SPRINGFIELD RESEARCH UNIVERSITY

Bachelor of Science: Molecular Biology and Biotechnology

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MISSION STATEMENT

The mission of SRU's molecular biology and biotechnology degree offers a biology and biotechnology perspective relevant to health and food practices, and will also highlight key issues of international relevance by exploring suitable examples and case studies. Laboratory-based learning is supported by fieldwork in health practices and natural habitats with wildlife populations. The students will study a wide range of topics including omic science, cell biology, biochemistry, genetics, immunology, microbiology, molecular biology, and plant physiology.

PROGRAM LEARNING OBJECTIVES

The molecular biology and biotechnology program will allow graduates to:

- Students will understand the scientific process, in the context of learning the fundamental biological and chemical 'facts' of molecular biology.
- Students will gain skills required to effectively do scientific research. More specifically, students will learn to implement the scientific method by proposing hypotheses to explain biological phenomena, designing and conducting experiments to test these hypotheses, and critically interpreting the resulting data.
- Students will learn to effectively communicate their results, both orally and in writing. In addition, they will be able to critically evaluate scientific literature and the current state of research progress in their area of interest.

PROGRAM LEARNING OUTCOMES

Program Goal 1 - *Molecular Literacy*

Students will build a comprehensive working knowledge of 1) proteins - their biology and their role as enzymes, structural, recognition, and signaling molecules; 2) nucleic acids - their structures, properties, and their roles in the storage and transmission of genetic information; 3) lipids, carbohydrates, and more complex biomolecules that have a diverse array of functions; 4) the roles of biomolecules in cellular signaling, metabolism, structure, and cellular organization; 5) the thermodynamics of specific molecular transformations, as well as integrated complex processes, and 6) the integration, interaction, and regulation of complex developmental, signaling, and metabolic pathways at the organismal level.

Learning Outcomes—Students will:

- Demonstrate a critical understanding of the biological and physical properties of small molecules found in living systems and will have a working knowledge of the phenomena that govern the behavior of biomolecules in aqueous and non-aqueous environments.

- Extend and apply their understanding of molecular structure and function to polymeric macromolecules and macromolecular complexes in order to predict and construct models for the behaviors of those more complicated biomolecules.

- Recognize and interpret the structural and functional aspects of molecules and their interactions that give rise to the supramolecular complexes such as organelles and cells and how those complexes function within organisms.

Program Goal 2 - ***Critical evaluation and analytical problem-solving ability***

Students will solve problems, applying foundational knowledge to the analysis of the complex and unknown. Through the thoughtful examination of problems and phenomena, students will reinforce and expand their knowledge.

Learning Outcomes—Students will:

- Evaluate sophisticated problems and synthesize detailed, logical and thoughtful solutions thereto, by using an analytical and critical approach.

Program Goal 3 - ***Experimental competency***

Students will propose explanations for the phenomena they observe and then rigorously prove or disprove those explanations through experimental science, generating new knowledge.

Learning Outcomes—Students will:

- Develop the ability to apply the scientific method to scientific problems. They will identify, characterize, and analyze the components of scientific problems, ask significant scientific questions, formulate hypotheses and design experiments to test these hypotheses, and collect, analyze, and interpret data.

- Develop the ability to identify and utilize the proper methodologies and instrumentation necessary to successfully test experimental hypotheses. They will demonstrate an ability to apply the appropriate scientific methods to the investigation of scientific questions.

- Collect scientific data, maintain laboratory notebooks, and perform data analyses using graphical and statistical computer software.

Program Goal 4 - ***Communication Proficiency***

Students will be thoughtful and effective communicators of knowledge, demonstrating independent thought and scientific intellect in written and oral mechanisms.

Learning Outcomes—Students will:

- Develop a familiarity with the scientific literature, an awareness of the theories, laws, and methods that govern scientific research, and fluency in the vernacular of scientific investigation. They will demonstrate the ability to communicate effectively with their scientific peers both in written and oral formats.

- Critically evaluate investigations from the primary scientific literature. They will clearly articulate their understanding of the data presented, the science behind the investigations, and the findings in those primary scientific papers. Students will evaluate the author's conclusions and propose and defend additional investigations that could clarify the conclusions and/or add to the scientific literature.

Program Goal 5 - ***Technology and information conversancy***

Students will be knowledgeable in the current state of the discipline by engaging the primary literature and by using contemporary technologies and tools for discovering and building knowledge in biochemistry and molecular biology.

Learning Outcomes—Students will:

- Demonstrate the ability to utilize literature search engines to find and collect primary scientific papers, review articles, book chapters, and other scientific literature. They will further exhibit the capacity to critically analyze these scientific works.

- Develop an understanding of, and familiarity with, Internet databases as well as experimental and analytical tools utilized in scientific investigations, data analyses, and data dissemination.

