# COURSE OUTLINE

**Course Number:**  
MLT 200  

**Course Title:**  
Clinical Chemistry  

**Credits:**  
4  

**Hours:**  
3 lecture/2 lab  

**Pre-requisite:**  
Permission of Program Coordinator  

**Implementation:**  
Fall B 2016  

---

**Catalog description:**  
Principles and theory of chemical analysis performed on clinical specimens. This class is an in depth study of specimen processing, analysis, test interpretation and quality control procedures used in routine manual and automated clinical chemistry testing. Emphasis is placed on basic chemical calculations, reagent preparations/functions, and the analytical methodologies that monitor body acid/base balance: kidney, liver, and heart functions; as well as carbohydrate, heme protein and lipid metabolism. Brief sections on measurements of endocrine function, DNA analysis, and TDM, toxicology, and tumor markers are also included. Students will present a group presentation of an assigned chemistry analyzer that focuses on the instrument’s basic components, principles of operation, maintenance, and quality control.

**Course Revision:**  
10/2016

---

**Required text:**  
Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics  
by Carl A. Burtis and David E. Bruns  
7th Edition  
ISBN10: 1455741655  
Cover type: Hardback

---

**Course Instructor:**  
Lisa Shave MLS (ASCP)SBB  
shavel@mccc.edu  
Office: 609 570 3387  
Office hours: MS 156
MCCC General Education Core Competencies and Goals

General Education Core Competencies: (GC)
A. Communication: Students will communicate effectively in both speech and writing.
B. Critical Thinking and Problem-Solving: Students will use critical thinking and problem solving skills in analyzing information.
C. Ethical Reasoning and Action: Students will understand ethical issues and situations.
D. Information Literacy: Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.
E. Computer Literacy: Students will use computers to access, analyze or present information, solve problems, and communicate with others.
F. Collaboration and Cooperation: Students will develop the interpersonal skills required for effective performance in group situations.
G. Intra-Cultural and Inter-Cultural Responsibility: Students will demonstrate an awareness of the responsibilities of intelligent citizenship in a diverse and pluralistic society, and will demonstrate cultural, global, and environmental awareness.

General Education Goals (GG)
Goal 1. Written and Oral Communication in English: Students will communicate effectively in both speech and writing.
Goal 2. Mathematics: Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
Goal 3. Science: Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.
Goal 4. Technology or Information Literacy: Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.
Goal 5. Social Science: Students will use social science theories and concepts to analyze human behavior and social and political institutions and to act as responsible citizens.
Goal 6. Humanities: Students will analyze works in the fields of art, music, or theater; literature; philosophy and/or religious studies; and/or will gain competence in the use of a foreign language.
Goal 7. History: Students will understand historical events and movements in World, Western, non-Western or American societies and assess their subsequent significance.
Goal 8. Diversity and Global Perspective: Students will understand the importance of a global perspective and culturally diverse peoples.
**Course Competencies/Goals:**

*Upon completing the course, the student will be able to:*

1. Identify key elements of laboratory safety and universal precautions.
2. Demonstrate knowledge of the function and physiology of the body systems including renal, liver, cardiovascular, respiratory, digestive, endocrine, and reproductive.
3. Correlate clinical chemistry laboratory results to conditions of health or disease in the human body.
4. Apply knowledge of general and physiological chemistry to manual and automated laboratory testing.
5. Apply knowledge of mathematics in the performance and analysis of statistical measurements used for quality assessment in the clinical laboratory.
6. Discuss topics in relation to tumor markers, therapeutic drug monitoring and toxicology.
7. Recognize differences in reference ranges for diverse populations.
8. Demonstrate critical thinking skills in the evaluation of patient case studies relating data to a medical diagnosis and clinical conditions that occur as a result of disease processes.
9. Perform basic lab techniques used in clinical chemistry.
10. Access information on a chemistry analyzer and prepare a classroom presentation

