SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

ACADEMIC AFFAIRS

Course Number:	MLT-212	Department:	Clinical Lab Science
Course Title:	Clinical Chemistry	Semester: Fall	Year: 2021

COURSE DESCRIPTION:

This course is designed to acquaint the student with the theory and function of the clinical chemistry laboratory. Course of study includes analysis of blood and body fluid during routine and emergency testing in the clinical chemistry laboratory. Manual and automated procedures in testing are stressed as well as preparation of solutions, interpretation of procedures, and analysis of results. Prerequisite MLT-118, 120, 124, 126 Co-Requisite MLT-212L

Objectives/Competencies

Course Objective	Competencies
Upon the completion of each lecture section, the student will be able to fulfill the section objectives as outlined in the assigned text and materials and/or defined by verbal instruction to the level identified in the MLT Program Matriculation Policy.	
Basic Chemistry and Biochemistry	• Describe the function of clinical chemistry and the relationship to chemistry results in the diagnosis of disease. • Describe and apply the basic chemistry concepts of: solution properties, colligative properties, redox potential and conductivity. • Describe and apply the basic biochemistry concepts including: atomic and molecular structure, chemical bonds, pH, and organic compounds. • Describe the classifications used for reagent grade water. • List and describe the most common reagents used within the chemistry laboratory.
Spectrophotometry and Beer's Law	• Explain the principle of spectrophotometry. • Explain and interpret Beer's Law. • Solve for concentration if unknowns using Beer's Law and standard curve graph.

Carbohydrates & Diabetes	• List and define the major classes of carbohydrates and give examples of each. • Recognize the structure of the common stereoisomers of carbohydrates. • Review the digestion of carbohydrates from the role of salivary amylase to the final CO2 and H2O. • Define the most common terms associated with carbohydrate metabolism. • Briefly summarize the three major biochemical pathways associated with carbohydrate metabolism. • List the various hormones that affect carbohydrate metabolism and summarize their functions (gland and action). • Compare and contrast the main characteristics of the two major types of diabetes mellitus (DM) (type 1 and type 2). • Review other carbohydrate disorders, including: Gestational diabetes, other types of diabetes (secondary diabetes mellitus), and impaired glucose tolerance. • List and explain the changes that occur in the body with hyperglycemia (complications of DM). • List the American Diabetes Association criteria for the diagnosis of DM, impaired glucose tolerance, and impaired fasting glucose. • Define hypoglycemia and discuss the common causes of drug-induced, reactive, and fasting hypoglycemia. • List the three factors in Whipple's triad. • Summarize the common enzymatic glucose methodologies: glucose oxidase and hexokinase • Correlate diseases and conditions that result in carbohydrate disturbances with laboratory findings and classify them using standard terminology.
Enzymes	• Define enzyme and list general functions of enzymes. • Write the formula for enzyme-catalyzed reactions. • List the six major groups of enzymes and the reactions catalyzed by each group. • Review enzyme catalysis, including the role of enzymes in decreasing activation energy. • Define apoenzyme, prosthetic groups, and holoenzyme. • Define cofactor, coenzyme, and metalloenzyme and give examples of each. • Define first-order and zero-order reactions. • Explain how various factors affect enzyme reactions—for example, pH, temperature, and substrate concentration. • Examine the differences among competitive, noncompetitive and uncompetitive inhibition. • Summarize the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for all clinically significant enzymes. • Review the clinical significance of the three major CK isoenzymes (heart, muscle, and brain), including their dimeric composition and major sources. • Identify a normal CK isoenzyme pattern and the typical pattern following a myocardial infarction (MI). • Briefly examine other CK isoenzyme procedures—for example, electrophoresis and immunoinhibition. • Differentiate the five major LD isoenzymes, including their tetrameric composition and the major tissue(s) involved.

