MLTK 2500 Clinical Chemistry

Semester/Year: Fall 2006

Lecture Hours: 1  
Lab Hours: 3  
Credit Hours: 3

Class Time: Lecture 9-9:50  
Days: M, W  
Room: LS109

Lab 10-11:50  
M, W  
LS104

Instructor’s Name: Dino Madsen

Instructor's Contact  
Office Phone: 268-2542  
Email: dmadsen@caspercollege.edu

Home Phone: 266-9687

Office Hours: MW 12:00-2:00

Course Description:

This course provides fundamental theory and principles of clinical chemistry, advanced instrumentation, and techniques used in clinical laboratories, pharmaceutical research and design, and biotechnology. Primary focus will be on student performance of diagnostic testing and its clinical correlation to disease states, preventive medicine and healthcare. Advanced topics in quality assurance, therapeutic drug monitoring and endocrinology will be discussed.

Statement of Prerequisites:

CHEM 1025 and 1028, MATH 1400, and MLTK 1800

Health Requirements You will need to obtain proof of the following health requirements to be in student laboratory.

- Health Insurance (Private or available through Casper College)
- Hepatitis B vaccination (at least the first in the series of three)

Goal:

The students will build upon their knowledge and skills learned in previous laboratory classes while gaining new information in pathophysiology and diagnostic testing. Students will explain, characterize, compare and evaluate patient data for the presence of disease states and disorders. Students will demonstrate a working comprehension of the technical and procedural aspects of laboratory testing, safety and ethical standards of practice through performance and practice.
Students will be able to explain the application of physical chemistry in clinical instrumentation and the generation of patient data.

Outcomes:

1. Perform, interpret and evaluate patient data and chemistry procedures given the proper procedures, reagents and equipment.

2. Perform, interpret and evaluate, necessary quality control and calibration procedures related to chemistry procedures given the proper procedures, reagents and equipment.

3. Perform, interpret, and initiate normal preventative maintenance on chemistry analyzers given the proper procedures, reagents and equipment.

4. Describe the basic biochemistry, physiology and pathology relevant to the practice of clinical laboratory medicine.

5. Describe concepts of clinical chemistry, testing methods, and correlate laboratory data with mechanisms of disease processes.

6. Describe key points of laboratory safety as it applies to clinical chemistry.

7. Describe various types of instruments, physical chemistry and techniques used in clinical chemistry analysis.

8. Describe the fundamental principles used in clinical instrument designs.

9. Compare, contrast and evaluate clinical instrument methodologies.

10. Describe techniques and statistical procedures that can be use to evaluate clinical data.

11. Relate the mechanisms and symptoms of toxicity to therapeutic drug monitoring and exposure to toxic substances.


13. Describe the biologic function of trace elements and vitamins and relate clinical findings to conditions associated with decreased or increased levels.


Methodology:

Formal and informal lecture, one-on one instruction, group demonstration and student laboratory are
used in combination for student instruction.

Evaluation Criteria:

REQUIRED STUDENT TASKS/ASSIGNMENTS

The required tasks and assignments are used to evaluate the student’s acquisition and comprehension of the learning objectives. Assignments are designed allow students utilize information from class lecture and discussion, and place into practice, technical skills and decision making. Details about each assignment (including grading criteria) will be discussed in class.

Lecture exams/Pop Quizzes/Final: (50%)

Unit exams will cover material listed in the learning objectives for each of the defined segments or units outlined on the lecture schedule. Most material will be covered specifically in class but exam question may cover materials presented in the assigned reading. CLS review books (ASCP, NCA and others) provide practice questions for subjects on the course outline.

Instrumentation Evaluation (15% of course grade)

Each student will evaluate instrument methodology and select an instrument to market or make a “sales pitch” to the class. Each student will compare that instrument with other instruments available and promote their instrument based upon quality assurance principles and test specificity and sensitivity. Each "sales pitch" should include a power point presentation, principle methodology, automation devices, data interpretation, quality control, reporting, LIS, and clinical correlation.

Correlation Study (15% of total grade)

Given two sets of data, each student will run a correlation study between two instruments. Using statistical analysis, the student will evaluate the clinical data and predict any types of statistical error that may be present.

Lab reports/Exams : (20%)

Refer to the course lecture and lab schedule. Those laboratories with an asterisk (*) denote laboratories that you are responsible for “writing up” a lab report. Each lab report will include:

Introduction-basic physiology or pathology in question

Theory or Principle methodology-basis of the test, chemical reaction, fundamental principle that allows determination and measurement of analyte (Show any formulas or reactions)

Procedure-a summary of the procedure method
Data-a tabular or collection of experimental data

*Interpretation/calculations*-data evaluated or calculated to determine value of analyte with its relationship to “normal or reference” ranges. This includes the evaluation of quality control materials, their acceptance or rejection and a discussion of patient data, whether it is normal or abnormal, relating to a disease state.

*References*: Sources of information and test methodology.

