CAMOSUN COLLEGE	***School of Arts & Science*** ***CHEMISTRY AND GEOSCIENCE DEPARTMENT*** **CHEM 250-001** **Molecular Biotechnology** **2007W**

COURSE OUTLINE

This course covers fundamentals of molecular biotechnology and applications to drug, vaccine, and diagnostics development with emphasis on medical biotechnologies, industrial processing, and agrobiotechnology. Topics include gene expression systems, protein engineering, targeted tissue delivery, gene therapy, DNA diagnostics, recombinant DNA vaccines, fermentation, bioremediation, and intellectual property and regulatory issues. (T)

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The Approved Course Description is available on the web @
http://www.camosun.bc.ca/calendar/chem.php#250

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, 11:30 am to 12:00 pm & 1:30 pm to 2:00 pm
Tuesday, 11:30 am to 1:30 pm
Wednesday, 11:30 am to 12:00 pm
Friday, 1:30 pm to 2:30 pm

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

(c) Location Room 350A, Fisher Building, Lansdowne Campus

(d) Phone 370-3438

(e) E-mail jdoran@camosun.bc.ca

(f) Website http://www.camosun.bc.ca/schools/artsci/chemgeo/doran.php

2. Intended Learning Outcomes

Students successful in this course will be able to:

1. Students will be able to compare and align their relevant fundamental knowledge of biochemistry and chemistry with the applications of molecular biotechnology platform technologies in medical, veterinary, agricultural and environmental biotechnology.
2. Students will be able to evaluate the basic significance and future potential of molecular biotechnologies in clinical and veterinary medicine, laboratory and field-based diagnostic testing, nutrition and agriculture, and environmental biotechnology.
3. Students will be able to compare and contrast competitive diagnostics or therapeutics.
4. Students will be able to compare small-scale and large-scale gene expression systems.
5. Students will have obtained the basic vocabulary of molecular biotechnology.
6. Students will have the hands-on experimental skills that are fundamental to the utilization of recombinant DNA technology.
7. Students will have the ability to evaluate experimental design, design control experiments, and interpret data arising from basic recombinant DNA technologies.
8. Students will have the ability to conduct fundamental, computer-based analyses of DNA and protein sequence data using databases and programs available via the internet.
9. Students will be capable of working in a level-1 biosafety laboratory.
10. Students will be experienced in the preparation, handling and storage of many types of biochemical reagents and buffers.
11. Students will have the skills required to properly maintain a laboratory notebook as a verifiable record of experimental work.
12. Students will be able to compare the various forms of intellectual property protection relevant to the molecular biotechnology industry.
13. Students will be able to outline the variety of potential career paths in molecular biotechnology industries.

3. Required Materials

(a) **Text:** ***Molecular Biotechnology: Principles and Applications of Recombinant DNA.*** Third Edition, 2003. Au. Bernard R. Glick and Jack J. Pasternak. ASM Press, Washington, D.C.
This textbook is *required* for this course.
A copy of the textbook is available in the reserve library.

(b) **Experimental Procedures**

These will normally be provided prior to each laboratory session. Biosafety information will be provided in advance of any laboratory work with bacterial cultures.
Information on the proper maintenance of a laboratory notebook will be provided during the first laboratory period.

(c) ***General Materials and Supplies***

Students must familiarize themselves with the requirements for working properly in a level-one biosafety lab. This reading material will be provided.

Safety glasses: Safety glasses are required when handling hazardous chemicals or biochemicals. The students are required to provide 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, or handling bacterial strains. Students are required to provide their own lab coats. Students lacking lab coats when required will not be permitted to work in the laboratory. The lab coats must remain in the laboratory throughout the semester.

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 to protect valuable biochemicals from becoming degraded by enzymes from the skin.