Lipids, Lipoprotiens and Cardiovascular Disease	• Review cholesterol metabolism, absorption, synthesis, and catabolism. • Outline and describe classes of clinically significant lipids. • Define unsaturated and saturated fatty acids. • List and explain the role of the major apolipoproteins. • Summarize lipid metabolism, including exogenous, endogenous, and reverse cholesterol pathways. • List the major components and the percentage composition of the major lipoproteins—for example, apoproteins, cholesterol, and triglycerides. • Review the four major lipoproteins and their density and function. • List conditions associated with hypercholesterolemia and hypocholesterolemia. • Summarize the major cholesterol methodologies. • Identify causes of hypertriglyceridemia and hypotriglyceridemia. • Review triglyceride methodologies. • Summarize HDL-C methodologies. • Calculate LDL-C using the Friedewald formula. • Examine Lipoprotein (a) [Lp(a)] and its clinical significance. • Relate the clinical significance of lipid and lipoprotein values in the assessment of coronary heart disease.
Non-protein Nitrogen & Renal Function Tests	• List the major components of nonprotein nitrogen (NPN). • Identify the source of blood urea nitrogen (BUN) and the major organ of the urea cycle. • Review the most common BUN methodologies including chemical reactions and specificity. • State the reference range for BUN. • Convert BUN to urea and urea to BUN. • Define azotemia and uremia. • Outline common causes of prerenal, renal, and postrenal azotemia. • Identify causes of a decreased BUN. • Explain the source of creatinine (CR). • Explain the Jaffe reaction and creatinase procedures. • Cite the reference range for creatinine. • Classify sources of increased creatinine. • Calculate the BUN:CR ratio and discuss its clinical significance. • Summarize the formation and excretion of uric acid. • Review the major uric acid methodologies. • Explain primary hyperuricemia (gout), including causes (precipitating factors) and treatment. • Outline causes of secondary hyperuricemia. • Review the renal clearance tests, including creatinine, the protein:creatinine ratio, and inulin clearance. • Calculate a creatinine clearance given the relevant data. • Summarize the formation and excretion of ammonia. • Describe the major ammonia methodologies and the preanalytic considerations.

	• List the clinical significance of ammonia level in patient assessment. • Summarize the etiology and clinically significant laboratory findings of major renal diseases.
Electrolytes	• List examples of electrolytes found in plasma water, interstitial fluid, and intracellular water. • Identify the analytes required to calculate anion gap and osmolality. • State the specific fluid compartments that make up total body water. • Distinguish between serum and plasma. • State the principle differences between interstitial fluid and plasma, major intracellular cation, major extracellular cation, major extracellular anion • Identify four methods used to measure chloride in sweat • Identify major methods for analysis of each major electrolyte • Describe and define typical laboratory findings of the various disease states associated with electrolyte imbalance. • Given data, interpret the levels and determine the most probable disease state.
Blood Buffer Systems	• State the Henderson–Hasselbalch equation and identify the respiratory and metabolic components. • List the components and effects of the four major body buffer systems. • Identify the five ways in which carbon dioxide is carried in blood. • Identify preanalytical sources of errors in blood-gas analysis. • Identify the specimen of choice discuss the proper handling of specimen for blood-gas analysis. • Describe and define typical laboratory findings of the various disease states associated with blood buffer imbalance. • Given data, interpret the levels and determine the most probable disease state.
Vital Minerals	• Identify three forms of calcium as they exist in circulation. • Describe three distinct methods for measuring total serum calcium. • Identify two main causes of hypercalcemia. • Indicate the source of parathyroid hormone. • Discuss the feedback effects of PTH on calcium and phosphorus levels in circulation. • List three functions of vitamin D. • Describe the structure, source, and function of calcitonin. • Identify two chemical compounds used to measure inorganic phosphate in serum. • Describe the analytic methods used to measure inorganic phosphate in serum or plasma. • Identify three compounds used to measure magnesium in serum. • Describe the analytic methods used to measure magnesium in serum or plasma. • Describe and list several biochemical markers for bone disorders. • Explain the biochemistry of iron in humans. • Explain how iron is transported in the human body. • Outline the metabolism of iron and iron-containing compounds. • Cite examples of specific diseases associated with iron deficiency and iron overload.

