CAMOSUN COLLEGE - DEPARTMENT OF CHEMISTRY & GEOSCIENCE

Chemistry 255 - PRINCIPLES OF BIOCHEMISTRY

Course Outline, Winter 2005

Course Description

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.

Semester offered	Winter 2005
Credits	4 credits
In-class workload	6 hours per week • There is an average of about five 50-minute lectures per week including lab lectures. • Laboratory periods are approximately 2 h.
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

Intended Learning Outcomes

- Students successful in this course will gain an understanding of the fundamental characteristics of proteins, including enzymes, carbohydrates, lipids, and the nucleic acids, DNA and RNA.
- Students will acquire a basic understanding of the chemical and biochemical principles governing the structure-function relationships of biomolecules and membranes.
- Students will learn the underlying themes of key biochemical processes including metabolism, bioenergetics, gene expression and protein synthesis.
- Students will appreciate the most important aspects of the biochemical framework of cellular function at a molecular level, and the chemical bases thereof.
- Students will acquire the basic vocabulary of biochemistry.
- Students will become familiar with internet-based resources to enhance the learning and appreciation of the principles of biochemistry.
- Students will gain an awareness of the significance of biochemistry in clinical and veterinary medicine, laboratory analyses, nutrition, agriculture, and biotechnology.
- Students will develop laboratory skills concerned with protein and DNA biochemistry.

- **Instructor**

Jamie Doran, Ph.D.

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Office hours: Regular office hours are posted on the office door.
These are: Monday, 11:30 to 12:00
Tuesday, 11:30 to 1:20
Wednesday, 11:30 to 1:20
Thursday, 11:30 to 12:00
Students are welcome *whenever* the door is open.
Appointments may be made to meet at other times.
Office hours will be extended before exam times.

Course times and locations

Lecture times
Monday
10:30 AM to 11:20 AM
Fisher Building, Room F360

Tuesday
10:30 AM to 11:20 AM
Fisher Building, Room F200

Wednesday
10:30 AM to 11:20 AM
Fisher Building, Room F202

Thursday
10:30 AM to 11:20 AM
Young Building, Room Y219

Laboratory/Lecture Periods* Friday
10:30 AM to 12:20 PM
Fisher Building, Rooms F360 and/or F358

*This time 2 h time period is used variously for laboratory experimentation, lectures, and midterm exams.
Please see the laboratory and midterm exam schedules below.

Textbook (Required)

Principles of Biochemistry. Third Edition. 2002. Au. H.R. Horton, L.A. Moran, R.S. Ochs, J.D. Rawn & K.G. Scrimgeour. Prentice-Hall Canada Inc., Toronto.
Various, optional, relevant, web-based, learning resources are outlined in the textbook.

Copies of the slides used during lectures are available in the reserve library.

Experimental Procedures & Study Guide

A booklet of experimental procedures, and study guides for portions of each chapter of the textbook that are included in the course, is available for purchase through the College Bookstore.

General Materials and Supplies

Safety glasses Safety glasses are required when handling hazardous chemicals or biochemicals. The students are required to purchase their own pairs of 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 any experiments involving hazardous chemicals or biochemicals. Students are required to provide their own lab coats. Students lacking lab coats when required will not be permitted to work in the laboratory.

Latex gloves Latex or similar gloves will be available in the lab and are to be used when appropriate to protect the skin from hazardous chemicals or biochemicals. They are also required at times to protect valuable biochemicals from becoming contaminated with biomolecules or bacteria on the skin, or from becoming degraded by enzymes from the skin.

Scientific calculator Calculators may be required in the lab, in class or during exams. Students are required to provide their own calculators.

Course evaluation

Attendance at the final exam is mandatory. Appropriate documentation must accompany any explanation for absence.

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% or 30%) to the percentage value of 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 suitable note from Medical Doctor.

NB. There are no laboratory reports to be handed in after each experiment but *students are responsible for understanding the principles, practical aspects, and expected results of each experiment*. These aspects of the laboratory work will be subject to examination on the midterm and final exams.

Midterm Exam #1

This exam covers relevant material from approximately the first third of the course. The delineation of material that you may be responsible for on this exam will be provided in class at least one week before the date of the exam.

This is a 110 minute exam that will be written on Friday, February 18th in the lab/lecture period.

The value this exam contributes to the final grade is **25%.**

Midterm Exam #2

This exam covers relevant material from approximately the second third of the course. The delineation of material that you may be responsible for on this exam will be provided in class at least one week before the date of the exam.

This is a 110 min. exam that will be written on Friday, April1st.

The value this exam contributes to the final grade is **25%**.

Metabolic Pathways Chart Project.

This assignment will be described in detail in a handout to be provided prior to the time when the course begins to deal with the relevant topics of intermediary metabolism.

This is an out-of-class project. Each individual is required to hand in the results of her or his own work.

The metabolic pathways chart is due on the final day of classes of the Winter 2004 semester, but may be kept by students until the date of the final exam to be used for study purposes.

The value this project contributes to the final grade is **5%**.

Final Exam

The final exam is a comprehensive exam.
The time and location of the final exam will be posted by the College.
The value this exam contributes to the final grade is **45%**.

Grade scale

The percentage marks for the course will be converted to letter grades according to the grading system published in the current edition of the Camosun College Calendar.

