BSBE Department

S.NO	Course code	Name of Course	L-T-P-C	Proposed Level (UG/PG)
1	BB 102	Essential biology for engineers	3-0-1-7	UG
2	BB 103	Introduction to Modern Biology	2-1-0-6	UG
3	BB 201	Biomolecules	2-1-0-6	UG
4	BB 301	Basics of Cell Biology and Genetics	2-1-0-6	UG
5	BB 402	Introduction to Biochemical Engineering	3-0-0-6	UG
6	BB 403	Metabolism and Bioenergetics	2-1-0-6	UG
7	BB 404	Biophysics	3-0-0-3	UG
8	BB 405	Biostatistics	3-0-0-3	UG
9	BB 406	Microbiology	2-1-0-6	UG
10	BB 407	Molecular Biology	2-1-0-6	UG
11	BB 408	Ecology and Evolutionary Biology	2-1-0-6	UG
12	BB 409	Systems and computational biology/Bioinformatics	3-0-0-3	UG
13	BB 410	Bio-separations	3-0-0-6	UG
14	BB 411	Biology Lab I	0-0-3-3	UG
15	BB 412	Biology Lab II	0-0-3-3	UG
16	BB 413	Biology Lab III	0-0-6-6	UG
17	BB 414	Biology Lab IV	0-0-3-3	UG
18	BB 420	Enzyme and protein engineering	3-0-0-3	UG
19	BB 421	Tissue engineering	3-0-0-3	UG
20	BB 422	Bioinformatics lab	0-0-3-3	UG
21	BB 423	Genetic Engineering	3-0-0-3	UG
22	BB 601	Biomedical Imaging and Instrumentation	3-0-0-6	PG
23	BB 603	Introduction to Biostatistics	3-0-0-6	PG
24	BB 604	Biomedical Spectroscopy and Imaging	3-0-0-6	PG
25	BB 605	Bioinformatics	3-0-0-6	PG
26	BB 606	Biophysical methods	3-0-0-3	PG
27	BB 607	Immunology	2-1-0-6	PG
28	BB 608	Genomics and proteomics	3-0-0-3	PG
29	BB 609	Physiology	2-1-0-6	PG
30	BB 610	Advance cell Biology	2-1-0-3	PG
31	BB 620	Plant Biotechnology	2-1-0-3	PG

32	BB 701	Neurobiology	3-0-0-3	PG
33	BB 702	Animal Biotechnology	2-1-0-3	PG
34	BB 703	Bioprocess technology	2-1-0-3	PG
35	BB 704	Biomedical Imaging	2-1-0-3	PG
36	BB 705	Developmental Biology	2-1-0-3	PG
37	BB 801	Molecular Biology of Cancer	3-0-0-6	PG
38	BB 802	Cellular and Molecular Immunology	3-0-0-6	PG
39	BB 801	Cancer Biology	2-1-0-3	PG
40	BB 803	IPR, Biosafety and Bioethics	3-0-0-3	PG
41	BB 804	Research Methodology and Scientific Writing	2-0-1-3	PG
42	BB 901	Stem Cells and Regenerative Medicine	2-1-0-3	PG
43	BB 902	Biomaterials	3-0-0-3	PG
44	BB 908	Seminar	4 credits	PG
45	BB 915	Molecular biology techniques and applications	3-0-0-6	PG
46	BB 810	Research Philosophy	3-0-0-6	PG
47	BB 302	ALO-UG Research Laboratory Exposure	2-0-2-2	UG
48	BB 611	Modern translational Biology	3-0-0-6	PG
49	BB 612	Animal Models in Biomedical Research	3-0-0-6	PG
50	BB 613	Enzymology	3-0-0-6	PG
51	BB 614	Molecular and Cellular Neuroscience	3-0-0-6	PG

1	**Title of the course** (L-T-P-C)	**Essential biology for engineers** **(3-0-1-7)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Quantitative views of modern biology. Importance of illustrations and building quantitative/qualitative models. Role of estimates. Cell size and shape. Temporal scales. Relative time in Biology. Key model systems – a glimpse. Management and transformation of energy in cells. Mathematical view – binding, gene expression and osmotic pressure as examples. Metabolism. Cell communication. Genetics. Eukaryotic genomes. Genetic basis of development. Evolution and diversity. Systems biology and illustrative examples of applications of Engineering in Biology.
4	**Texts/References**	1. Miko, I. & Lejeune, L., eds. Essentials of Genetics. Cambridge, MA: NPG Education, 2009.O'Connor, C. M. & Adams, J. U. Essentials of Cell Biology. Cambridge, MA: NPG Education,2010. 2. Watson JD, Baker, TA, Bell SP, Gann A, Levin M, Losick R, Molecular Biology of the Gene, Pearson Education, 2004. 3. Dan E. Krane, Michael L. Raymer. Fundamental Concepts of Bioinformatics, Pearson Education India. 2003

1	**Title of the course** (L-T-P-C)	**Introduction to Modern Biology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Quantitative views of modern biology. Importance of illustrations and building quantitative/qualitative models. Role of estimates. Cell size and shape. Temporal scales. Relative time in Biology. Key model systems – a glimpse. Management and transformation of energy in cells. Mathematical view – binding, gene expression and osmotic pressure as examples. Metabolism. Cell communication. Genetics. Eukaryotic genomes. Genetic basis of development. Evolution and diversity. Systems biology and illustrative examples of applications of Engineering in Biology.
4	**Texts/References**	Campbell Biology 12th edition, Pearson publication by Lisa Urry,Michael Cain,Steven Wassserman

1	**Title of the course** (L-T-P-C)	**Biomolecules** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**Major classes of biological molecules:** Comparison of the alphabets and sources of structural diversity of proteins, nucleic acids, carbohydrates and lipids. **Proteins:** Ramachandran plot, evolution of protein structure, structure-function **relationships:** myoglobin and adaptations in myoglobin structure in deep diving mammals; allostery in hemoglobin; Bohr effect (for pH and carbon dioxide); adult and foetal hemoglobin. **Post-translational modifications:** special types of covalent bonds found in proteins. Protein folding: Natively folded and natively disordered proteins; Mini proteins and peptide toxins; Anfinsen's observations, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, diseases associated with protein folding. **Carbohydrates:** Sources of structural diversity; structure- function relationship in glycogen and cellulose, Difficulty associated with sequencing of glycans. **Lipids:** Structure and properties of storage and membrane lipids. **Self-assembly of lipids:** packing parameter; Bio membrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena. **Nucleic acids:** Historical perspective leading up to the proposition of double helical structure with emphasis on the innovativeness of experimental design; Secondary structure of RNA; chromatin organization. **Enzymes:** General principles of catalysis; quantitation of enzyme activity and efficiency; Henri-Michaelis-Menten and Briggs-Haldane relationships; **Transition state:** definition Pauling's intuition and proposal, catalytic antibodies; Catalytic strategies; Isozymes: Haldane relationship between kinetic constants and equilibrium constant; Zymogens. **Bioenergetics:** basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism. Relevant metabolic pathways may be included to discuss relevant concepts.
4	**Texts/References**	1. Rodney F Boyer, Concepts in Biochemistry. John Wiley & Sons; 3rd Ed (2 December 2005). 2. Thomas Miilar, Biochemistry Explained: A Practical Guide to Learning Biochemistry CRC Press; 1 edition (30 May 2002) 3. Lubert Stryer et al., Biochemistry.W. H. Freeman; 6th Edition edition (14 July 2006) 4. 4. David L Nelson, and Michael M Cox et al., Lehninger principles of biochemistry WH Freeman; 7th ed. 2017 edition (1 January 2017)

1	**Title of the course** (L-T-P-C)	**Basics of Cell Biology and Genetics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** 1. Introduction to genetics **2.** Mendelian genetics: Mendel's law and examples, Monohybrid and di- hybrid cross, recessive and dominant mutation, concept of allele **3.** Non-Mendelian genetics: incomplete dominance, semi- dominance, and introduction to epigenetics, Cytoplasmic inheritance, infection heredity. **4.** Genetic interactions: approach towards generating a network (epistasis, redundancy, synthetic lethality, lethal interactions) **5.** Model organisms and studies on molecular and genetic interactions **6.** Structure of prokaryotic and eukaryotic cells **7.** Introduction of cell biology, classification of living organisms, Prokaryotic cells, eukaryotic cells. **8.** Membrane structure and function. **9.** Structure and Composition of the Cell Membrane, Membrane Proteins, Transport across the Cell Membrane. **10.** Structural organization and function of intracellular organelles **11.** Structure and function of cytoplasm, Cytoskeletal elements and architecture, Structure and Function of mitochondria, Ribosomes, Endoplasmic reticulum, Rough endoplasmic reticulum and protein secretion, Lysosomes, The Golgi Complex, Peroxisomes, Vacuoles, plant cell organelles, Cell locomotion
4	**Texts/References**	**1**. Anthony JF Griffiths et al., An Introduction to Genetic Analysis W.H. Freeman and Co 7th Edition 2000 **2**. Watson et. al., Molecular Biology of the Gene, Pearson, 7th Edition 2013 **3**. Jocelyn E. Krebs et al., Lewin's Gene Jones & Bartlett Learning; 11 edition (December 31, 2012) 4. Richard Kowles, Solving Problems in Genetics Springer; 2001 edition (June 21, 2001) **4**. Gerald Karp, Cell Biology, WILEY (Feb. 4th, 2013) **5**. Bruce Alberts et al., Essential Cell Biology; Richard Goldsby and Thomas J, &F/Garland, 4th Edition, (2014). **6**. Alberts, Bruce.; Molecular Biology of the Cell, Garland Science; 5th edition (2 January 2008)

