CAMOSUN COLLEGE	**School of Arts & Science** **CHEMISTRY AND GEOSCIENCE DEPARTMENT** **CHEM 255-001** **Biochemistry** **Fall Semester, 2014**

COURSE OUTLINE

This course concerns fundamental aspects of biomolecules and biochemical processes and their relevance to biotechnology and health. Topics include: noncovalent interactions, buffers, structure-function relationships in biomolecules**,** enzymology, lipids and membranes, bioenergetics, carbohydrate, lipid, amino acid and nucleotide metabolism, DNA synthesis, gene expression, protein synthesis and prevalent biochemistry laboratory techniques.

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, 10:00 am to 11:00 am Wednesday, 10:00 am to 11:20 am Thursday, 10:00 am to 11:00 am Friday, 11:30 am to 12:20 pm Everyone is welcome whenever my office door is open. Appointments may be made to meet at other times. Office hours will be extended prior to test dates.
(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. 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. Chapter study guides are included in the course pack containing the laboratory manual. A collection of relevant lecture slides is available as a separate course pack. Both course packs are available through the Lansdowne Campus book store.

(b) Other

Chem 255 Laboratory Manual & Course Study Guides. 2013 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 in the course. 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 Lansdowne Campus book store.

Chem 255 Lecture Slides Course Package, 2013 Edition.
The experience of very, very many past-students over 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 Lansdowne Campus book store.

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 be 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 be in the laboratory.

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 labile biochemicals from contamination or from becoming degraded by enzymes from the skin.

Calculator — A scientific calculator is *required* at times in the laboratory, in lecture, and during exams. 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 exams.

4. Course Content and Schedule

Credits: 4 credits

In-class workload: 6 hours per week

- There are four 50-minute lectures per week. Term exam review periods will be scheduled into an appropriate lecture slot prior to each term 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 to host the two term exams, and for the 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, 8:30 AM - 9:20 AM
Fisher Building, Room F360

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

Laboratory Experiments & Term Exam Times*

Friday, 9:30 AM to 11:20 AM
Fisher Building, Room F360

** Please see the laboratory and term exam 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; 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
& Proteoglycan Complexes. Structure-Function Relationships in Carbohydrates and in Glycoconjugates.

Lipids & Membranes *[Chapter 9]*
Classes of Lipids, Structures and Roles of Lipids; Membrane Structure and Functions; 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 or 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, Exam & Assignment Schedule

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

Friday, September 5th **Experiment 1**
Separation of Proteins by Gel Permeation Column Chromatography

Friday, September 12th **Experiments 2 & 3**
Purification of Proteins Ion-Exchange Column Chromatography
& Affinity Column Chromatography

Friday, September 19th **Experiment 3**
Purification of Concanavalin A by Affinity Chromatography *(completion).*

Analyses of Column Chromatography Results & Comparative Review of Chromatography Principles
(In preparation refer to Chapter 3 in the text & the introductory materials in the laboratory manual).

Friday, September 26th **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 3rd Review Period (Students from Chem 255 section 002 welcome; additional review time in the afternoon for students in both sections of Chem 255)

Friday, October 10th **Term Exam 1** 9:30 AM to 11:20 AM

Friday, October 17th **Experiment 4** (continued)
SDS-PAGE *Part 2 - Protein Electrophoresis, & Staining for Detection of Proteins*

Friday, October 24th Experiment 4 **(completion)**
SDS-PAGE *Part 3 – Analyses of SDS-PAGE Results & Principles and Theory*
(In preparation refer to Chapter 3 in the text & the introductory materials in the laboratory manual).

Friday, October 31st **Experiment 5**
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments
Part 1 - Theory & PCR Amplification of DNA Fragments

Friday, November 7th **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 14th **Term Exam 2** 9:30 AM to 11:20 AM

Friday, November 21st **Experiment 5** (completion)
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments
Part 3 - Analysis of PCR Results.

Friday, November 28th ***Analyses of Blood Glucose, Triglycerides, Total Cholesterol, HDL and LDL Levels*.**

Friday, December 5th. **Final Exam Review Session**
Metabolic Pathways Chart Project Due Date

Final Exam: The time and location of the Chem 255 Final Exam will be published by the College during the Fall 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. 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) Term Exams

Term Exam #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 10th from 9:30 AM to 11:20 AM in F360.
The results of this test contribute to **25%** of the final grade.

Term Exam #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 14th from 9:30 AM to 11:20 AM in F360. 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.

(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 Fall Semester. *(Please note that the exam time and date cannot be changed to accommodate vacation or other plans.)*

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
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.
Laboratory participation and performance contributes **5%** to the final grade.

Please come to each lab period prepared for the 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.

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

The chapter, laboratory and course study guides provided in the Laboratory Manual and Course Study Guides package will 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, 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. 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.