Department of Biotechnology
B.Tech. Biotechnology & Bioinformatics Course description

Fields	Values
Course Code	BT10010
Course Name	INTRODUCTION TO LIFE SCIENCES
Pre-Requisites (If any)	
Nature of Course	
Type of Course	ID
Credits	1
Targeted Program and Year	1st Year
Contents	Relevance of Biological Principles to Engineering undergraduates. Water and its special properties: Relevance to life. Building blocks of life: Bio-molecules and their structure-function aspects. Cell structure and organelles, cell membrane, cellular transport and signaling. How does a cell sustain life? Cell metabolism and its regulation; Cell energetic: harvesting chemical and solar energy. Cell division and cancer. DNA structure and packing. its replication, damage and repair: Consequences of unrepaired DNA damage. Dogma in Molecular Biology: Transfer of information from DNA to protein synthesis. Biotechnology.
References	
Course Objective	
Justification:	

Fields	Values
Course Code	BT10023
Course Name	Basic Bioinformatics
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Core
Credits	2
Targeted Program and Year	1st Year
Contents	Introduction to the biomolecules (DNA, RNA, Proteins, Lipids and Carbohydrates); gene, genome, DNA and Protein sequence, sequence assembly, sequence comparison, biological databases, similarity searches, multiple sequence alignment, Visualizing protein and DNA 3-D structures
References	1. Essential Bioinformatics by Jin Xiong, Cambridge University Press, ISBN-13 978-0-511-16815-4 eBook; 978-0-521-84098-9 hardcopy 2. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press, ISBN: 978-087969712-9 3. Bioinformatics: A practical guide to the analysis of genes and proteins by Baxevanis A.D. and Ouellette B.F. John Wiley & Sons, New York, ISBN: 978-0-471-47878-2 4. Bioinformatics An Introduction by Ramsden Jeremy, Springer 2021, ISBN: 9783030456078
Course Objective	This course is designed to introduce fundamental concepts of bioinformatics and its applications in biomedical research.
Justification:	

Fields	Values
Course Code	BT10110
Course Name	Introduction to bio-nanotechnology
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Department Core
Credits	1
Targeted Program and Year	1st Year
Contents	Introduction to nanotechnology and bionanotechnology, Biological self-assembly, Biologically inspired nanostructures - introduction to biomimetics, Nucleic acid nanotechnology, DNA origami, Protein engineering, Lipid nanotechnology, Chirality in biological systems, Interaction of nanomaterials with biological systems, Virology: viruses and vaccines
References	1. *Introduction to bionanotechnology* by "Young-Chul Lee and Ju-Young Moon" ASIN : B085WNVX1T; Springer; 1st ed. (2020) 2. *Physical Biology of a cell* by Rob Phillip, Jane Kondev and Julie Theriot ASIN 0815344503; Garland Science; 2nd edition (2012)
Course Objective	Introducing students with the concept of designing nanodevices using biological matter, famously known as "living software revolution".
Justification:	The idea of programming biomolecules to create nanodevices for their proposed applications in therapeutics, sequencing, drug-delivery *etc* is taking shape. This course focusses on giving the students a feel for this emerging research area of biological sciences. No large matching with the existing course of IITH.

Fields	Values
Course Code	BT20011
Course Name	Basic Biotechnology lab
Pre-Requisites (If any)	BT1020
Nature of Course	Practical/Lab
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	2nd Year
Contents	Basic practices of the biotechnology laboratory (laboratory safety, introduction to basic laboratory equipments and calibrations, Solution and buffer preparation, working under aseptic condition and sterilization, biological waste disposal), introduction to good laboratory practices (GLP), preparation of bacterial culture media and sterilization, preparation of LB agar plates, microbial plate streaking, bacterial growth curve, storage and preservation of microbial cultures, Genomic and plasmid DNA extraction, Nanodrop estimation of DNA, agarose gel electrophoresis, bacterial transformation, protein extraction, quantitative protein estimation using Bradford reagent, SDS-polyacrylamide gel electrophoresis (SDS-PAGE), Staining and destaining of PAGE gels.
References	Text Books: 1. Sambrook, Joseph. Molecular Cloning : a Laboratory Manual. Cold Spring Harbor, N.Y. :Cold Spring Harbor Laboratory Press, (2010). 2. Basic Laboratory Methods for Biotechnology by Lisa Seidman, Cynthia Moore, Second Edition, Pearson publisher, ISBN: 0321570146 (2008) 3. Biotechnology: A Laboratory Skills Course by J. Kirk Brown, Student Edition, Second Edition, ISBN: 978-0-9832396-3-5 (2011) 4. Biotechnology: A Laboratory Course 2nd Edition by Jeffery Becker, Gay Caldwell, Eve Ann Zachgo, Academic Press, ISBN: 0120845628 (1996)
Objective	This course provides practical training to work in the biotechnology laboratory.
Justification	The course covers basic hands-on techniques required for the undergraduates. It has about no overlap with other courses.

Fields	Values
Course Code	BT20023
Course Name	Biostatistics
Pre-Requisites (If any)	
Nature of Course	Theory and computer lab
Type of Course	Department core
Credits	3
Targeted Program and Year	2nd Year
Contents	Plotting and data visualization, Measures of central tendencies, Dispersion and shape of distributions, Correlation and Regression, Interpolation and extrapolations, Ψ^2 test and goodness of a fit, Non-linear data fitting, Introduction to python and R programming, Probability, Conditional probability and Baye's theorem, Random variables, Probability density function, Expectation, variance and co-variance, Binomial, Poisson and Gaussian distributions, Data distributions and central limit theorem, Confidence intervals, Test of hypothesis.
References	1. *Introduction to Probability & Statistics* by Medenhall, Beaver and Beaver 14th Edition Publisher ; Cengage Learning; 14th edition (2012) ISBN-10 : 1133103758 2. *Introduction to Probability & Statistics for Engineers and Scientists* by S M Ross, 3rd Edition; Academic Press; 5th edition (2014) ISBN-10 : 0123948118
Course Objective	This course is designed to introduce the basic concept of data or statistics and their application into the related areas of biosciences. Students will be able to effectively present their data and findings in different situations, achieve greater precision with available recourses.
Justification:	In the age of information, statistics has become an integral part of research, particularly it has profound applications in human health and disease control. Overall this course will help students to understand the importance of data and preparing them for scientific research and presentation. No large matching with the existing course of IITH.

