



# MLAB 2401 Clinical Chemistry (Hybrid)

Course Syllabus: Fall 2020

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*“Northeast Texas Community College exists to provide personal, dynamic learning experiences empowering students to succeed.”*

**Instructor: Gaylon Barrett**

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Office	Monday	Tuesday	Wednesday	Thursday	Friday	Online
Hours	9a-12 noon Zoom	1p-4p Campus	9a-12 noon Zoom	11a-12 noon Campus	By appt.	

***This syllabus is an agreement between the instructor and the student.***

*Information relative to the delivery of the content contained in this syllabus is subject to change. Should that happen, the student will be notified by the instructor.*

**Course Description:** This course is an introduction to the principles and procedures of various tests performed in Clinical Chemistry. The course presents the physiological basis for the test, the principle basis for the test, the principle and procedure for the test, and the clinical significance of the test results, including quality control and normal values. Also includes basic chemical laboratory techniques, chemical laboratory safety, electrolytes and acid-base balance, proteins, carbohydrates, lipids, enzymes, metabolites, endocrine function, and toxicology.

**Prerequisite(s):** Acceptance into the MLT Program

**Student Learning Outcomes:** The primary goal of this course is to provide students with an understanding of the basic principles and techniques of clinical chemistry. Upon completion of this course, the student should be able to do the following:

- ❖ Exhibit knowledge of human body chemistry levels under healthy and abnormal conditions.
- ❖ Evaluate the suitability of clinical specimens.
- ❖ Explain and perform procedures routinely performed in a clinical chemistry laboratory, including:
  - Electrolytes
  - Blood gases and acid-base balance
  - Proteins and enzymes
  - Carbohydrates and lipids
  - Liver, kidney, and endocrine function
  - Toxicology and therapeutic drug monitoring (TDM)
  - Vitamins and trace elements
- ❖ Evaluate laboratory test outcomes and correlate test results with patient conditions.

**Evaluation/Grading Policy: Lecture Grade (75%):**

4 exams

**Grading Scale**

<i>A</i>	≥90%
<i>B</i>	80-89%
<i>C</i>	70-79%
<i>D</i>	60-69%
<i>F</i>	<60%

**Laboratory grade (25%):**

Lab reports/homework

***A minimum grade of “C” is required in both the lecture and laboratory components of all Medical Laboratory Technician courses. Failure to meet the minimum passing score in each area will result in a “D” for the course and dismissal from the program.***

Required Instructional Materials: Sunheimer, R.L., Graves, Linda, *Clinical Laboratory Chemistry*, 2<sup>nd</sup> Edition. Pearson Education Inc., 2011.

**Publisher: Pearson Education****ISBN Number: 978-0-13-441332-7****Optional Instructional Materials: Powerpoint slides****Required Computer Literacy Skills:**

<b>Scan Competency</b>	<b>Clinical Chemistry</b>
Resources	Identify reagents and supplies needed for each lab and organize laboratory procedure so that reagents, supplies and equipment are utilized correctly. Perform laboratory procedures using only necessary supplies and within a predetermined, reasonable amount of time.
Interpersonal	Recognize limitations of expertise and communicate with instructor when questions arise. Show respect for instructor and peers during class time.
Information	Apply information gained from lecture, laboratory and independent study to problem-solve results provided as case studies or unknowns during laboratory. Evaluate quality control results within pre-established parameters.
Systems	Apply critical thinking skills to identify and take correction actions when quality control results do not fall within expected parameters. Apply critical thinking skills to theoretical case studies.
Technology	Achieve competency in routine clinical chemistry procedures.

Course Structure and Overview: The clinical chemistry course utilizes a variety of instructional methods, including reading assignments, lectures, laboratory experiments and practice, computer-aided instruction and written assignments. Students are responsible for all reading assignments, lecture material, laboratory and other assignments.