**GRADING:**

A = 92-100%  
Final grades: Lecture exams/Pop Quizzes/Final  
50%

B = 82-91%  
Instrumentation Evaluation  
15%

C = 70-81%  
Correlation Study  
15%

D = 60-69%  
Lab Reports/Exams  
20%

F = <60%

**Required Text, Readings, and Materials:**


**Required Personal Protective Equipment (PPE)**

(you will need to purchase)

Gloves

Scrubs (any color)

Safety goggles

**Class Policies:**

Last Date to Change to Audit Status or to Withdraw with a W Grade is the Casper College deadlines.

Exams must be completed without the use of textbooks, notes or assistance from classmates. Attendance is required for lecture and student labs. No make-up labs will be available.

**Student Rights and Responsibilities**: Please refer to the Casper College Student Conduct and
Judicial Code for information concerning your rights and responsibilities as a Casper College Student.

Chain of Command: If you have any problems with this class, you should first contact the instructor in order to solve the problem. If you are not satisfied with the solution offered by the instructor, you should then take your problem through the appropriate chain of command starting with the department head, then the division chair, and lastly the vice president for academic affairs.

Student complaints should be addressed through the following chain of command:

1) The instructor of your course. (Dr. Hentzen)
2) Biology Department Chair (Ms. Brandy Atnip)
3) The Life Science Division Chair, (Dr. Clifford).
4) The Vice President for Academic Affairs (Dr. Carmen Simone).

Academic Dishonesty - Cheating & Plagiarism: Casper College demands intellectual honesty. Proven plagiarism or any form of dishonesty associated with the academic process can result in the offender failing the course in which the offense was committed or expulsion from school. See the Casper College Student Code of Conduct.

ADA Accommodations Policy: It is the policy of Casper College to provide appropriate accommodations to any student with a documented disability. If you have a need for accommodation in this course, please make an appointment to see me at your earliest convenience.

**Applied Clinical Analysis-Course Outline:**

I. Introduction to Clinical Chemistry

A. The chemistry Laboratory

B. Types of tests performed

C. Collection of specimens

1. Routine sampling

2. Pediatric sampling

3. Special sampling techniques
D. Laboratory Mathematics

1. Dilution problems
2. Calculation of normal and molar solutions
3. Percent solutions

E. Laboratory chemicals and supplies

II. Carbohydrate Metabolism

A. Diabetes mellitus and glucose testing

1. Typed of diabetes
2. Genetic defects
3. Diagnosis
4. Glucose procedures
5. Glycosylated hemoglobin and fructosamine

III. Kidney function and diagnostic testing

A. Normal and abnormal kidney function
B. Common urinary tract diseases and diagnosis
C. Routine Urinalysis
D. BUN, Creatinine and Uric Acid procedures
E. Special kidney function tests

1. Creatinine clearance
2. Inulin clearance
3. Other special testing

IV. Amino Acids, proteins and abnormal/reactive proteins

A. Diagnostic testing
   a. Total serum protein
b. Amino acids
c. Immunoassays

B. Electrophoresis
1. Types of electrophoresis
2. Protein migration
3. Electrophoresis patterns
4. Interpretation of PEP patterns

V. Enzymes
A. Basic enzymology
B. Enzymes of clinical importance
1. Hydrolases
2. Dehydrogenases
3. Transferases
C. Isoenzymes
1. Diagnosis of myocardial infarction
2. CPK isoforms (MM and MB)
3. LDH isoforms
4. New methods of detection-immunoassays

VI. Lipids
A. Lipid metabolism
B. Lipid classification
C. Triglyceride procedures
D. Cholesterol, HDL and LDL procedures
E. Calculation of coronary risk
F. Methods of cholesterol reduction

VII. Liver function

A. Normal and abnormal liver function

B. Metabolism and clinical significance of bilirubin

C. Analysis of bilirubin and other liver function tests

VIII. Electrolytes/Blood Gases and inorganic ions

A. Clinical significance and analysis of electrolytes

B. Anion gap

C. Blood gases

D. Acid base balance

E. Other inorganic ions-Calcium and phosphorous

F. Instrumentation

1. Electrodes

2. Types of Automated Instruments Available

G. Henderson-Hasselbalch Equation

1. Nomograms

2. Calculations of Base Excess and Bicarbonate

H. Specimen Collection

I. Expected Values

J. Laboratory Exercises

IX. Endocrinology

A. General Endocrinology

1. Chemical nature
2. Steroid and peptide hormones
3. Regulatory control

B. Thyroid testing and pathology
1. Anatomy of thyroid
2. Metabolism of iodine and thyroid synthesis
3. Pathological conditions and changes in disease
4. Tests for pathological conditions

C. Female and male sex hormones
1. Anatomy
2. Biosynthesis of steroid hormones
3. Pathological conditions
   4. Fertility and infertility
5. Function tests

D. Adrenal hormones
1. Physiology of adrenal hormones
2. Biosynthesis and catabolism
3. Pathological conditions
4. Function tests
   5. Changes in disease

