

**Syllabus CHEM/ENCH 323:
Biological Chemistry**

Winter term 2024

On Campus (3 credits)

Pre-requisites: CHEM 223 or CHEM 282

Course instructors

Dr Avena Ross (she/her)

CHE 407, Chernoff Hall

email: avena.ross@chem.queensu.ca

Dr Chantelle Capicciotti (she/her)

CHE 405, Chernoff Hall;

Bott 625, Botterell Hall

email: c.capicciotti@queensu.ca**Lectures:**

Office Hours: Will be offered by appointment, please email us, your instructors to book a time. If you have questions about the course material, please either ask us directly after class, book an office hour time or post in the OnQ discussion forum. Please reserve email questions for personal or private matters. Please note there will be dedicated office hours scheduled before the midterm and final exams, dates/times and locations to be posted in OnQ

Lectures will use a combination of PowerPoint slides and handwritten notes, The last 2 weeks of the course will be dedicated to group presentations on timely Biological Chemistry topics, the exact format will be determined closer to the time.

Important University Dates

Key dates (first day of class, tuition due date, last day to add/drop courses) are important to your academic success. Please find them at [Important Dates](#).

Please note that the last day of classes is Monday, April 8th, as indicated in SOLUS.

Welcome Message

Welcome to CHEM/ENCH 323, we are your instructors, Dr. Ross and Dr. Capicciotti. We are experts in the areas of biomolecule biosynthesis (Dr. Ross) and Glyco-chemistry/biology (Dr. Capicciotti). We are really looking forward to meeting you all and sharing our love of biological chemistry and all the cool things it can be applied to. We hope that after taking this course you will feel confident discussing the basic structure and function of biomolecules.

Equity, Diversity and Inclusivity Statement

You belong here! Equity in an educational institution is achieved when all members of our society have fair and equal opportunity to participate in and enjoy the benefits of an education, including the opportunity to experience success and human dignity while developing the skills, knowledge and attitudes necessary to contribute as leaders and citizens in society. We are committed to counteracting discrimination in this institution and developing a climate of educational equity that recognizes and respects the equal dignity and worth of all who seek to participate in the life, work and mission of the University.

Land Acknowledgement

To begin, let us acknowledge that Queen's is situated on traditional and unceded Anishinaabe and Haudenosaunee territory. We are grateful to be able to be live, learn and play on these lands. – [Four Directions Indigenous Student Centre, Queen's University](#)

Expectations**For instructors:**

As your instructors we will enthusiastically guide you through the course material, we will post lecture material to OnQ in advance of classes and provide updates to the class using announcements in OnQ. We welcome your questions (come talk after class or make an office hour appointment) and we will do our best to be responsive to email queries within 48 hours (please keep in mind this does not include weekends and should only be used for personal/non-content related matters). It is ok to make mistakes, we are all learning, if you have concerns about your progress in the course, please let us know, so we can help. We want you to learn and have designed this course with your success in mind, if you are concerned you will not be able to complete an assessment or reach a deadline please let us know and we can work together to find a solution.

For Students:

We ask that you attend classes as much as you can, although we will not be taking attendance. Students will get the most out of these lectures by attending class. We will endeavor to lecture capture as best as possible, and will post recorded lectures and class notes after class. However, we cannot guarantee that every lecture will be recorded, therefore **do not solely rely** on posted recorded lectures as the sole method to obtain the delivered lecture/class. The best way to learn is to attend class and ask questions when the material is fresh in your minds!

Students are expected to be familiar with course materials posted through OnQ and to seek answers to questions using this resource before contacting the instructors. As such, students are expected to monitor OnQ for class announcements and to access class notes through OnQ before attending class. Some material will only be provided in class and if you are unable to attend it is your responsibility to obtain any missed material from a classmate if the lecture is not captured or posted. Academic integrity is important, and we expect all members of the course to properly attribute the creator of any content, submission of someone else's work as your own is not acceptable and will be dealt with following the University's policy. Our class is a place of inclusion where all students are welcome and where interaction with each other will be respectful and constructive.

For Interactions:

Throughout this course, there will be opportunities for you to interact with your instructor and your classmates. Students will interact with their peers and have opportunities to learn from their colleagues during learning activities that include group presentations. You are expected to behave with integrity at all times both in face-to-face interactions and when engaging with each other online. See the netiquette and discussion guidelines below which we expect everyone to adhere to when interacting with one another whether in person or online.

