TEXAS A&M UNIVERSITY-CORPUS CHRISTI
Clinical Laboratory Science Program

Course Number & Section: BIMS_4325_001-101
Instructor: Dr. Felix Omoruyi
Class Meeting Time: LEC TR-11:00-11:50 AM
Office: Center for Sciences 130B
LAB R- 8:00-10:50 AM
Hours: M – 12:00 - 1:00 PM
Location: TR-BH 104 & R-CS 228
Office: Center for Sciences 130B
W – 12:00 – 2:00 PM
Fall 2014
R – 2:00 – 4:00 PM
Office Tel.: 825-2473
Phone: 825-2473 (Office)
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BIMS 4325: CLINICAL CHEMISTRY 1
FALL 2014 SYLLABUS

COURSE DESCRIPTION
This course consists of the principles and practice of procedures found in general clinical chemistry laboratory. It includes methodology of diagnostic tests of normal and abnormal human physiology as applied to the diagnosis of pathological conditions.

COURSE GOALS
- To develop an understanding of the principles of selected laboratory instruments
- To develop an understanding of disease processes and the use of laboratory tests in diagnosis, prognosis, and treatment
- To acquire knowledge of the principles of laboratory methods, their uses, and sources of error
- To acquire skill in the use of laboratory equipment and performance of manual analyses

Specific course objectives are attached.

TEXT AND MATERIALS

Disposable lab coats and gloves will be provided for you and are required for all labs. You will not be permitted to work in the lab without these items. You will also need a scientific calculator and a black Sharpie marker.

ACADEMIC INTEGRITY/PLAGIARISM
University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.
DROPPING A CLASS
I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. Please consult with me before you decide to drop to be sure it is the best thing to do. Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. June 20, 2014 is the last day to drop a class with an automatic grade of “W” this term.

CLASSROOM/PROFESSIONAL BEHAVIOR
Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor's ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

STATEMENT OF CIVILITY
Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

COURSE EVALUATION:
The final course grade will be based on three exams, quizzes/attendance and the average of graded lab assignments.
Examination average (3 exams) 45%
Laboratory average 25%
Problem portfolio 15%
Final examination 15%
100%

GRADES
Specific Course and Laboratory objectives are included in the required laboratory workbook. You are expected to read the material that corresponds to the objectives as they are covered. Mastering course objectives will require that you have read the material. You must score ≥ 70% in both LAB and LEC (Exam & Problem Portfolio) components to earn the final passing grade.
The following scale will be used to report grades:

- A 90 - 100
- B 80 - 89
- C 70 - 79
- D 60 - 69
- F below 60

**ACADEMIC HONESTY**

As stated in the university catalog, "University students are expected to conduct themselves in accordance with the highest standards of academic honesty." Therefore, cheating will not be tolerated and will result in a failing grade for the course.

**Unannounced quizzes may be given throughout the course of the semester.**

There is no provision for making up late work and/or missed exams or quizzes. A grade of zero will be entered for any late or missed exam or quiz due to an unexcused absence. The only **excused** absences are personal illness, immediate family medical emergency or immediate family funeral.

**ATTENDANCE**

Students are expected to attend all lectures. If you know in advance that you will miss an exam due to official University business, you must provide the Professor with official documentation of the absence at least fourteen days prior to missing. It is the student's responsibility to obtain official documentation in timely fashion. Once the documentation has been verified, the Professor will decide how to handle the absence. In the overwhelming majority of cases, assignments and exams will be turned in or completed prior to the planned, official absence. Exams given outside regularly scheduled times may vary in format and content at the discretion of the faculty member. Absolutely nothing may be turned in late by anyone for any reason.

**DISABILITIES ACCOMMODATIONS**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call or visit Disability Services at (361) 825-5816 in Corpus Christi Hall 116.