Fields	Values
Course Code	BT20030
Course Name	Biochemistry
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	2nd Year
Contents	Stereoisomers and life; thermodynamics of biochemical reactions; Structural biochemistry: Protein Structure, Protein Folding; Enzyme Catalysis, Enzyme Kinetics; Lipid structure and membrane assembly, Bioenergetics: Glycolysis, Glycolysis of red blood cells and liver, The citric acid cycle, Electron transport, ATP synthesis; Photosynthesis; Regulation of blood sugar: Overview of metabolic biochemistry; Overview of synthesis and degradation of Biomolecules.
References	Text Books: 1. Lehninger Principles of Biochemistry (WH Freeman, 7th Edition, (2017) by David L. Nelson and Michael M. Cox 2. Voet′s Principles of Biochemistry (John Wiley & Sons, 5th Edition, (2018) by Donald Voet, Judith G. Voet, Charlotte W. Pratt
Objective	This course aims to provide basic concepts of biochemistry
Justification	The course covers basic concepts of biochemistry of the cell, that is essential for understanding the cellular process especially metabolic processes and physiology of the cell. It has about 10% overlap with the masters level course BT5010.

Fields	Values
Course Code	BT20040
Course Name	Microbiology
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Core
Credits	2
Targeted Program and Year	2nd Year
Contents	Evolution of microorganisms and microbiology; Cell structure and organisation - prokaryotic and eukaryotic cells; Microbial taxonomy and diversity; Staining and microscopy; Microbial growth; Bacterial culture methods; Microbial metabolism; Control of microorganisms - physical and chemical methods for control of microorganisms, antimicrobial chemotherapy, resistance to antibiotics; Microorganisms in the environment – microbiology of soil, air, freshwater, and seawater; Biogeochemical cycles -carbon cycle, nitrogen cycle, sulphur cycle; Medical microbiology and virology- microbial diseases, detection and control; Industrial and food microbiology
References	1. Prescott's Microbiology 11th Edition - By Joanne Willey and Kathleen Sandman and Dorothy Wood, McGraw-Hill, ISBN13: 9781260211887. 2. Microbiology by E.C.S. Chan,Michael J. Pelczar, Jr.,Noel R. Krieg, Tata McGraw-Hill Education Pvt. Ltd, ISBN 13: 9780074623206. 3. Fundamental Principles of Bacteriology by A.J. Salle, Tata McGraw Hill Education; 7th edition, ISBN-13: 978-0070995628.
Course Objective	This course aims to deliver elementary concepts of microbiology
Justification:	

Fields	Values
Course Code	BT20053
Course Name	Big Data Biology and Biological Databases
Prerequisite (If any)	
Nature of Course	Theory
Type of Course	Departmental Core
Credit	3
Targeted Program and Year	2nd Year
Contents	Introduction to big data in biology, Big data characteristics, Big data revolution, Industrialization of big data biology, Big data analytics, Challenges in big data analytics, Big data privacy and security, Big data visualization and integration, Big data analytics in health research, Electronic health records (EHR), OMICS disciplines and revolution, OMICS data integration, OMICS data management, OMICS tools, Biological databases and their development, Nucleic acid databases, Protein data banks, Genomic and proteomic databases, Pathway databases.
References	Text Book(s): 1) Bioinformatics for Omics Data (Methods and Protocols), Editors: Mayer, Bernd (Ed.) (Springer) (2011) 2) Big Data Analysis for Bioinformatics and Biomedical Discoveries. ISBN 9780367240226 Chapman and Hall/CRC Shui Qing Ye (Ed.) (2019) 3) Big Data Analytics in Bioinformatics and Healthcare (IGI Global) by Baoying Wang, Ruowang Li and William Perrizo. ISBN: 9781466666115 (2014)
Objective	The course aims to provide insight into high-throughput big data in biology, its analysis, interpretation and storage.
Justification	In the recent time, we are witnessing a huge surge of biological data specially omics data coming from different worldwide projects. Big data always comes with its own challenges e.g., analysis, storage, maintenance, security and privacy. This course work aims to impart knowledge on these aspects of big data in biology to students. This course is unique and not matching with other existing courses at large.

Fields	Values
Course Code	BT20060
Course Name	Molecular and Cellular Biology
Pre-Requisites (If any)	
Nature of Course	Theory and practical
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	2nd Year
Contents	Basics of cell and cell organelles, introduction to biomolecules (DNA, RNA, Proteins, Fatty Acids), cell cycle (mitosis and meiosis) and its regulation, enzymes, enzyme kinetics, cellular energetics, eukaryotic and prokaryotic DNA replication, transcription (gene regulation), and translation (protein synthesis), protein sorting, 3D genome organization, epigenetics, mitotic bookmarking and epigenetic transcription memory, apoptosis, necrosis, cell junctions, stem cells. Techniques used in cell and molecular biology: PCR, RT-PCR, Electrophoresis for DNA and proteins, blotting techniques, cloning, visualizing cellular processes by fluorescence microscopy, immunofluorescence, immunoprecipitation assays, FACS, chromatography (affinity, ion-exchange, size exclusion, HPLC), electron microscopy (TEM/SEM), next generation sequencing, cell and tissue culture, CRISPR-Cas9 based genome editing, DNA and protein microarrays, X-Ray diffraction, mass-spectrometry. The practical component of this course contains a demonstration of PCR, RT-PCR, Gel electrophoresis of DNA and proteins, western blotting, cloning, fluorescence microscopy, immunofluorescence, microscopy image processing using ImageJ, and data analysis.
References	Text Book(s) 1) Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, W.W. Norton & Company, ISBN: 0815344643 2) Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris Kaiser, Monty Krieger, Matthew Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, W.H. Freeman publisher, ISBN: 1429203145
Course Objective	This course provides a basic understanding of how a cell works, and how cellular machines are regulated for fundamental processes of life. It covers different topics and techniques pertaining to cell biology and molecular biology. The practical component of this course provides a demonstration of cutting-edge research tools used in cell and molecular biology research.
Justification:	Cell and Molecular Biology is one of the core branches of Medical Biotechnology, with immense applications in

	biomedical research. Providing a fundamental understanding of cell mechanics and the research technologies used to visualize and quantify cellular processes are the major goals of this course. The practical component of this course provides hands-on experience with a variety of basic technologies used in molecular and cellular biology.

