



**Chemistry 255**  
**BIOCHEMISTRY**  
*Fall Semester 2011*

**COURSE OUTLINE**

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*This course concerns fundamental aspects of biomolecules and biochemical processes. Topics include: noncovalent interactions; buffers; protein, enzyme, and carbohydrate structure-function relationships; lipids and membranes; bioenergetics; carbohydrate, lipid, amino acid and nucleotide metabolism; nucleic acid structure and synthesis; gene expression and protein synthesis; nutrition; biotechnology applications; and prevalent biochemistry laboratory techniques.*

The course description is online @ <http://camosun.ca/learn/calendar/current/web/chem.html>

*This outline may not be on-line indefinitely. It is recommended students keep this copy for their records.*

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**1. Instructor Information**

- (a) Instructor    Jamie Doran, Ph.D.
- (b) Office hours    Monday, 3:30 to 4:20 pm  
                          Wednesday, 12:30 to 2:20 pm  
                          Thursday, 12:30 to 2:20 pm  
                          Friday, 1:30 to 3:20 pm

*Students are welcome whenever my office door is open.  
Appointments may be made to meet at times other than those listed above.  
Office hours will be extended prior to exams.*

- (c) Location    Room 350C, Fisher Building, Lansdowne Campus
- (d) Phone        250.370.3441
- (e) E-mail        jdoran@camosun.bc.ca

## 2. Intended Learning Outcomes

Students successful in this course will be able to:

- Demonstrate an understanding of the fundamental characteristics of proteins, including enzymes, carbohydrates, lipids, and the nucleic acids, DNA and RNA.
- *Demonstrate a basic understanding of the chemical and biochemical principles governing the structure-function relationships of biomolecules and membranes.*
- *Demonstrate an understanding of the underlying themes of key biochemical processes including metabolism, bioenergetics, gene expression and protein synthesis.*
- *Demonstrate an understanding of, and evaluate, the most important aspects of the biochemical framework of cellular function at a molecular level, and the chemical bases thereof.*
- *Use the basic vocabulary of biochemistry.*
- *Use internet-based resources to enhance the learning and appreciation of the principles of biochemistry.*
- *Demonstrate an appreciation of the significance of biochemistry in clinical and veterinary medicine, laboratory analyses, nutrition, agriculture, and biotechnology.*
- Isolate specific proteins using gel-permeation, ion-exchange, and affinity-based column chromatography methods.
- Analyze proteins by SDS-polyacrylamide gel electrophoresis (SDS-PAGE).
- Conduct polymerase chain reaction amplification of DNA molecules.
- Utilize agarose gel electrophoresis for analysis of DNA samples.
- Critically analyze the results obtained using each of the biochemical experimental techniques described above.
- Work with an awareness of the basic safety considerations and general procedures associated with a biochemistry laboratory.

### 3. Course Materials

#### (a) Text:

*Principles of Biochemistry*. Fourth Edition. 2006.

H.R. Horton, L.A. Moran, K.G. Scrimgeour, M.D. Perry & J.D. Rawn.  
Prentice-Hall Canada Inc., Toronto.

#### **This textbook is required for this course.**

Links to relevant web-based learning resources are presented in the text.

A copy of the textbook is available in the reserve library of the Lansdowne Campus.

A rather extensive collection of relevant lecture slides mainly taken from the test is available as a set through the Lansdowne book store (see below).

#### (b) Laboratory Manual & Study Guides:

*Chem 255 Experimental Procedures & Course Study Guide. 2010 Edition*

This is a booklet of experimental procedures as well as a collection of study guides for all subjects of each chapter of the textbook included in the course. *This is required material* and is available through the Camosun College Lansdowne Campus Bookstore.

#### (c) *Chem 255 Lecture Slides package, 2009 Edition.*

The experience of past students for many years has indicated that this package is extremely beneficial to note-taking, and to promoting lecture-based learning and in-class discussion. *Therefore, it is very highly recommended*, and rarely done without. It is available through the Camosun College Lansdowne Campus Bookstore.

