CAMOSUN COLLEGE	**School of Arts & Science** **CHEMISTRY AND GEOSCIENCE DEPARTMENT** **CHEM 255-001** **Biochemistry** **Winter Semester, 2017**

COURSE OUTLINE

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

Ω *Please note: the College electronically stores this outline for five (5) years only.*
*It is **strongly recommended** you keep a copy of this outline with your academic records.*
You will need this outline for any future application/s for transfer credit/s to other colleges/universities.

1. Instructor Information

(a)	Instructor:	Jamie Doran, Ph.D.		
(b)	Office Hours:	Monday, 3:00 pm to 4:00 pm Tuesday, 10:00 am to 12:00 pm Wednesday, 11:30 am to 12:30 pm Wednesday, 3:00 pm to 4:00 pm Thursday, 3:00 pm to 4:00 pm		
(c)	Location:	Room 350C, Fisher Building, Lansdowne Campus		
(d)	Phone:	(250) 370-3441		
(e)	Email:	jdoran@camosun.ca		

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. Also, 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 the textbook are available as a separate course pack (please see below).

(b) Other

Chem 255 Laboratory Manual & Course Study Guides.
This is a course pack of experimental procedures with introductory, *required* material that, along with the textbook, provides an understanding of the biochemical techniques employed in the course. This course pack also includes individual chapter study guides for the textbook. *This course pack is required material* and is available through the Lansdowne Campus bookstore.

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 also available through the Lansdowne Campus bookstore.

General Materials and Supplies

Safety glasses — Safety glasses *are required* when handling hazardous chemicals, and should be worn when handling laboratory glassware. Each student is required to provide her or his pair of safety glasses.

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 — Latex or other '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, much more often, to protect biochemicals from degradative enzymes found on 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 scientific 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 slot is also used to host the two term tests.

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

Lectures

Tuesday, 8:30 AM - 9:20 AM
Fisher Building, Room F360

Wednesday, 8:30 AM - 9:20 AM
Fisher Building, Room F360

Thursday, 8:30 AM - 9:20 AM
Fisher Building, Room F360

Friday, 8:30 AM - 9:20 AM
Fisher Building, Room F360

Laboratory Experiments & Term Test Times*

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

** 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 Chemistry 255 Laboratory Manual and Course Study Guides package available through the 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; Biochemically & Physiologically Relevant Elements; Classes of Organic Compounds; Functional Groups; Covalent Linkages; SI unit prefixes and metric conversions. *(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; pKa; Ionization and Potential Roles of Amino Acid Functional Groups in Covalent and Noncovalent bonding; Peptide Bonds; Peptide Bond Group Structure-Function Relationships; Protein Purification Techniques; Primary Protein Sequence; Protein Sequencing; MALDI-TOF MS; Comparative Analyses of Protein Sequences.

Protein Structure & Function *[Chapter 4]*

Proteomics; 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 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 & 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]*

Glycogen Metabolism; Gluconeogenesis; Cori Cycle; Glucose-Alanine 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, Krebs Cycle); Regulation of the PDH Complex and 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; Shuttling of Krebs Cycle Intermediates.

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 and The 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 *lac* 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 and Protein Secretion.

Laboratory & Term Test Schedule

Please thoroughly read the introductory material and experimental protocol(s) in preparation for each experiment.

Friday, January 13th **Laboratory orientation. Mini-lab: *Making a Buffer***

Friday, January 20th **Experiment 1**
Separation of Proteins by Gel Permeation Column Chromatography

Friday, January 27th **Experiments 2 & 3**
Purification of Proteins by Ion-Exchange Column Chromatography
& Affinity Column Chromatography *(start)*

Friday, February 3rd **Experiment 3**
Isolation of Concanavalin A by Affinity Chromatography *(completion)*

Discussion of Column Chromatography Results, & Comparative Review of Chromatography Principles & Techniques *(In preparation, please refer to Chapter 3 in the text & the introductory material to each experimental protocol.)*

Friday, February 10th **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
(In preparation, refer to Chapter 3 in the text & the introductory materials in the laboratory manual.)

Friday, February 17th Reading Break. College Closed.

Friday, February 24th **Term Test 1** 10:30 AM to 12:20 PM in F360

Friday, March 3rd **Experiment 4 - *SDS-PAGE* (continued)**
Part 2 - Protein Electrophoresis, & Staining for Detection of Separated Proteins

Friday, March 10th **Experiment 4 - *SDS-PAGE* (completion)**
Part 3 – Analyses of SDS-PAGE Results & Further Principles and Theory

Friday, March 17th **Experiment 5**
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments
Part 1 – Theory & PCR Amplification of DNA Fragments

Friday, March 24th **Experiment 5** (continuation)
PCR Amplification of Cloned SAGE Tag Fragments
Part 2 - Agarose Gel Electrophoresis & Detection of PCR Amplified DNA Fragments

Friday, March 31st **Term Test 2** 10:30 AM to 12:20 PM in F360

Friday, April 7th **Experiment 5** (completion)
PCR Amplification of Cloned SAGE Tag Fragments
Part 3 - Analysis of PCR Results.

Friday, April 14th *Good Friday Holiday*
Final Exam The time and location will be published by the College during the Winter Semester.

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. 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 Friday, February 24th from 10:30 AM to 12:20 PM in F360. The results of this test contribute to **25%** 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 Friday, March 31st 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 similarly justifiable reason, with accompanying documentation, the percentage value of that term test (25%) will be added to the value of the final exam.

(c) **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 **40%**. The time and location of the final exam will be published by the College during the Winter 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.
Please come to each lab period prepared for the experiment. 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)

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	Minimum level of achievement for which credit is granted; a course with a "D" grade cannot be used as a prerequisite.	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 E-1.5 at **camosun.ca** for information on conversion to final grades, and for additional information on student record and transcript notations.

Temporary Grade	Description
I	*Incomplete*: 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	*In progress*: A temporary grade assigned for courses that, due to design may require a further enrollment in the same course. No more than two IP grades will be assigned for the same course. *(For these courses a final grade will be assigned to either the 3rd course attempt or at the point of course completion.)*
CW	*Compulsory Withdrawal:* 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.

7. Recommended Materials or Services to Assist Students to Succeed Throughout the 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, at Student Services, or the College web site at camosun.ca.

STUDENT CONDUCT POLICY

There is a Student Conduct Policy **which includes plagiarism**.
It is the student's responsibility to become familiar with the content of this policy.
The policy is available in each School Administration Office, at Student Services,
and the College web site in the Policy Section.

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. 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.

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