



CHEM-255-002

Biochemistry

Fall 2019

COURSE OUTLINE

The course description is online @

<http://camosun.ca/learn/calendar/current/web/chem.html>

Ω Please note: This outline will not be kept indefinitely. It is recommended students keep this outline for their records, especially to assist in transfer credit to post-secondary institutions.

1. Instructor Information

(a) **Instructor** Jamie Doran, Ph.D.

(b) **Office hours** Tuesday, 3:00 PM to 4:00 PM
Wednesday, 3:00 PM to 4:00 PM
Thursday, 10:00 AM to 11:00 AM
Friday, 2:30 PM to 4:30 PM
Please make an appointment.
Everyone is welcome to contact me by email, including in the evenings and on weekends.

(c) **Location** Room 350C, Fisher Building, Lansdowne Campus

(d) **Phone** 250.370.3441 (voice-mail available)

(e) **E-mail** jdoran@camosun.ca (available evenings and weekends throughout the semester)

2. Intended Learning Outcomes

Upon completion of this course the student will be able to:

1. Describe the fundamental characteristics of proteins, including enzymes, carbohydrates, lipids, and the nucleic acids, DNA and RNA.
2. Describe the chemical and biochemical principles governing the structure-function relationships of biomolecules and membranes.
3. Describe the underlying themes of key biochemical processes, including metabolism, bioenergetics, gene expression and protein synthesis.
4. Describe and evaluate the important aspects of the biochemical framework of cellular function at a molecular level, and the chemical bases thereof.
5. Use the basic vocabulary of biochemistry.
6. Explain the significance of biochemistry in clinical and veterinary medicine, laboratory analyses, nutrition, agriculture, and biotechnology.
7. Isolate specific proteins using gel-permeation, ion-exchange, and affinity-based column chromatography methods.
8. Analyze proteins by SDS-polyacrylamide electrophoresis.
9. Conduct polymerase chain reaction amplification of DNA molecules.
10. Utilize agarose gel electrophoresis for analysis of DNA samples.
11. Critically analyze the results obtained using each of the biochemical experimental techniques described above.
12. Work with an awareness of the basic safety considerations and general procedures associated with a biochemistry laboratory.

3. Required Materials

(a) Text

Moran, L.A., Horton, H.R., Scrimgeour, K.G. & Perry, M.D. 2012. *Principles of Biochemistry*. 5th ed. Pearson Education Inc., Toronto.

This textbook is *required* for this course. It may be purchased from the Lansdowne campus bookstore. A copy is available in the Reserve Library at the Lansdowne campus. Chapter study guides are included in the course pack containing the laboratory manual (please see below). Links to relevant web-based learning resources are presented in the text. A collection of relevant lecture slides, primarily based on this textbook, are available as a separate course pack (please see below).

(b) Other

Chem 255 Laboratory Manual & Course Study Guides.

This course pack contains experimental procedures with introductory material that, along with the textbook, provide an understanding of the biochemical techniques employed in the laboratory component of the course. This course pack also includes chapter study guides for optimizing use of the textbook and lecture notes. *This course pack is required material*, and is available through the Lansdowne Campus book store.

Chem 255 Lecture Slides Course Package.

This *required material* has proven to be vital in promoting optimal lecture-based learning, in-class discussion, and salient note-taking. It is available through the Lansdowne Campus book store.

General Materials and Supplies

Safety glasses Safety glasses *are required* when handling hazardous chemicals, and are recommended when handling laboratory glassware. Each student is required to provide her or his own pair of safety glasses. Students lacking safety glasses when they are required will not be permitted 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.

Latex gloves Disposable, plastic, 'non-allergenic' gloves *will be available in the laboratory* and are to be used when appropriate to protect the skin from potentially hazardous chemicals or, more typically, to protect biochemicals from degradative enzymes found on the skin.

Calculator A scientific calculator is *required* at times in the laboratory, in lecture, and during term tests and the final exam. Each student is *required* to provide her or his own calculator. Cell phone-based, tablet-based or computer-based calculators cannot be used during term tests or the final exam.

4. Course Content and Schedule

Credits	4 credits
In-class workload	6 hours per week There are four 50-min lectures per week. Term test review periods will be scheduled into an appropriate lecture slot prior to each term test. Experiments, pre-lab talks & post-lab analyses are conducted during most of the 1 h & 50 min laboratory periods. This time period is also used to host two term tests.
Out-of-class workload	6 hours per week
Number of weeks	14 weeks
Pre-requisite	C in Chem 121 - College Chemistry 2
Pre- or Co-requisite	Chem 230 – Organic Chemistry 1

Course times and locations

<u>Lectures</u>	Monday, 1:30 - 2:20 PM Fisher Building, Room F360
	Tuesday, 1:30 - 2:20 PM Fisher Building, Room F360
	Wednesday, 1:30 - 2:20 PM Fisher Building, Room F360
	Friday, 1:30 - 2:20 PM Fisher Building, Room F360

Laboratory Experiments & Term Test Times Please see the laboratory and term test schedule.