Course Content Outline**1. Introduction to Biomolecules**

2. Proteins: Properties of Amino Acids- nomenclature, stereochemistry, acid/base, **Properties of Peptide Bonds-** formation, geometry, nomenclature, sequence analysis, **Polypeptide Structures-** conformations, secondary structure, interactions between secondary structure

3. Enzymes: Enzyme Kinetics- Michaelis Menten kinetics, parameters, **Enzyme Inhibition-** competitive, uncompetitive, mixed, **Mechanisms of Catalysis-** General acid/base, covalent, co-factors/pyridoxal phosphate

4. Carbohydrates: Structure and Properties of Carbohydrates – nomenclature, mutarotation, anomeric effect, conformation of monosaccharides, oligosaccharides and glycosidic bonds, glycosyltransferases and biosynthesis.

5. Nucleic Acids: Structure and Synthesis of DNA- DNA replication, selection, catalysis, error correction, ligation; **Structure and Transcription of RNA-** RNA polymerase, regulation, **Translation of RNA-** ribosome, tRNA, rRNA synthetases, initiation, recognition, bond formation, termination

6. Peptide and Carbohydrate Synthesis and Biosynthesis: Selected examples of the following topics may be discussed: solution and solid supported synthesis – peptides and carbohydrates; general strategies for making glycosidic bonds and orthogonal protecting group strategies; RiPPs (Ribosomally synthesized and post-translationally modified peptides); NRPs (non-ribosomal peptides); Chemo-enzymatic synthesis.

7. Student Presentations on Biological Chemistry Topics: A project where groups of 4 students will research a Biological Chemistry topic and then give a presentation for 15 mins to teach the rest of the class about this topic

Intended Student Learning Outcomes

At the end of CHEM 323, students will be able to...

1. Identify important features of peptide, protein, nucleic acid and carbohydrate structures. Recommend and illustrate structure determination techniques.
2. Propose reaction mechanisms for enzyme-catalyzed reactions that produce amino acid, nucleic acid and carbohydrate based biomolecules.
3. Demonstrate the interconnections between molecule classes in the central dogma of molecular biology by designing nucleic acid sequences based on protein sequences and vice versa
4. Collaborate with a small group of peers to deliver a presentation, on a topic of biological importance, which extends and applies course concepts

Approximate Content Timeline

Week	Content Covered	Assessments (Tentative)
Week 1 (Jan 8-12)	Introduction to Biological Chemistry and Molecules	
Week 2 (Jan 15-19)	Proteins	Assignment 1 Posted
Week 3 (Jan 22-26)	Proteins	Assignment 1 Due
Week 4 (Jan 29-Feb 2)	Proteins	Assignment 2 Posted
Week 5 (Feb 5-9)	Enzyme Kinetics and mechanisms	Assignment 2 Due
Week 6 (Feb 12-16)	Carbohydrates	
Reading Week (Feb 19-23)		
Week 7 (Feb 26- Mar 1)	Carbohydrates	Assignment 3 Posted
Week 8 (Mar 4-8)	Nucleic Acids	
Week 9 (Mar 11-15)	Nucleic Acids	Assignment 3 Due
Week 10 (Mar 18-22)	Peptide and Carbohydrate Synthesis and Biosynthesis	Assignment 4 Posted
Week 11 (Mar 25-28)	Group Presentations	
Week 12 (Apr 1-5)	Group Presentations	Assignment 4 Due

Assessment

Assessment	Applicable learning outcomes	Assessment Weight
Mid term	1) Identify important features of peptide, protein, nucleic acid and carbohydrate structures. Recommend and illustrate structure determination techniques and 2) Propose reaction mechanisms for enzyme-catalyzed reactions that produce amino acid, nucleic acid and carbohydrate based biomolecules	25-35% (Whichever is best for you)
Assignments (up to 4 in total)	1), 2) and 3) Demonstrate the interconnections between molecule classes in the central dogma of molecular biology by designing nucleic acid sequences based on protein sequences and vice versa	20% (5% Each)
Presentations ((i) in groups of 4, 15 min (ii) active participation in question session)	1, 2, 3 and 4) Collaborate with a small group of peers to deliver a presentation, on a topic of biological importance, which extends and applies course concepts	20%
Final Exam (during exam period in April)	1, 2, and 3	25-35% (Whichever is best for you)

Essential Requirements and Flexibility to Succeed

Assignments

This course will have 4 Assignments, given out approximately in weeks 2, 4, 7 and 10. You will have 1-2 weeks to complete each assignment. Students can choose to hand in assignments **individually or in groups of up to three students**. Assignments will have a 24 hour grace period: that is, the assignment is due on the date posted, but will be accepted, without penalty, up to 24 hours afterwards. After 24 hours, a 10% penalty per day will be deducted for late submissions. Please discuss any short-term accommodations needed that are uploaded in Ventus. *Note:* if students hand in assignments as a group, all students will receive the same mark. If students choose to work as a group, they do not have to remain as the same group throughout the course but can change this as the course proceeds. Short-term accommodations cannot be granted if submitting assignments as a group.

