B.Tech. in Biotechnology and Bioinformatics

Sem	Course No	Course Name	Type	Credits
1	CY1017	Environmental Chemistry-I	BS	2
	EP1108	Modern Physics	BS	2
	ID1063	Introduction to Programming	BE	3
	MA1110	Calculus-I	BS	1
	MA1220	Calculus-II	BS	1
	BT1020	Basic Bioinformatics	DC	2
	LAxxxx	Personality Development	SS	1
	LAxxxx	English Communication	SS	2
	EMxxxx	Introduction to Entrepreneurship	SS	1
Sem Total				**15**
3	BT2030	Biochemistry	DC	3
	BT2040	Microbiology	DC	2
	ID2230	Data structure and Application	BE	3
	BT2011	Basic Biotechnology lab	DC	3
	CY1017	Environmental Chemistry-II	BS	2
	BT2050	Big Data biology & Biological databases	DC	3
	LAxxxx	LA Elective	LA	2
Sem Total				**18**
5	BT3010	Bio-reaction Engineering	DC	3
	Fxxxx	Free Elective	FE	2
	BT3021	Analytical Biotechnology Lab	DC	3
	BT3030	Sequence alignment algorithms	DC	2
	BTxxxx	Elective (BI)	DE	2
	BT3041	Genetic Engineering Lab	DC	2
	BT3050	Genomics, Transcriptomics & Proteomics	DC	3
Sem Total				**17**
7	BT4010	Computer aided drug design	DC	3
	Laxxxx	LA Electives	LA	2
	BT4030	Bioprocess Technology	DC	3
	BT4040	Immunology and Immunotechnology	DC	2
	BTxxxx	Elective (BI)	DE	3
	BT4026	Seminar in Biotechnology and Bioinformatics	DC	2
Sem Total				**15**
Total (all sem)				

Sem	Course No	Course Name	Type	Credits
2	MA1140	Elementary Linear Algebra	BS	1
	MA1150	Differential Equations	BS	1
	ID1054	Intro to AI & ML	BE	1
	CH1040	Thermodynamics	BE	3
	EP1031	Physics lab	BS	2
	AI1102	Probability & Random variables	BE	3
	CY1031	Chemistry Lab	BS	2
	ID1054	Digital Fabrication	BE	2
	BT1010	Introduction to Life Sciences	BS	1
Sem Total				**16**
4	BT2060	Molecular and Cellular Biology	DC	3
	BT2070	Biochemical Engineering	DC	3
	BT2090	Protein structure, function and disease	DC	3
	BT2110	Genetic Engineering	DC	3
	Fxxxx	Free Electives	FE	2
	BTxxxx	Elective (BT)	DE	3
Sem Total				**17**
6	Fxxxx	Free Electives	FE	6
	Laxxxx	LA Electives	LA	3
	BT3015	Option 1: Internship (CGPA > 7.0) Option 2: Departmental Project	DE	6
Sem Total				**15**
8	BT5010	Systems Biology	DC	3
	Fxxxx	Free Electives	FE	2
	Laxxxx	LA Elective	LA	2
	BTxxxx	Elective (BI)	DE	3
	BTxxxx	Elective (BT)	DE	3
	BTxxxx	Elective (BT)	DE	2
Sem Total				**15**
				128

Department Elective (DE) Biotechnology (BT)

Code	Course Name	Credits	SEM
BT2120	Molecular Biophysics	3	4
BT2140	Model Systems in Biology	3	4
BT4230	Nucleic acid-protein Interaction	2	8
BT4130	Neuroscience and Technology	2	8
BT4210	Intellectual Property Rights and Bioethics	2	8
BT4050	Principles of Pharmacology	2	8
BT4150	Single-Cell Technologies	3	8
BT6030	Molecular Virology	3	8
BT5020	BioSignalling	3	8

Department Elective (DE) Bioinformatics (BI)

