CAMOSUN COLLEGE	**School of Arts & Science** **CHEMISTRY AND GEOSCIENCE DEPARTMENT** **CHEM 250 - 001** **Molecular Biotechnology** **Winter 2012**

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.

The course description is online @ http://camosun.ca/learn/calendar/current/web/chem.html

Ω *Please note: the College electronically stores this outline for five (5) years only.*
*It is **strongly recommended** you keep a copy of this outline with your academic records.*
You will need this outline for any future application/s for transfer credit/s to other colleges/universities.

1. Instructor Information

Instructor:	David Stuss		
Office Hours:	Mon 14:30-15:20, Wed 12:30-14:20, Thu 12:30-13:20		
Location:	F344D		
Phone:	250-370-3506		
Email:	stussd@camosun.bc.ca		
Website:	http://camosun.ca/learn/programs/chem.html		

2. Intended Learning Outcomes

Upon completion of this course the student will be able to:

1. Compare and align their relevant fundamental knowledge of biochemistry and microbiology with the applications of molecular biotechnology platform in the medical, veterinary, agricultural and environmental sectors of the biotechnology industry.
2. 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. Obtain the basic vocabulary of molecular biotechnology.
4. Compare and contrast competitive diagnostics or therapeutics.
5. Compare and contrast small-scale and large-scale gene expression systems.
6. Have hands-on experimental skills that are fundamental to the utilization of recombinant DNA technology.
7. Evaluate experimental design, design control experiments, and interpret data arising from basic recombinant DNA technologies.
8. Conduct fundamental, computer-based analyses of DNA and protein sequence data using databases and programs available via the internet.
9. Work in a level-1 biosafety laboratory.
10. Prepare, handle and store many types of biochemical reagents and buffers.
11. Properly maintain a laboratory notebook as a verifiable record of experimental work.
12. Compare the various forms of intellectual property protection relevant to the molecular biotechnology industry.
13. Outline the variety of potential career paths in molecular biotechnology industries.

3. Required Materials

Text

Molecular Biotechnology: Principles and Applications of Recombinant DNA.
Auths . Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten.
Fourth Edition, 2010. ASM Press, Washington, D.C.

This textbook is required for this course. A copy of the textbook is available in the reserve library.

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 and 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.

Laboratory notebook — Students are required to supply standard black laboratory notebooks (available in bookstore) to record all experimental work.

Experimental Procedures

Relevant information will be provided prior to each laboratory session, primarily as information sheets and protocols from suppliers and professional manuals (similar to the workplace in the biotech sector).

Biosafety information will be provided in advance of any laboratory work with bacterial cultures.

Information on the proper maintenance of a laboratory notebook sufficient to meet the demands of intellectual property law will be provided.

4. Course Content and Schedule

Credits	4 credits		**Number of weeks**	14
Workload / week	3 h lecture 3 h lab 6 h study		**Pre- / Co-requisite**	CHEM 255

Course Locations & Times

	Time	Location
Lecture	Monday 9:30 – 10:20 PM Tuesday* 2:30 – 3:20 PM Wednesday 9:30 – 10:20 PM	Fisher Building, Rooms 358 / 360
Lab	Tuesday 3:30 – 6:20 PM	Fisher Building, Rooms 358 / 360

***** *Typically ~ 50 min of the ~4h lecture/laboratory time period will be used for lecture. The time of delivery of relevant lecture material depends upon the nature of the experimental work.*

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 and 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 characterizing 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 viruses
- Subunit vaccines
- DNA vaccines
- Heterologous vaccine expression systems
- Economic (production and market) considerations
- Strategies for the development of HIV vaccines

VII. Fermentation

- Batch, batch-fed and continuous fermentations
- Large-scale fermentation systems
- Cell harvesting, 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
- Application strategies

XI. Biopharmaceuticals

- Identification of new therapeutic products
- 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

- *Discussed throughout the course.*

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.

I. Preparation of buffers, other solutions, and media

II. 'Mini-prep' isolation of plasmid DNA (two methods)

- Rapid, small-scale isolation of plasmid DNA from *E. coli* using the Birnboim and Doly Alkaline Lysis Method.
- Rapid, small-scale isolation of plasmid DNA from *E. coli* using the QIAGEN mini-prep spin 'columns'.
- Agarose gel electrophoresis of purified plasmid DNA.
- DNA staining, UV-transillumination and photography.
- Analysis of plasmid DNA morphologies, and general analysis of AGE results.
- A_{260nm} -based DNA quantitation.

III. DNA Subcloning

- Restriction enzyme digestion of vector and target DNA.
- DNA ligation to form recombinant plasmids.
- DNA transformation of competent bacteria.
- Plating of bacterial cells on antibiotic-containing medium to select for isolated colonies of transformed cells.
- Use of colorimetric, enzymatic, insertional gene-inactivation assay to visually select recombinant plasmids (blue-white selection).

IV. Physical Mapping of DNA

- Single- and double-restriction enzyme digestion.
- Molecular weight/size determination of linear DNA fragments using agarose gel electrophoresis.
- Physical mapping of DNA fragments by data analysis.

V. Southern Blot Analysis

- Southern transfer technique.
- Southern hybridization using nonradioactively-labeled probe.
- Detection of hybridized DNA probes.
- Interpretation of hybridization results.

VI. DNA Amplification by the Polymerase Chain Reaction

- PCR analyses of cloned DNA fragments from recombinant clones.
- Optimization of PCR.
- Agarose gel electrophoresis analysis of amplified DNA to determine sizes of amplified, cloned DNA fragments.

VII. Bioinformatics: Computer Analyses of DNA and Protein Sequences

- Application of BLASTN, BLASTX, BLITZ and similar software packages to analyze sequences by comparison to worldwide DNA and protein databases
- Analysis of open reading frames (ORF's) for consensus sequences for transcription and translation (dependent on available software)
- Comparative protein sequence analyses by CLUSTAL W & similar software.

5. <u>Basis of Student Assessment (Weighting)</u>

(a) Projects and Assignments (6 x 7.5% each) 45 %

Assignment 1.	Biotechnology Industry Survey & Analysis
Assignment 2.	Interpretation & Analysis of a Patent
Assignment 3.	'Thinking Problem'
Assignment 4.	Analysis of a Scientific Journal Article
Assignment 5.	DNA restriction mapping (using lab data)
Assignment 6.	Analysis of the scientific, regulatory, societal and ethical concerns of a high-profile area of biotechnology (*May include a round-table discussion*)

Assignments will be provided at appropriate times during the semester.

(b) Laboratory Performance & Lab Book Evaluation 15 %

The lab work is a continual flow of experiments utilization recombinant DNA 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 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. Any or all 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. Reasons for missed labs must also be documented by email to the instructor.

(c) Final Exam 40%

The final exam is a comprehensive exam.
The time & location of the final exam will determined 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	Minimum level of achievement for which credit is granted; a course with a "D" grade cannot be used as a prerequisite.	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 E-1.5 at **camosun.ca** for 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, due to design may require a further enrollment in the same course. No more than two IP grades will be assigned for the same course. *(For these courses a final grade will be assigned to either the 3rd course attempt or at the point of course completion.)*
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.

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 the College web site in the Policy Section.

Students may not use recording devices in the classroom without the prior permission of the instructor. However, the instructor's permission is not required when the use of a recording device is sanctioned by the College's Resource Centre for Students with Disabilities in order to accommodate a student's disability and when the instructor has been provided with an instructor notification letter which specifies the use of a recording device. Recordings made in the classroom are for the student's personal use only, and distribution of recorded material is prohibited.