ENTRY REQUIREMENTS

The student must have 6 passes in SGCSE/GCE/IGCSE O' level including a pass with Grade C or better in English Language and at least four other subjects. Special: Mathematics and any other two from Agriculture/Geography, Biology, Chemistry, Combined Science, Physics, Physical Science and/or Human and Social Biology. Faculty may set mature entry requirements subject to approval by Senate.

CAREER OPPORTUNITIES

Career opportunities are available as Scientists or Managers in the Medical Laboratories, in the Veterinary Industry, the Pharmaceutical Industry, in Biomedical Engineering, in the Agricultural Industry, the area of product manufacturing & Production, Nutritional Biotechnology, in Bioinformatics, in forensic investigations and Marine Biotechnology.

Springfield Research University

Bachelor of Science Molecular Biology and Biotechnology

Proposed Course Modules and Synopsis

YEAR 1

Semester	Code	Course	Lectures (Hrs)	Practicals (Hrs)	Credits
1	MBB100	Analytical and Physical Chemistry	100	0	10
1	MBB101	Analytical and Physical Chemistry Laboratory	0	60	6
1	MBB102	Introduction to Biology	100	0	10
1	MBB103	English	50	0	5
1	MBB104	Introduction to Info Technology	60	0	6
1	MBB105	Introduction to Biology	100	0	10
1	MBB106	Laboratory Safety and Management	0	60	6
	TOTAL				53
2	MBB107	Organic Chemistry	100	0	10
2	MBB108	Organic Chemistry Laboratory	0	60	6
2	MBB109	Mathematics and Biophysics	100	0	10
2	MBB110	Introduction to Molecular Biology	100	0	10
2	MBB111	Microbiology	100	0	10
2	MBB112	Cell Biology	100	0	10
2	MBB113	Genetics	100	0	10
	TOTAL				66

YEAR 2

Semester	Code	Course	Lectures (Hrs)	Practicals (Hrs)	Credits
3	MBB214	Animal and Human Physiology	100	0	10
3	MBB215	Introduction to Bioinformatics	100	0	10
3	MBB216	Genome Structure and Organisation	100	0	10
3	MBB217	Molecular Biology	100	0	10
3	MBB218	Plant Physiology	100	0	10
3	MBB219	Bio-Statistics	100	0	10
	TOTAL				60
4	MBB220	Animal Cell Culture	100	0	10
4	MBB221	Biochemistry	100	0	10

4	**MBB222**	Plant and Animal Breeding	**100**	**0**	**10**
4	**MBB223**	Food Biotechnology	**100**	**0**	**10**
4	**MBB224**	Techniques in Molecular Biotechnology	**100**	**0**	**10**
4	**MBB225**	Plant Tissue Culture and Laboratory	**100**	**60**	**16**
	TOTAL				**66**

YEAR 3

Semester	Code	Course	Lectures (Hrs)	Practicals (Hrs)	Credits
5	**MBB326**	Omic Science	**100**	**0**	**10**
5	**MBB327**	Genetic Engineering	**100**	**0**	**10**
5	**MBB328**	Bioinformatics	**100**	**0**	**10**
5	**MBB329**	Biotechnology for Crop and Animal Improvement	**100**	**0**	**10**
5	**MBB330**	Environmental Biotechnology	**100**	**0**	**10**
5	**MBB331**	Plant Pest and Diseases	**100**	**0**	**10**
	TOTAL				**60**
6	**MBB332**	Industrial Biotechnology	**100**	**0**	**10**
6	**MBB333**	Organisational Leadership	**100**	**0**	**10**
6	**MBB334**	Protein Engineering	**100**	**0**	**10**
6	**MBB335**	Immunology	**100**	**0**	**10**
6	**MBB336**	Human Genome and Medical Biotechnology	**100**	**0**	**10**
6	**MBB337**	Introduction to Nanotechnology	**100**	**60**	**10**
	TOTAL				**60**

YEAR 4

Semester	Code	Course	Lectures (Hrs)	Practicals (Hrs)	Credits
7	**MBB438**	Experimental Design and Research Methodology	**100**	**0**	**10**
7	**MBB439**	Regulation in Gene Expression	**100**	**0**	**10**
7	**MBB440**	Biosafety, Regulations and Ethics	**100**	**0**	**10**
7	**MBB441**	Introduction to Business Management and Entrepreneurship	**100**	**0**	**10**
7	**MBB442**	Quality Control Management of Food Products	**100**	**0**	**10**

ELECTIVE MODULES					
7	MBB443	Advanced Molecular Biology	100	0	10
7	MBB444	Advanced Bioinformatics	100	0	10
7	MBB445	Bioprocessing	100	0	10
	TOTAL				60
4	MBB446	Forensic in Biotechnology (Optional)	100	0	10
4	MBB447	Research Project	0	240	24
4	MBB448	Internship	0	450	45
	TOTAL				79

DESCRIPTION OF COURSES

MBB100 ANALYTICAL AND PHYSICAL CHEMISTRY

The course provides a foundation and detailed understanding for fields such as chemical engineering, energy, materials science, geology, nanotechnology, and the environment. In the Chemistry - Physical and Analytical students will also develop an understanding of chemistry in the energy sector, environmental processes, thermodynamics, quantum chemistry, chemical equilibrium and the properties of polymers and surfactants. This also covers theoretical and computational chemistry, qualitative and quantitative analysis along with the preparation of new materials. Physical and Analytical Chemistry will, importantly, complement other disciplines such as Engineering Science, Environmental Science, Geology and Physics.