1	**Title of the course** (L-T-P-C)	**Introduction to Biochemical Engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Introduction to fermentation technology:** Interaction between biochemical engineering; Microbiology and Biochemistry; Introduction to fermentation processes; Microbial culture; Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms; Inoculum production for bacterial and fungal processes. **Raw material and media formulation forfermentation process:** Fermentation media;Natural media; synthetic media. Sources ofCarbon; Nitrogen and vitamins; antifoams andoptimization; Types of Fermentation: Solid Substrate fermentation and submerged fermentation; Process parameters: measurement of temperature; pressure and pH;dissolved Oxygen; foam etc. Strain improvement by mutation and screening ofimproved cultures; random and strategic screening methods; strategies of strain improvement for primary; secondarymetabolites with relevant examples; Preservation of cultures after strain improvement programme. **Design and construction of a Fermentors:** Body construction; construction material; Aeration and agitation systems; Stirrer glands and bearings; Baffles; Valves and steam traps; Pressure-control valves; computer applications in fermentation technology; specialized bioreactors; membrane bioreactors; tower bioreactors; fluidized bed bioreactors; Immobilized system and packed bed reactors and Photobioreactors. **Downstream Processing:** Biomass separation by centrifugation; filtration; flocculation and other methods; Cell disintegration: Physical; chemical and enzymatic methods; Separation of solid and liquid phases; isolation and purification techniques for proteins and other products based on different physico-chemical properties; Principles of bioprocess control; bioprocess automation and application ofcomputers in bioprocessing; recombinant products with representative examples.
4	**Texts/References**	**1.** "Bioprocess Engineering" by Michael L Shuler Fikret Kargi 2ndedition (Perason Publication) **2**. "Bioprocess Technology: Kinetics and Reactors" by Anton Moser andPhilip Manor 1st edition (Springer)

1	**Title of the course** (L-T-P-C)	**Metabolism and Bioenergetics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Design principles of metabolism **2.** Principles of energy release from biological macromolecules. **3.** Principles of bioenergetics. **4.** Carbohydrate metabolism **5.** Alternative oxidation of glucose by Pentose Phosphate pathway (PPP). **6.** Krebs /TCA /CAC cycle **7.** Strategies in citrate cycle. **8.** Oxidative phosphorylation **9.** Photosynthesis **10.** Fatty acid metabolism **11.** Amino acid metabolism **12.** Nucleic acid metabolism **13.** One carbon metabolism **14.** Secondary metabolism **15.** Interconvertibility of fuels **16.** Molecular chaperones in protein folding, experimental strategies to study protein mis-folding and disease, regulation of metabolism through metabolic networks, metabolic messengers, generation of NO and oxygen radicals.
4	**Texts/References**	**1**. Rodney F Boyer, Concepts in Biochemistry. John Wiley & Sons; 3rd Edition edition (2 December 2005) **2**.Thomas Millar, Biochemistry Explained: A Practical Guide to Learning Biochemistry. CRC Press; 1 edition (30 May 2002) **3**.Lubert Stryer et al., Biochemistry. W. H. Freeman; 6th Edition edition (14 July 2006) **4.**John E. McMurry and Tadgh Begley. The Organic Chemistry of Biological Pathways. WH Freeman; 2nd edition (11 December 2015) **5.**Laurence A Moran, Principles of Biochemistry. Pearson; 5 edition (30 July 2013) **6.**David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry WH Freeman; 7th ed. 2017 edition (1 January 2017)

1	**Title of the course** (L-T-P-C)	**Biophysics** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	

3	**Course content**	• Diffusion and Brownian motion and Biological applications.
		• Electrostatic interactions
		• Chemical Potential and Chemical reactions
		• Self-assembly, micelles, cell membranes
		• Helix coil transition
		• Stretching of macromolecules
		• Protein folding
		• Unzipping of DNA
		• Machines in membranes
		  ○ Electro-osmotic effects
		  ○ Ion pumping
		• Nerve Impulses
		  ○ Action Potentials
		  ○ Ion Channels
		• Physical Techniques and related biology
		  ○ X-ray diffraction, light and neutron scattering
		  ○ Nuclear magnetic Resonance
		  ○ Fluorescence
		  ○ DNA Microarrays
		  ○ Manipulation of bio-molecules using optical tweezers.
		  ○ Tomography
		  ○ Patch clamps

4	**Texts/References**	**1**. Physical Biology of the Cell, Second Edition by Rob Phillips, Jane Kondev, Julie Theriot, and Hernan Garcia (Garland Science, 2012). **2.** Biological Physics: Energy, Information, Life Student edition by Philip Nelson. (Chiliagon Science)

1	**Title of the course** (L-T-P-C)	**Biostatistics** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	• **Introduction to statistics for biologists:** importance of statistics, hypothesis testing, overview of statistical tests, variables. • **Summarizing and visualizing data:** types of data, summarizing data, displaying data, descriptive statistics, tools for graphical display. • **Probability & distributions:** basic probability, laws of probability, types of distributions, statistics of distributions, probability distributions. • **Methods of sampling:** populations and samples, sampling & non-sampling errors, various methods of sampling, experimental design. • **Hypothesis testing**: need for statistical testing, acceptable errors, P-values. • **Parametric & non-parametric tests:** concept of parametric & non-parametric statistics, tests for differences. • **ANOVA:** one-way ANOVA, Two-way ANOVA, Three-way ANOVA, Multiway ANOVA, Nested ANOVA, ANCOVA. • **Correlation & regression:** scatter plot, correlation coefficient, partial correlation coefficient, linear regression, non-linearity, non-linearity. • **Survival analysis:** censoring, survival times, summarizing and presentation. • **R for biostatistics:** introduction, performing common statistical tests in R, visualizing data in R, exporting data and analysis.
4	**Texts/References**	**1.** Michael C. Whitlock and Dolph Schluter, The Analysis of Biological Data, Roberts And Company Publishers, 2015. **2.** Steve McKillup, Statistics Explained: An Introductory Guide for Life Scientists, Cambridge University Press, 2006. **3.** Calvin Dytham, Choosing and Using Statistics: A Biologist's Guide, Wiley-Blackwell, c2011

1	**Title of the course** (L-T-P-C)	**Microbiology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Microbial physiology: structure of microbes - prokaryotic cell structure & function, autotrophic and heterotrophic metabolisms - , growth and its control factors - culturing and measurement of microbial growth, physical & chemical methods of microbe control. **2.** Microbial development: division - bacterial cell division, sporulation - endospores, organelle, biofilms. Overview of microbial development with examples from model systems such as Bacillus, cyanobacteria, yeast, filamentous fungi and protozoa. **3.** Microbial communication - quorum sensing and chemosensory response - bacterial chemotaxis, regulatory network of chemotaxis. **4.** Microbial pathogenesis: types, mode of infection with examples of human and plant pathogens. Antimicrobial agents and their mode of action. **5.** Applied microbiology: biodegradation, bioremediation, fermentation, recombinant protein production **6.** Bacterial Genetics: transposition, mapping of mutations, plasmids, bacterial two-hybrid systems, genetics of bacteriophages, conjugation, transformation, transduction as a tool in bacterial genetics.
4	**Texts/References**	**1.** Klein's Microbiology by Willey, Joanne M; Sherwood, Linda; Woolverton, Christopher J; Prescott Harley, McGraw- Hill, 7th Edition, 2008. **2.** Microbiology: An Introduction by Michael T. Madigan, John **3.** M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock 14th edition (Pearson) **4.** Cardona (2016) The Progress of Therapeutic Vaccination with Regard to Tuberculosis, Frontiers in Microbiology 7 **5.** Wai-Leung Ng and Bonnie L. Bassler (2009) Bacterial Quorum-Sensing Network Architectures **6.** AnnuRevGenet,2009;43:197?222. doi:10.1146/annurevgenet- 102108-134304. chemotaxis:http://chemotaxis.biology.utah.edu/ParkinsonLa b/projects/ecolichemotaxis/ecolichemotaxis.html Endotoxin:http://textbookofbacteriology.net/endotoxin.html

1	**Title of the course** (L-T-P-C)	**Molecular Biology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** **Nucleic acid:** building blocks, nucleotide analogs as drugs **2.** **DNA structure**- base pairing and stabilizing forces, different forms of DNA. minor and major grooves, supercoiling, organization into chromosomes, nucleosomes, heterochromatin, euchromatin, genes and organization, unique genes, operons, gene families, repetitive DNA, genome organization, transposons. **3.** **Replication:** basic processes in bacteria and eukaryotes, telomeres and telomerase **4.** **DNA damage and repair:** Basic steps in gene expression and regulation, transcriptional and post-transcriptional regulation of gene expression **5.** **Bacterial translation:** **6.** **Eukaryotic translation:** **7.** **Epigenetics:** DNA methylation in prokaryotes and eukaryotes, epigenetic gene regulation by DNA methylation in plants and mammals. Methods to detect epigenetic modifications **8.** **Protein-nucleic acid interactions** - nucleic acid recognition by proteins binding motifs - techniques to study protein-nucleic acid interactions. **9.** **Non-coding RNA:** Biogenesis and its function.
4	**Texts/References**	**1.** Molecular Biology of the cell by Bruce Alberts et al. 6th edition. **2.** Lewin's Genes XII by Elliott S. Goldstein, Jocelyn E.Krebbs, and Stephen T. Kilpatrick. 12^{th} edition (2017) **3.** DNA Repair and Mutagenesis (2nd Edition) Friedberg and others. **4.** Mehta, A. and Haber J. E. (2014) sources of DNA double strand breaks and Models of Recombination DNA repair Cold Spring Harb Perspect Biol 6: a016428. **5.** Anand, R.P, Lovett, S.T. and Haber J.E. (2013) Break Induced DNA Replication. Cold Spring Harb Perspect Biol 5: a010397.

