S. No	New Course code	Name of Course	L-T-P-C	Proposed Level (UG/PG)
1	BB 601	Biomedical Imaging and Instrumentation	3-0-0-6	PG
2	BB 603	Introduction to Biostatistics	3-0-0-6	PG
3	BB 604	Biomedical Spectroscopy and Imaging	3-0-0-6	PG
4	BB 605	Bioinformatics	3-0-0-6	PG
5	BB 606	Biophysical Methods	3-0-0-3	PG
6	BB 607	Immunology	2-1-0-6	PG
7	BB 608	Genomics and proteomics	3-0-0-3	PG
8	BB 609	Physiology	2-1-0-6	PG
9	BB 610	Advance cell Biology	2-1-0-3	PG
10	BB 620	Plant Biotechnology	2-1-0-3	PG
11	BB 701	Neurobiology	2-1-0-6	PG
12	BB 702	Animal Biotechnology	2-1-0-3	PG
13	BB 703	Bioprocess technology	2-1-0-3	PG
14	BB 704	Biomedical Imaging	2-1-0-3	PG
15	BB 705	Developmental Biology	2-1-0-3	PG
16	BB 805	Molecular Biology of Cancer	3-0-0-6	PG
17	BB 802	Cellular and Molecular Immunology	3-0-0-6	PG
18	BB 801	Cancer Biology	2-1-0-3	PG
19	BB 803	IPR, Biosafety and Bioethics	3-0-0-3	PG
20	BB 804	Research Methodology and Scientific Writing	2-0-1-3	PG
21	BB 901	Stem Cells and Regenerative Medicine	2-1-0-3	PG
22	BB 902	Biomaterials	3-0-0-3	PG
23	BB 908	Seminar	0-0-4-4	PG
24	BB 915	Molecular Biology Techniques and Applications	3-0-0-6	PG
25	BB 810	Research Philosophy	3-0-0-6	PG
26	BB 611	Modern translational biology	3-0-0-6	PG
27	BB 612	Animal model in Biomedical Research	3-0-0-6	PG
28		Enzymology	3-0-0-6	PG
29		Molecular and Cellular Neuroscience	3-0-0-6	PG

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., 5th Ed., 2015. **6**. R. Silverstein, F. Webster, D. Kiemle, and D. Bryce "Spectrometric identification of organic compounds", 8th Ed., Wiley, 2015. **7**. C. Banwell and E. McCash "Fundamentals of molecular spectroscopy" 4th Ed., McGraw Hill Education, 2017. **8**. J. Keeler "Understanding NMR spectroscopy" 2nd 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 means, 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**	1. Introduction to Probability and Statistics: Medenhall, Beaver, Beaver 14th Edition. 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), Immunoelectrophoretic, 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 7^{th} 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)	**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)	**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. **10.** **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) Plant Biotechnology: The Genetic Manipulation of Plants by Slater 2nd edition (Oxford university press)

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) 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**	**1.** Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts and Applications," Prentice Hall, 2014. **2.** Gonzalez R C, Woods R E, "Digital Image Processing," Third Edition, Prentice Hall, 2007. **3.** Rangayyan R M, "Biomedical Image Analysis," Fifth 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, concept of 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. 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. 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., Theodore 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**	**1.** Sasson A, Biotechnologies and Development, UNESCO Publication. **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)	**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 transduction (More elaborative for mechanisms involved in development), Metabolism of stem cells. 3 Pluripotent stem cells: Types of pluripotent stem cells; Isolation, characterization of embryonic stem cells; Generation of iPS cells and disease modeling; Biology of ES and iPS cells; Genome editing technologies; Alternative medicine. 4 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. 5 Cancer stem cells: Concepts, identification, biology, and potential applications of cancer stem cells. 6 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). 7 Transplantation biology: Immunology of transplantation and graft rejection, mechanisms of homing of transplanted stem cells. 8 Tissue engineering: Ex vivo expansion of stem cells, Ex vivo construction of tissues, scaffolds, bioreactors. 9 Stem cells in clinic: Avenues for stem cell use (metabolic, genetic diseases, cancers, and trauma), Potential application of stem cells in clinic and present clinical use. Hurdles and future directions. 10 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)	**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)	**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 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)	**Animal Models in Biomedical Research** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**1.** Introduction to Animal Model in Disease Research: Historical overview and significance, Basic criteria for selecting organisms as a model organism. **2.** Type 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 M=manipulation and transgenic models, including disease phenotype, phenotype charterization and validating **4.** Animal Model for studing Human disease: Animal model for cancer, model for infection disease (Bacteria, virus, fungal and protozoans), animal model for obesity, animal model for neurodegenerative diseases, model for cardiac disease, model for autoimmune diseases and ibflammatory diseases, advantage, and limitations, **5.** Emerging Topics in Animal Models for Diseases Research: Genomic approaches in diseases 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 and anesthesia, animal waste disposable **7.** Ethical Consideration in aminal 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. Michael Conn. **2.** The ethics of animal research. Talking point on the use of animals in scientific research. Festing S, Wikinsion R EMRO Rep, 2007; 8(6): 526-530 **3.** Ethical issues in the use of animal in biomedical and psycharmocological research. Gluck JP, bell J. Psychopharmacology (berl), 2003 Dec; 171 (1): 6-12 doi: 10.1007/s00213-003-1478-y.. **4.** Experimental Animal Model of Human Diseases- An Effective Therapectic 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 Significant of enzyme, nomenclature and classification, structure, and function. **2.** Enzyme Kinetics: Reaction 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, Mechanisms of enzyme- catalyzed reactions. **4.** Enzymes regulation: Allosteric Regulation, Enzyme inhibition and activators, feedback inhabitation in metabolic pathways. **5.** Enzymes 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.** Enzyme in Biotechnology: Enzymes as diagnostic markers, Enzymes in drug and development and pharmacology, Enzymes replacement therapy and medical applications. **7.** Enzymes in medicine: Enzymes as diagnostic markers, Enzymes in drug and development and pharmacology, Enzymes in textile and paper industries **8.** Industrial Application of Enzymes: Enzymes in food and beverage productions, Enzymes in biofuel production, 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 Mechanism by N. S. Punekar. **2.** Enzyme Kinetic and Mechanism by Paul F. Cook, W. W. Caleand. **3.** Enzymes: principle and biotechnological applications by Robinson PK, Essays Biochem. 2015; 59:1-41. Doi: 10.1042/bse0590001.

1	**Title of the course** (L-T-P-C)	**Modern Translation biology** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	**Identification of genes/ molecules involved in various disorders,** Investigation of gene function, and underlying mechanisms. Transcription factors, Signalling molecules. Signalling hubs, Metabolites, **Necessity/Sufficiency of genes for a phenotype.** Knockout/ Knock-in-models, Genetic chimeras, Spemann- Mangold Organizer Developmental gradients and domains of gene expression. In Vitro and in vivo model systems for investigating disease pathogenesis and therapeutics. Primary cell culture Immortalized cell lines Transgenic animal models (vertebrate/invertebrates) High-throughput screening Development and testing of novel therapeutics. Drug design. Drug screening. Gene therapy. Investigation of disease pathophysiology Mechanisms of cytotoxicity and cell death Apoptosis, necrosis Oxidative stress
4	**Texts/References**	**1.** Molecular Cloning: A Laboratory Manual Fourth Edition, Joe Sambrook and Michael Green **2.** Molecular Biology Techniques: A Classroom laboratory manual, Fourth Edition, Sue Caron, Healther Miler, 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**	--
4	**Texts/References**	----