	• Describe the analytic methods used to measure iron in serum or plasma.
Liver Assessment	• Describe the location and anatomy of the liver. • Describe major liver functions and list examples of each category. • Summarize the main steps of bilirubin metabolism . • Differentiate conjugated and unconjugated bilirubin, including composition & solubility in water& alcohol. • Explain the clinical significance of bilirubin, including levels of total, direct, and indirect bilirubin. • Describe the analytic methods used to measure total, indirect and direct bilirubin in serum or plasma. • Define jaundice, and identify and list examples of the three major categories of jaundice. • Explain the enzyme deficiency or metabolic defect involved in Crigler–Najjar, Gilbert, Dubin–Johnson, and Rotor syndromes. • Identify type of virus, route of transmission, at risk populations, incubation period, and recovery rate for the following types of viral hepatitis: A, B, C, and D. • Briefly outline the progression in alcoholics from alcoholic fatty liver to alcoholic hepatitis to alcoholic cirrhosis. • Summarize the clinical significance of increased ammonia. • Briefly outline other liver function tests: enzymes, albumin, urinary and fecal urobilinogen, and prothrombin time.
Pancreatic Assessment	• Describe the location and anatomy of the pancreas. • Identify the islets of Langerhans and the major cells found in the islets of Langerhans. • Summarize the endocrine and exocrine functions of the pancreas. • Explain the major invasive test for assessing exocrine pancreatic function secretin–cholecystokinin (CCK). • 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. • Identify and interpret result from insulin and C-peptide for monitoring the pancreas endocrine function • Summarize the signs, symptoms and clinical findings of diabetes mellitus, the major endocrine pancreatic disease. • List the two primary causes of acute pancreatitis. • Outline Ranson's Indicators of Severity in acute pancreatitis. • Describe the etiology and prognosis of chronic pancreatitis. • Summarize the etiology of cystic fibrosis.
Cardiac Assessment	• Explain the inflammatory response associated with atherosclerosis. • Define acute coronary syndrome (ACS). • List five factors that define an ideal cardiac biomarker. • Name and describe the use of clinically significant cardiac biomarkers. • Define hs-CRP and describe its role in assessing cardiac function. • For each of the following cardiac events, identify the biomarkers used to evaluate the event and describe how they are interpreted: ASVD, AMI, Congestive Heart failure, Acute Coronary Syndrome, Acute Myocardial Ischemia, Hypertensive Heart Disease

	• Enumerate the pros and cons for using point-of-care testing (POCT) for cardiac biomarkers. • Discuss the temporal relationship and concentration of each the following relevant to acute myocardial infarction (AMI): Myoglobin, CK-MB, Cardiac troponin I
Endocrinology	• List and describe the three major classes of hormones and give examples of hormone in each class. • Define the hormone control mechanisms including negative feedback loop, pulsivity and cyclivity. • Describe the location and function of the major endocrine gland. • Identify hormones released by the thyroid gland, adrenal glands, pituitary, hypothalamus and gonadal tissue. • For each of the following hormones, list the producing tissue, target tissue(s) and the function: thyroxine, prolactin, testosterone, antidiuretic hormone, oxytocin, growth hormone, aldosterone, cortisol, epinephrine, luteinizing hormone, follicle stimulating hormone • Describe clinical manifestations and associate abnormal laboratory results with a disease or syndrome associated with hormone imbalance. • State the methods used to quantitate the amount of hormones in blood.
Tumor Markers	• Define all terms associated with tumors and tumor markers. • List five roles of tumor markers in the assessment of cancers. • Describe four different methodologies that may be used to detect markers associated with malignancy. • Define terms associated with the predictive value of an assay. • Given data, select the appropriate formula and calculate assay sensitivity, specificity and predictive value. • List commonly used tumor markers and state their clinical significant to the following types of cancer: Prostate disease/cancer, Colorectal cancer, Ovarian cancer, Breast cancer, Bladder cancer, Pancreatic cancer • Describe the major consideration in tumor marker test ordering and performance.
Therapeutic Drug Monitoring	• Describe the purpose of therapeutic drug monitoring. • Identify the four principle biological events associated with pharmacokinetics. • Identify the factors that influence drug absorption. • List examples of conjugation compounds. • Discuss two mechanisms associated with drug excretion. • Identify two factors that significantly affect steady state. • Identify appropriate specimens for selected therapeutic drugs and pre-analytical considerations. • List the 8 therapeutic drug category and describe the general therapeutic action/function. • For each therapeutic drug category: • Name the chemical, generic, and trade name nomenclature for drugs • Describe the specific function, therapeutic range and route of absorption/administration • Give examples of additional laboratory tests to evaluate organ function(s) in patients taking prescribed medications.

Toxicology	• Describe the requirements and process for analysis of toxic substances. • Identify methods and instrumentation used to measure selected toxic substances in clinical laboratories. • Describe the dose-rate relationship as it applies to toxic substances. • List 4 examples of Type 1 and Type 2 toxic substances measured in clinical laboratories. • Identify the acidic or ketone metabolites of the following compounds: Ethanol, Methanol, Ethylene glycol, Isopropyl alcohol, Salicylate • Describe the rationale and method for analysis of Drug of Abuse. • List the major classes of drugs that are included in urine-drugs-of-abuse screening procedures and list one drug from each class. • Identify 2 sources of lead that may result in high blood levels. • List six substances frequently used as adulterants in urine specimens for drug abuse testing.
Case Studies Review & Disease Fact Sheet Oral Presentations	• Analyze case studies with attention to problem solving and trouble shooting. • Research and report on one Biochemical disorder or diseases