

**Course Structure
of
MSc (2 year), MSc + PhD Dual Degree
in
Biotechnology
and
Syllabi of Courses**

Course Structure for MSc (2 year)/ MSc + PhD Dual Degree Program in Biotechnology from AY 2017-2018

Minimum Education Qualification (MEQ): 1. Bachelor's degree in any branch of science / Pharmacy / Veterinary / Engineering / Medicine **AND** 2. JAM qualification in Biological Sciences (BL) or Biotechnology (BT).

Eligibility Requirement (ER): As mentioned in the JAM Brochure by the organizing Institute

Duration of the Program: Two years full-time

Total Intake: 12 (with category-wise breakup of 6/3/2/1 for Gen/OBC-NC/SC/ST)

Course Structure for two-year Full-time M.Sc. (Biotechnology) Program

1st Year: Semester-I

Course code	Course Title	Contact Hours (L-T-P)	Credits
BSE 601*	Advanced Molecular Biology	2-1-0	3
BSE 603*	Analytical Biochemistry	2-1-0	3
BSE 605/ BSE 405*	Molecular Biophysics	2-1-0	3
BSE 609	Microbiology	2-1-0	3
BSE 611	Biochemistry	2-1-0	3
BSE 651	Biochemistry Lab	0-0-4	2
BSE 659	Microbiology Lab	0-0-4	2
Total minimum credits earned during the semester			19
Additional course (as per the requirement basis)			
BSE 600	Physics and Mathematics for Biologists	2-1-0	PP/NP
HS 641	English Communication Skills	2-0-2	PP/NP

1st Year: Semester-II

Course code	Course Title	Contact Hours (L-T-P)	Credits
BSE 610	Cell and Developmental Biology	2-1-0	3
BSE 612	Immunology and Immunotechnology	2-1-0	3
BSE 614	General Physiology	2-1-0	3
BSE 616	Infectious Diseases and Medical Microbiology	2-1-0	3
BSE 618	Biostatistics and Bioinformatics	2-0-2	3
BSE 652	Genetic Engineering Lab	0-0-6	3
BSE 698	PG Seminar Course	0-2-0	2
Total minimum credits earned during the semester			20

* *Already existing course*

2nd Year: Semester–III

Course code	Course Title	Contact Hours (L-T-P)	Credits
BSE 799	M.Sc. Project (Statge–I)	0-0-36	18
Total minimum credits to be earned during the semester			18

2nd Year: Semester–IV

Course code	Course Title	Contact Hours (L-T-P)	Credits
BSE 800	M.Sc. Project (Stage–II)	0-0-36	18
Total minimum credits to be earned during the semester			18
Total minimum credits to be earned during the program			75

NOTE: 1. Request for conversion from MSc to MSc + PhD dual degree will be considered after evaluating the research potential of the promising and motivating PG students at the end of the **third semester of their program**. The confirmation to PhD program will be subjected to successfully qualifying CSIR/UGC-JRF or equivalent fellowship.

2. If the student opts for Dual Degree Programme but cannot complete the requirements of a PhD, an **exit option** with the MSc degree can be earned at the end of the final semester of the normal MSc Programme by getting the MSc Research Project examined in the standard manner as per the requirements for the award of an MSc degree.

3. The enhancement in the scholarship, if any, from MSc to PhD will be from the beginning of the fifth semester or from the date on which all requirements for the award of MSc degree are fulfilled, whichever is later.

1.	Course Code	BSBE 600
2.	Title of the Course	Physics and Mathematics for Biologists
3.	Credit Structure	L-T-P-Credits (2-1-0-PP/NP)
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Objectives of the course	The course would provide comprehensive introduction to basics of the field related to biological science.
7.	Course Syllabus	<p>Introductory Calculus: Limit, Continuity, Differentiation, Integration and Ordinary Differential Equations.</p> <p>Properties of Matter: Elasticity, Hydrostatic, Surface tension, Microscopic consideration for study of properties of matter, Atomic and Molecular structure, Structure of solids, amorphous solids, Structure of single crystals, Broad classification of solids</p> <p>Thermal Physics: Laws of Thermodynamics and its application in Biological system, Temperature and related topics, Internal energy, Heat and First law of Thermodynamics, The ideal monatomic gas, Application of first law to Ideal Gases, Entropy and the second law</p> <p>Fundamental Electromagnetism: Charge and Current, Coulomb's law, Electric field, Electrostatic potential, Guass's law for Electronics, Magnetic effects on study currents, Forces on current in a magnetic field, Forces on charges in Electric and Magnetic field, Electromagnetic induction</p> <p>X-ray crystallography: A basic introduction to x-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination</p> <p>Optics: geometrics optics, ray tracing, diffraction and scattering some topics related to nonlinear and quantum optics.</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. Hugh Neil, Calculus: A Complete Introduction, 1st ed., John Murray Learning, 2013, ISBN-10: 144419111X ISBN-13: 978-1444191110. 2. Halliday, Resnick and Walker, Fundamentals of Physics, 9th ed., Wiley, ISBN-10: 0470469080) 3. Sears and Zemansky, University Physics with Modern Physics, 13th ed., Addison-Wesley, ISBN-10: 0321696867. 4. Thornton and Marion, Classical Dynamics of Particles and Systems, 5th ed., Cengage Learning, ISBN-10: 0534408966 5. Mark Zemansky, Heat and Thermodynamics, 7th ed., McGraw Hill, ISBN-10: 0070170592 6. Arthur Besier, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, 7th Ed., McGraw Hill Education, ISBN-10: 9351341852 ISBN-13: 978-9351341857.

1.	Course Code	BSE 609
2.	Title of the course	Microbiology
3.	Credit Structure	L-T-P-Credits 2-1-0-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Scope of the course	The course will cover the fundamental of Microbiology
7.	Course Syllabus	<p>History and Microbial Diversity The historical foundations and development of microbiology; An overview of microbial world; Microbial diversity - Prokaryotic and eukaryotic microbial diversity; The bacteria and the archaea; Principles of bacterial taxonomy Molecular methods in taxonomy; Intraspecies classification of bacteria. Morphology and structure of bacteria; Surface structures and inclusions of bacteria; Viruses- unique properties, morphology and structure; Virion, Viroids and Prions; Viral replication. Viral diversity –bacterial, plant and animal viruses; Fungi –properties and classification.</p> <p>Microbial Growth and Culturing Factors influencing microbial growth. Environmental and nutritional factors; Nutritional types of bacteria; Microbial locomotion – flagellar motility, gliding motility and amoeboid motion; Chemotaxis, Phototaxis and other taxes. Cultivation of bacteria- culture media and methods; Measurement of bacterial growth. Bacterial growth curve; Binary fission, Growth cycle, Microbial growth at different temperature, pH and oxygen level; Continuous cultures; Maintenance and transport of cultures.</p> <p>Identification of bacteria and Sterilisation methods Identification of bacteria. Staining reactions; Cultural, physiological and biochemical characteristics; Sterilisation – Principles and methods, physical and chemical methods; Disinfectants – modes of action; Testing of disinfectants; Antibiotics – mechanism of action; Drug resistance in bacteria; Antibiotic sensitivity tests.</p> <p>Microbial genetics Genetic materials in bacteria; Bacterial chromosome; Extrachromosomal genetic elements; Plasmid, Transposons; Mutation, DNA repair, Mutant selection; Mechanism of gene transfer – transformation, transduction and conjugation.</p> <p>Microbial metabolism Microbial metabolism; Central pathways, Glycolysis, Pentose phosphate pathway, Entner Doudoroff pathway, TCA cycles, Electron transport chain, Aerobic and anaerobic respiration; Fermentation. Anaplerotic reaction; Peptidoglycan synthesis, Bacterial photosynthesis.</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. A. D. Russel et al., Principles and practice of disinfection, preservation and sterilization, 5th ed., Wiley-Blackwell, 2013, ISBN-10: 1444333259 ISBN-13: 978-1-444333251 2. L. E. Bryan (Ed.), Antimicrobial Drug Resistance, Academic Press, 1984, ISBN-10: 012138120X ISBN-13: 978-0121381202 3. Bernard D.Davis et al., Microbiology, Harper International Edition, ISBN-10: 0061406910 ISBN-13: 9780061406911 4. Gerhardt P et al., Manual of Methods for General Bacteriology, American Society for Microbiology, 1981, ISBN-10: 0914826301 ISBN-13: 978-0914826309. 5. Pelczer Jr. Chan. Creig, Microbiology: Concepts and Applications, McGraw Hill Inc, 1993, ISBN-10: 0070492581 ISBN-13: 9780070492585 6. L. M. Prescott, J. P. Harley, D. A. Klein, Microbiology, 6th ed., McGraw-Hill, 2004, ISBN-10: 0697293904 ISBN-13: 9780697293909

