction (MI).
- b. List five factors that define an ideal cardiac biomarker.
- c. Define hs-CRP relative to cardiac usefulness.
- d. Discuss the advantages of point-of-care testing (POCT) for cardiac biomarkers.
- e. State the origin and the usefulness in the detection of and risk assessment for a MI:
  - i. CK/MB
  - ii. Myoglobin
  - iii. Troponin
  - iv. hs-CRP
  - v. Lp(a)
  - vi. Homocysteine

**17. Chapter 19- Liver Function**

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

- a. List diseases associated with bilirubin metabolism:
  - i. Prehepatic jaundice (neonatal/hemolytic anemia):
    - a) Dubin-Johnson syndrome
    - b) Rotor's
    - c) Crigler-Najjar
  - ii. Hepatitis
  - iii. Cirrhosis
  - iv. Posthepatic jaundice
- b. State basic concepts relating to the significance of bilirubin:
  - i. Heme catabolism
  - ii. Bilirubin conjugation
- c. State methods of analysis for total/direct bilirubin
- d. State the usefulness of ammonia measurement
- e. Explain ammonia synthesis and mode of excretion
- f. List methodologies for ammonia; For the most common methods, state the principle of the chemical reaction, sample type, reference interval, most common interfering substances/sources of error.

**18. Chapter 20- Iron, Porphyrins, and Hemoglobin**

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

- a. State the physiologic function and distribution of Iron
- b. State the regulation of Iron:
  - i. Iron Intestinal absorption
  - ii. Transferrin
  - iii. Serum iron Ferritin

**19. Chapter 21- Therapeutic Drug Monitoring**

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

- a. Define the TDM-associated terminology:
  - i. Therapeutic drug monitoring
  - ii. Toxicology
  - iii. Steady State

- iv. Half-life ( $t_{1/2}$ )
  - v. Therapeutic range
  - vi. Peak and trough
  - vii. Drugs of abuse
  - viii. Emergency toxicology
  - ix. Chronic poisoning
  - b. List factors that influence toxicity
  - c. Contrast chemical, generic, and trade name nomenclature for drugs.
  - d. Explain and demonstrate proper specimen collection: Time of blood draw relative to last dose.
- 20. Chapter 22- Toxic Substances**  
**(1b-ii, iv. 2c-iii, d-i.)**
- a. State the physiologic function and distribution of copper.
  - b. Explain the usefulness of screening methods.
  - c. Requirements for legal samples, Requirements for forensic samples
- 21. Chapter 23- Nutrition and Vitamins**  
**(1a-i, ii, v, b-v. 2c-i, iii)**
- a. List the fat-soluble vitamins.
  - b. Correlate disease states with vitamin deficiencies.
- 22. Chapter 24- Tumor Markers**  
**(1a-i, ii, v, b-v. 2c-i, iii)**
- a. Describe the purpose and function of the immunosurveillance system for tumor recognition.
  - b. List and discuss antigens that are associated with human tumors:
    - i. Carcinoembryonic antigen (CEA)
    - ii. Alpha-fetoprotein (AFP)
    - iii. Prostate-specific antigen (PSA)
    - iv. Beta-2-microglobulin
    - v. HCG
    - vi. CA 125
    - vii. CA 19-9)
- 23. Chapter 26- Pediatrics**  
**(1a-i, ii, v, b-v. 2c-i, iii)**
- a. Define genetic disease
  - b. Categorize and list examples of genetic diseases:
    - i. Chromosomal aberration
    - ii. Inborn errors of metabolism
- 24. 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. Define statistical data for quality control and statistical analyses
  - g. Calculate and utilize statistical data for quality control and statistical analyses:
    - i. Mean
    - ii. Median
    - iii. Mode
    - iv. Standard Deviation
    - v. Coefficient of Variation
    - vi. Confidence Limits
  - h. Describe the proper labeling when a reagent or control is opened and/or reconstituted in the lab.
    - i. Describe why controls are important in the clinical lab.
  - j. Evaluate quality control data:
    - i. Select control materials for use
    - ii. Analyze data for acceptability
    - iii. If data unacceptable, identify problems or causes
    - iv. Follow corrective action to resolve problem and document



- k. Verify or establish reference intervals (Normal ranges)
- l. List reference intervals for major analytes.

## 25. Lab #2

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

- a. Perform routine maintenance checks on all spectrophotometers
- b. Describe the operation of a spectrophotometer:
  - i. Function controls
  - ii. Standard curves
- c. Perform test procedures on standards, controls, and unknowns:
  - i. Calculate, if necessary, and record quality control (QC) data
  - ii. Evaluate quality control data (QC)
  - iii. Accept/reject results
  - iv. Take appropriate corrective action, if necessary
  - v. Report results, if acceptable
  - vi. Correlate test results with other laboratory test and patient diagnosis.
- d. Perform test procedures on standards, controls, and unknowns:
  - i. Evaluate quality control data (QC)
  - ii. Accept/reject results
  - iii. Take appropriate corrective action, if necessary
  - iv. Report results, if acceptable
- e. Perform carbohydrate analyses according to established laboratory protocol:
  - i. Determine acceptability of results
  - ii. Report results according to laboratory protocol
  - iii. Perform, document, and evaluate quality control
- f. Explain the purpose of the blank in spectrophotometry.
- g. Discuss the importance and the reason we are required to run controls.
- h. Explain Beer's law as it relates to the activity performed today. (How the intensity of the observed color relates to concentration)
- i. Explain the difference in wavelengths used on spectrophotometer. List the wavelength used in today's procedures.
- j. Identify all parts of the spectrophotometer we used today (light source, monochromator, cuvette, photodetector, output).
- k. Discuss PHYSICAL factors of the patient that have an effect on the concentration of cholesterol in the blood.
- l. Discuss where cholesterol is found in the body.
- m. List common mistakes that can be made in spectrophotometry testing.
- n. Explain maintenance/quality assurance of instrumentation:
  - i. Stray light
  - ii. Sensitivity
  - iii. Linearity
  - iv. Wavelength calibration

## 26. 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.
- i. Describe the basic components of electrophoresis:
  - i. Support media: cellulose acetate/gel/agarose
  - ii. Chamber Buffer
  - iii. Electrodes
  - iv. Power supply
  - v. Densitometer

- j. State basic concepts of electrophoresis:
  - i. Principles of electrophoresis Voltage
  - ii. current
  - iii. pH
  - iv. Ionic strength
  - v. Buffers
  - vi. Temperature
- k. Describe the operation of electrophoresis:
  - i. Sample application
  - ii. Time
  - iii. Temperature Voltage
  - iv. current
  - v. Stains
- l. Perform analyses according to laboratory procedure:
  - i. Accept/reject results
  - ii. Evaluate and record quality control data
  - iii. Report results, if acceptable

**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 Assignments
2. Chapter 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 1-4, 6-9
2. Chapters 10-15, 17-18
3. Chapters 19-24
4. Lab #1 in lab assignment
5. Lab #2 in lab assignment
6. Lab #3 in lab assignment

**Assessment(s):**

1. Chapter quizzes
2. Lab 1-3 pre and post quizzes
3. 3 proctored exams
4. Proctored final exam

**Course Grade:**

The grading scale for this course is as follows:

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

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

### Lecture

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

### 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.