Code	Course Name	Credits	SEM
BT2113	MATLAB	2	5
BT3123	Introduction to R and Python	2	5
BT3113	Cellular Image Analysis	3	7
BT4110	Biological Pathways and Network analysis	3	7
BT4223	Algorithms for Molecular Dynamics simulations	3	8
BT4140	Statistical Methods for Gene Expression Analysis	3	8

BS	Basic Science
BE	Basic Engineering
SS	Soft Skill
DC	Departmental Core
DE	Departmental Elective

Course Description
BTech in Biotechnology and Bioinformatics

Course code:	BT1020
Course name:	Basic Bioinformatics
Type	Departmental Core
Credit	2

Course Objective: This course is designed to introduce fundamental concepts of bioinformatics and its applications in biomedical research.
Course Content: 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
Text Books:

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 code:	BT2030
Course name:	Biochemistry
Type	Departmental Core
Credit	3

Course objective: This course aims to provide basic concepts of biochemistry
Course content: Stereoisomers and life, thermodynamics of biochemical reactions; Structural biochemistry: Protein Structure, Protein Folding, Enzyme Catalysis, Enzyme Kinetics, Lipid structure and membrane assembly, Carbohydrate structure; Bioenergetics: Glycolysis, Glycolysis of red blood cells and liver, Bacterial Energetics, The citric acid cycle, Electron transport, ATP synthesis, Regulation of blood sugar; Overview of metabolic biochemistry; Overview of synthesis and degradation of Biomolecules.
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

Course code:	BT2040
Course name:	Microbiology
Type	Departmental Core
Credit	2

Course objective: This course aims to deliver elementary concepts of microbiology
Course Content: 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
Textbooks:

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 code:	BT2011
Course name:	Basic Biotechnology lab
Type	Departmental Core
Credit	3

Course Objective: This course provides practical training to work in the biotechnology laboratory.
Course Content: Basic practices of the biotechnology laboratory (laboratory safety, introduction to basic laboratory equipments and calibrations, reagent preparation, working under aseptic condition and sterilization, biological waste disposal), microbial cell culture, animal cell culture, plant tissue culture, DNA, RNA and protein extraction and quantification, bacterial transformation, agarose gel electrophoresis, SDS-polyacrylamind gel electrophoresis (SDS-PAGE), western bloting, Immunoassay-ELISA, polymerase chain reaction (PCR), storage and preservation of cell lines and microbial cultures, Good Laboratory Practices (GLP)
Text Books:

1) Basic Laboratory Methods for Biotechnology by Lisa Seidman, Cynthia Moore, Second Edition, Pearson publisher, ISBN: 0321570146
2) Biotechnology: A Laboratory Skills Course by J. Kirk Brown, Student Edition, Second Edition, ISBN: 978-0-9832396-3-5
3) Biotechnology: A Laboratory Course 2nd Edition by Jeffery Becker, Gay Caldwell, Eve Ann Zachgo, Academic Press, ISBN: 0120845628
4) Laboratory Manual for Biotechnology Students by Ashish Verma, Surajit Das, Anchal Singh, S Chand and Company, ISBN: 938374622X"

Course code:	BT2050
Course name:	Big Data biology and Biological databases
Type	Departmental Core
Credit	3

Course objective: The course aims to provide insight about the accumulation massive various high-throughput “OMICS” data, the existing huge challenges to handle such large data sets, analyze and interpret them.
Course content: Introduction of various “OMICS” data - Types and importance of biological databases, The need for Multi “OMICS” data integration - Further perspective of the biological databases
Text Book(s):

1) Bioinformatics for Omics Data (Methods and Protocols), Editors: Mayer, Bernd (Ed.) (Springer)
2) Big Data Analysis for Bioinformatics and Biomedical Discoveries. ISBN 9780367240226 Chapman and Hall/CRC Shui Qing Ye (Ed.)

Course code:	BT2060
Course name:	Molecular and Cellular Biology
Type	Departmental Core
Credit	3

Course Objective: This course offers basics of cell biology and molecular biology, intracellular orgenelles, their functions and coordination, intracellular processes and how cell devides to make daughter cells, molecular biology methods for manipulating DNA, RNA, proteins.