MBB101 ANALYTICAL AND PHYSICAL CHEMISTRY LABORATORY

This course is the laboratory portion of Analytical Chemistry I. Experiments include: potentiometric titration of acid mixtures, spectrophotometric determination of pH, spectrophotometric determination of iron in drinking water, lithium by flame emission, fluoride ion-selective electrodes, copper in metal alloys by liquid-liquid extraction, and quantitative analysis of hydrocarbons by gas chromatography.

MBB102 INTRODUCTION TO BIOLOGY

This introductory course defines biology and its relationship to other sciences. We examine the overarching theories of life from biological research and also explore the fundamental concepts and principles of the study of living organisms and their interaction with the environment. We will examine how life is organized into hierarchical levels; how living organisms use and produce energy; how life grows, develops, and reproduces; how life responds to the environment to maintain internal stability; and how life evolves and adapts to the environment. This course covers the following topics: Recurrent Themes in Biology, The Method of Scientific Inquiry, Introductions to Biological Chemistry, Organic Molecules, Cell Theory, Metabolism, Genetics, Evolution, Human Body & Health and Ecology.

MBB103 ENGLISH

This course will help students become more proficient and effective writers, while also developing reading comprehension and analysis skills. Students will study the basic tenets of effective writing and incorporate those elements into four essays and a visual presentation. Students will be introduced to effective reading strategies and will apply these to reading and writing assignments. Students will learn to write in stages, including pre-writing, drafting, and revising.

MBB104 INTRODUCTION TO INFORMATION TECHNOLOGY

This is the fundamental computer fluency course. It is designed to promote a working knowledge and understanding of computer information technology concepts, skills and capabilities that support academic and professionally related goals and requirements. Students learn about the application and science of information technology. Concepts to master include the fundamentals of computer information technologies along with issues that affect people today such as : Internet and other network technologies, web publishing, digital media, hardware, software, file and database management, information security, viruses, and spyware, social impact, as well as algorithmic thinking and the limits of computation. Students develop capabilities such a managing complexity, assessing the quality of information, collaborating and communicating using IT, anticipating technological change and thinking abstractly and critically about IT. Students develop computer-related skills in support of their college studies and career goals. This is accomplished, in part, by the mastery of word processing, spreadsheet, presentation, and database software.

MBB105 INTRODUCTION TO BIOTECHNOLOGY

This course is an introduction to the field of biotechnology. Topics include recombinant DNA, production of biological molecules, bioprocessing, and current events. Students also review employment and careers in the biotechnology and biopharmaceutical industries. Laboratories include aseptic technique, pipetting and measurement, DNA extraction and restriction digestion, gel electrophoresis, and PCR.

MBB106 LABORATORY SAFETY AND MANAGEMENT

Lab workers use hazardous substances differently than other workers. Where industrial applications typically use large quantities of a few hazardous substances, labs use a wide variety of substances, but in smaller quantities and change substances as well as procedures more often. This program is intended to provide information to assist you in the reduction of risk involved in your work in the laboratory. Knowledge of the hazards associated with each chemical and the proper steps to protect yourself is critical to your safety as well as that of your co-workers. You must always minimize chemical exposures and potential emergencies, as well as comply with all state and federal regulations. Also, this course will review chemical hazards, chemical hygiene, personal protective equipment and ventilation in the lab.

MBB107 ORGANIC CHEMISTRY

This course is the first in a sequence of courses for chemistry majors, premedicine students, biologists, or any other majors requiring a good background in organic chemistry, this course covers the fundamentals of structure and chemical behavior of organic molecules.

MBB108 ORGANIC CHEMISTRY LABORATORY

Techniques used in the isolation, purification, and synthesis of organic compounds.

MBB109 MATHEMATICS AND BIOPHYSICS

This course reviews mathematical operations and introduces concepts of physics that will be of value to students in the Fitness, Health and Human Kinetics Program. In particular, topics of physics that enable the description of motion and the forces that affect motion will be considered This course is an introduction to biophysics examining many topics in this broad area. The course will cover a wide range of topics, applying physical principles and techniques to different problems in biology. There will be a number of projects for students to collaborate on. Varied backgrounds in a team, such as biology, and physics, will enhance the learning experience.

MBB110 INTRODUCTION TO MOLECULAR BIOLOGY

A thorough grounding in the fundamentals of biology, including a broad review of the life sciences with emphasis on molecular biology. Topics include the basic concepts and processes of cell biology, molecular biology, and immunology. The components of a cell, the processes occurring in a single cell, and the functioning of a multicellular organism are explained. Discussion also covers the use of model organisms to understand basic and applied biology.