1.	Course Code	BSE 659
2.	Title of the Course	Microbiology Lab
3.	Credit Structure	L-T- P-Credits 0-0-4-2
4.	Name of the Discipline	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	Basic biology courses undergraduate level
6.	Scope of the Course	This course aims to introduce basic laboratory techniques in microbiology (Bacteriology, Virology, Immunology) through experiments that will be conducted as Experimental Projects.
7.	Course Syllabus	<ol style="list-style-type: none"> 1. Introduction to Light Microscopy, Laboratory Procedure for Microscopic Examination 2. Introduction to laboratory sterilization technique, Media Preparation; Bacterial Culture Media preparation and sterilization 3. Bacterial Isolation, Culturing Techniques and Microscopic Examination of Bacterial Morphology, Structures, Motility. 4. Antigen-Antibody Reactions; Agglutination and Precipitation Techniques 5. Introduction to virological methods and techniques. Animal cell culture techniques, cell propagation, cell counting, maintenance 6. Quantification of virus by plaque assay. Reverse transcription PCR techniques 7. Enzyme-Linked Immunosorbent Assay (ELISA) assay for viral antigen detection, Western Blot 8. Cell staining and immunofluorescence techniques, Image acquisition through epifluorescence techniques
8.	Suggested Books	<ol style="list-style-type: none"> 1. M. R. Green and J. Sambrook, Molecular Cloning: A Laboratory Manual, 4th ed., Cold Spring Harbor Laboratory Press, 2012, ISBN 978-1-936113-42-2. 2. Anna Oller, Microbiology Lab Manual, Spi Lab edition, Kendall Hunt Pub Co., 2016, ISBN-10: 1465295380 ISBN-13: 978-1465295385. 3. James G. Cappuccino and Chad T. Welsh, Microbiology: A Laboratory Manual, 11th ed., Pearson, 2016, ISBN-10: 0134098633 ISBN-13: 978-0134098630.

1.	Course Code	BSE 611
2.	Title of the course	Biochemistry
3.	Credit Structure	L-T-P-Credits 2-1-0-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Scope of the course	The course will cover the fundamentals of Biochemistry
7.	Course Syllabus	<p>Properties of water and aqueous solution: Water as biological solvents; acid bases and buffers; physiological buffers; Henderson Hasselbach equations; fitness of aqueous environment for living organisms.</p> <p>Functional groups: Structure and reactions; Review of organic reaction: classification; mechanisms</p> <p>Biomolecules: Composition; basic structure and function of biomolecules: carbohydrates, lipids, proteins, nucleic acids and vitamins.</p> <p>Hormones: Classification; site of formation, target organs; mechanism of action of peptide and steroid hormones (with suitable examples).</p> <p>Stabilizing interactions: Covalent bonds; Ionic bonds; Disulfide linkages; Non- covalent interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.</p> <p>Free radicals in biological systems: Pro oxidants and anti oxidants in biological systems.</p> <p>MACROMOLECULES: STRUCTURE AND FUNCTION</p> <p>CARBOHYDRATES:</p> <p>Oligosaccharides: Glycosidic bonds; Classification: glycoproteins (O-linked and N- linked), glycolipids; Nature of carbohydrate moiety attached; Functions: as cell recognition factors, in intracellular targeting; Purification and Characterization of oligosaccharides from cell membranes</p> <p>Polysaccharides: Classification: Homopolysaccharides (Cellulose, Starch, Chitin, and Glycogen), Heteropolysaccharides (bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and heparin); Structural characteristics and functions of above mentioned polysaccharides; Exopolysaccharides from bacterial systems and their uses; Purification and Characterization of polysaccharides from biological systems.</p> <p>Metabolism of carbohydrates: Introduction, Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation. TCA cycle - Regulation, Glyoxylate cycle, amphibolic and anaplerotic reactions. Electron Transport chain, Oxidative phosphorylation, and production of ATP, Inhibitors of ETC and ATP synthesis, balance sheet of glucose oxidation, Oxidative stress., Pentose phosphate pathway (HMP shunt) & its regulation, Glycogen metabolism and regulation, Photosynthesis – ‘light’ and ‘dark’ reactions: Light reaction- structure of chlorophyll, Light harvesting complexes (LHC’s) Photosystems PSI & II; Mechanism of energy production, photophosphorylation, ancillary pigments. Dark reaction and regulation Calvin cycle, stoichiometry of carbon cycle, C4-pathway, efficiency of photosynthesis.</p> <p>PROTEINS and NUCLEIC ACIDS</p> <p>Protein structure and function: Primary, Secondary, Tertiary and Quaternary structure of Proteins w.r.t: Globular protein (eg: Hemoglobin and Myoglobin), Fibrous protein: (Collagen), Membrane Protein (ATP synthetase); Protein structure and molecular approach to medicine: introduction (Sickle cell anaemia, p53 and its role in Cancer).</p> <p>Nucleic acid structure and function: Supercoiling of the DNA molecule; topoisomers and superhelixes; Higher orders of DNA Structure: Chromatin Structure: Histones and Nucleosomes; Conformation of Chromatin fibers; Organization of the DNA Sequence:</p>

