

Prerequisites: General biology and chemistry

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Contact Information: Faculty may be contacted through the Canvas messaging system

Additional Information: www.portagelearning.edu^{1*}

Course meeting times: CHEM 212 is offered continuously

Course Description: An exploration of Biochemistry relative to the dynamic relationship between the structure and function of biomolecules and metabolism. Chemical and cellular foundations are explored including cell organization, organic chemistry, and aqueous systems. The structure and function of biomolecules, including amino acids, proteins, carbohydrates, lipids, and nucleic acids, are examined. Finally, the metabolism and energy transformation of biomolecules is covered. The laboratory component of this course is delivered using virtual labs and interactive simulations with detailed instruction and demonstrations from an experienced instructor.

Course Outcomes: As a result of this course experience a student should be able to:

- Explain the elemental composition of biomolecules.
- Describe and articulate the biochemical role that carbon holds in biological organisms.
- Explain the importance of water, including its chemical and physical properties, for sustaining life.
- Classify and differentiate between the types of macromolecules found in nature.
- List the functions of proteins, carbohydrates, lipids, and nucleic acids in the cell.
- Recognize the essential properties and functions of the cellular membrane.
- Describe the biochemical processes surrounding energy flow, production, and storage in the cell.
- Discuss the significant metabolic pathways used for energy production.

**Please see the [Module & Lab Topics](#) section below for expanded course outcomes.*

^{1*} Portage Learning college courses are offered by Geneva College, which is regionally accredited by the Middle States Commission on Higher Education. Portage Learning is included in the College's Department of Professional and Online Graduate Studies; courses are delivered through the Portagelearning.edu platform.

Each of these CHEM 210 student learning outcomes is measured:

- Directly by: (1) Module application problems (with instructor feedback)
 (2) Module Exams
 (3) Cumulative Final Exam

Indirectly by an end of course student-completed evaluation survey

Course Delivery: This course is asynchronously delivered online and is composed of 40 - 50 hours of reviewed module assignments with instructor feedback and 8 contact hours of secure online module exams.

Course Progression: It is the policy for all Portage Learning courses that only one (module lecture/final) exam is to be completed within a 48-hour period. Research on the best practices in learning indicates that time is needed to process material for optimal learning. This means that once an exam has been completed, the next exam may not be opened or taken until 48 hours after the submission of the previous module exam. This allows for instructor feedback/class expectations as the student moves through the material. Instructors, like the College, are not available during the weekend; grading, therefore, is M-F and may take up to 72 hours during these days. Also, it is the policy of Portage Learning to support a minimum of 28 days to complete a course; this is not a negotiable time period. Please plan your time accordingly.

Note: Professors reserve the right to reset any exam taken in violation of these guidelines.

Required readings, lectures and assignments: Portage courses do not use paper textbooks. Students are required to read the online lesson modules written by the course author which contain the standard information covered in a typical course. **Please NOTE: the exam questions are based upon the readings.** Video lectures which support each lesson module subject should be viewed as many times as is necessary to fully understand the material.

We do not support the use of outside resources to study, except for the ones listed in the syllabus under "Suggested External References". If you have questions about the material or would like further explanation of the concepts, please contact your instructor. If you are still unable to grasp the concepts after messaging your instructor, you may make an appointment with the Academic Helpline (888-724-3590 – Option #2).

Module Problem Sets: The practice problems within the modules are a part of your final grade, and the module work will be reviewed for completeness (not correctness) by the instructor. **Be sure to answer all of the problems, being careful to answer the questions in your own words at all times since this is an important part of adequate preparation for the exams.** After you answer the practice problems, compare your answers to the solutions provided at the end of the module. If your answers do not match those at the end, attempt to figure out why there is a difference. If you have any questions, please contact the instructor via the Canvas messaging system (see Inbox icon).

NOTE: Module problem sets are not an option or a choice; they are required. This means that you must complete all the review questions within the modules. Not only are problem sets class participation, they are the best way to prepare for the exams.

