CAMOSUN COLLEGE	**School of Arts & Science** **CHEMISTRY AND GEOSCIENCE DEPARTMENT** **CHEM 250** **Molecular Biotechnology** **Winter Semester 2014**

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

(a)	Instructor:	Jamie Doran, Ph.D.
(b)	Office Hours:	Monday, 1:30 to 2:20 pm Tuesday, 11:30 to 1:20 Wednesday, 1:30 pm to 2:20 pm Thursday, 1:30 pm to 2:20 pm Friday, 1:30 pm to 3:20 pm Everyone is welcome whenever my office door is open. Appointments may be made to meet at other times. Office hours will be extended prior to test dates as desired.
(c)	Location:	Room 350C, Fisher Building, Lansdowne Campus
(d)	Phone:	(250) 370-3441
(e)	Email:	jdoran@camosun.ca

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 chemistry with the applications of molecular biotechnology platform technologies 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. *Utilize the basic vocabulary of molecular biotechnology.*
4. *Compare and contrast competitive diagnostics or therapeutics.*
5. *Compare 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 of 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

(a) Text

Introduction to Biotechnology. Third Edition. William J. Thiemann & Michael A. Palladino.
(Pearson Education Inc. 2013.)
This textbook is *required* for this course. A copy of the textbook is available in the reserve library.

Reference Text:
Molecular Biotechnology: Principles and Applications of Recombinant DNA.
Fourth Edition. Bernard R. Glick, Jack J. Pasternak & Cheryl L. Patten. ASM Press. 2010.
A copy of this textbook is available in the library.

(b) Other

In terms of experimental protocols and supporting information, relevant information will be provided prior to each laboratory session. To a large degree, information sheets and protocols from scientific suppliers and professional manuals will be provided as these are what exist in the workplace in the biotech sector.

Students *must* familiarize themselves with the requirements for working properly in a level-one biosafety lab. Biosafety information will be provided in advance of any laboratory work with bacterial cultures , drug-resistance encoding plasmids, and recombinant DNA.
Information on the proper maintenance of a laboratory notebook sufficient to meet requirements for intellectual property protection will be provided.

General Materials and Supplies

Safety glasses — Safety glasses are required when handling hazardous chemicals or biochemicals. Each student is required to provide her or his pair of safety 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 all experimental work in the laboratory. Each student is required to provide her or his own lab coat. *The lab coats must remain in the laboratory throughout the semester.* Students lacking lab coats will not be permitted to work in the laboratory.

Latex gloves — Latex or other '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, much more often, to protect labile biochemicals from contamination or potential degradation by enzymes from the skin.

Calculator — A scientific calculator is required at times in the laboratory, in lecture, and during tests and exams. Each student is required to provide her or his own scientific calculator. Cell phone- and tablet-based calculators cannot be used during tests or exams.

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 laboratory & lecture time period on Tuesdays.
Out-of-class workload	6 hours per week
Number of weeks	14 weeks
Pre-requisite	Chem 121 - College Chemistry 2
Pre- or Co-requisites	Chem 230 - Organic Chemistry 1 Chem 255 - Biochemistry

Course times and locations

Lectures

Monday, 9:30 AM - 10:20 AM
Fisher Building, Rooms F360/358

Tuesday, 2:30 AM - 3:20 AM
Fisher Building, Rooms F360/358

Wednesday, 9:30 AM - 10:20 AM
Fisher Building, Rooms F360/358

Laboratory Experiments

Tuesday, 3:30 AM to 6:20 PM
Fisher Building, Rooms F360 & F358

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
- basic laboratory techniques for molecular cloning
  - DNA purification & characterization
  - restriction fragment preparation & 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 DNA mapping
  - restriction endonuclease mapping of DNA
- DNA sequencing
  - strategies for enzymatic (dideoxy) nucleotide sequencing
- transcriptional analysis
  - Northern hybridization
  - reporter genes
  - SAGE
  - microarray-based analyses (please see below)
- 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

VII. Fermentation
- batch, batch-fed, and continuous fermentations
- large-scale fermentation systems
- cell harvesting and downstream processing

VIII. Diagnostic molecular biotechnologies
- nucleic acid based diagnostics
  - gene probes
  - nucleic acid amplification-based technologies
  - DNA & RNA 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
  - *Agrobacterium 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 and other microbes and plants
- biodegradation of environmental pollutants including xenobiotics
- strategies for application

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
(These sorts of issues will be addressed throughout the course.)

Laboratory Outline

Please thoroughly read the experimental protocol(s) in preparation for each experiment.

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 always be thinking.

1. **Preparation of buffers, other solutions, and media.**
(Please note the laboratory work begins in Week 1)

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

3. **DNA Subcloning**
(a) Restriction enzyme digestion of vector and target DNA.
(b) DNA ligation to form recombinant plasmids.
(c) DNA transformation of competent bacteria.
(d) Selection of isolated colonies of transformed cells.
(e) Use of colorimetric, enzymatic, insertional gene-inactivation assay to visually select recombinant plasmids (blue-white selection).

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

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

6. **DNA Amplification by the Polymerase Chain Reaction**
(a) PCR analyses of cloned DNA fragments from recombinant clones.
(b) Optimization of PCR.
(c) Agarose gel electrophoresis analysis of amplified DNA to determine sizes of amplified, cloned DNA fragments.

7. **Bioinformatics: Computer Analyses of DNA and Protein Sequences**
(a) Application of BLAST and related and similar programs to DNA analyze sequences by comparison to worldwide sequence and literature data bases.
(b) Analysis of DNA sequences for open reading frames (ORF's) and for consensus sequences for transcription and translation.
(c) Comparative protein sequence analyses by CLUSTAL W & similar software.

8. **qPCR DNA Amplification and Target Quantification***
(a) Understanding of instrument operation
(b) RT and qPCR reactions
(c) Determination of the number of original target RNA molecules
* dependent upon reagent availability

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 Patent…….. .7.5%
Assignment 3.	'A Purely Thinking Problem in Biotechnology' …….. 7.5%
Assignment 4.	Analysis of a Scientific Journal Article in Biotechnology…… 7.5%
Assignment 5.	DNA restriction mapping (using lab data)…… 7.5%
Assignment 6.	Start-up & operation of new instrumentation in qPCR…….. 7.5%

Assignments or projects will be conducted at appropriate times during the semester.

(b) Laboratory Performance & Lab Book Evaluation (combined value, 15%)

The lab work is a continual flow of experiments utilizing recombinant DNA and related 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, and accounts for 7.5% of the final grade. Information provided by a biotechnology intellectual property lawyer will provide the basis for keeping a proper lab book. There is no separate laboratory exam; however, students are responsible for the principles and practical aspects of the laboratory experiments. 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.

Laboratory performance accounts for 7.5% of the final grade. An outline of the detailed criteria for evaluation of lab performance will be provided.

(c) Final Exam

The final exam is a comprehensive exam that includes components from the laboratory section of the course. 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. *(Please note that the exam time and date cannot be changed to accommodate vacation or similar personal plans.)*

Attendance at the final exam is mandatory. Appropriate documentation must accompany any explanation for absence if an incomplete grade (I grade) is warranted.

(d) Other

Laboratory Experiments

Attendance in the lab periods is mandatory. No laboratory experiment can be missed without an acceptable reason submitted in writing, such as a proper letter from a Medical Doctor.

Please come to each lab period prepared for the experiment. Read the introductory material and create a flow sheet for the laboratory protocol(s) to be conducted.

There are no laboratory reports due for the experiments but *students are responsible for understanding the principles, technical bases, and results of each experiment*. <u>These aspects of the laboratory work will be subject to examination on the term tests and the final exam.</u>

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

Textbook reading lists for each course topic will be provided. Supplementary materials will be provided during the course. The textbook includes website learning support, and practice problems. A copy of the textbook is on reserve in the library. An extensive reference text is available in the general library.

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.

Please Note:
Students may not use recording devices in the classroom without the prior permission of the instructor or DRC. The instructor's permission is not required when the use of a recording device is sanctioned by the College's Disabilities Resource Centre for Students 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.