Professional Postgraduate Program in Bioinformatics (PPGP-BI)

(Autonomous, full-time, 11 months, residential Program
in association with **ATG Biosystems**)

21st century biology has been flooded with vast amounts of biological data that has made computational methodologies in life sciences increasingly important in research. Biological data is scattered across hundreds of biological databases and thousands of scientific journals. Current high throughput genomics technologies generate large quantities of high dimensional data. Microarray, NMR, mass spectrometry, protein chips, gel electrophoresis data, Yeast-Two-Hybrid, QTL mapping, gene silencing and knockout experiments are all examples of technologies that capture thousands of data points, often in single experiments. The challenge for Integrative Bioinformatics is to capture, model, integrate and analyze these data in a consistent way to provide new and deeper insights into complex biological systems.

This Professional Postgraduate Program in Bioinformatics aims to deliver students with a world view, knowledge and practical ability in tools and techniques of Integrative Bioinformatics. The Program therefore, offers core techniques and formalisms to every student, while allowing sufficient differentiation and choice in research projects and practical applications in the emerging field of Integrative Bioinformatics. The field of Integrative Bioinformatics is concerned with integrating the parts of system to generate the model at various levels in order to have deeper insights in to biological systems. The technical side of the Integrative Bioinformatics Program includes issues such as programming, algorithm design, data storage and mining protocols, integrating databases, systems biology and kinetic modeling, but all the time intimately integrated with biological and genomics problems.

Distinctive Features

☐ Theory and laboratory sessions to gain practical experience of generating information based hypothesis in 21st century biology and data generation through empirical biology
☐ Working with in-house developed and industry standard bioinformatics tools
☐ Collaboration with the bioinformatics companies at National and international levels (CLC bio, ATG Biosystems, vLife Sciences etc.)
☐ Expert lectures, seminars and case studies by leading experts from industries
☐ Twelve weeks full time project to enhance the understanding of translational research in Integrative Bioinformatics

Eligibility

Graduates / Postgraduates with a Bachelor's/Master's Degree in Life Sciences / Information Science / Computer Science / Physics / Chemistry / Mathematics and Statistics or Pharmacy and Medicine (with minimum 50 percent marks or equivalent grades).

Curriculum

Basic Courses:

CS001 / CS002 / CS003 Life Skills Development – I / II / III (Each 20 Hours): The Life Skills Development Program prepares students for communication and interaction in an organizational set-up. The focus would be on grammar, vocabulary, spoken English, remedial English, presentation skills, debates, group discussions, team building, time management. cross-cultural communication, creative and business writing. The ultimate objective of this course is to develop individuals with high intelligence and emotional quotients who are also competent speakers of English. At the end of the Life Skills Development Program the students would be well equipped with language skills. soft skills and life skills to enter the challenging corporate world.

Bridge Courses:

BI001 Basic Biology (10 Hours): Levels or Organization in Biology. Prokaryotic and Eeukaryotic Cells. Viruses. Growing Cells and Viruses. Control of Microorganisms. Organelles of the Eukaryotic Cells. Structure and Function. The Cell Cycle. Mendelian Genetics. Genetics of Bacteria and Phages. Development and Cell Differentiation. Population Genetics and Evolution. DNA and Genetic Information. Genome Structure. DNA Replication. DNA Transcription. Gene Expression Regulation. Messenger RNA Translation. Protein Synthesis.

BI002 Basics of Computer Science (10 Hours): Introduction to Computers. CPU. RAM and ROM Memories. BUS. Input and Output Devices. Controllers and Mass Storage Devices. Programming Languages. Machine Languages. Assembler. High Level Languages. Compiled Languages. Interpreted Languages. Operating Systems. Networking Applications. Internet. Computer Clusters. Supercomputers.

BI003 Organic and Biochemistry (15 Hours): Structure of Molecules. Introduction to Organic Molecules and Functional Groups. Stereochemistry Structure of Biomolecules. Biomolecules in Water. Chemical Composition of Cells. Levels of Protein Organization. Structure – Function Relationships in Proteins. Enzymes. General Concepts. Classification. Kinetics. Regulation of Enzyme Activity. Metabolic Pathways.

Foundation Courses:

BI501 Database and Programming Skills (50 Hours): Introduction to Database Systems. Data Modeling. The Relational Model and Normalization. SQL. Introduction to Client/Server and Internet Database Environment. Data Types in Biology. Data Marts. Federated Databanks. Data Abstract Types.

BI502 Analysis and Design of Algorithms (60 Hours): Introduction to Algorithms. Search Algorithms. Sort Algorithms. Greedy Algorithms. Graph Search Algorithms. Designing Algorithms. Algorithms in Molecular Biology.

BI503 Perl and Bioperl Programming (60 Hours): Programming Basics. Operators. Statements. Logical Expressions. Program Design. Control Structures. Arrays. Hashs. File Handling. CGI. Regular Expressions I. Regular Expressions II. Subroutines. Bioperl.