Academic Integrity is a serious matter. In the educational context, any dishonesty violates freedom and trust, which are essential for effective learning. Dishonesty limits a student's ability to reach his or her potential. Portage places a high value on honest independent work. We depend on the student's desire to succeed in the program he or she is entering. It is in a student's own best interests not to cheat on an exam or put their work into question, as this would compromise the student's preparation for future work. It is the student's responsibility to review the **Student Handbook** and all policies related to academic integrity. If clarification is necessary, the student should reach out to their instructor for further explanation **before** initiating module one.

Required Computer Accessories: It is recommended that students use a desktop or laptop computer, PC or Mac, when taking the course. Some tablet computers are potentially compatible with the course, but not all features are available for all tablet computers. The latest full version of Google Chrome, Firefox, Edge, or Safari browser is required for the optimal operation of the Canvas Learning Management System. In addition, this course will use the Respondus Lockdown Browser for exams; a strong internet connection is needed. You are also **required to use LockDown Browser with a webcam**, which will record you during an online, nonproctored exam. (The webcam feature is sometimes referred to as "Respondus Monitor.") **Your computer must have a functioning webcam and microphone. Additionally, students will need a photo ID that includes your picture and full name is required. Please note, Chromebooks and tablets (other than iPad) are not compatible on exams using the Lockdown Browser.** Instructions on downloading and installing this browser will be given at the start of the course. We highly recommend using a high-speed Internet connection to view the video lectures and labs. You may experience significant difficulties viewing the videos using a dial-up connection.

For more information on basic system and browser requirements, please reference the following:

Canvas browser and system

requirements: <https://community.canvaslms.com/t5/Canvas-Basics-Guide/What-are-the-browser-and-computer-requirements-for-Canvas/ta-p/66>

Respondus Requirements: <https://web.respondus.com/he/lockdownbrowser/resources/>

Respondus Monitor Requirements: <https://web.respondus.com/he/monitor/resources/>

Additional Tools: There are two different calculators that will be provided within the exam. One of the calculators can be found here: <https://www.desmos.com/scientific>. It will be provided for questions that require a calculation. If you plan on using this calculator for the exams it would be wise to practice using it for the module problem sets. You are allowed to copy and paste your answers from the calculator into the answer boxes. There is also a calculator that is built into LockDown Browser. It can be found in the top left hand corner

as a small calculator symbol and only appears during exams. If you have any questions regarding how to input numbers or perform certain calculations, please contact your instructor for assistance before moving forward in the course. You are also welcome to use a personal calculator (non-cell phone) if you would like. Keep in mind that you do not need to purchase an expensive calculator as the features you will need are available on basic scientific calculators with a cost of less than \$20.

Module & Lab Topics:

- Module 1:** In this module, the field of biochemistry and the fantastic molecules that permits life is introduced. Molecules, such as Vitamin C, hemoglobin, and insulin, are introduced and shown to give organisms specific characteristics. An overview of the organization (monomer, oligomer, and polymers) found in the molecules of life is presented. Furthermore, the point that all biomolecules are made up of the elements from the periodic table made. Elements, including C, H, O, N, S and some metals, combine in a variety of ways to make up the molecules that enables life. The element carbon is especially crucial for life due to its unique bonding patterns. The focus on carbon flows to an introduction of organic chemistry topics.
- Module 2:** In this module, the topic of water, its properties, and buffers are introduced. The fundamental properties of water, including its molecular shape and unique physical features, such as high H-bonding ability, high boiling point, and solubilizing ability are covered. These unique properties are related to common phenomena like water beading up on a waxed surface and a drink coaster "sticking" to a wet glass. Also, the ability of water to solubilize buffers systems such as phosphate and bicarbonate is covered. Buffered systems will be included in some detail bringing in pH, K_a , and pK_a calculations. As a connection to the health fields, blood buffering and the renal system is presented.
- Module 3:** This module covers amino acids, peptides, and proteins. The 20 standard amino acids, the peptide bond, levels of protein structure, and structure-function of proteins are all covered. Common proteins such as insulin, hemoglobin, and glucagon are covered to connect the course to common health issues. The secondary structure of proteins, alpha helices, beta sheets, and beta turns are discussed with some details of their arrangements. A protein's tertiary and quaternary levels of structure will be discussed; myoglobin and hemoglobin will serve as examples.
- Module 4:** The structures of carbohydrates, their structures, and functions are covered in this module. The module begins with the different functions of carbohydrates, such as energy and structure, in the natural world. Then, the mono-, oligo-, and polysaccharide molecules are introduced. Hexoses, including glucose, is covered with the numbering of carbons and the ring structure of hexoses.

