Bachelor of Biotechnology (B.Sc. Hons)
Syllabus

FIRST SEMESTER

BIO1101: DIVERSITY OF LOWER PLANTS [2 1 0 3]

Algae: Occurrence, general characteristics, classification system, thallus structure, pigments, reproduction and importance. Study of life cycle of the following genera: Volvox, Chara, Vaucheria. Bryophytes: Occurrence, distribution, general characteristics, alternation of generation, classification and economic importance. Study of life cycle of the Marchantia. Pteridophytes: Occurrence, general characteristics, classification, stele system, seed habit and heterospory, apospory and apogamy. Study of life cycle of the Marsilea. Comparative study of the algae, bryophytes and pteridophytes in general. Global applications of cryptogams in industry.

References:

1. V. Singh, P.C. Pande and D.K. Jain. Diversity of Microbes and Cryptogams, 5th Revised Edition, Rastogi Publication, Meerut, India. 2012.
2. N. S. Parihar. Biology and Morphology of Pteridophytes, Central Book Depot., Allahabad, 2002.
3. S. K Bassi, Diversity of Microbes and Cryptogams. S. Chand Publications, New Delhi, India, 2007.
4. B. R. Vashishta, A. K. Sinha and V. P. Singh. Botany for Degree Students: Algae, S. Chand Publications, New Delhi, India. 2014.
5. G. M. Smith. Cryptogamic Botany: Bryophytes and Pteridophytes, Tata McGraw Hill Publishing Co., New Delhi, 2008.
6. E. Karl. Cryptogams: Cyanobacteria, Algae, Fungi, Lichens. Cambridge University Press. 1982.

BIO1102: FUNDAMENTALS OF BIOTECHNOLOGY [2 1 0 3]

Biotechnology: Introduction and history. Basic concepts, definition and descriptions of some important terminology in biotechnology. Study of various branches of Biotechnology including plant, animal, medical, industrial, environmental, marine biotechnology, bioinformatics. Introduction of Techniques: Genetic engineering, plant and animal tissue culture, fermentation technology, immobilized enzymes, monoclonal antibodies and hybridoma technology, embryo transfer technology, introduction to gene and genomes, proteins and proteome, recombinant DNA technology, DNA fingerprinting and forensic analysis. Avenues of Biotechnology: Current status of biotechnology and future of biotechnology in developing world, role of biotechnology in Indian industry, new trends in biotechnology. Practice of biotechnology: Medicine, industry, agriculture, livestock improvement and environment.

References:

1. S. C. Bhatia, *Textbook of Biotechnology*. Atlantic Publisher and Distributor, New Delhi. 2012.
2. A. K. Chakravarty. Introduction to Biotechnology. Oxford University Press, New Delhi, 2013.
3. J. William, M. Thieman and A. Palladino. *Introduction to Biotechnology*. Benjamin Cummings. 2013.
4. R.W. Old and S.B. Primrose. *Principles of Gene Manipulation*. Blackwell Scientific Publications, U.K. 2006.

BIO1103: CELL BIOLOGY: STRUCTURE & FUNCTIONS [2 1 0 3]

History and Introduction of Cell: Cell theory, eukaryotic and prokaryotic cells, different models of cell membrane and structure of cell wall, active & passive transport. Cell organelles: Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplasts, Ribosome, Peroxisomes, Nucleus, lysosomes, Vacuole, Cytosol and Cytoskeleton (Microtubules, Microfilaments and Intermediate filaments). Discovery, morphology and structural organization of chromosome- chemical composition and karyotype. Cell Division: Amitosis, Mitosis & meiosis, cell cycle. Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways. Cellular communication: Cell adhesion and roles of different adhesion molecules. Cell Senescence and Programmed Cell Death (PCD).

References:

1. S. C. Rastogi. Cell Biology, Tata Mc Graw Hill Pub. Co. New Delhi, 2017.
2. P. K. Gupta. A Textbook of Cell and Molecular Biology, Rastogi Publications, Meerut, 2012.
3. B. Alberts, D. Bray, J. Lewis, M. Raff and J.D. Watson. Molecular Biology of the Cell, Garland Publishing Inc. New York, 2017.
4. D. Robertis, Cell and Molecular Biology, Waverly International, New York, 2011.
5. H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore, and J. Darnell, Molecular Cell Biology, WH Freeman & Co., New York, 2013.

BIO1131: BIOTECHNOLOGY LABORATORY-I [0 0 4 2]

Laboratory: Introduction to lab and lab environment, Good Laboratory Practices (GLP), Lab Safety: Introduction to safety rules, handling chemicals, and biological materials. Pipetting: Use and calibrate micropipettes, correct techniques, and avoid errors. Serial Dilution: Preparing dilution series, calculations, and applications in microbiology and molecular biology. Basic Procedures: Buffer preparation, Data Handling: Writing lab reports and analyzing experimental data. Identification of different cells (bacteria, fungi, plant, animal), mitosis in onion root tips. Study of electron micrographs of cell organelles- cell ultrastructure, specialized chromosomes, nucleus, Golgi body and endoplasmic reticulum. Study of different stages of mitosis in onion root tips. Study of different stages of meiosis in anthers of Datura innoxia.

CAP1170 FUNDAMENTALS OF COMPUTERS [1 1 0 2]

Computer Fundamentals, Definition and Purpose, Data, Information and Knowledge, Characteristics of Computers, Classification of Computers, Generations of Computer, Basic organization of Computer, System Software and Application Software. Operating Systems and Multimedia, Types of Operating System, Windows v/s Linux, Mobile based OS, Multimedia, Definition and Types , Multimedia Software, Computer Networks, Applications of Networking, Network Topologies- Mesh, Bus, Star, Ring, Types of Network (LAN, MAN, WAN), Network Cables- Optical Fiber, Twisted, Co-axial, Network Devices- Hubs, Switch, Router, Network Interface Card, Ethernet, Internet, Introduction and Usage of Internet, Internet Connectivity Options (Wired and Wireless), IP Addressing and DNS, Website, URL, HTML, Web Browser and Search Engines, Operational Guideline of Computer Usage, Do's and Don'ts of Computer, E-mails, Email Etiquettes, Cyber Security, Internet Frauds, Secure Password Formation , Computer Security, Malware, Virus, Ransomware, Social Media and its Impact.

References:

1. R. Thareja, Fundamental of Computer, (1e) Oxford Publications, 2014.
2. K. Atul, Information Technology, (3e) Tata McGraw Hill Publication, 2008.

CAP1175 FUNDAMENTALS OF COMPUTERS LAB [0 0 2 1]

Computer Peripheral and Windows operations, MS WORD- Creating and formatting of a document, Introduction of cut, copy and paste operations, to explore various page layout and printing options, creating. Formatting, editing Table in MS word, Introduction of Graphics and print options in MS word, Introduce the student with mail merge option. MS EXCEL- creation of spreadsheet and usage of excel, Formatting and editing in worksheet, Sorting, searching in Excel sheets, using formula and filter in MS excel, printing and additional features of worksheet, maintaining multiple worksheet and creating graphics chart. MS POWER POINT – creation of presentation, Power point views, creating slides and other operations, using design, animation, and transition in slides, Internet Tools, Using Email and Outlook facilities, Google Drive, Google Forms, Google Spreadsheet, Google groups.

References:

1. R. Thareja, Fundamental of Computer, (1e) Oxford Publications, 2014.
2. K. Atul, Information Technology, (3e) Tata McGraw Hill Publication, 2008.

CHY1003: ENVIRONMENTAL SCIENCE [3 0 0 3]

Introduction: Multidisciplinary nature, scope and importance, sustainability and sustainable development. Ecosystems: Concept, structure and function, energy flow, food chain, food webs and ecological succession, examples. Natural Resources (Renewable and Non-renewable Resources): Land resources and land use change, Land degradation, soil erosion and desertification, deforestation. Water: Use and over-exploitation, floods, droughts, conflicts. Energy resources: Renewable and non- renewable energy sources, alternate energy sources, growing energy needs, case studies. Biodiversity and Conservation: Levels, biogeographic zones, biodiversity patterns and hot spots, India as a mega-biodiversity nation; Endangered and endemic species, threats, conservation, biodiversity services. Environmental Pollution: Type, causes, effects, and controls of Air, Water, Soil and Noise pollution, nuclear hazards and human health risks, fireworks, solid waste management, case studies. Environmental Policies and Practices: Climate change, global warming, ozone layer depletion, acid rain, environment laws, environmental protection acts, international agreements, nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human Communities and the Environment: Human population growth, human health and welfare, resettlement and rehabilitation, case studies, disaster management, environmental ethics, environmental communication and public awareness, case studies. Field Work and visit.

