Introduction to Biochemistry Syllabus

Department of Biochemistry & Molecular Biology

BIOC 2300 Fall 2024

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructors

Name	Email	Office Hours
Kathryn Vanya Ewart (Instructor)	vewart@dal.ca	Book meeting
Petra Kienesberger (Instructor)	pkienesb@dal.ca	Schedule via email
Gregory Seaton (Teaching assistant)	BIOC2300@dal.ca	n/a

Course Description

This online course surveys basic topics and concepts of Biochemistry. The structures, properties and metabolic inter-relations of proteins, carbohydrates and lipids are considered together with an introduction to nutrition and metabolic control. Although mammalian examples predominate some consideration of special aspects of biochemistry of microbes and plants is included.

Note
Students are advised to also take CHEM 2401.03 and CHEM 2402.03

Course Prerequisites
BIOL 1010.03 (or equivalent), CHEM 1011.03 (or equivalent) and CHEM 1012.03 (or equivalent); all with grades of C or higher, or instructor's consent.

Course Exclusions
BIOC 2200.03

Prior knowledge from CHEM 1011/1012 & BIOL 1010

The following tables highlight the prior knowledge you will need to ease into BIOC 2300. Please use the information provided here as a guide for review and catch-up. It is often much more helpful to assess your knowledge of these concepts through questions. Therefore, a prior knowledge inventory has been constructed in the form of an ungraded readiness test. Please see below for details.

CHEM 1011:	CHEM 1012:
Determining limiting reagents	Equilibrium and reaction quotient
Solution concentration: molarity	Equilibrium constant
Dilution	Relationship between the Equilibrium Constant and Gibbs Energy
Electron affinity	Apply Le Chatelier's Principle to predict the effect of perturbing an equilibrium
Electronegativity	Relate the Reaction Quotient to the Equilibrium Constant
Electrostaic interaction and ionic bonding	Calculate Gibbs Energy under standard and nonstandard conditions
Resonance	Enthalpy
Covalent bonding	Entropy
Non-covalent interactions	Gibbs free energy
Electronegativity and bond polarity	Assigning oxidation number
Molecular polarity and dipole moment	Identifiy oxidation and reduction processes
Column chromatography	Reduction potential and its relationship to Gibbs free energy
Delocalized electron model	Functional groups
Acid and base chemistry (strong vs weak)	Identify chiral centers
Ka and pKa	UV/Vis spectroscopy
pH	NMR
Buffer and buffer capacity	Beer's law
Henderson-Hasselbalch equation	Catalyst and its effect on activation energy and reaction rate

BIOL 1010:
Describe the process by which carbohydrates, lipids and proteins are assembled from monomers and identify their functional roles in the eukaryotic cell.
Describe the structure and function of the organelles found in eukaryotic cells, demonstrating an appreciation for the overall architecture of the cell.
Identify the components of biological membranes, including the various types of membrane proteins.
Explain the fluid mosaic model and describe how membranes exhibit selective permeability.
Describe the role of ATP as the energy currency in the cell and appreciate its importance for driving cellular work.
List the key products and features of glycolysis, the citric acid cycle, and oxidative phosphorylation and understand the flow of energy through the entire process.
Identify the mechanism by which a signal is transmitted into the cell via G protein Coupled Receptors and Tyrosine Kinase Receptors.
List several examples of second messengers and describe how each is involved in signal transduction pathways.
Describe the basic chemical structure of deoxyribonucleic acid (DNA) and how it differs from ribonucleic acid (RNA); what role does each molecule play in the transfer of information from genotype (DNA) to phenotype (protein) and the deciphering of the genetic code.
Describe the basic principles of DNA technology/Biotechnology, its applications and the ethical and societal implications of this technological revolution.
Describe the most basic similarities and differences between Bacteria, Archaea and Eukaryotes.
Describe the phenomenon of (primary) endosymbiosis and its role in the origins of mitochondria and plastids