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

4. Course Content and Schedule

Credits	4 credits	
	In-class workload	6 hours per week • There are three 50-minute lectures per week. • Three hours of experimental work is conducted during the four-hour lab & lecture time slot.
	Out-of-class workload	6 hours per week
	Number of weeks	14 weeks
	Pre- or Co-requisite	Chem 255 – Principles of Biochemistry

Course times and locations

Lecture times

Monday 12:30 PM to 1:20 PM in F358
Tuesday* 2:30 PM to 3:20 PM in F360/F358
Thursday 12:30 PM to 1:20 PM in F358

Laboratory/Lecture Periods*

Tuesday during the 2:30 to 6:20
Laboratory/Lecture Slot in F360/F358*

*Normally about 50 min of the almost four hour lecture/laboratory time period will be used for lecture.

Lecture Outline

I. Introduction

- Introduction to molecular biotechnology
  Basic sciences to platform technologies to applications.
- Sectors of the biotechnology industry
  The BC biotech industry

II. Intellectual property protection

- Patents, trade secrets, trademarks and copyright.

(Where appropriate, the material described below in sections III to V will be introduced in the course of conducting related experiments)

III. Molecular cloning & other recombinant DNA technologies

- review of gene structure, function and regulation
- plasmid cloning vectors
- cosmids, phagemids & bacteriophage-based vectors

- laboratory techniques for molecular cloning
    - DNA purification
    - restriction fragment digestion and ligation
    - transformation, transfection and electroporation
    - DNA amplification technologies

IV. Techniques for the characterization of cloned DNA
- screening and detection of cloned genes
    - Southern, colony, and plaque hybridization
    - autoradiographic, colorimetric & chemiluminescent detection
- physical mapping
    - restriction endonuclease mapping of DNA
- DNA sequencing
    - strategies for enzymatic (dideoxy) nucleotide sequencing
- transcriptional analysis
    - Northern hybridization
    - primer extension
    - reporter genes
- recognition of protein products
    - Western blotting (immunodetection)
    - phage display peptide library screening

V. Gene expression technologies
- prokaryotic expression systems
    - factors affecting gene expression
    - high-level expression systems
- eukaryotic expression systems
    - unicellular yeast systems
    - insect cell systems
    - cultured mammalian cells

VI. Recombinant vaccines
- attenuated vaccines
- subunit vaccines
- DNA vaccines
- heterologous vaccine expression systems
- economic (production and market) considerations
- strategies for the development of HIV vaccines

VII. Fermentation

(a site-visit to a fermentation facility may be involved)
- batch, batch-fed, and continuous fermentations
- large-scale fermentation systems
- cell harvesting and disruption, and downstream processing

VIII. Diagnostic molecular biotechnologies
- nucleic acid based diagnostics
    - gene probes
    - nucleic acid amplification-based technologies

DNA microarray technologies
RFLP analyses
forensic applications & genetic disease diagnosis

- immunodiagnostics
  agglutination-based strategies
  membrane-based immunodetection
  ELISA
  biosensor technology

IX. Molecular agrobiotechnology

- applications of transgenic plant technologies
  genetic engineering of nitrogen-fixing bacteria
  A. tumefaciens & Ti plasmid mediated gene transfer systems

  genetically engineered crop plants and forest trees
  plants as bioreactors
- applications of transgenic animal technologies (overview)
  relevance to agriculture and aquaculture
  novel protein production systems

X. Molecular biotechnologies for bioremediation

- genetically engineered organisms for biodegradation of environmental pollutants

XI. Biopharmaceuticals

- identification of new therapeutic targets
- genomics, proteomics and bioinformatics
- emerging therapeutics including iRNA
- combinatorial chemistries & drug design

XII. Technologies for drug delivery

- liposome-based systems
- microencapsulation
- virus-based systems
- targeted delivery

XIII. Strategies for gene or cell therapy

- nucleic acid therapeutic agents including antisense technologies
- concerns and potential human gene therapy
- emerging cellular approaches
- concerns and potential applications of stem cells

XIV. Regulatory, entrepreneurial, ethical and social issues

Laboratory Outline

The following scheme represents a continuous series of recombinant DNA experiments. Success in each experiment is required to continue to the next one. Prepare well, work carefully, be observant, ask lots of questions, and think.