Finally, the descriptive, structural terms, such as anomers and epimers will be discussed are presented.

- Module 5:** This module covers lipids using the functional definition: a lipid is a carbon compound that dissolves in non-polar solvents. The five common classes of lipids: fatty acids, triacylglycerols, phospholipids, sphingolipids, and sterols are covered in detail. The basic structure and function of each type are presented. The relationship between composition and naming is introduced using the standard and omega systems. Additionally, the composition and structure of cellular membranes is discussed. The functionalities of phospholipids and cholesterol within the membrane are introduced. Proteins, solubilized by the lipids of the membrane and how they contribute a variety of functions such as transporters and receptors, is also reviewed. The general structure of membrane components, their functions and overall properties will be introduced (fluidity, mosaic, organization).
- Module 6:** The structure and function of nucleic acids, RNA, and DNA are presented in this module. The presentation of information starts with the structure of the standard bases, including structures of pentose and bases. The structures unique to DNA and RNA are explored, along with their particular functions. Finally, formation and properties of the RNA and DNA polymers are presented.
- Module 7:** The metabolic terminology such as flux, regulation, and control is introduced. An overview of the metabolic pathways of glycolysis and fatty acid are covered in detail. These pathways will be shown to lead to the electron transport chain, the primary energy production site whereby the biochemical processes are described in detail. A systematic evaluation of the citric acid cycle, fatty acid oxidation, breakdown byproducts and medium-chain fatty acid oxidation mutation pathways will be covered in detail.
- Module 8:** The goal of this module is to highlight the importance of the N handling by the body and the production of ATP by the mitochondrion. The reactions of the nitrogen-processing urea cycle are introduced along with the compartmentalization of the reactions. The connection of the carbon oxidation of amino acids will be covered but in no depth. The general scheme of funneling electrons and protons through the electron transport chain, which results in ATP production by ATP synthase are presented. The importance of the chemiosmotic theory and ATP are included.

Lab 1: Pipettes and electrophoresis (Agarose and acrylamide gels)

In this introductory experiment to the biochemistry laboratory, the use of pipettes will be shown. The accuracy and precision of the volumetric and automatic pipettes will be investigated. In the second part of the experiment, students will be introduced to the electrophoresis of proteins and nucleic acids.

Lab 2: Organic Intermolecular Forces and buffer preparation

In the first part of this experiment, a battery of organic molecules will be used to investigate the intermolecular forces of hydrogen bonding, dipole-dipole forces, and London forces. The intermolecular forces will be measured in experiments of viscosity and evaporation to highlight the strength of these forces. In the second part, buffers will be prepared, and the buffering ability investigated.

Lab 3: Enzymatic Activity of Lactase

Lactase degradation of lactose will be used to illustrate enzyme activity and kinetics. A colorimetric assay will be used in experiments to show lactose processing at select temperature and pH levels.

Lab 4: Chromatography of molecules

Ion exchange and size exclusion are essential biochemistry laboratory techniques. The binding and separation of a mixture of five colored biomolecules using cation-exchange, anion-exchange, and size exclusion chromatography will be performed.