Fields	Values
Course Code	BT20070
Course Name	Biochemical Engineering
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	2nd Year
Contents	Cell growth kinetics, Cell growth in batch and continuous stirred tank fermentation, Kinetics of substrate utilization and product formation, Enzymes, Role of enzymes in biochemical reactions, Kinetics of enzyme catalysed reactions, Enzyme Inhibition kinetics and types (competitive, non-competitive, uncompetitive), Reaction thermodynamics (laws of thermodynamics, Gibbs free energy, entropy, enthalpy, endothermic and exothermic reactions, chemical equilibrium), Bioprocess stoichiometry and yield concepts, Mass and energy balances in biochemical engineering, Transport phenomena in bioprocess system (mechanism of transportation, mixing, heat transfer, mass transfer), Fermentation technology (submerged fermentation, solid-state fermentation, industrial fermenter and material analysis), Process control and automation, Bio-separation and downstream processing (cell disruption, sedimentation, centrifugation, filtration, extraction, evaporation, crystallization), Membrane processes (dialysis, ultrafiltration, microfiltration, reverse osmosis), Scale-up and economic analysis in biochemical processes.
References	Text book: 1) Biochemical Engineering Fundamentals by James Bailey and David Ollis, 2nd edition, McGraw Hill Education publisher, ISBN: 9780070701236 2) Introduction to Biochemical Engineering by D G Rao, 2nd edition, McGraw Hill Education publisher, ISBN: 0070151385 3) Biochemical Engineering: A textbook for engineers, chemist and biologist, 2nd edition by Shigeo Katoh, Jun-ichi Horiuchi and Fumitake Yoshida, Wiley-VCH publisher, ISBN: 9783527338047
Course Objective	Biochemical Engineers develop processes of a variety of natural as well as synthetic substances such as platform chemicals, biofuels, ecological development, environmental changes, and developing medicines to improve the quality of the healthcare sector, diagnostic processes, food processing and medicines. This course is designed to teach fundamentals of biochemical engineering.
Justification:	

Fields	Values
Course Code	BT20083
Course Name	Next Generation Sequencing
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Departmental Core
Credits	2
Targeted Program and Year	2nd Year
Contents	Introduction to NGS, First-generation DNA sequencing: Maxam-Gilbert Method, Sanger Method, Second-generation DNA sequencing: Sequencing by hybridization, Sequencing by synthesis, 454 pyrosequencing, Ion Torrent, Illumina technology, Third-generation DNA sequencing: Single molecule real time (SMRT) sequencing (PacBio), Fourth-generation DNA sequencing: Nanopore based sequencing, Human genome project, Genome assembly, NGS analysis and bioinformatics pipeline, Clinical applications of NGS: Molecular diagnosis of genetic diseases, Understanding of epigenome using NGS technologies, Microbial sequencing methods
References	Books: 1) Next Generation Sequencing: Translation to Clinical Diagnostic by Lee-Jun C. Wong, ISBN 9781461470007 (2013) 2) Next-generation DNA sequencing Informatics by Stuart M. Brown, Cold Spring Harbor Laboratory, 2013. ISBN 9781621821236 3) Big Data Analysis for Bioinformatics and Biomedical Discoveries by Shui Quing Ye. ISBN 9780367783273 (2016) Research/Review Articles: 1) Barton E. Slatko, Andrew F. Gardner, and Frederick M. Ausubel. Overview of Next Generation Sequencing Technologies. Curr Protoc Mol Biol. 2018 April ; 122(1): e59 2) James M. HeatherBenjamin Chain. The sequence of sequencers: The history of sequencing DNA. Genomics 107 (2016) 1–8.
Course Objectives	On passing the course, students should know 1) Early methods of DNA sequencing 2) Different generations of DNA sequencing methods 3) How high throughput DNA sequencing methods work 4) Basic knowledge of NGS data analysis and relevant bioinformatics tools 5) Clinical applications of NGS technologies in understanding of genetic diseases.
Justification	Next generation sequencing (NGS) technologies revolutionized the health sector and the recent advancements in NGS technologies tremendously increase our capabilities to sequence the complex genomes in a massively parallel fashion. Importance

	of NGS has also been proved in COVID-19 pandemic, where it helped in detecting new variants and genomic surveillance of SARS-CoV-2 worldwide. This course will help students to learn about these indispensable technologies and how it can help us in understanding of complex genetic diseases. The content of this course matches <5% with BT3050, which include very basic introduction of NGS.

Fields	Values
Course Code:	BT20090
Course Name:	Protein structure, function and disease
Prerequisite (If any)	
Nature of Course	
Type of Course	Departmental Core
Credit	3
Targeted Program and Year	2nd Year
Contents	Primary structure – Secondary structure – Tertiary Structure - Quaternary Structure – Ramachandran Diagram - Fibrous proteins – Globular proteins – sequence-to-structure-to-function paradigm- protein fold classification - Sickle cell anaemia
References	
Objective	The course provides the elementary concepts about protein structure and function
Justification	

Fields	Values
Course Code:	BT20120
Course Name:	Molecular Biophysics and Macromolecular Structural Biology
Prerequisite (If any)	Biochemistry (BT2030)
Nature of Course	Theory
Type of Course	Departmental Elective
Credit	3
Targeted Program and Year	2nd Year
Contents	Biophysical measurements, the structure and properties of proteins, enzyme action, the structure and properties of nucleic acids at the molecular level. Cooperative transitions in biological macromolecules. Quantification and characterization of interactions, involving proteins with other molecules termed as ligands (proteins, nucleic acids, carbohydrate, peptide, inorganic molecules etc), using appropriate biophysical techniques. Art of macromolecules crystallization. Macromolecular crystallography and macromolecular structural biology. Biophysical approaches to understand structure-function relationship of macromolecules. It will also cover understanding of entropy and enthalpy driven processes, biochemical equilibrium, phase transitions in lipid, bilayers and membranes, intra- and intermolecular interactions, and spectroscopy of proteins and nucleic acids. Physical techniques and related biology.
References	Reference books: 1. Biophysics: An Introduction: R. Glaser (2012) Springer 2. Physical Biology of the Cell: Rob Phillips, Jane Kondev, Julie Theriot, and Hernan Garcia (2012) Garland Science. 3. Outline of Crystallography for Biologists: D. Blow (2002), Oxford University Press 4. Essentials Of Biophysics, P. Narayanan, New Age International Publishers, 2007
Objective	The course covers basic concepts of biophysics and physical biochemistry.
Justification	This course covers the physical aspects of macromolecules interactions and quantifications. These are basic concepts for drug discovery, engineering biomaterials and understanding the functioning of macromolecules in the cell.