1	**Title of the course** (L-T-P-C)	**Ecology and Evolutionary Biology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	1. **Overview of Biology:** What is life? Characteristics of living organisms; Importance of studying biology; Scales in biology (molecules (including DNA), organelles, cells, tissues, organs, organisms, populations, communities and ecosystems); Disciplines of biology in relation to these scales; Origins of life. 2. **Principles of Evolutionary Biology:** History of evolutionary thinking - ideas that formed the basis of modern understanding of evolution; Genes and alleles; Fundamental concepts (variation, selection, units of selection, fitness, adaptation); Prerequisites for evolution by natural selection; Evidence for natural selection and evolution; Types of selection (directional, stabilizing, disruptive); Evolution without selection (genetic drift, gene flow); Species concepts and speciation; Phylogenetics (basic terminology, tree of life, phylogenetic reconstruction, molecular dating); Macroevolutionary patterns (mass extinction, adaptive radiation, convergent evolution, divergent evolution). 3. **Principles of Ecology:** Biomes; Ecosystems (trophic levels, trophic structure, energy transformation, gross and net production, primary productivity, secondary productivity); Ecosystem types (tropical, temperate, subtropical); Population ecology (population characteristics, growth, life history strategies, population regulation, metapopulations); Community ecology (ecological succession, microhabitats, niche, structure of communities); Species interactions (predation, parasitism and mutualism). 4. **Behavioural ecology:** Adaptive value of behaviour; Sexual selection; Mating systems; Kinship; Cooperation; Sociality (altruism, cooperation, kin selection, reciprocal altruism, etc.); Optimal foraging theory; Parental care; Social symbiosis. 5. **Biodiversity and conservation biology:** Taxonomy and phylogenetic systematics; Diversification of life - a phylogenetic perspective; Diversification of life - a timeline; Measuring extant diversity; Threats to extant biodiversity (habitat loss and degradation, Invasive species, Pollution, Overexploitation, Global climate change); In-situ and ex-situ conservation; Biodiversity of India; Island biogeography.
4	**Texts/References**	**1.** Manuel C Molles, Ecology: Concepts and Applications Mc Graw Hill 7th Edition 2014 **2.** Douglas J Futuyma, Evolution Oxford University Press 3rd Edition 2013 **3.** Barton et al., Evolution Cold Spring Harbor Laboratory Press 1st Edition 2007 **4.** Stephen C. Stearns and Rolf F. Hoekstra, Evolution: An Introduction Oxford University Press 1st Edition 2000 **5.** Nicholas J. Gotelli, A primer of Ecology Oxford University Press, 4th Edition 2008 **6.** Begon et al., Ecology: From Individuals to Ecosystem Wiley-Blackwell, 4th Edition 2005

1	**Title of the course** (L-T-P-C)	**Systems and computational biology/Bioinformatics (3-0-0-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Biological data & sources - origin and types of biological data, public databases, storingbiological data and data security. **2.** Data mining - concept of data mining, methodsof data mining: text-based, mining tasks, applications. **3.** DNA sequence analysis - dot plot, basic concepts of sequence similarity, identity and homology, homologs, orthologs, paralogs, concepts behind scoring matrices, dynamic programming pairwise alignment - Smith-Waterman and Needleman-Wunsch algorithm,FASTA. **4.** BLAST & Remote homology search - theBLAST algorithm, parsing BLAST results,advanced BLAST algorithms. **5.** Multiple Sequence Alignment - methods of MSA: progressive alignments, consistency- based and structure-based alignment, programs for MSA. **6.** Motif finding algorithms - sequence motifconcepts, algorithms to detect DNA sequence motifs, Gibbs sampler, MEME. **7.** Protein bioinformatics - Protein secondary structure calculation – DSSP, membranetopology prediction, ligand-receptor interactions, composition of active sites infunctional proteins, conformational change and activity, allostery, effects of point mutations on proteins structure and function. **8.** RNA structure analysis - RNA structure, RNAsequence databases, RNA structure prediction: Nussinov algorithm, EM algorithm. **9.** Next generation sequencing and principles of NGS data analysis - introductory concepts, types of NGS data, various platforms of NGS, alignment algorithm - BWA, RNA-Seq, ChIP- Seq, single cell genomics. **4.** 10.R for bioinformatics - introduction, basic elements of R, plotting high-dimensional data, statistical analysis, programming.
4	**Texts/References**	**1.** Bioinformatics- Sequence and Genome Analysis by David W. Mount; Cold SpringHarbor Laboratory Press,U.S.; 2ndRevised edition edition; 2004. **2.** Introduction to Computational Genomics by Nello Cristianini and Matthew W. Hahn; Cambridge University Press; 2007 **3.** Bioinformatics: Sequence and Genome Analysis by David W Mount (Cold SpringLaboratory Press 2004, Second Edition).

1	**Title of the course** (L-T-P-C)	**Bio-separations** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Introduction to bio separations and purification:** Products from industrial fermentation, biomass, protein, and valuable metabolites; various downstream process steps; bioproduct from cell culture-intracellular and extracellular. **Cell disruption**: mechanical, enzymatic, andchemical methods. **Solid-liquid separation**: filtration andcentrifugation **Membrane separation:** ultrafiltration, dialysisand reverse osmosis. **Precipitation of proteins:** salting out, andsolvent induced precipitation. **Chromatography:** principles, techniques and methods of affinity chromatography, ion- exchange chromatography, hydrophobic interaction chromatography, and size exclusion chromatography. **Polishing and improving stability ofbioproducts:** Crystallization, Drying and lyophilization.
4	**Texts/References**	Handbook of Bioseparations (Separation Scienceand Technology) Volume I-II, by Satinder Ahuja, Academic Press, USA. Bioseparations-principles and techniques, BSivasankar, Prentice Hall of India, N Delhi,2005. Bioseparation & bioprocessing, Subramanian Ganapathy, Wiley-VCH, 2007. Bioprocess Engineering Basic Concepts, by M Shuler and F. Kargi, Prentice Hall (2002) Research articles in Journals: Separation and Purification Technology (Elsevier publisher);Bioseparations in Jorunal of Chemical Technology and Biotechnology (SCI publisher)

1	**Title of the course** (L-T-P-C)	**Biology Lab I** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Biological solutions preparation **2.** Titration of amino acids, **3.** Estimations of reducing non-reducing sugars, proteins, DNA, RNA, lipids, **4.** paper chromatography/TLC, **5.** SDS-PAGE, isoelectric focusing, **6.** DNA melting curves **7.** Enzyme assays
4	**Texts/References**	NA

1	**Title of the course** (L-T-P-C)	**Biology Lab II** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Methods of describing, observing, counting and estimating the abundance, diversity and behaviour of living organisms. **2.** Light Microscopy, sample preparation and examination, identification of microorganisms, **3.** Staining techniques (Gram's, acid fast), **4.** Bacterial plating, tests for antibiotic resistance, **5.** Microbial growth kinetics, bacterial motility assay **6.** Transformation,
4	**Texts/References**	NA

1	**Title of the course** (L-T-P-C)	**Biology Lab III** **(0-0-6-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Genetic engineering lab will a micro-project-based lab. The micro-project will cover following techniques- 1. DNA isolation 2. Primer Design, 3. PCR, 4. Cloning Transgene expression and validation using PCR and Western Blot, 6. Site-directed Mutagenesis, 7. qRT-PCR
4	**Texts/References**	NA

1	**Title of the course** (L-T-P-C)	**Biology Lab IV** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Fluorescence microscopy to examine intracellular compartments, Cell fractionation and centrifugation methods, isolation of intracellular compartments by differential centrifugation techniques, nuclei, cytoplasm etc. Basics of cell culture methods: cell counting, culture media preparation. Proliferation and using live cell imaging and MTT assay, Purification and analysis of Immunoglobulins, Immunoprecipitation, Enzyme-linked immunosorbent assay (ELISA), Fluorescence-activated cell sorting (FACS) and analysis of cells Immunostaining and imaging,
4	**Texts/References**	NA

1	**Title of the course** (L-T-P-C)	**Enzyme and protein engineering** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Kinetics of enzyme-catalyzed reactions. The Michaelis-Menten and the Briggs-Haldanemodel. Enzyme inhibitors: competitive, non- competitive, uncompetitive. Activity assays. Definitions of enzyme unit and the marketing of enzymes. Molecular mechanisms of selected enzymes: α-chymotrypsin, DNA polymerases, and lactate dehydrogenase. Rational design of artificial proteins. Principles and practice of rational protein engineering. Construction of enzyme variants featuring improved thermostability or altered catalytic performances. Introduction of artificial disulfide bonds and thermostability. Grafting of the seryl-proteases catalytic triad into target proteins and construction of artificial proteases. Multifunctional enzymes. Directed evolution of enzymes. Principles and practice of directed evolution. Generation and recombination of mutant libraries by means of mutagenic PCR, DNA shuffling, STEP (staggered extension process). Screening and selection strategies. Construction of thermostable enzymes by meansof directed evolution. Bacterial mutator strains asa tool for the construction of random mutant libraries.
4	**Texts/References**	1. Daniel Purich, Enzyme kinetics: catalysis and control, 2010, Elsevier 2. Sheldon J. Park & Jennifer R. Cochran,Protein Engineering and design, 2009, CRC Press 3. Biochemistry: Lubert Stryer; W. H.Freeman; 7th Edition; 2010. 4. Biochemistry by Donald Voet, Judith G. Voet; Wiley; 4th edition; 2010.