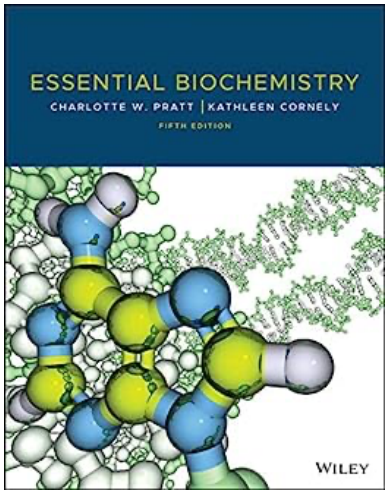
Biochemistry Readiness Test

To help you review and assess your prior knowledge, we highly encourage you to practice the Biochemistry Readiness Test on Brightspace. Please note, this test is not for credit, but rather for you to learn by diagnosing any missing conceptual knowledge and thus providing a means for you to catch up and become better prepared for the upcoming course content.

Student Resources/Course Material

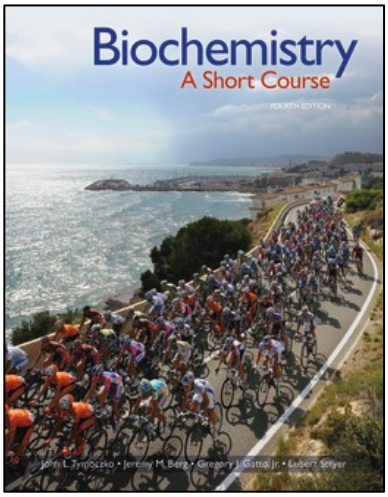
- Study materials, including PDF files of lecture notes, lecture videos, assigned readings and links to online videos will be available in Brightspace.

- The purchase of a course textbook is not required. Any reputable and reasonably up-to-date biochemistry textbook would suffice for background information. However, the following two are the ones most recommended for those who wish to obtain a textbook:



Essential Biochemistry

(5th edition, 2022) by Pratt & Cornely



Biochemistry: A Short Course

(4th edition, 2019) by Tymoczko; Berg; Gatto; & Stryer

- Within our class, there are multiple ways to keep in touch with the instructional team. In the table on the next page, we highlight the purpose of each method of communication:

Method of Communication	Purpose	Advantage
Brightspace Discussion Board	Ask any questions on the course content & administration.	Fast response, easily accessible, open for everyone to see and share.
Course email: BIOC2300@dal.ca	Ask **short** course content-related questions.	Managed by our teaching assistant; response within 48 hours; only for short content questions
Biochemistry resource centre (in Tupper, 8th floor, Room 8J) Time: Thursday 11:00-2:00	• Obtain in-person 1-on-1 or 1-on-a few targeted support • Resolve any questions that cannot be easily answered through email	• Work and learn in a supervised environment. • Good for addressing questions. • Discuss learning strategies.
Dr. Ewart's Office Hours: Book meeting	• Ask questions on course administration • Request 1-on-1 or 1-on-a-few meetings for feedback, exam review, content help, etc.	• Short, efficient and effective • Confidential
Dr. Kienesberger's Office Hours: schedule via email	• Request 1-on-1 or 1-on-a-few meetings for feedback, exam review, content help, etc.	• Short, efficient and effective • Confidential
Dr. Ewart's email: vewart@dal.ca Dr. Kienesberger's email: pkienesb@dal.ca	In case our office hours do not fit your schedule, we can meet at a time that works for you.	Flexible and private.
Anonymous Feedback: Feedback	This form allows you to provide constructive feedback so that we can improve throughout the course.	Easy to complete, anonymous, and concerns can be addressed immediately.

Course Structure

The course will involve several components.

1. **Lecture files and videos:** As noted above, lecture material will be available as PDF files and in video form in Brightspace.

2. **Practice problems:** Problems will be posted regularly for individual and/or group practice.

3. **Weekly tutorials:** Questions relating to practice problems, other questions and discussion will be undertaken on MS Teams from 2:35 - 3:55 on Thursdays.

4. **Introductory assignment:** A short writing assignment worth 5% will allow students to reflect on biochemistry in the news and on their goals for the course.

