CHM 220H: Physical Chemistry for the Life Sciences

Course Syllabus: Fall 2020

I CONTACTS

INSTRUCTORS

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II COURSE OVERVIEW

COURSE DESCRIPTION:

A central theme of CHM 220H is that, starting from a few basic physical principles, it is possible to understand phenomena ranging from the small-scale behavior of single molecules to complex biological processes. One of the goals of the course is to give you an introduction to this remarkable relationship between physical chemistry concepts and observations. CHM 220H will cover key concepts in modern physical chemistry and biophysics. It will prepare you for 300-level life science classes or will serve as an introductory course for physical chemistry. Problems will involve calculations and some mathematical concepts, as well as qualitative topics. It is important both to understand the ideas presented from a conceptual point of view, and to be able to use them to solve quantitative problems.

STUDENT LEARNING OUTCOMES:

By the end of this course, students will be able to:

- **apply central concepts** in physical chemistry (e.g. entropy, Gibbs energy) to the description of biochemical systems
- **formulate** scientific questions about biochemical systems in quantitative terms
- **plan** ways to calculate answers to questions
- **calculate** and **interpret** answers to the questions
- **communicate** results, and conclusions using appropriate SI units, language, and formats.

Physical chemistry is a problem-solving discipline: therefore, you must be able to apply concepts taught in classes to solve new problems. Note that tutorials will provide very useful examples of problems that you should be able to solve on quizzes and tests and provide an excellent opportunity to ask questions. It is, therefore, highly recommended that you take advantage of this resource.

PREREQUISITE KNOWLEDGE:

This course requires that you have a fundamental understanding of introductory chemistry (CHM 135H, CHM 136). In addition, you are required to have taken a course in differential and integral calculus: (MAT 135H, 136H)/137Y/157Y. MAT 235Y/237Y is a recommended co-requisite course.

TEXTBOOKS:
For the thermodynamics section (weeks 0-8), we will use The Molecules of Life, by Kuriyan, Konforti, & Wemmer (TMOL). This is available from the U of T Bookstore: https://uoftbookstore.com/buy_book_detail.asp?pf_id=14646522.

For the Quantum Mechanics portion of the course (weeks 9-12), reference will be made to Physical Chemistry for the Chemical and Biological Sciences, by Raymond Chang. Only selected chapters from this text, listed below, will be used and these chapters will be available online.

The textbooks provide a useful resource to better understand class material and to provide more sample problems. Note, however, that you are **not responsible for material in the textbooks that is not covered in classes.**

III HOW THE COURSE IS ORGANIZED

Over the course of each week, you are expected to watch online classes and read the corresponding sections of the textbooks according to the schedule outlined below. **The first class will be Friday Sept. 11th, 2020 at 15:00. It will be live online (synchronous) through links provided on Quercus and is an introduction to the course.**
Most classes will then be available online asynchronously. However, the timetabled class hours (Monday and Wednesday 13:00 -14:00 and Friday 15:00-16:00) are reserved so that we can conduct online synchronous (live interactive sessions) from time to time. The timing of these sessions will be announced at least one week in advance. These will also be recorded.

COURSE SCHEDULE (tentative):

DATES	WEEK	TOPICS
Sept. 11	0	Introduction to Course (live online)
Sept. 14 – Sept. 18	1	TMOL Chapter 6 – Energy and Intermolecular Forces: Thermodynamics of heat transfer, Heat capacities and introduction to the Boltzmann distribution, Basic definitions; The 1st Law of Thermodynamics
Sept. 21 – Sept. 25	2 – tutorial A and quiz A	TMOL Chapter 7 - Entropy: Counting statistics and multiplicity, entropy, statistical and thermodynamic descriptions
Sept. 28 – Oct. 2	3 - tutorial B and quiz B	TMOL Chapter 8 – Linking Energy and Entropy: energy distributions

	Test 1 Oct. 2	and entropy, the Boltzmann distribution, entropy, and temperature
Oct. 5 – Oct. 9	4 - tutorial C and quiz C	TMOL Chapter 9 - Gibbs Free Energies: free energy, standard free energies, free energy, and work
Oct. 12 – Oct. 16	5- **Test 2 Oct. 16**	TMOL Chapter 10 Chemical Potential and the Drive to Equilibrium: chemical potential, equilibrium constants, acid/base, protein folding
Oct. 19 – Oct. 23	6 - tutorial D and quiz D	TMOL Chapter 11 (part) – Voltages and Free Energy: Basic definitions; ionic mobility; thermodynamics of ions in solution; biological membranes and transport
Oct. 26 – Oct. 30	7- tutorial E and quiz E **Test 3 Oct. 30**	TMOL Chapter 12 (part) – Molecular Recognition: The thermodynamics of Binding: thermodynamics of molecular interactions, drug binding to proteins
Nov. 2-6	8 **Test 4 Nov. 6 (thermo)**	QM, Chapter 14 (part), R. Chang, Quantum Mechanics and Atomic structure: The wave theory of Light
Nov. 9-13	*Reading week*	
Nov. 16-20	9 - tutorial F and quiz F	QM, Chapter 14 (part), R. Chang, Quantum Mechanics and Atomic structure: Quantization of the Atom
Nov. 23-27	10 - tutorial G and quiz G **Test 5 Nov. 27**	QM, Chapter 14 (part), R. Chang, Quantum Mechanics and Atomic structure: The wave equation
Nov. 30 – Dec. 4	11- tutorial H and quiz H	QM, Chapter 15 (part), R. Chang, The Chemical bond: Molecular Orbital Theory
Dec. 7 - 10	12- **Test 6 Dec. 11**	QM, Chapter 17 (part), R. Chang, Spectroscopy:

TUTORIALS:

Tutorials begin the week of September 21. These will be online synchronous. Attendance is highly encouraged.

