

COMMUNITY COLLEGE BIOTECHNOLOGY PROGRAMS

September, 2001



The University of New Mexico

BUREAU OF BUSINESS AND ECONOMIC RESEARCH
The University of New Mexico

COMMUNITY COLLEGE
BIOTECHNOLOGY PROGRAMS

September, 2001

BUREAU OF BUSINESS AND ECONOMIC RESEARCH
The University of New Mexico

COMMUNITY COLLEGE BIOTECHNOLOGY PROGRAMS

In this section we take a look at established Biotechnology programs at various community colleges around the country. There was quite a large selection to choose among, and we chose what we believed to be a fair representation. Our choices were: Austin Community College, Austin, Texas; Lakeland Community College, Kirtland, Ohio; Lansing Community College, Lansing, Michigan; Shoreline Community College, Bothell, Washington, and The New Hampshire Community Technical College System, New Hampshire.

Each profile contains a short description of the college. The program requirements for the associates (two-year) degree are listed. Several of the colleges also offer a one-year program leading to a certificate. However, we did not list the requirements for the certificate. We also listed course descriptions for the Biology and Biotechnology courses.

LAKELAND CC
KIRTLAND, OHIO
(<http://www.lakeland.cc.oh.us>)

Lakeland Community College is located in Kirtland, Ohio, about 30 miles from Cleveland. It is a public institution, dedicated to providing quality education at reasonable cost to the surrounding area, offering transfer programs emphasizing the arts and sciences, technical programs preparing students for employment at paraprofessional levels, and community service programs designed to meet the needs of the college's service district through educationally related cultural and personal enrichment offerings.

Lakeland offers numerous technology oriented courses of study, including Biotechnology Science. The Bioscience Technology program prepares students for entry-level laboratory technician positions in research and industrial laboratories engaged in biotechnology. Graduates may choose career paths in medical, pharmaceutical, agricultural, environmental, or forensic science industries, as well as basic biological research. The program emphasizes hands-on training utilizing industry standard equipment to perform both routine and specialized experimental techniques. Students become adept in macromolecular separation and characterization, genetic manipulation, cell culture, and microbial growth control. Fundamental laboratory skills such as documentation, reagent preparation, safety, troubleshooting, good laboratory practice (GLP), and good manufacturing practice (GMP) are stressed. Prospective students must earn a grade of "C" in Elementary Chemistry and Intermediate Algebra prior to enrolling.

CURRICULUM

First Semester:

Introduction to Bioscience Technology
Bioscience Lab Skills
Principles of Biology I
General Chemistry I

Second Semester:

Introduction to Biochemistry
Microbiology
General Chemistry II
English Composition I
Introduction to Personal Computers

Summer:

Advanced Molecular Separations
Applied Microbiology

Elective

Third Semester:

Recombinant DNA Technology
Bioscience Manufacturing Processes
English Composition II
Electives

Fourth Semester:

Bioscience Seminar
Fundamentals of Public Speaking *or* Fundamentals of Interpersonal Communication
Tissue Culture
Internship

COURSE DESCRIPTIONS

Introduction to Bioscience Technology

This course introduces students to the field of biotechnology. The course addresses applications of biotechnology to the medical, agricultural, environmental and chemical industries. Discussions will include the safety, ethical, regulatory, and proprietary issues of the application of biotechnology to industry and health care.

Bioscience Lab Skills

This course introduces students to the fundamental knowledge and techniques associated with the operation of a laboratory engaged in biotechnology. The course includes the instruction and application of laboratory mathematics, biostatistics, good laboratory practice, and laboratory safety. Students will record the procedures, data, and analysis of laboratory activities. Students will learn experimental techniques, including reagent preparation, cell culture, filtration, centrifugation, spectroscopy, and microscopy.

Introduction to Biochemistry

This course introduces students to the chemistry of biological systems. It emphasizes the chemical structures, regulation, biological roles and metabolism of proteins, nucleic acids, carbohydrates, and lipids. Laboratory exercises will focus on basic techniques of isolation and characterization of biomolecules, including separation, chemical reactivity, and kinetics. Students will record experimental procedures, data, and interpretations.

Advanced Molecular Separations

This course includes specialized study of the theory and methodology of the separation and some subsequent characterization of biomolecules. Chromatographic techniques discussed and employed will include affinity, thin layer, paper, gas, ion exchange, and High Performance Liquid Chromatography (HPLC). The course emphasizes separation and specific identification of proteins. Students will record experimental procedures, data, and interpretations.

Applied Microbiology

This course advances the student's knowledge of microbial metabolism and genetics, with an emphasis on biotechnological applications. Students will manipulate cell growth conditions experimentally for native and genetically altered microbes. The course also covers the genetics of microbial viral pathogens (phage). Students will record experimental procedures, data, and interpretations

Tissue Culture

This course introduces students to the establishment, maintenance, characterization, and storage of eukaryotic cell cultures. In the laboratory, students will prepare media, manipulate cells using aseptic technique, characterize ectopically expressed gene products, and catalog cell cultures. The course also addresses monoclonal antibody production. Students will record experimental procedures, data, and interpretations

Recombinant DNA Technology

This specialized course includes the basic genetics and technical aspects of introducing foreign and native genes into organisms. The course also addresses molecular diagnostics for health care, forensic science, and research purposes. In the laboratory, the students will isolate, characterize, manipulate, and clone nucleic acids. The course emphasizes record-keeping and good laboratory practice.

Bioscience Manufacturing Processes

This course introduces students to the principles and techniques of fermentation and bioprocessing. Laboratory experiments will include food and beverage fermentations; microbial fermentations yielding specific products such as antibiotics or amino acids; and product formation using isolated enzymes. This course also examines the economics and operational factors encountered when producing microbial by-products on an industrial scale. Students will record experimental procedures, data, and interpretations.

Internship

This specialized course provides students with supervised practical experience in an academic or industrial laboratory engaged in biotechnology. The internship integrates the student's bioscience knowledge and laboratory skills, acquired within the core coursework of the Bioscience Technology program, with job experience representative of an entry-level Bioscience laboratory technician position.

Bioscience Seminar

This course is a specialized topical course providing students a venue to discuss internship issues, as well as recent biotechnology innovations. The course discusses such issues as non-proprietary internship experiences relating to laboratory practices, governmental regulations, and ethics.

LANSING COMMUNITY COLLEGE
LANSING, MI
(<http://www.lansing.cc.mi.us>)

Lansing Community College is located in Lansing, MI. In 1988 the Science Department at Lansing, in consultation with faculty at Michigan State University, developed a 2-year curriculum leading to an Associate of Applied Science Degree in Molecular Biotechnology.

CURRICULUM

First Semester

Cell Biology
General Chemistry Lecture I
General Chemistry Laboratory I
College Algebra *or* College Algebra and Trigonometry

Second Semester

General Chemistry Lecture II
General Chemistry Laboratory II
Composition I
Dynamics of Communication
Elective

Third Semester

Molecular Biology I
Organic Chemistry Lecture
Composition II
Introduction to Sociology
Elective

Fourth Semester

Molecular Biology II
Organic Chemistry Lecture II
Organic Chemistry Laboratory
Elective

Electives

Organismal Biology
Microbiology (3-lecture course)
Microbiology Laboratory
Introduction to Computers
Introductory Physics I
Internship in Science Technology

COURSE DESCRIPTIONS

Cell Biology

Lecture topics include chemistry of carbohydrates, lipids and proteins; structure and function of prokaryotic and eukaryotic cells; biochemistry of respiration and photosynthesis; and genetics and the regulation of gene expression. Laboratory stresses techniques of cell and molecular biology as well as genetics.

Organismal Biology

This course examines adaptations of organisms to changing environments. Major emphasis is on physiological adaptations, natural selection, ethology, and ecology. Aquatic systems are examined in the laboratory; sampling techniques and statistical methods are used to analyze a local river.

Molecular Biology I

Introduces basic principles of molecular biology, DNA/RNA structure, function and replication, Polymerase Chain Reaction, and recombinant DNA technology. Laboratory emphasizes reagent preparation, culturing bacteria, isolating and purifying both bacterial and plasmid DNA, restriction enzyme digests of DNA, and agarose gel electrophoresis analysis of DNA. Field trip to research laboratories.