5. **Low-stakes assessments:** In addition to the typical midterm and final exams, eight online quizzes will be assigned for submission on specific dates (mostly Sundays) at 11:59 p.m. Students will have two attempts for each quiz and the lowest two quiz marks for the semester will be eliminated, resulting in the remaining 6 quizzes counting worth 2.5% each.

6. **Independent study**: This course will require substantial independent study of the material in order to develop broadly based and in-depth knowledge of the methods and concepts covered.

7. **Communication and assistance:**
    a. The Biochemistry Resource Centre (Right side of Tupper, Room 8J, on the 8th floor) will be open from 11:00 - 2:00 every Thursday for supervised work and questions.
    b. Appointments for consultation or extra help can be set up by scheduling a meeting using the links above. As noted above, students who cannot meet in these intervals are welcome to contact instructors by email to schedule different meeting times.

Assessment

Evaluation will include the following components:

Assessment*	**Deadlines and exam dates**	**Weight (%)**
Introductory assignment	Sunday, September 22nd at 11:59 p.m.	5
Online quizzes	Specific dates (mostly Sundays) at 11:59 p.m. (following each quiz assignment)	15
Midterm exam 1* (non-cumulative)	October 7th at 7:00 p.m. in CHEB room C170	20
Midterm exam 2* (non-cumulative)	November 5th at 7:00 p.m. in CHEB room C170	20
Final exam* (cumulative)	In the Dalhousie final exam schedule, (date and location TBA)	40

*NOTE: If one midterm grade is higher than the final exam, that midterm grade will be made worth 25% and the final exam worth 35%. If both midterm grades are higher than the final exam, then each midterm will be made worth 25% and the final will be worth 30%. This only applies if both midterms are written.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	**B+** (77-79)	**C+** (65-69)	**D** (50-54)
A (85-89)	**B** (73-76)	**C** (60-64)	**F** (<50)
A- (80-84)	**B-** (70-72)	**C-** (55-59)	

Course Policies on Missed or Late Academic Requirements

- The written assignment will be docked one mark per day if submitted late.
- If a student is unable to complete the written assignment or the final exam at the scheduled time due to illness or for other valid reasons, the student must submit a **Student Declaration of Absence** form (available on Brightspace) either electronically or in printed form within 3 days of the event. A maximum of 2 declarations of absence will be accepted per student. If a declaration of absence is submitted for an assignment, students then have five extra days to complete the assignment before marks are docked as described above.
- Quizzes cannot be submitted after the set deadlines. Therefore, the declaration of absence has no effect on quizzes.
- There will be **no make-up midterm** exams. If a midterm exam is missed, then the remaining midterm and final exam will automatically count for 30% and 50%, respectively. If no midterm exams are written, the final exam will automatically count for 80%.
- The final exam is compulsory. If missed, a declaration of absence must be submitted and a make-up exam must be written.
- **Travel for holidays will not be accommodated.**

Course Policies related to Academic Integrity

- Students are expected to complete their online quizzes and writing assignments independently.

Learning Objectives

Welcome to Introduction to Biochemistry (BIOC 2300), where you will begin to learn how life works at the molecular level. Biochemistry is at the nexus of the physical, natural and medical sciences, yet has developed its own language and culture that are distinct from those disciplines. The knowledge and tools of biochemistry (along with the closely related discipline of molecular biology) will continue to be at the forefront of discoveries in medicine and biotechnology, driving advances in such areas as molecular and personalized medicine, nanotechnology, agriculture, environmental remediation, and evolution. The concepts and skills obtained in this course will prepare you for more advanced training in biochemistry & molecular biology for careers in biotechnology, biomedical research, medicine, and other health professions.

At the end of this course, you will be able to:

1. Use your knowledge of fundamental principles of chemistry and physics (e.g. molecular bonding, thermodynamics, kinetics) to explain important concepts in biochemistry.
2. Describe and interrelate the hierarchical levels of protein structure (1˚ to 4˚) and provide examples of how this structure relates to the function (or dysfunction) of various classes of proteins.
3. Explain how enzymes can increase the rates of biochemical reactions at the molecular level, and how enzymes may be inhibited and regulated.
4. Outline the major pathways by which precursor biomolecules (carbohydrates, lipids, amino acids) are synthesized and degraded, and the key points at which these pathways are regulated.
5. Describe how organisms obtain, store, and utilize energy through metabolic interconversion of biomolecules.
6. Understand how metabolic pathways are controlled to maintain homeostasis of organisms under normal physiological conditions, and how this may be disrupted by certain pathological states.
7. Place biochemical events within a genomic and cellular context.
8. Relate/apply the fundamental biochemical concepts to your life and your daily activities.