Monday, 10:30 AM to 12:20 PM
Fisher Building, Room F360

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 *Chemistry 255 - Biochemistry Laboratory Manual and Course Study Guides* course pack. Each chapter study guide includes a section by section reading list 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; Perspective on early developments in biochemistry; Biochemically Relevant Elements; Classes of Organic Compounds; Functional Groups; SI unit prefixes and metric conversions

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.

Amino Acids and the Primary Sequence of a Protein

[Chapter 3]

Structures of Common Amino Acids; pKa; Ionization and Potential Roles of Amino Acid Functional Groups in Covalent and Noncovalent bonding; Peptide Bonds; Peptide Bond Groups and Related Structure-Function Relationships; Protein Purification Techniques; Primary Protein Sequence; Protein Sequencing; MALDI-TOF MS; Comparative Analyses of Protein Sequences.

Protein Structure & Function

[Chapter 4]

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

Enzymes

[Chapter 5]

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

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.

Carbohydrates

[Chapter 8]

Roles and Structures of Monosaccharides, Disaccharides, Polysaccharides & Proteoglycan Complexes; Structure-Function Relationships in Carbohydrates and in Glycoconjugates.

Lipids & Membranes

[Chapter 9]

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

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]

Gluconeogenesis; Cori Cycle; Glucose-Alanine Cycle; Pentose Phosphate Pathway; Glycogen Metabolism; Maintenance and Regulation of Blood Glucose Levels.

The Citric Acid Cycle

[Chapter 13]

Pyruvate Dehydrogenase Complex Activity; The Nature and Roles of Citric Acid Cycle (aka TCA Cycle, Krebs Cycle); Regulation of the PDH Complex.

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; Shuttling of Krebs Cycle Intermediates.

Lipid Metabolism

[Chapter 16]

Lipoprotein Structure and Function; Storage and Mobilization of Fatty Acids and Cholesterol; Fatty Acid, Phospholipid, Cholesterol and Ketone Bodies Metabolism; β -Oxidation.

Amino Acid Metabolism

[Chapter 17]

Assimilation of Ammonia; Amino Acid Catabolism and Anabolism; Renal Glutamine Metabolism.

Nucleotide Metabolism

[Chapter 18]

Purine and Pyrimidine Biosynthetic Pathways.

DNA & RNA

[Chapter 19]

Nucleosides & Nucleotides; DNA Structure; Restriction Endonucleases and DNA Cloning; Physical Mapping of DNA; DNA Finger-Printing.

DNA Replication and Biotechnological Applications

[Chapter 20]

DNA synthesis; DNA Sequencing; Site-Specific Mutagenesis; Polymerase Chain Reaction (PCR).

RNA Synthesis (Transcription)

[Chapter 21]

RNA Polymerase Function; Promoters; Transcriptional Regulation of the *lac* Operon.

Protein Synthesis (Translation)

[Chapter 22]

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

Laboratory & Term Test Schedule

In preparation, please read through the introductory material in the laboratory manual & refer to relevant material in the textbook. Preparation of a flow chart for each experiment is required. Please complete these and, when appropriate, the pre-lab questions in time for submission at each laboratory period.

Monday, September 9th **Laboratory Orientation & Experiment 1**
Separation of Proteins by Gel Permeation Column Chromatography

Monday, September 16th **Experiments 2 & 3**
Purification of Proteins by Ion-Exchange Column Chromatography
& Affinity Column Chromatography (start)

Monday, September 23rd **Experiment 3**
Isolation of Concanavalin A by Affinity Chromatography (completion)
Discussion of Results, & Comparative Review of Chromatography Principles & Techniques

Monday, September 30th **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

Monday, October 7th **Term Test 1 10:30 AM to 12:20 PM in F360**

Monday, October 14th **Thanksgiving Day**

Monday, October 21st **Experiment 4 - SDS-PAGE (continued)**
Part 2 - Protein Electrophoresis, & Staining for Detection of Separated Proteins

Monday, October 28th **Experiment 4 - SDS-PAGE (completion)**
Part 3 – Analyses of SDS-PAGE Results & Further Principles and Theory

Monday, November 4th **Experiment 5**
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragment, Part 1 – Theory & PCR Amplification of DNA Fragments

Monday, November 11th **Remembrance Day**

Monday, November 18th **Term Test 2 10:30 AM to 12:20 PM in F360**

Monday, November 25th **Experiment 5 (continuation)**
PCR Amplification of Cloned SAGE Tag Fragments
Part 2 - Agarose Gel Electrophoresis & Detection of PCR Amplified DNA Fragments

Monday, December 2nd **Experiment 5 (completion)**
PCR Amplification of Cloned SAGE Tag Fragments
Part 3 - Analysis of PCR Results

☞ & Final Exam Review ☞

☞ **Final Exam** ☞ The time and location will be published by the College during the semester.