References:

1. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2016.
2. A. K. De, Environmental Studies, New Age International Publishers, New Delhi, 2007.
3. E. Bharucha, Textbook of Environmental Studies for undergraduate courses, Universities Press, Hyderabad, 2013.
4. R. Carson, Silent Spring, Houghton Mifflin Harcourt, 2002.
5. M. Gadgil & R. Guha, This Fissured Land: An Ecological History of India, University of California Press, 1993.
6. M. J. Groom, K. Meffe Gary and C. R. Carroll, Principles of Conservation Biology, OUP, USA, 2005.

LLC1106: COMMUNICATIVE ENGLISH [2 0 0 2]

Communication- Definition, Process, Types, Flow, Modes, Barriers; Types of Sentences; Modal Auxiliaries; Tenses and its Usage; Voice; Reported Speech; Articles; Subject-Verb Agreement; Spotting Errors; Synonyms and Antonyms; One Word Substitution; Reading Comprehension; Précis Writing; Essay Writing; Formal Letter Writing; Email Etiquettes; Résumé & Curriculum Vitae; Statement of Purpose; Presentations

References:

1. Collins English Usage. Harpers Collins, 2012.
2. Hobson, Archie Ed. The Oxford Dictionary of Difficult Words. Oxford, 2004.
3. Jones, Daniel. English Pronouncing Dictionary. ELBS, 2011.
4. Krishnaswamy, N. Modern English: A Book of Grammar Usage and Composition, Macmillan India, 2015.
5. Longman Dictionary of Contemporary English. Pearson, 2008.

6. McCarthy, M. English Idioms in Use. Cambridge UP, 2002.
7. Mishra, S. and C. Muralikrishna. Communication Skills for Engineers. Pearson, 2004.
8. Oxford Dictionary of English. Oxford UP, 2012.
9. Turton, N. D. and J.B. Heaton. Longman Dictionary of Common Errors. Pearson, 2004.

SECOND SEMESTER

BIO1201: MYCOLOGY AND PLANT PATHOLOGY [2 1 0 3]

Fungi: Occurrence, general characteristics, structure, classification (Alexopoulos and Mims, 1979), recent developments in fungal taxonomy, reproduction, parasexual cycle, heterothallism, mushroom cultivation, economic and ecological importance, Study of life cycle of the following genera: *Albugo, Puccinia.* Plant diseases and their control measures: history, classification, symptoms, defense mechanism, mechanism of host parasite interaction, transmission and dissemination of diseases. Causal organisms of disease cycle of the following: green ear disease of Bajra, rust of Crucifers, rusts and smuts of Wheat. Disease Management: prophylaxis-quarantine measures, biological control and integrated pest management. Association of Algae and Fungi: General characteristics, structure, types, reproduction and ecological importance.

References:

1. H.C. Dube. An Introduction to Fungi, Vikas Publishing House Pvt., Ltd. Delhi, 2013.
2. V. N. Pathak, N.K. Khatri and M. Pathak, Fundamentals of Plant Pathology, Agrobios, Jodhpur, 2012.
3. B. R. Vashishta, A. K. Sinha and A. Kumar. Botany for Degree Students: Fungi. S. Chand & Company Pvt. Ltd, New Delhi, 2016
4. C. J. Alexopoulos, C.W. Mims, and M. Blackwel, Introductory Mycology, John Wiley & Sons Inc, New Delhi, 2012.
5. R.S. Singh, An Introduction to Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2011.

BIO1202: ELEMENTS OF BIOCHEMISTRY [2 1 0 3]

Introduction to Biochemistry: Structure and properties of important biomolecules: Carbohydrates: Classification of carbohydra tes, chemical structure and properties of monosaccharide, disaccharides, oligosaccharides and polysaccharides- Starch, cellulose and glycogen. Lipids: Saturated and unsaturated fatty acids. Protein: Structure and classification of amino acids. Primary, secondary and tertiary structure of protein. Ramachandran Plot. Membrane proteins, Hydropathy plots, Significance of membrane proteins. Vitamins: Structure and functions. Principles of thermodynamics: First and Second law of thermodynamics, concept of free energy. Enzymes: classification, nomenclature, holoenzyme, co-enzyme and cofactors, isozymes and ribozymes. Features of enzyme catalysis, Enzyme kinetics: Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. K_m and V_{max}, K_{cat} and turnover number. Enzyme inhibition, regulation of enzyme activity. Purine and Pyrimidine: structure and properties, nucleotid e biosynthesis, Conformation of nucleic acids [helix (A, B, Z), t-RNA, micro-RNA].

References:

1. H.S**.** Srivastav. Elements of Biochemistry**,** Rastogi Publication, Meerut, 2005.
2. J. L. Jain. Fundamentals of Biochemistry. S. Chand & Co. Pvt. Ltd. New Delhi, 2016.
3. J. Jayaraman. Laboratory Manual in Biochemistry, New Age Publishers, New Delhi, 2011.
4. A. J. Ninfa, D.P. Ballou and M.B. Parsons. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Wiley Inter Science, 2009.
5. D. Voet and J. G. Voet. Biochemistry, John Wiley & Sons Inc., New Delhi, India, 1995.
6. A. Lehninger, D. L. Nelson and M. M. Cox. Principles of Biochemistry, Freeman Publishers, New York, 2017.
7. M. Holtzhauer. Basic Methods for the Biochemical Lab, Springer, USA, 2006
8. S. O. Farrell and L.E. Taylor. Experiments in Biochemistry: A Hands-on Approach, Cengage Learning, USA, 2005.

BIO1203: GYMNOSPERMS AND PALAEOBOTANY [2 1 0 3]

Gymnosperms: Occurrence, distribution, general characteristics, classification (Sporne, 1974; Kremer and Green, 1990), evolution of seed habit, origin and evolution of gymnosperms and economic importance, Life cycle of the following genera: *Cycas, Gnetum*. Comparative study of Pteridophytes, Gymnosperms and Angiosperms. Paleobotany: Geological time scale. Types of fossils, techniques for study of fossils. Applied aspects of fossils: use in coal and petroleum exploration, fossil Pteridophytes and fossil Gymnosperm.

References:

1. S. P. Bhatnagar and A. Moitra. Gymnosperms, New Age International Pvt. Ltd., New Delhi, 2010.
2. Purohit and Vyas. A Textbook of Gymnosperms, Ramesh Book Depot, Jaipur, 1997.
3. Bendre and A. Kumar. A Textbook of Practical Botany-II. Rastogi Publications, Meerut, 2011.
4. K. R. Sporne. The Morphology of Gymnosperms, Hutchinson and Co. Ltd., London, 1994.
5. W.N. Stewart and G.W. Rathwell. Paleobotany and the Evolution of Plants, Cambridge University Press, Cambridge, 1993.
6. C. J. Chamberlain. Gymnosperms: Structure and Evolution, CBS Publishers and Distributors, New Delhi, 2010.

BIO1204: ESSENTIALS OF MICROBIOLOGY [2 1 0 3]

History and development and scope of Microbiology: Contribution of Anton Leeuwenhoek, Joseph Lister, Edward Jenner, Paul Ehrlich, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese, Ronald Ross and Ananda M. Chakraborty, M. S. Swaminathan. Spontaneous generation *vs*. biogenesis, study of various microbiological techniques. Establishment of the field of medical microbiology. Diversity of Microbial world: Introduction to archaea, bacteria and eukaryote. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

References:

1. R.Y. Stainer, M.J. Doudoroff and E.A. Adelberg. The Microbial World. Prentice Hall (India) Pvt. Ltd. 2005.
2. J.W. Brown. Principles of microbial diversity, 1st edition ASM press, 2015.
3. M.J. Pelczar, E.C.S. Chan and N.R. Krieg. Microbiology. 5th edition. McGraw Hill Book Company, 2005.
4. M.T. Madigen, J.M. Martinko, K.S. Bender, D.H. Buckley, D. A. Stahl and T. Brock. Brock Biology of Microorganisms. 14th edition, Benjamin Cunnings-Pearson, 2014.
5. J. Cappucino and Sherman. Microbiology: Laboratory Manual. 9th edition. Pearson Education limited, 2010.
6. R.Y. Stanier, J.L. Ingraham, M.L. Wheelis, and P.R. Painter. General Microbiology. 5th Edition. McMillan Publishers, 2005.
7. J. Willey, L. Sherwood and J Woolverton. Prescott's Microbiology. McGraw Hill Education, USA, 2017.