Molecular Biology II

Advanced lecture topics in bacteriophage biology, gene analysis, gene sequencing, and applications of molecular biotechnology. Gene cloning experiments with lambda bacteriophage and plasmid vectors, Southern hybridizations, and construction of a genomic library of lambda phage DNA.

General Chemistry Lecture I

The first of two semester courses designed to provide an in-depth introduction to general chemistry for students who plan careers in the health professions, physical sciences, biological sciences, or engineering. Topics discussed include measurement, aqueous reactions, stoichiometry, thermochemistry, atomic structure, bonding, and acids and bases.

General Chemistry Lecture II

The second of two semester courses designed to provide an in-depth introduction to general chemistry for students who plan careers in the health professions, sciences, or engineering. Topics include kinetics, ionic equilibria, thermodynamics, electrochemistry, descriptive chemistry, and nuclear chemistry.

General Chemistry Laboratory I

Laboratory course designed to complement CHEM 151. Stresses basic laboratory techniques, writing lab reports, and critical thinking exercises. Topics include density determination, synthesis, empirical formulas, molecular geometry, gas laws, pH and water hardness.

General Chemistry Laboratory II

This is the second semester general chemistry laboratory course. The main focus of the course is inorganic synthesis and analysis.

Organic Chemistry Lecture I

The first lecture course of a two-semester sequence in organic chemistry for chemical engineering, chemical technology, chemistry, or preprofessional majors. Topics include structure and bonding, hybridization, nomenclature, stereochemistry, thermodynamics and kinetics of organic reactions, functional groups including reactions and mechanisms, and applications of mass spectrometry.

Organic Chemistry Lecture II

Topics include aromatic compounds, spectroscopy, organometallic compounds, aldehydes and ketones, carboxylic acids and their derivatives, amines, enolates, phenols, carbohydrates, polymers, and proteins.

Internship in Science Technology

This course provides on-the-job training for an applied degree in science technology. Placement is made at an approved training site to earn credits for satisfactory work performance. This internship may be a paid or unpaid work experience. Students will apply knowledge and skills learned in academic courses to real world situations.

Microbiology

An introduction to bacteria, viruses, and other microorganisms as they relate to human health. Emphasis on bacterial and viral structure, life cycles, and genetics; antimicrobial therapy; immunology and host defenses; and the epidemiology, treatment, and prevention of selected infectious human diseases.

Microbiology Lab

Basic laboratory principles of microbiology for allied health students. Emphasis on microscopy, aseptic cultivation of microorganisms, differential staining, assays of antimicrobial agents, and diagnostic laboratory techniques. Students will identify unknown bacterial species and examine medically important parasites.

SHORELINE COMMUNITY COLLEGE
BOTHELL, WASHINGTON
(<http://www.shore.ctc.edu/shoreline/>)

Shoreline Community College is located in Bothell, Washington, just north of Seattle. Seattle has a strong biotechnology sector. The College offers transfer, professional/technical, basic skills and continuing education programs to over 12,000 full- and part-time students. It lists 50 degree and certificate professional/technical education programs, including health, business, automotive & manufacturing technology, education and human services, criminal justice, science-related technology, visual communications technology and music technology.

Shoreline's Biotechnology Specialist program offers both a two-year Associate in Applied Arts and Sciences degree and a one-year Certificate of Proficiency for those with a science background.

CURRICULUM

Fall Quarter, First Year

English Composition *or* Professional Communications
Principles of Biology
Multicultural Issues

Winter Quarter, First Year

General Chemistry
Survey of Plant & Animal Kingdoms *or* Anatomy & Physiology
First Aid & Personal Safety
Business Computer Applications

Spring Quarter, First Year

Basic Organic Chemistry
Introduction to Probability & Statistics
Topics in Microbiology
Human Relations

Summer Quarter, First Year

Media & Solution Preparation

Fall Quarter, Second Year

Gravimetric & Volumetric Methods
Molecular Biology

Winter Quarter, Second Year

Electrical, Optical and Chromatographic Methods.

