BIOTECHNOLOGY
(INTERNATIONAL PROGRAM)

PROGRAM TITLE Doctor of Philosophy Program in Biotechnology (International Program)
DEGREE TITLE Doctor of Philosophy (Biotechnology)
Ph.D. (Biotechnology)

PROGRAM STRUCTURE

Total program credit (For Master Background) **48 credits**
Plan 2.1 (Dissertation 36 credits)
1. **English Courses** **non credits**
2. **Compulsory Courses** **3 credits**
3. **Elective Courses** **9 credits**
4. **Dissertation** **36 credits**

Total program credit (For Bachelor Background) **76 credits**
Plan 2.2 (Dissertation 48 credits)
1. **English Courses** **non credits**
2. **Compulsory Courses** **4 credits**
3. **Elective Course** **24 credits**
4. **Dissertation** **48 credits**

1. English Courses — non credits

1.1 English Courses

LNG	601	Foundation English for International Programs	3 (2 – 2 – 9)

2. Compulsory Courses

Plan 2.1 (Dissertation 36 credits) — **3 credits**

BIT	692	Seminar II	1 (0 – 2 – 3)
BIT	693	Seminar III	1 (0 – 2 – 3)
BIT	761	Selected Topics	1 (1 – 0 – 3)

Plan 2.2 (Dissertation 48 credits) — **4 credits**

BIT	691	Seminar I	1 (0 – 2 – 3)
BIT	692	Seminar II	1 (0 – 2 – 3)
BIT	693	Seminar III	1 (0 – 2 – 3)
BIT	761	Selected Topics	1 (1 – 0 – 3)

3. Elective Courses — 9/24 credits

BIT	611	Molecular Modeling	3 (3 – 0 –9)
BIT	612	Cellular and Molecular Physiology	3 (3 – 0 –9)
BIT	631	Molecular Biotechnology	3 (3 – 0 –9)
BIT	632	Bioinformatics and Genomics	3 (3 – 0 –9)
BIT	641	Treatment and Utilization of Biological Wastes	3 (3 – 0 –9)
BIT	651	Applied Computational Methods in Life Science	3 (3 – 0 –9)
BIT	661	Nanobiotechnology	3 (3 – 0 –9)
BIT	662	Special Topic I	3 (3 – 0 –9)
BIT	663	Marine Biotechnology	3 (3 – 0 –9)
BIT	664	Electroanalytical Chemistry	3 (3 – 0 –9)
BIT	665	Bioinformatics	3 (3 – 0 –9)
BIT	667	Special Topic II	3 (3 – 0 –9)
BIT	668	Special Topic III	3 (3 – 0 –9)
BIT	669	Techniques and Solution in Biotechnology	1 (1 – 0 –3)
BIT	671	Technical Bioprocess Systems	3 (3 – 0 –9)
BIT	672	Biological Process Modeling and Model Analysis	3 (3 – 0 –9)
BIT	673	Advanced Biotechnology	3 (3 – 0 –9)
BIT	681	Business and Management of Biotechnology Enterprise	3 (3 – 0 –9)
BIT	682	Biotechnology Enterprise Initiative	3 (3 – 0 –9)
BIT	683	Marketing of Biotechnological Products	3 (3 – 0 –9)
BIT	684	Investment in Biotechnology Industry	3 (3 – 0 –9)
BIT	685	Ethical, Legal, and Regulatory Issues in Biotechnology	3 (3 – 0 –9)
BIT	686	Special Topic IV	3 (3 – 0 –9)
BIT	711	Advanced Microbial Physiology	3 (3 – 0 –9)
BIT	732	Advanced Gene Technology	3 (3 – 0 –9)
BIT	775	Separation and Purification in Bioprocess	3 (3 – 0 –9)