Course Schedule

Date	Item	Topic
NOTE: Eight quizzes will be announced on Brightpace. Please be aware of notices.		
September 3rd-8th	Introductory video	Introduction to the course
	Lecture 1	Aqueous chemistry
	Tutorial	Thursday at 2:35 on Teams
September 9th-15th	Lecture 2	Acid-base chemistry and buffers
	Lecture 3	Amino acids and protein primary structure
	Lecture 4	Secondary, tertiary and quaternary protein structuture
	Tutorial	Thursday at 2:35 on Teams
September 16th-22nd	Lecture 5	Isolating and analyzing proteins
	Lecture 6	Protein function A: hemoglobin and antibodies
	Lecture 7	Protein function B: structural and motor proteins
	Tutorial	Thursday at 2:35 on Teams
September 22nd	Due date	Introductory news assignment
September 23rd-29th	Lecture 8	Protein function C: light absorbtion and emission
	Lecture 9	Enzymes and how they work
	Lecture 10	Enzyme kinetics and inhibition
	Tutorial	Thursday at 2:35 on Teams
October 1st - 6th	Lecture 11	Lipids and membranes
	Lecture 12	Membrane transport
	Review	Exam prep session on Teams (TBA)
	Tutorial	Thursday at 2:35 on Teams
October 7th	Exam	Midterm exam on video lectures 1-9 at 7:00-8:30 p.m. in person
October 7th-13th	Lecture 13	Nucleic acids, genomics and DNA technology
	Lecture 14	DNA technology learning activity
	Lecture 15	Carbohydrates: form and function
	Tutorial	Thursday at 2:35 on Teams
October 15th-20th	Lecture 16	Glycobiology: sugars beyond energy storage
	Lecture 17	Carbohydrate learning activity
	Lecture 18	Glycogen metabolism: glycogenolysis
	Tutorial	Thursday at 2:35 on Teams
October 21st-27th	Lecture 19	Glycogen metabolism: glycogenesis
	Lecture 20	Glycogen metabolism learning activity
	Lecture 21	Thermodynamics: Flux of biochemical reactions
	Tutorial	Thursday at 2:35 on Teams
October 28th-November 3rd	Video 22	Glycolysis: nuts & bolts of glycolytic reactions
	Video 23	Glycolysis & fermentation in health and disease
	Review	Exam prep session on Teams (TBA)
	Tutorial	Thursday at 2:35 on Teams
November 5th	Exam	Midterm exam on video lectures 10-21 at 7:00-8:30 p.m. in person
November 4th-17th (regular week + study break)	Video 24	Gluconeogenesis: the "reverse" of glycolysis?
	Video 25	Tricarboxylic acid cycle (TCA): when breath becomes air
	Video 26	Oxidative phosphorylation I: Electron transport chain
	Tutorial	Thursday (Nov 7th) at 2:35 on Teams
November 18th-24th	Video 27	Oxidative phosphorylation II: Tabulating ATP production
	Video 28	Fatty acid oxidation: nuts and bolts of beta oxidation
	Video 29	Fatty acid oxidation in health & diseases
	Tutorial	Thursday at 2:35 on Teams
November 25th-December 1st	Video 30	Fatty acid synthesis: nuts & bolts of fatty acid synthesis
	Video 31	Fatty acid synthesis in health & diseases
	Video 32	Introduction to amino acid metabolism
	Tutorial	Thursday at 2:35 on Teams
December 2nd-4th	Review	Review sessions on teams (TBA)
December exam period	Exam	Final exam on whole course (concentrating on material since midterm 2) in person at time and location TBA

Blue =	Dr. Ewart
Orange =	Dr. Kienesberger
Grey =	Both

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouriginal-plagiarism-detection.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.