X. Toxicology and Therapeutic Drug Monitoring
A. TDM collection for collection
1. Techniques for analysis
   A. Immunological
B. Chromatography  
C. Spectrophotometry  
D. Other techniques  

2. Pharmokinetics  
3. Dosage and therapeutic ranges  
4. Clinical indications  

B. Toxicology  
1. Mechanisms of toxicology  
2. Drugs and nontherapeutic agents  
3. Medicolegal aspects  
4. Methods of analysis  

XI. Prenatal and Perinatal Testing  
A. Prenatal testing  
1. Biochemical changes during pregnancy  
2. Fetal biochemical changes  
3. Pathological conditions  
B. Assessment of fetal maturity  
   1. Amniotic fluid testing  

XII. Trace Elements  
A. Magnesium  
B. Iodide  
C. Zinc  
D. Selenium
E. Methods of analysis

XIII. Vitamins
A. Analytical techniques
B. Classification
C. Functions and deficiencies
D. Methods of analysis

XIV. Tumor Markers
A. Cancer etiology and diversity
B. Laboratory tests
C. Change of analytes in disease
D. Methods of analysis

XV. Statistical Analysis and Quality Assurance In The Clinical Laboratory
A. Calculation of mean and standard deviation
B. Interpretation of data
1. Trends and shifts
2. Westgaard’s rules and 2s rule
3. Automated quality assurance Quality assurance techniques
   a. Allowable error
   b. Making medical decisions
   c. Control of quality and error detection
   d. Resolution of quality problems
   e. Calibration verification
   f. External quality control
C. Evaluation of methods
   a. Instrument selection and laboratory evaluation
   b. Confidence-internal criteria

D. Correlation studies

XVI. Basic Instrumentation

A. Spectrophotometer
   1. Beer’s Law
   2. The standard curve and its use

B. Flame photometer

C. Atomic Absorption Instrument

D. Fluorometer
   1. Theory of Fluorescence
   2. Chemiluminescence
   3. Bioluminescence

E. Fluorescent Polarization

F. Nephelometer
   1. Theory of Nephelometry
   2. Turbidity

G. Reflectance Photometry

H. Instruments Available

I. Clinical Chemistry instrumentation
   1. History
   2. Automation
3. Physician office instruments/ Point of care testing

XVII. Electrophoresis

A. Theory of Electrophoresis

B. Special Techniques

1. Western Blot

2. Southern Blot

3. Northern Blot

4. Isoenzyme Electrophoresis

C. Stains and Buffers

D. Interpretation of Scans

E. Laboratory Exercises

XVIII. Immunological Assays

A. Definitions and Theories

1. Antibody-Antigen Interaction

2. Affinity and Avidity

B. Theory of Assays

1. EIA

2. RIA

3. IRMA and EMIT

4. Types of Immunelectrophoresis

C. Monoclonal Antibodies

XIX. Electrochemistry

A. Potentiometric and Volumetric Techniques
B. The Nernst Equation and Nova

C. Ion-Selective Electrodes

D. Reference Electrodes

E. Special Electrodes
   1. Oxygen Electrodes
   2. Glucose Electrodes
   3. Other Types of Gas Electrodes

XX. Osmometry And Chromatography

A. Theory and Instrumentation in Osmometry

B. Clinical Uses of Osmometry

C. Types and Uses of Chromatography
   1. Liquid-solid
   2. Partition
   3. Ion-exchange
   4. Steric Exclusion
   5. Affinity
   6. Thin Layer
   7. Gel

XXI. Gas Chromatography And Mass Spectrometry

A. Gas Chromatography
   1. Principles
   2. Instrumentation
   3. Clinical Uses

B. Mass spectrometry
1. Components of Mass Spectrometer
2. Principle of Mass Spectrometer
3. Uses in Confirming Drugs of Abuse
4. quadruple Mass Analyzer and Tandem MS

XXII. Flow Cytometry And DNA Probes
A. Flow Cytometry
1. Flow Cytometry Theory
2. Light Sources and Dyes
   3. Uses in Hematology, Automated Diffs, AIDS and Oncology Testing
B. DNA Probes
   1. Theory of DNA Probes/Hybridization
   2. Direct Methodology
   3. Amplification Techniques
   4. Clinical Uses

XXIII. Laboratory Computers
A. Reasons for Use of Computers
B. Information Systems and Instrument Computers
C. Hospital Information Systems (HIS), Laboratory Information Systems (LIS)
D. Use of PC’s in the Laboratory
E. Use of Computers in Patient Diagnosis and Storage of Results
F. Considerations in Purchase of LIS

Calendar or schedule indicating course content
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<td>Introduction and Basic Principles of Clinical Chemistry Chpts 1, 2, 3</td>
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<td>Lab math/LJ charts/QC</td>
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Chpt 21

Chpt 22

Chpt 24, 23

Chpt 25-31
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