1. Preparation of buffers, solutions and media. (Week 1)

2. 'Mini-prep' isolation of plasmid DNA (two methods)
(a) Rapid, small-scale isolation of plasmid DNA from bacterial cells.
(b) Restriction enzyme digestion assay.
(c) Agarose gel electrophoresis.
(d) Ethidium bromide staining, UV-transillumination and photography.

3. DNA Subcloning
(a) DNA ligation to form recombinant plasmids.
(b) DNA transformation of competent bacteria.
(c) Use of colorimetric, enzymatic, insertional gene-inactivation assay to visually select recombinant plasmids (blue-white selection).
(d) Plating of bacterial cells to obtain isolated colonies.
(e) Use of antibiotic-containing medium to select for transformed cells.

4. Physical Mapping of DNA
(a) Single and double restriction enzyme digestion.
(b) Molecular weight/size determination of linear DNA fragments using agarose gel electrophoresis.
(c) Physical mapping of DNA fragments by data analysis.

5. Southern Blot Analysis
(a) Southern transfer technique.
(b) Southern hybridization technique using nonradioactively-labeled probe.
(c) Detection of DNA hybridization.
(d) Interpretation of hybridization results.

6. DNA Amplification by the Polymerase Chain Reaction
(a) Performance of PCR reactions using a thermocycler.
(b) Analysis of amplified DNA using by agarose gel electrophoresis.

7. DNA Sequencing Techniques
(a) Techniques for pouring a DNA sequencing gels
(b) Dideoxy DNA sequencing reactions.
(c) Preparation and operation of a manual DNA sequencing apparatus (option).
(d) Handling of a DNA sequencing gel in preparation for autoradiography.
(e) Analysis of autoradiographs and data from automated DNA sequencing.

8. Bioinformatics: Computer Analyses of DNA and Protein Sequences
(a) Application of BLASTN, BLASTX and BLITZ, and similar software packages to analyze sequences by comparison to worldwide DNA and protein

data bases.

(b) Analysis of open reading frames (ORF's) for consensus sequences for transcription and translation (dependent on available software), and comparative protein sequence analyses by CLUSTAL W & similar software

5. Basis of Student Assessment (Weighting)

(a) Projects and Assignments (combined value) **45 %**

Assignment 1.	Biotechnology Industry Survey & Analysis	(7.5%)
Assignment 2.	Interpretation & Analysis of a Relevant Patent	(7.5%)
Assignment 3.	'Thinking Problem' (to be provided)	(7.5%)
Assignment 4.	Analysis of a Scientific Journal Publication	(7.5%)
Assignment 5.	DNA restriction mapping (using own data)	(7.5 %)
Assignment 6 -	Analysis of the scientific, regulatory, societal and ethical concerns of a high-profile area of biotechnology. (includes a round-table discussion)	(7.5%)

Assignment descriptions will be provided in a timely manner.

(b) Laboratory Performance & Lab Book Evaluation* **15 %**

The lab work is basically a continuation of experiments in recombinant DNA and associated technologies. There are no laboratory reports due to be handed in after each individual experiment. Notably, students will each maintain a laboratory notebook as they would if they were working in a biotechnology research laboratory. This lab book will be graded at the end of the course. Information provided by a biotechnology intellectual property/patent lawyer will be provided as the basis for keeping a proper lab book.

An outline of the detailed criteria for evaluation of lab performance will be provided.

There is no separate laboratory exam; however, students are responsible for the principles and practical aspects of the laboratory experiments. These are subject to examination on 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.

(c) Final Exam

The final exam is a comprehensive exam. 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.

6. Grading System

Standard Grading System (GPA)

Percentage	Grade	Description	Grade Point Equivalency
95-100	A+		9
90-94	A		8
85-89	A-		7
80-84	B+		6
75-79	B		5
70-74	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	*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 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	*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.

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

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 on the College web site in the Policy Section.

Materials will be provided during the course as indicated above.