If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

**GRADE APPEALS**

A student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is on the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details on the process, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, consult Texas A&M University-Corpus Christi University Procedure 13.02.99.C2.01 *Student Grade Appeal Procedures*
(http://www.tamu.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage (http://sci.tamu.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school or the College of Science and Engineering Dean's Office.
BIMS 4325: Clinical Chemistry I
SCHEDULE FALL 2014

Aug.  28  Spectral Techniques
Sept.  02  Beer’s Law & Problem solving
           04  Spectrophotometry and Curves
           09  Flame Photometry & Atomic Absorption
           11  Fluorometry & Chemiluminescence
           16  Nephelometry & Turbidity
           18  Electrochemistry
           23  Osmolality
           25  Exam 1
           29  Proteins
Oct.  02  Proteins
           07  Enzymes
           09  Enzyme assays
           14  Carbohydrates
           16  Glucose Assays & Glyco Hgb
           21  Diabetes Mellitus
           23  Exam 2
           28  Lipids
           30  Non-Protein Nitrogen Compounds
Nov.  04  Electrolytes
           06  Anion Gap
           11  Renal Function
           13  Acid-Base Balance
           18  Blood Gases
           20  Calcium & Phosphate
           25  EXAM 3
           27  Thanksgiving Holiday
Dec.  02  Liver, Bilirubin & Jaundice
Dec  04  FINAL  11:00 am - 1:30 pm
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<tr>
<th>Date</th>
<th>Time</th>
<th>Topic</th>
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<tr>
<td>Thurs Aug.</td>
<td>Aug. 28</td>
<td>Introduction to Lab &amp; Safety</td>
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<tr>
<td>Thurs Sept.</td>
<td>Sept. 04</td>
<td>Pipet Exercise</td>
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<td>Thurs</td>
<td>11</td>
<td>Spectrophotometer Function</td>
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<td>Thurs</td>
<td>18</td>
<td>Calibration Curves</td>
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<td>25</td>
<td>Molar Absorptivity</td>
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<td>Thurs Oct.</td>
<td>Oct. 02</td>
<td>Total Protein &amp; Albumin</td>
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<td>Thurs</td>
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<td>Enzymes</td>
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<td>Thurs</td>
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<td>Glucose</td>
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<td>23</td>
<td>Cholesterol &amp; Triglyceride</td>
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<td>BUN &amp; Creatinine</td>
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<td>Calcium &amp; Phosphorous</td>
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<td>Total &amp; Direct Bilirubin</td>
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<td>Thurs</td>
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**General Disclaimer:**

The instructor reserves the right to modify the schedule when necessary. These changes will be announced during regularly scheduled lecture periods. In case of absence during this announcement, it is the responsibility of the student to obtain the information as no effort will be made to contact students who were absent when the announcement was made.
LEARNING OUTCOMES FOR BIMS 4325, CLINICAL CHEMISTRY I

SPECTROPHOTOMETRY AND BEER'S LAW
The student should be able to:
1. describe the relationship between color of light, color of solution or substance, wavelengths absorbed, and wavelengths transmitted or reflected.
2. describe the relationships between wavelength, frequency, and energy and define the major regions of the electromagnetic spectrum in terms of wavelength and energy.
3. describe the relationship between transmittance, % transmittance, and absorbance.
4. state Beer's Law and perform calculations involving Beer's Law.
5. define absorptivity and molar absorptivity and perform calculations using Beer's Law and molar absorptivity.
6. describe how the wavelength for an assay is selected.
7. discuss deviations from Beer's Law.
8. discuss the use of standard curves to set assay limits.

THE SPECTROPHOTOMETER
The student should be able to:
1. name the components of a spectrophotometer and describe the functions of each.
2. define: bandpass, linearity, wavelength accuracy, photometric accuracy, stray light and discuss methods used to check for each.

ATOMIC ABSORPTION SPECTROPHOTOMETRY AND FLAME EMISSION PHOTOMETRY
The student should be able to:
1. name the components of a generalized emission flame photometer or atomic absorption spectrophotometer and describe the function of each component and in general terms describe the principle of each technique.
2. describe the major sources of interference in each method and measures used to control each type of interference.
3. explain the use of an internal standard.

