

## CASPER COLLEGE COURSE SYLLABUS MLTK 2500 H1 Clinical Chemistry

Semester/Year: Fall 2015

Lecture Hours: 2                      Lab Hours: 4                      Credit Hours: 3

Class Time: 11:00-4:00              Days: 9/10, 9/24, 10/22, 11/12,      Room: AH 106  
12/10

Instructor's Name: Jed Doxtater

Instructor's Contact                      Office Phone: 268-2505                      Email:  
doxtater@caspercollege.edu

Office Hours: Monday, Tuesday, Wednesday 10:00 – 12:00 or by appointment; Please email to set up appointment. Office hours also available via teleconference.

### Course Description:

This course provides fundamental theory and principles of clinical chemistry, advanced instrumentation, techniques used in clinical laboratories, and 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 1005, and 1006 or 1025 and 1028, MATH 1000 or 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. Explain and advocate the significance and value of quality control as it relates to quality assurance and patient care.
4. Perform, interpret, and initiate normal preventative maintenance on chemistry analyzers given the proper procedures, reagents and equipment.
5. Describe the basic biochemistry, physiology and pathology relevant to the practice of clinical laboratory medicine.
6. Describe concepts of clinical chemistry, testing methods, and correlate laboratory data with mechanisms of disease processes.
7. Describe key points of laboratory safety as it applies to clinical chemistry.
8. Describe various types of instruments, physical chemistry and techniques used in clinical chemistry analysis.
9. Describe the fundamental principles used in clinical instrument designs.
10. Compare, contrast and evaluate clinical instrument methodologies.
11. Describe techniques and statistical procedures that can be use to evaluate clinical data.
12. Relate the mechanisms and symptoms of toxicity to therapeutic drug monitoring and exposure to toxic substances.
13. Correlate pharmacokinetics to therapeutic drug monitoring.
14. Describe the biologic function of trace elements and vitamins and relate clinical findings to conditions associated with decreased or increased levels.
15. Correlate laboratory detection of tumor markers with cancers and metastatic disease.

#### Course Objectives:

1. Use quantitative analytical skills to evaluate and process numerical data.

#### Methodology:

Internet powerpoints, 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 to allow students to 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:

Unit exams will cover materials listed in the learning objectives for each of the defined segments or units outlined on the class calendar. Most material will be covered specifically in class but exam questions may cover materials presented in the assigned reading.

#### Correlation Study

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 :

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 associated with lab testing and usefulness in diagnosis.

*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 table or collection of experimental data (absorbance, pos/neg, fluorescence)

*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 compared to QC ranges and a discussion of patient data, whether it is normal or abnormal and relationship to a disease state.

*References*: Sources of information and test methodology for performance of lab procedure.

### Chemistry Study Cards :

Based upon ASCP content guidelines, you will make a study card for each topic that includes: topic, abnormal physiology, significant analytes, testing methodology, result interpretation and correlation to disease. First half of the cards will be due at lab session dated October 24 and the second half is due December 12. NO LATE CARDS. Chemistry Card Content list available through ascp.org, medical lab technician content outline under certification link

<http://www.ascp.org/PDF/BOC-PDFs/Guidelines/ExaminationContentGuidelineMLT.aspx> .

Please do part 1 and 2 (carbohydrates and protein and non nitrogen for first half) and parts 3 and 4 (enzymes and special chemistry) for second half. Card format/copy at the end of the syllabus.

### GRADING:

A = 90-100%

B = 80-89%

C = 70-79%

D = 60-69%

F = <60%

Final grades: Lecture exams/Pop Quizzes/Final

Study Cards

Correlation Study

Lab Reports/Exams

### Required Text, Readings, and Materials:

Sunheimer, Robert L. and Graves, Linda, Clinical Laboratory Chemistry (2011) ISBN-13 978-0131721715 or ISBN-10 0131721712, Pearson, Upper Saddle River, NJ.

### Required Personal Protective Equipment (PPE)

Gloves PLEASE BUY 2 BOXES FOR THE START OF CLASS

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/Program Director, the Dean, 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 (Jed Doxtater 268-2505)
- 2) Program director (Dr. Audrey Hentzen 268-2632)
- 3) Dean, School of Health Science (Dr. Tammy Frankland 268-2495)
- 4) Interim Vice President for Academic Affairs (Dr. Shawn Powell).

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 for more information on this topic.

**NO CELL PHONES DURING CLASS. IF YOU HAVE AN EMERGENT PHONE CALL TAKE IT OUTSIDE. NO TEXTING WHILE IN LAB OR CLASS AND PHOTOS BY PERMISSION.**

Official Means of Communication: Casper College faculty and staff will employ the student's assigned Casper College email account as a primary method of communication. Students are responsible to check their account regularly.

ADA Accommodations Policy: If you need academic accommodations because of a disability, please inform me as soon as possible. See me privately after class, or during my office hours. To request academic accommodations, students must first consult with the college's Disability Services Counselor located in the Gateway Building, Room 344, (307) 268-2557, [bheuer@caspercollege.edu](mailto:bheuer@caspercollege.edu). The Disability Services Counselor is responsible for reviewing documentation provided by students requesting accommodations, determining eligibility for accommodations, and helping students request and use appropriate accommodations.

Course calendar or schedule is available on the moodle webpage.

### **Applied Clinical Analysis-Course Content 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. Types 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. Pharmacokinetics
    - 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 Immuno-electrophoresis
- C. Monoclonal Antibodies
- XIX. Electrochemistry
  - A. Potentiometric and Volametric 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 Diff, 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

Week	Date (WEEK OF)	Lab day S 11-4 pm	Topic	Reading
1	8/24		Overview	Chpt 1
2	8/31		QA/Lab instruments & Techniques	Chpt 2, 3
3	9/7		Lab Math	
	9/10	LAB DAY	QC, lab math, solutions, spectrophotometers, standard curves	
4	9/14		Carbohydrates	Chpt 4
5	9/21		<b>EXAM</b>	
	9/24	LAB DAY	Carbohydrates, glycoHgb, Diabetes	
6	9/28		Hemoglobin	Chpt 5
7	10/5		Renal	Chpt 6
8	10/12		Liver	Chpt 7
9	10/21		Cardiovascular	Chpt 8
	10/22	LAB DAY	Electrolytes, blood gases, total protein, cardiac risk, kidney function	<b>1<sup>st</sup> half cards due</b>
10	10/26		Respiratory	Chpt 9
11	11/2		<b>EXAM</b>	
12	11/9		Nutrition	Chpt 10
	11/12	LAB DAY	Enzymes, hepatitis, cardiac special testing	
13	11/16		Endocrine	Chpt 11
14	11/23		Repro/Endocrine	Chpt 12
15	11/30		TDM	Chpt 14
	11/30		<b>EXAM</b>	
16	12/7			
	12/10	LAB DAY	Toxicology screens, pregnancy testing	2nd half cards due

\*Schedule subject to change with notice.

Chemistry Study Cards

Initials: \_\_\_\_\_

Topic:

Relationship to metabolism, organ dysfunction or patho-physiology:

Gold Standard Test Methodology

Specimen:

Methodology:

Special notes:

Lab Test:

Reference Range:

Clinically Significant Results:

Chemistry Study Cards

Initials: \_\_\_\_\_

Topic:

Relationship to metabolism, organ dysfunction or patho-physiology:

Gold Standard Test Methodology

Specimen:

Methodology

Special notes:

Lab Tests:

Reference Range:

Clinically Significant Results: