



UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF BIOLOGICAL SCIENCES  
COURSE OUTLINE

1. **Course: BCEM 393 - INTRODUCTION TO BIOCHEMISTRY**

D2L Site – BCEM 393 L01 – (Spring 2017) – Introduction to Biochemistry

Biological Sciences Department BI 186; (403) 220-3140; biosci@ucalgary.ca

**COURSE PERSONNEL:**

**COURSE AND LAB COORDINATOR:** Dr. Isabelle Barrette-Ng BI 430A 220-6240 mibarret@ucalgary.ca

**LAB TECHNICIAN:** Ms. Jennifer Kearley BI 136

**TA's:** You will find a list of all TA's for this course, along with their email addresses on the course's D2L site. A schedule of their office hours as well as office hour location is also available from this site.

**LECTURE SCHEDULE AND LOCATIONS:**

MWF 09:00 EEEL 161

**LABORATORIES:**

Please note that labs run every week. Please ensure that you attend the correct lab section.

Section No.	Day	Time	Room
01	W	12:00	BI 136
02	R	12:00	BI 136
03	R	16:00	BI 136
04	F	12:00	BI 136

Labs will begin during the week of May 15, 2017. The laboratory manual is available for download from the course's D2L site.

2. **Prerequisites:** Biology 311 or Medical Sciences 341 (BHSc students only); and Chemistry 351

See section 3.5.C in the Faculty of Science section of the online Calendar

(<http://www.ucalgary.ca/pubs/calendar/current/sc-3-5.html>)

3. **Grading:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

<b>In-class team application activities</b>	<b>10%</b>
<b>Peer evaluations</b>	<b>2%</b>
<b>In-class and online quizzes</b>	<b>12%</b>
<b>Laboratories</b>	<b>24%</b>
<b>Midterm Exam</b>	<b>26%</b>
<b>Final Exam</b>	<b>26%</b>

**There will be a final exam scheduled by the Registrar's office.**

In order to pass the course, students will be required to **pass** the **laboratory component** of the course.

Each piece of work (assignment, laboratory report, midterm test or final examination) submitted by the student will be assigned a percentage score. The student's average percentage score for the various components listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade, bearing in mind that a grade of F will result if the student does not pass the laboratory component.

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize himself/herself with these regulations. See also [Section E.6](#) of the University Calendar.

If you miss a laboratory exercise, an in-class assignment, an in-class quiz or the midterm exam for medical reasons, the only documentation that will be accepted in BCEM 393 is a completed **Physician/Counsellor Statement Form**, which can be downloaded from the following website: <http://www.ucalgary.ca/registrar/files/registrar/physcoun.pdf>. This form must be completed by your physician or counsellor and brought to Dr. Barrette-Ng within 48 hours of the date that you missed the lab, assignment, quiz or exam.

If you miss the final exam due to medical reasons, please contact the Registrar's Office. Please see [http://www.ucalgary.ca/registrar/exams/deferred\\_final](http://www.ucalgary.ca/registrar/exams/deferred_final) for reasons that will be accepted to defer a final exam as well as the procedure to apply for a deferred exam.

5. **Scheduled out-of-class activities:** Dates and times of approved class activities held outside of class hours.

Midterm Exam: TUESDAY JUNE 13, 2017; 9:00 AM - 12:00 PM

Location TBD

**REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME ACTIVITY.** If you have a clash with this out-of-class-time activity, please inform your instructor as soon as possible so that alternative arrangements may be made for you.

6. **Textbook:**

We will be using the following textbook:

Lehninger Principles of Biochemistry, Nelson and Cox. W.H. Freeman. 6<sup>th</sup> Edition

It is **recommended** and both used and new copies are available from the bookstore. You can choose to purchase either a hardcover or binder-ready version of the textbook. Both versions come pre-packaged with the student companion entitled "The Absolute, Ultimate Guide to Lehninger Principles of Biochemistry Study Guide and Solutions Manual", which was written by Marcy Osgood and Karen Ocorr. This study guide contains chapter summaries, additional practice problems and self-tests.

**Laboratory manual:**

The laboratory manual is available from the D2L course site for download.