FLUOROMETRY, TURBIDIMETRY, AND NEPHELOMETRY
The student should be able to:
1. describe in general terms the process of fluorescence.
2. explain in general terms the two characteristic spectra of a fluorescent species.
3. describe the components and configuration of generalized fluorometer and the use of the instrument in an assay.
4. describe advantages and limitations of fluorometry.
5. define: turbidimetry and nephelometry.
6. describe instrumental requirements for each technique and the components and configuration of a nephelometer.
7. name some applications of turbidimetry and nephelometry.
8. identify sources of interference in turbidimetry and nephelometry.
ELECTROCHEMICAL METHODS
The student should be able to:
1. discuss the theory of ion measurement using potentiometry.
2. describe the construction of the glass-membrane pH electrode, the calomel reference electrode, and the silver-silver chloride reference electrode.
3. name other ions that are commonly measured using potentiometric electrodes.
4. define 'coulometric titration' and explain, using Faraday's Law, why the time required for the titration is related to the chloride concentration of the sample.
5. explain how the instrument generates titrant and detects the endpoint of the titration.

PROTEINS-NATURE AND ASSAY
The student should be able to:
1. describe the general characteristics of a protein including structure and nature of amino acids, the peptide bond, primary, secondary, tertiary, and quaternary protein structure.
2. describe the following methods for assay of total protein: Briefly - Kjeldahl technique, UV light absorption in detail, including reaction or principle, sensitivity, specificity, interferences - Biuret, refractive index, anionic precipitation, Folin-Lowry.
3. explain the principle of dye-binding methods for albumin assay, list dyes used, and discuss specificity and interferences.
4. give the reference range (adult) for serum total protein and serum albumin.
5. discuss the clinical significance of hyperproteinemia and hypoproteinemia.
6. describe the stability of the sample and recognize factors in sample collection which can influence results.

INTRODUCTION TO ENZYMES
The student should be able to:
1. explain what an enzyme is, chemically and functionally.
2. describe the type reaction catalyzed by each of the six classes of enzymes and the specificity of an enzyme for its substrate.
3. discuss the Michaelis-Menten theory regarding substrate concentration and reaction velocity. Define 'Km' and describe practical application of the Km.
4. define 'zero-order' and 'first-order' as applied to enzyme kinetics and requirements for each.
5. describe the effects of pH and temperature on reaction velocity and define the assay temperature proposed by the IUB.
6. define the terms coenzyme and activator. Discuss the role that each serves and the effect in the regulation of reaction velocity. List 2 hydrogen and 2 nonhydrogen transfer enzymes used in many clinical enzyme assays.
7. discuss competitive and noncompetitive inhibition and effect of each type of inhibition on the Km. Discuss the effects of metal ions on enzyme activity.
8. list 3 methods of measuring enzyme concentrations and discuss the theory of each method. Designate the method that is preferred when enzyme activity is measured.
9. define the International Unit of enzyme activity and calculate enzyme activity in U/L or mU/mL.
ENZYMES: ASSAY METHODS AND DIAGNOSTIC APPLICATIONS
The student should be able to:
1. discuss the meaning and etiology of plasma-specific, non-plasma-specific, and inducible enzymes in the plasma.
2. define the term isoenzyme and list methods of separating isoenzymes.
3. discuss each of the following enzymes: function, source, specimen requirements, assay methods, isoenzyme separation (if applicable), and clinical significance - lactate dehydrogenase, creatine kinase, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, acid phosphatase, gamma-glutamyl transferase.
4. discuss each of the following enzymes: function, source, clinical significance - pseudocholinesterase, isocitrate dehydrogenase, glucose-6-phosphate dehydrogenase, ceruloplasmin.

CARBOHYDRATES AND GLUCOSE METABOLISM
The student should be able to:
1. chemically define a ‘carbohydrate’ and define: aldoses, ketoses, D and L sugars, alpha and beta configuration.
2. list the three monosaccharides of biological importance and name the monosaccharide units of the three disaccharides of biological importance.
3. define: glycogenesis, glycogenolysis, gluconeogenesis, glycolysis, lipogenesis, lipolysis.
4. trace the biochemical pathways associated with carbohydrate metabolism: digestion and absorption, glycolytic pathway, pentose phosphate shunt pathway, common pathways.
5. identify the source organ and effect on glucose metabolism of the hormones: insulin, glucagon, epinephrine, growth hormone, cortisol, thyroxine.