MBB111 MICROBIOLOGY

A study of microorganisms including bacteria, viruses, rickettsiae, fungi, and other microbial forms. The morphology, physiology, ecology, evolution of these organisms, their pathogenesis, host responses, epidemiology, and control are discussed. Laboratory exercises illustrate morphology, growth, biochemical characteristics, identification and classification, microbial immunity, genetics and various laboratory techniques.

MBB112 CELL BIOLOGY

Application of genetic and biochemical concepts to the rigorous analysis of the structure and function of cells. Special attention is devoted to the interactions between cells and between cells and the non-cellular environment, signaling and response mechanisms, and regulation of gene activity. Specific examples for illustration will be drawn from developmental contexts and disease states. The laboratory will use cell culture as a means of providing model systems to afford students experience with techniques used to elucidate cellular integration and regulation mechanisms.

MBB113 GENETICS

An introduction to heredity. A balanced presentation is made in the fields of classical, molecular, and population genetics. Topics include: Mendelian inheritance, Molecular Genetics, Population Genetics, Quantitative Genetics, Phylogenetics, and Evolution. Laboratory investigations span a variety of organisms and techniques used in modern Genetics applications.

MBB214 ANIMAL AND HUMAN PHYSIOLOGY

The course deals with basic physiological and anatomical principles in a wide variety of species. Beginning at the tissue level, the physiology and anatomy of the major systems including endocrine, nervous, gastrointestinal and hepatic are covered. The course then takes an integrative approach allowing students to examine the breadth of these systems including disease mechanisms and sensory and cognitive functions of the whole animal. The course takes a comprehensive study of the anatomy and physiology of the human body. Topics include body organization, homeostasis, cells and tissues, integument, skeletal system, muscular system, nervous system and special senses. Laboratory study includes microscope work, substantial organ and animal dissection, and experiments designed to illustrate normal function and physiologic responses to specific stresses. Designed for students in Nursing, Radiologic Technology and other health related programs.

MBB215 INTRODUCTION TO BIOINFORMATICS

Modern manipulation of molecular genetic data in the field of bioinformatics. Topics include genomics, proteomics, and systematics. A discussion of data collection techniques is followed by demonstration of data manipulation and analysis. A semester-long project based on human genetic diseases allows for the development and implementation of pertinent techniques in the field via computer analysis of international genetic databases.

MBB216 GENOME STRUCTURE AND ORGANISATION

The genome is the entire genetic material of an organism. It is found in the nucleus of a cell, and is composed of a chemical called DNA. The study of the structure and function of the genome is called genomics. DNA is a polymer - a large and complex molecule. The monomers that make it are called nucleotides. DNA is made up of two strands forming a twisted ladder structure called a double helix. The nucleotides are arranged along the DNA to form a code. This genetic code, determines the characteristics of a living organism. Genomes of different organisms: Genetic material for eukaryotes is in their nucleus. Prokaryotes such as bacteria do not have nuclei. Their genetic material is in the cytoplasm and includes small loops of DNA called plasmids. Genes and chromosomes: Many nucleotides form each gene. A gene is a small section of genetic code in the DNA of a chromosome. Each gene codes for a particular sequence of amino acids in order to make a specific protein. It is a unit of heredity, and may be copied and passed on to the next generation.

MBB217 MOLECULAR BIOLOGY

This course covers a detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. The topics covered in lectures and readings of relevant literature include gene regulation, DNA replication, genetic recombination, and mRNA translation. In particular, the logic of experimental design and data analysis is emphasized.

MBB218 PLANT PHYSIOLOGY

Plants are integral to agricultural production systems but do you understand the processes that drive plant growth and development? Plant physiology is the study of plant structure and function. This course will examine the main physiological processes, how plants interact with their environment and aspects of plant biology relevant to currently active or promising research areas. A strong emphasis is placed on aspects of physiology that are relevant to crops important in agriculture and horticulture.

MBB219 BIO-STATISTICS

Hands-on experience using statistical tools to answer real- world questions. Students will design and implement a short survey and analyze their results. Emphasis on analysis of actual survey data using statistical software. Statistical topics include numerical/graphical summaries, measures of association, and hypothesis testing. Focus is on interpretation, not calculation.

MBB220 ANIMAL CELL CULTURE

The course will focus on practical aspects of cell culture, like design and layout of the laboratory, aseptic technique, cloning and selection of specific cell types, contamination, methods for measuring viability and cytotoxicity, cell culture environment (substrate, gas phase, medium), and the culturing of specific cell types. After completing the course, the student shall be able to: demonstrate knowledge of basic cell culture techniques, demonstrate knowledge of establishment of cell inlines and their maintenance, demonstrate knowledge on design and use the cell culture facilities, critically evaluate cell cultures constraints and possibilities as an in vitro model and discuss the advantages and limitations of primary cell culture compared to immortalized or transformed cell lines.