		<p>Genes, pseudogenes, extragenic regions (beta globin gene and gene family) duplicated genes; Reassociation kinetics, Repetitive DNA sequences: Tandem repeats (Satellites, minisatellites, and microsatellites), Interspersed repeats (LINE, SINES) Single copy genes; RNA Structure: Types of RNA; structure of mRNA, tRNA and rRNA ,Si RNA, micro RNA with emphasis on importance of structure to its function.</p> <p>LIPIDS Glycerophospholipids: Structure and function of (Phosphatic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl glycerol, Phosphatidyl choline, Phosphatidyl inositol), CDP-diacylglycerol, Lung surfactants. Glycosphingolipids: Structure and function of (Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides); Eicosanoids: Prostaglandins, Leukotrienes and Thromboxanes: Chemistry, formation and physiological function. Steroids: Steroids in animal system: Glucocorticoids, mineralocorticoids and Sex hormones (Site of biosynthesis, functions and mechanism of action; Sterols in Plant system: Phytohormones: Brassinosteroids (functions); Sterols in microbial system.</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. Hiram. F. Gilbert, Biochemistry: A Students survival Guide, McGraw-Hill, 2002, ISBN 0-07-135657-6 2. David L. Nelson, Michael M. Cox, Lehninger, Principles of Biochemistry, 4th ed., W. H. Freeman; 2004, ISBN-10: 0716743396 ISBN-13: 978-0716743392 3. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, (2012) A Text Book of Biochemistry, Oxford and IBH Publishing Co., ISBN-10: 8120417607 ISBN-13: 978-8120417601 4. Donald Voet, Judith G. Voet, Biochemistry [with Cdrom], John Wiley & Sons Inc. 2004, ISBN: 047119350X ISBN-13: 9780471193500 ISBN-10: 978-0471193500 5. Geoffrey L Zubay, William W Parson, Dennis E Vance, Principles Of Biochemistry, McGraw-Hill Book Company, 1995, ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757 6. Robert Horton H, Laurence A Moran, Gray Scrimgeour K, Principles Of Biochemistry, 4/e (2006), Pearsarson, ISBN: 0131977369, ISBN-13: 9780131977365, 978-0131977365 7. Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer, Biochemistry: International Edition, 7th ed., W. H. Freeman, 2011, ISBN:071676766X ISBN-13: 9780716767664, 978-716767664

1.	Course Code	BSE 651
2.	Title of the Course	Biochemistry Lab
3.	Credit Structure	L-T- P-Credits 0-0-4-2
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	Basic biochemistry courses at the undergraduate level
6.	Scope of the Course	This course aims to introduce basic laboratory techniques in biochemistry through experiments that will be conducted as Experimental Projects.
7.	Course Syllabus	<ol style="list-style-type: none"> 1. To prepare an Acetic-NaAcetate buffer system and validate the Henderson-Hasselbach equation. 2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer-Lambert's Law. 3. Titration of Amino Acids and separation of aliphatic, aromatic, and polar AA by TLC. 4. An enzyme purification theme (such as E. Coli alkaline phosphatase): <ol style="list-style-type: none"> (a) Preparation of cell-free lysates, (b) ammonium sulfate precipitation, (c) Ion-exchange chromatography, (d) Gel filtration, (e) Affinity chromatography, (f) Generating a purification table, (g) Assessing purity by SDS0PAGE gel electrophoresis, (h) Assessing purity by 2D-gel electrophoresis, and (i) Enzyme kinetic parameters: K_m, V_{max}, and K_{cat}.
8.	Suggested Books	<ol style="list-style-type: none"> 1. D. Holme & H. Peck; Analytical Biochemistry, 3rd ed., Longman, 1998. ISBN-10: 058229438X ISBN-13: 978-0582294387 2. T.G. Cooper; The Tools of Biochemistry, Wiley Intersciences, 1977, ISBN-10: 0471171166 ISBN-13: 978-0471171164 3. Robert K. Scopes, Protein Purification -Principles & Practices, 3rd ed., Springer International Edition, 2014, ISBN-10: 8132214838 ISBN-13: 978-8132214830. 4. Daid Freifelde, Physical Biochemistry: Application to Biochemistry and Molecular Biology, 2nd ed., W. H. Freeman, 1983, ISBN-10: 0716714442 ISBN-13: 9780716714446 5. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000. ISBN 052165873X, 9780521658737

