



Chemistry 255
PRINCIPLES OF BIOCHEMISTRY
Winter Semester, 2009

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.

The Approved Course Description is available on the web @
<http://www.camosun.bc.ca/calendar/chem.php#255>

Please note: This outline will not be kept indefinitely. It is recommended students keep it for their records.

1. Instructor Information

- (a) Instructor Jamie Doran, Ph.D.
- (b) Office hours Monday, 1:30 to 2:20 pm
 Tuesday, 11:30 am to 12:20 pm
 Wednesday, 11:30 am to 1:20 pm
 Thursday, 11:30 to 12:20 pm
 Friday, 12:30 pm to 2:20 pm

Folks are welcome whenever my office door is open.
Appointments may be made to meet at other times.
Office hours will be extended prior to exam times.

- (c) Location Room 342C, 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 electrophoresis.
- 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.

Copies of relevant lecture slides are available through the bookstore.

(b) Laboratory Manual & Study Guides:

Chem 255 Experimental Procedures & Course Study Guide. 2008 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 that are included in the course. *This is required material* and is available through the Camosun College Lansdowne Bookstore.

(c) *Chem 255 Lecture Slides package, 2008 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.* It is available through the Camosun College Lansdowne 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 '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 valuable biochemicals from contamination or becoming degraded by enzymes from the skin.

Scientific calculator: Calculators may be required in the lab, in class and during exams. Each student is required to provide her or his own calculator.

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. A term exam review period 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 one hour & 50 minute Friday time slots. This time period is also used for the two term exams.
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>Lecture times</u>	Monday, 10:30 - 11:20 AM Fisher Building, Room F358
	Tuesday, 10:30 - 11:20 AM Fisher Building, Room F216
	Wednesday, 10:30 - 11:20 AM Fisher Building, Room F358
	Thursday, 10:30 - 11:20 AM Fisher Building, Room F216
<u>Laboratory Periods*</u>	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 '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 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

Vitamins and Health (overview); Nature, Roles and Structures of Coenzymes and Vitamins.

Carbohydrates

Chapter 8

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

Lipids & Membranes

Chapter 9

Classes and Structures of Lipids, Membrane Structures, Membrane Transport, Transmembrane Signal Transduction.

Overview of Metabolism Introduction to Intermediary Metabolism and Bioenergetics.	<i>Chapter 10</i>
Glycolysis The Metabolic Pathway of Glycolysis and its Regulation.	<i>Chapter 11</i>
TCA Cycle Mitochondrial Transport of Pyruvate; Pyruvate Dehydrogenase Activity and Regulation; The Citric Acid Cycle (Krebs) Cycle; Regulation of Krebs' Cycle.	<i>Chapter 12</i>
Other Pathways in Carbohydrate Metabolism Glycogen Metabolism; Gluconeogenesis; Cori Cycle; Pentose Phosphate Pathway; Maintenance and Regulation of Blood Glucose Levels.	<i>Chapter 13</i>
Electron Transport and Oxidative Phosphorylation Introduction to Bioenergetics; The Chemiosmotic Hypothesis; Electron Transport; Oxidative Phosphorylation in Mitochondria; Malate-Aspartate Shuttle System.	<i>Chapter 14</i>
Lipid Metabolism Dietary Fats and Health (Overview); Lipoprotein Structure and Function; Storage and Mobilization of Fatty Acids and Cholesterol; Fatty Acid β -Oxidation; Ketone Bodies; Fatty Acid, Phospholipid and Cholesterol Metabolism.	<i>Chapter 16</i>
Amino Acid Metabolism Nitrogen Assimilation; Introduction to Amino Acid Metabolism; Urea Cycle.	<i>Chapter 17</i>
Nucleotide Metabolism Introduction to Nucleotide Metabolic Pathways.	<i>Chapter 18</i>
DNA Composition, Structure and Mapping Introduction to Nucleic Acids; Nucleotides & Nucleosides; Nucleases; Restriction Endonucleases and Physical Mapping of DNA; DNA Finger-Printing (also see Ch. 23).	<i>Chapter 19</i>
DNA Replication and Repair DNA Polymerase; DNA Replication; DNA Sequencing; DNA Repair.	<i>Chapter 20</i>
RNA Synthesis (Transcription) Classes of RNA; RNA Polymerase Function & Promoter Sequences; Transcriptional Regulation of the <i>lac</i> Operon.	<i>Chapter 21</i>
Protein Synthesis (Translation) 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.	<i>Chapter 22</i>
Recombinant DNA Technologies & Biotechnology Basic Molecular Cloning Strategies; PCR (also see lab info); Site-Directed Mutagenesis.	<i>Chapter 23</i>