MBB221 BIOCHEMISTRY

Biochemistry of carbohydrates, lipids, amino acids, proteins, nucleotides and nucleic acids; mechanism of enzyme action and regulation of enzymatic pathways; intermediary metabolism; lipid and nitrogen metabolism; physiochemistry of hemoglobin, the vitamins and selected hormones. Laboratory exercises consist of modern techniques and instrumentation of biochemistry: spectrophotometry; electrophoresis; column chromatography; enzymatic determinations; protein isolation and characterization.

MBB222 PLANT AND ANIMAL BREEDING

The field of plant breeding encourages applications from students interested in crop improvement in the context of global agriculture. The breeding program deals with development of plant materials for greater yield, disease resistance, adaptability, quality, etc. and with studies of breeding methods and principles. Molecular and biochemical studies to identify and isolate agriculturally important genes seek to relate information from model species to crop plant genomes, to compare crop genomes, to assess genetic diversity, and to develop bioinformatic tools relevant to crop improvement. The application of scientific methods to animal breeding has led to major improvements in the output, cost and quality of meat, milk and fibre. In addition, animal breeding plans are important for continued improvement of companion animals and management of endangered species. Topics include an introduction to quantitative genetics, maximising response to selection, crossbreeding, estimation of genetic parameters and breeding values, mode of inheritance, mating systems, fitness and quality traits, animal diversity, development of breeding programs, use of biotechnology in breeding programs including gene mapping and parentage testing.

MBB223 FOOD BIOTECHNOLOGY

The course discusses the microbiological and technological principles of industrial application of microorganisms and enzymes in food production and processing systems to provide useful products and services. Lectures cover basic properties, characteristics, structures and functions of living cells (microbial) and enzymes; metabolic pathways and how these are harnessed, manipulated and applied through natural selection, genetic engineering, optimized reactor and environmental designs and controls to increase productivity. Major fermented food product technologies are also discussed with specific references to alcoholic beverages, dairy products, biomass, solvents, organic acids, traditional fermented products and biodegradation of waste into biogas and other useful products. The practical component of the course will include pilot plant alcoholic fermentation (wine), sauerkraut and yoghurt processing. A field trip to a commercial brewery will be arranged to enhance the learning experience.

MBB224 TECHNIQUES IN MOLECULAR BIOTECHNOLOGY

The course applies molecular biotechnology and reverse genetics approaches to the study of apoptosis, or programmed cell death (PCD), in Drosophila cells. RNA interference (RNAi), or double stranded RNA-mediated gene silencing, will be used to inhibit expression of candidate apoptosis-related genes in cultured Drosophila cells. Teams of 2 or 3 students will design and carry out experiments to address questions about the genes involved in the regulation and execution of PCD in this system. Some projects involve the use of DNA damaging agents or other cytotoxic chemicals or drugs to help understand the pathways that control a cell's decision to undergo apoptosis. Instruction and practice in written and oral communication are provided.

MBB225 PLANT TISSUE CULTURE AND LABORATORY

Plant tissue culture is a method to propagate plants asexually (vegetatively) under sterile conditions. This method is also known as cloning, where the plants produced by tissue culture have the same characteristics as the starting material. Parts (tissue) are taken from the starting material and placed on the appropriate culture media (medium) so that the growth (development) of these parts can take place. Relatively little starting material is needed and within a relatively short time one can obtain a massive amount of healthy plant material. Some advantages of Plant tissue culture are: the resulting plant material has properties identical to the originating material, the resulting plant material is healthy, the number of plants obtained through these techniques is greater than when it is propagated in the traditional way, preservation of plants that are threatened with extinction, and the ability to produce plants in the absence or absence of seeds.

MBB326 OMIC SCIENCE

The course is aimed at familiarizing participants with the basis and application of various omics disciplines: genomics, transcriptomics, metabolomics, proteomics, and bioinformatics. Each of the omics disciplines will be covered by a lecture and a practical bioinformatics session. By the end of the course users should understand, for each omics level: the basis of the discipline, the instrumentation used to generate high-throughput biological data, key applications, and how to visualize the resulting data using commonly used software packages. Participants will also be aware of how different large-scale data sets can be integrated in order to obtain better biological inference, and appreciate the nature of other modern challenges in bioinformatics.

MBB327 GENETIC ENGINEERING

Genetic Engineering course explains the process and the power of genetic engineering. Genetic engineering is the deliberate modification of genetic material (DNA). It is used extensively in research, drug discovery, drug development and biomanufacturing. Biotechnology is built on genetic engineering and therefore it is a "must know" topic for those who work in or with the biopharma industry.

MBB328 BIOINFORMATICS

The course introduces students to biological problems and systems that benefit from interrogation through bioinformatics and computational biology. Ever larger datasets are being generated by high throughput sequencing and other genomic, proteomic, and cellular technologies. Insights into biological systems from these data require creative thinking, computational depth, and awareness of how best to exploit new high performance computing technologies. In a weekly seminar format, students will be introduced to new technologies, new types of data, and challenges in using these data to examine biological systems.