Recombinant DNA Techniques

Spring Quarter, Second Year

Electrical, Optical and Chromatographic Methods.

Immunology

Biotechnology Techniques

Biotechnology Seminar

Summer Quarter, Second Year

Tissue Culture & Stain

Internship

COURSE DESCRIPTIONS

Principles of Biology

Examines the cell as the basic unit of life. Topics covered include: cellular activities, reproduction, development, as well as the genetics of individuals and populations. For life science majors and allied health students. Laboratory.

Survey of Plant and Animal Kingdoms

Survey of the plant and animal kingdoms. The goal of the course is to give the student an understanding and appreciation for the vast diversity of living things, their special adaptations to their environment and their evolutionary and ecological relationships.

Introduction to Human Anatomy and Physiology

Introduction to the systems of the human body. Structures and functions of these systems will be stressed along with unifying principles such as nutrition, sex, genetics, environment, exercise and the aging process.

Topics in Microbiology

Principles necessary to understand the importance of microorganisms in medicine, the environment and industry. Includes the disease process and immunology. Laboratory includes cultivation, identification and control of selected microorganisms.

Solution and Media Preparation

Laboratory course in preparation of solutions and media commonly used in the biotechnology industry. Preparation of solutions with varying concentrations of one to many chemicals, putting these chemicals into solution under the appropriate conditions and sterilizing and adjusting pH's as necessary. Media typically used in biotechnology and microbiology laboratories will be prepared according to protocols, autoclaved and poured for use. Problem sets will be completed by students to assure correct calculations necessary for these preparations.

Molecular Biology

This course will focus on DNA replication, transcriptional and translational, and regulatory mechanisms in prokaryotic and eukaryotic systems.

Recombinant DNA Techniques

Basic course in the theory and concepts of recombinant DNA techniques. Course will focus on the methods of gene cloning with bacteriophage and plasmid vectors, growth and maintenance of *E. coli*, extraction and purification of DNA, polymerase chain reaction, southern blots, probe preparation, hybridization methods, and DNA sequencing. The lab will focus on “hands on” techniques.

Immunology

Concepts and laboratory procedures necessary to understand basic immunology which includes antigen and antibody structure and function, the genetic basis of antibody production, humoral and cellular based immunity, role of the major histocompatibility complex, control mechanisms, autoimmunity, innate and acquired immunity. Laboratory includes immunoassays using dot blots and ELISA (Enzyme Linked Immunosorbent Assay) and immunoaffinity purification.

Biotechnology Techniques

A laboratory course which will focus on the techniques currently prevalent in the manufacturing and production aspect of the biotechnology industry. Course will focus on the isolation and purification of proteins. This will include cation-anion exchange chromatography, selective binding using hydrophobic interactions, ultrafiltration, isoelectric focusing and high performance liquid chromatography (HPLC). There will also be exposure to good manufacturing practices (GMP), quality control procedures (QC), biological potency assays, radioisotope use and handling, FDA regulations and clinical trials.

Solution and Media Preparation

Laboratory course in preparation of solutions and media commonly used in the biotechnology industry. Preparation of solutions with varying concentrations of one to many chemicals, putting these chemicals into solution under the appropriate conditions and sterilizing and adjusting pH's as necessary. Media typically used in biotechnology and microbiology laboratories will be prepared according to protocols, autoclaved and poured for use. Problem sets will be completed by students to assure correct calculations necessary for these preparations.

Internship

This course is a cooperative education experience that provides students with work experience in the biotechnology industry.

Seminar in Biotechnology

This course will include speakers from the biotechnology industry, field trips to biotechnology laboratories, special topics such as radiation safety, quality control, resume writing and interviewing and discussion and presentation of journal articles.

NEW HAMPSHIRE COMMUNITY TECHNICAL COLLEGE SYSTEM
(<http://www.nhctcs.tec.nh.us/>)

The New Hampshire Community Technical College System is a consortium of seven community colleges distributed throughout the state. In the Fall of 1991, a state-wide committee composed of members from industry and education came together in order to determine the extent of the biomedical and biotechnology industry in New Hampshire, its potential for growth, and the existence of educational programs to support the biomedical/biotechnology industry as it matured through the end of this century.