**Units of Study in Detail**

**Unit 1: Laboratory Principles & Statistics, Quality Assurance and Quality Control Practices and Automated Instruments**

*At the end of this unit, students will be able to:*

**Learning (cognitive) objectives:**

1. Identify methods used to produce laboratory grade water for use in the clinical laboratory. GG3
2. List the 3 parameters that need to be monitored during the purification process. GC A, B  GG1,3
3. Explain the purpose of different types of glassware used in clinical chemistry. GC A, GG1,3
4. Identify different types of plasticware used in clinical chemistry. GG3
5. Explain the proper use of pipettes when working with laboratory reagents and clinical specimens. GC A, GG1,3
6. Define the different measures for solution concentration including specific gravity, molarity, normality, molality and percent solution. GC A, B  GG1,2,3
7. Convert results from one unit to another. GC B GG2,3
8. Convert temperatures from one system to another. GC B  GG2,3
9. Calculate the volume of diluent needed to make up various dilutions. GC B  GG2,3
10. Explain how a serial dilution is performed. GC A,B  GG1,2,3
11. Explain how the measurement of light can be used to measure analytes in a solution. GC A,B GG1,2,3
12. Describe the technology used in the following analytical methods: Spectrophotometry, Reflectometry, Chemiluminescence, Fluorometry, Nephelometry, Refractometry, Electrochemistry, Electrophoresis and Chromatography GC A,B  GG1,3,4
13. Explain the preanalytical, analytical and post analytical stages of laboratory testing. GC A, GG1,3
14. Identify terms associated with automated testing such as random access, carryover and LIS interfacing. GG 3
15. Describe the advantages and disadvantages of automated laboratory testing. GC A, GG1,3
16. Explain how a Gaussian curve is used in laboratory quality assurance. GC A,B  GG1,3
17. Differentiate the terms: precision, accuracy, sensitivity and specificity. GG3
18. Explain how a Levy-Jennings chart and Westgard Rules are used for quality control. GC A,B GG1,2,3
19. List the responsibilities of the technician in maintaining a safe work environment. GC A,C,F GG3
20. Describe the role of regulatory agencies in maintaining standards in laboratory testing. GC A, GG1,3

Performance (psychomotor) objectives:
1. Demonstrate proper use of various pipettes in the clinical lab. GG3
2. Perform simple and serial dilutions. GC B GG2,3
3. Experiment with the functions of a spectrophotometer. GC F, GG3
4. Calculate the concentration of a solution given the absorbent values for test and standard samples. GG2,3

Affective Objectives: By the end of this unit, the student should be able to demonstrate the following behaviors and attitudes:
1. Perform analyses carefully with good technique while paying close attention to detail and quality.
2. Maintain and operate equipment and instrumentation reliably; generate quality results.
3. Leave work area, equipment and instrumentation clean and in good working order after use.
4. Organize for priority and efficiency.

Unit 2: Carbohydrates and Lipids, and Amino Acids, Peptides and Proteins
At the end of this unit, students will be able to:
Learning (cognitive) objectives:
1. Discuss the molecular structure and function of carbohydrates. GC A, GG1,3
2. Summarize the biochemical pathways of carbohydrate metabolism. GC A, GG1,3
3. List the endocrine glands and hormones that affect carbohydrate metabolism. GC A, GG1,3
4. Compare and contrast Type 1 and Type 2 diabetes. GC A, GG1,3
5. Explain the physiological changes that occur with hyper- and hypoglycemia. GC A, GG1,3
6. Describe the methodologies used to measure serum, urine and body fluid glucose levels. Identify abnormal and critical levels of glucose. GC A, GG1,3
7. Distinguish between cholesterol, lipids, triglycerides and fatty acids. GC A, GG1,3
8. Explain the role of apolipoproteins. GC A, GG1,3
9. Identify the risk factors associated with coronary heart disease. GG3
10. Explain the laboratory methodologies for measuring serum lipids. GC A, GG1,3
11. Describe the structure and function of proteins. GC A, GG1,3
12. Explain the significance of the protein bands seen in serum protein electrophoresis. GC A,B GG1,3
13. Discuss causes of hyper- and hypoproteinemia. GC A, GG1,3
14. Compare the methodologies used for measuring protein and albumin in clinical specimens. GG3
15. Describe the methods used for protein screening in urine and the clinical significance of a positive test. GC A, GG1,3
16. Explain the clinical significance of an elevated protein level in CSF and the methodologies used for measurement. GC A,B GG1,3
17. Define and calculate an A/G ratio. GC A,B GG1,2,3

