



Chemistry 255
BIOCHEMISTRY
Fall Semester 2012

COURSE OUTLINE

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.

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

1. Instructor Information

- (a) Instructor Jamie Doran, Ph.D.
- (b) Office hours Monday, 12:30 to 1:00 pm
Monday, 2:30 to 3:20 pm
Wednesday, 12:30 to 1:00 pm
Wednesday, 2:30 to 3:20 pm
Thursday, 12:30 to 1:00 pm
Thursday, 2:30 to 3:20 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.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*. Fifth Edition. 2012. Moran, Horton, Scrimgeour, & Perry. PearsonCanada, Toronto.

This textbook is required for this course. A copy of the textbook is available in the reserve library at the Lansdowne Campus. Links to relevant web-based learning resources are presented in the text. A collection of relevant lecture slides is available as a set through the Lansdowne book store (see below).

(b) Laboratory Experimental Procedures and Background & Chapter Study Guides:
Chem 255 Laboratory Manual & Course Study Guides. 2012 Edition

This is a course pack of experimental procedures with introductory explanatory material that, along with the textbook, provides an understanding of the biochemistry techniques employed. This course pack also includes a collection of study guides for

each chapter of the textbook included in the course. *This is required material* and is available through the Camosun College Lansdowne Campus Book Store.

(c) ***Chem 255 Lecture Slides Course Package, 2012 Edition.***

The experience of very many past students over many, many years has indicated that this package is vital to note-taking, and to promoting lecture-based learning and in-class discussion. *Therefore, it has become required material.* This second course pack 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, much more so, 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 lecture, and during tests and exams. Each student is required to provide her or his own scientific calculator. Cell phone-based calculators cannot be utilized.

4. Course Content and Schedule

Credits	4 credits
In-class workload	6 hours per week <ul style="list-style-type: none">• There are four 50-minute lectures per week. Term exam review periods will be scheduled into an appropriate lecture slot prior to each exam.• Experiments, pre-lab talks & post-lab analyses are conducted during most of the 1 h & 50 min Friday laboratory periods. This time slot is also used for the two term tests and for a final exam review period.
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

Chem 255 Section 001

Lectures

Monday, 11:30 AM - 12:20 PM
Fisher Building, Room F360

Tuesday, 11:30 AM - 12:20 PM
Fisher Building, Room F360

Wednesday, 11:30 AM - 12:20 PM
Fisher Building, Room F360

Thursday, 11:30 AM - 12:20 PM
Fisher Building, Room F360

Laboratory Experiments & Term Tests Times*

Friday, 8:30 AM to 10:20 AM
Fisher Building, Rooms F360 & F358

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

Chem 255 Section 002

Lectures

Monday, 1:30 PM - 2:20 PM
Fisher Building, Room F360

Tuesday, 1:30 PM - 2:20 PM
Fisher Building, Room F360

Wednesday, 1:30 PM - 2:20 PM
Fisher Building, Room F360

Thursday, 1:30 PM - 2:20 PM
Fisher Building, Room F360

Laboratory Experiments & Term Tests Times*

Friday, 10:30 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 required Chemistry 255 Laboratory Manual and Course Study Guides course package available through the Camosun College Lansdowne Campus Book Store. Each study guide includes a section by section reading list for a particular chapter inclusive of a listing of salient figures and tables, a listing of the relevant vocabulary, and recommended practice questions.*

Introduction to Biochemistry

[Chapter 1]

Introduction; History; Physiologically Relevant Elements, Classes of Organic Compounds, Functional Groups; Covalent Linkages; SI unit prefixes. *(Review material in this chapter also forms part of the assigned reading listed in the study guide)*

Noncovalent bonding, pH & pKa, and Buffers & Buffering

[Chapter 2]

Noncovalent Bonding in Biomolecules; pH & pKa; The Henderson-Hasselbach Equation; Buffers & 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]

Proteomics; The Nature of the Peptide Bond; Secondary, Tertiary and Quaternary Protein Structures; Protein Folding, Stability, Denaturation & Renaturation; Protein Structure-Function Relationships.

Enzymes

[Chapter 5]

Classes of Enzymes; Enzyme Kinetics; Michaelis-Menton Equation; Enzyme Inhibition; Interpretation of Lineweaver-Burk Plots; Allosteric and Covalent Regulation of Enzyme Activity; Regulation of Quaternary-Structured Enzymes.

Mechanisms of Enzyme Catalysis

[Chapter 6]

Overview of Enzyme Function; Chemical Mechanisms of Enzyme Catalysis; Proximity Effects and Transition State Stabilization; Mechanism of Chymotrypsin Activity.

Coenzymes and Vitamins

[Chapter 7]

Roles and Structures of Essential Ions, Coenzymes and Vitamins; Vitamins & Health.

Carbohydrates

[Chapter 8]

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

Lipids & Membranes	[Chapter 9]
Classes of Lipids, Structures and Roles of Lipids; Membrane Structure and Function; Membrane Transport; Transmembrane Signal Transduction.	
Overview of Metabolism	[Chapter 10]
Introduction to Intermediary Metabolism and Bioenergetics.	
Glycolysis	[Chapter 11]
The Nature and Role of Glycolytic Metabolic Pathway, and its Regulation.	
Other Major Pathways in Carbohydrate Metabolism	[Chapter 12]
Glycogen Metabolism; Gluconeogenesis; Cori Cycle; Pentose Phosphate Pathway; Maintenance and Regulation of Blood Glucose Levels.	
The Citric Acid Cycle	[Chapter 13]
Mitochondrial Transport of Pyruvate; Pyruvate Dehydrogenase Complex Activity and Regulation; The Nature and Roles of Citric Acid Cycle (aka TCA Cycle or Krebs' Cycle); Regulation of the Krebs' Cycle.	
Electron Transport and Oxidative Phosphorylation	[Chapter 14]
Introduction to Bioenergetics; The Chemiosmotic Hypothesis; Electron Transport; Oxidative Phosphorylation in Mitochondria; Glycerol Phosphate & Malate-Aspartate Shuttle Systems.	
Lipid Metabolism	[Chapter 16]
Lipoprotein Structure and Function; Storage and Mobilization of Fatty Acids and Cholesterol; Fatty Acid, Phospholipid and Cholesterol Metabolism; Fatty Acid β -Oxidation; Ketone Bodies; Dietary Lipids & Health.	
Amino Acid Metabolism	[Chapter 17]
Assimilation of Ammonia; Amino Acid Catabolism and Anabolism; Urea Cycle; Renal Glutamine Metabolism.	
Nucleotide Metabolism	[Chapter 18]
Purine and Pyrimidine Biosynthetic Pathways & Their Regulation.	
DNA & RNA	[Chapter 19]
Nucleosides & Nucleotides; DNA Structure; Restriction Endonucleases & Physical Mapping of DNA; DNA Finger-Printing.	
DNA Replication and Repair	[Chapter 20]
DNA Polymerase; DNA Replication; DNA Repair; DNA Sequencing.	
RNA Synthesis (Transcription)	[Chapter 21]
Classes of RNA; RNA Polymerase Function & Promoter Sequences; Transcriptional Regulation of the <i>lac</i> Operon.	
Protein Synthesis (Translation)	[Chapter 22]

The Genetic Code; tRNA Structure and Function; Aminoacyl tRNA Synthetases; Ribosome Structure and Function; the Shine-Dalgarno Sequence & the Initiation of Translation; Translational Regulation by Repression & Attenuation; Signal Sequences & Protein Secretion.

Laboratory, Exam & Assignment Schedule

Friday, September 7th. Equipment orientation & overview of the general strategy for protein purification and characterization, and the relationship between experiments.

Friday, September 14th. **Experiment 1**

Separation of Proteins by Gel Permeation Column Chromatography

Friday, September 21st. **Experiments 2 & 3**

Purification of Proteins Ion-Exchange Column Chromatography & Affinity Column Chromatography

Friday, September 28th. **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 5th. Term Test 1 255-001 8:30 to 10:20 AM; 255-002 11:30 AM to 1:20 PM

Friday, October 12th. **Experiment 4**

SDS-Polyacrylamide Gel Electrophoresis (SDS-PAGE): Separation & Identification of Proteins, and Determination of Protein Molecular Weight

Part 1 - Theory & Preparation of a Polyacrylamide Gel for the Separation of Proteins

Friday, October 19th. **Experiment 4 (continued)**

SDS-PAGE Part 2 - Protein Electrophoresis, & Staining for Detection of Proteins

Friday, October 26th. **Experiment 4 (completion)**

SDS-PAGE Part 3 – Experimental Principles & Analyses of SDS-PAGE Results

Friday, November 2nd. **Experiment 5**

Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments

Part 1 - Theory & PCR Amplification of DNA Fragments

Friday, November 9th. Term Test 2 255-001 8:30 to 10:20 AM; 255-002 11:30 AM to 1:20

Friday, November 16th. **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, November 23rd. **Experiment 5 (completion)**

Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments

Part 3 - Analysis of PCR Results.

Friday, November 30th. **Experiment 6**

Analyses of Blood Glucose, Triglycerides, Total Cholesterol, HDL and LDL Levels.

Friday, December 7th. Final Exam Review ☞ **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. Both sections write together.

☞ An additional final exam review 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 student 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 portions of 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 5th from 8:30 AM to 10:20 AM for section 001, and from 11:30 AM to 1:20 PM for section 002.

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 9th in room F360 from 8:30 AM to 10:20 AM for section 001, and from 11:30 AM to 1:20 PM for section 002. 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 with accompanying documentation, 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 that includes components from the laboratory section of the course. The value this exam contributes to the final grade is **45%**. The time and location of the final exam will be published by the College during the Fall Semester. (*Please note that the exam time and date cannot be changed to accommodate vacation plans.*)

Attendance at the final exam is mandatory. Appropriate documentation must accompany any explanation for absence if an incomplete grade (I grade) is warranted.

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 or 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 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 Laboratory manual and Course Study Guides course package prove very valuable. The same is true of the introductory material that accompanies each laboratory experiment. In addition to the practice problems provided, there are lists of representative problems from the text and the website corresponding to the textbook. Also, the textbook includes reading lists, and provides additional links to websites. Together these resources will further enhance the understanding and appreciation of the curriculum and laboratory training of this introductory course in biochemistry.

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:

Students may not use recording devices in the classroom without the prior permission of the instructor or DRC. The instructor's permission is not required when the use of a recording device is sanctioned by the College's Disabilities Resource Centre for Students 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 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