One observation made in the Fall of 1991 was that entry-level biotechnology education and training programs did not exist anywhere in New Hampshire (or in Maine or Vermont), so it was decided that the New Hampshire Technical College System should offer such a program, although the location of the program was not envisioned at the time. In the Fall of 1993, the first round of Advanced Technology Education grants from the National Science Foundation were announced. These new grants were offered by NSF for the purpose of encouraging the development of high tech programs at two year colleges in the United States. A grant to fund the equipping of a biotechnology wet-lab and teaching/independent student learning center was submitted entitled, "The New Hampshire Biotechnology Technician Education and Training Center". An \$80,000 equipment grant was awarded in July 1994 with the state of New Hampshire matching the NSF dollars and providing funds to construct the lab at the New Hampshire Technical College-Stratham/Pease Center.

Depending upon a persons academic background and work experience, the Biotechnology technician-in-training may enter one of three programs: the two semester Biotechnology Certificate (10 credits), the one year Biotechnology Diploma (33 credits), or the two year Biotechnology Associate in Science Degree (65 credits). All programs are united by the requirement of the biotechnology cornerstone courses: Biotechnology Experience I: Research (5 credits) and Biotechnology Experience II: Manufacturing (5 credits). The cornerstone courses are offered in the fully equipped state-of-the-art benchtop biotechnology research, development, and manufacturing laboratory with its associated teaching and independent student learning center containing computers and peripherals and a lending library of books, journals, videotapes, and CD-ROM's. New Hampshire Technical College's Biotechnology Programs have been developed with the Bioscience Industry Skill Standards in mind so that graduates have the necessary skills, knowledge, and attributes to allow them to go to work immediately upon graduation and to advance rapidly with on-the-job experience and continued academic training provided by the industry.

CURRICULUM (Associate Degree)

First Semester

Introduction to Computers
General Chemistry 1
Intermediate Algebra
College Composition
General Biology I

Second Semester

Writing Technical Documents
Social Science Elective
General Chemistry 2
General Biology
Microbiology

Third Semester

Bioethics
Organic Chemistry
Laboratory Animal Science
Biotechnology Experience: Research

Fourth Semester

Elective
Probability and Statistics
Biotechnology Experience: Manufacturing

COURSE DESCRIPTIONS

Biotechnology Explorations

Biotech Careers: Inside Out, The Story of Human Insulin, Discovery Research, Process Development, Biology's Central Dogma, The Central Dogma, Illustrated, DNA, RNA, Protein, The Commercialization of Biopharmaceuticals, Today's Biotechnology Product: Protein Biopharmaceuticals, How Biopharmaceuticals are Produced,

Biotechnology Experience I

Models, Discovery, Research, Genomics, Bioinformatics, Process Development: the Next Step, Bioprocessing Overview, Bioprocessing: The Biomanufacturing of Protein Therapeutics and Vaccines, Upstream Processing, Downstream Processing, The FDA and the Biopharmaceutical Industry.

Biotechnology Experience I

Models, cGMP Bioprocessing, Bioprocessing, Offshoots from the Core of the Industry, DNA Forensics, Diagnostics, The Business of Biotech, Environmental Biotechnology.

Bioethics

This course discusses the major issues (ethical, legal and societal) that plague biotechnology today. Biotechnology encompasses a huge area of scientific knowledge, from manipulating genes to cloning.

Bioethics is the study of the legal and ethical aspects of biology and medicine. The bioethical issues include many topics that include what to do at the end of life, what to do with frozen embryos and who will get the results of genetic testing and many more. The problems are endless. Aside from being current and interesting, these problems will be the problems you will face in your future lives. You the consumers of these new technologies.

During the 15 weeks of this course we will be analyzing cases, doing readings, questioning our own values and morals, arguing opinions and learning new cases. These topics are interesting, thought provoking and fun. This course will allow you to look at topics that you have seen on television, read about in newspapers and wondered about.