BIO1230: BOTANY LABORATORY-II [0 0 4 2]

Study of specimens of lichens such as Lecidia, Graphis, Parmelia, Usnea, Cladonia, Ramalina. Observation of disease symptoms in different hosts. Study and microscopic preparation of slides of the following fungi: Albugo and Puccinia. Field visit and study of some locally available plant diseases caused by viruses, mycoplasma, bacteria and fungi. Preparation of posters of following diseases: Green ear disease of Bajra, rust of Crucifers, rusts and smuts of Wheat. Study of specimens and permanent slides of all the above-mentioned course material. Demonstration of mushroom cultivation Identification of the external morphology of Gymnosperms: cones, needles, foliage/scale leaves,megasporophylls/ microsporophylls and female/male cones. Internal structure of Gymnosperms through microscopic double stained slide preparation: Cycas (T.S. of leaf, T.S. of normal and coralloid root, male cone and megasporophyll), Pinus (T.S. of stem, needle, male cone), Gnetum (stem, male and female cone), preparation of charts of geological time scale. Preparation of chart showing the life cycle stages and alternation of generations in Gymnosperms. Documentary on Birbal Sahni Institute of Paleobotany, Lucknow. Study on the evolutionary history of Gymnosperms through fossils: observation of fossil specimens and identifying features that link them to modern Gymnosperms, discussing their evolutionary significance.

BIO1231: BIOTECHNOLOGY LABORATORY-II [0 0 4 2]

Preparation of Buffers: Preparation of buffer solutions at specific pH values: pH 2.0 (acidic), pH 7.0 (neutral), and pH 10.0 (basic). pH meter calibration and adjustment of pH using acids and bases. Biochemical Tests Benedict's Test for Carbohydrates: Identification of reducing sugars by observing color changes after heating with Benedict's reagent. Iodine Test for Starch: Testing for the presence of starch by a colorimetric reaction with iodine solution. Ninhydrin Test for Proteins: Detecting amino acids and proteins through the color reaction with Ninhydrin reagent. Estimation of Protein by Lowry's Method: Quantitative protein estimation using Lowry's method involves a colorimetric assay based on protein-copper complex formation. Methods of sterilization, preparation of culture media, pure culture techniques – streak, spread, pour plate methods. Simple staining and differential staining, culture of bacteria on solid and liquid medium, determination of bacterial growth by turbidimetric method. Isolation of bacteria from soil, water and air. Morphological, cultural and biochemical identification. Staining methods. Antibiotic sensitivity test. Assessment of microbial growth wet weight. Enumeration of microorganisms.

THIRD SEMESTER

BIO2101: FUNDAMENTALS OF BIOINFORMATICS [2 1 0 3]

Introduction to Bioinformatics: Background, scope and application of bioinformatics. Genome organization: Genomes, transcriptome and proteomes, Evolution of genomes, Sequencing projects (Homo sapiens and E. coli), Biological databases: Gene, protein, and structural databases. Sequence alignment and phylogenetic trees: Similarity, identity, and homology ((BLAST). Alignment – local and global alignment, pairwise and multiple sequence alignments (CLUSTALW), alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), Construction of phylogenetic tree, dendrograms. Structural bioinformatics and drug discovery: Protein structure prediction methods, drug discovery and development.

References:

1. T. K. Attwood, and P. Smith. Introduction to Bioinformatics, Pearson Education, New Delhi, 2004.
2. S. C. Rastogi, N. Mendairatta and P. Rastogi. Bioinformatics: Methods and Applications (Genomics, proteomics and drug discovery,) Printice Hall India Pvt. Ltd. New Delhi, 2008.
3. C. Subramanian. A textbook of Bioinformatics. Dominat Publishers. New Delhi. 2015.
4. S. Pennigton and M.J. Dunn. Proteomics: From protein sequences to function, Viva Books Publishers, New Delhi, 2002.
5. D. H. Mount. Bioinformatics, CBS Publishers, New Delhi, 2005.

BIO2102: MOLECULAR BIOLOGY [2 1 0 3]

Nucleic acids transfer genetic information: DNA as the carrier of genetic information, key experiments establishing-the Central Dogma, DNA Double helix, genetic code. The Structures of DNA and RNA: DNA Structure, types of DNA, denaturation and renaturation. DNA topology. The replication of DNA in prokaryotes and eukaryotes, general principles- bidirectional replication, semiconservative, semi discontinuous. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase and other accessory proteins. Mechanism of Transcription and translation: Prokaryotes and eukaryotes. Regulation of gene expression: Lac operon model, catabolite repression.

References:

1. B.D. Singh. Biotechnology. Kalyani Publishers, New Delhi, India. 2015.
2. P. K. Gupta. Textbook of Cell and Molecular Biology, Rastogi Publications, Meerut, 2012.
3. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. *Molecular Biology of the Cell,* Garland Publishing Inc., New York, 2017.
4. G. Karp. Cell and Molecular Biology: Concepts and Experiments, John Wiley & Sons, New Delhi, 2008.
5. H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore and J. Darnell. *Molecular Cell Biology*, WH Freeman & Co. New York, 2013.

BIO2103: PRINCIPLES OF GENETICS [3 1 0 4]

Science of Genetics: Overview of modern history of Genetics. General areas of genetics: Classical, Molecular & Evolutionary. Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory, Incomplete and co-dominance, Multiple alleles, pleiotropy, non-Mendelian inheritance: cytoplasmic inheritance. Linkage, Crossing Over and Chromosomal Mapping, Sex linked, sex limited, and sex influenced characters. Interaction of genes: Intragenic and intergenic interactions, lethal genes, complementary genes, supplementary genes, inhibitory genes, duplicate genes, epistatic genes. Mutations: chromosomal mutations: deletion, duplication, inversion, translocation, aneuploidy and polyploidy, Molecular cytogenetics: Nuclear DNA content, CoT curve and its significance.

References:

1. B.D. Singh. Fundamentals of Genetics. Kalyani Press, New Delhi, 2014.
2. B.N. Pandey. Cytology, Genetics and molecular genetics. Tata McGraw Hill, New Delhi, 2012.
3. M.W. Strickberger. *Genetics*, Prantice Hall, 4th ed., New York, 2006.
4. E. J. Gardener, M. J. Simmons and D. P. Snustand. *Principles of Genetics*, John Wiley & Sons Publications, New Delhi, 2005.

BIO2104: PLANT TISSUE CULTURE TECHNIQUES [2 1 0 3]

Introduction and history of plant tissue culture: Introduction to techniques: laboratory facilities, tools and techniques; laboratory planning and design. Concept of asepsis and methods of sterilization: physical and chemical methods of sterilization. Nutrient Media: components of media, media preparation and its selection, growth hormones, vitamins, adjuvants. Different types of media: Murashige & Skoog, B5, Nitsch and Nitsch, Woody Plant Medium (WPM) Tissue culture methodologies: cellular totipotency, explant, callus culture, soma clonal variation, cell suspension culture, single cell culture, organ micro-culture, plant micropropagation, somatic embryogenesis, synthetic seed technology, protoplast culture. Secondary metabolite production in tissue culture: culture initiation, biotransformation, elicitation, hairy root culture, immobilization, permeabilization, introduction to bioreactor. Green house operation and management: hardening and acclimatization of tissue cultured plants.

References:

1. M.K. Razdan, An introduction of Plant Tissue Culture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. 2005.
2. S.S. Bhojwani, and M.K. Razdan. Plant Tissue Culture theory and practice a Revised Edition, Elsevier Science Publishers, New York, USA, 2011.
3. S.D. Purohit. Introduction to Plant Cell, Tissue and Organ Culture. PHI Learning Pvt. Ltd. New Delhi, 2013.
4. O.L. Gemborg and G.C. Phillips. Plant Cell Tissue and Organ Culture. Narosa Publishing House, New Delhi. 1998.
5. S. Narayanaswamy. Plant Cell and Tissue Culture. Tata Mc Graw Hill Publication, New Delhi. 9th reprint. 2008.

BIO2130: BOTANY LABORATORY-III [0 0 2 1]

Mendelian genetics: Monohybrid and dihybrid crosses, Punnett square exercises, Mendelian inheritance in pea plants or simulated genetic crosses. Study of linkage, recombination, gene mapping using marker-based data from Drosophila. Study of Human and Phlox/ Allium Karyotype (normal and abnormal). Pedigree analysis of some human inherited traits. Study of Hardy-Weinberg Law using simulations (seeds). Preparation of temporary mount and microscopic analysis of mitosis in onion roots via chromosome staining. Isolation and purification of DNA from microbial cells (Bacteria) and plants. Agarose gel electrophoresis of isolated DNA, native and denature electrophoresis of protein using PAGE.