Grading Method

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

Grade	Numerical Course Average (Range)
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	49 and below

Suggested Time Commitment

In this course, you should expect to invest on average 8 to 10 hours per week. This will include the time you spend in class or lab/tutorial, studying course material, and completing weekly homework or preparing for your larger assignments and exams. You are encouraged to use a term at a glance and a weekly study schedule (visit [SASS](#)) that distributes the 8-10 hours per week and avoid 'cramming'. This way you will be more likely to complete the course successfully and remember what you learned longer.

Statement of the Location and Timing of Final Examinations

The exam dates for each Term are listed on the Faculty of Arts and Science webpage under [Important Dates](#). Student exam schedules for the Fall Term are posted via SOLUS immediately prior to the Thanksgiving holiday; they are posted on the Friday before Reading Week for the Winter Term and for the summer term, they are individually noted on the Arts and Science Online syllabi. **Students should delay finalizing any travel plans until after the examination schedule has been posted. Exams will not be moved or deferred to accommodate employment, travel/holiday plans or flight reservations.**

Deferred Exams

Students receiving permission to write a deferred mid-year or final exam will be expected to write their exam during the Faculty of Arts and Science deferred exam period, May 16 to 19, with exact time, date, and location TBA. Requests for individualized deferred exam dates will not be accommodated. The deferred exam is considered an official exam to which all the exam regulations apply.

Recommended textbook

Biochemistry, Voet & Voet, 4th edition

Note: older editions are also accepted (just make sure that there is no ambiguity on the assigned reading, either with your fellow students or with the instructor)

Additional useful textbooks

- **Foundations of Chemical Biology**, C.M. Dobson, J. A. Gerrard, A. J. Pratt, Oxford Chemistry Primers, Oxford University Press: this very short (92 pages) summarizes the essentials in an easy-to-read manner. This is an ebook available through the library.

- **Organic Chemistry**, Clayden, Greeves & Warren: strong Organic Chemistry refresher

- **Essentials of Glycobiology**, 3rd Edition. <https://www.ncbi.nlm.nih.gov/books/NBK579918/>
This is a free ebook resource and some sections will be relevant to the carbohydrates section, including: Chapters 5-7, 9-10, 14-15.

Useful websites

a) *To read more: Encyclopedia of Biological Chemistry:*

<http://www.sciencedirect.com/science/referenceworks/9780124437104>

A collection of short review articles written by experts, A wonderful complement to the textbook!

b) *For research:*

- **Web of Science** (Access Through Databases Tab at <http://library.queensu.ca/>)

This is a searchable database for scientific literature. Very helpful for finding journal articles by topic searching and for then finding other research that is related to those articles.

- **National Center for Biotechnology Information (NCBI):** <https://www.ncbi.nlm.nih.gov/>
for journal articles, protein sequences, DNA sequences, align protein sequences (BLAST), find protein structures and lots more

- **ExPASy Proteomics Server** (also known as Swiss-Prot): <http://ca.expasy.org/>
This is an annotated database dedicated to proteins, which also contains lots of useful online tools for protein sequence and structure analysis. A user-friendly protein structure viewer is available for download as well (<http://ca.expasy.org/spdbv/>).

- **Protein Data Bank:** <https://www.rcsb.org/>
This is where structures of proteins or nucleic acids, determined by X-ray or NMR, are deposited. You can search for a biomolecule then download the file to your own PC for viewing on PyMOL or Swiss-PDBView

- **Nucleic Acids Database:** <http://ndbserver.rutgers.edu/>
More sources of nucleic acids structures (X-ray or NMR). Advanced searches are possible. Download the file to your own computer and view with free software.

Useful software:

Download one (or both) of the following FREE programs for viewing and analyzing 3-dimensional structures of biomolecules:

PyMol: <http://www.pymol.org/>

Swiss PDB-Viewer: <http://ca.expasy.org/spdbv/>

Questions about the Course and Contacting the Teaching Team

Throughout this course, you may come upon some general questions about the course and any assignments. You have several options, you can come chat with your instructor after class or make an office hour appointment or, you are invited to post your question in the Course Questions discussion forum in OnQ. Feel free to help answer your peers' questions on this forum. The teaching team will monitor this discussion forum and answer questions. Most questions are answered within 48 hours. Any other questions that you would prefer to ask privately, can be addressed in person or by email using the addresses listed at the top of this syllabus.