BIF	612	Molecular Biochemistry	3 (3 – 0 –9)
BIF	614	Molecular Evolution	3 (3 – 0 –9)
BIF	622	Special Topic I	3 (2 – 2 –9)
BIF	632	Drug Design and Discovery	3 (3 – 0 –9)
BIF	634	Functional and Comparative Genomics	3 (3 – 0 –9)
BIF	662	Special Topic I	3 (3 – 0 –9)
BIF	664	Special Topic II	3 (3 – 0 –9)
BIF	666	Special Topic III	3 (3 – 0 –9)
BIF	772	Systems Biology and Metabolic Engineering	3 (3 – 0 –9)
BCT	601	Enzyme Technology	3 (3 – 0 –9)
BCT	621	Lipid Technology	3 (3 – 0 –9)
CHE	512	Membrane Technology	3 (3 – 0 –9)
CHE	540	Biochemical Engineering	3 (3 – 0 –9)
CHE	634	Adsorption Separation	3 (3 – 0 –9)
EET	627	Energy System Design	3 (3 – 0 –9)
EET	692	Bio-Energy Conversion	3 (3 – 0 –9)
FDE	519	Food Engineering Principles	3 (3 – 0 –9)
FDE	521	Food Process Engineering	3 (3 – 0 –9)
EEV	520	Wastewater Treatment	3 (3 – 0 –9)
EEV	623	Advanced Wastewater Treatment	3 (3 – 0 –9)
EEV	631	Hazardous Materials and Safe Disposal of Hazardous Waste	3 (3 – 0 –9)
EEV	632	Treatment and Utilization of Solid Waste	3 (3 – 0 –9)

Subjects chosen by the research group of the Department of Biotechnology

3.1 Molecular Biotechnology

BIT	611	Molecular Modeling	3 (3 – 0 – 9)
BIF	612	Molecular Biochemistry	3 (3 – 0 – 9)
BIF	614	Molecular Evolution	3 (3 – 0 – 9)
BIT	632	Bioinformatics and Genomics	3 (3 – 0 – 9)
BIT	665	Bioinformatics	3 (3 – 0 – 9)
BIT	711	Advanced Microbial Physiology	3 (3 – 0 – 9)
BIT	732	Advanced Gene Technology	3 (3 – 0 – 9)
BIF	622	Experimental Techniques in Molecular Biology	3 (2 – 2 – 9)
BIF	632	Drug Design and Discovery	3 (3 – 0 – 9)
BIF	634	Function and Comparative Genomics	
BIF	662	Special Topic I	3 (3 – 0 – 9)
BIF	664	Special Topic II	3 (3 – 0 – 9)
BIF	666	Special Topic III	3 (3 – 0 – 9)
BIF	772	Systems Biology and Metabolic Engineering	3 (3 – 0 – 9)

3.2 Bioengineering

BIT	671	Technical Bioprocess Systems	3 (3 – 0 – 9)
BIT	672	Biological Process Modeling and Model Analysis	3 (3 – 0 – 9)
BIT	673	Advanced Biotechnology	3 (3 – 0 – 9)
BIT	775	Separation and Purification in Bioprocess	3 (3 – 0 – 9)
CHE	512	Membrane Technology	3 (3 – 0 – 9)
CHE	540	Biochemical Engineering	3 (3 – 0 – 9)
CHE	634	Adsorption Separation	3 (3 – 0 – 9)

3.3 Waste Utilization and management

BIT	641	Treatment and Utilization of Biological Wastes	3 (3 – 0 – 9)
EEV	520	Wastewater Treatment	3 (3 – 0 – 9)
EEV	623	Advanced Wastewater Treatment	3 (3 – 0 – 9)
EEV	631	Hazardous Materials and Safe Disposal of Hazardous Waste	3 (3 – 0 – 9)

3.4 Chemical Censor and Biotechnology

BIT	661	Nanobiotechnology	3 (3 – 0 – 9)
BIT	664	Electroanalytical Chemistry	3 (3 – 0 – 9)

3.5 Business Biolotechnology

BIT	681	Business and Management of Biotechnology Enterprise	3 (3 – 0 – 9)
BIT	682	Enterprise Initiative	3 (3 – 0 – 9)
BIT	683	Marketing of Biotechnological Products	3 (3 – 0 – 9)
BIT	684	Investment in Biotechnology Industry	3 (3 – 0 – 9)
BIT	685	Ethical, Legal, and Regulatory Issues in Biotechnology	3 (3 – 0 – 9)
BIT	686	Special Topic IV	3 (3 – 0 – 9)

Remarks: Students can select elective course in their interest or research with consent from their thesis advisor.

4. Dissertation

BIT	798	Dissertation	36 credits
BIT	799	Dissertation	48 credits

STUDY PLAN

Plan 2.1 (Dissertation 36 credits)

- **First Year**

First Semester

XXX	xxx	Elective Courses I	3 (3 – 0 – 9)
XXX	xxx	Elective Courses II	3 (3 – 0 – 9)
XXX	xxx	Elective Courses III	3 (3 – 0 – 9)
BIT	692	Seminar II	1 (0 – 2 – 3)
		Total	**10 (9 – 2 – 30)**

Second Semester

BIT	761	Selected Topics	1 (0 – 2 – 3)
BIT	693	Seminar III	1 (0 – 2 – 3)
BIT	798	Dissertation	5 (0 – 10 – 20)
		Total	**7 (1 – 12 – 26)**

- **Second Year**

First Semester

BIT	798	Dissertation	6 (0 – 12 – 24)
		Total	**6 (0 – 12 – 24)**

Second Semester

BIT	798	Dissertation	9 (0 – 18 – 36)
		Total	**9 (0 – 18 – 36)**

- **Third Year**

First Semester

BIT	798	Dissertation	9 (0 – 18 – 36)
		Total	**9 (0 – 18 – 36)**

Second Semester

BIT	798	Dissertation	7 (0 – 14 – 28)
		Total	**7 (0 – 14 – 28)**

Plan 2.2 (Dissertation 48 credits)

- **First Year**

First Semester

XXX	xxx	Elective Courses I	3 (3 – 0 – 9)
XXX	xxx	Elective Courses II	3 (3 – 0 – 9)
BIT	691	Seminar I	1 (0 – 2 – 3)
		Total	**7 (6 – 2 – 21)**

Second Semester

XXX	xxx	Elective Courses III	3 (3 – 0 – 9)
XXX	xxx	Elective Courses IV	3 (3 – 0 – 9)
XXX	xxx	Elective Courses V	3 (3 – 0 – 9)
BIT	692	Seminar II	1 (0 – 2 – 3)
		Total	**10 (9 – 2 – 30)**

- **Second Year**

First Semester

XXX	xxx	Elective Courses VI	3 (3 – 0 – 9)
XXX	xxx	Elective Courses VII	3 (3 – 0 – 9)
XXX	xxx	Elective Courses VIII	3 (3 – 0 – 9)
BIT	693	Seminar III	1 (0 – 2 – 3)
		Total	**10 (9 – 2 – 30)**

Second Semester

BIT	761	Selected Topics	1 (1 – 0 – 3)
BIT	799	Dissertation	8 (0 – 16 – 32)
		Total	**9 (1 – 16 – 35)**

- **Third Year**

First Semester

BIT	799	Dissertation	10 (0 – 20 – 40)
		Total	**10 (0 – 20 – 40)**

Second Semester

BIT	799	Dissertation	10 (0 – 20 – 40)
		Total	**10 (0 – 20 – 40)**

◆ **Fourth Year**

First Semester

BIT	799	Dissertation	10 (0 – 20 – 40)
		Total	**10 (0 – 20 – 40)**

Second Semester

BIT	799	Dissertation	10 (0 – 20 – 40)
		Total	**10 (0 – 20 – 40)**

COURSE DESCRIPTIONS

BIT 611 Molecular Modeling 3 (3 – 0 – 9)

Prerequisite: consent of instructor

Concepts of modeling of biomolecular systems and processes. Experimental and theoretical methods for determination and analysis of three-dimension biologically important molecules. Application of these methods in the study of relationships between molecular structure and biological activities, including RNA and protein folding, protein-protein interactions, protein-ligand binding, membrane topology, and drug design.

BIT 612 Cellular and Molecular Physiology 3 (3 – 0 – 9)

Prerequisite: None

Structures and function of important macromolecules, structural assembly, biochemical process underlying metabolism, transport system, metabolic regulation, macromolecular synthesis and processing, protein trafficking, gene expression, regulation and control, cell growth and its regulation, cell signaling, response of cells to environmental stress.

BIT 631 Molecular Biotechnology 3 (3 – 0 – 9)

Prerequisite: consent of instructor

Principle of gene structure and function. Basic techniques in gene manipulation. Application of gene technology in expressing commercially-important proteins and metabolite in recombinant systems, such as in bacterial, yeast, fungi, animal, and plant cells. Genomics and bioinformatics technology for agriculture, medical, and biotechnological applications.

BIT 632 Bioinformatics and Genomics 3 (3 – 0 – 9)

Prerequisite: consent of instructor

Principle and application of bioinformatics and genomics in modern biological and biotechnological research. Topics include: genomics technologies (transcriptomics, proteomics, metabolomics): high-throughput data structure and databases and how to generate them; bioinformatics tool packages and applications; genomics data search, analysis, and interpretation; functional and comparative genomics. Hands-on practice using computational tools to solve biological and biotechnological problem. Current trends in these and related fields.

BIT 641 Treatment and Utilization of Biological Wastes 3 (3 – 0 – 9)

Prerequisite: None

Parameters of water pollution, ecology of waste disposal. Treatment and use of water in food processing and other biological industries. Generation of solid wastes, sources, types, and composition. Onsite handling, storage, and processing. Collection systems, equipment, transfer, and transport. Processing techniques and equipment. Volume and size reduction. Component separation. Drying and dewatering. Disposal of solid waste and residual matter. Site selection landfilling methods and operation. Design of landfills. Methods of waste utilization. Recovery of resources, chemical, and biological conversion products. Recovery of energy from conversion products. Future of waste utilization.

BIT 651 Applied Computational Methods in Life Science 3 (3 – 0 – 9)

Prerequisite: None

A special course designed for students in biotechnological field. The course prepares students to face real world biological research problems and how to apply the mathematical techniques to cope with those problems. The course focuses on the introductions of computational methods and their applications in biological processes. The course includes conventional techniques such as linear algebra and differential equations and their applications in life science and new computational techniques such as Artificial Neuron Network (ANN) and Genetic Algorithm (GA) in solving life science problems. The course also includes some statistical methods such as linear regression and non linear regression. Some numerical methods and some software programs that are useful for solving life science problems are introduced.

BIT 661 Nanobiotechnology 3 (3 – 0 – 9)
Prerequisite: consent of instructor
Basics of biosystems at micro and nanoscales. Principles of microfabrication techniques. Nanoanalytics. Harnessing the structures and processes of biomolecules for designing new classes of nanofabricated devices, such as novel functional materials, biosensors, bioelectronics, for medical and biotechnological applications

BIT 662 Special Topic I 3 (3 – 0 – 9)
Prerequisite: consent of instructor
New or advanced topics in biotechnology. The contents will be specified at the time the course is offered.

BIT 663 Marine Biotechnology 3 (3 – 0 – 9)
Prerequisite: BIT 612 Cellular and Molecular Physiology
Development in marine biotechnology. Potential use of marine animals, plants, algae, and microbial for food, chemicals, bioactive metabolites, and medicine e.g. anticancer, steriols, alkaloids, halogenated acetogenins, phenolic compounds, and terpenoids. Marine algae as sources of polysaccharides e.g. agar, carrageenan and emulsifying agents. Potential use of freshwater and marine microalgae as sources of glycerol, pigments (carotenoids, β-carotene), polyunsaturated fatty acids, e.g. arachidonic acid, eicospentaenoic acid, and gamma-linolenic acid. Cultivation of algae, harvesting and extraction of chemicals. Development of photobioreactors. Immobilization of algae cells for commercial production of chemicals.

BIT 664 Electroanalytical Chemistry 3 (3 – 0 – 9)
Prerequisite: None
Fundamental concepts, electrochemical cells, principles of voltammetry, electrode-solution interface, types of electrodes, electron transfer, mass transport, types of voltammetry, potentiometry, modified electrodes, and spectroelectrochemistry.

BIT 665 Bioinformatics 3 (3 – 0 – 9)
Prerequisite: consent of instructor
Biological data cataloguing, management and utilization using the global network databases. In silico annotation and prediction of gene structure and functions, cellular functions and evolution. Impacts of bioinformatics on biotechnology, food technology, agriculture, pharmaceuticals, medicine, and environment. Hands-on access and utilization of the databases via internet.

BIT 666 Trends in Modern Biotechnology 3 (3 – 0 – 9)
Prerequisite: consent of instructor
This is an intensive self-study course in which students will do a literature survey, gather information, and give a series of presentations on the evolution/development, principles, applications, and recent research findings of modern biotechnology with implications in the medical, agricultural, food, biomaterials, energy, and environmental areas. Students will have to give English presentations to class as well as prepare a final report in English through regular consultation with the advisor who works in the area of interest outside class. Evaluation of student's knowledge and insight in the topic as well as learning and pres.

BIT 667 Special Topic II 3 (3 – 0 – 9)
Prerequisite: consent of instructor
New or advanced topics in biotechnology. Contents of the course will be specified at the time the course is offered.

BIT 668 Special Topic III 3 (3 – 0 – 9)
Prerequisite: consent of instructor
New or advanced topics in biotechnology. Contents of the course will be specified at the time the course is offered.

BIT 669 Techniques and Solution in Biotechnology 1 (1 – 0 – 3)
Prerequisite: None
The course is focused on learning techniques through small project assigned. Participants must partake in at least three research laboratories of interest in order to facilitate and achieve thesis work.

BIT 671 Technical Bioprocess Systems 3 (3 – 0 – 9)
Prerequisite: consent of instructor
Important technical systems in biological process, mass and heat transfers during fermentation, bioengineering systems design for reactor, kinetics of fermentation, types of fermentation, monitoring and controlling in biological process. Simulation and data analysis from packaging software

BIT 672 Biological Process Modeling and Model Analysis 3 (3 – 0 – 9)
Prerequisite: None
A course introduces students to real-life biological modeling problems. Fundamental principles and process model development are introduced. The fundamentals are then applied to model the real-life biological processes. Numerical techniques are introduced as tools for solving those models. Basic tools for model analysis are also introduced.

BIT 673 Advanced Biotechnology 3 (3 – 0 – 9)
Prerequisite: consent of instructor
The course covers recent advances in biotechnology, focusing on the development and operation of modern fermentation processes. Topics addressed include strain improvement, monitoring and control of key environmental parameters, and downstream processing for the recovery of fermentation products. Recent progress in the development of biosensors for fermentation monitoring and techniques for cultivation of plant cells and production of viruses are described. Applications of biotechnology in the food, agriculture, and medical industries are discussed.

BIT 681 Business and Management of Biotechnology Enterprise 3 (3 – 0 – 9)
Prerequisite: None
The first half of the course includes an overview of biotechnology applications and business trends locally and globally and basic business components required for a start-up of biotechnology companies ranging from nature of biotechnology companies, overview on investment and business plan. Second half of the course focuses on development of skills needed for managers and leaders in biotechnology companies such as problem-solving strategies, leadership skills for a diverse and global workforce, negotiation and motivation techniques, and goal integration. Students will research on biotechnology markets, products, technology, and organization. Course format includes lectures, class discussion, attending workshops, seminars, and a project.

BIT 682 Biotechnology Enterprise Initiative 3 (3 – 0 – 9)
Prerequisite: BIT 681 Business and Management of Biotechnology Enterprise & BIT 683 Marketing of Biotechnological Products or consent of instructor
This course provides foundation to build a biotechnology enterprise. Topics addressed involve market assessment of innovative technology, preparing a business plan, core financial components, strategies for raising finance and source of finance, entrepreneurship, human resource, etc. Students will have to develop a business plan for a biotechnology start-up and present the plan to a panel of experts from public and private sectors.

BIT 683 Marketing of Biotechnological Products 3 (3 – 0 – 9)
Prerequisite: consent of instructor
This course introduces students to the fundamentals in marketing such as concepts, tools, and techniques, the role of marketing versus technology in biotechnology industries, develop and implement a marketing plan for biotechnological products, design and implementation of marketing mix strategies over the product life cycles through a combination of case studies, guest speakers, student project, and discussions.

BIT 684 Investment in Biotechnology Industry 3 (3 – 0 – 9)
Prerequisite: consent of instructor
This course emphasize on developing the theory and tools to undertake capital budgeting, financial risk, and other analysis for long run investment planning for business.

BIT 685 Ethical, Legal, and Regulatory Issues in Biotechnology 3 (3 – 0 – 9)
Prerequisite: None
This course is divided into three sections of ethics, legal issues, and regulations which will be taught by guest lecturers from public and private sectors who specialized in the area. The ethic section will involve the core ethical values that guide the practice of science in biotechnology industry. Legal section will provide key concepts in protecting and managing biological resources, inventions, intellectual property, patent and licensing, and corporate laws. Regulatory section will address the range of local and global regulatory oversight mechanisms with which biotechnology industry have to comply. Students will learn through a combination of case studies, guest speakers, student project, and discussions.

BIT 686 Special Topic IV 3 (3 – 0 – 9)
Prerequisite: consent of instructor
Discussion on news, information, knowledge, and trends in business aspect of biotechnology and in biotechnology enterprise. Skills development in general and business communication, information mining and analysis emphasizing on policy and business perspective through various approaches especially with guest speakers from policy and private sectors.

BIT 711 Advanced Microbial Physiology 3 (3 – 0 – 9)
Prerequisite: BIT 612 Cellular and Molecular Physiology & BIT 631 Molecular Biotechnology
Current and future status and new techniques for studying microbial physiology. Critical analytical and presentation skill for clearly understanding microbial physiology

BIT 732 Advanced Gene Technology 3 (3 – 0 – 9)
Prerequisite: BIT 631 Molecular Biotechnology
Discussion of advanced research and future status of gene technology development.

BIT 761 Selected Topics 1 (3 – 0 – 3)
Prerequisite: None
Current interesting topics and research in Biotechnology and related area will be offered from time to time by Division staff and invited speakers.

BIT 775 Downstream processing for Biotechnology 3 (3 – 0 – 9)
Prerequisite: None
Separations and purification of metabolic products for specific uses e.g. food, pharmaceuticals, and cosmetics.

BIT 691 Seminar I 1 (0 – 2 – 3)
Prerequisite: None
Students are required to present seminars on advanced topics in Biotechnology or related areas to their classmates and members of teaching staff. Reports of the seminars have to be submitted for grading afterwards. Participation in seminar given by invited experts is also required.

BIT 692 Seminar II 1 (0 – 2 – 3)
Prerequisite: BIT 691 Seminar I
Students are required to present seminars on advanced topics in Biotechnology or related areas to their classmates and members of teaching staff. Reports of the seminars have to be submitted for grading afterwards. Participation in seminar given by invited experts is also required.

BIT 693 Seminar III 1 (0 – 2 – 3)
Prerequisite: BIT 692 Seminar II
Students are required to present seminars on advanced topics in Biotechnology or related areas to their classmates and members of teaching staff. Reports of the seminars have to be submitted for grading afterwards. Participation in seminar given by invited experts is also required.

BIF 612 Molecular Biochemistry 3 (3 – 0 – 9)
Prerequisite: None
Genome, transcriptome, proteome, basis of molecular evolution and their applications, cellular signaling.

BIF 614 Molecular Evolution 3 (3 – 0 – 9)
Prerequisite: BIF 612 Molecular Biochemistry
Molecular evolution and development, phylogenetic principles, phylogenetic reconstruction by distance, parsimony, and likelihood method, molecular clock and speciation.

BIF 622 Experimental Techniques in Molecular Biology 3 (2 – 2 – 9)
Prerequisite: None
This course is intended to provide an intensive overview of molecular biological techniques with both theoretical background and "hands-on" experiences. The focus will be on techniques used to study gene structure and expression. Techniques such as polymerase chain reaction (PCR); restriction endonuclease analysis; agarose and polyacrylamide gel electrophoreses; molecular cloning; automated DNA sequencing; Southern blot analysis; mRNA extraction, RT-PCR, northern blot and DNA microarray analysis; and 2D gel electrophoresis and proteome analysis will be performed. (Practices are important to enable computer scientists and mathematicians to get a feel for the techniques.)