BIO2131: BIOTECHNOLOGY LABORATORY-III [0 0 4 2]

PDB analysis of protein structure by RASMOL, NCBI, EMBL and DDBJ (accession of information's). BLAST and FASTA search. Pairwise and multiple sequence alignments (CLUSTALW and X), program for function, operation overloading program for multiple constructors in a class program for multiple handling program for error handling. Agarose gel electrophoresis, Isolation of genomic DNA. Determination of plasmid in given bacterial strain. Perform Southern Blot Hybridization, Perform Western Blot. Demonstration of DNA amplification by PCR.

BIO2132: PLANT TISSUE CULTURE LAB [0 0 2 1]

Methods of sterilization of explants, preparation of culture media: Stock preparations of macro and micronutrients, hormones, vitamins, different sterilization techniques of glassware and nutrient medium. In vitro germination of seeds, artificial seed production, micropropagation using different explants.

FOURTH SEMESTER

BIO2201: INTRODUCTION TO BIOTECHNIQUES [2 1 0 3]

Microscopy: Light microscope- resolution and visibility, types, applications of microscopes. pH meter: calibration and standardization of pH meter. Colorimeter: Calibration of colorimeter, calibration curve, principle, description and application of colorimeter. Electrophoresis: Principle, types, horizontal, vertical and two-dimensional gel electrophoresis. Spectroscopy: Principle and law of absorption- Beer -Lambert's law, UV-visible spectroscopy. Chromatography: Principle, types- paper, thin layer, adsorption, ion-exchange, affinity, gel filtration, gas, HPLC and ion exchange chromatography. Centrifugation: Principle of sedimentation, types and uses, different types of rotors and autoradiography.

References:

1. K. Ghatak. Techniques and Methods in Biology, PHI Learning Pvt. Ltd., New Delhi, 2011.
2. S. V. S. Rana. Biotechniques: Theory and Practice, Rastogi Publications, Meerut, 2017-18.
3. H. Willard and H. Merrit. Instrumental Methods of Analysis, Prentice Hall India Publications, New Delhi, 2008.
4. D. Skoog. Instrumental Methods of Analysis, International Thomson Computer Press, UK, 2007.
5. A. Hofmann and S. Clokie. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, UK, 2018.

BIO2202: FUNDAMENTALS OF IMMUNOLOGY [2 1 0 3]

Immunology: History, types of immunology (Innate and acquired), active and passive, humoral and cell mediated immunology. Types of Immune Cells: Myeloid and Lymphoid Lineages. Cells of Immunology: B & T cells. Antigen and Immunogens: Characteristic of antigen, adjuvants, haptens. Antibody: Types and structure, antigen and antibody interactions. Interferon: Introduction, immunodeficiency and HIV, prions and diseases. Blood Groups: Blood cell components, ABO blood groups, Rh typing.

References:

1. P. M. Rajasekara and S. B. Kumar. Immunology and Immunotechnology, Panima Publishing Corporation, New Delhi, 2007.
2. J. Kuby. Immunology, Freeman and Company, New York, 2013.
3. A. Nigam and A. Ayyangari. Lab Manual in Biochemistry, Immunology and Biotechnology, McGraw-Hill Education, India, 2008.
4. A. Sharma. Immunology: Concepts and Techniques, Indiana University Press, USA, 2007.
5. T. A. Springer. Hybridoma Technology in the Biosciences and Medicine, Plenum Press, New York, 2004.

BIO2203: RECOMBINANT DNA TECHNOLOGY AND FORENSICS [3 1 0 4]

Basics of Genetic Engineering Technology: Milestones in genetic engineering and biotechnology. Tools of recombinant DNA technology. Restriction Modification Systems: Types I, II and III, mode of action, nomenclature, application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications. Cloning Vectors: Definition, plasmid, cosmids, phage vectors, BAC, YAC and shuttle vectors. Linkers and adaptors. Transformation of DNA by chemical and physical methods. Methods of Gene Delivery in Plants and Animals: Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery. Introduction to GM crops. Amplification of Nucleic Acids: Polymerase chain reaction- enzymes used, primer design. *In vitro* mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. RNAi technology.

References:

1. P.K. Gupta. A Textbook of Cell and Molecular Biology, Rastogi Publications, Meerut, 2012.
2. B.D. Singh. Molecular Biology and Genetic Engineering. Kalyani Publishers, New Delhi, India, 2005.
3. R.W. Old and S.B. Primrose. Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell Science Publications, New Delhi, 2016.
4. B. Lewin. Genes XII, Oxford University Press, Oxford, New York, 2013.

BIO2204: BIOTECHNOLOGY IN AGRICULTURE [2 1 0 3]

Techniques for plant transformation: *Agrobacterium* mediated gene transfer, process of T-DNA transfer, direct gene transfer methods, applications of DNA based molecular markers (RFLP, AFLP, RAPD, ISSR, SSR) in plant biotechnology. Genetic manipulation of plants for herbicide tolerance, insect resistance, stress resistance, disease resistance, improvement of crop yield and quality. Genetically modified crops: Making of Bt-cotton, Falvr-Savr tomato, Golden Rice, Bt-Mustard. Public acceptance of genetically modified crops: Current status of transgenic crops, regulation of GM crops and products, biosafety guidelines, environmental release of GMOs, risk analysis and risk assessment. PGPR: Plant growth promoting rhizobacteria. Applications and scope of Biotechnology in agriculture.

References:

1. S.S. Bhojwani and M. K. Razdan. Plant Tissue Culture: Theory and Practice, Elsevier Science Publishers, New York, USA, 2011.
2. S. Narayanswamy. Plant Cell and Tissue Culture, Tata McGraw Hill, New Delhi, 2011.
3. S. Ignacimuthu. Plant Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2001.
4. H.A. Collins and S. Edwards. Plant Cell Culture, Bios Scientific Publishers, Oxford, U.K., 1998.

BIO2206: PLANT MORPHOLOGY [2 1 0 3]

Diversity of plants. Evolution of tree habit in monocotyledons and dicotyledons. Characteristics of monocotyledons and dicotyledons. Root, Stem and Leaf: structure and function. Anatomy: Simple and complex permanent tissues, Meristem: Characteristics, types, theories of organization: Histogen theory, tunica-corpus theory, Korper & Kappe theory. Secondary Growth: Cambium, periderm, secretory tissues, laticifer ducts and lenticels, anomalous secondary growth in dicots and monocots. Vascular tissue differentiation, transition of apical shoot apex into reproductive shoot apex

References:

1. V. Singh, P.C. Pande, D. K. Jain. A Textbook of Angiosperms, Rastogi Publications, Merrut, 2008.
2. B.P. Pandey. Plant Anatomy, S, Chand & Co., New Delhi, 2012.
3. R. C. Grewal. Plant Anatomy, Campus Books International, New Delhi, 2009.
4. J. Eames. An Introduction to Plant Anatomy, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1997.
5. K. Esau. Anatomy of Seed Plants, John Wiley &Sons, New York, 2011.

BIO2230: BOTANY LABORATORY-IV [0 0 4 2]

Working principles of various available laboratory instruments: Laminar air flow cabinet, centrifuge, spectrophotometer, oven, incubator, BOD incubator, autoclave. Study of UV absorption spectra of macromolecules (carbohydrates, protein, and nucleic acid). Determination of lambda max of a dye solution. Determination of carbohydrate, protein and nucleic acid concentration by spectrophotometric method. Separation and identification of amino acids using TLC. Field visit for the study of morphological diversity in leaf shape, size and other foliar features of dicotyledons and monocotyledons. Microscopic slide preparation of primary and secondary growth in monocots and dicots roots & stems. Double stained preparation of the anomalous secondary growth in plant samples. Study of internal structure of dicot and monocot leaves. Study of structure and development of stomata. Study of adaptations/modifications in plants by specimens and slide preparation of the following genera: Hydrophytes-Hydrilla; Xerophytes- Casuarina, Nerium, seeds and pollen viability test.

BIO2231: BIOTECHNOLOGY LABORATORY-IV [0 0 4 2]

Identification of human blood groups. Total leukocytes count of the given blood sample. Differential leukocytes count of the given blood sample. Separation of serum from the blood sample from rat (demonstration). Double diffusion by Ouchterlony method. Immunoassays; Performing DOT ELISA. Blood film preparation and identification of cells. Preparation of antigens. Separation of lymphocytes from peripheral blood sample from rat. Radial immuno diffusion (RID), Immuno-electrophoresis. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis. Ligation of DNA fragments. Competent cell preparations. Transformation of competent cells. Selection of transformed cells. Expression analysis of recombinant using Southern blotting, SDS page/western blotting.