Lab 5: Lipids: Isolation of Cholesterol from Egg Yolk

Cholesterol is a lipid with important health concerns. Saponification, chromatography, and chemical modification will be used to isolated and investigate cholesterol from egg yolk.

Lab 6: Isolate of an enzyme from pig heart Days 1 to 3

The enzyme Glutamate Oxaloacetate Transaminase (GOT) will be isolated from a pig heart by a series of fractionation steps. In Part 1, starting with a pig heart, GOT will be concentrated by heat precipitation and salt fractionation determination. Enzyme and protein assays will be used to follow purification.

Lab 7: Isolate of an enzyme from pig heart Days 5 to 6

In Part 2 of this experiment, dialysis and column chromatography are used to purify Glutamate Oxaloacetate Transaminase further. Electrophoresis is used to characterize this protein and to gauge its purity. An overall purification table is developed.

Lab 8: Electron Transport Chain inhibition

The Electron Transport Chain (ETC) is essential in producing Adenosine Triphosphate (ATP) in cells. Inhibition of the ETC can occur with molecules such as cyanide resulting in a change in pH. To investigate this process, mammalian cells will be grown in the presence of select inhibitors, and a colorimetric indicator of pH will examine the effects of inhibition.

Suggested Timed Course Schedule: (to complete the course within a typical college semester)

All Portage courses are offered asynchronously with no required schedule to better fit the normal routine of adult students, but the schedule below is suggested to allow a student to complete the course within a typical college semester. Students may feel free to complete the course on a schedule determined by them within the parameters outlined under "Course Progression."

<u>Time Period</u>	<u>Assignments</u>	<u>Subject Matter</u>
Days 1-14	Module 1, Exam 1 Lab 1, Lab Exam 1	Introduction to biochemistry Pipettes and electrophoresis (Agarose and acrylamide gels)
Days 15-30	Module 2, Exam 2 Lab 2, Lab Exam 2	Overview of aqueous reactions and buffers Organic Intermolecular Forces and buffer preparation
Days 31-45	Module 3, Exam 3 Lab 3, Lab Exam 3	Amino acids, proteins and enzymes Enzymatic Activity of Lactase
Days 46-60	Module 4, Exam 4 Lab 4, Lab Exam 4	Overview of carbohydrate structure and function Chromatography of molecules

Days 61-75	Module 5, Exam 5	Lipid compositions and membrane formation
	Lab 5, Lab Exam 5	Lipids: Isolation of Cholesterol from Egg Yolk
Days 76-90	Module 6, Exam 6	Overview of nucleic acids
	Lab 6, Lab Exam 6	Isolate of an enzyme from pig heart Days 1 to 3
Days 91-105	Module 7, Exam 7	Bioenergetics and metabolic pathways: Part I
	Lab 7, Lab Exam 7	Isolate of an enzyme from pig heart Days 5 to 6
Days 106-120	Module 8, Exam 8	Bioenergetics and metabolic pathways: Part II
	Lab 8, Lab Exam 8	Electron Transport Chain inhibition
Days 121-125	Final Exam	Based on module material

Grading Rubric:

Check for Understanding =	1 pt.
8 Module Problem Sets = 5 pts. each x 8 =	40 pts.
8 Module Exams = 100 points each x 8 =	800 pts.
8 Lab Reports = 10 pts each x 8 =	80 pts.
8 Lab Exams = 30 pts each x 8 =	240 pts.
<u>Final Exam = 120 pts.</u>	<u>120 pts.</u>
Total	1,281 pts.

*The current course grade and progress is continuously displayed on the student desktop.

Grading Scale:

96.5% - 100%	= A+
92.5% - 96.4%	= A
89.5% - 92.4%	= A-
86.5% - 89.4%	= B+
82.5% - 86.4%	= B
79.5% - 82.4%	= B-
76.5% - 79.4%	= C+
72.5% - 76.4%	= C
69.5% - 72.4%	= C-
66.5% - 69.4%	= D+
62.5% - 66.4%	= D
59.5% - 62.4%	= D-
0% - 59.4%	= F

Suggested External References:

If the student desires to consult a reference for additional information, the following textbooks are recommended as providing complete treatment of the course subject matter.