#### (d) *General Materials and Supplies*

Safety glasses Safety glasses are required when handling hazardous chemicals or biochemicals. Each student is required to provide her or his pair of safety glasses. Students lacking safety glasses when they are required will not be permitted to work in the laboratory.

Lab coats Lab coats are required for all experimental work in the laboratory. Each student is required to provide her or his own lab coat. Students lacking lab coats will not be permitted to work in the laboratory.

Latex gloves Latex or other 'non-allergenic' gloves *will be available in the lab* and are to be used when appropriate to protect the skin from potentially hazardous chemicals or, more frequently, to protect labile biochemicals from contamination or becoming degraded by enzymes from the skin.

Calculator A scientific calculator is required at times in the laboratory, in class and during tests and exams. Each student is required to provide her or his own scientific calculator. Cell phone-based calculators cannot be used.

#### 4. Course Content and Schedule

Credits	4 credits
In-class workload	6 hours per week <ul style="list-style-type: none"><li>• There are four 50-minute lectures per week. Term exam review periods will be scheduled into an appropriate lecture slot prior to each exam.</li><li>• Experiments, pre-lab talks &amp; post-lab analyses are conducted during most of the 1 h &amp; 50 min Friday laboratory periods. This time slot is also used for the two term tests and for a final exam review period*.</li></ul>
Out-of-class workload	6 hours per week
Number of weeks	14 weeks
Pre-requisite	Chem 121 - College Chemistry 2
Pre- or Co-requisite	Chem 230 – Organic Chemistry 1

#### Course times and locations

<u>Lectures</u>	Monday, 11:30 AM - 12:20 PM Fisher Building, Room F200
	Tuesday, 11:30 AM - 12:20 PM Fisher Building, Room F200 (Repeated 12:30 PM - 1:20 PM (due to Biol 228 conflict))
	Wednesday, 11:30 AM - 12:20 PM Fisher Building, Room F202
	Thursday, 11:30 AM - 12:20 PM Fisher Building, Room F202

#### Lab Experiments, Term Tests or Final Exam Review Times\*

Friday Lab Section 001A  
8:30 AM to 10:20 AM  
Fisher Building, Rooms F360 & F358

Friday Lab Section 001B  
11:30 AM to 12:20 PM  
Fisher Building, Rooms F360 & F358

\* Please see the laboratory and term test schedule below.

## **Lecture Outline**

A general outline of the topics to be covered in the course is provided below. *Study guides for each chapter of the textbook are provided in the laboratory manual-inclusive 'course package' available through the College Bookstore. Each study guide includes an assigned reading list for the chapter, a listing of the relevant vocabulary, and suggested practice questions.*

### **Introduction to Biochemistry**

Chapter 1

Introduction; History; Physiologically Relevant Elements, Classes of Organic Compounds, Functional Groups; Covalent Linkages; Classes of Biomolecules. (*Other review material in this chapter forms part of the assigned reading listed in the study guide*)

### **Noncovalent bonding, pH, pKa, and Buffers & Buffering**

Chapter 2

Noncovalent Bonding in Biomolecules; pKa; The Henderson-Hasselbach Equation; Buffering; the Bicarbonate Blood-Buffer System; Acidosis & Alkalosis (*additional material not presented in Chapter 2*). (*Other review material in this chapter forms part of the assigned reading*)

### **Amino Acids and the Primary Sequence of a Protein**

Chapter 3

Structures of Common Amino Acids; Ionization & pKa's of Amino Acid Functional Groups; Peptide Bonds; Protein Purification Techniques; Primary Protein Sequence; Protein Sequencing; Comparative Analyses of Protein Sequences; MALDI-TOF.

### **Protein Structure & Function**

Chapter 4

Informatics - Proteomics, Genomics, Systemics, & Metabonomics (*additional material not presented in Chapter 4 but covered in part in Chapter 23*); The Nature of the Peptide Bond; Secondary, Tertiary and Quaternary Protein Structures; Protein Folding and Stability; Protein Structure-Function Relationships.

### **Enzymes**

Chapter 5

Classes of Enzymes; Enzyme Kinetics; Michaelis-Menton Equation; Enzyme Inhibition; Interpretation of Lineweaver-Burk Plots; Regulation of Enzyme Activity.

### **Mechanisms of Enzyme Catalysis**

Chapter 6

Overview of Enzyme Function; Mechanisms of Enzyme Catalysis; Mechanism of Chymotrypsin Activity.

### **Coenzymes and Vitamins**

Chapter 7

Roles and Structures of Coenzymes and Vitamins; Vitamins & Health (overview)

### **Carbohydrates**

Chapter 8

Roles and Structures of Monosaccharides, Disaccharides, Polysaccharides & Glycoconjugates.

### **Lipids & Membranes**

Chapter 9

Classes, Structures and Roles of Lipids; Membrane Structure and Function; Membrane Transport; Transmembrane Signal Transduction.

### **Overview of Metabolism**

Chapter 10

<b>Glycolysis</b>	<i>Chapter 11</i>
The Nature and Role of Glycolytic Metabolic Pathway, and its Regulation.	
<b>TCA Cycle</b>	<i>Chapter 12</i>
Mitochondrial Transport of Pyruvate; Pyruvate Dehydrogenase Activity and Regulation; The Citric Acid Cycle (aka TCA Cycle, Krebs Cycle); Regulation of the Krebs Cycle.	
<b>Other Pathways in Carbohydrate Metabolism</b>	<i>Chapter 13</i>
Glycogen Metabolism; Gluconeogenesis; Cori Cycle; Pentose Phosphate Pathway; Maintenance and Regulation of Blood Glucose Levels.	
<b>Electron Transport and Oxidative Phosphorylation</b>	<i>Chapter 14</i>
Introduction to Bioenergetics; The Chemiosmotic Hypothesis; Electron Transport; Oxidative Phosphorylation in Mitochondria; Glycerol Phosphate & Malate-Aspartate Shuttle Systems.	
<b>Lipid Metabolism</b>	<i>Chapter 16</i>
Lipoprotein Structure and Function; Storage and Mobilization of Fatty Acids and Cholesterol; Fatty Acid $\beta$ -Oxidation; Ketone Bodies; Fatty Acid, Phospholipid and Cholesterol Metabolism; Dietary Lipids & Health (Overview).	
<b>Amino Acid Metabolism</b>	<i>Chapter 17</i>
Amino Acid Catabolism and Anabolism; Urea Cycle.	
<b>Nucleotide Metabolism</b>	<i>Chapter 18</i>
Purine and Pyrimidine Biosynthetic Pathways.	
<b>DNA Composition, Structure and Mapping</b>	<i>Chapter 19</i>
Nucleotides & Nucleosides; DNA Structure; Restriction Endonucleases & Physical Mapping of DNA; DNA Finger-Printing (also see Chapter 23).	
<b>DNA Replication and Repair</b>	<i>Chapter 20</i>
DNA Polymerase; DNA Replication; DNA Repair; DNA Sequencing.	
<b>RNA Synthesis (Transcription)</b>	<i>Chapter 21</i>
Classes of RNA; RNA Polymerase Function & Promoter Sequences; Transcriptional Regulation of the <i>lac</i> Operon.	
<b>Protein Synthesis (Translation)</b>	<i>Chapter 22</i>
The Genetic Code; tRNA Structure and Function; Aminoacyl tRNA Synthetases; Ribosome Structure and Function; the Shine-Dalgarno Sequence & the Initiation of Translation; Signal Sequences & Protein Secretion; Attenuation.	
<b>Recombinant DNA Technologies &amp; Biotechnology</b>	<i>Chapter 23</i>

Recombinant DNA Technology (Gene Cloning); PCR (also see related material in the laboratory manual in presented in relevant labs); Site-Directed Mutagenesis.