Performance (psychomotor) objectives:
1. Experiment with thin layer chromatography. GC F, GG3
2. Perform a protein electrophoresis. GC A,B,G, F, GG3
Affective objectives:
1. Strictly follow written procedures and verbal instructions.
2. Demonstrate initiative and resourcefulness; learn more than the minimum.
3. Demonstrate consideration for other students in the student laboratory and a spirit of teamwork.

Unit 3: Electrolytes & Blood Gases, Osmolality, Enzymes and Tumor Markers

At the end of this unit, students will be able to:

Learning (cognitive) objectives:
1. List the significant electrolytes routinely measured in the laboratory. GC A, GG1,3
2. Define and calculate an ‘anion gap’. GC A,B, GG1,2,3
3. Explain the clinical significance of serum and urine osmolality. GC A, GG1,3
4. Name the colligative properties of solutions used in measuring osmolality. GC A, GG1,3
5. Define respiratory and metabolic alkalosis and acidosis. GC A, GG1,3
6. Explain the role of the lungs, kidneys and physiological buffer system in acid-base balance. GC A,B, GG1,3
7. Describe the collection method, testing methodologies and result parameters seen in blood gas analysis. GC A, GG1,3
8. Explain the function of enzymes. GC A, GG1,3
9. Describe enzymatic reactions including first and zero-order kinetics, cofactors and factors that affect reaction speed. GC A, GG1,3
10. Summarize the clinical significance of the following enzymes: CK, LD, AST, ALT, ALP, GGT, 5’-NT, Amylase, Lipase and Trypsin. GC A, GG1,3
11. Describe the methodologies used for measuring serum enzymes. GC A, GG1,3
12. List the tumor markers that are used in assessing cancer. GC A, GG1,3
13. Explain the methodologies used in detecting tumor markers. GC A, GG1,3

Performance (psychomotor) objectives
1. Participate in a demonstration of a variety of osmometers with the help of an Allied Instruments® technician. GC A,B,G, F, GG3
2. Measure enzyme catalysis through the use of a spectrophotometer. GC A,B,G, F, GG3

Unit 4: Renal, Liver and Cardiac Functions, and Introduction to Iron, Porphyrins and Hemoglobin

At the end of this unit, students will be able to:

Learning (cognitive) objectives:
1. Describe the anatomy and physiology of the kidney. GC A, GG1,3
2. Explain the source of blood urea nitrogen and creatinine and the role they play in the assessment of kidney function. GC A,B, GG1,3
3. Define ‘azotemia’ and describe common causes of this condition. GC A, GG1,3
4. Summarize the formation and excretion of uric acid. GC A,B, GG1,3
5. Explain the condition of ‘gout’; it’s causes and treatments. GC A, GG1,3
6. Describe how a ‘creatinine clearance’ is performed. GC A, GG1,2,3
7. List other screening tests for renal disease. GC A, GG1,3
8. Explain how dialysis helps in the treatment of renal disease. GC A, GG1,3
9. Explain the following laboratory tests used to assess cardiac function: Myoglobin, CK-MB, Troponin and BNP. GC A, GG1,3
10. Describe the structure and function of the liver. GC A, GG1,3
11. Summarize the breakdown of bilirubin. GC A, GG1,3
12. State the differences between conjugated, unconjugated, direct, indirect and total bilirubin. GC A, GG1,3
13. Briefly describe the pathology of the following liver disorders: Jaundice, Hepatitis, Cirrhosis, Bile duct obstruction, inherited metabolic disorders and enzyme deficiencies. GC A, GG1,3
14. Explain the clinical significance of an elevated serum ammonia level. GC A, GG1,3
15. List the laboratory tests that are included in liver function assessment. GC A, GG1,3
16. Describe the physiology, transport and metabolism of iron. GC A, GG1,3
17. Identify laboratory methods used to measure serum iron, porphyrins and hemoglobin. GC A, GG1,3

Performance (psychomotor) objectives
1. Challenge the procedure for a ‘creatinine clearance’ test and by performing calculations through examples. GC A,B GG1,2,3
2. Conduct research on an assigned chemistry analyzer using library, manufacturer’s website and clinical site resources. GC B,D,E,F,G GG4

Unit 5: Endocrinology, Thyroid Disorders, Pregnancy, Toxicology and Nutritional Minerals, Vitamins and Elements
Describe laboratory methods used for measuring serum calcium and phosphate. GC A, GG1,3
1. Describe laboratory methods used for measuring serum calcium and phosphate. GC A, GG1,3
2. Explain the role that PTH and Vitamin D has on calcium and phosphate levels. GC A, GG1,3
3. Discuss the clinical significance of measuring ionized magnesium. GC A, GG1,3
4. List the function of the following hormones: thyroxine, cortisol, epinephrine, antidiuretic hormone, growth hormone, aldosterone, luteinizing hormone, FSH, estrogen, progesterone, testosterone, prolactin, oxytocin. GC A, GG1,3
5. Discuss methodologies used to measure hormones in the laboratory. GC A, GG1,3
6. Define the ‘negative feedback system’ as it relates to hormone regulation. GC A, GG1,3
7. Associate abnormal hormone levels with various diseases and syndromes. GC A,B GG3
8. Outline the functions of the components of the GI system. GC A, GG1,3
9. Explain laboratory tests used to assess diseases of the GI tract. GC A, GG1,3
10. Summarize the endocrine and exocrine function of the pancreas. GC A, GG1,3
11. List laboratory tests used to assess pancreatic function. GC A, GG1,3
12. Define the term ‘pharmacokinetics’ and its implication in TDM. GC A, GG1,3
13. Explain the terms: Elimination half-life, steady state, bioavailability, loading dose, peak & trough. GC A,B GG1,3
14. List therapeutic drugs that are commonly measured in the laboratory. GC A, GG1,3
15. Name toxic substances that are commonly measured in the laboratory. GC A, GG1,3
16. Identify laboratory methods used to measure toxic substances. GC A, GG1,3
17. Describe laboratory methods used for screening for drugs of abuse. GC A, GG1,3
18. List caused of high blood levels of lead. GC A, GG1,3
19. Discuss the physiological role of trace elements in the body. GC A, GG1,3
20. Identify specimen types and instrumentation used to measure trace elements in the laboratory. GC A, GG1,3
21. Differentiate between fat and water soluble vitamins. GC A, GG1,3
22. Identify laboratory methods for measuring vitamin levels. GC A, GG1,3
23. Correlate abnormal levels of vitamins with various disease states. GC A,B GG1,3

Performance (psychomotor) objectives:
1. Experimenting with levels of hCG via an ELISA test. GC A,B,G, F, GG3
2. Diagnostically measuring levels of drugs of abuse using a manufactured rapid immunoassay kit. GC A,B,G, F, GG3

Grading:
Homework ..............................................10%
Quizzes (4) .............................................20%
Midterm ..................................................20%
Final ..........................................................20%
Total Lecture 70%

Lab:
Quizzes (3) ..............................................10%
Midterm ..................................................5%
Lab Final ..................................................5%
Analyzer Presentation .................................5%
Homework ------------------------------------- 2.5%
Affective Score ....................................... 2.5%
Total Lab 30%

