BIMS 4325: CLINICAL CHEMISTRY 1
FALL 2011 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 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.
**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. April 01, 2011 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.

**COURSE EVALUATION:**

The final course grade will be based on three exams, quizzes/attendance and the average of graded lab assignments.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Examination average (3 exams)</td>
<td>30%</td>
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<tr>
<td>Laboratory average</td>
<td>30%</td>
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<tr>
<td>Problem portfolio</td>
<td>20%</td>
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<tr>
<td>Final examination</td>
<td>20%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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**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.

All questions are keyed to the specific course and lab objectives. Use these objectives to study.

Unannounced quizzes may be given throughout the course of the semester and grades for this will be assigned to Problem portfolio.

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, lab, quiz or practical due to an unexcused absence. The only **excused** absences are personal illness, immediate family medical emergency or immediate family funeral.
The following scale will be used to report grades:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
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<tbody>
<tr>
<td>A</td>
<td>90 - 100</td>
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<tr>
<td>B</td>
<td>80 - 89</td>
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<td>C</td>
<td>70 - 79</td>
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<tr>
<td>D</td>
<td>60 - 69</td>
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<td>F</td>
<td>below 60</td>
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**GRADE APPEALS**

As stated in the Texas A&M University-Corpus Christi University Rules and Procedures (Section B [Academic Program], Pat 13 [Students]: 13.02.99.C2 [Student Grade Appeals] and 13.02.99C2.01 [Student Grade Appeal Procedures]), 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, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, consult the University Rules and Procedures specified above (accessible through the University Rules and Procedures website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html)). For assistance and/or guidance in the grade appeal process, students may contact the Office of Student Affairs.

**ACADEMIC HONESTY**

The University catalog contains the university statement on academic integrity. It is essential that anyone considering a health career demonstrate honesty and integrity in their academic and professional life. Therefore, cheating will not be tolerated and will result in a failing grade in the course and possible further disciplinary action by the university.

**ATTENDANCE AND LAB ASSIGNMENTS**

LAB SAFETY BRIEFINGS: Mandatory Laboratory Safety Briefings are scheduled outside of the regularly scheduled lab time. You must attend and complete one of the Lab Safety Briefings to be admitted into your lab.

Students who register late must make up any work they have missed during the first week.

Class attendance is expected. If absent from class you will be responsible for knowing the material covered.

In the case of an extreme emergency causing an absence on major exam days, evidence that the absence was necessary will be required.
Lab worksheets are to be turned in the week following the assignment and must be
turned in at the beginning of the lab period. Late labs will be docked 10% for not being
turned in during the first part of the lab and 10% for every day past the due date. If you
miss the lab period you may still turn in the lab worksheet for partial credit only (50%).

**AMERICANS WITH DISABILITIES ACT (ADA)**

Texas A&M University-Corpus Christi is committed to providing persons with disabilities
an equal opportunity to access campus facilities, resources and programs. The 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 for their disabilities. Support and accommodations are also
available for returning veterans who experience cognitive and/or physical access issues
in the classroom or on campus. Our Office of Disability Services arranges such support
and academic accommodations. To make a request, or for more information, call (361)
825-5816 or visit the office in Driftwood 101. It is important to contact the Office of
Disability Services in a timely fashion as it will take time for them to review requests and
prepare accommodations and accommodation letters.
BIMS 4325: Clinical Chemistry I  
SCHEDULE FALL 2011

