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. Select appropriate method of water purification: distilled, deionized, reverse osmosis.
      a. Explain types of (CLSI) reagent grade water.
      b. Identify attributes, advantages, advantages and disadvantages of specific type of glassware
   c. Define:
      i. units of systems of measurement (Metric and SI)
      ii. dilutions (serial and ratio),
   d. Describe basic mechanisms and types of balances.
   e. Define balancing terminology: capacity, sensitivity, precision, readability, tare
   f. Operate balances: leveling, handling weights, pan and/or beam arrest, weight paper or boats,
      cleanliness, temperature, elimination of drafts, vibrations, etc
   g. Calibrate balances following established laboratory procedure.
   h. Perform routine maintenance checks on all balances.
   i. Perform basic calculations:
2. Chapter 2 - Safety in the Clinical Chemistry Laboratory
(1a-ii, i, 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
   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 Transcription 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 Cortisol
   iii. Adrenocorticotropic hormone (ACTH)
   iv. Epinephrine
   v. Thyroxine
   vi. Growth hormone (GH)
   vii. 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. Hypogammaglobulinemia
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. Hypogammaglobulinemia 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 1
      x. inhibitor
      xi. Kinetic
      xii. International Unit
      xiii. Isoenzyme
      xiv. Vmax
      xv. Km
      xvi. Energy of Activation (EA)
      xvii. Michaelis-Menten Constant
First-Order Kinetics

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 of 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
   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. Hypermartremia
   iii. Hypokalemic
   iv. Hyperkalemia
   v. Hypochloremia
   vi. Hyperchloremia
   vii. Increased levels of bicarbonate Decrease 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. pCO2 electrode
      ii. pO2 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+ secretion
   ii. Sodium-potassium exchange/secretion of K+
   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 HCO3−)
   ii. Hypoventilation if bicarbonate increased (increased pCO2 if increased HCO3−)
   iii. Hyperventilation if bicarbonate decreased (decreased pCO2 if decreased HCO3−)
   iv. Renal compensation with primary respiratory change (change in CO2)
   v. Retention of bicarbonate, if CO2 is retained
   vi. Excretion of bicarbonate, if CO2 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 CO2
   ii. Factors affecting pCO2 or H2CO3

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
Renin
Catecholamines
Vanillylmandelic acid (VMA)
metanephrines

List relevant hormone and/or metabolite determinations in Infertility Testing:

FSH
LH
Testosterone
Progesterone
Estrogens

State the most common screening and diagnostic testing for hypothyroid disorders:

Hashimoto’s thyroiditis
Myxedema
Congenital

State the source and intended effect of protein hormones: Growth hormone

Adrenocorticotropic hormone (ACTH)
Thyroid stimulating hormone (TSH)
Follicle stimulating hormone (FSH)
Luteinizing hormone (LH)
Prolactin (PRL)
Antidiuretic hormone (ADH)/vasopressin
Calcitonin
Parathyroid hormone (PTH)
Insulin
Glucagon
Human chorionic gonadotropin (HCG)

State the source and intended effect of steroid hormones:

Cortisol
Aldosterone
Androgens
Testosterone
Dehydroepiandrosterone (DHEA)
Dehydroepiandrosterone-sulfate (DHEA-S)
Progesterone
Estrogens/estradiol/estriol

State the source and intended effect of amine hormones:

Catecholamines
Thyroxine (T4)
Triiodothyronine (T3)
Serotonin/5-hydroxyindolacetic acid (5-HIAA)

List disease states and disorders associated with endocrine metabolism

Chapter 17 - Pancreas

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
fecal elastase.

Summarize briefly diabetes mellitus, the major endocrine pancreatic disease.
Outline Ranson’s indicators of severity in acute pancreatitis.
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 (t1/2)
      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 is 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, monochromater, 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  
   ii. Voltage  
   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:

<table>
<thead>
<tr>
<th>Lecture Grade</th>
<th>Lab Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Exams 50%</td>
<td>Pre-Lab Quizzes 10%</td>
</tr>
<tr>
<td>Quizzes 15%</td>
<td>Case Assignments 20%</td>
</tr>
<tr>
<td>Homework Assignments 20%</td>
<td>In-Lab Assignments 20%</td>
</tr>
<tr>
<td>Final Exam 15%</td>
<td>Practicals 50%</td>
</tr>
</tbody>
</table>

Texts, Materials, and Supplies:
- textbook
• other materials

Required Readings:
• 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.

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 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.