Laboratory & Term Test Schedule

Friday, January 9th. Overview of the series of experiments.

Friday, January 16th. **Experiment 1**

Separation of Proteins by Gel Permeation Column Chromatography

Friday, January 23rd. **Experiments 2 & 3**

Ion-Exchange Column Chromatography & Affinity Column Chromatography

Friday, January 30th. **Experiment 3 & Summary of Expts. 1 to 3.**

Separation of Proteins by Affinity Chromatography (continuation).

Consideration of Column Chromatography Techniques.

Friday, February 6th. **Experiment 4, Part I**

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, February 13th. **Term Test 1 - 10:30 am to 12:20 pm, Rm. F360**

Friday February 20th. *Reading Break*

Friday, February 27th. **Experiment 4 - Part 2**

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

Part 2 - Polyacrylamide Gel Electrophoresis, & Staining for Detection of Proteins

Friday, March 6th. **Experiment 4 - Part 3**

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

Part 3 - Analysis of SDS-PAGE Results

Friday, March 13th. **Experiment 5 - Part 1**

Partial Analysis using the Polymerase Chain Reaction (PCR) of Cloned SAGE Tag Fragments Representing Genes Expressed by Pre-Cancerous Cells

Part 1 - PCR Amplification of Cloned SAGE Tag DNA Fragments.

Friday, March 20th. **Experiment 5 - Part 2**

Partial Analysis using the Polymerase Chain Reaction (PCR) of Cloned SAGE Tag Fragments Representing Genes Expressed by Pre-Cancerous Cells

Part 2 - Agarose Gel Electrophoresis & Detection of PCR Amplified DNA Fragments.

Friday March 27th **Term Test 2 - 10:30 am to 12:20 pm, Rm. F360**

Friday, April 3rd. **Experiment 5 - Part 3**

Partial Analysis using the Polymerase Chain Reaction (PCR) of Cloned SAGE Tag Fragments Representing Genes Expressed by Pre-Cancerous Cells
*Part 3 - Analysis of PCR Results. Friday, April 10th. **Statutory Holiday** (Good Friday, Easter Holiday).*

Final Exam: The time and location of the Chem 255 Final Exam 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 the relevant topics of intermediary metabolism arise in the course. This is an out-of-class project aside from a single overview lecture on the subject. 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 lecture: Thursday, April 9th, but may be handed in earlier. It should be considered very useful for study purposes in preparation for the final exam. The value this project contributes to the final grade is 5%.

(b) **Laboratory Component**

Come to each lab period prepared for the experiment. There are no laboratory reports to be handed in after each experiment 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. 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 Medical Doctor. The mark for laboratory participation and performance contributes 5% to the final course grade.

(c) **Term Tests**

Term Test #1

This exam covers relevant material from approximately the first third of the course. The delineation of material that you 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, February 13th** in F360 from 10:30 AM to 12:20 PM. 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 that you are responsible for 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, March 27th** in F360 from 10:30 AM to 12:20 PM. The results of this test contribute to 25% of the final grade.

If either of the midterm exams is missed due to illness or for any other justifiable reason (accompanied by appropriate documentation), a student may either take a substitute test to be written at a mutually agreeable time, or choose to add the percentage value of that midterm exam (25%) 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 40%.

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 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 course package, that 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>

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