Course Content: Cell chemistry and biosynthesis, cell organelles and cell membrane, cell cycle and its regulation, cell division: mitosis and meiosis, DNA as the genetic material, DNA replication, transcription and translation in eukaryotes and prokaryotes, regulation of gene expression, RNA processing, post-translational modifications of proteins, protein sorting, cellular energetics, programmed cell death, cell junctions and adhesion, methods for manipulating DNA, RNA and proteins, methods for visualizing cells.

Text Books:

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 code:	BT2070
Course name:	Biochemical Engineering
Type	Departmental Core
Credit	3

Course Objective: Biochemical Engineers develop processes of a variety of natural as well as artificial substances such as oil refining, ecological development, environmental changes, 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.

Course Content: kinetics of cell growth and growth phases in batch culture, cell growth in batch fermentation and continuous stirred tank fermentation, mathematical models for substarte uptake and product formation, plasmid stability in recombinant cell cultures, kinetics of enzyme catalyzed reactions, mass and energy balances in biochemical engineering, stoichiometric relations and yield concepts, heat transfer, membrane processes (dialysis, ultrafiltration, microfiltration, reverse osmosis, membrane modules), Process automation, Bioprocess engineering, Bio-seperation and downstream processing, transport phenomena in bioprocess system, mathematical modelling in biochemical engineering, safety management in bioprocess industries, biological thermodynamics, fermentation technologies, animal cell culture and tissue engineering, biomaterials and components, biomechanics, Bio-MEMS

Text Books:

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 code:	BT2090
Course name:	Protein structure, function and disease
Type	Departmental Core
Credit	3

Course objective: The course provides the elementary concepts about protein structure and function

Course content: 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

Text Book(s):

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

Course code:	BT2110
Course name:	Genetic Engineering
Type	Departmental Core
Credit	3

Course objective: The overall objective of this course is to provide a detailed understanding of different gene manipulation technologies and to elaborate on their diverse applications.

Course content: Introduction to recombinant DNA technology; Cutting and joining DNA molecules; Restriction endonucleases; Basic biology of plasmid and phage vectors; Cosmids, phasmids and other advanced vectors; Gene cloning strategies; Construction of cDNA libraries in plasmids; Manipulating DNA in microbes, plants and animals; Advanced transgenic technologies; Radioactive and non-radioactive methods for labelling DNA; DNA sequencing; Transformation; Transfection; Hybridization techniques- Northern, Southern, and colony hybridization; PCR technology; RT-PCR and quantitative RT-PCR; CRISPR/Cas9 gene editing; Site-directed mutagenesis and protein engineering; Applications of recombinant DNA technology; Safety regulations related to genetic engineering

Textbooks:

1. Molecular Biology of the Gene, by James D. Watson, Pearson Education; Seventh edition, ISBN-13: 978-9332585478.
2. Principles of Gene manipulation and Genomics, 7th edition/S. By Sandy B. Primrose, Richard Twyman. Wiley-Blackwell, ISBN: 978-1-405-13544-3.
3. Lewin's GENES XII 12th Edition, by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, ISBN-13: 978-1284104493.

Course code:	BT3010
Course name:	Bio-reaction Engineering
Type	Departmental Core
Credit	3

Course Objective: This course teaches theories for cellular energetics and bioreaction kinetics, which are essential for designing commercially viable bioprocesses.

Course Content: The chemistry of metabolic pathways (glycolysis, TCA cycle, oxidative phosphorylation, pentose phosphate pathway, currencies of Gibbs free energy and of reducing power), production of ethanol, amino acids, antibiotics, secreted proteins, design of bioprocess and criteria for commercial success (strain design and selection, optimization of fermentation process, strain improvement), continuous stirred tank reactor (CSTR) and plug flow reactor (PFR), yield coefficient, black box stoichiometries, thermodynamics of bioreactions (chemical equilibrium and thermodynamic state functions, heat of reaction), biochemical reaction network, growth energetics, flux analysis in large metabolic networks, enzyme kinetics (Michaelis-Menten model and its varients, cooperativity and allosteric enzymes), kinetics of enzyme catalyzed reactions in free and immobilized states, kinetics of substrate utilization, product formation and biomass production: Monod growth model and its various modifications, structured and unstructured kinetic rate models, metabolic control analysis, gas-liquid mass transfer

Text Books:

1) Bioreaction Engineering Principles by John Villadsen, Jens Nielsen, Gunnar Liden, Third edition, Springer, ISBN: 9781441996886
2) Chemical Reaction Engineering by O. Levenspiel, 3rd edition, John Wiley and Sons 1999, ISBN: 9780471254249
3) Bioprocess Engineering Principles by Doran, 2nd edition, Academic press 2014, ISBN: 9780080917702

Course code:	BT3021
Course name:	Analytical Biotechnology Lab
Type	Departmental Core
Credit	3

Course Objective: This course provides exposure to the analytical biotechnology applications and process control frequently used in healthcare, industry and research.
Course Content: Use of immobilized biomolecules in biotechnology and bioanalysis, immunological techniques, immunological strip tests, fluorescence detection and confocal techniques, optical and electrochemical biosensors, biochips, micro dotting, novel transducers such as nano clusters, atomic force microscopy based techniques and measuring analytes in complex media such as fermentation broth, plasma and serum. Techniques related to HPLC, capillary electrophoresis, gel electrophoresis, and mass spectrometry. Process monitoring and control for recombinant protein production.
Text Books:

1) Analytical Biotechnology by Kane Lloyd, Callisto Reference publisher, ISBN: 1641164922.
2) Analytical Techniques in Biotechnology by Suzy Hill, Syrawood Publishing House 2016, ISBN: 1682862380.
3) Analytical Biotechnology by C. Van Dijk, Elsevier, ISBN: 9780444599186.
4) Analytical Biotechnology by Thomas Schalkhammer, Birkhauser publisher, ISBN: 9783034881012

Course code:	BT3030
Course name:	Sequence Alignment Algorithms
Type	Departmental Core
Credit	2

Course objective: The course provides insight about the algorithms involved in sequence alignment
Course content: 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.
Text Book(s)

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 code:	BT3041
Course name:	Genetic Engineering Lab
Type	Departmental Core
Credit	2

Course objective: This course will provide hands-on experiences of basic and advanced gene manipulation technologies. The goal of this course is to prepare a student for real-world applications of recombinant DNA technologies.
Course content: Isolation of DNA, Estimation of DNA and RNA; Isolation of plasmid DNA, Genomic DNA extraction; 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; PCR amplification from bacterial plasmid; DNA sequencing; In silico analysis of DNA sequences; Expression of a recombinant protein in E. coli. Analysis of proteins using SDS-PAGE.
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

Course code:	BT3050
Course name:	Genomics, Transcriptomics, Proteomics
Type	Departmental Core
Credit	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.
Course content: 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
Textbooks:

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 code:	BT4010
Course name:	Computer aided Drug Design
Type	Departmental Core
Credit	3

Course 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
Course content: 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.
Text Book(s)

1) Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008
2) 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) Principles of Medicinal Chemistry, 4th Edition, edited by W.O. Foye, T.L. Lemke, and D. A. Williams, Williams and Wilkins: Philadelphia, 1995.
4) Medicinal Chemistry: Principles and Practice, edited by F.D. King, Royal Society of Chemistry: Cambridge, 1994.
5) A Practical Guide to Combinatorial Chemistry, edited by A. W. Czarnik and S. H. DeWitt, American Chemical Society: Washington DC, 1997.

Course code:	BT4026
Course name:	Seminar in Biotechnology and Bioinformatics
Type	Departmental Core
Credit	2

Course 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.