## **COURSE OUTLINE**

**NOTE: The class schedule is subject to change by the instructor when deemed necessary or appropriate.**

### **Unit 1:**

#### **General Laboratory Equipment and Basic Principles of Clinical Chemistry**

##### Chapters 2 - 5

- Explain the principles of clinical chemistry testing instrumentation, including spectrophotometry, potentiometry, electrophoresis, immunoassay, and chromatography.
- Derive the formula for Beer's law and explain the relationship between absorbance and transmittance.
- Compare and contrast the various analytic techniques, including limitations and clinical applications.
- Define the following terms: automation, channel, continuous flow, discrete analysis, dwell time, flag, random access, and throughput.
- Explain the major steps in automated analysis and provide examples of commercially available discrete chemistry analyzers and modular systems.
- Define immunoassay and explain the difference between competitive immunoassay and noncompetitive immunoassay.
- Explain the difference between a homogeneous immunoassay and heterogeneous immunoassay.

#### **Carbohydrates**

##### Chapter 7

- Discuss the metabolism of carbohydrates in the body and the mode of action of hormones in carbohydrate metabolism.
- Differentiate the types of diabetes by clinical symptoms and laboratory findings according to the American Diabetes Association.
- Explain the clinical significance of the three ketone bodies.
- Relate expected laboratory results and clinical symptoms to the following metabolic complications of diabetes: ketoacidosis and hyperosmolar coma.
- Distinguish between reactive and spontaneous hyperglycemia.
- Describe the principle, specimen of choice, and advantages and disadvantages of the glucose analysis methods.
- Describe the three commonly encountered methods for glycosylated hemoglobin, specimen of choice and source of error.
- Describe the use of glycosylated hemoglobin in the long-term monitoring of diabetes.
- Discuss the methods of analysis for ketone bodies and the advantages and disadvantages of each

#### **Lipids and Lipoproteins**

##### Chapter 8

- Describe the structure of fatty acids, phospholipids, triglycerides, cholesterol, and the various types of lipoprotein particles.
- Describe the laboratory tests used to assess lipids and lipoproteins, including principles and procedures.
- Identify the reference ranges for the major serum lipids.
- Identify common lipid disorders from clinical and laboratory data.
- Relate the clinical significance of lipid and lipoprotein values in the assessment of coronary heart disease.

#### **Amino Acids and Proteins**

##### Chapter 9

- Describe the structures and general properties of amino acids and proteins.
- Outline protein synthesis and catabolism

- Discuss the function and clinical significance of the following proteins: prealbumin, albumin,  $\alpha_1$ -antitrypsin,  $\alpha_1$ -fetoprotein, haptoglobin, ceruloplasmin, transferrin, fibrinogen, C-reactive protein, immunoglobulin, and troponin.
- Discuss at least five general causes of abnormal serum protein concentrations.
- List the reference intervals for total protein and albumin and discuss any nonpathologic factors that influence the levels.
- Describe and compare the methodologies used in the analysis of total protein, albumin, and protein fractionation. Name and recognize the fractions, interpret any abnormality in the pattern and associate these patterns with common disease states given a densitometric scan.
- Describe the diseases associated with alterations in CSF proteins

## Unit 2:

### Enzymes

#### Chapter 10

- Discuss the different factors affecting the rate of an enzymatic reaction, using these factors to explain enzyme kinetics such as zero-order and first-order kinetics.
- Explain why the measurement of serum enzymes is useful clinically
- Discuss which enzymes are useful in the diagnosis of various disorders, including cardiac, hepatic, bone and muscle disorders, malignancies and acute pancreatitis.
- Discuss tissue sources, diagnostic significance and assays, including sources of error, for the following enzymes: CK, LD, AST, ALT, ACP, GGT, amylase, lipase, cholinesterase and G-6-PD.
- Evaluate patient serum enzyme levels in relation to disease states.