Textbook (online):

Ahern, K.; Rajagopal, I. Book: Biochemistry Free & Easy (Ahern and Rajagopal)

[https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3ABiochemistry_Free_and_Easy_\(Ahern_and_Rajagopal\)](https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3ABiochemistry_Free_and_Easy_(Ahern_and_Rajagopal)) (accessed Oct 10, 2018).

Paper Models:

PDB101: Learn: Paper Models <http://pdb101.rcsb.org/learn/paper-models> (accessed Oct 10, 2018).

NOTE: We do not support the use of outside resources to study, except the ones listed above.

Learning Support Services:

Each student should be sure to take advantage of and use the following learning support services provided to increase student academic performance:

Video lectures: Supports diverse learning styles in conjunction with the text material of each module

Messaging system: Provides individual instructor/student interaction

Tech support: Available by submitting a help ticket through the student dashboard

Accommodations for Students with Learning Disabilities:

Students with documented learning disabilities may receive accommodations in the form of an extended time limit on exams, when applicable. To receive the accommodations, the student should furnish documentation of the learning disability at the time of registration, if possible. Scan and e-mail the documentation to studentservices@portagelearning.edu. Upon receipt of the learning disability documentation, Portage staff will provide the student with instructions for a variation of the course containing exams with extended time limits. This accommodation does not alter the content of any assignments/exams, change what the exam is intended to measure or otherwise impact the outcomes of objectives of the course.

One-on-one Instruction:

Each student is assigned to his/her own instructor. Personalized questions are addressed via the student dashboard messaging system.

Online learning presents an opportunity for flexibility; however, a discipline to maintain connection to the course is required; therefore, communication is essential to successful learning. **Check your messages daily.** Instructors are checking messages daily Monday-Friday to be sure to answer any questions that may arise from you. It is important that you do the same, so you do not miss any pertinent information from us.

Holidays:

During the following holidays, all administrative and instructional functions are suspended, including the grading of exams and issuance of transcripts.

New Year's Day	MLK Day
Easter	Memorial Day
Juneteenth	Independence Day
Labor Day	Thanksgiving weekend
Christmas Break	

The schedule of holidays for the current calendar year may be found under the Student Services menu at www.portagelearning.edu

Code of Conduct: Students are expected to conduct themselves in a way that supports learning and teaching and promotes an atmosphere of civility and respect in their interactions with others. Verbal and written aggression, abuse, or misconduct is prohibited and may be grounds for immediate dismissal from the program; see the Student Handbook for further details.

This is a classroom; therefore, instructors have the academic freedom to set forth policy for their respective class. Instructors send a welcome e-mail detailing the policy of their class, which students are required to read prior to beginning the course.

Grievances: If a student has a complaint about the course, the student is advised to first consult the instructor of the course. After communicating with the instructor, if the matter is still unresolved, students may file a formal grievance for consideration by the Academic Review Committee. The process must be initiated via written communication to academics@portagelearning.edu, with “Academic Grievance” listed in the subject line of the email.

Remediation: At Portage Learning we allow a "one-time" only opportunity to re-take an alternate version of **one** module exam on which a student has earned a grade lower than 70%. This option must be exercised before the final exam is started. If an exam is retaken, the original exam grade will be erased, and the new exam grade will become a permanent part of the course grade. However, before scheduling and attempting this retest, the student must resolve the questions they have regarding the material by reviewing both the old exam and the lesson module material. Once ready to attempt the retest of the exam they must contact their instructor to request that the exam be reset for the retest. Remember, any module retest must be requested and completed **before** the final exam is opened.

Note: Exams on which a student has been penalized for a violation of the academic integrity policy may not be re-taken.

Syllabi are subject to change as part of ongoing educational review practices. Students are responsible for accessing and using the most recent version of the course syllabus.