**Online course components:**

In the lecture component of this course, we will use the Top Hat Monocle classroom performance system, where you will be asked to use a cell phone to text answers to questions during class. The use of the Top Hat Monocle system is optional, but highly recommended to enhance learning in the classroom. If you answer 85% or more of the in-class questions, your lowest grade on the individual portion of one of the in-class quizzes will be replaced by 100%. If you answer less than 85% of the in-class questions, a grade of 0 will be assigned for this course component, and the grade for the lowest individual in-class quiz will not be replaced. It is your responsibility to ensure that their participation is being properly recorded by the Top Hat Monocle system. In the event of any discrepancy, you must contact the administrators of the Top Hat Monocle system to have them corrected. Correction of any discrepancies must be done prior to 5 PM on June 26, 2017. If a student is unable to use the Top Hat Monocle system, please contact Dr. Barrette-Ng within the first week of class to make alternate arrangements.

7. **Examination Policy:** No electronic or written aids (e.g. cell phones, tablets, computers, notes, textbooks) will be allowed during writing of any exams. Only non-programmable calculators will be permitted to answer quantitative questions on exams, if applicable, and permission to do this will be clearly indicated on the examination paper. Students should also read the Calendar, Section G, on Examinations.
8. **Writing across the curriculum statement:** In this course, the quality of the student's writing in laboratory reports will be a factor in the evaluation of those reports. See also [Section E.2](#) of the University Calendar.
9. **Human studies statement:** If you agree, your course work may be used for research purposes. Your responses will remain anonymous and confidential. Grouped data (no individual responses) may be used in academic presentations and publications. Participation in such research is voluntary and will not influence grades in this course. Students' signed consent forms will be withheld from instructors until after final grades are submitted. More information will be provided at the time student participation is requested. See also [Section E.5](#) of the University Calendar.

STUDIES IN THE BIOLOGICAL SCIENCES INVOLVE THE USE OF LIVING AND DEAD ORGANISMS. Students are expected to be familiar with <http://www.ucalgary.ca/pubs/calendar/current/sc-5-1.html> of the on-line calendar. See also <http://www.ucalgary.ca/pubs/calendar/current/e-5.html>.

10. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

- (a) **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K](#). Student Misconduct to inform yourself of definitions, processes and penalties.
- (b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).

(c) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at [http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities\\_0.pdf](http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf).

Students needing an Accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of Biological Sciences, Dr. H. Addy by email [addy@ucalgary.ca](mailto:addy@ucalgary.ca) or phone 403-220-3140.

(d) **Safewalk:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 403-220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

(e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also <http://www.ucalgary.ca/secretariat/privacy>.

(f) **Student Union Information:** VP Academic Phone: 403 220-3911 Email: [suypaca@ucalgary.ca](mailto:suypaca@ucalgary.ca)  
SU Faculty Rep. Phone: 403-220-3913 Email: [science1@su.ucalgary.ca](mailto:science1@su.ucalgary.ca), [science2@su.ucalgary.ca](mailto:science2@su.ucalgary.ca) and [science3@su.ucalgary.ca](mailto:science3@su.ucalgary.ca)  
Student Ombuds Office: 403-220-6420 Email: [ombuds@ucalgary.ca](mailto:ombuds@ucalgary.ca); <http://ucalgary.ca/provost/students/ombuds>

(g) **INTERNET and ELECTRONIC COMMUNICATION DEVICE Information. The use of your cell phone in class must be restricted to answering in-class questions using the Top Hat Monocle system.** Importantly, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

(h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses ([www.ucalgary.ca/usri](http://www.ucalgary.ca/usri)). Your responses make a difference - please participate in USRI Surveys.

Department Approval \_\_\_\_\_ ORIGINAL SIGNED \_\_\_\_\_ Date \_\_\_\_\_

Associate Dean's Approval for  
out of regular class-time activity: \_\_\_\_\_ ORIGINAL SIGNED \_\_\_\_\_ Date: \_\_\_\_\_  
C393 P17 co; 5/9/2017 1:32 PM

**UNIVERSITY OF CALGARY – DEPARTMENT OF BIOLOGICAL SCIENCES**  
**BIOCHEMISTRY 393 – INTRODUCTION TO BIOCHEMISTRY**  
**COURSE SYLLABUS SPRING 2017**  
**SECTION NO. 01**

**PREREQUISITES:** Biology 311 or Medical Sciences 341 (BHSc students only); and Chemistry 351  
**ANTIREQUISITE:** Credit for both Biochemistry 393 and 341 will not be allowed.

A student may not register in this course unless they have a grade of at least C- in each prerequisite course.

