

BIOINFORMATICS PROGRAM (International Program)

Bioinformatics is a relatively new scientific discipline that is concerned with the study of biological information, ranging from the vast genetic information being rapidly accumulated, to patterns of protein expression and their links to disease states. Bioinformatics is very much the scientific and technical foundation of the human genome project, and promises to be the central life science of the coming century.

The international Bioinformatics course at KMUTT is designed for students who desire focused training in the elements of computer science, biology and biochemistry needed for a successful career in this exciting new discipline. Students in our program will receive comprehensive training in genomics, algorithms for sequence analysis, database design and management, software engineering and programming (including web-based development). Each student will apply their skills to a practical project, where they will design and implement a solution to a real-world problem under the guidance of an experienced mentor in industry or academia.

The degree program requires a total of 38 credits (for student who has strong back ground in both biological and computer sciences). In order to receive a Master's degree, students must demonstrate mastery of the core subject matter (expected to maintain a minimum grade of "B" in all core courses) and reach a minimum TOEFL test score of 500 (paper) or 173 (computer) prior to or on completion of the course. In 24 months students gain the knowledge and skills necessary to enter a career with industry or a career in research as a bioinformatics or biocomputing specialist

Master of Science Program in Bioinformatics

CURRICULUM

Total program credit **38 credits**
Curriculum Component

Plan A Thesis

A. Core Courses	12 credits
B. Elective Courses	12 credits
C. Seminar Courses	2 credits
D. Thesis	12 credits

Plan B Non-thesis

A. Core Courses	12 credits
B. Elective Courses	18 credits
C. Seminar Courses	2 credits
D. Special Project Study	6 credits

		Plan A non credit	Plan B non credit
1. Fundamental Courses			
BIF 412	Microbiology and Biochemistry		3(3-0-9)
BIF 511	Computer Systems and Programming		3(2-2-9)
BIF 512	Molecular Biology		3(3-0-9)
BIF 521	Data Structures and Algorithms		3(3-0-9)
2. Core Courses		12 credits	12 credits
BIF 612	Molecular Biochemistry		3(3-0-9)
BIF 621	Sequence Analysis and Annotation		3(3-0-9)
BIF 622	Experimental Techniques in Molecular Biology		3(2-2-9)
BIF 633	Data Mining for Bioinformatics		3(3-0-9)
3. Elective Courses		12 credits	18 credits
3.1 Biosciences			
BIF 614	Molecular Evolution		3(3-0-9)
BIF 632	Drug Design and Discovery		3(3-0-9)
BIF 634	Functional and Comparative Genomics		3(3-0-9)
BIF 662	Selected Topics in Bioinformatics I		3(3-0-9)
BIF 664	Selected Topics in Bioinformatics II		3(3-0-9)
BIF 666	Selected Topics in Bioinformatics III		3(3-0-9)
BIF 674	Advanced Biotechnology		3(3-0-9)
BIF 712	Advanced Microbial Physiology		3(3-0-9)
BIF 772	Systems Biology and Metabolic Engineering		3(3-0-9)
3.2 Computer Sciences			
BIF 611	Computer Architecture and Organization		3(3-0-9)
BIF 613	Operating Systems		3(3-0-9)
BIF 631	Database Systems		3(3-0-9)
BIF 641	Computer Systems Analysis and Design		3(3-0-9)
BIF 643	Software Engineering		3(3-0-9)
BIF 651	Artificial Intelligence		3(3-0-9)
BIF 653	Fuzzy Logic and Neural Network		3(3-0-9)
BIF 661	Operations Research		3(3-0-9)
BIF 663	Simulation Techniques		3(3-0-9)

BIF	671	Computer Graphics	3(3-0-9)
BIF	677	Selected Topics in Information Technology I	3(3-0-9)
BIF	679	Selected Topics in Information Technology II	3(3-0-9)

4. Seminar Courses **2 credits 2 credits**

BIF	692	Seminar in Bioinformatics I	1(0-2-4)
BIF	694	Seminar in Bioinformatics II	1(0-2-4)

5. Thesis / Special Project Study **12 credits 6 credits**

BIF	696	Special Project Study	6(0-12-24)
BIF	698	Thesis	12(0-24-48)

STUDY PLAN

Plan A Thesis

◆ Pre session

BIF	412	Microbiology and Biochemistry	3(3-0-9)
BIF	511	Computer Systems and Programming	3(2-2-9)
BIF	512	Molecular Biology	3(3-0-9)
BIF	521	Data Structures and Algorithms	3(3-0-9)

◆ First Year First Semester

BIF	612	Molecular Biochemistry	3(3-0-9)
BIF	621	Sequence Analysis and Annotation	3(3-0-9)
BIF	622	Experimental Techniques in Molecular Biology	3(2-2-9)
BIF	633	Data Mining for Bioinformatics	<u>3(3-0-9)</u>
		Total	<u>12 (11-2-36)</u>

Second Semester

BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	692	Seminar in Bioinformatics I	<u>1(0-2-4)</u>
		Total	<u>13 (12-2-40)</u>

◆ Second Year First Semester

BIF	698	Thesis	<u>6(0-12-24)</u>
		Total	<u>6 (0-12-24)</u>

Second Semester

BIF	698	Thesis	6(0-12-24)
BIF	694	Seminar in Bioinformatics II	<u>1(0-2-4)</u>
		Total	<u>7 (0-14-28)</u>

Plan B Non-thesis

◆ Pre session

BIF	412	Microbiology and Biochemistry	3(3-0-9)
BIF	511	Computer Systems and Programming	3(2-2-9)
BIF	512	Molecular Biology	3(3-0-9)
BIF	521	Data Structures and Algorithms	3(3-0-9)

◆ First Year First Semester

BIF	612	Molecular Biochemistry	3(3-0-9)
BIF	621	Sequence Analysis and Annotation	3(3-0-9)
BIF	622	Experimental Techniques in Molecular Biology	3(2-2-9)
BIF	633	Data Mining for Bioinformatics	3(3-0-9)
		Total	<u>12 (11-2-36)</u>

Second Semester

BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	692	Seminar in Bioinformatics I	1(0-2-4)
		Total	<u>13 (12-2-40)</u>

◆ Second Year First Semester

BIF	696	Special Project Study	6(0-12-24)
		Total	<u>6 (0-12-24)</u>

Second Semester

BIF	XXX	Elective	3(3-0-9)
BIF	XXX	Elective	3(3-0-9)
BIF	694	Seminar in Bioinformatics II	1(0-2-4)
		Total	<u>7 (6-2-22)</u>

COURSE DESCRIPTIONS

Biosciences

BIF	412	Microbiology and Biochemistry Prerequisite : none Biomolecules and biosynthesis; microbial growth, nutrition, and energy metabolism; microorganisms and cell structures, prokaryotes, eukaryotes and Archeabacteria; yeasts and molds; virus; microbial genetics; immunology	3(3-0-9)
BIF	512	Molecular Biology Prerequisite : none Gene organization in prokaryotes and eukaryotes, molecular mechanisms of protein synthesis, regulation of gene expression in prokaryote, transcription and post-transcription process in eukaryotes, genome dynamics, gene manipulation	3(3-0-9)
BIF	612	Molecular Biochemistry Prerequisite : none Genome, transcriptome, proteome, basis of molecular evolution and their applications, cellular signaling	3(3-0-9)
BIF	614	Molecular Evolution Prerequisite : BIT 612 Molecular evolution and development, phylogenetic principles, phylogenetic reconstruction by distance, parsimony, and likelihood method, molecular clock and speciation.	3(3-0-9)
BIF	622	Experimental Techniques in Molecular Biology Prerequisite : none 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.)	3(2-2-9)
BIF	632	Drug Design and Discovery Prerequisite : BIT 511 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 activities and 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 <i>de novo</i> drug design	3(3-0-9)
BIF	634	Functional and Comparative Genomics 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.	3(3-0-9)

BIF	662	Selected Topics in Bioinformatics I Prerequisite : As suggested by instructor/ lecturer New or advanced topics in Bioinformatics. The contents will be specified at the time the course is offered.	3(3-0-9)
BIF	664	Selected Topics in Bioinformatics II Prerequisite : As suggested by instructor/ lecturer New or advanced topics in Bioinformatics. The contents will be specified at the time the course is offered.	3(3-0-9)
BIF	666	Selected Topics in Bioinformatics III Prerequisite : As suggested by instructor/ lecturer New or advanced topics in Bioinformatics. The contents will be specified at the time the course is offered.	3(3-0-9)
BIF	674	Advanced Biotechnology Prerequisite : BIT 673 or As suggested by instructor/ lecturer Recent advances in biotechnology, with a focus on the development and operation of modern fermentation processes. Topics addressed include strain improvements, monitoring and control of key environmental parameters and downstream processing for recovery of fermentation products. Recent progress in the development of biosensors for fermentation monitoring, and techniques for cultivation of plants cells and production of viruses are described. Applications of biotechnology in the food, agriculture, and medical industries are discussed.	3(3-0-9)
BIF	692	Seminar in Bioinformatics I Prerequisite : none Review, discussion, invention, analysis, and synthesis of principles and concepts, current problems and literature in bioinformatics.	1(0-2-4)
BIF	694	Seminar in Bioinformatics II Prerequisite : none Review, discussion, invention, analysis, and synthesis of principles and concepts, current problems and literature in bioinformatics.	1(0-2-4)
BIF	696	Special Project Study Application of knowledge and skills in Bioinformatics to solve problems in the field of biological science and related areas.	6(0-12-24)
BIF	698	Thesis Analysis and development of an appropriate mathematical, statistical, and computing method for solving biological sciences problem.	12(0-24-48)
BIF	712	Advanced Microbial Physiology Prerequisite : BIT 411 and BIT 612 Current and future status in microbial physiology research	3(3-0-9)
BIF	772	Systems Biology and Metabolic Engineering 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.	3(3-0-9)

Computer Sciences

BIF	511	Computer Systems and Programming Prerequisite : none Basic structure of computer systems, operating systems and computer networks; the fundamental concepts of programming languages; structure programming: variables, operators, functions and I/O; various control statements and operations of languages; relationship among variables, pointers, and memory usage; local and global variables; function parameter passing; strings; file I/O; arrays; program design, writing, and debugging; construction of data structures using objects and pointers. Students will also have programming assignments in Bioinformatics problems.	3(2-2-9)
BIF	521	Data Structures and Algorithms Prerequisite : none Data structures: lists, stacks, queues, trees, hash tables, binary heaps; sorting algorithms: insertion sort, shellsort, heapsort, quicksort; graph algorithms; complexity theory: NP-completeness and undecidability; tree algorithms. Computational problems, set and graphs, searching algorithms, sorting algorithms, divide-and-conquer approach to problem solving, asymptotic efficiency of algorithms, algorithm optimizations using dynamic programming and greedy algorithms. Students will learn data structures used in bioinformatics problems.	3(3-0-9)
BIF	611	Computer Architecture and Organization Prerequisite : BIF 511 or equivalent and BIF 521 The computer systems: process, memory, and I/O modules, plus the interconnections among these major components; the central processing unit: control unit, registers, ALU, and the instruction unit; architectural issues: instruction set design; organizational issues: pipelining, parallel organization.	3(3-0-9)
BIF	613	Operating Systems Prerequisite : BIF 511 or equivalent and BIF 521 Operating system architecture, goals, and structure, process management, memory management, secondary storage management, computer security, and an introduction to distributed operating systems.	3(3-0-9)
BIF	621	Sequence Analysis and Annotation Prerequisite : BIF 511 or equivalent and BIF 521 An introduction to the theory and methods of DNA and protein sequence analysis, methods of sequence alignments including dynamic programming and statistical methods, methods of phylogenetic analysis, and database similarity searching	3(3-0-9)
BIF	631	Database Systems Prerequisite : BIF 511 or equivalent and BIF 521 File system; database system; DBS components and architecture; DBLC; database design: conceptual, physical, normalization; database languages: SQL, QBE; introduction to OODB and distributed database. Students will learn database systems used in bioinformatics.	3(3-0-9)
BIF	633	Data Mining for Bioinformatics Prerequisite : BIF 511 or equivalent and BIF 521 Introduction to probability theory, Bayesian Networks, Hidden Markov Model, Introduction to data mining and knowledge discovery in databases (KDD); the process of KDD; association rules; nearest neighbor classification; decision tree classification; neural networks classification; clustering; data mining applications in bioinformatics.	3(3-0-9)

BIF	641	Systems Analysis and Design Prerequisite : BIF 511 or equivalent and BIF 521 System components, SDLC, analysis methodologies and CASE tools; technical, operational, and economical feasibility studies; DFD, ERD, input design, output design, database design, documentation, presentation.	3(3-0-9)
BIF	643	Software Engineering Prerequisite : BIF 511 or equivalent and BIF 521 Software life cycle; requirement analysis; architectural design; software development for reuse; testing; software project management; complexity measurement; CASE tools.	3(3-0-9)
BIF	651	Artificial Intelligence Prerequisite : BIF 511 or equivalent and BIF 521 Problems in the domain of AI; uninformed searches; heuristic searches; means-ends analysis; adversarial searches; game playing; planning; understanding; natural language processing; robotics. Students will learn AI techniques used in bioinformatics.	3(3-0-9)
BIF	653	Fuzzy Logic and Neural Network Prerequisite : BIF 651 Fuzzy sets, fuzzy logic inference operations, neural computing elements, basic learning algorithms, biological neural concepts, neural network taxonomies, applications of neural network in bioinformatics.	3(3-0-9)
BIF	661	Operations Research Prerequisite : BIF 511 or equivalent and BIF 521 Deterministic models: linear programming (dual prices, inventory analysis), networks (Floyd's shortest path, relationships between networks and flows, transportation, and transshipment models), goal programming, integer programming, deterministic dynamic programming, and deterministic inventory models; probabilistic models: forecasting models, discrete simulation techniques and queuing models.	3(3-0-9)
BIF	663	Simulation Techniques Prerequisite : BIF 511 or equivalent and BIF 521 Defining and modeling simulation, values of simulation models; simulation techniques: problem formulation, data collection and analysis, developing simulation models, random number generation, model verification and validation, model experimentation and optimization, implementing simulation results, simulation techniques for bioinformatics.	3(3-0-9)
BIF	671	Computer Graphics Prerequisite : BIF 511 or equivalent and BIF 521 Hardware and software components; fundamental algorithms for two-dimensional graphics; methodologies for producing basic picture components and techniques for adjusting size, color and other attributes; two-dimensional geometric transformations and viewing algorithms; representations of three-dimensional objects; computer graphics applications in visualization of bioinformatics data.	3(3-0-9)
BIF	677	Selected Topics in Information Technology I Prerequisite : consider of advisor New or advanced topics in information technology. The contents will be specified at the time this course is offered.	3(3-0-9)
BIF	679	Selected Topics in Information Technology II Prerequisite : consider of advisor New or advanced topics in information technology. The contents will be specified at the time this course is offered.	3(3-0-9)