GLUCOSE METHODS AND FUNCTIONAL TESTS
The student should be able to:
1. discuss specimen requirements for glucose assay including the variability of glucose concentration in the following situations: whole blood vs serum, capillary vs venous sample.
2. discuss each of the following glucose methods including reaction, specificity, and interferences: 0-toluidine, glucose oxidase (calorimetric and electrode), hexokinase.
3. give normal and panic blood glucose values for adults and neonates.
4. describe proper performance of the OGTT including preparation of the patient, contradictions, glucose load, collection of samples.
5. describe the clinical and biochemical features of diabetes mellitus types I and II, and other classification groups and list diagnostic criteria for group classification.
6. discuss the glycosylated hemoglobin test including: origin of glycosylated fractions, clinical applications of the test, methods of glycosylated fractions, methods of assay, sources of error.
7. discuss hypoglycemia in adults and neonates, definition, etiology, evaluation
8. describe the clinical application of the C-Peptide assay.
10. describe the fecal carbohydrate test for glucose intolerance.
LIPIDS
The student should be able to:
1. structurally characterize the triglycerides, cholesterol, and phospholipid.
2. discuss the metabolism of cholesterol and triglycerides including the role of the liver and apoproteins.
3. describe or give the reactions for assay methods for triglycerides and cholesterol.
4. give the desirable ranges for cholesterol and triglycerides in serum and indicate general variation with age and sex. Describe proper collection and handling of samples.

NPN SUBSTANCES OF PLASMA
The student should be able to:
1. briefly outline nephron structure and the formation of urine.
2. describe sources of plasma urea, creatinine, and uric acid and factors affecting plasma levels.
3. define: azotemia, prerenal azotemia, renal azotemia, postrenal azotemia, uremia.
4. describe current methods for assay of urea, creatinine, and uric acid, including reactions, specificity, and interferences.
5. give the normal ranges for urea, BUN, uric acid, creatinine, and BUN/creatinine ratio.

ELECTROLYTES, REGULATION AND METHODS
The student should be able to:
1. name and define the three body fluid compartments, name the major cations and major anions of each compartment, and point out the primary differences in composition of the three fluids.
2. explain the function of the plasma proteins in maintaining intravascular fluid volume, including Gibbs-Donnan equilibrium.
3. describe the operation of control mechanisms - thirst, ADH, renin-aldosterone.
4. discuss factors affecting plasma levels of water, sodium, potassium, chloride, and bicarbonate.
5. discuss current methods for assay of each electrolyte and proper collection and handling of specimens.
6. give the reference range and panic values for each electrolyte.

ELECTROLYTES AND ANION GAP
The student should be able to:
1. give the rules for electrolyte balance, define 'anion gap', calculate anion gap, and give the normal range for anion gap.
2. give possible causes of increased anion gap and decreased anion gap.
3. identify common patterns of electrolyte imbalance and associate these with possible disease processes. Recognize incompatible electrolyte values and give reasonable course of action.

BODY WATER AND OSMOLALITY
The student should be able to:
1. define 'colligative properties', name the colligative properties, and indicate what change occurs in each when solute is added to solvent.
2. given concentration, calculate freezing point or, given freezing point, calculate osmolality and given molarity, calculate osmolarity.
3. explain the principle of the freezing-point osmometer and the principle of the vapor-pressure (dew-point) osmometer.
4. calculate expected osmolality and osmolal gap given Na, glucose, and BUN values and discuss the significance of these values.
5. describe performance of a concentration test and interpretation of results.
6. give normal values for urine/serum Osmolality ratio.
7. calculate and discuss the significance of osmolal clearance and free water clearance.

RENNAL FUNCTION TESTS
The student should be able to:
1. define: total renal blood flow, effective renal plasma flow, glomerular filtration rate, tubular secretory capacity.
2. give the normal volume for 24 hour urine collections in adults.
3. calculate clearance problems when given a suitable set of data.
4. discuss the procedure for and interpretation of clearance tests that measure GFR and those that measure the secretory ability of the tubules.