1.	Course Code	BSE 610
2.	Title of the course	Cell and Developmental Biology
3.	Credit Structure	L-T-P-Credits 2-1-0-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Scope of the course	The course will cover the fundamental of Cell and Developmental Biology
7.	Course Syllabus	<p>Cell structure: Ultra structure of prokaryotic and eukaryotic cells, Cell Organelles: Structure and function of: Endoplasmic reticulum, Golgi complex, Types of vesicles - transport and their functions, Lysosomes. Nucleus - Internal organization, Nuclear pore complex, Nucleosomes Chromatin. Mitochondrial Genome, Structure and Function</p> <p>Cell Metabolism: Oxidative in the Mitochondrion – The Role of Mitochondria in the formation of ATP – Translocation of Protons and the Establishment of a proton-motive force – The Machinery for ATP formation – Peroxisomes. Genome studies of Mitochondria. Chloroplast structure and function – An overview of photosynthetic Metabolism, Cytoskeleton – components of Cytoskeleton, Microtubules, Intermediate filaments – Microfilaments,</p> <p>Cellular Transport and Cell Signaling: Protein trafficking, Cell Signaling: Hormones and Receptors, Intracellular signaling in Development and Disease, Transport across Cell Membranes, Protein Sorting: Organelle Biogenesis and Protein secretion, Stem Cell Biology, Cancer, Regulation of Cell Death; Apoptosis, Circadian Rhythms.</p> <p>Developmental Biology: Introduction to genomes and differential gene expression, mechanism of differentiation, fertilization, self-adhesion, cell-adhesion, stem cells, early amphibian development, neurulation, neural tube pattern, neural crest. Organ developments</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris Kaiser, Monty Krieger, Matthew Scott, Lawrence Zipursky and James Darnell, Molecular Cell Biology, 5th ed., W.H Freeman and Company, 2003, ISBN: 9780716743668. 2. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, 5th ed., Sinauer Associates Inc., 2009, ISBN-10: 0878933972 ISBN-13: 978-0878933976. 3. Bruce Alberts et al., Molecular Biology of the Cell, 6th ed., Garland Sciences, 2014, ISBN-10: 0815344643 ISBN-13: 978-0815344643. 4. Jeff Hardin and Gregory Bertoni, Becker's World of the Cell, 9th ed., Pearson/Benjamin Cummings, 2015, ISBN-10: 0134145798 ISBN-13: 978-0134145792. 5. Gerald Karp, Cell Biology, 7th ed., Wiley, 2013, ISBN-10: 1118318749 ISBN-13: 978-1118318744. 6. Scott F. Gilbert and Michael J. F. Barresi, Developmental Biology, 11th ed., Sinauer Associates Inc., 2016, ISBN-10: 1605356042 ISBN-13: 978-1605356044.

