Kurukshetra University, Kurukshetra

(*Established by the State Legislature Act XII of 1956*)
(*A Grade NAAC Accredited*)

Department of Biotechnology

Scheme and Syllabus
Master of Science
(M. Sc.)
Biotechnology

(Based on CBCS-LOCF Pattern)

(Effective from 2020-2021 in Phased Manner)

Faculty of Life Science

Program Outcomes (POs) for Post Graduate (PG) Courses of Faculty of Life Science

PO1	To acquaint students with recent knowledge and techniques in basic and applied biological sciences.
PO2	To develop understanding of organismal, cellular, biochemical and environmental basis of life.
PO3	To provide insight in to ethical implications of biological research for environmental protection and good laboratory practices and biosafety.
PO4	To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.
PO5	To understand application of biotic material in health, medicine, food security for human well-being and sustainable development.
PO6	To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self-reliance.

Program Specific Outcomes (PSOs)

Master of Science (M. Sc.) in Biotechnology	
PSO#	**Program Specific Outcomes (PSOs)**
PSO1	To acquaint students with Theoretical and Practical knowledge in different areas of Biotechnology. Students will be able to understand various Biological aspects and will develop into Biotech savvy integrated personalities with Scientific thinking.
PSO2	Students will be able to analyse, solve various problems related to Biotech fields. They would be able to launch start-ups and become entrepreneurs for novel Biotechnology products and processes in various industries.
PSO3	Students will be able to understand Biosafety measures, Ethical issues and regulatory compliances of Biotechnology.
PSO4	Students will be able to communicate effectively, work independently, imbibe the value of team spirit, able to write, execute and manage their Research Project.

Kurukshetra University, Kurukshetra
Scheme of Examination for M.Sc. Biotechnology (CBCS-LOCF)
(Effective from the Academic Session 2020-2021 in Phased Manner)

Semester - I

Paper No.	Nomenclature	Paper Type	Credits	Contact Hours per Week	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
BT-101	Biomolecules	Core	4	4	20	80	100	Three
BT-102	Microbiology	Core	4	4	20	80	100	Three
BT-103	Molecular Cell Biology	Core	4	4	20	80	100	Three
BT-104	Biotechniques	Core	4	4	20	80	100	Three
BT-105	Lab Course based on Biomolecules and Biotechniques	Core	4	8	20	80	100	Three
BT-106	Lab Course based on Molecular cell Biology & Microbiology	Core	4	8	20	80	100	Three
		Total Credits = 24			**Total Marks = 600**			

Kurukshetra University, Kurukshetra
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Semester – II

Paper No.	Nomenclature		Paper Type	Credits	Contact Hours per Week	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
BT-201	Genetic Engineering		Core	4	4	20	80	100	Three
BT-202	Animal Cell & Tissue Culture		Core	2	2	10	40	50	Three
BT-203	Plant Cell & Tissue Culture		Core	2	2	10	40	50	Three
BT-204	Bioinformatics		Core	4	4	20	80	100	Three
BT-205	Enzyme Technology		Core	4	4	20	80	100	Three
BT-206	Seminar		Core	1	1	25	-	25	-
BT-207	Biotechnology and Human Welfare-1	Any One	*Open Elective	2	2	10	40	50	Three
BT-208	MOOC on Swayam Portal		Open Elective	2				50	
BT-209	Lab Course based on Genetic Engineering & Cell and Tissue Culture Technology		Core	4	8	20	80	100	Three
BT-210	Lab Course based on Enzyme Technology & Bioinformatics		Core	4	8	20	80	100	Three
			Total Credits = 27			**Total Marks = 675**			

Kurukshetra University, Kurukshetra
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Semester – III

Paper No.	Nomenclature		Paper Type	Credits	Contact Hours per Week	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
BT-301	Plant Biotechnology		Core	4	4	20	80	100	Three
BT-302	Microbial Biotechnology		Core	4	4	20	80	100	Three
BT-303	Molecular Genetics		Core	4	4	20	80	100	Three
BT-304	Immunology	Any one	Elective	4	4	20	80	100	Three
BT-305	Molecular Medicine and Diagnostics		Elective	4	4	20	80	100	Three
BT-306	Seminar		Core	1	1	25		25	
BT-307	Biotechnology and Human Welfare-II	Any One	Open Elective	2	2	10	40	50	Three
BT-308	MOOC on Swayam Portal		Open Elective	2				50	
BT-309	One Month Summer/Industrial Training*		Open Elective	2				50	
BT-310	Lab Course based on Plant Biotechnology & Microbial Biotechnology		Core	4	8	20	80	100	Three
BT-311	Lab Course based on Molecular Genetics, Immunology/ Molecular Medicine and Diagnostics		Core	4	8	20	80	100	Three
			Total Credits = 27			**Total Marks = 675**			