1	**Title of the course** (L-T-P-C)	**Tissue engineering** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Principles of Tissue Engineering: Scaffolds and Cells: Introduction to Tissue Engineering, Introduction to scaffolds with example of Scaffolds: Collagen-GAG Analogs of Extracellular Matrix; Differentiated versus Stem Cells; Scaffolds: Recent Advances in Tissue Engineering Scaffolds: Self-Assembled Proteins **2.** Principles of Tissue Engineering: Cells and Regulators: Scaffolds: Biomimetics Design, Cells: Effects of Culture Conditions, Regulators: Response to Mechanical Loading, Regulators: Roles of Environmental Factors, Cells: Embryonic and Other Stem Cell for Tissue Engineering. **3.** Practice of Tissue Engineering: Clinical Applications: Applications: Skin and Peripheral Nerve Regeneration, Blood Vessels, Heart Valves, Urinary Tissues/Organs, Clinical Applications and Underlying Principles, Bone regeneration and cartilage repair
4	**Texts/References**	1. Principles of Tissue Engineering by Robert Lanza and Robert Langer (AP publication) Tissue Engineering for Artificial Organs: Regenerative Medicine, Smart Diagnostics and Personalized Medicine" by Anwarul Hasan 1st edition (Wiley)

1	**Title of the course** (L-T-P-C)	**Bioinformatics lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Biological data & sources - origin and types of biological data, public databases, storing biological data and data security. **2.** Data mining - concept of data mining, methods of data mining: text-based, mining tasks, applications. **3.** DNA sequence analysis - dot plot, basic concepts of sequence similarity, identity and homology, homologs, orthologs, paralogs, concepts behind scoring matrices, dynamic programming pairwise alignment - Smith-Waterman and Needleman-Wunsch algorithm, FASTA. **4.** BLAST & Remote homology search - the BLAST algorithm, parsing BLAST results, advanced BLAST algorithms. **5.** Multiple Sequence Alignment - methods of MSA: progressive alignments, consistency-based and structure-based alignment, programs for MSA. **6.** Motif finding algorithms - sequence motif concepts, algorithms to detect DNA sequence motifs, Gibbs sampler, MEME. **7.** Protein bioinformatics - Protein secondary structure calculation – DSSP, membrane topology prediction, ligand- receptor interactions, composition of active sites in functional proteins, conformational change and activity, allostery, effects of point mutations on proteins structure and function. **8.** RNA structure analysis - RNA structure, RNA sequence databases, RNA structure prediction: Nussinov algorithm, EM algorithm. **9.** Next generation sequencing and principles of NGS data analysis - introductory concepts, types of NGS data, various platforms of NGS, alignment algorithm - BWA, RNA-Seq, ChIP-Seq, single cell genomics. **10.** R for bioinformatics - introduction, basic elements of R, plotting high-dimensional data, statistical analysis, programming.
4	**Texts/References**	**1.** Bioinformatics, David Mount, CSHL, 2003 **2.** Bioinformatics & Functional Genomics, Jonathan Pevsner, Wiley 2015 **3.** M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, Elsevier, 2010

1	**Title of the course** (L-T-P-C)	**Genetic Engineering** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Molecular tools for gene cloning: Nucleases: Exonucleases and Endonucleases, Restriction Enzymes (Type I, Type IType III, Type IV & Type V), rnases Methylases: cpg Methylase, Dam Methylase, Dcm Methylase Polymerases: DNA Pol I, Klenow Fragments, Reverse Transcriptase, Taq & Pfu Polymerases Ligases: T4 DNA Ligase, E.coli DNA Ligase, T4 RNA Ligase Topoisomerases: Type I(A, B) & Type II(A,B) End Modifying Enzymes: Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases **2.** Vectors and gene cloning Introduction to cloning vectors -- Desirable properties of vectors – Prokaryotic & Eukaryotic Expression Systems (Constitutive & Inducible) Plasmid Vectors -- Phage Vectors -- Cosmids -- Phagemids -- bacs -- Yeast Vectors -- yacs -- Lentiviral Vectors – Adenoviral Vectors -- Plant Vectors, Insect Vectors (Optional Reading) **3.** Advanced techniques in molecular biology Polymerase Chain Reaction -- Quantitative Real Time PCR -- Gel Electrophoresis: AGE & PAGE -- Blotting Techniques: Southern, Western & Northern Methods of gene transfer in Plants and Animals: Chemical, Physical & Viral mediated DNA transfer Construction of Genomic & cdna Libraries -- DNA Sequencing -- Protein Engineering: Site Directed Mutagenesis – Reporter Gene Assays -- DNA Protein Interactions: EMSA, DNA Footprinting – Protein-Protein Interactions: Y2H, Y3H, B1H, B2H **4.** Recent trends in molecular biology research Targeted Genome Editing: zfns, talens, crisprs – Gene Targeting: Knock-ins & Knock-outs -- DNA Finger Printing
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Biomedical Imaging and Instrumentation** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	BB102, EE102
3	**Course content**	**Module 1**: Human Physiology **Module 2:** Medical Imaging and Instrumentation(ECG, CT etc) **Module 3:** Basics of microscopy **Module 4**: Nuclear Magnetic Resonance spectroscopy (NMR) and magnetic resonance imaging (MRI) **Module 5**: Mass Spectrometry and applications **Module 6**: Fluorescence spectroscopyand applications **Module 7**: Infrared spectroscopyand applications **Module 8:** Raman spectroscopyand applications
4	**Texts/References**	**1.** Laser fundamentals, William. T Silfvast, 2004 **2.** Photonics, Volume 4: Biomedical spectroscopy, photonics and microscopy, David L Andrews,2015 **3.** Biophotonics: vibrational spectroscopic diagnostics, Mathew baker, Caryn Hughes, Katherine A Hollywood,2016 4.Fundamentals of Medical imaging, Suetens P, 2017 **5**. D. Pavia "Introduction to spectroscopy" Cengage Learning India Private Ltd., 5^{th} Ed., 2015. **6**. R. Silverstein, F. Webster, D. Kiemle, and D. Bryce "Spectrometric identification of organic compounds", 8^{th} Ed., Wiley, 2015. **7**. C. Banwell and E. McCash "Fundamentals of molecular spectroscopy" 4^{th} Ed., McGraw Hill Education, 2017. **8.** J. Keeler "Understanding NMR spectroscopy" 2^{nd} Ed., Wiley, 2011 **9**. J.K. Hall: Guyton and Hall Medical Physiology. Second South Asia Edition 2019, Elsevier

1	**Title of the course** (L-T-P-C)	**Introduction to Biostatistics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	NA
3	**Course content**	**1.** Introduction, Data Representation & Plotting. **2.** Arithmetic mean, Geometric mean. **3.** Measure of variability, standard deviation. **4.** SME, Z-score, Box Plot. **5.** Kurtosis, R programming. Correlation and regression. Interpolation and extrapolation. Nonlinear data fitting. Concept of probability. Permutation and combination. Conditional probability and random variables. Probability mass function. Probability density function. Probability distribution. Poisson, uniform and exponential distribution. Sampling distribution, Central limit theorem. Confidence interval. Test of Hypothesis. T-test, Chi-square test. ANOVA, ANOVA for linear regression.
4	**Texts/References**	2. Introduction to Probability and Statistics: Medenhall, Beaver, Beaver 14th Edition. 3. 2.Introduction to Probability and Statistics for engineers and scientists: S M Ross, 3rd Edition

1	**Title of the course** (L-T-P-C)	**Biomedical Spectroscopy and Imaging** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Module 1: Medical Imaging Module 2: Spectrometry and Instrumentation Module 3: Hyperspectral Imaging, line scanning, and Pointspectroscopy Module 4: Fluorescence spectroscopy and applications Module 5: Infrared spectroscopy and applications Module 6: Raman spectroscopy and applications
4	**Texts/References**	Laser fundamentals, William. T Silfvast, 2004 Photonics, Volume 4: Biomedical spectroscopy, photonics and microscopy, David L Andrews,2015 Biophotonics: vibrational spectroscopic diagnostics, Mathew baker, Caryn Hughes, Katherine A Hollywood,2016 Fundamentals of Medical imaging, Suetens P, 2017