FIFTH SEMESTER

BIO3101: ETHNOBOTANY [2 1 0 3]

Ethnobotany and Agriculture: History, industrialization, sustainable crop domestication, evolution, and conservation of genet ic diversity. Biodiversity hot spots and mega biodiversity centers of world. General account: Vegetables (radish, potato, tomato, onion, garlic, cabbage, cauliflower, ladyfinger and cucumber), fruits (apple, mango, banana, papaya, watermelon and orange), cereals & millets (wheat, maize, rice, sorghum, and bajra), spices (cumin, capsicum, coriander), beverages (tea and coffee), vegetable oils (groundnut, soybean, mustard), Fibers (cotton, jute and coconut), wood (teak, sagwan, bamboo) and Medicinal plants (turmeric, ferula, rauwolfia, papaver, safed musli, ocimum and withania).

References:

1. K. L. Chadha. Handbook of Horticulture, ICAR Publication, New Delhi, 2008.
2. P.D. Sharma. Ecology and Environment, Rastogi Publication, New Delhi, 2012.
3. S.L. Kocchar. Economic Botany in Tropics, McMillan India Ltd., 2nd Edition, New Delhi, 2010.
4. H. T. Hartman and D. E. Kester. Plant propagation principles and practices, Prenice Hall of India, New Delhi, 1989.
5. E. P. Odum, Fundamentals of Ecology, Saunders, Philadelphia, New York, 1996.
6. J. L. Chapman and M.J. Reiss. Ecology: Principles and Applications, Cambridge University Press, Cambridge, U.K. 2006.

BIO3102: FUNDAMENTALS OF CELL CULTURE [2 1 0 3]

Animal cell cultures: Primary and secondary cell lines cell culture environment, safety measures laminar hood, maintenance and preservation of cell cultures freezing media, suspension cultures, confluent culture and the necessity of sub-culture, advantages of Animal Cell Culture, disadvantages of animal cell culture, advantages of primary cell culture, characteristics of cultured animal cells. General cytotoxicity assessment of xenobiotics using cell lines: Neutral red uptake assay, MTT assay, traditional cell lines used for target organ toxicity testing, sphere formation assay, developing animal models from cell culture, applications of animal cell culture.

References:

1. S.C. Bhatia, Textbook of Biotechnology. Atlantic Publisher and Distributor, New Delhi.2008
2. Chakravarty. A.K. Introduction to Biotechnology. OUP India. 2013.
3. M.J. Pelczar, E.C.S. Chan, Krieg N.R. Microbiology. 5th Edition, Tata McGraw-Hill. 2011.
4. J. William, M. Thieman, Palladino, A. Introduction to Biotechnology. Benjamin Cummings. USA. 2013.

BIO3103: INDUSTRIAL BIOTECHNOLOGY [2 1 0 3]

Principles of fermentation technology: Screening and isolation of microorganisms, maintenance of strains, strain improvement. Fermentation media: Natural and synthetic media, sterilization techniques. Construction of a Fermenter, Factors affecting Fermentation process. Types of fermenters: Solid state, submerged, continuous fermentation, immobilized enzyme and cell bioreactors. Enzyme immobilization: Adsorption, Cross linking, Encapsulation, Entrapment, Covalent Binding. Process of aeration, agitation, temperature regulation and foam control. Production of microbial products: Brief account of the following products obtained by industrial microbiological fermentation, alcoholic beverage-beer, amino acids-glutamic acid, enzyme-amylase and single cell protein (SCP). Biotechnology in specific medical & industrial applications: Retting of jute, microbial process for immunization (Production of monoclonal antibodies).

References:

1. J. Casida. Industrial Microbiology, New Age International Pvt. Ltd. New Delhi, 2006.
2. S.C Prescott and C.G. Dunn. Industrial Microbiology, Agrobios (India) Pvt. Ltd. New Delhi, 2004.
3. M. Murrey, Comprehensive Biotechnology, Pergamon, USA, 2007.
4. W. Cruger and A. Crueger. Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, New Delhi, 2008.

BIO3130: BOTANY LABORATORY–V [0 0 2 1]

Study of the tribal distribution/ tribal communities/villages for the collection of plant samples/ ethnobotanical knowledge. Questionnaire Development for Ethnobotanical Research. Documentation of ethnobotanical knowledge. Preparation of herbarium sheets and inventory of locally available medicinal plants. Study of the models of the types of ovules. Survey of nurseries. Study of the technique of vegetative propagation-cutting, budding, grafting and air layering. Study about the threat categories for plants and survey of medicinal plants in natural habitats for biodiversity and threat assessment. Preparation of medicinal plants: basic extraction and fractionation procedures.

BIO3131: BIOTECHNOLOGY LABORATORY-V [0 0 4 2]

Introduction to animal cell culture laboratory, Preparation of animal cell culture media, Culture of the Fibroblast cell lines, Cell passage by using trypsin, Counting of animal cells using trypan blue, Cell Viability assay, Isolation of DNA and RNA of cultured cells, Cell Culture Karyotyping assay, DNA Staining of Cultured Cells using DAPI (4',6-diamidino-2-phenylindole) and Propidium Iodide (PI). Determination of the Cultured cells Growth Curve Media preparation, sterilization and monitor quality control. Isolation of microorganisms and characterization. Monitoring bacterial growth via UV-Vis Spectrophotometer. Determination of bacterial growth curve. Hand on training on Fermenters. Production of microbial products through fermentation. Single cell protein production. Enzyme or cell Immobilization using sodium alginate. Microbial biopolymers and bio-surfactants production.

SIXTH SEMESTER

BIO3201: PHYSIOLOGY OF LIVING SYSTEMS: [2 1 0 3]

Plant Physiology: Plant cell-water relations, water and mineral absorption. Transpiration, guttation, mineral nutrition- essential micro and macro nutrients, deficiency of minerals, nitrogen metabolism. Photosynthesis: Photosystems, photophosphorylation, Calvin cycle, C_4 pathway, CAM, photorespiration. Respiration: RQ, ATP- the biological energy currency, glycolysis, Kreb's cycle, Electron transport mechanism, oxidative phosphorylation, pentose phosphate pathway. Animal Physiology: Blood and Circulation: Blood corpuscles, Hemopoiesis and formed elements, Plasma function, Hemostasis. Cardiovascular System: Comparative anatomy of heart structure, Myogenic heart, Specialized tissue, Cardiac cycle, Blood pressure. Respiratory System: Transport and exchange of gases. Nervous System: Central and peripheral nervous system, Neural control of muscle tone and posture.

References:

1. L. Taiz, E. Zeiger, I.M. Møller, A. Murphy. Plant physiology and development. Sunderland, MA: Sinauer Associates. 2015.
2. S. Shabala, Plant stress physiology. Cabi, 2017.
3. C.D. Moyes, P.M. Schulte. Animal Physiology. San Francisco, CA: Benjamin Cummings; 2005.
4. F.P. Gardner, R.B. Pearce, R.L. Mitchell. Physiology of crop plants. Scientific Publishers; 2017.
5. K. Patton, and T. Anatomy, Physiology-E-Book. Elsevier Health Sciences, 2015.

BIO3202: MEDICAL BIOTECHNOLOGY [2 1 0 3]

Biotechnology and medicine: Background and timeline, pharmaceuticals and biopharmaceuticals, vaccines and monoclonal antibodies, biopharmaceuticals/therapeutic proteins, common techniques used in medical biotechnology, role of PCR in medical biotechnology, fluorescence In Situ hybridization, DNA sequencing, interference RNA, genome editing, emerging Trends in medical biotechnology, Stem cells, cancer stem cells, products of medical biotechnology, stem cell therapy, commercial potential for stem cell therapies, genetic modification in medicine - gene therapy, drug discovery and development; drug efficacy and toxicology, biomarker based drug discovery, various approaches, different type of cancer and other related diseases , understanding metastasis, role of animal models in medical biotechnology, DNA targeting drugs, cancer growth blockers, epigenetics, DNA damage and repair genes, ethical issues related with medical biotechnology. CRISPR technology.

References:

1. P.K. Gupta. A Textbook of Cell and Molecular Biology, Rastogi Publications, Meerut, 2012.
2. B.D. Singh. Molecular Biology and Genetic Engineering. Kalyani Publishers, New Delhi, India. 2005
3. H. Lodish and D. Baltimore. Molecular Cell Biology, WH Freeman and company, USA, 2012.
4. B. Alberts, A. Jahusan, J. Levis, M. Raff, K Roberts and P Walter. Molecular Biology of Cell, Garland Science, USA, 2002.

BIO3203: APPLIED PLANT BIOLOGY [2 1 0 3]

Horticulture: Fundamentals, techniques of plant propagation, a brief account of pomology, olericulture, floriculture and ornamental horticulture, viticulture, applications of plant tissue culture in horticulture. Development of garden and nursery : Fundamentals of landscape design, principles and styles of landscape design, propagation and conservation of plants. Management of gardens. Industrial Botany: Organic farming, biofuels and biodiesel, applications of plants in cosmetic industry, aroma therapy, pharmaceutical industry, phytoremediation. Center of origin of crop plants (wheat, rice and maize).

References:

1. K. L. Chadha. Handbook of Horticulture, ICAR Publication, New Delhi, 2008.
2. P. D. Sharma. Ecology and Environment, Rastogi Publication, New Delhi, 2012.
3. S.L. Kocchar. Economic Botany in Tropics, McMillan India Ltd., 2nd Edition, New Delhi, 2010.
4. H. T. Hartman and D. E. Kester. Plant propagation principles and practices, Prenice Hall of India, New Delhi, 1989.
5. E.P. Odum. Fundamentals of Ecology, Saunders, Philadelphia, New York, 1996.
6. J.L. Chapman and M.J. Reiss. Ecology: Principles and Applications, Cambridge University Press, Cambridge, U.K. 2006.

BIO3230: BOTANY LABORATORY–VI [0 0 4 2]

Study of flora, monographs, icons, manuals and indexes. Preparation of herbarium sheets. Principles of plant propagation: Stem Cuttings, Leaf Cuttings, Root Cuttings, Layering, Grafting, Budding, Plant Tissue culture, - micropropagation, Seed propagation; Hydroponics and Aeroponics, Seeds and pollen viability test. Survey of nurseries. Understand the fundamentals of gardening an d nursery management, Study of landscape designing. Soil Testing – Soil pH, Water holding capacity, fertility of soil preparation of soil for gardens, Measuring Pulse Rate and Effects of Exercise: Stopwatch, exercise equipment, pulse monitor. Reaction Time Experiment: ruler-drop test. Blood Pressure and Stress Levels: Blood pressure monitor, stress-inducing tasks. Observing the Effect of Light on Human Pupils. Heart Rate and Breathing Rate During Various Activities. The Stroop Effect Experience: Cognitive Processing and Interference. Observe and count stomata on the surface of leaves using staining techniques.

BIO3231: BIOTECHNOLOGY LABORATORY–VI [0 0 2 1]

Identification Chemical Mutation in DNA by Ames Test, Effect of pH on protein denaturation using UV visible spectroscopy, Isolation of DNA from biological samples, Quantification of DNA by spectrophotometry, Agarose gel electrophoresis of genomic DNA & plasmid DNA. CRISPR cascade mediated gene silencing in bacteria, measurement of the susceptibility of bacteria to antibiotics by antibiotic sensitivity test, Isolation and separation of protein by SDS-PAGE, Acid Fast staining of the bacterial sample, Separation of Amino acids by paper chromatography. Separation of plasma and serum from blood. Estimation of Total Plate Count in any food sample. Detection of E. coil in food material. MBRT test on milk samples. Acetic acid/Vinegar Production and estimation of the product. Effect of internal factors on microbial growth in food i.e. pH, Temperature, Water Activity. Methods of food preservation.

References:

1. S.F. Gilbert. Developmental Biology. Sinauer Associates Inc, USA. 2006.
2. L. Wolpert, C. Tickle and AM Arias. Principles of Development. Oxford University Press, USA. 2015.

DISCIPLINE SPECIFIC ELECTIVES (DSE)

DSE – I

BIO2240: ETHICAL ISSUES AND IPR IN BIOTECHNOLOGY [2 1 0 3]

Intellectual property rights: Classification and importance of IPRs in the fields of science and technology. Patents and copyright: Concepts and principles of patenting and copyrights, patentable subject matter. Procedure of obtaining patents: Rights of patents, infringement of patent rights, remedies for infringement of patent rights: process validation, regulation of biotechnology. Gene patents and Ethical issues, plant breeder's rights, criticism of intellectual property, plagiarism. Ethical issues: Society and public perception towards biotechnology. Release of genetically modified organisms. International and Indian Scenario. Designing of manufacturing area: GMP, FAO requirements. Biosafety: Good lab practices, biosafety for human health and environment, biological warfare.

References:

1. D.O. Fleming, and D.L. Hunt. Biological Safety: Principles and Practices, American Society for Microbiology, USA, 2006.
2. T.A. Shannon. An Introduction to Bioethics, Paulist Press, USA, 2009.
3. H.B. Rockman. Intellectual Property Law for Engineers and Scientists. Wiley-IEEE Press, USA, 2004.
4. L. Vaughn. Bioethics: Principles, Issues, and Cases, Oxford University Press, UK, 2009.
5. WHO. Laboratory Biosafety Manual, World Health Organization, 2005.

BIO2241: CELL BASED ASSAYS [2 1 0 3]

Understanding principals of an assay: Cell proliferation assay and cell cycle assay, Cell viability assay, Cytotoxicity assay, Reporter gene, Luciferase reporter assay. Apoptosis: Introduction to apoptosis mechanisms, Apoptosis marker and detection method, Autophagy, Introduction to autophagy mechanisms, Autophagy marker and detection method. Introduction to Reactive Oxygen Species: Measurement of ROS in Cells, Cell and organelle Labelling, cell culture, Specialized cell culture, Stem cell culture, Sphere formation assay, Microscopy: Phase contrast microscopy, Endocytosis, TMR-dextran labelling, Lysosome labelling, Mitochondrial labelling, Nucleus labelling, confocal microscopy, Cell metabolism, ATP measurement in cell, Glycolysis, TCA cycle. Telomere detection: FISH, Chromatin immunoprecipitation (ChIP), Flow cytometry: Method and principal, Cell analysis and quantitation by FACS, Role of cell-based assay in cancer research.

References:

1. P.K. Gupta. A Textbook of Cell and Molecular Biology, Rastogi Publications, Meerut, 2012.
2. B.D. Singh. Molecular Biology and Genetic Engineering. Kalyani Publishers, New Delhi, India. 2005
3. H. Lodish and D. Baltimore. Molecular Cell Biology, WH Freeman and company, USA, 2012.
4. B. Alberts, A. Jahusan, J. Levis, M. Raff, K Roberts and P Walter. Molecular Biology of Cell, Garland Science, USA, 2002.

DSE – III (A)

BIO3140: ENTREPRENEURSHIP DEVELOPMENT [2 1 0 3]

Entrepreneurship: Starting, Managing, and Leading Biotech. Companies, entrepreneurship practices and strategies: biological entrepreneurship and general characteristics, Difference between general and biological entrepreneurship, driving forces for decision, strategies to prevent failure, characteristics of successful biotechnology leaders. Marketing: labeling requirements, Biotechnology clusters, Building, managing and motivating teams, potential investors, term sheet, contract and balance sheet, biotechnology product sector, biotechnology business models and managing risk.

References:

1. C. Shimasaki. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Elsevier Inc. USA, 2014.
2. M. Lall and Shikha Sahai. Entrepreneurship, Excel Books, New Delhi, 2008.
3. D. Hine and J. Kapeleris. Innovation and Entrepreneurship in Biotechnology, an International Perspective: Concepts, Theories and Cases. Edward Elgar Publishing Limited, England 2006.
4. T. K. Ghose and P. Ghosh. Biotechnology in India, Springer-Verlag, USA, 2003.

BIO3141: ORGANIC FARMING [2 1 0 3]

Organic Farming: Historical development of Organic Farming in India, definition and scope, detrimental effects of chemical dependent farming and pesticide contamination. Types of Farming: Pure Organic Farming, Integrated Farming system, Concept of different cropping systems in relation to Organic Farming. Developing organic farms: Important steps. Sources of nutrients for Organic Agriculture: Organic Manure – FYM/Rural compost, City compost, Oil cakes, Animal wastes, Vermi composts; Bio-fertilizers: recycling of organic matter in organic agriculture, preparation of compost, preparation of vermin compost, quali ty improvement of finished vermin compost; Status of organic farming and Government policies in India.

References:

1. J.M. Fortier, M. Bilodeau. The Market Gardener: A Successful Grower's Handbook for Small-scale Organic Farming. New Society Publishers, Gabriola Island, Canada, 2014.
2. B. Rateaver. Organic method primer update: A practical explanation: the how and why for the beginner and the experience (Conservation gardening and farming). The Rateavers; Special Edition. Western Australia, 1993.

DSE – III (B)

BIO3142: BIOPHYSICS [2 1 0 3]

Introduction: General Biophysical methods and scope; Radiobiology: Radioactive labeling & counting, Nuclear Biology; Structural Biophysics: Biomolecular structure analysis; CD spectroscopy, X-ray crystallography, Cryo-Electron Microscopy; Optical tweezers; Membrane Biophysics: membrane transport, action potential, ion channels Bioenergetics: Glycolysis, TCA cycle; Oxidative phosphorylation; Coupled and group transfer reactions; Bio-molecular Interaction: Surface Plasma Resonance (SPR) and fluorescence methods to study biological systems

References:

1. V. Pattabhi and N. Gautham. Biophysics, Narosa Publishing house, New Delhi 2002.
2. P. Narayanan. Essential of Biophysics, New Age International Publishers, New Delhi, 2000.
3. R. Cotterill. Biophysics: An Introduction, John Wiley and Sons, England, 2002.
4. W. S. Bialek. Biophysics: Searching for Principles, Princeton University Press, USA, 2012

BIO3143: PROBIOTICS [2 1 0 3]

Introduction and history of Probiotics, Probiotic microorganisms, Safety of probiotic microorganisms, Segal status of probiot ics. Characteristics of Probiotics for Selection: Tolerance to additives, Stability during storage, Stability during passage to intestinal sites, Minimum effective dose, Maintenance of probiotic microorganisms. Role of Probiotics in Health and Disease: Prevention and treatment of gastrointestinal bacterial infection, Treatment and prevention of constipations, Treatment of hepatic encephalopathy, Chronic urinary tract infection, Antitumor and antihypertensive, Cholesterol level. Mechanism of Probiotics:

Complete exclusion, Production of antimicrobial substances, Modulation of immune system, Alteration of intestinal bacterial metabolite action, Alteration of microecology of healthy humans and patients. Probiotics in various foods: fermented milk products, non-milk products etc. Quality Assurance of probiotics and safety. Prebiotics: Concept, definition, criteria, types and sources of prebiotics, Prebiotics and gut microflora. Prebiotics and Health Benefits: Mineral absorption, Immune response, Cancer prevention, IBD, Elderly health and infant health, Prebiotics in foods.

References:

1. Y. K. Lee, Salminen S. Handbook of Probiotics and Prebiotics. A John Willey and Sons Inc. Publication. 2009.
2. T. M. Sandholm, Saarela, M. Functional Dairy Products. CRC Woodhead Publishing Ltd. 2003.
3. S. Salminen, Wright, A. V. Lactic Acid Bacteria, Marcel Dekker, 1998.
4. R. G. Glenn, R. Marcel Handbook of Prebiotics. CRC press, 2008.

DSE – IV (A)

BIO3240: PLANT BREEDING [2 1 0 3]

History, introduction and scope of plant breeding: Centers of origin of cultivated and food plants, germplasm conservation, p lant introduction, Methods of plant breeding in self- and cross-pollinated crops: selection, pedigree analysis, acclimatization, hybridization, heterosis and inbreeding depression. The Hardy-Weinberg Law and its applications in plant breeding. Brief account of mass selection: Pure line and clonal selection, mutation and polyploidy breeding. Molecular marker systems: identification, utilization and integration in plant breeding programs. Renowned Indian and international plant breeders. Contributions of national and international institutes of plant breeding and centers for plant breeding. Green revolution. Horticulture, organ ic farming, biofuels and phytoremediation.

References:

1. B. D. Singh. Plant Breeding, Kalyani Publishers, New Delhi, 2011.
2. P. K. Gupta. Genetics and Plant Breeding, Rastogi Publications, Meerut, 2011.
3. R.A. Allard. Principles of Plant Breeding, John Wiley & Sons, New York, 1999.
4. G. Acquaah. Principles of Plant Genetics and Breeding, Wiley Blackwell, New York, 2012.

BIO3241: SYSTEM BIOLOGY [2 1 0 3]

Animal Development: Overview of how the modern era of developmental biology emerged through multidisciplinary approaches, stages of development- zygote, blastula, gastrula, neurula, cell fate & commitment – potency- concept of embryonic stem cells, terminal differentiation lineages of three germ layers, fate map, Differentiation: cytoplasmic determinants, embryonic induction, Model organisms in Developmental biology, medical implications of developmental biology. Plant Development: Structure of anther, microsporogenesis, pollination and its types. Megasporogenesis, ovule development, types of ovules, embryo sac, double fertilization, endosperm. Embryogenesis: embryo development, polyembryony, Seed structure: monocotyledons and dicotyledons.

References:

1. S.S. Bhojwani, S.P. Bhatnagar, P.K. Dantu. The Embryology of Angiosperms. Vikas Publishing House, New Delhi. 2000
2. S. Maheshwari. An Introduction to Embryology of Angiosperms, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2012.

DSE – IV (B)

BIO3242: FOOD BIOTECHNOLOGY [2 1 0 3]

Historical background, Composition of food, improvement of food resources through Biotechnology (e.g. Golden Rice, Potato). Traditional fermented foods (meat, fish, bread, sauerkraut, soybean, coffee, cocoa, tea). Food Fermented products: Fermented milk, cheese, butter, yoghurt, Alcoholic beverages (beer, wine, whisky), sauerkraut, pickles, soy products, tea, coffee. SCPs (e.g. *Spirulina, Yeast*) as food supplements. Edible fungus: Mushrooms, potential of probiotics. Flavor enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products. Importance of vitamins and their supplementation in foods and feedstock. Food preservation and storage. Food Processing. Growth of microorganisms in food: Intrinsic and extrinsic factors. Food spoilage (microbial and non-microbial). Control mechanisms of food spoilage: Physical and Chemical.

References:

1. V. Dhawan. Biotechnology for Food and Nutritional Security. The Energy and Resources Institute, New Delhi, 2004.
2. R. Singh. Food Biotechnology. Global Vision Publishing House, New Delhi, 2005.
3. B.H. Lee. Fundamentals of Food Biotechnology, Wiley-Blackwell, Canada, 2014.
4. G.F.G. Lopez, G. Canaas, E.V. Nathan. Food Sciences and Food biotechnology. Boca Raton, CRC Press, 2003.
5. M. Ruse, D. Castle. Genetically Modified Foods. Prometheus Books, USA, 2002.
6. T. Hohn and K.M. Leisinger. Biotechnology of Food Crops in Developing Countries. Plant Gene Research, Springer-Verlag Wien, Netherland, 1999.

BIO3243: EXPRESSION PURIFICATION OF THERAPEUTIC PROTEINS [2 1 0 3]

Purification and characterization of proteins and peptides: Native or heterologously expressed proteins from a complex mixture (involving the following methods/techniques. Exercises: Preparation of the sample. Ion-exchange chromatography. Gel filtration chromatography. Affinity chromatography. Electrophoresis. Principle ad instrumentation of High-Performance Liquid Chromatography (HPLC): Demonstration of various protein and peptide purification columns, scaling up strategy. Principle and

instrumentation of UV-visible spectroscopy: Determination of concentration of a protein solution by Lowry/BCA method. Downstream processes: Dialysis; salting in and salting out of proteins; analysis of oligomeric behavior, activity.

References:

1. H.S. Srivastav. Elements of Biochemistry, Rastogi Publication, Meerut, 2005.
2. J.L. Jain. Fundamentals of Biochemistry. S. Chand& Co. Pvt. Ltd. New Delhi, 2016.
3. J. Jayaraman. Laboratory Manual in Biochemistry, New Age Publishers, New Delhi, 2011
4. A.J. Ninfa, D.P. Ballou, M.B. Parsons. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Wiley Inter Science, 2009.
5. S.N. Gupta. Concepts of Biochemistry. Rastogi Publications, Meerut, 2016.
6. D. Voet, J. G. Voet. Biochemistry, John Wiley & Sons Inc., New Delhi, India, 1995.
7. D. Lehninger, L. Nelson and M. M. Cox. Principles of Biochemistry, Freeman Publishers, New York, 2017.
8. M. Holtzhauer. Basic Methods for the Biochemical Lab, Springer, USA, 2006.
9. S.O. Farrell, L.E. Taylor. Experiments in Biochemistry: A Hands-on Approach, Cengage Learning, USA, 2005.

BIO3247: SANITATION AND SLUDGE MANAGEMENT [2 1 0 3]

Definition, Global situation, Onsite and Offsite sanitation, Sanitation value chain, Characterization of faecal sludge, Pathogens in faecal sludge. Physical, chemical and biological treatment mechanisms, Collection and Transport practices; Treatment technologies: Co-composting, Co-treatment, Anaerobic digestion, Vermicomposting, Black soldier flies, Unplanted and planted drying beds, End use of treatment products: Use as soil conditioner and resource recovery.

References:

1. Strande, L., & Brdjanovic, D. (Eds.). *Faecal sludge management: Systems approach for implementation and operation*. IWA publishing, 2014
2. Velkushanova, K., Brdjanovic, D., Koottatep, T., Strande, L., Buckley, C., & Ronteltap, M. *Methods for faecal sludge analysis*. IWA Publishing, 2021

GENERIC ELECTIVES (GE)

GE – I & LAB

CHY1160: GENERAL CHEMISTRY-I [2 1 0 3]

Introduction to stereochemistry; Conformational analysis of open chain systems; Conformational analysis of cyclic systems; Symmetry elements, Point group analysis; Stereochemical conventions; Stereogenicity, Topicity; Stereochemical reactions; Reactions involving stereo centres; Aromaticity, Aromatic stabilization energy, Hückel MO, Polycyclic aromatic hydrocarbon (PAH), Polyacenes, Annulene; Aromatic Electrophilic substitutions; Aromatic Nucleophilic substitutions; Reaction dynamics, Hammond postulate; Linear free energy relationship, Hammett equation; Carbocation: Generation, Structure and Geometry, Stabilization of carbocation, Reactions of Carbocation; Carbanions: pKa and its significance; Hard and Soft Acid and Base principle; Structure, Formation, Stability, Reactivity; Free radical: Formation, Structure, Stability, Reactivity; Carbene, Nitrene: Generation, Structure, Reactivity.

References:

1. G. W. Solomon and B. F. Craig, Organic Chemistry, John Wiley & Sons, Inc., 2010.
2. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson India, 2003.

CHY1138: ORGANIC CHEMISTRY LABORATORY [0 0 2 1]

Basics: Distillation, crystallization, decolorization and crystallization using charcoal, sublimation. Qualitative Analysis: Identification, functional group analysis, melting point, preparation of derivatives.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

GE – II (A) & LAB

CHY1260: GENERAL CHEMISTRY-II [2 1 0 3]

Basics in Inorganic Chemistry; Purification of elements; Coordination chemistry; 18 electron rule; Valence bond theory; Crystal field theory; Term symbols; Spectroscopy of complexes; Jahn-Teller distortion; Spinels; Magnetism; Bio-inorganic chemistry, Enzymes; Hemoglobin and Myoglobin; Toxicity; Medicinal inorganic compounds

References:

1. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
2. J. E. Huheey, E. A. Keiter & R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India, 2008.

CHY1238: INORGANIC CHEMISTRY LABORATORY [0 0 2 1]

Inorganic: Qualitative analysis of inorganic salts, volumetric analysis of inorganic mixtures, synthesis of transition metal complexes.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

GE – II (B) & LAB

CHY1261: GENERAL CHEMISTRY-III [2 1 0 3]

Thermodynamics everywhere; historical development of thermodynamics; Zeroth Law of Thermodynamics and concept of temperature; Discussion on internal energy heat and work; First Law of Thermodynamics; State function and path function; calculation of p-V work; Heat capacities; Joule & Joule-Thomson expansion; Some practice problems; thermochemistry; Second Law of thermodynamics (various statements and their equivalence); Carnot cycle; definition of entropy; Heat engines and their efficiencies; practice problems on the classical second law; Statistical Formulation of the Second Law (probability overview; Boltzmann formula, distribution of energy); Statistical formulation of the Second Law continued (the most probable distributi on, Boltzmann distribution); Calculation of entropy for various processes using Boltzmann entropy formula; Fundamental equation and entropy postulates; introduction to free energies; Maxwell Relations and conversion of thermodynamic derivatives; Applications of free energy

References:

1. A. Bahl, S. S. Bahl, G. D. Tuli, Essentials of Physical Chemistry, S. Chand, 2016.
2. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2010.

CHY1239: PHYSICAL CHEMISTRY LABORATORY [0 0 2 1]

Physical: Determination of rate constants, conductometric titrations, thermochemistry, phase diagrams.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

GE – III (A) & LAB

CHY2160: ANALYTICAL CHEMISTRY [2 1 0 3]

Basic Concepts: Introduction to analytical chemistry. Measurement Basics: Introduction, electrical components and circuits, operational amplifiers in chemical instrumentation. Atomic spectroscopy: Introduction to spectrometric methods, components of optical instruments, atomic absorption and atomic fluorescence spectrometry, atomic emission spectrometry, atomic mass spectrometry, atomic X-ray spectrometry. Molecular Spectroscopy: UV-Vis, IR, NMR, mass, Raman, fluorescence spectroscopy, instrumentations and applications. Electroanalytical Chemistry: Introduction to electroanalytical chemistry, potentiometry, coulometry, voltammetry, instrumentation and application. Separation Methods: An introduction to chromatographic separations, gas chromatography, high-performance liquid chromatography, capillary electrophoresis and capillary electrochromatography, components of instruments and applications. Miscellaneous Methods: Thermal methods for analytical chemistry, instrumentation and applications.

References:

1. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, Saunders College Publishing, 2013.
2. H. H. Willard, L. L. Merritt Jr., J. A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishing Company, 2012.
3. G.D. Christian, Analytical Chemistry, John Wiley, 2004.
4. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical chemistry, Brooks/Cole, 2004.

CHY2138: ANALYTICAL CHEMISTRY LABORATORY [0 0 2 1]

Analytical: TLC, paper chromatography, determination of Rf values, separation techniques.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

GE – III (B) & LAB

MAS2146: FUNDAMENTALS OF BIOSTATISTICS [2 1 0 3]

Introduction: Definition, scope, functions, limitations, uses, types of data, types of variables, classification, tabulation, graphical representation of biological data; Measures of Central Tendency: Mean, mode, median; Measures of Dispersion: Range, standard deviation, mean deviation, co-efficient of variation, their applications, merits and demerits; Probability: Definitions of probability , additive rule, multiplicative rule, conditional probability, Bayes theorem; Random Variable and Probability Distribution: Definition, types of random variable, functions of probability distribution of random variables, expected value and variance of random variables, Binomial distribution, Poisson distribution, Normal Distribution; Correlation and Regression: Introduction, Karl Pearson's, Spearman's coefficient of correlation, regression equations, regression lines, regression coefficients, similarities and dissimilarities of correlation and regression; Testing of Hypothesis: Large sample tests, student 't'-test, chi square test, run test, sign test and median test.

References:

1. A.K. Sharma. Textbook of Biostatistics I. Discovery Publishing House, New Delhi, 2005.
2. B.K. Mahajan. Methods in Biostatistics. Jaypee Brothers Publishers, New Delhi. 2002.
3. B. L. Agarwal. Basic Statistics. New Age International, New Delhi, 2006.
4. M. Pandey. Biostatistics: Basic and Advanced, MV learning, 2015.
5. A.K. Irfan. A. Khanum, S. Khan. Fundamentals of Biostatistics, 5th Edition, 2018.
6. G. K. Kanji, 100 Statistical Tests, SAGE Publication, 3rd Edition, 2006.

MA2134: LAB ON FUNDAMENTALS OF BIOSTATISTICS [0 0 2 1]

The following practical will be performed using statistical software**:** graphical representation of biological data, mean, mode, median, range, standard deviation, mean deviation, co-efficient of variations, correlation, regression, large sample tests, student't'-test, chi square test, run test sign test and median test.

GE – IV & LAB

CHY3260: BIOPHYSICAL CHEMISTRY [2 1 0 3]

Basic Concepts: Introduction to physical chemistry. General Biophysical Principles: Laws of biophysics, hydrogen bonding, van der Waals and hydrophobic interactions, disulphide bridges, role of water and weak interactions, energies, forces & bonds, kinetics of biological processes, electron transport & oxidative phosphorylation. Methods in Biophysics: Analytical ultracentrifugation, micro calorimetry, x-ray diffraction, spectroscopy – UV, IR, NMR, mass fluorescence, circular dichroism, microscopy, separation techniques. Molecular Biophysics: Principles of protein structure & confirmation, proteins structure and stability, structure of nucleic acids. Protein Engineering: Micro sequencing methods for proteins & engineering proteins for purification chemical approach to protein engineering & protein engineering for thermostability. Membrane Biophysics: Membrane structure & models, physical properties of membrane, membrane transport, molecular dynamics of membranes, Membrane potential and lipid membrane technology.

References:

1. D. L. Nelson, M. M. Cox, Lehninger's Principles of Biochemistry, W. H. Freeman, 2015.
2. Satyanarayana, Biochemistry, Elsevier, 2017.
3. J. M. Berg, J. L. Tymoczko, L. Stryer, Biochemistry, W. H. Freeman, 2011.

CHY3238: APPLIED CHEMISTRY LABORATORY [0 0 2 1]

Applied chemistry: Water analysis, effluent analysis, pH-metric and conductometric titrations. Computational: Scientific software,data handling.

Reference:

1. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.