SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

ACADEMIC AFFAIRS

Course Number:	CLLS 302	Department:	Clinical Laboratory Science
Course Title:	Clinical Chemistry	Semester:	Spring Year: 2014

Competencies /Objectives

Competencies	Course Objective
1. Student will apply all safety protocols, universal precautions when practicing laboratory skills. (Re: CLLS 103)	▪ Practice all safety protocols and apply universal precautions when performing laboratory skills in the student laboratory and on clinical affiliation.
2. Student will possess a complete understanding of the role of the chemistry clinical chemistry laboratory.	▪ Describe the function of clinical chemistry and the relationship to chemistry results in the diagnosis of disease.
3. Student will comprehend the basic concepts of chemistry and biochemistry (CHEM-101 and BIOL-148).	▪ 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, organic compounds.
4. Student will possess a complete knowledge of the principles and function of basic laboratory equipment, supplies and practices.	▪ List and describe the most common reagents used within the chemistry laboratory. ▪ Discuss the types and function of basic laboratory

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	equipment. ▪ Demonstrate proficiency in the operation of all basic laboratory equipment. ▪ Define the types of separation techniques used in clinical chemistry. ▪ Identify the types of specimens analyzed within the clinical chemistry laboratory. ▪ Describe the process of specimen handling and possible variability in specimens.
5. Student will review spectrophotometry and the application of 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.
6. Student will comprehend the function of carbohydrates in the body, normal and abnormal metabolism and chemical methods of testing glucose and associated analytes.	• 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

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	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.
7. Student will comprehend the function of proteins in the body, normal and abnormal metabolism, classification and chemical methods of testing proteins and associated analytes.	• Describe protein structure. • List the major functions of protein. • Discuss clinically significant proteins, including function, clinical significance, and protein band in electrophoresis.

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	• Explain the principle of major protein methodologies. • Describe urinary protein screening, clinical significance, and methodologies. • Discuss the major components of protein electrophoresis. • List in order the protein electrophoresis bands and approximate percentages of total protein. • Explain changes in the protein electrophoresis associated with the more common causes • of abnormal patterns. • Calculate A/G ratio. • Correlate diseases and conditions that result in amino acid and protein disturbances with laboratory findings and classify them using standard terminology.
8. Student will comprehend the function of enzymes in the body, normal and abnormal metabolism, classification and chemical methods of analysis.	• 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—

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	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 the following cardiac enzymes: creatine kinase (CK), creatine kinase isoenzymes, and lactate dehydrogenase (LD). • 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. • Summarize the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for the following liver enzymes: aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatases (ALP). • Differentiate the five major LD isoenzymes, including their tetrameric composition and the major tissue(s) involved. • Summarize the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance,

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	and reference ranges for the following biliary tract enzymes: gammaglutamyl transferase (GGT) and 5'-nucleotidase (5'-NT). • Relate the reaction catalyzed (including activators and coenzymes), methodologies, clinical significance, and reference ranges for the following pancreatic and liver enzymes: amylase (AMY), lipase (LPS), trypsin (TRY), and chymotrypsin (CHY).
9. Student will comprehend the function of lipids in the body, normal and abnormal metabolism, classification and chemical methods of analysis.	• 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

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	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.
10. Student will comprehend the function of kidney function tests in the body, normal and abnormal metabolism, factors that affect the kidney in a diseased state, classification and chemical methods of analysis.	• 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

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	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.
11. Student will comprehend the function of the blood buffer systems, minerals, and electrolytes in the body, normal and abnormal metabolism, classification and chemical methods of analysis.	• 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.

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	• Select the electrolyte associated with each of the following:
	  ○ major intracellular cation
	  ○ major extracellular cation
	  ○ major extracellular anion
	• Identify four methods used to measure chloride in sweat.
	• Identify methods and instrument techniques used to measure electrolytes in body fluids.
	• Name the four colligative properties of solutions.
	• 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 the various disease states associated with blood buffer imbalance.
	• Given data, interpret the levels and determine the most probable disease state.

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12. Student will comprehend the function vital minerals in the body, normal and abnormal metabolism, classification and chemical methods of analysis.	• 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

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13. Student will understand the function of the liver specific to the physiologic, metabolic, excretory, and secretary functions.	deficiency and iron overload. • Describe the analytic methods used to measure iron in serum or plasma. • Review the location and anatomy of the liver. • Review major liver functions and list examples of each category. • Summarize the main steps of bilirubin metabolism from the breakdown of hemoglobin to excretion as urobilin. • Differentiate conjugated and unconjugated bilirubin, including composition and solubility in water and alcohol. • Review 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 examine the progression in alcoholics from alcoholic fatty liver to alcoholic hepatitis to alcoholic

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14. Student will understand the function of the pancreas specific to the physiologic, metabolic, endocrine, and exocrine functions.	cirrhosis. • Summarize the clinical significance of increased ammonia. • Briefly outline other liver function tests: enzymes, albumin, urinary and fecal urobilinogen, and prothrombin time. • Review 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. • Review the two major tests for monitoring the endocrine function of the pancreas: insulin and C-peptide. • Summarize briefly diabetes mellitus, the major endocrine pancreatic disease. • List the two primary causes of acute pancreatitis. • Outline Ranson's indicators of severity in acute pancreatitis.