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading Material</th>
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<tbody>
<tr>
<td>Aug. 25</td>
<td>Spectrophotometry</td>
<td>Chapter 5</td>
</tr>
<tr>
<td>30</td>
<td>Beer’s Law</td>
<td>Chapter 5</td>
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<tr>
<td>Sept. 01</td>
<td>Problem solving</td>
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<tr>
<td>Sept. 06</td>
<td>Standard Curves</td>
<td>Chapter 5</td>
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<tr>
<td>08</td>
<td>Flame Emission Photometry</td>
<td>Chapter 5</td>
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<tr>
<td>13</td>
<td>Atomic Absorption</td>
<td>Chapter 5</td>
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<tr>
<td>15</td>
<td>Fluorometry &amp; Chemiluminescence</td>
<td>Chapter 5</td>
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<td>20</td>
<td>Nephelometry &amp; Turbidity</td>
<td>Chapter 5</td>
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<td>22</td>
<td>Electrochemistry</td>
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<td>Osmometry</td>
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<tr>
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<td>Oct. 04</td>
<td>Proteins</td>
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<td>11</td>
<td>Enzymes</td>
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<td>Enzyme assays</td>
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<td>18</td>
<td>Carbohydrates</td>
<td>Chapter 13</td>
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<td>20</td>
<td>Glucose Assays &amp; Glyco Hgb</td>
<td>Chapter 13</td>
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<tr>
<td>25</td>
<td>Diabetes Mellitus</td>
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<td>Nov. 01</td>
<td>Lipids</td>
<td>Chapter 14</td>
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<td>03</td>
<td>Non-Protein Nitrogen Substances</td>
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<td>08</td>
<td>Electrolytes</td>
<td>Chapter 15</td>
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<td>Nov. 10</td>
<td>Anion Gap</td>
<td>Chapter 15</td>
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<td>Renal Function</td>
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<td>17</td>
<td>Acid-Base Balance</td>
<td>Chapter 16</td>
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<td>22</td>
<td>Blood Gases</td>
<td>Chapter 16</td>
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<td>24</td>
<td>Thanksgiving Holiday</td>
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<tr>
<td>29</td>
<td>Calcium &amp; Phosphate</td>
<td>Chapter 16</td>
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<tr>
<td>Dec. 01</td>
<td>EXAM 3</td>
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<tr>
<td>Dec. 06</td>
<td>Liver, Bilirubin &amp; Jaundice</td>
<td>Chapter 24</td>
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<tr>
<td>Dec 08</td>
<td>FINAL</td>
<td>11:00 am - 1:30 pm</td>
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Laboratory Schedule  
Time: 9-11:50 AM  
Room: CS 228

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<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>Thurs Aug 25</td>
<td>Introduction to Lab &amp; Safety</td>
</tr>
<tr>
<td>Thurs Sep 01</td>
<td>Pipet Exercise</td>
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<tr>
<td>Thurs 08</td>
<td>Spectrophotometer Function</td>
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<td>Thurs 15</td>
<td>Calibration Curves</td>
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<tr>
<td>Thurs 22</td>
<td>Molar Absorptivity</td>
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<td>Thurs Aug 29</td>
<td>Total Protein &amp; Albumin</td>
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<td>Thurs 06</td>
<td>Enzymes</td>
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<td>Thurs 13</td>
<td>Glucose</td>
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<td>Thurs 20</td>
<td>Cholesterol &amp; Triglyceride</td>
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<td>Thurs 27</td>
<td>NPN</td>
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<td>Thurs Nov 03</td>
<td>Creatinine Clearance</td>
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<td>Calcium &amp; Phosphorous</td>
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<td>Thurs 17</td>
<td>Bilirubin</td>
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<td>Thurs 24</td>
<td><strong>Thanksgiving Holiday</strong></td>
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<tr>
<td>Thurs Dec 01</td>
<td>Electrolytes</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 $K_m$ and describe practical application of the $K_m$
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 IVB
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 $K_m$. 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. for each of the following enzymes discuss: 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. for each of the following enzymes discuss: 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
9. briefly describe performance and interpretation of: tolbutamide test, epinephrine test, lactose tolerance test
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 osmolar 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 ration.
7. calculate and discuss the significance of osmolal clearance and free water clearance.

**RENAL 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
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: P_{CO₂}, CO₂ content, P_{O₂}, O₂ saturation, P_{50})
5. **describe specimen requirements for blood gases.** Discuss the effect on blood gas results in the following situations: patient hyperventilating 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**