Fields	Values
Course Code	BT20123
Course Name	Biomolecular Simulations
Pre-Requisites (If any)	
Nature of Course	Theory and computer lab
Type of Course	Department Core
Credits	3
Targeted Program and Year	2nd Year
Contents	Historical perspective, Statistical ensembles, Quantum Mechanics (QM) Foundations of Molecular Mechanics (MM), Force-fields, Introduction molecular dynamics simulations, Equation of motion, Scheme of integrations, Langevin Dynamics, Non-bonded Computations, Brownian Dynamics, Monte Carlo Techniques, Coarse Graining Models
References	1. *Molecular modelling and simulation*: An interdisciplinary guide by Tamar Schlick Springer; 2nd ed. 2010 ISBN-10 : 1441963502 2. *Computer Simulations of Liquids* by M.P. Allen and D. J. Tildesly Oxford ISBN-13: 9780198803195 (2017) 3. *Understanding molecular: From Algorithms to Applications* by Daan Frenkel and Berend Smit Academic Press; 2nd edition (2001) ISBN: 0122673514
Course Objective	To provide an introduction to computer modeling of biomolecules. Prepare the students for multiscale modelling approaches in biotechnology and bioinformatics.
Justification:	With the advancement in computer architecture and algorithms, computer simulation has become a valuable tool to probe biomolecular form and function. This introductory course focuses on presenting an interdisciplinary guide for ever increasing field of biomolecular modeling and simulation. No large matching with the existing course of IITH

Fields	Values
Course Code	BT20140
Course Name	Model Systems in Biology
Pre-Requisites (if any)	
Nature of Course	
Type of Course	Departmental Elective
Credits	3
Targeted Program and Year	2nd Year
Contents	
References	1) Model Organism; Rachel Ankeny and Sabina Leonelli, Cambridge University Press. 2021 (1st ed) ISBN: 9781108593014 2) The Biological Resources of Model Organisms (2020) 1st ed. Robert L. Jarret and Kevin McCluskey (Ed.) ISBN 9781138294615 3) The paradox of model organisms by Philip Hunter, EMBO rep 2008,9:717-720.
Course Objectives	This course demonstrates various model systems used for biomedical research, their advantages and disadvantages and how to select the best model system to address specific biological question. Topics included: classification of the model systems (such as plants, bacteria, yeast, drosophila, zebrafish, mouse, human cells, stem cells), their unique features, how the genetic manipulations are carried out with each model system and their limitations, which resources/databases are available for each model system such as genome sequence databases, toolboxes for genetic manipulations etc, methods/media for growth and cultivation, methods for visualizing/imaging, how to select the best model system for addressing various biological questions, ethical issues for selecting a model system or for sacrificing number of animals.
Justification	

Fields	Values
Course Code	BT30030
Course Name	Sequence Alignment Algorithms
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Core
Credits	2
Targeted Program and Year	3rd Year
Contents	Sequence alignment: Pair-wise alignment method, Dynamic programming: Needleman-Wunsch method; Smith Waterman method, Multiple sequence alignment method Heuristic method: BLAST-Introduction to phylogenetic trees.
References	1) David W Mount, Bioinformatics sequence and genome analysis, CBS publishers & Distributors 2nd Ed. (2004) ISBN 978-087969712-9 2) Multiple Sequence Alignment Methods; David J Russell, (Ed.) 1st Ed. 2014 ISBN 978-1-62703-646-7
Course Objectives	The course provides insight about the algorithms involved in sequence alignment
Justification	

Fields	Values
Course Code	BT30043
Course Name	Genetic Engineering
Pre-Requisites (if any)	
Nature of Course	Theory and Lab
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	3rd Year
Contents	Theory: Introduction to recombinant DNA technology; Cutting and joining DNA molecules; Restriction endonucleases; Basic biology of plasmid vectors; Gene cloning strategies; Construction of cDNA libraries in plasmids; Radioactive and non-radioactive methods for labelling DNA; DNA sequencing; Transformation; PCR technology; RT-PCR and quantitative RT-PCR; Practical: Isolation of plasmid DNA, PCR amplification of a DNA fragment; Separation of PCR products by gel electrophoresis; Ligation of PCR product into a plasmid vector. Transformation of the ligation products into E. coli; RT-PCR; Analysis of proteins using SDS-PAGE.
References	Textbooks: 1. Molecular Cloning: A Laboratory Manual, by Joseph Sambrook, David Russell, Cold Spring Harbor Laboratory Press, U.S.; 3rd Revised edition (2012), ISBN-13: 978-0879695774. 2. Principles of Gene manipulation and Genomics, 7th edition (2014) S. By Sandy B. Primrose, Richard Twyman. Wiley-Blackwell, ISBN: 978-1-405-13544-3 3. Molecular Biology of the Gene, by James D. Watson, Pearson Education; Seventh edition, ISBN-13: 978-9332585478.(2010) 4. Lewin's GENES XII 12th Edition, by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, ISBN-13: 978-1284104493 (2018).
Course Objectives	The overall objective of this course is to provide a detailed understanding of different gene manipulation technologies and to elaborate on their diverse applications.
Justification	This course will help students to learn about these essential recombinant DNA technologies. The content of this course does not have any overlap with the existing course of IITH.