Mondays 11:00 – 12:00; Wednesdays 14:00 – 15:00; Thursdays 16:00 – 17:00

Tutorial Objectives & Quizzes:

Tutorials are designed to give you practice at applying concepts learned during that week to the description of biochemical systems to solve quantitative problems. Problem sets for the tutorials will be posted ahead of time. You should try to solve the problems before coming to the tutorial. At the tutorial, the tutor will show how to work the problems and provide further reinforcement of concepts learned. Tutorial quizzes will be based on problem sets and will be available online from 5-10 pm on the day of your tutorial. These are designed to test whether you have achieved the learning objectives for that week.

IV EVALUATION/GRADING SCHEME

Tutorial Quizzes (best 7 of 8) worth 3% each
Thermodynamics Assignment (Due Nov. 6th 12 midnight)- 10%
Quantum Mechanics Assignment (Due Dec. 9th 12 midnight)- 9%
Online Tests (best 5 of 6) 12% each (Approximately every two weeks). These will be held on Fridays from 5 – 10 pm (Toronto time).

Notes:

- If network disruption occurs at your end during assessment, don't panic! Please, contact the course administrator, Dr. Chulliparambil, (susha.chulliparambil@utoronto.ca) with details of the situation - how long you had been writing the Quiz/Test for and at what time the disruption occurred. Please note that you may not receive a response until after your assignment window closes. Stay calm – we will get back to you!
- If an unexpected technical issue occurs with a university system (e.g., Quercus services, network outage) that affects availability or functionality, it may be necessary to revise the timing or weighting of the assessments.

V COURSE POLICIES

- The course website (on Quercus) will serve as a primary source for the information upon which you need to remain up to date. Information concerning classes, tutorials, assignments, quiz and test information and other course material will be posted frequently on the website as the course progresses. Visit the course website on a regular basis!

- Online live sessions will use links within the course website.

- CHM 220 email policy: Please, note, your email to the CHM 220 teaching team will only be accepted if:
  1.You send it from your utoronto.ca account.
  2. You identify yourself as a student in CHM 220 and include your name and student i.d. number.
  3. No attachments or screenshots are sent.
  4. You are aware that chemistry can be discussed during office hours much more effectively than by email. Please use email for administrative issues and for making appointments with instructors - detailed course material questions will not be answered. Scheduled instructor virtual office hours are posted on the web page - alternative hours are available by arrangement.

- The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

- This course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session. Course videos and materials belong to your instructor, the University, and/or other source depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

- Deadlines for assignments will be posted. Late assignments will have 10% deducted per 24h period.

ABSENCE:

In order to receive consideration for the work missed for an illness or related reason, a completed University of Toronto Medical Certificate (at http://www.illnessverification.utoronto.ca) must be submitted to Dr. Chulliparambil, the Course Administrator within one week of the date of absence. Only serious illness (or equivalent reasons) will be accepted as justification for absence.

For absences due to cold or flu-like symptoms only, or due to self-isolation requirements, you will need to instead record these absences through the Absence Declaration tool on ACORN. The tool can be found in the ACORN Profile and Settings menu. You should record each day of your absence as soon as it begins, up until the day before you return to classes or other academic activities. The University will use

this information to provide academic accommodation and to monitor overall absences.

- There will be no make-up tests. For students missing one test, the other 5 will count. For students missing two tests for a valid reason, the missed test mark will be calculated based on your performance on the other tests and the class average. For students missing three or more tests for valid reasons, the mark for the missing tests will be replaced by a cumulative oral assessment (online).

VI TECHNOLOGY REQUIREMENTS

Guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here:
https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/

General advice regarding online learning is available here:
https://onlinelearning.utoronto.ca/getting-ready-for-online/

This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you have a stable internet connection, maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses, crashed hard drives, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are **not acceptable grounds** for a deadline extension. Further, please, note, that Quercus is known to have some specific issues that you need to be aware of. The browsers that work best so far and are not known to cause issues are **Chrome and Firefox**, (the updated versions). The **Safari browser does NOT work well on Quercus.** If you are using Apple devices, download one of the other browsers, and use it, particularly when you are doing your assessments (quizzes, tests).

VII INSTITUTIONAL POLICIES AND SUPPORT

ACADEMIC INTEGRITY

On Academic Integrity:
Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters
(https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-

academic-matters-july-1-2019) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In assignments:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and quizzes:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see https://www.academicintegrity.utoronto.ca/).

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If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise all such reproduction is an infringement of copyright and is absolutely prohibited. More information regarding this is available here: https://teaching.utoronto.ca/ed-tech/audio-video/copyright-considerations/

ACCESSIBILITY NEEDS

Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact Accessibility Services as soon as possible.

ADDITIONAL SERVICES and SUPPORT

The following are some important links to help you with academic and/or technical service and support

- General student services and resources at Student Life

- Full library service through University of Toronto Libraries
- Resources on conducting online research through University Libraries Research
- Resources on academic support from the Academic Success Centre
- Learner support at the Writing Centre
- Information for Technical Support/Quercus Support