5. Basis of Student Assessment (Weighting)

(a) Assignments

Metabolic Pathways Chart Project.

This assignment is 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. This project contributes **5%** to the final grade.

(b) Term Tests

Term Test #1

This test covers relevant material from approximately the first third of the course. The delineation of material that students are responsible for, including that from the laboratory section of the course, 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 Monday, October 7th from 10:30 AM to 12:20 PM in F360. The results of this test contribute to **20%** of the final grade.

Term Test #2

This test covers relevant material from approximately the second third of the course. The delineation of material that students are responsible for, including that from the laboratory section of the course, will be provided in class about one week before the date of the test. This is a 110 min. test that will be written on Monday, November 18th from 10:30 AM to 12:20 PM in F360. The results of this test contribute to **25%** of the final grade.

If either term test is missed due to illness, or a similarly justifiable reason, with accompanying documentation the percentage value of that term test will be added to the value of the final exam.

(c) Final Exams

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 **40%**. The time and location of the final exam will be published by the College during the semester.

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

(d) Other

Laboratory Experiments

Laboratory participation and performance contributes **5%** to the final grade. **Attendance in the lab periods is mandatory.** No laboratory experiment can be missed without an acceptable reason submitted in writing, such as a letter from a MD.

Pre-lab assignments and flowcharts also contribute equally a total of **5%** of the final grade.

Please come to each lab period prepared for the experiment. Prepare a flow-chart and have the rest of the pre-lab assignment completed. *Understanding of the principles, scientific and technical bases, and results of each experiment is subject to examination on term tests and the final exam.*

6. Grading System

Standard Grading System (GPA)

Competency Based Grading System

7. Recommended Materials to Assist Students to Succeed Throughout the Course

Please refer to descriptions of the required textbook, and required course packages, in Section 3, above.

8. College Supports, Services and Policies



Immediate, Urgent, or Emergency Support

If you or someone you know requires immediate, urgent, or emergency support (e.g. illness, injury, thoughts of suicide, sexual assault, etc.), **SEEK HELP**. Resource contacts @ <http://camosun.ca/about/mental-health/emergency.html> or <http://camosun.ca/services/sexual-violence/get-support.html#urgent>

College Services

Camosun offers a variety of health and academic support services, including counselling, dental, disability resource centre, help centre, learning skills, sexual violence support & education, library, and writing centre. For more information on each of these services, visit the **STUDENT SERVICES** link on the College website at <http://camosun.ca/>

College Policies

Camosun strives to provide clear, transparent, and easily accessible policies that exemplify the college's commitment to life-changing learning. It is the student's responsibility to become familiar with the content of College policies. Policies are available on the College website at <http://camosun.ca/about/policies/>. Education and academic policies include, but are not limited to, Academic Progress, Admission, Course Withdrawals, Standards for Awarding Credentials, Involuntary Health and Safety Leave of Absence, Prior Learning Assessment, Medical/Compassionate Withdrawal, Sexual Violence and Misconduct, Student Ancillary Fees, Student Appeals, Student Conduct, and Student Penalties and Fines.

A. GRADING SYSTEMS <http://camosun.ca/about/policies/index.html>

The following two grading systems are used at Camosun College:

1. 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

2. Competency Based Grading System (Non GPA)

This grading system is based on satisfactory acquisition of defined skills or successful completion of the course learning outcomes

Grade	Description
COM	The student has met the goals, criteria, or competencies established for this course, practicum or field placement.
DST	The student has met and exceeded, above and beyond expectation, the goals, criteria, or competencies established for this course, practicum or field placement.
NC	The student has not met the goals, criteria or competencies

	<i>established for this course, practicum or field placement.</i>
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B. 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 <http://camosun.ca/about/policies/index.html> 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	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.</i>

Academic Honesty

Please become familiar with the new School of Arts & Science guide on academic honesty: <http://camosun.ca/learn/school/arts-science/images/Arts%20and%20Science%20Academic%20Honesty%20Guidelines.pdf>

Please Note:

Students may **not** use recording devices in the classroom without the prior permission of the instructor or the Centre for Accessible Learning. The instructor's permission is not required when the use of a recording device is sanctioned by the College's Centre for Accessible Learning 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. Such recordings made in the classroom are for the student's personal use only, and distribution of recorded material is prohibited. Recordings made during the course would include statements, questions and comments made by students in the class, and these are not to be disseminated or repeated in any manner based on the recordings. Otherwise, please have cell phones turned off and put away while in lectures.

Please have cell phones turned off and put away while in lectures. Thank you.

Camosun College is a scent-free institution.

Please refrain from wearing scents. Thank you.