



**Chemistry 250**  
**MOLECULAR BIOTECHNOLOGY**  
*Winter Semester, 2009*

**COURSE OUTLINE**

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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)

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.*

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**1. Instructor Information**

(a) Instructor    Jamie Doran, Ph.D.

(b) Office hours    Tuesday, 11:30 to 12:20 pm  
                          Thursday, 11:30 to 1:20 pm  
                          Friday, 12:30 am to 2:20 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 exam times.

(c) Location    Room 342C, Fisher Building, Lansdowne Campus

(d) Phone        370-3441

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

## 2. Intended Learning Outcomes

Students successful in this course will be able to:

- 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.
- 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.
- Students will be able to compare and contrast competitive diagnostics or therapeutics.
- Students will be able to compare small-scale and large-scale gene expression systems.
- Students will have obtained the basic vocabulary of molecular biotechnology.
- Students will have the hands-on experimental skills that are fundamental to the utilization of recombinant DNA technology.
- Students will have the ability to evaluate experimental design, design control experiments, and interpret data arising from basic recombinant DNA technologies.
- 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.
- Students will be capable of working in a level-1 biosafety laboratory.
- Students will be experienced in the preparation, handling and storage of many types of biochemical reagents and buffers.
- Students will have the skills required to properly maintain a laboratory notebook as a verifiable record of experimental work.
- Students will be able to compare the various forms of intellectual property protection relevant to the molecular biotechnology industry.
- Students will be able to outline the variety of potential career paths in molecular biotechnology industries.

### 3. Course 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. To a large degree, information sheets and protocols from suppliers and professional manuals will be provided as these are what exist in the biotech sector workplace. 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.

#### (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, 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. Students are required to provide their own calculators.

## 4. Course Content and Schedule

Credits	4 credits
In-class workload	6 hours per week <ul style="list-style-type: none"><li>• There are three 50-minute lectures per week.</li><li>• Three hours of experimental work is conducted during the four-hour lab &amp; lecture time slot.</li></ul>
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 9:30 AM to 10:20 AM in F358
	Tuesday* 2:30 PM to 3:20 PM in F360/F358
	Wednesday* 9:30 AM to 10:20 AM in F358

Laboratory/Lecture Periods*	Tuesday during the 2:30 to 6:20 <sup>‡</sup> Laboratory/Lecture Slot in F360/F358*
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\* Normally about 50 min of the almost four hour lecture/laboratory time period will be used for lecture. The timing depends upon the nature of the experimental work.

\*This lecture will be offered a second time in some weeks due to a course conflict.

<sup>‡</sup>The Tuesday afternoon period will be extended to 7:20 pm for folks who cannot arrive until 3:30 PM due to course conflicts.

### 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, other 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 (if time allows)

- (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 Article..... 7.5%
  - Assignment 5. DNA restriction mapping (using lab data)..... 7.5%
  - Assignment 6. Analysis of the scientific, regulatory, societal and ethical concerns of a high-profile area of biotechnology. (This may include a round-table discussion)..... 7.5%Assignments will be provided at appropriate times across the semester.

- (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 provide 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. All or any of these are potentially 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 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](http://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](http://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**

Textbook reading lists for each course topic will be provided.

A copy of the textbook is on reserve in the library.

Supplementary materials will be provided during 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, 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](http://www.camosun.bc.ca/divisions/pres/policy/2-education/2-5.html)