Fields	Values
Course Code	BT30050
Course Name	Genomics, Transcriptomics, Proteomics
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	3rd Year
Contents	Brief overview of prokaryotic and eukaryotic genome; Extrachromosomal DNA: bacterial plasmids, mitochondria and chloroplast; The Organization and Structure of Genomes; Mapping and sequencing genomes; Next Generation DNA Sequencing (NGS); Analysis of the transcriptome; RNA sequencing; Human genome project; Accessing and retrieving information from different genome projects; Genomic insight into evolution-comparative genomic analysis; Pharmacogenomics; Transition from genomics to proteomics; Basics of protein chemistry and proteomics; Technical aspects of different quantitative proteomics methods; Mass-spectrometry and data analysis; Analysis of protein-protein interactions; Human proteome projects; Proteogenomics; Metabolomics and global biochemical networks; Integrated omics technologies and personalised medicine
References	1) Functional Genomics (Methods in Molecular Biology) by Kaufmann, Michael, Klinger, Claudia, Savelsbergh, Andreas, Humana Press; ISBN: 978-1-4939-7230-2. 2) Proteomics: From Protein Sequence to Function. Stephen Pennington, Michael J Dunn, Viva Books Private Limited, ISBN: 9789386105998. 3) Discovering genomics, proteomics, and bioinformatics, by A Malcolm Campbell; Laurie J Heyer; Cold Spring Harbor Laboratory Press.; Benjamin/Cummings Publishing Company, ISBN: 0805382194 9780805382198. 4) Principles of Gene manipulation and Genomics, 7th edition/S. By Sandy B. Primrose, Richard Twyman. Wiley-Blackwell, ISBN: 978-1-405-13544-3.
Course Objective	The course purposes to make the students familiar with the concepts of technologies pertinent to Genomics, Transcriptomics, and Proteomics, and to demonstrate their applications.
Justification:	

Fields	Values
Course Code	BT30123
Course Name	Python and R for Biologists
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Department Elective
Credits	2
Targeted Program and Year	3rd Year
Contents	R: Installation of R and RStudio, Basics of R, Vector, Matrix, Array, Lists, Dataframe, Workflows, Data visualization with ggplot2, heatmaps, strings, dplyr, tidyr, statistics in R, Bioconductor packages Python: Introduction to Python: Installing Python and Jupyter Notebook, importing packages; Conditional statements and loops; Data structures in Python: Lists, tuples, dictionary, sets; String handling; Functions; Iterables & Iterators; Generators; File handling Application of R and Python in Bioinformatics and computational biology
References	1. Master Python Programming : Learn essential Python for Machine Learning and Data Science (Volume 1) 2. Learn to Code by Solving Problems: A Python Programming Primer by Daniel Zingaro 3. The Book of R by Tilman M. Davis; ISBN: 9781593276515 4. R for Data Science by Hadley Wickham; ISBN: 9781491910344 5. Learning R Programming by Kun Ren; ISBN: 9781785889776
Course Objective	This course is designed to understand the basics of Python and R programming, data organization, basic operations and get hands-on experience to develop scripts for biological problems
Justification:	As part of modern biology, many high-throughput omics technologies generate biological big data that is usually organized in the form of large matrices. To process this data from files, perform mathematical / statistical operations on such matrices and to generate relevant outputs in the form of visualizations, reports, the knowledge of Python and R is essential for biotechnology graduates. This will expand the technical expertise of the students and also make them relevant to current career expectations from engineering graduates.

Fields	Values
Course Code:	BT30203
Course Name:	Machine Learning in Bioinformatics
Prerequisite (If any)	
Nature of Course	Combined, theory and lab
Type of Course	Department Elective
Credit	2
Targeted Program and Year	3rd Year
Contents	Theory: Introduction to statistical learning: classification and regression problems, concepts of features and instances, supervised and unsupervised clustering approaches; Unsupervised ML algorithms: Hierarchical clustering, K-means clustering, graph-based clustering; Supervised ML algorithms: logistic regression, artificial neural networks, support vector machines, decision trees & random forests; Feature selection: principal component analysis, SVM-RFE; Performance metrics: accuracy, sensitivity, specificity, precision, recall, F-score, Mathews correlation coefficient; Introduction to Multi-class learning; Introduction to deep learning concepts Lab: Supervised and unsupervised clustering with toy examples. Programming for machine learning classification and regression using r-weka, caret, e1071
References	*1.* The Hundred-Page machine learning book by Andriy Burkov *2.* A guide to machine learning for biologists, Greener et al., 2021, Nature Reviews Molecular Cell Biology *3.* Statquest YouTube Channel: https://www.youtube.com/@statquest/playlists
Objective	This course will train biologists to apply machine-learning techniques to biological problems. This course will cover the basics of supervised and unsupervised clustering with emphasis on popularly used machine learning algorithms
Justification	Machine learning is one of the fastly growing areas in all fields of science. High-throughput omics approaches generate an enormous volume of data that can be used to create predictive models for answering specific biological questions. ML approaches have found applications in the biotechnology industry to solve problems related to healthcare, agriculture, and drug discovery. Students need to be exposed to the concepts of machine learning and deep learning approaches for performing biological big data analysis which will enhance their future career prospects.

Fields	Values
Course Code:	BT40130
Course Name:	Neuroscience and Technology
Prerequisite (If any)	
Nature of Course	
Type of Course	Departmental Elective
Credit	2
Targeted Program and Year	3rd Year
Contents	Introduction and basic neurobiology; Neuroscience: past, present, and future; Structural and functional neuroanatomy of the human brain; Brain energy metabolism; The central nervous system; Cellular components of nervous tissue; Neural communications; Sensory and motor systems; Principles and methods in neuroimaging; Brain and behaviour; Circadian clocks; Sleep-wake cycles; Neural regulation of the cardiovascular system; Neurological disorders.
References	1) Neuroscience: Exploring the Brain, by Mark F. Bear, Barry W. Connors, Michael A. Paradiso, ISBN: 9780781778176. 2) Fundamental Neuroscience-4th Edition, by Larry Squire Darwin Berg Floyd E. Bloom Sascha du Lac Anirvan Ghosh Nicholas C. Spitzer, Academic Press (Elsevier), ISBN: 9780123858702. 3) Fundamental Neuroscience for Basic and Clinical Applications, Fifth Edition • 2018, by Duane E. Haines and Gregory A. Mihailoff, Elsevier, ISBN: 978-0-323-39632-5.
Objective	This course intends to provide basic of concepts in neurobiology, including neurophysiology of the human central nervous system, neural signaling, and neurological disorders.
Justification	

