CAMOSUN COLLEGE - CHEMISTRY & GEOSCIENCE DEPARTMENT

Chemistry 255 PRINCIPLES OF BIOCHEMISTRY

Class 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.

Instructor Jamie Doran, Ph.D.
Chair, Applied Chemistry & Biochemistry Program

Office	Room 350A, Fisher Building, Lansdowne Campus
Telephone	250 370-3438
Fax	250 370-3417
E-mail	jdoran@camosun.bc.ca

Office Hours: Monday 12:30 PM to 1:30 PM
Tuesday 1:30 PM to 2:20 PM
Wednesday 10:30 PM to 11:30 PM
Thursday 1:30 PM to 2:30 PM

NB. Office hours will be extended prior to exam times.
Open door policy: Whenever my door is open, feel free to talk with me.
Appointments: Appointments can be scheduled at other times.

Course offering

Semester	Fall, 2002
Credits	4
In-class workload	6 hours per week • There is an average of 5 h of lecture per week. • There is an average of 1 h of laboratory work per week, however, experiments typically involve about 2 h of work per laboratory period.
Out-of-class workload	6 hours per week
Pre-requisite	Chem 121 - College Chemistry 2
Pre- or Co-requisite	Chem 230 – Organic Chemistry 1

Course times and locations

Sections 001A & R01A	Monday	11:30 to 12:20 in F310
	Wednesday	9:30 to 10:20 in F302
	Thursday	12:30 to 1:20 in F200
	Friday	9:30 to 11:20 in F360 and/or F358*
	Friday	3:30 to 4:20 in F302
Sections R01B	Monday	11:30 to 12:20 in F310
	Wednesday	9:30 to 10:20 in F302
	Thursday	12:30 to 1:20 in F200
	Friday	11:30 to 1:20 in F360 and/or F358*
	Friday	3:30 to 4:20 in F302

* This time 2 h time period is used variously for lectures, laboratory periods and midterm exams. See 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, relevant, web-based, learning resources are outlined in the textbook.

Laboratory Procedures
All individual experimental procedures will be handed out in class at an appropriate time prior to conducting each experiment.

General Materials and Supplies

Safety glasses — Safety glasses are required when handling hazardous chemicals and biochemicals. The students are required to purchase their own pairs of glasses. Students lacking safety glasses 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 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 are missed due to illness or for any other justifiable reason (accompanied by appropriate documentation), the student may either write a replacement test to be written at an appropriate time or chose to add the value of that midterm exam to the 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 (e.g. a note from medical doctor). *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 tests and final exam.

Midterm Exam #1

This exam covers relevant material from Chapters 1 to 7, related topics presented in lecture, and relevant information from the protein purification by column chromatography experiments.

This is a 90 min. exam that will be written in one of the two hour course periods on Friday, October 18, 2002.

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

Midterm Exam #2

This exam covers relevant material from Chapters 8 to 14 and 16 to 18, related topics presented in lecture, and relevant information from the experiments concerned with the SDS-polyacrylamide gel electrophoresis analysis of proteins.

This is a 100 min. exam that will be written in one of the two hour course periods on Friday, November 15, 2002 .

The value this exam contributes to the final grade is **30%**.

Metabolic pathways chart project.

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

It 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 Fall 2002 semester.

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 in February.

The value this exam contributes to the final grade is **40%**.

NB. There are no laboratory reports to be handed in after each experiment but students are responsible for the principles and practical aspects of the laboratory experiments. These are subject to examination on the midterm and final exams.

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. 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, Most 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, Biomolecular Buffering.

Amino Acids and the Primary Sequence of a Protein Chapter 3

Structure of Amino Acids, Ionization & pKa of Amino Acid Functional Groups, Peptide Bonds, Primary Protein Sequence, Protein Sequencing, Comparative Analyses of Protein Sequences.

Protein Structure & Function Chapter 4

Peptide bonds, Secondary, Tertiary and Quaternary Structures, Protein Folding and Stability, Protein Structure Function Relationships.

Enzymes Chapter 5

Classes of Enzymes, Enzyme Kinetics, Michaelis-Menton Equation, Enzyme Inhibition, 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 and Roles of Coenzymes and Vitamins.

Carbohydrates Chapter 8
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, The TCA (Krebs) Cycle, Regulation of TCA Cycle.

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

Electron Transport and Oxidative Phosphorylation Chapter 14
Introduction to Bioenergetics, The Chemiosmotic Hypothesis, Electron Transport, Oxidative Phosphorylation in Mitochondria, Malate-Aspartate Shuttle.

Lipid Metabolism Chapter 16
Dietary Fats and Health (Overview), Lipoproteins, Storage and Mobilization of Fatty Acids, Fatty Acid ⍵-Oxidation, Ketone Bodies, Fatty Acid, Phospholipids and Cholesterol Metabolism.

Amino Acid Metabolism Chapter 17
Nitrogen Assimilation, Synthesis of Nonessential and Essential Amino Acids, Amino Acid Catabolism, Urea Cycle.

Nucleotide Metabolism Chapter 18
Introduction to Nucleotide Metabolism, Purine Synthesis, Pyrimidine Synthesis, Salvage Pathways.

DNA Composition, Structure and Mapping Chapter 19
Introduction to Nucleic Acids, Nucleotides, Nucleosides, DNA Conformations, Supercoiling, Chromatin Structure; Nucleases, Restriction Endonucleases and Physical Mapping of DNA.

DNA Replication and Repair Chapter 20
DNA polymerase, DNA Replication, DNA Sequencing, DNA Repair

RNA Synthesis (Transcription) Chapter 21
Types of RNA, RNA polymerase, Promoter Sequences, Prokaryotic Transcription, Regulation of the *lac* Operon, Eukaryotic RNA Polymerases, Transcription and Processing.

Protein Synthesis (Translation) Chapter 22
The genetic code, tRNA Structure and Function, Anticodons, Shine-Dalgarno Sequences, Ribosome Function, Signal Sequences and Protein Secretion.

Recombinant DNA Technologies & Biotechnology Chapter 23
Basic molecular cloning strategies, PCR, Genomics, Biotechnology Applications.

Laboratory Schedule

Experiment 1 - **Purification of Proteins by Gel Permeation Chromatography**
Friday, September 13. (2 h)

Experiments 2 & 3 - **Purification of Proteins by Ion Exchange Column Chromatography & Affinity Column Chromatography**
Friday, September 27. (2 h)

Experiment 4 – **Determination of Protein Molecular Weight by SDS-PAGE**
Part 1 - Preparation of a Polyacrylamide Gel for the Separation of Proteins
Friday, October 11. (2 h)

Experiment 4 – **Determination of Protein Molecular Weight by SDS-PAGE**
Part 2 - Polyacrylamide Gel Electrophoresis (PAGE), and Staining of Gel
Friday, October 25. (2 h)

Experiment 4 – **Determination of Protein Molecular Weight by SDS-PAGE**
Part 3 – De-staining of Polyacrylamide Gel, and Analysis of PAGE Results
Friday, November 8. (2 h)

Experiment 5 – **PCR and Determination of the Size of a DNA Fragment**
Part 1 – Polymerase Chain Reaction (PCR), and the Formation of an Agarose Gel
Friday, November 22. (2 h)

Experiment 5 – **PCR and Determination of the Size of a DNA Fragment**
Part 2 – Agarose Gel Electrophoresis of PCR-Amplified DNA Fragment
Friday, November 29. (30 min)

Experiment 5 – **PCR and Determination of the Size of a DNA Fragment**
Part 3 – Staining of Agarose Gel, and Analysis of PCR Results
Friday, December 6. (2 h)