BIF 632 Drug Design and Discovery 3 (3 – 0 – 9)
Prerequisite: BIF 511 Programming Fundamentals
Techniques in computer-aided drug design and discovery. Using computer and information technologies in areas such as searching and analysis of structure and function analysis of biological macromolecules; analysis of structure function and structure activities relationships of physiologically active compounds; ligand designing and simulation of their interaction with biological macromolecules; predictions of pharmacological properties of new substances; molecular graphics and *de novo* drug design.

BIF 634 Functional and Comparative Genomics 3 (3 – 0 – 9)
Prerequisite: None
The study of biological processes through genome-wide expression and regulation in organisms. DNA microarrays analysis, interaction between proteins and signal transduction. Gene identification and clustering genes into functional groups. Building networks and pathways of interacting genes and gene products. Perspectives on comparative genomics. Genome and sequence comparisons to understand the human genetics and evolution of organisms and genomic responses to the challenges of evolutionary niches.

BIF 662 Selected Topics in Bioinformatics I 3 (3 – 0 – 9)
Prerequisite: consent of instructor
New or advanced topics in bioinformatics. The contents will be specified at the time the course is offered.

BIF 664 Selected Topics in Bioinformatics II 3 (3 – 0 – 9)
Prerequisite: consent of instructor
New or advanced topics in bioinformatics. The contents will be specified at the time the course is offered.

BIF 666 Selected Topics in Bioinformatics III 3 (3 – 0 – 9)
Prerequisite: consent of instructor
New or advanced topics in bioinformatics. The contents will be specified at the time the course is offered.

BIF 772 Systems Biology and Metabolic Engineering 3 (3 – 0 – 9)
Prerequisite: None
Principles and methodology of systems biology and metabolic engineering. Studies of biological systems by systematically perturbing them biologically, genetically, or chemically. Monitoring gene, protein, and informational pathway responses; integrating these data; and ultimately, formulating mathematical models that describe the structure of the system and its response to individual perturbations. Introduction of metabolic engineering. Metabolic network reconstruction and analysis. Mathematical and experimental techniques for the quantitative description, modeling, control, prediction of biological processes, and design of metabolic pathways. Applications in strain improvements of biotechnological and agricultural importance, drug discovery, disease gene identification, diagnostic and prognosis.

BCT 601 Enzyme Technology 3 (3 – 0 – 9)
Prerequisite: None
The chemistry and structure of enzymes. Enzyme kinetics and mechanisms of enzyme action. Enzyme regulation and production. Extraction and purification of enzymes. Techniques of immobilization. Characteristics of immobilization enzyme and enzyme reactors. Enzyme reaction in organic solvents; solid phase and supercritical fluids. Application of enzymes in industries. Modification of enzyme molecules. Principles of protien engineering. Modification of enzyme structure by protein engineering techniques. Examples of engineering enzymes.

BCT 621 Lipid Technology 3 (3 – 0 – 9)
Prerequisite: None
Chemistry, structures, and occurrence of triglycerides and other lipids. Biosynthesis and degradation of fatty acids. Polyunsaturated fatty acids. Extraction of total lipid and purification. Industrial processes of fat and oil extraction, degumming, physical and chemical refinings, deoderization, crystallization, and hydrodegenation. Microbial and enzymatic modification of lipids. Analysis and quality control of lipid and edible oil industries. Utilization and oleochemical industries. Nutritional value of essential fatty acids.

CHE 512 Membrane Technology 3 (3 – 0 – 9)
Prerequisite: Chemical and Mass transfer
Principal and theories of synthetic membrane separation and concentration processes such as reverse osmosis, ultrafiltration, dialysis, and pervaporation. Type and preparation of synthetic membranes. Introduction in the use of membrane separation equipment. Application of membrane separation processes.