Fields	Values
Course Code:	BT40010
Course Name:	Computer aided Drug Design
Prerequisite (If any)	
Nature of Course	
Type of Course	Departmental Core
Credit	3
Targeted Program and Year	4th Year
Contents	It covers the basic principles of how new drugs are discovered with emphasis on lead identification, lead optimization, classification and kinetics of molecules targeting enzymes and receptors, prodrug design and applications, as well as structure-based drug design methods. Recent advances in the use of computational and combinatorial chemistry in drug design will also be presented.
References	1. Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008 2. BMC – Burger's Medicinal Chemistry and Drug Discovery, 5th Edition, Vol. 1. Principles and Practice, edited by M. E. Wolff, John Wiley & Sons: New York, 1995. 3. PMC – Principles of Medicinal Chemistry, 4th Edition, edited by W.O. Foye, T.L. Lemke, and D. A. Williams, Williams and Wilkins: Philadelphia, 1995. 4. MCPP – Medicinal Chemistry: Principles and Practice, edited by F.D. King, Royal Society of Chemistry: Cambridge, 1994. 5. CC – A Practical Guide to Combinatorial Chemistry, edited by A. W. Czarnik and S. H. DeWitt, American Chemical Society: Washington DC, 1997.
Objective	The purpose of this course is to acquaint the students about the process of drug discovery and development from the identification of novel drug targets
Justification	

Fields	Values
Course Code:	BT40026
Course Name:	Seminar in Biotechnology and Bioinformatics
Prerequisite (If any)	
Nature of Course	Seminar
Type of Course	Departmental Core
Credit	1
Targeted Program and Year	4th Year
Contents	Seminar course deals with student presentations and discussion of latest journal articles in the frontier areas of biotechnology and bioinformatics. The seminar articles will be selected in consultation with the faculty coordinator.
References	Recent articles in various peer-reviewed journals, such as, Nature, Science, Cell Nature Biotechnology Molecular Cancer, Genomics Proteomics & Bioinformatics, PLoS Computational Biology, Proceedings of the National Academy of Sciences of the USA (PNAS) and related journals
Objective	The objective of seminar course is to impart the skills of effective comprehension and communication of science to the audience and at the same time getting familiar with the latest cutting-edge research.
Justification	This course focuses on developing presentation skill, critical analysis of scientific research papers, familiarity with upcoming technologies biotechnology and bioinformatics.

Fields	Values
Course Code	BT40030
Course Name	Industrial Biotechnology
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	4th Year
Contents	Bioproducts and their market, Classification of bio-products, Small molecules (primary metabolites, secondary metabolites), Large molecules, Types of bioproducts (bioenergy, biomaterials and biochemicals), Industrial fermentation processes (microbial biomass, industrial enzymes, metabolites, recombinant products, transformation processes), Single cell proteins, Classification of bioreactors (batch, fed-batch, continuous, packed bed, airlift reactor etc), Bioreactor design and analysis, Fermentation media, Sterilization process (media and air), Microbial thermal death kinetics, Bioprocesses for the production of organic acids, antibiotics, proteins, polysaccharides, lipids; Recovery and purification of bioproducts (cell separation and disruption, extraction (solid-liquid, liquid-liquid, aqueous two phase, supercritical fluid), Chromatography, Safety management in bioprocess industries.
References	Textbook: 1) Bioprocess Engineering: Kinetics, Sustainability and Reactor Design by Shijie Liu, 3rd Edition. Elsevier Science Publishing Company. ISBN: 0128210125. 2) Essentials in Fermentation Technology by Berenjian Aydin, Springer International Publishing, ISBN: 9783030162306, eBook. 3) Principles and Applications of Fermentation Technology by Arindam Kuila and Vinay Sharma, ISBN: 9781119460381, eBook.
Course Objective	Bioprocess engineers design a series of integrated bioreactions to make up a bioprocess that is economically viable to produce chemicals, biopharmaceuticals, antibiotics and biofuels. This course is intended to provide an overview of the bioprocess engineering and fermentation technologies, its applications and challenges.
Justification:	

Fields	Values
Course Code	BT40040
Course Name	Immunology and Immunotechnology
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Departmental Core
Credits	2
Targeted Program and Year	4th Year
Contents	Cells and organs of the immune system, innate immunity, T-cell development, B-cell development, B-cell receptor, antigen recognition by B-cells, hybridoma technology and antibody production, applications of antibodies in diagnostics and research covering their use in techniques such as ELISA, ELISpot, immunohistochemistry, immunocytochemistry, western blot and flow cytometry, T-cell receptor, antigen recognition by T-cells, introduction to major histocompatibility complex and its role in recognition of antigens by T-cells, the complement system, immune response to malaria and challenges therein.
References	Text Book: 1) Goldsby, Kindt, and Osborne. Kuby Immunology 6th ed. Freeman, 2007. 2) Roitt's Essential Immunology. 12th Edition.Peter J. Delves,Seamus J. Martin, Dennis R. Burton,Ivan M. Roitt (2011) 3. Reference book: 1) David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Immunology; Mosby Publisher, 7th ed. 2006
Objective	The learning outcome of this course is an overview of vertebrate immune system and basic knowledge of the essential components of the immune system and application of immunology.
Justification	A healthy human being can fight many infections on his own. This is due to our highly developed immune system. This course provides the detailed understanding of the immune system, its components and their function for beginners. This understanding and technological developments have allowed us to use immune system in various therapeutics. This topic will be covered in the applications of immunology in this course. This course has ~ 10 % overlap with BT6020 which is advanced master's level course focusing on advancements and therapeutics involving immunology.

Fields	Values
Course Code	BT40150
Course Name	Genome stability and human disease
Pre-Requisites (If any)	Nil
Nature of Course	Theory
Type of Course	Department Elective
Credits	3
Targeted Program and Year	4th Year
Contents	Important factors in maintaining genome stability; protein complexes involved in DNA replication, DNA repair, DNA damage tolerance, DNA damage signalling, cell cycle control and apoptosis. Defects that lead to increased mutations, chromosomal instability, cancer, cellular senescence and organismal aging. The role of chromatin in genome stability, human diseases associated with genome instability as well as changes in genome stability in response to aging.
References	1. Genome Stability, DNA Repair and Recombination by *James E Haber* (ISBN 9780815344858) Published by Garland Science (2014, 1st ed) 2. DNA Replication, Recombination, and Repair: Molecular Mechanisms and Pathology by *Fumio Hanaoka, Kaoru Sugasawa (eds.)* (ISBN: 443155873X) Sprnger (2016 1st ed)
Course Objective	This elective will cover major causes and types of DNA damages, as well as the mechanisms providing DNA repair and genomic stability in prokaryotic and eukaryotic organisms. The disease will cover cancers, neurodegenerative diseases, developmental syndromes, and many more. Students will learn to recognise and to explain the role of DNA repair and genome integrity for cell survival and its importance for human health.
Justification:	There are no similar courses available in IIT Hyderabad. This will expand the molecular biology knowledge of the students and also make them aware about the current advances in DNA technology.