1	**Title of the course** (L-T-P-C)	**Bioinformatics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction. Bioinformatics: What and why? Statistics: Descriptive Statistics, Probability and Distributions Regression and Correlation Parametric and Non- Parametric Statistics Basic Epidemiology and Vital Statistics Statistics for differential expression, multiple testing corrections Introduction to SPSS, Graph pad, R Statistical Data Analysis Using Microsoft Excel Data representation differential expression normalization Functional interpretation of array data. Genomics: Genomic sequences. Online databases: Intro to sequence alignment Scoring Matrices. Pairwise alignment. Gaps. Database searching: BLAST and BLAT. Limits of detection, significance. Advanced BLAST and BLAT: PSI-BLAST, Genomic DNA. Multiple sequence alignment and Relevance to inferences about evolution. molecular phylogeny introduction: Molecular phylogeny and evolution. mRNA and gene expression introduction, Characterizing eukaryotic genomes. Human variation and disease. Sequence variation, phenology, ,comparative genomics. Personalized medicine. Multiple testing
4	**Texts/References**	**1.** Statistical Methods in Bioinformatics: An Introduction Author(s): Gregory R. Grant, Warren J. Ewens. **2.** Developing Bioinformatics Computer Skills Author(s): Cynthia Gibas, Per Jambeck **3.** Bioinformatics: Sequence and Genome Analysis Author(s): David W Mount

1	**Title of the course** (L-T-P-C)	**Biophysical methods** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Chromatography: Principles of Chromatography, Chromatography Equipment, Modes of Chromatography, Open Column Chromatography, High Performance Liquid chromatography (HPLC), Fast Protein Liquid Chromatography, Perfusion Chromatography, Membrane- Based Chromatography Systems, Chromatography of a Sample Protein Spectroscopic Techniques: The Nature of Light, The Electromagnetic Spectrum, Ultraviolet/Visible Absorption Spectroscopy, Fluorescence Spectroscopy, CD spectroscopy, Spectroscopic Techniques Using Plane-Polarized Light, Infrared Spectroscopy, Raman spectroscopy, ESR, Lasers, SPR Mass Spectrometry: Principles of Mass Spectrometry, Mass Spectrometry of Proteins/Peptides, Interfacing MS With other Methods, Uses of Mass Spectrometry in Biochemistry Electrophoresis: Principles of Electrophoresis, Nondenaturing Electrophoresis, Denaturing Electrophoresis, Electrophoresis in DNA Sequencing, Isoelectric Focusing (IEF), Immunoelectrophoresis, Agarose Gel Electrophoresis of Nucleic Acids, Pulsed Field Gel Electrophoresis, Capillary Electrophoresis, Electroblotting Procedures, Electroporation. Three-dimensional structural detection: The Protein- Folding Problem, Structure Determination by NMR, Crystallization of Biomacromolecules, X-Ray Diffraction by Crystals, Calculation of Electron Density Maps, Other Diffraction Methods, Other Diffraction Methods, Structural Databases
4	**Texts/References**	Methods in Modern Biophysics by Bengt Nolting 3rd Physical Biochemistry: Principles and Applications by David Sheehan 2nd edition (Wiley)

1	**Title of the course** (L-T-P-C)	**Immunology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Basic Cell biology and Genetics, Microbiology
3	**Course content**	**1.** Introduction, Organization of the immune system (lymphoid tissues and organs). **2.** Immune cell development (hematopoiesis, T and B cell development). **3.** Innate and adaptive immunity (including cellular and humoral responses). **4.** Antigens and Antibodies (antibody classes, Ag/Ab structure and function). **5.** Immune signaling (T cell receptor, TLRs, inflammatory and cytokine responses) and cancer. **6.** The MHC and Ag presentation and T cell development. Immunity mechanisms in disease (allergies, autoimmunity, immuno-deficiency).
4	**Texts/References**	**1**. Judith A. Owen, Jenni Punt, Sharon A. Stranford, Patricia P. Jones., Kuby Immunology, W.H. Freeman and Company, 2013. **2**. Kenneth Murphy , Paul Travers , Mark Walport, Janeway's Immunobiology, Garland Science, Taylor & Francis Group, 200

1	**Title of the course** (L-T-P-C)	**Genomics and proteomics** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**Introduction to Genomics and Proteomics:** Organization and structure of genomes. Introduction to Proteomics. **Gene Identification and Expression:** Genome annotation, routes of gene identification, ORF, gene ontology, comparative genomics, determining gene function by sequence comparison and through conserved protein structure, Global expression profiling, applications of genome analysis and genomics. **Analysis of Proteomes I: Analysis of proteomes** – 2D gel electrophoresis, Image analysis of 2-DE gels. **Analysis of Proteomes II**: Mass spectrometry-based methods for protein identification. 2-DE gel electrophoresis coupled with mass spectrometry, **Micro array and RNA-seq techniques** **Applications of Genomics and Proteomics Analysis:** Analysis of Genomes – Human, Mouse, Plasmodium falciparum, Saccharomyces cerevisiae, Mycobacterium tuberculosis. Application of proteome analysis- drug development and toxicology, Pharmaceutical Applications.
4	**Texts/References**	**1.** Concepts and Techniques in Genomics and Proteomics by N Saraswathy P Ramalingam, first edition, 2011 (Woodhead Publishing). **2.** Introduction to Genomics by Arthur M. Lesk. 3rd edition (Oxford university press). **3**. Lewin's Genes XII by Elliott S. Goldstein, Jocelyn E. Krebbs, and Stephen T. Kilpatrick. 12th edition (2017) **4.** Human Genetics and Genomics by Bruce R. Korf. 4th edition (Blackwell publication). **5.** Introduction to Proteomics: Principles and Applications by Nawin C Mishra, Gunter Blobel 1st edition (Wiley publication).

1	**Title of the course** (L-T-P-C)	**Physiology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Nervous system and Sensory processing **2.** Endocrine system and Reproduction **3.** Feeding and Digestive system **4.** Muscular system and movement **5.** Respiratory system:
4	**Texts/References**	**1.** Animal Physiology by Richard W Hill, Gordon A Wyse and Margaret Anderson: Sinauer Associates. 4th Edition. **2**. Eckert's Animal Physiology: Mechanisms and Adaptations. David Randall, Warren Burggen and Kathleen French: 5th

1	**Title of the course** (L-T-P-C)	**Advance cell Biology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1. Methods used in cell biology:** microscopy, cell sorting, fractionation of cellular components, radioisotopes and antibodies as tools to study cellular functions. **2. Cell membrane:** organization and composition of the cell membrane, structural property of the membrane microdomains. Understanding of the functional link of the compositional diversity of the cell membrane (plasma membrane and intracellular membrane) to cellular processes pertaining to the organelles and plasma membranes. **3. Membrane transport-** endocytosis and exocytosis Vesicular transport system and intracellular trafficking, protein targeting. **4. Organelle biogenesis:** Understanding the biogenesis of subcellular structures such as mitochondria, centrosome, kinetochore in cells across the eukaryotic kingdom, **5. Components of the cytoskeleton and their regulations:** organization and function of actin, intermediate filaments, microtubules and motor proteins, integrins, cadherins. **6. Biology of Mitochondria & Chloroplasts –** Biology of Mitochondria & Chloroplasts, Mitochondrial DNA, Chloroplast DNA. Mitochondrial DNA & Aging in Human
4	**Texts/References**	**1** Cell Biology by Gerald Karp 7th edition (Wiley). **2** .Molecular Biology of the Cell, Bruce Alberts et al., 6th Edition (Garland Science)

1	**Title of the course** (L-T-P-C)	**Plant Biotechnology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	Molecular Biology, Genetics Engineering
3	**Course content**	**1** Molecular genetic basis of morphological diversity in plants. **2** Cell biological tools to understand cellular behaviour in live plants and computational modelling to study morphodynamics. **3** Cross talk and integration of hormone signaling pathways driving plant morphogenesis and physiology. **4** Photosynthesis, hormone physiology, photorespiration and transpiration) stresses. **5** Conventional methods of crop improvement, selection, mutation, polyploidy and clonal selection. **6** **Plant tissue culture:** - History, Laboratory organization, Sterilization methods, Media preparation, Plant Growth Regulators, Micro propagation, Callus culture, Cell Culture, Protoplast Culture and Fusion, Organogenesis and Somatic embryogenesis. **7** Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Seed storage proteins, Methods for Plant Conservation, Haploid production: - Anther, Pollen, Embryo and ovule culture and their applications. Somaclonal variations. **8** Plant genome organization, Organization and expression of chloroplast genome and mitochondrial genome, Cytoplasmic male sterility. Intergenomic interaction, Agrobacterium and crown gall tumors: - Ti plasmid & Ri Plasmid vectors. Mechanism of T-DNA transfer to plants, Agro infection. Plant viral vectors. Direct transformation of plants by physical methods. 9 **Genetic engineering in plants:**Selectable markers, Reporter genes and Promoters used in plant vectors. Genetic engineering of plants for bacteria, fungi, virus, pest, and herbicide resistance. Production of antibodies, viral antigens and peptide hormones in plants, biodegradable plastics in plants. **9** **Applications of secondary metabolites:** Isolation and characterization – drug development, Biopesticides, growth regulators, Biofertilizers. Value addition via bio transformation. Biocatalyst, Bioremediation, Biofuels, Feed stock Chemicals, Designer Chemicals
4	**Texts/References**	**1.** Plant Tissue and Organ Culture fundamental Methods by Gamburg OL and Philips GC 1st edition (Springer) **2.** Plant Biochemistry by Hans-Walter Heldt 4th edition (AP publication) **3.** Plant Biotechnology: The Genetic Manipulation of Plants by Slater 2nd edition (Oxford university press)