A+	= 95% to 100%	B-	= 70% to 74%
A	= 90% to 94%	C+	= 65% to 69%
A-	= 85% to 89%	C	= 60% to 64%
B+	= 80% to 84%	D	= 50% to 59%
B	= 75% to 79%	F	= 0% to 49%

Lecture Outline

A general outline of the topics to be covered in the course, and the respective chapters of *Principles of Biochemistry* by Horton et al., 2002, is provided below in the order in which the topics will be presented.
NB. Study guides will be provided for each chapter of the textbook as the associated material is covered in class. Each guide will include a listing of the relevant vocabulary, a reading list for the chapter, and a collection of practice questions.

Introduction to Biochemistry: *Chapter 1*
Introduction; History; Physiologically Relevant Elements; Organic Compounds, Functional Groups and Covalent Linkages; Classes of Biomolecules.

Noncovalent bonding, pH, pKa, and buffers: *Chapter 2*
Noncovalent Bonding in Biomolecules; pKa; The Henderson-Hasselbach Equation; Buffering, the Bicarbonate Blood-Buffer System.

Amino Acids and the Primary Sequence of a Protein: *Chapter 3*
Structure of Amino Acids; Ionization & pKa of Amino Acid Functional Groups; Peptide bonds; Protein Purification Techniques (Laboratory); Primary Protein Sequence; Protein Sequencing; Comparative Analyses of Protein Sequences.

Protein Structure & Function *Chapter 4*

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.

Enzyme Mechanisms *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 *Chapter 10*

Brief Introduction to Intermediary Metabolism and Bioenergetics.

Glycolysis *Chapter 11*

The Metabolic Pathway of Glycolysis and its Regulation.

TCA Cycle Chapter 12

Mitochondrial Transport of Pyruvate; Pyruvate Dehydrogenase Activity and Regulation; The Citric Acid Cycle (Krebs) Cycle; Regulation of Kreb's Cycle.

Electron Transport and Oxidative Phosphorylation *Chapter 14*

Introduction to Bioenergetics; The Chemiosmotic Hypothesis; Electron Transport; Oxidative Phosphorylation in Mitochondria; Malate-Aspartate Shuttle System.

Other Pathways in Carbohydrate Metabolism *Chapter 13*
Glycogen Metabolism; Gluconeogenesis; Cori Cycle; Pentose Phosphate Pathway; Maintenance and Regulation of Blood Glucose Levels.

Lipid Metabolism *Chapter 16*
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.

Amino Acid Metabolism *Chapter 17*
Nitrogen Assimilation; Introduction to Amino Acid Metabolism; Urea Cycle.

Nucleotide Metabolism *Chapter 18*
Introduction to Nucleotide Metabolism; Anabolic Pathways.

DNA Composition, Structure and Mapping *Chapter 19*
Introduction to Nucleic Acids; Nucleotides, Nucleosides; DNA Structure; Nucleases; Restriction Endonucleases and Physical Mapping of DNA; DNA Finger-Printing.

DNA Replication and Repair *Chapter 20*
DNA polymerase; DNA Replication; DNA Sequencing; DNA Repair.

RNA Synthesis (Transcription) Chapter 21
Classes of RNA; RNA polymerases; Promoter Sequences; Prokaryotic Transcription; Regulation of the *lac* Operon; Eukaryotic Transcription and RNA Processing.

Protein Synthesis (Translation) *Chapter 22*
The Genetic Code; tRNA Structure and Function; Aminoacyl tRNA Synthetases; Ribosome Structure and Function; Shine-Dalgarno Sequence; Signal Sequences and Protein Secretion.

Recombinant DNA Technologies & Biotechnology *Chapter 23*
Basic Molecular Cloning Strategies; PCR; Site-Directed Mutagenesis; Genomics & Proteomics.

Laboratory Schedule

Experiment 1 Friday, January 21st.
Separation of Proteins by Gel Permeation Column Chromatography

Experiments 2 & 3 Friday, January 28th & Friday, February 1st.
Ion-Exchange Column Chromatography &
Affinity Chromatography of Glucose Binding Protein
Part 1 - Chromatography

Experiments 2 & 3 (continued) Friday, February 1st.
Ion-Exchange Column Chromatography &
Affinity Chromatography of Glucose Binding Protein
Part 2 - Analysis of Column Fractions.
Review of the Principles of Column Chromatography

Note that the reading break is on February 10th and 11th .

Note that Midterm #1 is scheduled for Friday, February 18th

Experiment 4 Friday, February 25th .
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

Experiment 4 (continued) Friday, March 4th .
SDS-Polyacrylamide Gel Electrophoresis (SDS-PAGE) Separation & Identification of Proteins, and Determination of Protein Molecular Weight
Part 2 - Polyacrylamide Gel Electrophoresis (PAGE), and Staining for Detection of Proteins

Experiment 4 (continued) Friday, March 11th.
SDS-Polyacrylamide Gel Electrophoresis (SDS-PAGE) Separation & Identification of Proteins, and Determination of Protein Molecular Weight
Part 3 –Analysis of SDS-PAGE Results

Experiment 5 Friday, March 18th.
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments
Part 1 - PCR Amplification of DNA Fragments.

Note that the Good Friday Easter holiday is on March 25th.

Note that Midterm #2 is scheduled for Friday, April 1st

Experiment 5 (continued) Friday, April 8th.
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments
Part 2 - Agarose Gel Electrophoresis of PCR Amplified DNA Fragments.

Experiment 5 (continued) Friday, April 15th.
Polymerase Chain Reaction (PCR) Amplification of Cloned SAGE Tag Fragments
Part 3 - Analysis of PCR Results.