*One Month Summer/Industrial Training Report of Minor Research Project/ Summer Training in Biotechnology industry/Research Institute will be submitted by the M. Sc. Biotechnology student in the Semester-III followed by a presentation of the training report for evaluation.

Kurukshetra University, Kurukshetra
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Semester – IV

Paper No.	Nomenclature		Paper Type	Credits	Contact Hours per Week	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
BT-401	Food Biotechnology		Core	4	4	20	80	100	Three
BT-402	Environmental Biotechnology		Core	4	4	20	80	100	Three
BT-403	Animal and Medical Biotechnology		Core	4	4	20	80	100	Three
BT-404	Genomics, Proteomics and Metabolomics	Any one	Elective	4	4	20	80	100	Three
BT-405	Biosafety, Bioethics and IPR Issues		Elective	4	4	20	80	100	Three
BT-406	Lab Course based on Food and Environmental Biotechnology		Core	4	8	20	80	100	Three
BT-407	*****Project Work/Field Training Report		Core	4			100	100	
			Total Credits = 24			**Total Marks = 600**			
			Grand Total Credits = 102			**Grand Total of Marks = 2550**			

*****M. Sc. **s**tudents shall be allotted to teachers at the beginning of **Semester – II** for guidance in preparing the Project Work/Field Training Report of the research/training carried out during Semester break in house or in other institutes. The report will be based on Minor Research Project/Field Training in Biotechnology and will be evaluated by the Internal Examiner and External Examiner.

Semester – I

Paper BT-101 Biomolecules (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The objective of the course is to introduce students to the world of basic biochemistry. This course covers structure and function of biomolecules, and details of physical and chemical basis of biomolecules involved in life processes.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Water: Structure, hydrogen bonding, as a biological solvent, ionization and fitness of the aqueous environment for living organisms; pH; Buffers; an introduction to physiological buffers.

Carbohydrates: Structure, occurrence and biological importance of important monosaccharides, oligosaccharides and polysaccharides; carbohydrate of Industrial importance (cane sugar, starch, gum arabica, pectin, cellulose); Glycosaminoglycans; Proteoglycans.

Unit - II

Amino acids and Proteins: Common structural features, classification by R group, Zwitter ion structures, acid-base properties and titration curves of amino acids; Essential amino acids; biologically active peptides; Classification and different structural levels (Primary, secondary, tertiary & quaternary) of proteins; Ramachandran plot. Basic introduction to terms: domains, motifs, prion protein. Determination of amino acid sequences of proteins; Effect of amino acid sequence on the function of a protein and stability, Chemical synthesis of polypeptides.

Unit - III

Lipids: Classification, structures, nomenclature of fatty acids; Essential fatty acids; Acylglycerols; Characterization of fats-Saponification value, iodine number, rancidity, acid value; Structure and properties of phospholipids and sphingolipids (sphingomyelins, cerebrosides & gangliosides); Structure and functions of prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes and Sterols.

Unit - IV

Nucleic Acids: Structure and properties of purines and pyrimidine bases; Nucleosides and Nucleotides; Biologically important nucleotides; Nucleic acids as the genetic material – experimental evidences; Chargaff's rules; The covalent backbone of nucleic acids; Double helical model of DNA structure; Structural polymorphism of DNA (A, B and Z-DNA) and RNA; Denaturation & annealing of DNA; Biological functions of nucleotides; Chemical synthesis of oligonucleotides.