Calculator Policy

As noted in Academic Regulation 9.2, "Calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991 series calculator** is permitted and is the only approved calculator for Arts and Science students."

Web Browsers

onQ performs best when using the most recent version of the web browsers, Chrome or Firefox. Safari and Edge are strongly discouraged as these web browsers are known to cause issues with onQ.

Copyright of Course Materials

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the instructor's intellectual property. It is a

departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution (including note sharing sites), posting, sale or other means of dissemination without the instructor's *express consent*. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Academic Integrity

Queen's students, faculty, administrators and staff all have responsibilities for upholding the [fundamental values of academic integrity](#); honesty, trust, fairness, respect, responsibility and courage. These values are central to the building, nurturing, and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the [Senate Report on Principles and Priorities](#)).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and their behaviour conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see [Academic Regulation 1](#)), on the [Arts and Science website](#), and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery, use of forged materials, contract cheating, unauthorized use of intellectual property, unauthorized collaboration, failure to abide by academic rules, departure from the core values of academic integrity, and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions appropriate to the severity of the departure that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

- *In this course you are permitted to work with a partner or in groups of up to 3 to encourage collaboration, cooperation, and collective learning on lab/tutorial assignments that are designated as "group work". You are not permitted to share answers among large groups or as a tutorial group. You must work independently on all assignments, exams, quizzes and 'pop questions' designated as "individual work".*

Accommodations for Disabilities

Queen's University is committed to working with students with disabilities to remove barriers to their academic goals. Queen's Student Accessibility Services (QSAS), students with disabilities, instructors, and faculty staff work together to provide and implement academic accommodations designed to allow students with disabilities equitable access to all course material (including in-class as well as exams). If you are a student currently experiencing barriers to your academics due to disability related reasons, and you would like to understand whether academic accommodations

could support the removal of those barriers, please visit the [QSAS website](#) to learn more about academic accommodations or start the registration process with QSAS by clicking *Access Ventus* button at [Ventus | Accessibility Services | Queen's \(queensu.ca\)](#)

VENTUS is an online portal that connects students, instructors, Queen's Student Accessibility Services, the Exam's Office and other support services in the process to request, assess, and implement academic accommodations.

To learn more go to: <https://www.queensu.ca/ventus-support/students/visual-guide-ventus-students>

Academic Consideration for Students in Extenuating Circumstances

Academic Consideration is a process for the University community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to,

- **Short term Physical or Mental Illness or Injury** (stomach flu, anxiety/depression, mononucleosis, concussion, broken bones, surgery, medical treatments, etc.)
- **Traumatic Event/Confidential** (Bereavement, serious injury, illness or required treatment for a significant other/family member or a traumatic event such as divorce, sexual assault, social injustice, etc.)
- **Requirements by Law or Public Health Authorities** (court dates, jury duty, requirements to isolate, etc.)
- **Significant Event** (varsity athletic event, distinguished event, serving in the Reserve Forces, etc.)

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances. For more information, please see the [Senate Policy on Academic Consideration for Students in Extenuating Circumstances](#).

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's webpage on [Academic Consideration in Extenuating Circumstances](#) and submit a request via the [Academic Consideration Request Portal](#). Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their instructor and/or course coordinator as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration.

If you need to request academic consideration for this course, you will be required to provide the name and email address of the instructor/coordinator. Please use the following:
Instructor/Coordinator Name: Avena Ross, Chantelle Capicciotti
Instructor/Coordinator email address: avena.ross@queensu.ca, c.capicciotti@queensu.ca

For more information on the Academic Consideration process, what is and is not an extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts

and Science's [Academic Consideration website](#). ASO courses include links to information on **Academic Consideration** on your **Course Homepage** in onQ.

Please see the Teaching Team page for contact information for your instructor and TA(s), where relevant.

Discussion Guidelines

University is a place to share, question and challenge ideas. Each student brings a different lived experience from which to draw upon. To help one another learn the most we can from this experience please consider the following guidelines.

1. Make a personal commitment to learn about, understand, and support your peers.
2. Assume the best of others and expect the best of them.
3. Acknowledge the impact of oppression on the lives of other people and make sure your writing is respectful and inclusive.
4. Recognize and value the experiences, abilities, and knowledge each person brings.
5. Pay close attention to what your peers write before you respond. Think through and re-read your writings before you post or send them to others.
6. It's ok to disagree with ideas, but do not make personal attacks.
7. Be open to being challenged or confronted on your ideas and to challenging others with the intent of facilitating growth. Do not demean or embarrass others.
8. Encourage others to develop and share their ideas.