1.	Course Code	BSE 612
2.	Title of the Course	Immunology and Immunotechnology
3.	Credit Structure	L-T-P-Credits 2-1-0-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	Open to all graduates, with the prior permission of course instructor.
6.	Scope of the Course	This course deals with immune systems and their components at the cellular and humoral levels. Furthermore, this course deals with the practical aspects such as the production and engineering of antibodies, the application of antigens, the design of (recombinant) vaccines, strategies for immune intervention, etc.
7.	Course Syllabus	<p>Introduction to immunology. Cells & organs of immune system-lymphoid cells, B and T lymphocytes, null cells. Mononuclear cells- phagocytosis, antimicrobial and cytotoxic activities. Granulocytes- neutrophils, eosinophils and basophils. Mast cells, dendritic cells. Organs of immune system- primary and secondary lymphoid organs.</p> <p>Immunoglobulins: Structure and function-basic and fine structures of immunoglobulins. Isotypes, allotypes and idiotypes Classification of immunoglobulins. Genetic control of antibody response. Generation of antibody diversity. Theories of antibody formation. Clonal selection theory.</p> <p>Antigen-antibody interaction- strength of antigen-antibody interaction, cross reactivity, precipitin reactions. Radioimmunoassays (RIA). Enzyme linked immunosorbent assay (ELISA). Western blotting. immunoelectron microscopy. Complement proteins, complement features, classical and alternative pathways.</p> <p>Major histocompatibility complex (MHC): Structure and its significance. Transplantation immunity- immunological basis of graft rejection, xenotransplantation. Clinical manifestation of graft rejection. General and specific immuno suppressive therapy. Clinical transplantation. Hypersensitivity- type I, II, III, and IV hypersensitivity.</p> <p>Autoimmunity: Basis of autoimmune disorders, mechanism for the induction of autoimmunity. Treatment of autoimmune diseases. Immune response to infectious diseases. Antigen presentation via Class I and Class II pathways. Th1/ Th2 polarities, NK Effector Mechanism. Apoptosis.</p> <p>Monoclonal antibodies- production role and advantages of monoclonal antibodies. Detailed account on the application and uses of monoclonal antibodies. Humanization of antibodies.</p> <p>Cancer Immunology: Role of cytotoxic T lymphocytes in cancer immunology. AIDS pathogenesis, immunology of retroviruses, role of chemokines in management of AIDS. Vaccine technology, active and passive immunity, development of vaccine against infectious diseases.</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne. Immunology, 6th ed., W. H. Freeman, 2006, ISBN-10: 0716767643 ISBN-13: 9781429203944. 2. Abul K. Abbas and Andrew H. Lichtman, Cellular and Molecular Immunology, 2014, ISBN-10: 0323222757 ISBN-13: 978-0323222754 3. David K. Male, Jonathan Brostoff, David E. Roth, and Ivan M. Roitt, Immunology, 8th revised edition, Elsevier, 2012, ISBN-10: 0323080588 ISBN-13: 9780323080583 4. Thao Doan, Roger Melvold, Susan Viselli, Carl Waltenbaugh, Immunology, Lippincott Illustrated Reviews Series, 2012, ISBN-10: 1451109377 ISBN-13: 978-1451109375

1.	Course Code	BSE 614
2.	Title of the course	General Physiology
3.	Credit Structure	L-T-P-Credits 2-1-0-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Scope of the course	The course will cover the fundamentals of Physiology
7.	Course Syllabus	<p>Introduction to Physiology: The scope of human physiology, Elementary tissues- epithelial tissue, connective tissue, muscle tissue, nervous tissue, homeostasis, blood buffers, acid base balance, hormones</p> <p>Muscle physiology: Muscles classification, skeletal muscle, smooth muscle, muscle contraction, membrane excitation, neuromuscular junction, and rigor mortis</p> <p>Renal physiology: Kidney, nephron, renal circulation, GFR, renal regulation of water and electrolyte balance</p> <p>Cardiovascular Physiology: Heart, cardiac muscle, action potential in cardiac muscle, cardiac cycle, heart sounds, conducting mechanism, heart beat and regulation, cardiac output, ECG, blood pressure, role of baro and chemo receptors in blood pressure regulation, composition and functions of blood, plasma proteins and functions, cellular content of blood- haematopoiesis, haemoglobin, haemostasis, blood groups, blood transfusion, lymph</p> <p>Respiratory physiology: Organization of respiratory system, respiratory membrane, pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation, surfactants, exchange of gases, transport of gases, regulation of respiration, hypoxia, cyanosis, hypercapnia, dyspnea, apnea, periodic breathing, artificial respiration</p> <p>Digestive physiology: Salivary gland and secretion, gastric gland and secretion, secretion of pepsinogen, HCl secretion and regulation, pancreas, liver, bile</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. Vander's Human Physiology- The Mechanism of Body function. Widmaier, Raff, Strang, 2014 ISBN-10: 0073378305 ISBN-13: 978-0073378305 2. Arthur. C. Guyton & John. E. Hall, Text Book of Medical Physiology. 2010, ISBN-10: 1416045740 ISBN-13: 978-1416045748 3. John. B. West, Physiological basis of Medical Practice, 12th revised ed., Lippincott Williams and Wilkins, 1990, ISBN-10: 0683089471 ISBN-13: 978-0683089479 4. William. F. Ganong, Review of Medical Physiology, 25th ed., McGraw Hill Education, 2016, ISBN-10: 007182510-X ISBN-13: 978-0071825108. 5. K. Sembulingam & Prema Sembulingam, Essentials of Medical Physiology, 6th ed., JPB, 2013, ISBN-10: 9350259362 ISBN-13: 978-9350259368

1.	Course Code	BSE 616
2.	Title of the course	Infectious Diseases and Medical Microbiology
3.	Credit Structure	L-T-P-Credits 2-1-0-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Scope of the course	This course provides a basic understanding of issues related to infectious diseases, mechanism and pathophysiology.
7.	Course Syllabus	<p>General Principles of Infection: How diseases are caused by micro-organisms, Host factors, Virulence, Susceptibility, host defence, macrophages, cytokines, complement system, cell mediated immunity, Disease transmission mechanisms</p> <p>Microbial agents causing infections: Gram positive and gram-negative bacteria, anaerobic bacteria, spirochetes, rickettsia, fungi, viruses, algae, helminths etc.</p> <p>Diagnosis and Prevention of infection: Bacterial, Fungal, Viral and Parasitic infections, Immunization, Molecular techniques for detection, Immuno-diagnosis, Imaging of infections</p> <p>Treatment of Infectious Diseases: Antimicrobial agents, Antivirals including anti-retrovirals, Approaches for treatment of Sepsis, systemic infections, Eye infections, Pulmonary infections, GI infections, Sexually transmitted infections, skin and soft tissue infections, Orthopaedic, neurological, urological, hepatic infections and surgical infections.</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. S. L. Gorbach, J. G. Bartlett, N. R. Blacklow, Infectious Diseases Lippincott Williams & Wilkins (2004), ISBN: 9780781733717 2. W. F. Wright, Essentials of Clinical Infectious Diseases (2013), Demos Medical Publishing, ISBN: 9781617051531 3. D. Schlossberg, Clinical Infectious Disease, Cambridge University Press (2008), ISBN: 9781139576659 4. S. S. Shah, K. K. Hu, H. M. Crane, Blueprints Infectious Diseases, Lippincott Williams & Wilkins (2006), ISBN: 9781405104531 5. P. G. Engelkirk, J. L. Duben-Engelkirk, Laboratory Diagnosis of Infectious Diseases: Essentials of Diagnostic Microbiology, Lippincott Williams & Wilkins, (2008), ISBN: 9780781797016

1.	Course Code	BSE 618
2.	Title of the course	Biostatistics and Bioinformatics
3.	Credit Structure	L-T-P-Credits 2-0-2-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	None
6.	Scope of the course	In this course we will explore the use of statistical methodologies in designing, analyzing, interpreting, and biological experiments and observations. The course will cover descriptive statistics, probability, hypothesis testing and statistical interference, analysis of variance, correlation, and regression techniques.
7.	Course Syllabus	<p>Biostatistics: Introduction to Biostatistics: Variable and attribute; Population vs. sample; Census vs. sample survey; Arrangement of data; Frequency distribution. Graphical presentation of data: Line diagram; Bar diagram; Pie chart; Histogram. Measure of central tendency: Arithmetic mean; Mode; Median. Measure of dispersion: Variance; Standard deviation; Standard error of mean; Standard score. Testing of hypothesis and goodness of fit: Null hypothesis; Level of significance; Probability, Normal distribution, Error of inference, Student's t-test, Fisher's t-test, Chi-square test. Correlation, Regression and Analysis of variance (ANOVA)</p> <p>Bioinformatics: Introduction to Bioinformatics with historical background, major developments. Biological data and databases, data query and data mining; sequence databases: Nucleic acid sequence databases, protein sequence databases Sequence analysis: Basic concept of sequence similarity, identity, and homology; Scoring matrices: basic concept of a scoring matrix, matrices for nucleic acid and protein sequences, PAM, and BLOSUM series, matrix derivation method and principles.</p> <p>Pairwise sequence alignment: Basic concept of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, applications to nucleic acid and protein sequences. Multiple sequence alignments: basic concepts of various approaches for MSA, algorithm for CLUSTALW and PileUp and their application for sequence analysis, etc.</p> <p>Sequence pattern and profiles; Phylogenetic predictions: definitions and basic concepts, overview of methods.</p> <p>Monte Carlo (MC) and Molecular Dynamics (MD) simulations, free energy simulations, enhanced sampling methods</p> <p>Basic concepts of Network Theory: Basic definitions- graph, network, adjacency matrix, path, degree, importance of nodes betweenness, closeness and degree centrality, clustering coefficient and modularity, degree-degree correlations, weak ties.</p> <p>Biological Network: Biological Networks: Protein-protein interaction networks, gene regulatory networks, signal transduction networks, metabolic networks, inference of gene regulatory networks from gene expression data</p>
8.	Suggested Books	<ol style="list-style-type: none"> 1. Norman T. J. Bailey, Statistical Methods in Biology, 3rd ed., Cambridge University Press, 1995, ISBN-10: 0521498457 ISBN-13: 978-0521469838 2. Bernard Rosner, Fundamentals of Biostatistics, 8th revised ed., Cengage Learning Custom Publishing, 2015, ISBN-10: 130526892X ISBN-13: 978-1305268920. 3. David W. Mount, Bioinformatics: Sequence and Genome Analysis, 2nd ed., Cold Spring Harbor Laboratory Press, 2005, ISBN-10: 8123912412 ISBN-13: 978-8123912417. 4. Teresa K. Attwood and David J. Parry-Smith, Introduction to Bioinformatics, Prentice Hall, 1999 [ISBN-10: 0582327881 ISBN-13: 9788177586411]. 5. Bryan Bergeron, Bioinformatics Computing, 1st ed., Pearson Education, 2015, ISBN-10 9332549419 ISBN-13: 978-9332549418.