The objectives of this course are:

- articulate relevant ethical principles, values, virtues and approaches and apply them to cases
- reason in a self-reflective way about ethical issues that relate to biotechnology
- find and utilize ethics literature and other resources, primarily web sources
- analyze new cases and dilemmas, having developed lifelong learning practices
- synthesize information into a framework
- communicate the information
- work with other members of the group
- know how to find allies in dealing with problems

AUSTIN COMMUNITY COLLEGE
AUSTIN, TX
(<http://www.austin.cc.tx.us/>)

Austin Community College, located in high-tech Austin, Texas. It has programs for general education (university transfer), workforce development, customized training for businesses, continuing education and developmental education. Annual enrollment is in excess of 60,000.

The Austin Biotechnology Program offers both a two-year Associate in Applied Science degree and a one-year certificate option. The former provides biotechnology experience with general education courses in the arts and sciences and is designed to prepare persons for working in medical, research and industrial laboratory areas, while the latter prepares students to function as entry-level biotechnicians in the laboratory or in biotechnology manufacturing..

CURRICULUM

Semester I

Introduction to Biotechnology
Cellular and Molecular Biology
General Chemistry I
English Composition II *or* Business English: Intro to Technical Writing
College Algebra

Semester II

Biotechnology Lab Methods/ Techniques
General Chemistry II
Quality Assurance for the Biosciences
Personal Computing *or* Introduction to Computing

Semester III

Science/Math. Technology Elective
Ethics

Semester IV

Introduction to Psychology
Biotechnology Lab Instrumentation
Microbiology
Cell Culture Techniques

Semester V

Interpersonal Communication

Molecular Biology Techniques

Internship Biological Technology/Technician

COURSE DESCRIPTIONS

Introduction to Biotechnology

An introduction to biotechnology including career exploration, history and applications of DNA/RNA technology, molecular biology, bioethics, and laboratory safety practices. The student will perform basic laboratory skills of pipetting, weighing, and preparing solutions; describe various applications of biotechnology; identify various biotechnology career opportunities; prepare a biotechnology research paper describing laboratory techniques and their applications; discuss and debate current ethical and legal issues in biotechnology; and practice laboratory safety

Biotechnology Lab Methods/Techniques.

A study of laboratory operations, management, equipment, instrumentation, quality control techniques, and safety procedures. Laboratory practice in using pH meter, mixing buffers, performing measurements, preparing solutions, and performing separatory techniques.

Biotechnology Lab Instrumentation

Theory, applications, and operation of various analytical instruments. Separation and identification techniques including electrophoresis, spectrophotometer, and chromatography emphasized.

Cell Culture Techniques

A study of cell culture techniques. Laboratory emphasis on the principles and practices of initiation, cultivation, maintenance, preservation of cell lines and applications.

Molecular Biology Techniques

An introduction to the theory and laboratory techniques in molecular biology with an emphasis on proteins, gene expression and regulation, recombinant DNA, and nucleic acids.

Internship Biological Technology I

An experience external to the college for an intermediate student in a specialized field involving a written agreement between the educational institution and a business or industry. Mentored and supervised by a workplace employee, the student achieves objectives that are developed and documented by the college and that are directly related to specific occupational outcomes. This may be a paid or unpaid experience. This course may be repeated if topics and learning outcomes vary

Internship Biological Technology II

An experience external to the college for an intermediate student in a specialized field involving a written agreement between the educational institution and a business or industry. Mentored and

supervised by a workplace employee, the student achieves objectives that are developed and documented by the college and that are directly related to specific occupational outcomes. This may be a paid or unpaid experience. This course may be repeated if topics and learning outcomes vary.

Cellular And Molecular Biology

An introduction to the physical and chemical organization of living organisms; cell structure, function, and metabolism; classical and molecular genetics; gene regulation; genetic engineering; molecular aspects of development; and reproduction.

Microbiology

Characteristics and life activities of micro-organisms and their interactions with their surroundings. Emphasis is placed on relationships that influence man: infection, immunity, parasitism, and control. Includes laboratory techniques.