Grading Scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93-100</td>
</tr>
<tr>
<td>A-</td>
<td>90-92</td>
</tr>
<tr>
<td>B+</td>
<td>87-89</td>
</tr>
<tr>
<td>B</td>
<td>83-86</td>
</tr>
<tr>
<td>B-</td>
<td>80-82</td>
</tr>
<tr>
<td>C+</td>
<td>77-79</td>
</tr>
<tr>
<td>C</td>
<td>75-76</td>
</tr>
<tr>
<td>D</td>
<td>74-60</td>
</tr>
<tr>
<td>F</td>
<td>&lt;59</td>
</tr>
</tbody>
</table>

Affective Scoring based on Professional Performance

Affective objectives are behavioral standards that will be implemented during the professional phase of the Medical Laboratory Technology Program. Students will be evaluated by faculty using these standards throughout the course. The student is evaluated on the demonstration of performance that reflects achievement of important objectives for medical laboratory technicians. This professional performance will be evaluated during the laboratory course and will be returned to the student with their all laboratory worksheets submitted. See the last page for a detailed list of the criteria.

Note: To receive an acceptable passing grade, the student must achieve a 77% or above in the course. A final grade of a C+ or better in each Medical Laboratory Technology course is necessary to progress to the next professional phase course.

Unsatisfactory Performance

Unsatisfactory performance in any area of the behavioral standards or failure to keep a grade of 77 or above will require a consultation with the faculty and/or the MLT Program coordinator. The reason for the consultation will be clearly stated, counsel will be given and an action plan will be implemented. The student will be given the opportunity to give a written response. The consultation form will be kept in the student’s file.
**Attendance Policy**

Students are expected to attend all lecture and laboratory sessions. If an absence is anticipated, please e-mail the program coordinator shavel@mccc.edu or leave a phone message at 609-570-3387. Students are responsible for any material missed. There are no make-up labs.

**Academic Integrity**

Your examinations (tests, quizzes, assignments, laboratory work and practicals) must reflect your individual work and knowledge. Any exchange of information by talking, writing, electronic devices or gestures constitutes a violation of academic integrity. All academic integrity violations will be reported to the college’s Academic Integrity Committee.

**Support Services for Differing Abilities**

Mercer County Community College is committed to ensuring the full participation of all students in its programs. If you have a documented differing ability, or think that you may have differing ability that is protected under the ADA and section 504 of the Rehabilitation Act, please contact Arlene Stinson in LB 216 stinsona@mccc.edu for information regarding support services.

If you do not have a documented differing ability, other support services are available to all students on campus including the Learning Center located in LB 214.

**Financial Aid Application Statement for Syllabi**

It is recommended that students complete an application for financial aid to determine eligibility for financial assistance. The application is FREE and available for completion **beginning October 1, 2016** for the 2017-18 academic year. Visit [www.fafsa.ed.gov](http://www.fafsa.ed.gov) to complete your application. **Applications should be completed before December 1, 2016.** Students who are interested in MCCC Foundation scholarships are expected to complete an application as well.
# Lecture Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Unit</th>
<th>Chapter</th>
<th>Quiz/HW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tues Oct 25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>General Lab Practices, Glassware &amp; Safety</td>
<td>Ch. 1 and 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thurs Oct 27&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Basic Principles, Statistics &amp; Lab Math</td>
<td>Ch. 8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tues Nov 1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Analytical Techniques, Automation &amp; Instrumentation</td>
<td>Ch. 16; 9-12</td>
<td>HW 1 due</td>
</tr>
<tr>
<td></td>
<td>Thurs Nov 3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>QA, QC, Sensitivity &amp; Specificity, Reference Values and Method Validation</td>
<td>Ch. 2-3; 5-7</td>
<td>Quiz 1 on Week 1</td>
</tr>
<tr>
<td>3</td>
<td>Tues Nov 8&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Carbohydrates &amp; Lipids</td>
<td>Ch. 22-23; 33</td>
<td>HW 2 due</td>
</tr>
<tr>
<td></td>
<td>Thurs Nov 10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Amino acids, Peptides &amp; Proteins</td>
<td>Ch. 15 and 18</td>
<td>Quiz 2 on week 2</td>
</tr>
<tr>
<td>4</td>
<td>Tues Nov 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Electrolytes, Blood Gases &amp; Osmolality</td>
<td>Ch. 24 and 36</td>
<td>HW 3 due</td>
</tr>
<tr>
<td></td>
<td>Thurs Nov 17&lt;sup&gt;th&lt;/sup&gt;</td>
<td>MIDTERM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tues Nov 22&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Enzymes &amp; Tumor Markers</td>
<td>Ch. 19-20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RECESS 11/24-11/27</td>
<td>HAPPY THANKSGIVING!!!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Tues Nov 29&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Renal Function &amp; Kidney</td>
<td>Ch. 21 and 35</td>
<td>HW 4 due</td>
</tr>
<tr>
<td></td>
<td>Thurs Dec 1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Cardiac &amp; Liver Function, Iron, Porphyrins, Hemoglobin</td>
<td>Ch. 28-29; 34 and 37</td>
<td>Quiz 3 Wk 5/6(T)</td>
</tr>
<tr>
<td>7</td>
<td>Tues Dec 6&lt;sup&gt;th&lt;/sup&gt;</td>
<td>GI, Endocrinology, Thyroid &amp; Pregnancy</td>
<td>Ch. 38; 40-45</td>
<td>HW 5 due</td>
</tr>
<tr>
<td></td>
<td>Thurs Dec 8&lt;sup&gt;th&lt;/sup&gt;</td>
<td>TDM &amp; Toxicology</td>
<td>Ch. 30-32</td>
<td>Quiz 4</td>
</tr>
<tr>
<td>8</td>
<td>Tues Dec 13&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Nutrition, Minerals, Vitamins, Trace elements</td>
<td>Ch. 27; 39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thurs Dec 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Lecture Final</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# MCCC
## MLT 200: Clinical Chemistry
### Fall B 2016
#### Lab Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Unit</th>
<th>Quiz/HW</th>
</tr>
</thead>
</table>
| 1    | Tues Oct 25<sup>th</sup>  
Thurs Oct 27<sup>th</sup> | Safety exercises, Glassware & Pipetting  
Laboratory Math, Dilutions & Reagents |                              |
| 2    | Tues Nov 1<sup>st</sup>  
Thurs Nov 3<sup>rd</sup>  | Spectrophotometer/Beer’s Law  
Quality Control using Levy Jennings Charts | Week 1 HW due; **Quiz 1** |
| 3    | Tues Nov 8<sup>th</sup>  
Thurs Nov 10<sup>th</sup> | Principles of Thin Layer Chromatography  
Protein Electrophoresis | Week 2 HW Due  
**Quiz 2** |
| 4    | Tues Nov 15<sup>th</sup>  
Thurs Nov 17<sup>th</sup> | Osmometer Instrument Demo by Edward Mehrlust of Advanced Instruments | Week 3 HW due |
| 5    | Tues Nov 22<sup>nd</sup>  
RECESS 11/24-11/27 | Enzyme Spectrophotometer  
**HAPPY THANKSGIVING!!!** |                              |
| 6    | Tues Nov 29<sup>th</sup>  
Thurs Dec 1<sup>st</sup>  | Presentation Guidelines Handout/Research  
Creatinine Clearance | **Quiz 3** |
| 7    | Tues Dec 6<sup>th</sup>  
Thurs Dec 8<sup>th</sup>  | Endocrinology, Thyroid & Pregnancy  
Urine Toxicology Bio-Rad | Week 5/6 HW due |
| 8    | Tues Dec 13<sup>th</sup>  
Thurs Dec 15<sup>th</sup> | Lab Presentations  
**Lab Final** | |