Fields	Values
Course Code	BT40223
Course Name	Algorithms for Molecular Dynamics simulation
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Elective
Credits	2
Targeted Program and Year	4th Year
Contents	History of molecular dynamics simulation– Energy functions and molecular conformations - Force field and potential energy landscape- Units and derivatives - Newton's equation of motion and molecular dynamics simulation- Verlet algorithm - Ensembles – Trajectories and analyse. s – Introduction to enhanced sampling.
References	1) Molecular Modelling for Beginners, 2nd Edition, Alan Hinchliffe ISBN: 978-0-470-51314-9 2) Molecular Modeling and Simulation: An Interdisciplinary Guide by Tamar Schlick (2013) Springer ISBN 978-1-4419-6351-2
Objective	The objective of the course is to provide the concept behind the classical molecular dynamics simulations and their application understanding the biomacromolecular conformations
Justification	

Fields	Values
Course Code	BT30021
Course Name	Analytical Biotechnology
Pre-Requisites (If any)	BT20030
Nature of Course	Theory
Type of Course	Departmental Core
Credits	3
Targeted Program and Year	4th Year
Contents	Techniques related to chromatography, HPLC, gel electrophoresis of proteins. Recombinant protein production, Protein purification, Assay development using absorption and fluorescence spectrometry, Gene expression in mammalian cell lines, Cell culture techniques, cell-based assay development
References	Text Books: 1) Analytical Biotechnology by Kane Lloyd, Callisto Reference publisher, ISBN: 1641164922. (2019) 2) Analytical Techniques in Biotechnology by Suzy Hill, Syrawood Publishing House 2016, ISBN: 1682862380.(2016) 3) Analytical Biotechnology by C. Van Dijk, Elsevier, ISBN: 9780444599186. 4th Ed. (1996) 4) Analytical Biotechnology by Thomas Schalkhammer, Birkhauser publisher, ISBN: 9783034881012 (2002)
Objective	The course aims to provide insight into high-throughput big data in biology, its analysis, interpretation and storage.
Justification	This course focuses on the teaching application in cutting-edge technologies related to analytical biochemistry, molecular biology and cell biology. No overlap or match with the existing course of IITH.

Fields	Values
Course Code	BT40050
Course Name	Principles of Pharmacology
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Elective
Credits	2
Targeted Program and Year	4th Year
Contents	Principles of pharmacology, Pharmacodynamics, Pharmacokinetics, Metabolism, toxicity. Case studies of adverse drug reactions.
References	1) Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy-David E. Golan, Armen H. Tashjian, Ehrin J. Armstrong- Lippincott Williams & Wilkins (2011). 2) Pharmacology: An Essential Textbook, Mark Simmons, Thieme Medical Publishers Inc; 2020 (2nd ed)
Course Objective	The learning outcome of the course is to provide knowledge about the principles of pharmacology.
Justification:	

Fields	Values
Course Code	BT40110
Course Name	Biological Pathways and Network analysis
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Elective
Credits	3
Targeted Program and Year	4th Year
Contents	Introduction to molecular interactions; Theory and concepts of network analysis; Functional insights into biological data through network analysis; Protein-protein interaction networks; Data repositories, resources and tools available for biological pathways and network analysis; Gene Ontology (GO) annotations; Protein ANalysis THrough Evolutionary Relationships (PANTHER), Reactome pathway Knowledgebase, Search Tool for the Retrieval of Interacting Genes/Proteins (STRING), Database for Annotation, Visualization and Integrated Discovery (DAVID); Extending pathways - data integration; Hands-on experience in the use of PANTHER, DAVID, Cytoscape, and STRING.
References	1. Biological Network Analysis. by Pietro Hiram Guzzi and Swarup Roy, Elsevier, ISBN: 978-0-12-819350-1. 2. Biological Networks and Pathway Analysis (Methods in Molecular Biology), By Tatiana V. Tatarinova, Yuri Nikolsky, Springer, Humana Press, New York, NY, ISBN: 978-1-4939-7025-4. 3. Protein Networks and Pathway Analysis (Methods in Molecular Biology) by Yuri Nikolsky, Julie Bryant, Humana Press, ISBN: 978-1-60761-174-5.
Course Objective	This course will introduce concepts about biological network and pathway analysis of omics data. The course will also provide details regarding the data repositories, resources and tools available to reconnoitre and analyse large datasets from a network viewpoint.
Justification:	

Fields	Values
Course Code	BT40120
Course Name	Bioinformatics for Precision Medicine
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Department Elective
Credits	2
Targeted Program and Year	4th Year
Contents	Definition and history of precision medicine, origin and development of precision of medicine, precision oncology, impact of precision of medicine on human health, application of precision medicine other than oncology, future of precision medicine, role of bioinformatics in precision medicine, digital medicine and its relation precision medicine, Indian perspectives of precision medicine, industrial opportunities in precision medicine.
References	1. Clinical precision medicine; Editor Judy Crabtree; ISBN: 9780128198346 2. Precision Medicine: A Guide to Genomics in Clinical Practice by Bryce Mendelsohn 3. Genomic and Precision Medicine by Geoffrey Ginsburg ISBN: 9780128006849
Course Objective	This course is designed to enhance the understanding of precision medicine and application of bioinformatics in tailoring the precision medicine for the better treatment outcome.
Justification:	Due to the advancement in technology, field of medicine grown rapidly, which lead to the birth of precision medicine. Precision medicine utilizes the information in genetic architecture of patients and help in designing of therapy regimen. Right from the inception of precision medicine, bioinformatics played a critical role in this field and helped in fine tuning of precision medicine. This course will impart knowledge of how precision medicine improved human health and how bioinformatics became a central part of it.