1	**Title of the course** (L-T-P-C)	**Neurobiology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Physiology
3	**Course content**	**1.** Organization of the nervous system and Neuroanatomy **2.** Electrical properties of the neuron **3.** Goldman-Hodgkin-Katz equation, Hodgkin and Huxley model. **4.** Energetics of the Nervous System. **5.** Synaptic transmission: **6.** Learning and memory. **7.** Sensory Physiology: Vision, Olfaction, Somatosensory system: Touch, pain, cold and warmth receptors on skin and the signal transduction. Hearing **8.** Motor systems **9.** Experimental methods to study neurobiology. Diseases of the nervous system
4	**Texts/References**	**1.** John G. Nicholls, A. Robert Martin, David A. Brown, Mathew E. Diamond, David A. Weisblat, and Paul A. Fuchs, From neuron to brain, Sinauer Associates, Inc. Fifth edition, November 2011. **2.** Mark F. Bear, Barry W. Connors, Michael A. Paradiso, Neuroscience: Exploring the Brain, Lippincott Williams & Wilkins, Third Edition, April 1995. **3.** Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. Principles of Neural Science. Fifth Edition, October 2012. **4.** Arthur C. Guyton and John E. Hall. Textbook of Medical Physiology, Twelfth Edition.

1	**Title of the course** (L-T-P-C)	**Animal Biotechnology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	Molecular Biology, Genetics Engineering
3	**Course content**	**1.** Biology of cells in culture: Origin and characterization of different cell types, Subculture, selection of medium, Chemically defined and serum free media, Development of serum free media Advantages and disadvantages of serum free media **2.** Cultured cells-Biology and characterization: Characteristics of cultured cells, Cell bank, Measurement of growth parameters of cultured cells, Cell adhesion, Cell proliferation and differentiation, Identification of specific cell lines **3.** Gene mapping and gene cloning: Various methods of gene mapping, human genome project, gene mapping of mouse and other animals, basic strategies and methods of gene cloning. Gene knockout and mice model for human genetic disorders. **4.** Hybridomas and cell transformation: The basis of hybridoma technology, Storage of hybridoma cells, Monoclonal antibodies and their commercial production, Commercial production of monoclonal antibodies and their use for mankind. **5.** Animal transgenesis: Mechanism of transferring genes into specific animal tissues and cell lines. Production of transgenic animals (cattle, mice, sheep, goat, pig and fish) and chimeras. Artificial insemination and embryo transfer. **6.** Application of transgenic animals: Production of useful proteins and other products in transgenic animals (production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins).
4	**Texts/References**	**1.** Culture of Animal cells A Manual of Basic Technique and Specialized Applications, Sixth Edition by R Ian Freshney, **2.** Textbook of Animal Biotechnology by B Singh 1st edition (Teri Publication) **3.** Transgenic Animal Technology by Carl A. Pinkert 3rd Edition (Elesevier)

1	**Title of the course** (L-T-P-C)	**Bioprocess technology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Metabolism and Bioenergetics, Microbiology, Molecular Biolgy
3	**Course content**	**1.Introduction to fermentation technology:** Interaction between biochemical engineering; Microbiology and Biochemistry; Introduction to fermentation processes; Microbial culture; Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms; Inoculum production for bacterial and fungal processes. **2.Raw material and media formulation for fermentation process:** Fermentation media; Natural media; synthetic media. Sources of Carbon; Nitrogen and vitamins; antifoams and optimization; Types of Fermentation: Solid Substrate fermentation and submerged fermentation; Process parameters: measurement of temperature; pressure and pH; dissolved Oxygen; foam etc. Strain improvement by mutation and screening of improved cultures; random and strategic screening methods; strategies of strain improvement for primary; secondary metabolites with relevant examples; Preservation of cultures after strain improvement programme. **3.Design and construction of a Fermentors:** Body construction; construction material; Aeration and agitation systems; Stirrer glands and bearings; Baffles; Valves and steam traps; Pressure-control valves; computer applications in fermentation technology; specialized bioreactors; membrane bioreactors; tower bioreactors; fluidized bed bioreactors; Immobilized system and packed bed reactors and Photobioreactors. **4.Downstream Processing:** Biomass separation by centrifugation; filtration; flocculation and other methods; Cell disintegration: Physical; chemical and enzymatic methods; Separation of solid and liquid phases; isolation and purification techniques for proteins and other products based on different physico-chemical properties; Principles of bioprocess control; bioprocess automation and application of computers in bioprocessing; recombinant products with representative examples.
4	**Texts/References**	**1.** "Bioprocess Engineering" by Michael L Shuler Fikret Kargi 2nd edition (Perason Publication) **2.** "Bioprocess Technology: Kinetics and Reactors" by Anton Moser and Philip Manor 1st edition (Springer) Bioscience and Bioengineering, chemical Engineering

1	**Title of the course** (L-T-P-C)	**Biomedical Imaging** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1** **Objectives of biomedical image analysis** - Computer aided diagnosis - Nature of medical images: X-ray imaging – Tomography - Nuclear medicine imaging - SPECT imaging - Positron imaging tomography – Ultrasonography - Magnetic resonance imaging. Removal of artifacts - Space domain filters - Frequency domain filters - Optimal filtering - Adaptive filters. **2** **Image enhancement –** Gray level transforms - Histogram transformation - Convolution mask operators - Contrast enhancement. Detection of regions of interest - Thresholding and binarization - Detection of isolated lines and points - Edge detection - Region growing. **3** **Analysis of shape and texture -** Representation of shapes and contours - Shape factors - Models for generation of texture - Statistical analysis of texture - Fractal analysis - Fourier domain analysis of texture - Segmentation and structural analysis of texture. Pattern classification and diagnostic decision - Measures of diagnostic accuracy - Applications: Contrast enhancement of mammograms - Detection of calcifications by region growing - Shape and texture analysis of tumours. **4** **Cryo-electron microscopy and 3D image processing**
4	**Texts/References**	**5.** 1Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts And Applications", Prentice Hall, 2014. **6.** Gonzalez R C, Woods R E, "Digital Image Processing", Third Edition, Prentice Hall, 2007 **7.** Rangayyan R M, "Biomedical Image Analysis", Fifth **8.** Edition, CRC Press, 2005

1	**Title of the course** (L-T-P-C)	**Developmental Biology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1. History & Basic concepts of development** **a.** Overview of how the modern era of developmental biology emerged through multidisciplinary approaches stages of development- zygote, blastula, gastrula, neurula **b.** cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map **c.** Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, conceptof morphogen, mosaic and regulative development **d.** Pattern formation-- axis specification, positional identification (regional specification) **e.** Morphogenetic movements **f.** Model organisms in Developmental biology **2. Early Development in invertebrate /vertebrate models** **a.** Drosophila, C.elegans, Xenopus, Mouse/ human **b.** Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates **3. Late Development in invertebrate /vertebrate models** **a.** Organogenesis- development of central nervous system in vertebrates, **b.** vulval formation in C.elegans **4. Germ cell specification& migration** **5. Overview of plant development** **6. Medical implications of developmental biology** - genetic errors/ teratogenesis/ stem cell therapy etc
4	**Texts/References**	**1.** Developmental Biology by Scott F Gilbert. 8th edition (Sinauer Associates Inc., U.S) **2.** Essential Developmental Biology by Jonathan Slack 3rd edition (Wiley Blackwell)

1	**Title of the course** (L-T-P-C)	**Molecular Biology of Cancer** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	• Describe the six hallmarks of cancer • Explain the types of gene mutations possible and how these mutations can contribute to cancer formation • Describe an oncogene and why it is important in cancer development • Explain the cell cycle, its regulation, and how cell cycle dysfunction can lead to cancer • Describe the function of tumor suppressor genes • Explain how external or internal stimuli can lead to apoptosis • Clarify how cancer cells escape cell death • List and describe the steps that lead to metastasis • Give details on how chronic inflammation and infectious agents can lead to cancer • Explain the role of diet in cancer development and cancer prevention
4	**Texts/References**	**1.** The Biology of Cancer: Robert A. Weinberg, Garland Science 2014, Second Edition. **2.** Principles of Cancer Biology: Lewis J. Kleinsmith, Pearson 2016, First Edition. **3.** Biology of Cancer: Dorothy Lobo, Pearson Education 2012, Second Revised Edition **4.** The Biology of Cancer: Janice Gabriel, John Wiley & Sons Inc 2007, Second Edition.