CALCIUM & PHOSPHORUS
The student should be able to:
1. discuss the metabolism of calcium and phosphorus - activation of vitamin D, factors influencing absorption, hormonal mechanisms, and feedback systems for maintaining calcium homeostasis.
2. give the normal range for Ca and P, explain the fractions of plasma calcium and the relationship of total and ionized calcium to protein and pH.
3. for the following diseases discuss etiology and expected laboratory findings: primary hyperparathyroidism, secondary hyperparathyroidism, primary hypoparathyroidism, osteomalacia or rickets, osteoporosis, Paget's disease.
4. list other conditions commonly associated with hyper-or hypocalcemia.
5. discuss assay methods for calcium and phosphorus.

MAGNESIUM, AND COPPER
The student should be able to:
1. describe distribution, functions, and regulation of magnesium and discuss conditions associated with abnormal levels of serum magnesium.
2. describe assay methods for serum magnesium.
3. describe the metabolism of copper, the functions of copper as ceruloplasmin, and describe 2 copper-storage diseases and give typical lab findings in Wilson's Disease.
4. describe specimen requirements for each of the above ions.

PHYSIOLOGIC ACID-BASE BALANCE
The student should be able to:
1. use the Henderson-Hasselbalch equation to solve physiologic acid-base problems.
2. identify the fractions of CO2 in blood, distinguish between the respiratory and metabolic fractions, and explain the terms 'buffer base' and 'base excess'.
3. give the normal range for blood pH, total CO2 or bicarbonate, pCO and give the blood pH range considered compatible with life.
4. distinguish between: acidosis/alkalosis, metabolic/respiratory, compensated/uncompensated.
5. discuss the pathophysiology of common acid-base disturbances.
6. describe or recognize laboratory results in common acid-base disturbances.
BLOOD GASES AND TRANSPORT SYSTEMS
The student should be able to:
1. discuss control of respiration, O2 transport in blood, and the O2 dissociation curve.
2. discuss CO2 transport and factors affecting pCO2.
3. define and describe the chloride shift.

BLOOD GASES, METHODS AND INTERPRETATION
The student should be able to:
1. give the principle of each electrode in a blood gas instrument.
2. explain how a blood-gas analyzer is calibrated and calculate the theoretical partial pressure of the calibrating gases based on Dalton's Law.
3. describe the measurements dealing with O2 transport at the blood-tissue level and their measurement and/or calculation.
4. give the normal range for the following (arterial whole blood: PCO2, CO2 content, PO2, O2 saturation, P50.
5. describe specimen requirements for blood gases. Discuss the effect on blood gas results in the following situations: patient hyperventilate during collection, sample exposed to room air, venous blood used, sample allowed to stand at room temp before analysis, plastic syringe rather than glass, patient temperature is not 37°C.

THE LIVER AND BILIRUBIN
The student should be able to:
1. describe the anatomy of the liver.
2. briefly outline the physiologic role of the liver in the following: carbohydrate, protein, and lipid metabolism; excretory and protective function; normal bile pigment metabolism.
3. discuss the Evelyn-Malloy and Jendrassik-Grof methodology for bilirubin.
4. correlate direct/indirect, conjugated/unconjugated, soluble/insoluble bilirubin and give the normal ranges for serum total and direct bilirubin.

JAUNDICE AND LIVER FUNCTION TESTS
You should be able to:
1. classify the type of jaundice based on bilirubin test results and list disease states associated with each group.
2. describe the reactions that occur in the brain during the process of ammonia detoxification and applications of and methods for serum ammonia.
3. describe: Gilbert's disease, Crigler-Najjar syndrome, Dubin-Johnson syndrome, posthepatic obstructive jaundice, hepatitis (various forms), Wilson's Disease, Hemochromatosis.
4. describe clinical and lab findings associated with Reye's syndrome.
5. list the criteria for neonatal physiologic jaundice and criteria for exchange transfusion.