CHE 540 Biochemical Engineering 3 (3 – 0 – 9)
Prerequisite: Mass transfer
Biochemical and engineering principle of the industrial microbial and enzyme processes including: kinetics of enzyme-catalyzed reactions, isolation and utilization of enzymes, metabolic pathways and energetics, kinetics of microbe-catalyzed reactions, transport phenomena in microbial systems, design and analysis of bio-reactors, pure culture fermentation, and down stream processing.

CHE 634 Adsorption Separation 3 (3 – 0 – 9)
Prerequisite: Mass transfer
Concept of adsorption, gas-phase and liquid-phase adsorption force, rate of adsorption and equilibrium; Type characteristics and selection of adsorbents.

EET 627 Energy System Design 3 (3 – 0 – 9)
Prerequisite: None
Designing a workable system or an optimum system. Engineering economics. Equation fitting for characterization of energy equipment using experimental data. Modeling of energy equipment based upon physical laws. Energy system modeling and simulation. Selected optimization techniques for energy systems.

EET 692 Bio-Energy Conversion 3 (3 – 0 – 9)
Prerequisite: None
Concepts of biomass and energy transformation. Conversion and utilization of biomass to food, fiber chemicals, and fuel. Photosynthetic process and photochemical reactions in plants. Photo-production of hydrogen. Fermentation process and conversion of agricultural wastes to viable fuel alternatives. Alcohol fermentation. Methane production. Engineering operation and economics aspects of bio-digesters.

FDE 519 Food Engineering Principles 3 (3 – 0 – 9)
Prerequisite: None
The topics cover conversation of mass and material balances; conversation of energy and heat balances: the first law of thermodynamics: closed systems and control volumes; the second law of thermodynamics; fluid flow systems: external flow and internal flow; theory of momentum transfer, heat transfer: steady and unsteady state, mass transfer: and their application to food processing.

FDE 521 Food Process Engineering 3 (3 – 0 – 9)
Prerequisite: consent of instructor
Application of food and chemical engineering principles to an operational concept and design of various unit operations in food processes such as dehydration, concentration, freezing, filtration, membrane processing, extraction, and leaching. Thermodynamics. Steady and unsteady heating and cooling processes. Laboratory exercises illustrating the principle of the unit operations.

EEV 520 Wastewater Treatment 3 (3 – 0 – 9)
Prerequisite: None
Properties, structures, and functions of bacteria, algae, fungi, and protozoa. Growth and metabolism of microbes. Sterilization and analysis of water quality. Activated sludge process. Sludge drying bed. Anaerobic digestion. Planning, feasibility assessment, and site selection for water treatment by natural processes. Basic process responses and interactions. Fundamentals of wastewater treatment by natural processes such as stabilization ponds, land treatment systems, waste water reuse, etc.

EEV 623 Advanced Wastewater Treatment 3 (3 – 0 – 9)
Prerequisite: None
Chemical constituents and their effects in wastewater. Nitrogen and phosphorus removal. Design criteria of biological process. Design of removal processes of refractory organic, dissolved inorganic substances; carbon adsorption, ion exchange, ultrafiltration, electrodialysis. Utilization or disposal of concentrated contaminants resulting from advanced waste water treatment.

EEV 631 Hazardous Materials and Safe Disposal of Hazardous Waste 3 (3 – 0 – 9)
Prerequisite: None
Basic principles of hazardous materials. Atomic structure and chemical reactivity. Combustion mechanisms of reactive materials. Gas laws governing temperature, pressure, and volume behavior of compressed and cryogenic gases, explosive mechanism, shock waves, toxicity of materials, corrosive material, radioactive materials. Hazardous waste treatment technologies, physical, chemical, and biological treatments, treatment by precipitation, sedimentation, chemical oxidation, neutralization, extraction, incineration, landfills, land treatment, and ocean disposal.

EEV 632 Treatment and Utilization of Solid Waste 3 (3 – 0 – 9)
Prerequisite: None
Sources, types, and composition of wastes to be treated and utilized. Advantage and disadvantage in recycling wastes. Basic processing technologies. Processes of utilizing inorganic and organic wastes: composting, feed stuff, energy, chemical, landfill, and land treatment.