### Nonprotein Nitrogen Compounds and Renal Function

#### Chapter 11

- Diagram the anatomy of the nephron and describe the physiologic role of each part of the nephron.
- Discuss the significance and calculation of glomerular filtration rate and estimated glomerular filtration rate.
- Relate the clinical significance of total urine proteins, urine albumin microalbuminuria, myoglobin clearance, serum  $\beta_2$ -microglobulin, and cystatin C.
- Describe diseases of the glomerulus and tubules and how laboratory tests are used in these disorders.
- Distinguish between acute and chronic renal failure.
- List the nonprotein nitrogen components of the blood and recognize their chemical structures and relative physiologic concentrations.
- Describe the biosynthesis and excretion of urea, uric acid, creatinine, creatine and ammonia.
- Describe the major pathologic conditions associated with altered plasma concentrations of urea, uric acid, creatinine, creatine, and ammonia.
- Discuss commonly used methods for the determination of urea, uric acid, creatinine, creatine and ammonia in plasma and urine. Identify sources of error and variability in these methods and describe the effects on the clinical utility of the laboratory measurements. Recognize the reference intervals, particularly the effects of age and gender on these values.
- Describe the use of the urea nitrogen/creatinine ratio in distinguishing between prerenal, renal and postrenal causes of uremia.
- Relate the solubility of uric acid to the pathologic consequences of increased plasma uric acid.

- Explain the use and limitations of serum creatinine for calculations of estimated glomerular filtration rate.
- Describe the toxic effects related to an increased plasma ammonia concentration.

### **Electrolytes**

#### Chapter 12

- Define electrolyte, osmolality, anion gap, anion and cation.
- Discuss the physiology and clinical significance of each electrolyte described in the chapter.
- Calculate osmolality, osmolal gap and anion gap and discuss the clinical usefulness of each.
- Discuss the analytical techniques used to assess electrolyte concentrations.
- Identify reference ranges for sodium, potassium, chloride, bicarbonate, magnesium and calcium.
- Correlate patient data with disease states.
- State the specimen of choice for the major electrolytes.

### **Blood Gases, pH and Buffer Systems**

#### Chapter 13

- Describe the principles involved in the measurement of pH, PCO<sub>2</sub>, PO<sub>2</sub> and the various hemoglobin species.
- Outline the interrelationship of the buffering mechanisms of bicarbonate, carbonic acid and hemoglobin.
- Explain the clinical significance of the following pH and blood gas parameters: pH, PCO<sub>2</sub>, PO<sub>2</sub>, actual bicarbonate, carbonic acid, base excess, oxygen saturation, fractional oxyhemoglobin, hemoglobin oxygen (binding) capacity, oxygen content and total CO<sub>2</sub>.
- Determine whether data are normal or represent metabolic or respiratory acidosis or metabolic or respiratory alkalosis using the Henderson-Hasselbach equation and blood gas data. Identify whether the data represent uncompensated or compensated conditions.
- Identify some common causes of acidosis and alkalosis. State how the body attempts to compensate for the various conditions.
- Describe the significance of the hemoglobin-oxygen dissociation curve and the impact of pH, 2,3-DPG, temperature, and PCO<sub>2</sub> on its shape and release of O<sub>2</sub> into the tissues.
- Discuss problems and precautions in collecting and handling samples for pH and blood gas analysis.
- Describe instrumental approaches to measuring various hemoglobin species, pH and blood gas parameters.

## **Unit 3: Assessment of Organ/System Function**

### **Calcium Homeostasis and Hormonal Regulation**

#### Chapter 14

- Describe the endocrine and organ physiology of calcium metabolism.
- Discuss the laboratory tools used to evaluate calcium metabolism.
- Apply the laboratory tools to clinical disease states of calcium metabolism.

### **Introduction to Hormones and Pituitary Function**

#### Chapter 15

- Describe the functions of the anterior and posterior pituitary and the hypothalamus.
- Understand the concept of negative feedback and relate this to the function of the various hypothalamic-pituitary-endocrine target gland loops.
- Discuss the regulation of prolactin secretion.
- Understand the difference between primary and secondary endocrine deficiency states.
- Describe the clinical features of the excess and deficiency states for growth hormone, prolactin and vasopressin.

- Relate the physiology underlying strategies used for screening and definitive testing for suspected disorders of growth hormone.

### **Adrenal Function**

- Explain how the adrenal gland functions to maintain blood pressure, potassium and glucose homeostasis.
- Discuss the pathophysiology of adrenal cortex disorders, namely Cushing's disease and Addison's disease.
- Describe the synthesis, storage and metabolism of catecholamines.
- State the most useful measurements in supporting the diagnosis of pheochromocytoma.
- List the appropriate laboratory tests to differentially diagnose primary and secondary Cushing's disease and Addison's disease.