Fields	Values
Course Code	BT40133
Course Name	Nucleic Acid Nanotechnology and Computational Virology
Pre-Requisites (If any)	
Nature of Course	Combined, theory and lab
Type of Course	Department Elective
Credits	2
Targeted Program and Year	4th Year
Contents	Brief history and idea DNA nanotechnology, Holliday junctions, Tile-based DNA nanostructures, Wireframe and tensegrity DNA nanostructures, . DNA origami nanostructures, caDNAno designing of DNA origami, RNA nanostructures, Thermodynamics and self-assembly of DNA nanostructures, Forces and interactions at nanoscale, Functional and dynamic DNA nanostructures, Application of DNA nanotechnology. Virus structure and replication, Virus-host interactions, Impact of viruses on human health. Virus bioinformatics, Molecular Simulations of Virus Dynamics and Interactions
References	1. *"DNA Nanotechnology – From Structure to Function", Edited by* Chunhai Fan 2. *DNA Nanotechnology: Methods and Protocols*, Edited by Giampaolo Zuccheri and Bruno Samorì, Humana Press 3. *"Virology: Principles and Applications*" by John B. Carter and Venetia L. Saunders
Objective	Introducing students with the idea of creating nanostructure using DNA and RNA. Highlighting the usage of computer in understanding the form and functions of viruses, provide a comprehensive overview of the computational approaches used in the field of virology.
Justification	DNA nanotechnology was incepted on 1980s by Ned Seeman and holds promise for future of nanodevices. The past decade has witnessed a transition of nucleic acid nanotechnology from adolescence into adulthood, from laboratory to real life applications. This course makes students familiar with the functional DNA nanostructures and their usage in devices. The second part of the course deals with the computational methods which will help in understanding the molecular structure, evolution, and replication of viruses, as well as the host-virus interactions and the development of antiviral therapies

Fields	Values
Course Code	BT40143
Course Name	Biological Data Analysis
Pre-Requisites (If any)	
Nature of Course	Combined, theory and lab
Type of Course	Department Core
Credits	3
Targeted Program and Year	4th Year
Contents	This course will cover four major biological data analyses: 1. Genomics: Microbial/Eukaryotic genome assembly using Illumina or/and PacBio data, preprocessing of raw data, read alignment, Genome annotation, Genome assembly quality assessment, Genome Browser, biological interpretations, visualization Comparative genomics: Sequence/profile-based homology analysis, homology between multiple genomes, species identification strategies. Pan-genome studies. 2. Metagenomics: Amplicon-based taxonomy profiling, metagenome assembly, metagenome binning, metagenome annotation, quality check, function assessment, and identification of core microbes. 3. Transcriptomics: Introduction to Transcriptome, types of RNAs, preprocessing of raw data, read alignment, transcriptome reconstruction, expression quantification, differential expression analysis, normalization, biological interpretations, visualization 4. Single-cell omics: Overview of single-cell transcriptomics, proteomics, metabolomics, epigenomics; Focus on single-cell transcriptome sequencing and data analysis; Cell ranger, Seurat; Clustering and marker set analysis, Single/multi-omics dataset integration, Walkthrough of Seurat Analysis pipelines using test data for understanding single-and multi-dataset clustering and annotations
References	*1.* Bioinformatics: Methods and Applications. Editors: Dev Bukhsh Singh, Rajesh Kumar Pathak. 1st Edition - October 21, 2021. https://www.elsevier.com/books/bioinformatics/singh/978-0-323-89775-4 *2.* Advances in Bioinformatics. Editors: Vijai Singh, Ajay Kumar. DOI: https://doi.org/10.1007/978-981-33-6191-1 *3. Tutorial: guidelines for the computational analysis of single-cell RNA sequencing data, Andrews et al. Nature Protocols, 2021* *4. Current best practices in single-cell RNA-seq analysis: a tutorial, Leucken and Theis, Molecular Systems Biology, 2019* *Seurat tutorials from Satija Lab: https://satijalab.org/seurat/index.html*

Objective	This course is designed to provide practical knowledge of biological data analysis. Here, students will get full hands-on exposure to diverse data handling, analysis, interpretation, and visualization tools to execute genomics, metagenomics, transcriptomics, and experimental single-cell omics analysis. In addition, they will learn to handle high-throughput sequencing data and get extensive training in exploratory data analysis.
Justification	Modern biology is becoming increasingly data-oriented, where high throughput data is teasing apart different scales of biological systems for finding mechanisms and asking fundamental questions. Therefore, bioinformatics approaches to biological data analysis are required to use this high throughput data and extract meaningful information. In this context, exposing students to the current & future technologies (e. g., genomics, metagenomics, transcriptomics, single-cell omics) and current directions of biological research are essential to shape their careers and be up-to-date with these new advances.

Fields	Values
Course Code	BT50010
Course Name	Systems Biology
Pre-Requisites (If any)	
Nature of Course	Theory
Type of Course	Departmental Elective
Credits	3
Targeted Program and Year	4th Year
Contents	Cellular level systems: genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making. Population-level systems: models of pattern formation, cell-cell communication, and evolutionary systems biology.
References	Text Book(s) 2) Alon, Uri. An Introduction to Systems Biology: Design Principles of Biological Circuits. Chapman & Hall / CRC, 2006. ISBN: 9781584886426. (2006) 3) Nowak, M. A. Evolutionary Dynamics: Exploring the Equations of Life. Belknap Press, 2006. ISBN: 9780674023383. Reference(s) 1) Alberts, Bruce. Essential Cell Biology. Garland Science, 2009. ISBN: 9780815341291. 2) Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107.
Objective	The course aims to provide the concept of systems biology and its applications Course content: Introduction to cellular and population-level systems biology with an emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions and evolutionary dynamics.
Justification	This course focuses on basic understanding biological process at the system level combining latest analytical advances of biotechnology and bioinformatics. No overlap with any existing IITH course.

Fields	Values
Course Code	BT50020
Course Name	BioSignalling
Pre-Requisites (If any)	
Nature of Course	
Type of Course	Departmental Elective
Credits	3
Targeted Program and Year	4th Year
Contents	Introduction to cell signalling: different ways in which cells signal to each other, coordination of cell signalling, Components that comprise signalling pathways: ligands (hormones, cytokines, growth, factors, neurotransmitters), receptors, kinases and phosphatases, cyclic nucleotides and G-proteins intracellular calcium ions, Techniques used to study cell signalling, Specific examples of signalling pathways and events: calcium signalling in cardiomyocytes and heart dysfunction, signalling in diabetes.
References	1) Cell Signalling. John T Hancock, Oxford university press. 2017 (3rd edition) ISBN9780199658480 2) Molecular and cellular signaling, Martin Beckerman, Springer-Verlag New York, (1st Ed.) 2005.
Objective	The learning outcome of this course is the knowledge of signal transduction and to understand how cells can detect and respond to events in physiology and pathophysiology.
Justification	