MBB329 BIOTECHNOLOGY FOR CROP AND ANIMAL IMPROVEMENT

This is as an upper level course for students with an interest in learning how crop plants can be improved by altering their genetic make-up. The course covers methodology, theory, and applications with particular emphasis on integrating the various molecular techniques to achieve overall crop improvement goals. The course is designed primarily as a hands-on laboratory course where students will actively conduct biotechnology experiments. Students will investigate DNA extraction methods, DNA fingerprinting and profiling techniques using RFLP and PCR technology, PCR based GMO product testing, and tobacco and bacterial transformation techniques using the GUS and GFP genes. We will also cover government regulations of field testing, public concerns with genetic engineering, and legal protection of improved crops. Covers reproductive technologies; transgenic techniques; molecular genetics in animal selection; use of recombinant proteins for growth, lactation and reproduction; immunological modulation of animal production; improvement of feeds and rumen organisms; improvement of health. In addition, ethical and safety aspects will be considered. Emphasizes the application and impact of biotechnological techniques on animal production rather than the techniques themselves.

MBB330 ENVIRONMENTAL BIOTECHNOLOGY

This course will provide third-year students with a theoretical and quantitative understanding of cutting-edge environmental biotechnologies, including: a) bioremediation for soil and groundwater treatment; b) microbial electrotechnology for wastewater and groundwater treatment; c) biocatalysis and bioelectrocatalysis for biofuel and fine chemical production (Green Biotechnology). The course combines lectures and group work, where the students will apply their knowledge to actual case studies from industrial literature. At the end of the course, the students will be able to design in-principle applications of environmental biotechnology to soil and groundwater treatment.

MBB331 PLANT PEST AND DISEASES

Economic importance of bacterial diseases; plant pathogenic bacteria; ecology and spread of bacterial diseases; host range; measurement of bacterial growth; diseases caused by plant pathogenic bacteria; entry of bacteria into plants; pathogenicity and virulence factors in bacterial diseases; plant response to bacterial infection; diagnosis of bacterial diseases: symptoms, microscopic examination, isolation, gram stain test, biochemical tests, serological tests, fatty acid-based tests, Polymerase Chain Reaction (PCR)-based analysis, pathogenicity.

MBB332 INDUSTRIAL BIOTECHNOLOGY

The aim of the course if to provide insight into the innovation and valorization process in Industrial and Plant Biotechnology. The first step is the invention: to link a new scientific discovery to an application in biotechnology. The next important aspect is to protect the intellectual property of that invention in a patent. The third step is the applied research trajectory needed to obtain prove of concept for the invention, which is needed to turn the initial idea into a product that can be sold. The student is capable of using the acquired theoretical knowledge related to research in the field of white and green biotechnology to read and present patents in these fields. The student understands the importance of intellectual property rights for industry and academics and knows how to write an invention disclosure.

MBB333 ORGANISATIONAL LEADERSHIP

This course explores the dynamics of individual, group, and firm behavior used to develop broader managerial skills. Theoretical models and concepts will be evaluated in the areas of values, attitudes, personality traits, decision-making, motivation, communication, and the development of effective relationships in a diverse work environment. Students will examine the need for individuals to identify, comprehend, and maximize various aspects of proactive leadership devices such as organizational development, influence techniques, and total quality management as a means of effective leadership. Experiential exercises and case studies may be utilized to develop a broader understanding of behavior and leadership in the workplace. Students seeking graduate credit must complete all graduate course requirements.

MBB334 PROTEIN ENGINEERING

The course allows students to work on a current molecular biological and gene technological problem. The aim is to provide advanced knowledge and skills that enable you to find solutions on your own, and put these solutions into practice. After completing the course, you should be able to analyse the structure and function of proteins by computer-based methods, describe the structure and classification of proteins, analyse and compare the amino acid sequence and structure of proteins and relate these to function, review factors significant for protein folding processes and stability, explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design, plan mutagenesis experiments to test protein stability and/or function, carry out a PCR-based mutagenesis experiment, keep a lab journal according to GLP and design a simple research plan for a novel biotechnological invention.

MBB335 IMMUNOLOGY

Fundamentals of immunology, immunopathology, immunochemistry, and serology. Topics include: the immune system; structure, function, and formation of immunoglobulins; cellular and genetic basis of immune response; antigen-antibody reactions; the complement system; immunochemistry; hypersensitivity; transplantation; and methods in immunology. Laboratory exercises consist of methods to measure antibodies and the use of antibodies to detect other substances.

MBB336 HUMAN GENOME AND MEDICAL BIOTECHNOLOGY

Examination of genome structure and function in humans and other organisms. Topics include genome structure and function, the evolution of genomes and the role of genome analysis in medicine, pharmacology, and agriculture. Genetics aspects of human health and disease. Topics include birth defects, immunogenetics, cytogenetics, metabolic disorders, pattern of inheritance, and genetic counseling. Living cells and cell materials are used in the field of Medical biotechnology for research purposes to produce pharmaceutical and diagnostic products resulting in the treatment and prevention of human diseases. Insulin as well as growth hormones is the exemplary discoveries in the field of medical biotechnology. Tissue culture techniques are being used in detection of in born defects of metabolism and haemoglobinopathies; congenital abnormalities and understanding of clinical aspects of autosomal and sex chromosomal disorders. Medical biotechnology has advanced to develop organ culture, produce artificial blood and to perform transgenesis.