Course content: 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.
Reference Material:
Recent articles in various peer-reviewed journals including Nature Biotechnology
Science, Cell, Molecular Cancer, Genomics Proteomics & Bioinformatics, PLoS Computational Biology, Proceedings of the National Academy of Sciences of the USA (PNAS)

Course code:	BT4030
Course name:	Bioprocess Technology
Type	Departmental Core
Credit	3

Course Objective: Bioprocess engineers design a series of integrated bioreactions to make up a bioprocess that is economically viable for the production of chemicals, biopharmaceuticals, antibiotics and biofuels. This course is intended to provide an overview of the bioprocess engineering and fermentation technologies, its applications and challenges.
Course Content: Classification of bio-products, microbial fermentation and bioreactor design, fermentation media and sterilization process, bioprocesses for the production of organic acids, antibiotics, proteins, polysaccharides, lipids; recovery and purification of small molecules and large molecules, cell seperation and disruption, process economics and scale-up, microbial death kinetics, determination of Nabla factor and L90 value, batch, fed-batch and continuous processes in CSTR
Text Books:

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 code:	BT4040
Course name:	Immunology and Immunotechnology
Type	Departmental Core
Credit	2

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.
The innate and adaptive immune system and its components. Cells and molecules that participate in immune system. The genetic mechanisms that control the formation of the specific receptors B cell and T cell receptors and antibodies. Immunological diseases as allergy, autoimmunity and immune deficiencies The use of antibodies in biotechnological applications such as ELISA, ELISpot, immunohistochemistry, western blot, flow cytometry, proximity ligation assay. Technologies for production of antibodies and isolation/purifying with protein A as well as immunological tests based on cellular reactions.
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

3. Reference book:

1) David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Immunology; Mosby Publisher, 7th ed. 2006"

Course code:	BT5010
Course name:	Systems Biology
Type	Departmental Core
Credit	3

Course 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. 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.
Text Book(s)

1) Alon, Uri. An Introduction to Systems Biology: Design Principles of Biological Circuits. Chapman & Hall / CRC, 2006. ISBN: 9781584886426.
2) 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.

Course code:	BT2120
Course name:	Molecular Biophysics
Type	Departmental Elective
Credit	3

The course covers basic concepts of biophysics and physical biochemistry.
Topic included are thermodynamic properties of biological molecules, irreversible and open systems, information theory, biophysical measurements, the structure and properties of proteins, enzyme action, the structure and properties of nucleic acids at the molecular level, and molecular aspects of important biological systems. 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.
Reference books:

1) Biophysics: An Introduction: R. Glaser (2010, 2012) Springer
2) Physical Biology of the Cell: Rob Phillips, Jane Kondev, Julie Theriot, and Hernan Garcia (2012) Garland Science.

Course code:	BT2140
Course name:	Model Systems in Biology
Type	Departmental Elective
Credit	3

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.
Reference books:

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

Ref: The paradox of model organisms by Philip Hunter, EMBO rep 2008,9:717-720.

Course code:	BT2113
Course name:	MATLAB
Type	Departmental Elective
Credit	2

Course objective: The focus of the course is to familiarize the students about MATLAB programming and plotting

Course content:Installing and running simple MATLAB programs, Variables (scalars, arrays), printing, variable interpolation, string operations, mathematical operators, conditional operators, logical operators, file input/output, loops (if-then-else, for, while), List operations, regular expressions, functions, Plotting.

Text Book(s)

1) Introduction to MATLAB for Biologists (2019) Authors: Webb, Cerian Ruth, Domijan, Mirela 1st Ed. ISBN 978-3-030-21337-4
2) Fundamentals of Bioinformatics and Computational Biology: Methods and Exercises in MATLAB by Gautam B. Singh, Springer, 1st Ed.(2015) ISBN: 978-3-319-11403-3

Reference(s)

1. https://in.mathworks.com/help/index.html?s_tid=CRUX_lftnav
2. https://www.springer.com/gp/book/9783319253268

Course code:	BT3123
Course name:	Introduction to R and Python
Type	Departmental Elective
Credit	2

Course objective: The course provides fundamental understanding about R & Python scripts

Course content: R: Overview of R, R data types and objects, reading and writing data- Control structures, functions. Python: Editing and starting Python scripts - Variables, basic data types and assignments-Operators and expressions- Conditional Statements- Loops - Data Types.