Note: Simultaneous enrolment in, or prior completion of Biology 331 is strongly recommended.

**OVERVIEW OF THE COURSE:**

In the lecture and laboratory components of the course, we will explore the structure and function of carbohydrates, amino acids, proteins, lipids, coenzymes and enzymes. We will use this knowledge to create a framework to gain a deep understanding of carbohydrate metabolism and energy transduction.

The course is broken down into the following four main themes, with each theme containing a series of topics and sub-topics:

1. Water is the medium of life.
2. Proteins are critical to biological processes in the cell.
3. Carbohydrates are a main component of cells, and they are required as a source of fuel, as protection, and for signalling.
4. Lipids are a main component of cells, and are required as a source of fuel, for cell and organelle membranes, and for signalling.

The series of topics and sub-topics for each theme are listed in the tentative lecture schedule that is found at the end of this document. Further details on each topic are available from the lecture schedule on D2L.

**COURSE LEARNING OUTCOMES:**

By the end of this course, you should be able to:

- compare and contrast the roles of van der Waals forces, charge-charge interactions, hydrogen bonds, and hydrophobic interactions in protein and macromolecular structure and indicate how the roles of these forces differ from those of covalent bonds;
- describe the role of buffers in biological systems, and select and prepare the best buffer when given specific conditions;
- describe the structures and the physicochemical properties of the 20 amino acids, carbohydrates (monosaccharides, disaccharides and polysaccharides), lipids (fatty acids, triglycerides and glycerophospholipids) and nucleic acids (DNA and RNA);
- distinguish between the four levels of protein structure and identify the highest level of structure for a given protein;
- contrast the function of myoglobin and hemoglobin using differences in protein structure;
- list, discuss, use and evaluate the major techniques used in separating proteins, including ammonium sulphate precipitation, column chromatography, and SDS-PAGE;
- describe and experimentally examine how enzymes catalyze reactions, and how inhibitors and allosteric regulators can affect their function using the principles of protein structure and Michaelis-Menten kinetics;
- formulate a hypothesis and generate a written research proposal to investigate the effects of mutations on protein structure and function;
- distinguish between aerobic and anaerobic carbohydrate metabolism, and describe the reactants and products, the reaction purpose(s), the conditions under which they occur, and their regulatory mechanisms; and
- work effectively in diverse teams and provide constructive peer feedback to teammates.

**METHOD OF INSTRUCTION:**

To enhance your learning experience in BCEM 393 and help you hone your problem-solving skills, we will be using a flipped learning approach this semester. Various studies performed at institutions across North America including our own have shown that this approach allows students to learn material at a deeper level and achieve greater academic success.

In using this approach, I will do some lecturing, but we will focus much of our class time on working together in teams to solve problems. To facilitate the work we will do in teams together this semester, we will make use of the ITP Metrics system ([www.itpmetrics.com](http://www.itpmetrics.com)). This free, secure, web-based tool will be used to form teams in the first week of the semester and to conduct peer evaluations of team work throughout the semester.

The TA's and I are excited use the flipped learning approach this semester so that we can work with you during class and help you to apply your knowledge to various problems. So that we maximize the amount of time we spend in class working on practice problems, you will be asked at times to listen to short, 5-10 minute podcasts available through D2L or to read certain sections of the textbook before coming to class. More information on this approach as well as reading/podcast lists will be provided in class and on D2L.

**COURSE MATERIALS:**

## A. TEXTBOOK:

We will be using the following textbook: Lehninger Principles of Biochemistry. Nelson and Cox. W.H. Freeman. 6<sup>th</sup> Edition

It is **recommended** and both used and new copies are available from the bookstore. You can choose to purchase either a hardcover or binder-ready version of the textbook. Both versions come pre-packaged with the student companion entitled "The Absolute, Ultimate Guide to Lehninger Principles of Biochemistry Study Guide and Solutions Manual", which was written by Marcy Osgood and Karen Ocorr. This study guide contains chapter summaries, additional practice problems and self-tests.

## B. LABORATORY MANUAL:

The laboratory manual is available from the D2L course site for download.

## C. CLASSROOM PERFORMANCE SYSTEM:

We will use the classroom performance system Top Hat Monocle during the lecture component of this course to enhance learning in the classroom. Your use of the Top Hat Monocle system is **optional**. If you wish to participate, you need to have a cell phone with which you can send text messages, and you need to register for an account with Top Hat Monocle. Account registration is free.