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15. Student will understand the function of the cardiac specific to the physiologic, metabolic functions as they relate to various cardiac events.	• Briefly review the etiology and prognosis of chronic pancreatitis.
	• Summarize the etiology of cystic fibrosis.
	• Explain the inflammatory response associated with atherosclerosis.
	• Define acute coronary syndrome (ACS).
	• List five factors that define an ideal cardiac biomarker.
	• Identify the clinical usefulness of the following cardiac biomarkers:
	  ○ Lipoprotein (a)
	  ○ Lipoprotein-associated phospholipase A2
	  ○ Oxidized low-density lipoprotein (LDL)
	  ○ Cardiac troponin I and T
	  ○ Brain-type natriuretic peptide and NT-proBNP
	  ○ Ischemia-modified albumin (IMA)
	• Define hs-CRP relative to cardiac usefulness.
	• 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
	• Discuss the advantages of point-of-care testing (POCT)

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16. Student will acquire an understanding of hormones specific to the role in the human body, the glands that produce them, normal and abnormal metabolism, classification and chemical methods of analysis.	for cardiac biomarkers. • Discuss the temporal relationship and concentration of each the following relevant to acute myocardial infarction (AMI): o Myoglobin o CK-MB o Cardiac troponin I • Identify three major types of hormones. • State which of the three classes of hormones characterizes the following compounds: thyroxine, cortisol, parathyroid hormone, epinephrine and estrogen • Define the hormone control mechanisms including negative feedback loop, pulsivity and cyclivity. • Describe the location of the thyroid gland, adrenal glands, pituitary, hypothalamus and gonadal tissue. • Identify the 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: o thyroxine o prolactin o testosterone o antidiuretic hormone o oxytocin o growth hormone

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	○ 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.
17. Student will acquire an understanding of types and clinical significance of tumor markers in medicine today.	• 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 in relation to the following types of cancer. ○ Prostate disease and cancer ○ Colorectal cancer ○ Ovarian cancer

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18. Student will acquire an understanding of the principles of therapeutic drug monitoring and toxicology, the clinical importance, classifications and chemical methods of analysis.	○ Breast cancer ○ Bladder cancer ○ Pancreatic cancer • Describe the major consideration in tumor marker test ordering and performance. • 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 preanalytical considertations. • 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 • Identify examples of additional laboratory tests that may be requested to evaluate organ function(s) in patients taking prescribed medications.

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	• 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: a. Ethanol b. Methanol c. Ethylene glycol d. Isopropyl alcohol e. 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 that are frequently used as adulterants in urine specimens for drug abuse testing.

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17. Student will adhere to all affective behavioral objectives.	**Safety** ▪ Comply with all established laboratory safety regulations including: 1. Standard precautions including PPE use and handwashing. 2. Practice proper handling and disposal of biohazardous materials. 3. Proper handling and disposal of sharps. 4. Exercise proper safety practices when using all laboratory equipment, reagents and chemicals. ▪ Comply with established departmental dress code. **Work Practices and Organization** ▪ Adhere to department attendance policies by arrive to lecture/ laboratory at the expected time, as denoted in the course syllabus. ▪ Follow all written instructions. ▪ Actively listen to verbal instructions. ▪ Ask quality questions (clarifying, analytical and related to task). ▪ Submit neat, legible, organized and complete assignments. ▪ Demonstrate effective time management and complete all tasks within the assignment time frame. ▪ Keep all laboratory work areas neat, clean and in order. ▪ Properly care for and use all laboratory equipment. ▪ Achieve competency and independence in performance of all demonstrated lab skills.

Competencies	Course Objective
	Cooperation and Teamwork ▪ Actively participate in class activities and discussions by: 1. Effectively communicating with class members. 2. Showing respect and consideration for other students and instructors. 3. Willing to share ideas and equally contribute to assigned tasks. ▪ In laboratory sessions: 1. Share resources and equipment. 2. Work cooperatively by adjusting work style and speed. 3. Discuss equitable task allocation and organization prior to performing. **Ethics and Professionalism** ▪ Respond maturely to constructive criticism and instruction and make appropriate modifications. ▪ Seek advice when necessary, admitting limitations when appropriate. ▪ Recognize and admitting errors. ▪ Maintain patient confidentiality according to HIPPA regulations. ▪ Communicate using appropriate terminology and professional procedures. ▪ Display calm demeanor in all circumstances and maintain work quality under stress.