MBB337 INTRODUCTION TO NANOTECHNOLOGY

Introduction to Nanotechnology provides a broad overview of nanotechnology, discussing the fundamental science of nanotechnology and its applications to engineering, biomedical, and environmental fields. We will discuss the interdisciplinary nature of nanotechnology and how the different basic sciences merge to create the field. The course provides a background of the understanding, motivation, implementation, impact, future, and implications of nanotechnology. The course will also discuss specific applications of nanotechnology in electronic devices, biomedical fields, environmental solutions, and energy production. This class is suitable for high school students interested in gaining a fundamental knowledge of nanoscience, in understanding current applications of nanotechnology, and in learning about future prospects in this field. Class presentations and weekly quizzes will allow the students to demonstrate their understanding of the material. By the end of the course, the students will have gained knowledge in the following areas: What nanotechnology is, the size and shape dependent properties at the nanometer scale, enhanced physical properties of nanomaterials, what nanoparticles are and how to synthesize them, and applications of nanotechnology in engineering, biomedical, energy, and environmental fields.

MBB438 EXPERIMENTAL DESIGN AND RESEARCH METHODOLOGY

The course provides knowledge about experimental designs and analysis of data from experiments. Analysis of variance, randomized block designs, Latin-square designs, linear mixed models, split-plot designs, response surface methodology, mixture models and fractional 2k experiments are studied. Applications of experimental planning and analysis of variance play a prominent part. The course content is valuable when planning and carrying through experiments. This course aims to help students to understand methods and analyses that are frequently used in communication research and to gain fundamental knowledge and practical skills necessary to conduct statistical analyses and interpret the results.

MBB439 REGULATION IN GENE EXPRESSION

Provides in-depth and up-to-date coverage of gene expression and regulation. Lectures are centered on the principles of regulating gene expression in eukaryotic cells. The course covers macromolecule structure and function in gene expression; molecular mechanisms of the key gene expression events including transcription, RNA processing, localization and translation. Applications of these principles in medicine and therapeutics such as aging, cancer and drug design are also discussed.

MBB440 BIOSAFETY, REGULATIONS AND ETHICS

This course will consist of definitions of biosafety, bioethics and biopolicy, good laboratory procedure and practices, standard operating procedures for biotechnology research, legal and institutional framework for biosafety in Uganda, international agreements and protocols for biosafety. By the end of the course, students should be able to: define Biosafety and bioethics in the context of modern biotechnology, demonstrate good laboratory procedures and practices, describe the standard operating procedures for biotechnology research and assign Biosafety levels, justify the design of confinement facilities at different Biosafety levels, discuss the social and ethical issues related to plant and animal biotechnology, and discuss the relevance of intellectual property rights to modern biotechnological innovations.

MBB441 INTRODUCTION BUSINESS MANAGEMENT AND ENTREPRENEURSHIP

Entrepreneurship is an essential human behavior that underpins societal progress. Individual economic activity dominates day-to-day behavior in all but a few western societies and cultures today. Most of the world’s population depends on an entrepreneurial livelihood. Without an understanding of the role of the entrepreneur in economic formation and the conception of markets, a basic historical understanding of societal development is limited. Therefore, this course covers the many facets of entrepreneurship and its implications for careers, business, and society. It is designed to introduce the entrepreneurial mindset to students pursuing all University majors. This course qualifies as a General Education course in the Social Sciences subject area. The study of entrepreneurship draws from and contributes to theories rooted in sociology, psychology, anthropology, and economics. The entrepreneurial process is, as its very core, a social phenomenon. People identify opportunities and act on them to create value for others. Furthermore, the creation of new organizations (a common behavior of entrepreneurs) is the creation of social structure, bringing together people to achieve a common goal. The formation of new ventures is taught in this class as an evidence-based methodology to problem identification, analysis, and decision-making. Accordingly, the assignments are designed to develop and assess critical thinking skills.

MBB442 QUALITY CONTROL MANAGEMENT OF FOOD PRODUCTS

The course will introduce the concepts of food quality management and control from three different/complementary perspectives: 1) a detailed reading of the ISO 9001 standard, and insight into the use of this standard for the management of food quality; 2) monitoring of the food quality based on process monitoring tools such as Statistical Quality Control (SQC) and Lean Six Sigma to ensure a food product with minimal variation. Producing food requires understanding of all process steps, and knowledge of the performance of each step is critical to estimate the variability of the final product. Knowing the variability makes it possible to find solutions for adjusting it, if it is not in accordance with the process step and/or end-product specifications. Thus, the idea of measuring, understanding, adjusting, monitoring and controlling variability throughout the production is a key topic of this course. Quality in this course will be seen both in a wide context; i.e. as proof of product specification meaning that the variability of the food produced is known and below or within an acceptable limit to ensure customer satisfaction, as well as occasionally in a more narrow context; i.e. as food safety meaning that the amount of hazards is below a certain limit.