### **Gonadal Function**

- Describe the hypothalamic-pituitary-ovarian and hypothalamic-pituitary-testicular axes and how they regulate sex steroid and gonadotropin hormone production.
- Explain the principles of each diagnostic test for pituitary-gonadal axes dysfunction.
- Correlate laboratory information with regard to suspected gonadal disorders, given a patient's clinical data.

### **Thyroid Function**

- Discuss the biosynthesis, secretion, transport and action of the thyroid hormones.
- Describe the hypothalamic-pituitary-thyroid axis and how it regulated thyroid hormone production.
- Explain the principles of each thyroid function test discussed.
- Correlate laboratory information with regard to suspected thyroid disorders, given a patient's clinical data.

### **Pancreatic Function and GI Function**

#### Chapter 16

- Discuss the physiologic role of the pancreas in the digestive process.
- List the hormones secreted by the pancreas along with their physiologic roles.
- Describe the following pancreatic disorders and list the associated laboratory tests that would aid in diagnosis: acute pancreatitis, chronic pancreatitis, pancreatic carcinoma, and cystic fibrosis.
- List the tests used to assess gastric and intestinal function.
- Evaluate a patient's condition, given clinical data.

### **Cardiac Function**

#### Chapter 18

- Diagram the heart and explain the origin of six general symptoms of cardiac disease.
- Discuss the etiology and physiologic effects of the following cardiac conditions: congenital heart disease, hypertensive heart disease, infectious heart disease, coronary artery disease and congestive heart failure.
- Identify nine risk factors for coronary heart disease.
- Compare and contrast the specificity and sensitivity of the most commonly used serum cardiac markers.
- Assess the clinical utility of the various cardiac markers to assess myocardial infarction.
- List and briefly describe three novel markers of inflammation currently under investigation.

### **Liver Function**

#### Chapter 19

- Diagram the anatomy of the liver
- Explain the following functions of the liver: bile secretion, synthetic activity and detoxification.
- Define jaundice and classify the 3 different types of jaundice.

- Discuss the basic disorders of the liver and which laboratory tests may be performed to diagnose them.
- Evaluate liver-related data and correlate these data with normal or pathologic states.
- Compare and contrast how total and direct bilirubin measurements are performed.
- List the enzymes most commonly used to assess hepatocellular and hepatobiliary disorders.

## **Unit 4: Special Chemistry**

### **Porphyrins and Hemoglobin**

#### Chapter 20

- Outline the biochemical pathway of porphyrin and heme synthesis.
- Compare and contrast the porphyrias with regard to enzyme deficiency, clinical symptoms and clinical laboratory data.
- Explain the principles of the basic qualitative and quantitative porphyrin tests, to include PBG, ALA, uroporphyrin, coproporphyrin and protoporphyrin.

### **Therapeutic Drug Monitoring**

#### Chapter 21

- Discuss the characteristics of a drug that make therapeutic drug monitoring essential and describe the major toxicities..
- Identify the factors that influence absorption, distribution and elimination of a drug.
- Calculate volume of distribution, elimination constant and drug half-life.
- Name the therapeutic category of each drug presented in this chapter.

### **Toxicology**

#### Chapter 22

- Define the term toxicology.
- List the major toxicants and describe their pathologic mechanisms.
- Discuss the laboratory methods used to evaluate toxicity.
- Critically evaluate clinical laboratory data in poisoning cases and provide recommendations for further testing.

### **Nutrition and Vitamins**

#### Chapter 23

- Explain what is meant by macronutrient and micronutrient and list examples of each
- Discuss primary functions and symptoms associated with deficiency of vitamins A, Bs, C, D, E, K, and niacin
- State primary function of B12 and folate, and the anemia that results from deficiency
- State those proteins used as indicators of long-term and short-term malnutrition

### **Circulating Tumor Markers**

#### Chapter 24

- Explain the role of tumor markers in cancer management.
- Identify the characteristics or properties of an ideal tumor marker.
- State the major clinical value of tumor markers.
- Name the major tumors and their associated markers.
- Describe the major properties, methods of analysis and clinical use of AFP, CA-125, CEA, beta-hCG and PSA.