Core Courses:

BI601 Statistics in Bioinformatics (60 Hours): The Role of Statistics in Biology and Computational Biology. Random Sampling and Data Description. Point Estimation of Parameters. Statistical Intervals. Single Sample. Tests of Hypotheses. Statistical Inference. Simple Linear Regression and Correlation. Multiple Linear Regressions. Design and Analysis of Single-Factor Experiments: Analysis of Variance. Design of Experiments. Nonparametric Statistics. Multivariate Analysis. Bayesian Networks. Neural Networks. Classification and Clustering.

BI602 Computational Biology (50 Hours): Genome Assembly. Genome Annotation Pipeline. Sequence Analysis. DNA/RNA Sequence Analysis. Protein Sequence Analysis. Motif Search. Pair Wise Sequence Alignments. Multiple Sequence Alignment. Phylogeny. Structure analysis. Computational Methods. Algorithms in Molecular Biology.

BI603 Biological Informatics (60 Hours): Introduction. Text-based and functional databases. Sequence databases. Structure Databases. Genomics Databases. Transcriptomics. Proteomics Databases. Biological Data Integration. Literature Analysis. Text analysis. Information Retrieval. Information Extraction. Applications. Community Evaluation.

BI604 Laboratory Methods for Computational Biologist (60 Hours): Instrumentation. Laboratory Layout. Extraction. Purification and Characterization of Biomolecules. Estimation Methods. Electrophoresis. Chromatography Techniques. Bioseparation Techniques. PCR Applications.

Advanced Courses:

BI701 Science of Omics (60 Hours): Genomics. Genome Diversity. Genome Sequencing. Genotyping. Transcriptomics. Microarray Technology. Pharmacogenetics. Comparative Genomics. Proteomics. 2D Electrophoresis. Mass Spectrometry. Bioinformatics

in Proteomics. Metabolomics. Platform Technologies in Metabolomics. Regulatory and Standardization Issues. Experimental Design and Data Analysis.

BI702 Data Mining and Dynamic Modeling (60 Hours): Introduction. Association Rules. Rule Induction. KDD in Biological Data. Boolean Networks. Formal Grammars. Regular Grammars. Bioinformatics Data Analysis. Time Series. Hidden Markov Models.

BI703 Synthetic and Systems Biology (60 Hours): Synthetic Biology. Device Fabrication Characterization. System Design and Synthesis. Enabling Infrastructure. Applications. Systems Biology. Logical Dynamics of Gene Expression. Information Processing in Biological Networks. Cellular Decision Making. Molecular Oscillations. Spatial and Temporal Organization in Cells. Modularity and Robustness in Cellular Networks

BI704 Structural Biology and Drug Design (60 Hours): Protein Structure. Protein Databases. Computational Prediction of Protein Structure. 3D Prediction Computational Techniques. Protein Structure Validation Methods. Structure Based Drug Design. Structure of Protein Complexes. QSAR and Drug Designing.

BI705 Biotechnology (60 Hours): Biological Systems: Bacteria. Fungi. Yeast. Manipulation of Gene Expression. Raw Material.

Bioreactors. Large-scale Fermentation Systems. Growth (Fermentation). Harvesting Cells Systems. Downstream Processing. Recombinant Protein Products.

BI706 Industry Perspective Seminar (40 Hours): Industry experts and faculty will be providing case studies to prepare students for a career choice in Bioinformatics domain. Students need to provide their perspectives and defend their choices for evaluation.

Project:

BI801 Project (365 Hours): Students take up an industry-sponsored project or in-house project as one of the requirements of this program. For industry-sponsored projects, the Career Management Cell facilitates interaction between students and the industry. The students can also take-up the in-house projects under the guidance of the faculty and/or industry experts in their area of expertise. Students are encouraged to work on projects that will enhance their understanding in certain technology domains in real-life scenario. The project report has to be submitted to the Institute in the prescribed format, which will be examined by experts nominated by the Institute. The project is the culmination of the student's learning in the Institute and is expected to be of the high standards demanded by the industry.

Program Structure

Level	Subject Code	Subject Name	Hours
Basic			
	CS001	Life Skills Development - I	20
	CS 002	Life Skills Development - II	20
	CS 003	Life Skills Development - III	20
Bridge			
	BI 001	Basic Biology	10
	BI 002	Basics of Computer Science	10
	BI 003	Organic Chemistry and Biochemistry	15
Foundation			
	BI 501	Database and Programming Skills	50
	BI 502	Analysis and Design of Algorithms	60
	B I503	Perl and Bioperl Programming	60
Core			
	BI 601	Statistics in Bioinformatics	60
	BI 602	Computational Biology	50
	BI 603	Biological Informatics	60
	BI 604	Laboratory Methods for Computational Biologist	60
Advanced			
	BI 701	Science of Omics	60
	BI 702	Data Mining and Dynamic Modeling	60
	BI 703	Synthetic and Systems Biology	60
	BI704	Structural Biology and Drug Designing	60
	BI 705	Biotechnology	60
	BI 706	Industry Perspective Seminar	40
Project			
	BI 801	Project	365
			Total Hours: 1200