1.	Course Code	BSE 652
2.	Title of the Course	Genetic Engineering Lab
3.	Credit Structure	L-T-P-Credits 0-0-6-3
4.	Name of the Concerned Department	Biosciences and Biomedical Engineering
5.	Pre-requisite, if any (for the students)	Basic Biology and Basic Biochemistry (Undergraduate level).
6.	Course Objective	The emphasis of the lab is on understanding the principles behind experiments, the ability to design and execute experiments and time management. The purpose of various steps and project planning will be discussed.
7.	Course Syllabus	<ol style="list-style-type: none"> 1. Isolate genomic DNA from <i>Bacillus subtilis</i> (or equivalent organism) genome 2. PCR amplification of <i>flgM</i> gene and analysis by agarose gel electrophoresis 3. Preparation of plasmid pET-28a from <i>E. coli</i> DH5a and gel analysis 4. Restriction digestion of vector (gel analysis) and insert with <i>NcoI</i> and <i>XhoI</i> 5. Vector and insert ligation, b. Transformation in <i>E. coli</i> DH5a. 6. Plasmid isolation and confirming recombinant by PCR and RE digestion. 7. Transformation of recombinant plasmid in BL21(DE3). 8. Induction of FlgM protein with IPTG and analysis on SDS-PAGE. 9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE. 10. Random primer labeling of <i>flgM</i> with Dig-11-dUTP 11. Southern hybridization of <i>B. subtilis</i> genome with probe and non-radioactive detection.
8.	Suggested Reading	<ol style="list-style-type: none"> 1. T. Maniatis, E.F. Fritsch & J. Sambrook; Molecular Cloning: A Laboratory Manual. CSHL, 3rd ed., 2002. [ISBN-10: 0879695773 ISBN-13: 978-0879695774] 2. C Hardin, J Edwards, A Riell, D Presutti, W Miller and D Robertson; Cloning, Gene Expression and Protein Purification: Experimental procedures and process rationale. Oxford University Press, 2001. [ISBN-10: 0195132947 ISBN-13: 978-0195132946] 3. M.A. Innis, D.H. Gelfand, J.J. Sninsky & T.J. White. PCR Protocols. Academic Press, 1990. [ISBN 0-12-372181-4] 4. W. Old & Primrose; Principles of Gene Manipulation. 6th ed., S. B. University Press, 2001. [ISBN-10: 0632059540 ISBN-13: 978-0632059546] 5. K.E. Davies et al., Genome Analysis - A Practical Approach, 1988. [ISBN-10: 1852211105 ISBN-13: 978-1852211103]

1.	Course Code	BSE 698
2.	Title of the Course	PG Seminar Course
3.	Credit Structure	L-T-P-Credits 0-2-0-2
4.	Name of the Concerned Department	Center for Biosciences and Biomedical Engineering
5.	Pre-requisite, if any	Nil
6.	Course Objective	To develop confidence and presentation skills of the student
7.	Course Syllabus	In this course a PG student has to present seminar/presentation or a series of presentations on a topic(s) chosen by him/her in consultation with his/her PG Thesis Supervisor/ Faculty Advisor. The frequency of seminar/presentation will be decided by the Course Coordinator.
8.	Suggested Books	Books and research publications in various relevant journals/conference proceeding, etc.