Explain the use of enzymes and hormones as tumor markers

**Communications:** College email is the primary communication channel and answered within 24 hours. Office phone is second choice, and cell phone is for emergencies only.

### **Institutional/Course Policy:**

**Attendance and Absences:** You are expected to attend ALL scheduled lectures and labs and take the exams as scheduled. You will be held responsible for all information covered in powerpoint lectures. *If you will be absent, inform the instructor by phone or email at least 15 minutes BEFORE class begins. Absences will be counted as unexcused if the instructor is not informed in a timely manner.* **Excessive unexcused absences will result in loss of points from your grade. More than two unexcused absences will result in a reduction of five (5) points being subtracted from your final grade (percentage). More than five unexcused absences will result in the student being dropped from the course. Two unexcused late class attendance equals one unexcused absence.**

**Makeup Policy:** There will be no makeup for quizzes. Late homework will NOT be accepted unless there is a valid excuse (to be determined by the instructor). The student is responsible for requesting a makeup when they are unable to attend a regularly scheduled examination and must schedule the makeup **within 2 days** of the absence. Makeup exams will be scheduled only in the event of an EXCUSED absence. If the test is not made-up, the student will receive a zero for that exam. Makeup work for laboratory assignments will only be scheduled in the event of an EXCUSED absence.

### **NTCC Academic Honesty/Ethics Statement:**

NTCC upholds the highest standards of academic integrity. The college expects all students to engage in their academic pursuits in an honest manner that is beyond reproach using their intellect and resources designated as allowable by the course instructor. Students are responsible for addressing questions about allowable resources with the course instructor. Academic dishonesty such as cheating, plagiarism, and collusion is unacceptable and may result in disciplinary action. This course will follow the NTCC Academic Honesty and Academic Ethics policies stated in the Student Handbook. Refer to the student handbook for more information on these subjects.

### **ADA Statement:**

It is the policy of NTCC to provide reasonable accommodations for qualified individuals who are students with disabilities. This College will adhere to all applicable federal, state, and local laws, regulations, and guidelines with respect to providing reasonable accommodations as required to afford equal educational opportunity. It is the student's responsibility to request accommodations. An appointment can be made with the Academic Advisor/Coordinator of Special Populations located in Student Services and can be reached at 903-434-8264. For more information and to obtain a copy of the Request for Accommodations, please refer to the special populations page on the NTCC website.

### **Family Educational Rights and Privacy Act (FERPA):**

The Family Educational Rights and Privacy Act (FERPA) is a federal law that protects the privacy of student education records. The law applies to all schools that receive funds under an applicable program of the U.S. Department of Education. FERPA gives parents certain rights with respect to their children's educational records. These rights transfer to the student when he or she attends a school beyond the high school level. Students to whom the rights have transferred are considered "eligible students." In essence, a parent has no legal right to obtain information concerning the child's college records without the written consent of the student. In compliance with FERPA, information classified as "directory information" may be released to the general public without the written consent of the student unless the student makes a request in writing. Directory information is defined as: the student's name, permanent



address and/or local address, telephone listing, dates of attendance, most recent previous education institution attended, other information including major, field of study, degrees, awards received, and participation in officially recognized activities/sports.

**Tentative Course Timeline (\*note\* instructor reserves the right to make adjustments to this timeline at any point in the term):**

**Tentative Exam Schedule:**

<b>Exam</b>	<b>Unit/Topics Covered</b>	<b>Date</b>
1	Chapters 2-9	Sept. 22
2	Chapters 10-13	Oct. 13
3	Chapters 14-19	Nov. 10
Final	Chapters 20-24	Dec. 8

**Student Contract for MLAB 2501**

I, \_\_\_\_\_, have received, read and understand the syllabus for MLAB 2501 Clinical Chemistry, offered at Northeast Texas Community College.

\_\_\_\_\_  
Student's signature

\_\_\_\_\_  
Date

**Current Contact Information:**

Phone: \_\_\_\_\_

Cell phone: \_\_\_\_\_

Preferred email address: \_\_\_\_\_