BIOTECHNOLOGY PROGRAM
(International Program)

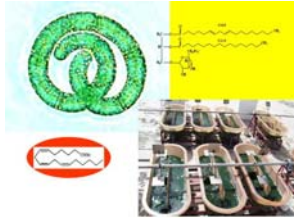
The School of Bioresources and Technology was established at KMUTT in 1993 with the aim of developing interdisciplinary curriculum that would produce personel capable of solving the problem arising from the change in the economic structure of Thailand from an agricultural to an industrial base. Natural resources need to be carefully exploited. With knowledge and experience, agricultural products can be converted from low to high value, freshness can be prolonged till reaching the end user, and agricultural soundness and productivity can be increased. This will help lead to a more sustainable development of the country. At present, the School offers a doctoral programme in biotechnology and master degree programmes in biotechnology and biochemical technology, postharvest technology, Natural Resource management, and biochemical technology.

Division of Biotechnology at King Mongkut's University of Technology Thonburi was founded in 1983. The Division is built around the resources and expertise of our researchers with the aim to promote research and development for the processing and production of biological materials to provide goods and services of value to society.

The graduate programme in Biotechnology is multidisciplinary courses providing necessary background for students and advanced courses in bioprocesses especially in fermentation technology. Realizing that genetic engineering and molecular biology is one of the principal technology among the various biotechnologies, the subject is also included in the programme. To meet the increasing demand of qualified personnel in the fast-growing economics of the country, the division started the Ph.D programme in 1991.

RESEARCH EXPERTISE

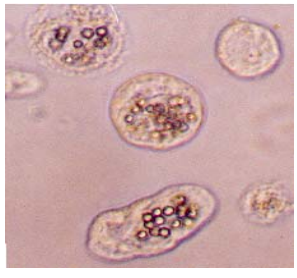
Algal Biotechnology



(boosya.bun@kmutt.ac.th)
-Mass cultivation of *Spirulina platensis*

-Harnessing genomics of *Spirulina platensis* for high value compound production
-Discovery of bioactive compound from cyanobacteria

Animal Cell Culture Laboratory

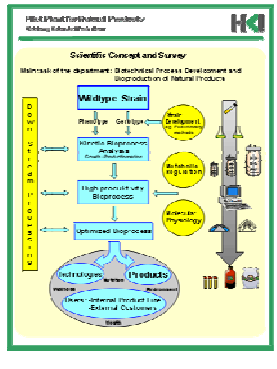


(kanokwan.poo@kmutt.ac.th)
-Molecular studies and production of wild type and genetic engineered baculovirus in insect cell culture
-Optimization and production of microorganisms and their high value products for animal feeds

Biodiversity Laboratory

(taweerat.vic@kmutt.ac.th)
-Endophytic fungi
-Fungal genomics and proteomics for fragrant aroma
-Glucan, an immune stimulant, production from edible mushroom

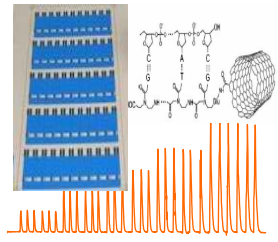
Bioprocess Modeling



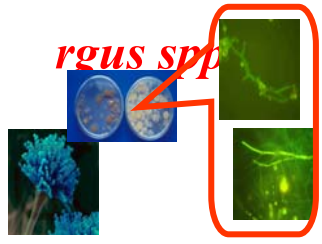
(anan.ton@kmutt.ac.th)
-Modeling of recombinant protein production by *Pichia pastoris*
-Modeling of amylase, protease production from fungi by solid state fermentation
-Software sensor for monitoring and bioprocess control

Chemical and biosensors
(werasak.sur@kmutt.ac.th)

-Biosensors
-Nanobiotechnology for analysis
-Computational sensor analysis
-Microfluidics for sensor application

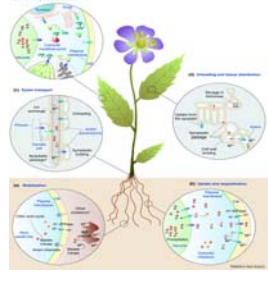


Fungal Biotechnology
(supapon.che@kmutt.ac.th)
-Systems biology study lipid metabolism involving fungal development and bioactive compound discovery
-Genome scale modeling of single cell oil producer
-Lipidomics of *Mucor rouxi*
-In silico and pilot scale analysis and production of essential fatty acids in fungi
-Molecular characterization of fungal polyketide synthases