## **Laboratory, Exam & Assignment Schedule**

Friday, September 9<sup>th</sup>. Overview of a general strategy for protein purification and characterization, and the relationship of the inter-related experiments in this course.

Friday, September 16<sup>th</sup>. **Experiment 1**  
*Separation of Proteins by Gel Permeation Column Chromatography*

Friday, September 23<sup>rd</sup>. **Experiments 2 & 3**  
*Purification of Proteins Ion-Exchange Column Chromatography & Affinity Column Chromatography*

Friday, September 30<sup>th</sup>. **Experiment 3, and Review & Analyses of Expts. 1 to 3.**  
*Separation of Proteins by Affinity Chromatography (completion).*  
*Analyses of Column Chromatography Results (also refer to Chapter 3 in the text).*

Friday, October 7<sup>th</sup>. **Experiment 4**  
*SDS-Polyacrylamide Gel Electrophoresis (SDS-PAGE): Separation & Identification of Proteins, and Determination of Protein Molecular Weight*  
*Part 1 - Preparation of a Polyacrylamide Gel for the Separation of Proteins*

Friday, October 14<sup>th</sup>. **Term Test 1** 001A 8:30 AM to 10:20 AM; 001B 11:30 AM to 1:20 PM

Friday, October 21<sup>st</sup>. **Experiment 4 (continued)**  
*SDS-PAGE Part 2 - Protein Electrophoresis, & Staining for Detection of Proteins*

Friday, October 28<sup>th</sup>. **Experiment 4 (completion)**  
*SDS-PAGE Part 3 – Theory; Analysis of SDS-PAGE Results*

Friday, November 4<sup>th</sup>. **Experiment 5**  
*Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments*  
*Part 1 - PCR Amplification of DNA Fragments*

Friday, November 11<sup>th</sup>. *Remembrance Day*

Friday, November 18<sup>th</sup>. **Term Test 2** 001A 8:30 AM to 10:20 AM; 001B 11:30 AM to 1:20 PM

Friday, November 25<sup>th</sup>. **Experiment 5 (continuation)**  
*Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments*  
*Part 2 - Agarose Gel Electrophoresis & Detection of PCR Amplified DNA Fragments*

Friday, December 2<sup>nd</sup>. **Experiment 5 (completion)**  
*Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments*  
*Part 3 - Analysis of PCR Results.*

Friday, December 9<sup>th</sup>. **Experiment 6** *Analyses of Blood Glucose, Triglycerides, Total Cholesterol, HDL and LDL Levels.*

☞ **Term Project Due** ☞

**Final Exam:** The time and location of the Chem 255 Final Exam will be published by the College during the Fall Semester.

☞ A final exam review period will be scheduled just prior to the exam date. ☞

## 5. **Basis of Student Assessment (Weighting)**

### (a) **Assignment: Metabolic Pathways Chart Project.**

This assignment will be described in detail in a handout to be provided once topics of intermediary metabolism arise in the course. Each individual is required to hand in the results of her or his own work. This metabolic pathways chart is due on the final day of class, but may be handed in earlier. It should be considered very useful for study purposes in preparation for the final exam. This project contributes 5% to the final grade.

### (b) **Laboratory Experiments**

**Attendance in the lab periods is mandatory.** No laboratory experiment can be missed without an acceptable reason submitted in writing, such as a proper letter from a Medical Doctor. *Please come to each lab period prepared for each experiment.* There are no laboratory reports due for the experiments but *students are responsible for understanding the principles, technical bases, and results of each experiment.* These aspects of the laboratory work will be subject to examination on the term exams and the final exam.

### (c) **Term Tests**

#### **Term Test #1**

This exam covers relevant material from approximately the first third of the course. The delineation of material students are responsible for will be provided in class about one week before the date of the test. This is a 110 minute test that will be written on Friday, October 14<sup>th</sup> from 8:30 AM to 10:20 AM for section 001A, and from 11:30 AM to 1:20 PM for section 001B.