## COURSE COMPONENTS:

### A. IN-CLASS TEAM APPLICATION ACTIVITIES

Some of the practice problems we will work on together during class time will be graded. There will be nine in-class activities during the semester that will be collected at the end of lecture and graded. Each in-class assignment is LOW-STAKES and will be worth at most between 1-1.5%. The goal of the graded in-class assignments is to provide me with an opportunity to provide you with frequent feedback to help you master the concepts we will study. The dates on which graded in-class assignment will be held are listed below:

In-class team application activity no.	Date	Worth
1	May 19	1%
2	May 29	1.5%
3	June 2	1.5%
4	June 9	1.5%
5	June 16	1.5%
6	June 19	1.5%
7	June 23	1.5%

Further details on these in-class assignments will be provided on D2L.

### B. PEER EVALUATIONS

Studies have shown that diverse teams of 5-7 people perform the best and provide all members with the best possible learning outcomes. To ensure that we can form the most diverse teams possible, I will make use of the ITP Metrics system to form teams in the first week of class. To help with team formation, you will be asked to complete a survey in week 1 of the semester. Once teams are formed, you will be asked to work with your teammates on the ungraded and graded in-class activities this semester. To ensure individual accountability in all team work that will be completed this semester, you will be asked to also use the ITP Metrics system to evaluate the contributions of each of the members of his/her group. Further details on how you will be asked to evaluate your peers will be provided in class.

### C. IN-CLASS AND ONLINE QUIZZES

There will be seven in-class or online quizzes; the dates on which each quiz will be administered/due are listed below:

In-class quiz no.	Type	Date	Worth
1	In-class	May 15	1% (pass/fail only)
2	Online	Complete by 5 PM on May 17	2%
3	In-class	May 24	2%
4	In-class	May 31	2%
5	In-class	June 5	2%
6	In-class	June 21	2%
7	Online	Complete by 5 PM on June 26	1% (pass/fail only)

Each LOW-STAKES quiz has been designed to help you assess your understanding of the various concepts we will be studying together this semester and to help you prepare for the exams. Further details on these quizzes will be given during the lecture component of this course.

## **D. LABORATORIES**

The laboratory exercises have been designed to give you an overview of current biochemical techniques used to study proteins, enzymes and metabolic pathways. The laboratory component of Biochemistry 393 will help you appreciate the basic aspects of structure and reactivity of the key biomolecules found in living things. To understand how molecular interactions and chemical reactions underlie physiological processes, it is important to see how experimental methods and observations are used to probe the complexities of biological molecules and the resulting metabolic processes occurring in living organisms.

As you progress through the laboratory component of this course, you will have the opportunity to develop many of the basic technical skills used for biochemical analysis in research and clinical laboratories. For example, you will have the opportunity to learn first-hand how to measure the activities of enzymes, purify proteins, analyze the purity of proteins using polyacrylamide gel electrophoresis and investigate the abilities of gut bacteria to metabolize both natural and artificial sweeteners! In addition to these technical skills, you will gain experience in making careful experimental observations, in recording data in an accurate and consistent manner, and in critically analyzing data.

To help you with the development of these skills, some of the laboratory exercises are inquiry-based, to give you the opportunity to put yourself in a scientist's shoes. These types of exercises will ask you to design your own experiments to solve a problem. Take advantage of these exercises! They are meant to help you hone your analytical and inquiry skills and get a great taste of what it is like to do "real science"!

The laboratory component has a value of its own, quite apart from the facility that it provides for the reinforcement of concepts taught in lectures. It is the place where you will be faced with the business of 'doing science', experience its frustrations and its intellectual satisfactions. Seize the opportunity because it is a meaningful part of your university education.

Six laboratory exercises will be offered in the laboratory component of this course. Each will have one or more associated assignments, which taken together will be worth 24% of the final grade. Please refer to the laboratory manual for a list of all laboratory assignments, their deadlines and their worth.

Attendance at all laboratory exercises is required. Laboratory assignments will not be accepted from students who missed the laboratory session in which the data were collected, unless valid documentation for the absence is provided. Please refer to the laboratory manual for the type of documentation required in this course and the deadline for submitting this documentation to Dr. Barrette-Ng.

## **E. MIDTERM AND FINAL EXAMS**

The midterm and final exams will consist only of written questions. The midterm exam will examine material covered between May 15 to June 9 inclusive. The final exam will examine material covered between June 12 to June 26 inclusive.