1	**Title of the course** (L-T-P-C)	**Cellular and Molecular Immunology (3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	• Introduction, Properties of Immune System. • Innate Immune System, Adaptive ImmuneSystem. • Antibodies and Antigens. • Major Histocompatibility Complex. • Antigen Processing and Presentation. • Antigen Receptors and Accessory Molecules ofT cell. • Development and Activation of Lymphocytes. • B cell activation and Antibody Production. • Immune Memory Response. • Cytokines. • Mechanism of Cell Mediated Immune Response. • Mechanism of Antibody Mediated ImmuneResponse. • Immunity to Microbes. • Transplant Immunology. • Tumor Immunology. • Hypersensitivity. • Congenital and Acquired Immunodeficiency. • Laboratory Techniques commonly used inImmunology.
4	**Texts/References**	**1.** Roitt's Essential Immunology: Peter J. Delves, Willey Blackwell, Thirteenth Edition. **2.** Kuby Immunology: Stanford Punt Owen, W. H. Freeman & Co, Seventh Edition. **3.** Cellular and Molecular Immunology: Abbas Litchman Pillai: Elsevier 2017, Ninth Edition. **4.** Immunology and Microbiology: Jeffrey K. Actor, Elsevier 2006, Second Edition.

1	**Title of the course** (L-T-P-C)	**Cancer Biology** **(2-1-0-3)**
2	**Pre-requisite courses(s)**	Advance Cell biology
3	**Course content**	**1.** Cell-cell signalling: overview of extracellular signalling, cell surface receptors, cell signalling during growth and differentiation. **2.** Cell cycle and its control: mechanisms of growth and division of eukaryotic cells, cell cycle checkpoints. **3.** Cell death mechanisms **4.** Types of cancers and Hall mark of cancer **5.** Principles of Carcinogenesis: Theory of carcinogenesis, Carcinogens (Chemicals, irradiation, physical). **5.** Molecular biology of cancer: Signal targets and cancer, Activation of kinases, Proto oncogenes and oncogenes activity, Identification of oncogenes, Retroviruses and oncogenes, Detection of oncogenes, Growth factors related to transformation, telomerases, Tumor suppressors. **6.** Cancer detection/screening and therapy
4	**Texts/References**	**1.** The Cell Cycle Principles of Control by David O Morgan 1st edition (Oxford university Press). **2.** The Biology of Cancer by Robert A. Weinberg (Garland Science). Cancer: Principles & Practice of Oncology by DeVita Jr., Vincent T., Theodor **3.** S. Lawrence, Steven A. Rosenberg 11th edition (Wolters Kluwer).

1	**Title of the course** (L-T-P-C)	**IPR, Biosafety and Bioethics** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Biosafety: Introduction – biosafety issues in biotechnology - historical background. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels - Levels of Specific Microorganisms, Infectious Agents and Infected Animals. **2.** Biosafety Guidelines: Guidelines and regulations (National and International including Cartegana Protocol) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of =GMOs - Risk - Analysis, Assessment, management and communication. **3.** Bioethics: Philosophy and Theories of Bioethics, Law and Global health ethics, Public health policy, Research ethics and Clinical ethics 4 .Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India , IPR in abroad, Major International Instruments concerning Intellectual Property Rights, Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights. Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.
4	**Texts/References**	**1.** Sasson A, Biotechnologies and Development, UNESCO Publications **2.** Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi. **3.** An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology, 1st edition (Elsevier) DBT, India Biosafety guidelines: http://dbtindia.gov.in/guidelines-biosafety

1	**Title of the course** (L-T-P-C)	**Research Methodology and Scientific Writing** **(2-0-1-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** What is the purpose of research? **2.** Take examples of Newton and the inverse square law of gravitational force and of the calculus. **3.** Ethics, Plagiarism and Fraud **4.** Plagiarism and Fraud. Examples of Mark Spector, Mendel and Kepler **5.** Ethics of managing data and authorship **6.** Research Design **7.** Choice of Research Topic and design of experiments: **8.** Controls. Controls. Controls. **9.** Writing manuscripts for journals **10.** Effective oral presentations (seminars, conferences, popular talks) **11.** Popular science writing
4	**Texts/References**	**4.** Sasson A, Biotechnologies and Development, UNESCO Publications **5.** Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi. **6.** An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology, 1st edition (Elsevier) **7.** DBT, India Biosafety guidelines: http://dbtindia.gov.in/guidelines-biosafety

1	**Title of the course** (L-T-P-C)	**Biomaterials** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Overview of classification and use of biomaterials in biomedical applications **a**. Classification of materials **2** Manufacturing and characterization of biomaterials **a.** Methodology for manufacturing of biomaterials (including 3D-printing) **b.** Analysis of physical, chemical, and mechanical properties of biomaterials **3** Tissue-material interactions **a.** Biocompatibility of biomaterials (assessing an adverse response) **b.** Bioactivity of biomaterials **c.** Methodology for analysis of host response at cellular and physiological levels **d.** Biological interactions with materials, cells, and tissues Biological responses: Inflammation, immunity, toxicity, coagulation, tumorigenesis. Biofilms, Pathological calcification, Biocompatibility
4	**Texts/References**	**1.** "Biomaterials: Introduction" by Joon B Park and Roderic S Lakes 2nd edition (Springer) **2.** Biomaterials, Medical Devices and Tissue Engineering: An Integrated Approach" by Fredrick H Silver, 1st edition (Springer)

1	**Title of the course** (L-T-P-C)	**Stem Cells and Regenerative Medicine (2-1-0-3)**
2	**Pre-requisite courses(s)**	Advance Cell Biology, Cancer Biology
3	**Course content**	**1.** Introduction to Stem cells: Basics of stem cells and principles of stemness, Early mammalian development, Evolution of stem cells. **2.** Biology of stem cells: Cell cycle regulation in stem cells, Mechanisms of differentiation, Signal. **3.** transduction (More elaborative for mechanisms involved in development), Metabolism of stem cells. **4.** Pluripotent stem cells: Types of pluripotent stem cells; Isolation, characterization of embryonic stem. **5.** cells; Generation of iPS cells and disease modeling; Biology of ES and iPS cells; Genome editing technologies; Alternative medicine. **6.** Adult stem cells: Properties, identification and separation of various stem cells, Biological principles of HSCs; hematopoietic development, regulation of proliferation and differentiation, Sources of HSCs and their clinical use. **7.** Cancer stem cells: Concepts, identification, biology and potential applications of cancer stem cells. **8.** Stem Cell niches: Extrinsic factors in the regulation of stem cell function. Biological, physicomechanical properties of stem cell micro-environment (for HSCs, epidermal, germ and intestinal stem cells). **9.** Transplantation biology: Immunology of transplantation and graft rejection, mechanisms of homing of transplanted stem cells. **10.** Tissue engineering: Ex vivo expansion of stem cells, Ex vivo construction of tissues, scaffolds, bioreactors. **11.** Stem cells in clinic: Avenues for stem cell use (metabolic, genetic diseases, cancers and trauma), **12.** Potential application of stem cells in clinic and present clinical use. Hurdles and future directions. **13.** Methods in stem cells: In vitro and in vivo methods to assay stem cells.
4	**Texts/References**	**1.** Essentials of Stem Cell Biology by Robert Lanza Anthony Atala (Eds.): Academic Press. 3rdEdition 2013. **2.** Stem Cells: An Insider's Guide by Dr. Paul Knoepfler: World Scietific publishing Co. Pvt. Ltd. 1 st Edition 2013. **3.** The science of stem cells by JMW Slack: Wiley Blackwell publishers. 1st Edition 2017. **4.** Stem Cells, Tissue Engineering and Regenerative Medicine by David Warburton (Ed.) World Scietific publishing Co. Pvt. Ltd. 1st Edition 2014. **5.** Stem Cells Handbook by Stewart Sell (Ed.). Springer 1st edition 2013. **6.** Stem Cells: A Short Course Rob Burgess. Wiley Blackwell publishers. 1st Edition 2016. **7.** Principles of Tissue Engineering Robert Lanza Robert Langer Joseph Vacanti (Eds.). Academic Press 4th edition 2013. **8.** The Biomedical Engineering Handbook by Joseph D. Bronzino, Donald R. Peterson. CRC Press Taylor & Francis. 1st edition. 2015.