MBB443 ADVANCED MOLECULAR BIOLOGY

The Advanced Molecular Biology option is designed for students interested in pursuing graduate work in molecular life sciences or entering the workforce in the biotechnology and pharmaceutical industries. It provides advanced training in genomics, epigenetics and other areas of current research in molecular biology, in addition to the core courses in the major. Students are strongly encouraged to participate in undergraduate research, and up to six research credits can be applied to the Upper-division Science Elective requirements.

MBB444 ADVANCED BIOINFORMATICS

This is a course on Bioinformatics that aims at exposing the students to some advanced statistical and computational techniques related to bioinformatics. This course would prepare the students in understanding bioinformatics principles and their applications. Genomic databases and analysis of high-throughput data sets, Analysis of DNA sequence, Sequence annotation, ESTs, SNPs. BLAST and related sequence comparison methods. EM algorithm and other statistical methods to discover common motifs in biosequences. Multiple alignment and database search using motif models, ClustalW and others. Concepts in phylogeny. Gene prediction based on codons, Decision trees, Classificatory analysis, Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models. Computational analysis of protein sequence, structure and function. Modeling protein families. Expression profiling by microarray/gene chip, proteomics etc., Multiple alignment of protein sequences, Modeling and prediction of structure of proteins, Designer proteins, Drug designing. Markov chains (MC with no absorbing states; Higher order Markov dependence; patterns in sequences; Markov chain Monte Carlo – Hastings-Metropolis algorithm, Simulated Annealing, MC with absorbing States), Bayesian techniques and use of Gibbs Sampling, Advanced topics in design and Analysis of DNA microarray experiments. Computationally intensive methods (Classical estimation methods, Bootstrap estimation and Confidence Intervals, Hypothesis testing, Multiple Hypothesis testing), Evolutionary models (Models of Nucleotide substitution), Phylogenetic tree estimation (Distances: Tree reconstruction – Ultrametric and Neighbor-Joining cases, Surrogate distances, Tree reconstruction, Parsimony and Maximum Likelihood, Modeling, Estimation and Hypothesis Testing), Neural Networks (Universal Approximation Properties, Priors and Likelihoods, Learning Algorithms – Back propagation, Sequence encoding and output interpretation, Prediction of Protein Secondary Structure, Prediction of Signal Peptides and their cleavage sites, Application for DNA and RNA Nucleotide Sequences), Analysis of SNPs and Haplotypes. Genomic databases and analysis of high-throughput data sets, BLAST and related sequence comparison methods, Statistical methods to discover common motifs in biosequences, Multiple alignment and database search using motif models, ClustalW, Classificatory analysis, Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models, Computational analysis of protein sequence, Expression profiling by microarray/gene chip, proteomics, Modelling and prediction of structure of proteins, Bayesian techniques and use of Gibbs Sampling, Analysis of DNA microarray experiments, Analysis of one DNA sequence, Analysis of multiple DNA or protein sequences, Computationally intensive methods, Multiple Hypothesis testing, Phylogenetic tree estimation, Analysis of SNPs and Haplotypes.

MBB445 BIOPROCESSING

This course will cover material related to the application of biological, biochemical, and engineering fundamentals in the area of bioprocess engineering. Students will review aspects related to molecular biology, cell biology, genetic engineering, biochemistry and microbiology as they pertain to bioprocess engineering concepts. Advanced topics will include bioprocessing kinetics (enzymes, cell growth, substrate utilization, and product formation); bioenergetics; quantification of metabolism; bioreactor design and selection; bioprocess scale-up; product recovery; biosafety and good manufacturing practices; and the role of bioprocess engineering in medicine.

MBB446 FORENSIC IN BIOTECHNOLOGY (OPTIONAL)

is a project-based course that will include studies in DNA fingerprinting, PCR, CRISPR, bioinformatics, and western blot technologies: all important biotechnology techniques currently used in forensic sciences. The course is designed to give students a fundamental understanding of techniques covered as well as a working knowledge, through the use of some virtual labs. Students will also learn how these techniques can be applied toward new challenges in the biotechnology industry. Projects will include integrating knowledge and skills in the examination, analysis, interpretation, reporting, and testimonial support of evidence. Students will also develop problem-solving and analytical skills that are more generally applicable to the life sciences. Furthermore, students will develop writing and presentation skills necessary for the biotechnology workforce.

MBB447 RESEARCH PROJECT

Individual laboratory-based research project in the broad area of biotechnology guided by an academic &/or industry supervisor.

MBB448 INTERNSHIP

An opportunity to connect work experiences in industry, government, or the non-profit sector to the academic program in molecular biology and biotechnology. Internships, either summer activities or full- or part-time work experiences during the academic year, are arranged by students in consultation with an instructor.