MLAB 2401 - Clinical Chemistry MLAB 2401.401 Course Syllabus

Description
An introduction to the principles, procedures, physiological basis, and significance of testing performed in Clinical Chemistry.
Prerequisites CHEM 1405 or CHEM 1411

Semester Offered
Fall only
Credits 4
Lecture Hours 2
Lab Hours 6
Extended Hours 0
Contact Hours 128
State Approval Code 5110040000
Instructor Name Antiquene Nichols
Semester/Year Fall 2024

Meeting Time and Location
MLAB 2401 - Online—students are expected to spend at least 3-4 hours per week** reading, reviewing, and participating in assigned activities for successful completion of this course.

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) for instructions about continuing courses remotely, CANVAS for each class for course-specific communication, and Panola College email for important general information.

Student Basic Needs
Unexpected circumstances may arise, but Panola College offers various resources to support students. If you need mental health services or are facing challenges with transportation, affording class materials and supplies, or accessing food regularly—issues that may impact your class performance—please visit panola.edu/resources.

Class Attendance
Regular and punctual attendance of classes and laboratories is required of all students. When a student has been ill or absent from class for approved extracurricular activities, he or she should be allowed, as far as possible, to make up for the missed work. If a student has not actively participated by the census date, they will be dropped by the instructor for non-attendance. This policy applies to courses that are in-person, online, hybrid, and hyflex.

Attendance in online courses is determined by submission of an assignment or participation in an activity. According to federal guidelines, simply logging into a distance learning course without participating in an

academic assignment does not constitute attendance. Distance learning is defined as when a majority (more than 50%) of instruction occurs when the instructor and students are in separate physical locations. Students must engage in an academic activity prior to the course census date.

When an instructor feels that a student has been absent to such a degree as to invalidate the learning experience, the instructor may recommend to the Vice President of Instruction that the student be withdrawn from the course. Instructors may seek to withdraw students for non-attendance after they have accumulated the following number of absences:

Fall or spring semesters:

3 or more class meeting times per week - 5 absences

2 class meeting times per week - 3 absences

1 class meeting per week - 2 absences

The student is responsible for seeing that he or she has been officially withdrawn from a class. A student who stops attendance in a class without officially withdrawing from that class will be given a failing grade; consequently, the student must follow official withdrawal procedures in the Admissions/Records Office.

Please note: Health Science and Cosmetology courses may require more stringent attendance policies based on their accreditation agencies. Please see the addendum and/or program handbook for further information concerning attendance.

Pregnant/Parenting Policy

Panola College welcomes pregnant and parenting students as a part of the student body. This institution is committed to providing support and adaptations for a successful educational experience for pregnant and parenting students. Students experiencing a need for accommodations related to pregnancy or parenting will find a Pregnancy and Parenting Accommodations Request form in the Student Handbook or may request the form from the course instructor.

Artificial Intelligence (AI) Course Policy

Broader use of Generative AI permitted within the course.

The use of artificial intelligence (AI) tools, including ChatGPT, is permitted in this course for students who wish to use it. Students must cite AI-generated material that informs their work. Using an AI tool to generate content without proper attribution qualifies as academic dishonesty.

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, advantages 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 have 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^o to C^o), (C^o to F^o).
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) have 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 have viii. nutritional status
viii. fasting
ix. post prandial
x. Exercise
xi. Position
xii. Posture
xiii. Sample processing
xiv. identification
xv. Method
xvi. interfering substances/sources of error
xvii. 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 have 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 have 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 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. 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 I
        x. inhibitor
        xi. Kinetic
        xii. International Unit
        xiii. Isoenzyme

xiv. Vmax
xv. Km
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 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 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. 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
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. Adrenocorticotropic 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 (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 have 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

Late assignments will be docked 15%.

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 are assigned and assessed during the semester and used to calculate the student's final grade.

Course Grade

The grading scale for this course is as follows:

Lecture Grade = 2/3 of grade	**Lab Grade = 1/3 of grade**
Major Exams 40%	Pre-Lab Quizzes 10%
Quizzes 20%	Case Assignments 20%
Homework Assign/Projects/Discussion 20%	In-Lab Assignments 40%
Final Exam 20%	Practicals 20% Post-Lab 10%

Texts Materials, and Supplies

Clinical Chemistry	Required	9780134413327	Sunheimer/2ND	Pearson

Required Readings

Clinical Chemistry	Required	9780134413327	Sunheimer/2ND	Pearson

Addendum

Lab Information

υ **Lab Dates:**
υ September 21, 2024
υ October 26, 2024
υ November 9, 2024
υ December 07, 2024

υ Hematology Lab: 8:00am – 11:00am
υ Clinical Chemistry Lab: 11:00am - 1:00pm
υ Lunch Break: 1:00pm – 2:00pm
υ Clinical Micro Lab 2:00pm – 5:00pm
υ Immunohematology Lab: 5:00pm – 8:00pm

All Proctored Exams will require Proof of Identification

Other

- Courses conducted via video conferencing may be recorded and shared for instructional purposes by the instructor.
- For current texts and materials, use the following link to access bookstore listings: https://www.panolacollegestore.com.
- For testing services, use the following link: https://www.panola.edu/student-services/studentsupport/academic-testing-center.
- 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 Charles C. Matthews Student Center or go to https://www.panola.edu/studentservices/student-support/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: https://www.panola.edu/ (located on at the bottom under student)

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 timeline 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 databases 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.