1	**Title of the course** (L-T-P-C)	**Molecular biology techniques and applications** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	NA
3	**Course content**	The course will include content on techniques involved in the molecular study, its mechanism, and mode of applications. Laboratory techniques such as biochemical estimation, microbial culture, chromatography, protein purification and estimation methods, PCR techniques, immunological assays, and sequencing techniques will be discussed in detail.
4	**Texts/References**	**1** Locquin and Langeron (1983). Handbook of Microscopy. Butterwaths **2** Ausubel et al (2002). Short Protocols in Molecular Biology. Wiley **3** Brown (2000). Essential Molecular Biology VI. AP **4** Brown (2000). Essential Molecular Biology VII. AP **5** Brown (2006). Gene Cloning and DNA Analysis - An Introduction. Blackwell 6 Glick and Pasternak (2003). Molecular Biotechnology. ASM Press **7** Kracher. Molecular Biology - A Practical Approach. **8** Krenzer and Massey (2000). Recombinant DNA and Biotechnology. ASM **9** Micklos and Freyer (1990). DNA Science. CSHL **10** Primrose (2001). Molecular Biotechnology. Panima **11** Robertson et al (1997). Manipulation & Expression of Recombinant DNA. AP **12** Sambrook et al (2001). Molecular Cloning. CSHL **13** Twyman (1999). Advanced Molecular Biology. Viva **14** Watson et al (1992). Recombinant DNA. Freeman Primrose and Twyman (2006). Principles of Gene Manipulation and Genomics. Blackwell

1	**Title of the course** (L-T-P-C)	**Human Physiology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	• Nervous system and Sensory processing • Endocrine system and Reproduction • Feeding and Digestive system • Muscular system and movement • Respiratory system: • Circulatory system • Excretory system
4	**Texts/References**	**1.** Animal Physiology by Richard W Hill, Gordon A Wyse and Margaret Anderson: Sinauer Associates. 4th Edition. **2.** Eckert's Animal Physiology: Mechanisms and Adaptations. David Randall, Warren Burgen and Kathleen French: 5th edition

1	**Title of the course** (L-T-P-C)	**Research Philosophy.** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Review of history of philosophy of science. Research as a passion or profession. Aspects of research conduct: Preparation, Choice of a problem, Experimentation, Chance and its role, Hypotheses and Ideas, Imagination and Intuition, Reasoning: Inductive & Deductive, Observation, Difficulties & Strategy, Science & Scientists. Scientific imagination; case studies of Darwin, Mendel and Galileo. The scientific methods in practice. The success of reductionist approach to problems in molecular biology. Contrast with holistic approaches (few examples from Biology). Cyclical phenomena with interdependent parallel processes, feedback loops and networks. Emergent properties of the system. The concept of Causality in light of extant complexity. Experimental and Observational sciences – Historicity in sciences. The interface between Science and Society: some controversies. Ethics in post-genomic society: Bio-safety and environmental concerns.
4	**Texts/References**	• Historical Introduction to the Philosophy of Science, J Losee, Oxford University Press (1972). • Philosophy of Biology, Ruse Michael (ed), MacMillan (1989) • Scientific method in Practice, Gauch H G. Jr., Cambridge University Press (2003). • Selected readings from Reviews, Commentaries and Biographies.

1	**Title of the course** (L-T-P-C)	**Animal Models in Biomedical Research** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	1. Introduction to Animal Models in Disease: Historical overview and significance, Basic criteria for selecting organisms as a model organism. 2. Types of Experimental Model used in research: Rodent models (mice and rats). Non-rodent models (dogs, pigs, primates), Zebrafish, Drosophila, C, elegans etc 3. Creating and Characterizing Animal Models: Genetic manipulation and Transgenic models, inducing diseases phenotype, phenotype Characterization and validation. 4. Animal Model for Studying Human Disease: animal model for cancer, model for infectious disease (Bacteria, Virus, fungal and protozoans), animal model for obesity, animal model for neurodegenerative disease, model for cardiac disease, model for autoimmune disease and inflammatory diseases, advantage and limitations.. 5. Emerging Topics in Animal Model for Disease research: Genomic approaches in disease modeling, Organoids and 3D culture systems, personalized medicine and precision animal models. 6. Animal and their welfare: Basic of animal handling, breeding and maintenance, animal behavior, administration of drug, use of analgesia and anesthesia, animal waste disposable. 7. Ethical consideration in animal Research: Ethical guidelines and regulations, Alternative method and the 3R principle (Replacement, Reduction, Refinement), Animal welfare and care.
4	**Texts/References**	1. Animal Models for the study of Human Disease: 2nd Edition. P. Michale conn, 2. The ethics of animal research talking point on the use of animal in scientific research. Fasting Wilkinson R EMBO Rep. 2007, 8(6):536-30. 3. Ethical issues in the use of animal in biomedical and Psychophysiological research Guck JP. Bel. Psychophysiological (berl). 2003 Dec 171 (1):6-12 doi:10.1007/s00213-1478.y.. 4. Experimental Animal Models of Human Diseases an effective Therapeutic Strategy by Bartholomew Ibeh.

1	**Title of the course** (L-T-P-C)	**Enzymology** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	1. Introduction to Enzymes: Background and Significance of enzyme, nomenclature and classification structure and function 2. Enzyme Kinetics: research rate and enzyme- catalyzed reactions, Michaelis-Menten Kinetics, Lineweaver Burk plots and enzyme inhibition 3. Enzyme Mechanisms: Coenzymes and cofactors, Enzyme-substrate binding and Specificity, Mechanism of enzyme-catalyzed reaction 4. Enzyme Regulation; allosteric regulation, Enzyme inhibition and activators, feedback inhabitation in metabolic pathways. 5. Enzyme in metabolic pathways: Enzymes in glycolysis, Enzymes in citric acid cycle. Enzymes in DNA replication and Protein synthesis, regulation of metabolic pathways by enzymes. 6. Enzymes in Biotechnology: Enzymes in molecular biology (e.G DNA polymerases, enzymes in recombinant DNA technology enzymatic assays and analysis. 7. Enzyme in Medicine: Enzymes as diagnostic markers, Enzymes in drug and development and Pharmacology, Enzymes replacement therapy and medical application. 8. Industrial application of Enzymes: Enzymes in food and beverage productions, Enzymes in biofuel production, Enzymes in textile and paper industries. 9. Enzymes in bioremediation, synthetic biology and personalized medicine 10. Ethical consideration in Enzymology: Ethical issue in enzyme, Ethical Consideration in biotechnology and industrial enzyme use
4	**Texts/References**	1. ENZYMES: Catalysis, Kinetics and Mechanisms by N S Punekar 2. Enzymes Kinetics and Mechanism by Pau F Cook W W Cleland 3. Enzymes: principles and biotechnological applications by Robinson PK Essays Beachem 2015:59 142 Doi 10 1043bse 0590001.

1	**Title of the course** (L-T-P-C)	**Modern translational Biology** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**Identification of genes/Molecules involved in various disorders,** 1. Investigation of gene function, and underlying mechanisms 2. Transcription Factors, 3. Signaling Molecules, 4. Metabolites **Necessity/Sufficiency of genus for a Phenotype**. 1. Knockout/Knock-in-models. 2. Genetic chimeras, 3. Spemann- Mangold Organizer 4. Developmental Gradients and Domains of Gene Expression. **In Vitro and vivo model systems for investigating diseases pathogenies and therapeutics.** 1. Primary cell culture 2. Immortalized cell lines 3. Transgenic animal models (Vertebrates/invertebrates) 4. High-Throughput screening **Development and testing of novel therapeutics** 1. Drug design 2. Durg screening 3. Gene therapy **Investigation of disease pathophysiology** 1. Mechanisms of cytotoxicity and cell death 2. Apoptosis, necrosis 3. Oxidative stress.
4	**Texts/References**	1. Molecular cloning: A laboratory Manual fourth edition, Jeo Sambrook and Michael Green 2. Molecular Biology Techniques: A Classroom Laboratory Manual, Fourth Edition, Sue Carson, Heather Miller, Melissa C. Srougi, D Scott Witherow 3. Cell Biology: Essential Techniques David Rickwood J Robin Harris

1	**Title of the course** (L-T-P-C)	**Molecular and Cellular Neuroscience** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	1. History of neuroscience: Edwin smith papyrus, Aristotle's views on brain anatomy, Camillo Golgi Santiago Ramon Y Cajal. 2. Organization of the nervous system: central nervous system, Brain, Cerebrum, Diencephalon, Brain, Stem, Cerebellum, Ventricles and Cerebrospinal Fluid, Spinal cord, peripheral I nervous system, autonomic and somatic nervous system, cranial and spinal nerves, Pain and iitch. 3. Development of the nervous system: Patterning the vertebrate baby plan, Axes and Germ layers, The Mesoderm and Early Nervous system, Patterning of the nervous system, Morphogenesis Cell Differentiation and stem Cells, Specification of neural fate, Axon guidance, Synapse formation, Activity Dependent Synaptic competition, Plasticity and language Development, Autism. 4. Cell types in the nervous system: Neurons, Establishment of polarity and compartmentalization, glia, astrocytes, oligodendrocytes, microglia Schwann cells Brain as a Cellular ecosystem. 5. Neuronal physiology and synaptic transmission, electrophysiology, synaptic, plasticity, learning and memory, reinforcement learning, Spike-Timing dependent plasticity, Long term potentiation, long term depression. 6. System neuroscience, sensory systems, visual system, development of visual system, ocular dominance, higher order visual areas, auditory systems, tonotopic mapping. Somatosensory system, barrel cortex development and plasticity, sensory homunculus, Hallucination and illusion, motor systems, motor homunculus, mesolimbic circuity, Motivation and Addiction. 7. Disorders of the brain, Alzheimer's disease, nigrostriatal pathway Parkinson's disease, multiple sclerosis, Schizophrenia , Disease Modeling.
4	**Texts/References**	1. Principle of neural science, Sixth edition, Eric R Kandel, John D Koester, Sarah H Mack, steven A Siegelbaum 2. Cellular and Molecular Neurophysiology, 3rd Edition, Constance Hammond 3. From Molecular to networks: An Introduction to cellular and Molecular Neuroscience, 3rd Edition , john H Byrne, Ruth Heidelberger, M Neal wax ham.