Microbial Fermentation Technology
(yuwapin.dan@kmutt.ac.th)
-Fungal submerged fermentation process
-Active drying baker's yeast fermentation
-Alcohol fermentation from *Zymomonas mobilis*

Remediation
(paitip.thi@kmutt.ac.th)
http:// www.pdti.kmutt.ac.th/remediation
-Phytoremediation
-Wastewater treatment by precipitation, adsorption and electrocoagulation
-Biohydrometallurgy
Waste Utilization and Management
(pawinee.cha@kmutt.ac.th)
-Microbial community structure of anaerobic reactor systems by 16s rRNA approach
-Development of anaerobic technology
-Kinetic modeling of anaerobic digestion
-Biogas purification
Applied Research



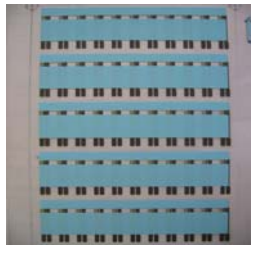
-Biogas production from Tapioca wastewater treatment

-Treatment of wastewater containing color and heavy metals by precipitation and adsorption

-Recycle of reused kerosene from printing industry

-Saccharomyces cerevisiae for probiotics

-Screen-printed electrode for blood glucose determination



Course expenses

M.Sc. Course (12 credits thesis)	80,300	baht
M.Sc. Course (18 credits thesis)	85,100	baht
Ph.D. Course (36 credits thesis)	127,650	baht
Ph.D. Course (48 credits thesis)	199,950	baht

Note:	-tuition fee	10,000	baht/semester
	-insurance	75	baht/semester
	-study courses	800	baht/credit
	-thesis	1,600	baht/credit

Number of graduated students

-M.Sc.	235	persons (1986 – 2005)
-Ph.D.	13	persons (1999 – 2005)

Number of present students

-M.Sc.	52	persons (2005)
-Ph.D.	24	persons (2005)

CURRICULUM

1. Master of Science Program

Total program credit **38 credits**
Curriculum Component

A.	Core Courses	11 credits
B.	Electives Courses	9 or 15 credits
C.	Thesis	12 or 18 credits

1. Core Courses 11 credits

BIT	621	Cellular and Molecular Physiology	3 (3-0)
BIT	631	Molecular Biotechnology	3 (3-0)
BIT	651	Applied Computational Methods in Life Science	3 (3-0)
BIT	691	Seminar I	1 (0-2)
BIT	692	Seminar II	1 (0-2)

2. Electives Courses 9 or 15 credits

BIT	611	Biodeterioration and Biodegradation	3 (3-0)
BIT	641	Treatment and Utilization of Biological Wastes	3 (3-0)
BIT	661	Nanobiotechnology	3 (3-0)
BIT	662	Selected Topics in Biotechnology	3 (3-0)
BIT	663	Marine Biotechnology	3 (3-0)
BIT	664	Electroanalytical Chemistry	3 (3-0)
BIT	665	Bioinformatics	3 (3-0)
BIT	671	Technical Bioprocess Systems	3 (3-0)
BIT	672	Biological Process Modeling and Model Analysis	3 (3-0)
BIT	673	Advanced Biotechnology	3 (3-0)
BIT	681	Business Aspects of BIotechnology	3 (3-0)
BIT	682	Biotechnology Enterprise Initiative	3 (3-0)
BIT	711	Advanced Microbial Physiology	3 (3-0)
BIT	732	Advanced Gene Technology	3 (3-0)
BIT	761	Selected Topics	1 (1-0)
BIT	775	Separation and Purification for Bioprocesses	3 (3-0)
BIF	612	Molecular Biochemistry	3 (3-0)
BIF	614	Molecular Evolution	3 (3-0)
BIF	622	Experimental Techniques in Molecular Biology	3 (2-2)
BIF	632	Drug Design and Discovery	3 (3-0)
BIF	634	Functional and Comparative Genomics	3 (3-0)
BIF	662	Selected Topics in Bioinformatics I	3 (3-0)
BIF	664	Selected Topics in Bioinformatics II	3 (3-0)
BIF	666	Selected Topics in Bioinformatics III	3 (3-0)
BCT	601	Enzyme Technology	3 (3-0)
BCT	621	Lipid Technology	3 (3-0)
CHE	512	Membrane Technology	3 (3-0)
CHE	540	Biochemical Engineering	3 (3-0)
CHE	634	Adsorption Separation	3 (3-0)
ET	627	Energy System Design	3 (3-0)
ET	692	Bio-Energy Conversion	3 (3-0)
FDE	519	Food Engineering Principles	3 (3-0)
FDE	521	Food Proces Engineering	3 (3-0)
EV	520	Wastewater Treatment	3 (3-0)
EV	623	Advanced Wastewater Treatment	3 (3-0)
EV	631	Hazardous Materials and Safe Disposal of Hazardous Waste	3 (3-0)
EV	632	Treatment and Utilization of Solid Waste	3 (3-0)

3. Thesis — 12 or 18 credits

BIT	698	Thesis	12 (0-24)
BIT	699	Thesis	18 (0-36)

Note : Student must pass the toefl score ≥ 500 or study LNG 601.
LNG 601 = Foundation English for International Program 1

STUDY PLAN

1 Thesis 12 credits

◆ First Year
First Semester

BIT	612	Cellular and Molecular Physiology	3 (3-0)
BIT	631	Molecular Biotechnology	3 (3-0)
BIT	651	Applied Computational Methods in Life Science	3 (3-0)
BIT	XXX	Elective	3 (3-0)
		Total	**12 (12-0)**

Second Semester

BIT	XXX	Elective	3 (3-0)
BIT	XXX	Elective	3 (3-0)
BIT	XXX	Elective	3 (3-0)
BIT	XXX	Elective	3 (3-0)
BIT	691	Seminar I	1 (0-2)
		Total	**13 (12-2)**

◆ Second Year
First Semester

BIT	692	Seminar II	1 (0-2)
BIT	698	Thesis	6 (0-12)
		Total	**7 (0-14)**

Second Semester

BIT	698	Thesis	6 (0-12)
		Total	**6 (0-12)**

2. Thesis 18 credits

◆ First Year
First Semester

BIT	612	Cellular and Molecular Physiology	3 (3-0)
BIT	631	Molecular Biotechnology	3 (3-0)
BIT	651	Applied Computational Methods in Life Science	3 (3-0)
BIT	691	Seminar I	1 (0-2)
		Total	**10 (9-2)**

Second Semester

BIT	XXX	Elective	3 (3-0)
BIT	XXX	Elective	3 (3-0)
BIT	XXX	Elective	3 (3-0)
BIT	691	Seminar I	1 (0-2)
		Total	**10 (9-2)**

◆ **Second Year**
First Semester

BIT	699	Thesis	9 (0-18)
		Total	**9 (0-18)**

Second Semester

BIT	699	Thesis	9 (0-18)
		Total	**9 (0-18)**

3. Doctor of Philosophy Program

Total program credit for **bachelor background** 76 credits
Curriculum Component
A. Core Courses 4 credits
B. Electives Courses 24 credits
C. Thesis 48 credits

1. Core Courses 4 credits

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

2. Electives Courses 24 credits

BIT	611	Biodeterioration and Biodegradation	3 (3-0)
BIT	621	Cellular and Molecular Physiology	3 (3-0)
BIT	631	Molecular Biotechnology	3 (3-0)
BIT	641	Treatment and Utilization of Biological Wastes	3 (3-0)
BIT	651	Applied Computational Methods in Life Science	3 (3-0)
BIT	661	Nanobiotechnology	3 (3-0)
BIT	662	Selected Topics in Biotechnology	3 (3-0)
BIT	663	Marine Biotechnology	3 (3-0)
BIT	664	Electroanalytical Chemistry	3 (3-0)
BIT	665	Bioinformatics	3 (3-0)
BIT	671	Technical Bioprocess Systems	3 (3-0)
BIT	672	Biological Process Modeling and Model Analysis	3 (3-0)
BIT	673	Advanced Biotechnology	3 (3-0)
BIT	681	Business Aspects of BIotechnology	3 (3-0)
BIT	682	Biotechnology Enterprise Initiative	3 (3-0)
BIT	711	Advanced Microbial Physiology	3 (3-0)
BIT	732	Advanced Gene Technology	3 (3-0)
BIT	761	Selected Topics	1 (1-0)
BIT	775	Separation and Purification for Bioprocesses	3 (3-0)
BIF	612	Molecular Biochemistry	3 (3-0)
BIF	614	Molecular Evolution	3 (3-0)
BIF	622	Experimental Techniques in Molecular Biology	3 (2-2)
BIF	632	Drug Design and Discovery	3 (3-0)
BIF	634	Functional and Comparative Genomics	3 (3-0)
BIF	662	Selected Topics in Bioinformatics I	3 (3-0)
BIF	664	Selected Topics in Bioinformatics II	3 (3-0)
BIF	666	Selected Topics in Bioinformatics III	3 (3-0)
BCT	601	Enzyme Technology	3 (3-0)

BCT	621	Lipid Technology	3 (3-0)
CHE	512	Membrane Technology	3 (3-0)
CHE	540	Biochemical Engineering	3 (3-0)
CHE	634	Adsorption Separation	3 (3-0)
ET	627	Energy System Design	3 (3-0)
ET	692	Bio-Energy Conversion	3 (3-0)
FDE	519	Food Engineering Principles	3 (3-0)
FDE	521	Food Proces Engineering	3 (3-0)
EV	520	Wastewater Treatment	3 (3-0)
EV	623	Advanced Wastewater Treatment	3 (3-0)
EV	631	Hazardous Materials and Safe Disposal of Hazardous Waste	3 (3-0)
EV	632	Treatment and Utilization of Solid Waste	3 (3-0)

Student can select master/doctoral courses offered by the program (under either compulsory and elective catagories) or master/doctoral courses offered by other program with the consent of the advisory committee.

3. Dissertation **48 credits**

BIT	799	Dissertation	48 credits

Note : Student must pass the toefl score ≥ 500 or study LNG 601.
LNG 601 = Foundation English for International Program

STUDY PLAN

◆ First Year
First Semester

XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
BIT	691	Seminar I	1 (0-2)
		Total	**7 (6-2)**

Second Semester

XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
BIT	692	Seminar II	1 (0-2)
		Total	**10 (9-2)**

◆ Second Year
First Semester

BIT	693	Seminar III	1 (0-2)
XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
		Total	**10 (9-2)**

Second Semester

BIT	761	Selected Topics	1 (1-0)
BIT	799	Dissertation	8 (0-16)
		Total	**9 (1-16)**

◆ Third Year
First Semester

BIT	799	Dissertation	10 (0-20)
		Total	**10 (0-20)**

Second Semester

BIT	799	Dissertation	10 (0-20)
		Total	**10 (0-20)**

◆ Fourth Year
First Semester

BIT	799	Dissertation	10 (0-20)
		Total	**10 (0-20)**

Second Semester

BIT	799	Dissertation	10 (0-20)
		Total	**10 (0-20)**

Total program credit for **master background** 48 credits

Curriculum Component

A.	Core Courses	3 credits
B.	Electives Courses	9 credits
C.	Thesis	36 credits

1. Core Courses 3 credits

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

2. Electives Courses 9 credits

2.1 Biotechnology

BIT	611	Biodeterioration and Biodegradation	3 (3-0)
BIT	621	Cellular and Molecular Physiology	3 (3-0)
BIT	631	Molecular Biotechnology	3 (3-0)
BIT	641	Treatment and Utilization of Biological Wastes	3 (3-0)
BIT	651	Applied Computational Methods in Life Science	3 (3-0)
BIT	661	Nanobiotechnology	3 (3-0)
BIT	662	Selected Topics in Biotechnology	3 (3-0)
BIT	663	Marine Biotechnology	3 (3-0)
BIT	664	Electroanalytical Chemistry	3 (3-0)
BIT	665	Bioinformatics	3 (3-0)
BIT	671	Technical Bioprocess Systems	3 (3-0)
BIT	672	Biological Process Modeling and Model Analysis	3 (3-0)
BIT	673	Advanced Biotechnology	3 (3-0)
BIT	681	Business Aspects of BIotechnology	3 (3-0)
BIT	682	Biotechnology Enterprise Initiative	3 (3-0)
BIT	711	Advanced Microbial Physiology	3 (3-0)
BIT	732	Advanced Gene Technology	3 (3-0)
BIT	761	Selected Topics	1 (1-0)
BIT	775	Separation and Purification for Bioprocesses	3 (3-0)

2.2 Other

BIF	612	Molecular Biochemistry	3 (3-0)
BIF	614	Molecular Evolution	3 (3-0)
BIF	622	Experimental Techniques in Molecular Biology	3 (2-2)
BIF	632	Drug Design and Discovery	3 (3-0)
BIF	634	Functional and Comparative Genomics	3 (3-0)
BIF	662	Selected Topics in Bioinformatics I	3 (3-0)
BIF	664	Selected Topics in Bioinformatics II	3 (3-0)
BIF	666	Selected Topics in Bioinformatics III	3 (3-0)
BCT	601	Enzyme Technology	3 (3-0)
BCT	621	Lipid Technology	3 (3-0)
CHE	512	Membrane Technology	3 (3-0)
CHE	540	Biochemical Engineering	3 (3-0)
CHE	634	Adsorption Separation	3 (3-0)
ET	627	Energy System Design	3 (3-0)
ET	692	Bio-Energy Conversion	3 (3-0)
FDE	519	Food Engineering Principles	3 (3-0)
FDE	521	Food Proces Engineering	3 (3-0)
EV	520	Wastewater Treatment	3 (3-0)
EV	623	Advanced Wastewater Treatment	3 (3-0)
EV	631	Hazardous Materials and Safe Disposal of Hazardous Waste	3 (3-0)
EV	632	Treatment and Utilization of Solid Waste	3 (3-0)

Student can select master/doctoral courses offered by the program (under either compulsory and elective catagories) or master/doctoral courses offered by other program with the consent of the advisory committee.

3. Dissertation 36 credits

BIT	799	Dissertation	36credits

Note : Student must pass the toefl score ≥ 500 or study LNG 601.
LNG 601 = Foundation English for International Program

STUDY PLAN

◆ First Year
First Semester

XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
XXX	XXX	Elective	3 (3-0)
BIT	692	Seminar II	1 (0-2)
		Total	**10 (9-2)**

Second Semester

BIT	761	Selected Topics	1 (1-0)
BIT	693	Seminar III	1 (0-2)
BIT	799	Dissertation	3 (0-6)
		Total	**5 (1-8)**

◆ Second Year
First Semester

BIT	799	Dissertation	6 (0-12)
		Total	**6 (0-12)**

Second Semester

BIT	799	Dissertation	9 (0-18)
		Total	**9 (0-18)**

◆ Third Year
First Semester

BIT	799	Dissertation	9 (0-18)
		Total	**9 (0-18)**

Second Semester

BIT	799	Dissertation	9 (0-18)
		Total	**9 (0-18)**

COURSE DESCRIPTIONS

BIT 611 Biodegradation and Biodeterioration 3 (3-0)
Prerequisite:Cellular and Molecular Physiology
Biodeterioration of materials, its causes, effects and prevention. The activity of different organisms in the decay of a wide range of organic and inorganic materials including metals. Organisms for biodeterioration testing. The techniques used in assessing the extent and cause of deterioration. Biodeterioration of timber in aquatic environments, petroleum products, synthetic polymers, tobacco and rubber in contact with water and sewage. Methods for testing wrappings and coatings for susceptibility to microbial attack. The microbial spoilage of pharmaceutical products, the detection of microorganisms. The microbial degradation of preservatives and antimicrobial agents. Product resistance to microbial attack. The microbial breakdown of pesticides and structural factors influencing biodegradability.

BIT 612 Cellular and Molecular Physiology 3 (3-0)
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)
Prerequisite: depend on instructor
Principles of gene structure and function. Basic techniques in gene manipulation. Applications of gene technology in expressing commercially-important proteins and metabolites in recombinant systems, such as in bacterial, yeast, fungi, animal and plant cells. Genomics and bioinformatics technology for agriculture, medical and biotechnological applications.

BIT 641 Treatment and Utilization of Biological Wastes 3 (3-0)
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)
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 Nanobiotechnologys 3 (3-0)
Prerequisite: depended on 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 Selected Topics in Biotechnology 3 (3-0)
Prerequisite: depended on 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)
Prerequisite: BIT 612
Development in marine biotechnology. Potential use of marine animals, plants, 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, carageenan 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)
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)
Prerequisite: depended on 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 671 Technical Bioprocess Systems 3 (3-0)
Prerequisite: depended on instructor
Important technical systems in biological process are refereed in the course. These include 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 is emphasized in the course.

BIT 672 Biological Process Modeling and Model Analysis 3 (3-0)
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)
Prerequisite: BIT 671 or depended on 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 Aspects of Biotechnology 3 (3-0)
Prerequisite: none
This course will serve as a foundation for biotechnology student an understanding of business, marketing, and management principles. It is designed for those interested in a multitude of business opportunities in biotechnology areas. Topics to be covered will be business planning, strategic approaches in marketing of biotechnological products and services, market assessment, business management skills, human resources management, finance, and business risk and risk assessment. Students will be required to conduct a survey on business and marketing strategies of biotechnology companies and present the case to the committee.

BIT 682 Biotechnology Enterprise Initiative 3 (3-0)
Prerequisite: none
This course will provide students an understanding of key factors important in the development of biotechnology industry as well as the formation and growth of biotechnology companies. Topics addressed will involve trends in modern biotechnology business, market assessment of innovative products and technology, patent and licensing, government policy and regulations, ethical concerns regarding research and applications in biotechnology. Leaders and executives from government sectors and private enterprises will be guest lecturers for many classes.

BIT 711 Advanced Microbial Physiology 3 (3-0)
Prerequisite: BIT 612 and BIT 631
Current and future status and new techniques for studying microbial physiology will be discussed. Critical analytical and presentation skill for clearly understanding microbial physiology will be focussed.

BIT 732 Advanced Gene Technology 3 (3-0)
Prerequisite: BIT 631 or depended on instructor
Discussion of advanced research and future status of gene technology development.

BIT 761 Selected Topics 1 (1-0)
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 Separation and Purification in Bioprocesses 3 (3-0)
Prerequisite: none
Separations and purification of metabolic products for specific uses e.g. food, pharmaceuticals and cosmetics.

BIT 691 Seminar I 1 (0-2)
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 guest lecturers from experts in Biotechnology.

BIT 692 Seminar II 1 (0-2)
Prerequisite: BIT 691
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 guest lecturers from experts in Biotechnology.

BIT 697 Special Project Study 6 (0-12)
Prerequisite: none
Application of knowledge and skills in Biotechnology to solve problems in the field of Biotechnology and related areas.

BIT 698 Thesis 12 (0-24)
Self-research and study under supervision of an advisor(s) which lead to new concept(s) or new finding in Biotechnology or related area.

BIT 699 Thesis 18 (0-36)
Self-research and study under supervision of an advisor(s) which lead to new concept(s) or new finding in Biotechnology or related area.

BIF 612 Molecular Biochemistry 3 (3-0)
Prerequisite: none
Genome, transcriptome, proteome, basis of molecular evolution and their applications, cellular signaling

BIF 614 Molecular Evolution 3 (3-0)
Prerequisite: BIF
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)
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. (Practicals are important to enable computer scientists and mathematicians to get a feel for the techniques.)

BIF 632 Drug Design and Discovery 3 (3-0)
Prerequisite: BIT 631
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)
Prerequisite: none
The study of biological processes through genome-wide expression and regulation in organisms. DNA microarrays analysis, protein-protein interaction 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 understanding the human genetics and evolution of organisms and genomic responses to the challenges of evolutionary niches.

BIF 662 Selected Topics in BioinformaticsI 3 (3-0)
Prerequisite: depended on 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)
Prerequisite: depended on 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)
Prerequisite: depended on 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)
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)
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)
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)
Prerequisite: chemical and mass transfer in BSc. study
Principles 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)
Prerequisite: chemical and mass transfer in BSc. study
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)
Prerequisite: chemical and mass transfer in BSc. study
Concept of adsorption, gas-phase and liquid-phase adsorption force, rate of adsorption and equilibrium; Type characteristics and selection of adsorbents.

ET 627 Energy System Design 3 (3-0)
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.

ET 692 Bio-Energy Conversion 3 (3-0)
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)
Prerequisite: depended on instructor
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)
Prerequisite: depended on 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.

EV 520 WasteWater Treatment 3 (3-0)
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.

EV 623 Advanced Wastewater Treatment 3 (3-0)
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.

EV 631 Hazardous Materials and Safe Disposal of Hazardous Waste 3 (3-0)
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.

EV 632 Treatment and Utilization of Solid Waste 3 (3-0)
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.