Text Book(s)

1) R programming for bioinformatics, Robert Gentleman (2008) 1st Ed. Chapman and Hall/CRC, ISBN: 9781420063684
2) Learning python (5th Edition) by Mark Lutz, O'Reilly Media, Inc (2013). ISBN:9781449355739
3) Python programming for biology by Tim J. Stevens and Wayne Boucher. Cambridge University Press 1st Ed. (2015) ISBN:9780511843556

Course code:	BT3113
Course name:	Cellular Image Analysis
Type	Departmental Elective
Credit	3

Light/fluorescence microscopy based quantitative imaging plays a crucial role in life science research. This course offers basics of light/fluorescence microscopy and its applications in lifescience research, image properties, computer vision and quantification of biological information from the microscopic images. Topics include basics of microscopic images/imaging, image quality check, intensity measurements and background substarction, thresholding and image segmentation, colocalization, quantification and visualization of 3D images, deconvolution, 3D rendering and reconstruction, introduction to Fiji and CellProfiler, application of artificial intelligence/machine learning and virtual reality in image analysis.

Reference Books:

1) Microscope Image Processing by Qiang Wu, Fatima Merchant and Kenneth Castleman, Academic Press, ISBN: 012372578X
2) Fundamentals of Light Microscopy and Electronic Imaging by Douglas Murphy and Michael Davidson, Second Edition, Wiley-Blackwell publisher, ISBN: 047169214X.

Course code:	BT4110
Course name:	Biological Pathways and Network analysis
Type	Departmental Elective
Credit	3

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.

Course content: 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.

Reference books:

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 code:	BT4130
Course name:	Neuroscience and Technology
Type	Departmental Elective
Credit	2

Course objective: This course intends to provide basic of concepts in neurobiology, including neurophysiology of the human central nervous system, neural signaling, and neurological disorders.

Course content: 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.

Textbooks:

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.

Course code:	BT4223
Course name:	Algorithms for Molecular Dynamics simulation
Type	Departmental Elective
Credit	2

Course objective: The objective of the course is to provide the concept behind the classical molecular dynamics simulations and their application understanding the biomacromolecular conformations

Course content: 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.

Text Book(s)

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

Course code:	BT4140
Course name:	Statistical Methods for Gene Expression Analysis
Type	Departmental Elective
Credit	2

Course objective: The course aims to provide insights about microarray technology and is use in functional genomics research

Course content: Introduction to microarray technology, dimensionality and complexity of microarray data, basic statistical methods used for microarray gene expression data analysis, differential expression, classification, and clustering.

Text Book(s):

1) A Biologist's Guide to Analysis of DNA Microarray Data, Steen Knudsen John Wiley & Sons, 2002 ISBN: 0-471-22490-1 | ISBN: 0-471-22490-1
2) The Analysis of Gene Expression Data, Methods and Software, Editors: Parmigiani, G., Garett, E.S., Irizarry, R.A., Zeger, S.L. (Eds.), springer

Course code:	BT4150
Course name:	Single-Cell Technologies
Type	Departmental Elective
Credit	3

Biological processes are often heterogenic in nature and predominant amount of information stems from the traditional approach of studying cell populations rather than studying a single cell. This course introduces to the cutting edge single cell analysis technologies for genomics, transcriptomics, proteomics and metabolomics. Topics: Technologies for isolation of single cells, single cell analysis by Imaging, single cell analysis technologies (single cell genomics, transcriptomics, proteomics, metabolomcis), single cell analysis applicaitons (spatial gene expression, spatial proteomics, single cell ATAC, single cell immune profiling), commercial platforms for single cell seperation, single cell data analysis and visualization.

Reference Books:

1) Essentials of Single-Cell Analysis: Concepts, Applications and Future Prospects by Fan-Gang Tseng and Tuhin Subhra Santra, Springer, ISBN: 978-3-662-49118-8 (eBook)
2) Handbook of Single-Cell Technologies by Tuhin Subhra Santra and Fan-Gang Tseng, Springer, ISBN: 978-981-10-8952-7.
3) Single Cell Analysis: Technologies and Applications by Prof. Dario Anselmetti, Wiley-VCH Verlag GmbH & Co., ISBN: 9783527626649.

Course code:	BT6030
Course name:	Molecular Virology
Type	Departmental Elective
Credit	3

The course provides essential knowledge regarding molecular aspects of viral genome organization, gene regulation, expression and interactions with human host.

Content includes Viral Protein–Nucleic Acid Interactions; Genome Packaging; Structure and Complexity of Virus Genomes; Investigation of Virus Replication; Genome Coding Strategies in Virus; Transcriptional Control of Expression; Posttranscriptional Control of Expression; Virus–Host Interactions; RNA Interference; Viruses and Immunodeficiency; Cell Transformation by Viruses; New and Emergent Viruses; Zoonoses; Bioterrorism.

Text books:

1) Principles of Virology (ASM Books) (Volume Set Edition) by S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, Lynn W. Enquist

2) Principles of Molecular Virology (6th Edition) By Alan Cann ISBN 9780128019467, 9780128019559

Course code:	BT4210
Course name:	Intellectual Property Rights and Bioethics
Type	Departmental Elective
Credit	2

Course objective: This course aims to provide details regarding intellectual property rights, including the knowhows on filing patents. This course will also provide an understanding of risk assessment and ethical issues in biological research.

Course content: Concepts of intellectual property rights (IPR); Legal framework to protect the interests of innovators; Patents - strategy for protection of intellectual property; Patent protection-laws and exemption; Economic theories about the costs and benefits of patents; Case studies with specific examples; International agreements, treaties and conventions on IPRs; Research ethics and scientific integrity; Disciplines and research professions - consent, privacy, data management, fraud, and plagiarism; Introduction to Bioethics; Bioethics in biomedical research; Scientific knowledge relevant to core bioethics topics; Access to biological resources; Biopiracy

Text books:

1) Intellectual Property Rights and Research Tools in Molecular Biology, The National Academies Press, Washington, DC, ISBN: 978-0-309-05748-6.
2) Handbook of Research Ethics and Scientific Integrity, By Ron Iphofen, Springer International Publishing, ISBN: 978-3-030-16758-5.
3) Intellectual Property Rights in India, by V.K. Ahuja, Lexis Nexis; First edition (1 January 2015), ISBN-13: 978-9351433880.

Course code:	BT4230
Course name:	Nucleic acids-protein Interactions
Type	Departmental Elective
Credit	2

The course provides basic understanding of nature of a multicomponent DNA interactiong proteins and their mode of interaction. The out come of this course will be the understanding the processes carried out by the molecular machines, structural
details of components making up the system, coordination of functions among the components and techniques available to characterize the microscopic machines. Content includes DNA-protein interactions; DNA polymerase; Endonuclease; Recognition and rectification by DNA repair proteins; Homologous and non-homologous Recombination; Transposition, Topoisomerase, Telomerase, Epigenetic modification enzymes

Reference Books:

1) Lewin's Genes X. Authors: Jocelyn E. Krebbs, Elliott S. Goldstein and Stephen T. Kilpatrick. Published by Oxford University Press (2011) ISBN: 9780763766320
2) Molecular Biology of Cell, 5th Edition. Authors: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Published by Garland Science (2008). ISBN: 978-0-8153-4105-5

Course code:	BT4050
Course name:	Principles of Pharmacology
Type	Departmental Elective
Credit	2

Course objective: The learning outcome of the course is to provide knowledege about the principles of pharmacology.

Course content: Principles of pharmacology, Pharmacodynamics, Pharmacokinetics, Metabolism, toxicity. Case studies of adverse drug reactions.

Text Book(s)

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 code:	BT5020
Course name:	BioSignalling
Type	Departmental Elective
Credit	3

Course 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.

Course content: 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.

Text Book:

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.