Recommended Books:

1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017) Maxmillan/Worth publishers/W.H. Freeman & Company
2. Essentials of Biochemistry, 5th edition by Satyanarayana and Chakrapani. (2019) Elsevier, India
3. Biochemistry, 5th edition, by R.H. Garrett and C.M. Grisham (2012).Michal Sabat, University of Virginia.
4. Biochemistry: Internationals edition by Jeremy M Berg, John L Tymoczko and Lubert Stryer. (2015). W.H. Freeman & Co., N.Y.
5. Biochemistry, 4 edition, by Donald Voet, Judith G. Voet (2010), John Wiley & Sons, INC
6. Chemistry of Biomolecules: An Introduction, by R. J. Simmonds. Royal Society of Chemistry

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-101.1. Understand cellular and organismal basis of living organisms.
BT-101.2. Evaluate the role of structure and functional relationships of various Biomolecules significant to Health of Living Beings.
BT-101.3. Understand application of Biomolecules at Industrial level.
BT-101.4. Perform structural analysis and chemical synthesis of significant Biomolecules.

Table: CO-PO Mapping Matrix for the Course: BT-101 Biomolecules

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-101.1	3	3	2	2	2	1
BT-101.2	3	3	3	3	3	-
BT-101.3	3	3	-	1	3	1
BT-101.4	3	3	1	3	3	3
Average	3	3	2	2.25	2.75	1.66

Table: CO-PSO Mapping Matrix for the Course: BT-101 Biomolecules

CO#	PSO1	PSO2	PSO3	PSO4
BT-101.1	3	3	-	2
BT-101.2	3	3	-	2
BT-101.3	2	3	2	3
BT-101.4	2	3	2	3
Average	2.75	3	2	2.5

Semester – I
Paper BT-102 Microbiology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The aim of this course is to introduce students to the Microbial world. This is the basic course that covers the microbial ecology; structure, salient features, growth, nutritional and physical requirements of various types of microbes; handling and safety measures; Aseptic techniques; Tests useful in taxonomy, classification and identification of microorganisms; Industrial importance of microbes; types of microbes; methods of their isolation, purification and preservation; Methods of sterilization, their validation; Antimicrobial agents and their action; Antibiotics and their potency; Food and water borne diseases and control of food spoilage; Toxins etc.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – I

Various branches and Applications of Microbiology, History and contributions of various scientists to this science with particular reference to the contribution of the following scientists- A. V. Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Alexander Fleming and Joseph Lister. Spontaneous generation versus biogenesis.

Distinguishing features of prokaryotic and eukaryotic microbial cells, Morphology and arrangement of bacterial cells, Bacterial- flagella, fimbriae, capsule, spores and cysts, cell walls of Gram +ve and Gram –ve bacteria, Nutritional requirements and nutritional categories of microorganisms, Influence of environmental factors on microbial growth (temperature, oxygen concentration, pH, pressure, solute, light, radiations), Enrichment culture techniques for isolation of microorganisms, pure culture techniques and preservation techniques, study of growth curve, Quantitative measurement of growth.

Unit – II

Distinguishing features of bacteria, viruses, fungi, protozoa, algae; Introduction to Microbial Classification and Taxonomy, Taxonomic ranks, Various approaches for identification of microorganisms including molecular approaches; Gram (+) and Gram (-) bacteria of medical and industrial importance; Characteristics of Mycobacterium and Mycoplasmas; photosynthetic prokaryotes (purple bacteria, green bacteria, cyanobacteria) and actinomycetes; brief account of different types of viruses with special reference to lambda phage, herpes, adenoviruses and retroviruses; viriods and prions; fungi and algae of industrial importance.

Unit – III

Sterilization methods- dry heat, moist heat, radiations, filtration, and gaseous sterilization. Validation of sterilization processes; Factors affecting antimicrobial action, Mode of action of antimicrobial agents, Antibiotics and their mode of action, Microbiological assay of antibiotics

(ampicillin, streptomycin, tetracycline etc.), characteristics of an ideal antimicrobial chemical agent, Disinfectants and techniques to evaluate the potency of antimicrobial chemical agents, Types of toxins and their mode of action.

Unit – IV

Microbial ecology: Biogeochemical cycles (carbon cycle, nitrogen cycle, phosphorous cycle, sulphur cycle); Physical environment: Microenvironment & Niche, Microorganisms and ecosystems. Soil microbiology: Types & functions of microorganisms in soil. Microorganism associations with vascular plants (Mycorrhizae, Rhizobia), Microbial spoilage of foods. Methods to control food spoilage, Food borne diseases. Microbiology of fermented foods.

Recommended Books:

1. Lim, D.V. (1998) Microbiology, West Publishing Company, New York.
2. Brock, T.D. (1990) Microbiology: A text book of Industrial Microbiology, Sameur Association.
3. Tortora, G. J., Funke, B. R. and Case, C. L. (2016) Microbiology: An introduction, Pearson Education.
4. Atlas, R.M. (1998) Microbiology: Fundamental and Applications, Macmillan Publishing Company, New York.
5. Pelczar, M.J., Chan, E.G.S. and Krieg, N.R. (2007) Microbiology, McGraw Hill Inc.
6. Heritage, J., Evance, E.G.V. and Killington, R.A. (1999) Microbiology in action, Cambridge University Press
7. Willey, J., Sherwood, L. and Woolverton, C. J. (2017) Prescott's Microbiology, McGraw-Hill Education
8. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R. (2005) General Microbiology, MacMillan Press Ltd.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-102.1 Analyse the Scope and Importance of Microbiology, understand the microbial world, exhibit the knowledge for isolation, purification, and preservation of microbial cultures and biosafety measures.

BT-102.2 Distinguish various types of microbes, understand the classification strategy and describe various approaches to identify the microbes, discuss and analyze the industrial importance of microbes.

BT-102.3 Exhibit the knowledge of various sterilization techniques, analyze their use and safety measures, also understand and describe the role & action of antibiotics, disinfectants and techniques to evaluate their potency, explain validation of various sterilization processes.

BT-102.4 Understand the role of micro-organisms in the environment, for making industrially important fermented foods and discuss the food borne diseases, spoilage of food items by microbes and analyse the food spoilage prevention strategy.

Table: CO-PO Mapping Matrix for the Course: BT-102 Microbiology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-102.1	3	3	3	3	3	3
BT-102.2	3	3	3	3	3	3
BT-102.3	3	3	3	3	3	3
BT-102.4	3	3	3	3	3	2
Average	3	3	3	3	3	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-102 Microbiology

CO#	PSO1	PSO2	PSO3	PSO4
BT-102.1	3	3	3	3
BT-102.2	3	3	3	3
BT-102.3	3	3	3	3
BT-102.4	3	2	3	3
Average	3	2.75	3	3

Semester-I

Paper BT-103 Molecular Cell Biology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The objective of the course is to make the students to understand the basic concepts of cell biology at molecular level and to have an insight of cellular and molecular aspects of life.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Overview of cells and cell research: Origin and evolution of cells, Cells as experimental models, tools of cell biology.

Fundamentals of Molecular Biology: Heredity, Genes, and DNA, Expression of Genetic Information, Recombinant DNA, Detection of Nucleic Acids and Proteins

Unit - II

Nucleus: Nuclear envelope and traffic between the nucleus and cytoplasm, internal organization of the nucleus, nucleolus, nucleus during mitosis.

Protein Sorting and Transport: Endoplasmic reticulum, Golgi apparatus, and Lysosomes, mechanism of vesicular transport

Unit - III

DNA Replication: DNA polymerases, replication fork, fidelity of replication, origins and initiation of replication, replication at the ends of chromosomes.

Mutations: nonsense, missense, frameshift and point mutations; intragenic and intergenic suppression

DNA Repair: Direct reversal of DNA damage, excision repair, error-prone repair, recombinational repair.

RNA Synthesis and Processing: Prokaryotic transcription, Eukaryotic transcription: RNA polymerases and transcription factors, model systems of transcriptional control: lac operon, trp operon lambda phage; promoters, enhancers, repressors, RNA processing and turnover,

Protein Synthesis, Processing and Regulation: universal genetic code, degeneracy of codons, mechanisms of initiation, elongation and termination of translation, wobble hypothesis, Protein folding and processing, regulation of protein function, protein degradation

Unit - IV

Cell Signalling: Signalling molecules and their receptors, functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton, Developmental abnormalities due to defective signalling pathways, Signal transducing machinery as targets for potential drugs

Cell death and cell renewal: programmed cell death, stem cells and maintenance of adult tissues. Embryonic stem cells and therapeutic cloning.

Cancer: Development and causes of cancer, tumour viruses, oncogenes, tumour suppressor genes, application of molecular biology to cancer prevention and treatment.

Recommended Books

1. Molecular Biology of the Cell, Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Garland Science Publishing (2008).
2. The world of the Cell, Becker, W.M., Klein smith, L.J. and Hal din, J., Seventh Edition, Pearson Education (2008).
3. The Cell - A Molecular Approach (sixth edition) Cooper, Geoffrey M. Sunderland (MA): Sinauer Associates, Inc.; c2013
4. