Virginia Western Community College
BIO 252
Nucleic Acid Methods

Prerequisites
One semester of college biology (BIO 101 or BIO 173); completion of CHM 111 is recommended.

Course Description
Introduces students to concepts and skills related to the understanding and application of nucleic acid structure and function. Prepares students to apply knowledge to real-world questions and applications utilizing advanced laboratory skills needed for employment in the field of biotechnology. Focuses on laboratory techniques including solution chemistry, cell culture, and DNA and RNA extraction and analysis. Additional skills include lab safety, proper laboratory documentation, quality control, and the use of Standard Operating Procedures (SOPs).

Semester Credits: 4 Lecture Hours: 3 Lab/Clinical/Internship Hours: 3

Required Materials

Textbook:
From Genes to Genomes: Concepts and Applications of DNA Technology. 3rd edition. von Schantz and Plant. Wiley. ISBN: 9780470683859

Other Required Materials:
Molecular Biology Techniques: A Classroom Laboratory Manual. Carson, Miller, and Witherow. Academic Press. ISBN: 9780123855442
Lab Coat
Lab Notebook

Course Outcomes

At the completion of this course, the student should be able to:

- Explain and understand the selection and interpretation of primary scientific literature.
- Effectively communicate scientific findings (both written and orally) and relate these findings to the greater whole (eg: social, ethical, or academic issues)
- Articulate knowledge of key concepts in molecular biology (e.g. transcription/translation, gene expression, role of DNA and RNA, recombinant DNA technology theories)
- Demonstrate knowledge of key concepts, including applications and limitations of each technology, related to nucleic acids including, but not limited to:
    1. Transformations
    2. DNA and RNA isolation and purification
    3. cDNA synthesis

4. Gel Electrophoresis
5. Immunocytochemistry
6. PCR and modifications to PCR (e.g. reverse-transcription PCR, qPCR)
7. Sequencing (e.g. Sanger, next-generation)
8. RNA based technologies (e.g. RNAi, CRISPR-Cas9)
9. Bioinformatics

- Appreciate the variety of recombinant nucleic acid techniques available and demonstrate knowledge of this information through experimental design
- Demonstrate workplace awareness and readiness as indicated through personal behavior (e.g. timeliness, collegiality, ability to work in a group, etc.)
- Exhibit an appreciation, enthusiasm, and interest for biotechnology and/or laboratory science

Following completion of the laboratory component of this course, the successful student will be able to demonstrate/perform:

- Identification of key pieces of laboratory equipment (e.g. centrifuges, electrophoresis equipment, thermocycler, incubator, microplate reader)
- Knowledge of basic laboratory math, including significant figures, unit conversions, dilutions, and other necessary techniques.
- Solution preparation and pH measurements
- Proper pipetting technique and accurate measurement of small (microliter) volumes
- Proper aseptic technique
- Knowledge of prokaryotic and eukaryotic cell culture
- Key steps related to bacterial transformations (e.g. plasmid preparation, restriction digests and vector preparation, DNA ligation)
- DNA and RNA isolation, purification, and measurement/visualization techniques (e.g. gel electrophoresis, PCR, immunocytochemistry)
- Utilization of bioinformatic techniques (e.g. BLAST, sequence mapping and gene annotation, genomic editing)
- Troubleshoot an experiment and develop alternative options (if necessary) for experimental design.
- Ability to generate professional and accurate written materials (e.g. lab notebook, report, poster) to document his/her laboratory work.

Topical Description

Topics	Chapter
I. Basics of Biotechnology	1
A. Advent of the Biotechnology Revolution	
B. Chemical Structure of Nucleic Acids	
C. Packaging of Nucleic Acids	
D. Model Organisms	

II. DNA, RNA, and Protein 2
- A. Central Dogma and Gene Expression
- B. Prokaryotic Transcription
- C. Eukaryotic Transcription
- D. mRNA Processing

III. Recombinant DNA Technology 3
- A. DNA Isolation and Purification
- B. Restriction Enzymes and Electrophoresis
- C. Methods for Detection of Nucleic Acids
- D. Hybridization
- E. Cloning and Expression Vectors
- F. DNA Libraries

IV. DNA Synthesis in vivo and in vitro 4
- A. Prokaryotic and Eukaryotic DNA Replication
- B. Chemical Synthesis of DNA
- C. PCR and its Modifications
- D. Reverse Transcriptase PCR

V. RNA based Technologies 5
- A. Antisense RNA
- B. RNAi
- C. Other RNA Technologies

VI. Genomics and Gene Expression 8
- A. Genetic Mapping
- B. Sequencing
- C. Microarrays
- D. Bioinformatics
- E. Genetic Evolution
- F. Pharmacogenetics

VII. Transgenic Organisms 14/15
- A. Plant tissue culture
- B. Cre/loxP Systems
- C. Transgenic Plants
- D. Food Safety
- E. Knock-out Organisms
- F. Transgenes and transgene expression
- G. Genetically Modified Organisms
- H. Transgenic Applications

VIII. Applications of Biotechnology-As time permits at the discretion of the instructor

A. Nanobiotechnology 7
B. Environmental Biotechnology 12
C. Gene Therapy 17
D. Cancer Biology 18
E. Biowarfare and Bioterrorism 23
F. Forensic Biology 24
G. Bioethics 25

Suggested Laboratory Topics

1. Introduction to Laboratory Safety/Pipetting
2. Making Solutions and Basic Laboratory Math
3. Aseptic Technique/Bacterial Cell Culture
4. Bacterial Transformations
5. Eukaryotic Cell Culture
6. DNA Extraction and Purification
7. PCR
8. Gel Electrophoresis
9. Sequencing and Bioinformatics
10. RNA Extraction and Purification
11. cDNA Synthesis
12. qPCR
13. Immunocytochemistry
14. Independent Project

Notes to Instructors

- Syllabus should state what the course grade will be based on, such as tests, quizzes, a comprehensive final exam, and any other assignments made by the instructor.
- The VWCC Biology Department uses a 10 point grading scale.
- A comprehensive final practical will be given at the end of the semester.
- Comprehensive study of the listed topics is beyond the reasonable expectations of a 15-week Protein Applications course. It is up to the discretion of the instructor to choose which topics are more detailed but each topic should be adequately covered.