## **F. LETTER GRADE BREAKDOWN**

The following letter grade breakdown will be used to assign final grades in BCEM 393 for the Spring 2017 semester.

A+: 97 or higher  
A : 86 and under 97  
A- : 82 and under 86  
B+: 78 and under 82  
B : 74 and under 78  
B- : 70 and under 74  
C+: 66 and under 70  
C : 62 and under 66  
C- : 58 and under 62  
D+: 54 and under 58  
D : 50 and under 54  
F : <50

**UNIVERSITY OF CALGARY – DEPARTMENT OF BIOLOGICAL SCIENCES  
BIOCHEMISTRY 393 – INTRODUCTION TO BIOCHEMISTRY  
COURSE SYLLABUS SPRING 2017, SECTION NO. 01**

**TENTATIVE LECTURE SCHEDULE<sup>1</sup>**

THEME	DATE	TOPICS AND SUB-TOPICS <sup>2</sup>
How can you be successful in this course?	May 15	Welcome to BCEM 393!  Approaches to studying and mastering biochemistry concepts
Water is the medium of life.	May 17	Water-lovers and water-haters – the main chemicals of life and the importance of water in biochemistry  pH and the importance of buffers in biochemistry
Proteins are critical to biological processes in the cell.	May 19-29	Amino acids are the building blocks of proteins.  Proteins are chains of covalently bound amino acids that adopt a specific 3-D structure. The following sub-topics will be covered while studying protein 3-D structure: <ul style="list-style-type: none"> <li>A. There are four different levels of protein structure.</li> <li>B. Protein primary structure determines all higher levels of protein structure.</li> <li>C. There are two types of secondary structure elements.</li> <li>D. There are many different super-secondary motifs.</li> <li>E. Tertiary structure is the highest level of structure for monomeric proteins.</li> <li>F. Quaternary structure is the highest level of structure for oligomeric proteins.</li> </ul> Protein structure is critical for protein function. The following sub-topics will also be covered while studying protein function and its relationship with protein structure: <ul style="list-style-type: none"> <li>A. Myoglobin and hemoglobin have different affinities for oxygen due to their protein structures.</li> <li>B. Proteins can lose their function due to denaturation.</li> </ul> Proteins can be post-translationally modified and these modifications can alter their function.
	May 31-June 2	Protein purification and its role in studying proteins and protein function.
	June 5-9	Enzymes are proteins that catalyze chemical reactions. The following sub-topics will also be covered while studying enzymatic catalysis: <ul style="list-style-type: none"> <li>A. Enzymes accelerate the rate of chemical reactions.</li> <li>B. Enzymes bind substrates in their active sites and stabilize the transition state.</li> <li>C. Enzymes have specific requirements to achieve full activity.</li> <li>D. Enzymes can be kinetically characterized and can be inhibited.</li> <li>E. There are 6 different classes of enzymes, where each is responsible for the catalysis of a different type of chemical reaction.</li> </ul>
Carbohydrates are a main component of cells, and they are required as a source of fuel, as protection and for signaling.	June 12	Carbohydrates have the general formula (CH <sub>2</sub> O) <sub>n</sub> and can be classified as aldoses or ketoses.  Monosaccharides are joined together via glycosidic bonds to form oligosaccharides and polysaccharides.
	June 12-23	Carbohydrates can be used in anaerobic and aerobic metabolism as a source of fuel. The following sub-topics will also be covered while studying carbohydrate metabolism: <ul style="list-style-type: none"> <li>A. Glycolysis</li> <li>B. Anaerobic fermentation of pyruvate</li> <li>C. Bridging reaction</li> <li>D. TCA</li> <li>E. Electron transport chain</li> <li>F. Regulation of carbohydrate metabolism</li> </ul> Carbohydrates can be generated through the process of gluconeogenesis.
Lipids are a main component of cells, and are required as a source of fuel, for cell and organelle membranes, and for signaling.	June 26	The most basic lipid is a fatty acid.  Fatty acids can be covalently attached to glycerol or sphingosine to form lipids found in membranes.  Lipids can be used as a source of fuel.

<sup>1</sup> The schedule may deviate slightly due to the needs of the class.

<sup>2</sup> More details on the list of topics/sub-topics that we will study along with a list of suggested readings in the required textbook as well as from journal articles will be provided on the course's D2L site.