The results of this test contribute to 25% of the final grade.

#### **Term Test #2**

This exam covers relevant material from approximately the second third of the course. The delineation of material students are responsible for on this test will be provided in class about one week before the date of the exam. This is a 110 min. test that will be written on Friday, November 18<sup>th</sup> in room F360 from 8:30 AM to 10:20 AM for section 001A, and from 11:30 AM to 1:20 PM for section 001B. The results of this test contribute to 25% of the final grade.

If either of the term exams is missed due to illness or other justifiable reason (appropriate documentation required), the percentage value of that term exam (25%) will be added to the percentage value of the final exam.



(d) **Final Exam**

The final exam is a comprehensive exam.

The value this exam contributes to the final grade is **45%**.

Attendance at the final exam is mandatory. Appropriate documentation must accompany any explanation for absence. The time and location of the final exam will be published by the College during the semester.

## 6. Grading System

### Standard Grading System (GPA)

Percentage	Grade	Description	Grade Point Equivalency
90-100	A+		9
85-89	A		8
80-84	A-		7
77-79	B+		6
73-76	B		5
70-72	B-		4
65-69	C+		3
60-64	C		2
50-59	D		1
0-49	F	Minimum level has not been achieved.	0

### Temporary Grades

Temporary grades are assigned for specific circumstances and will convert to a final grade according to the grading scheme being used in the course. See Grading Policy at [camosun.ca](http://camosun.ca) for information on conversion to final grades, and for additional information on student record and transcript notations.

Temporary Grade	Description
I	<i>Incomplete:</i> A temporary grade assigned when the requirements of a course have not yet been completed due to hardship or extenuating circumstances, such as illness or death in the family.
IP	<i>In progress:</i> A temporary grade assigned for courses that are designed to have an anticipated enrollment that extends beyond one term. No more than two IP grades will be assigned for the same course.
CW	<i>Compulsory Withdrawal:</i> A temporary grade assigned by a Dean when an instructor, after documenting the prescriptive strategies applied and consulting with peers, deems that a student is unsafe to self or others and must be removed from the lab, practicum, worksite, or field placement.

Temporary grades are assigned for specific circumstances and will convert to a final grade according to the grading scheme being used in the course. See Grading Policy E-1.5 at [camosun.ca](http://camosun.ca) for information on conversion to final grades, and for additional information on student record and transcript notations.

## **7. Recommended Materials or Services to Assist Students to Succeed Throughout the Course**

The chapter, laboratory and course study guides provided in the course package, which also includes the experimental protocols, will prove very valuable. In addition to the practice problems provided, there are lists of representative problems from the text and the corresponding website. Also, the textbook includes additional problems and their answers, and provides links to websites. Together these resources will further enhance the understanding and appreciation of the curriculum of this biochemistry course.

### **LEARNING SUPPORT AND SERVICES FOR STUDENTS**

There are a variety of services available for students to assist them throughout their learning. This information is available in the College Calendar, Registrar's Office or the College web site at <http://www.camosun.bc.ca>

#### **Please Note the Following College Policy:**

Students may not use recording devices in the classroom without the prior permission of the instructor. However, the instructor's permission is not required when the use of a recording device is sanctioned by the College's Resource Centre for Students with Disabilities in order to accommodate a student's disability and when the instructor has been provided with an instructor notification letter which specifies the use of a recording device. Recordings made in the classroom are for the approved student's personal use only, and distribution of recorded material is prohibited.

### **ACADEMIC CONDUCT POLICY**

There is an Academic Conduct Policy. It is the student's responsibility to become familiar with the content of this policy. The policy is available in each School Administration Office, Registration, and on the College web site in the Policy Section.

[www.camosun.bc.ca/divisions/pres/policy/2-education/2-5.html](http://www.camosun.bc.ca/divisions/pres/policy/2-education/2-5.html)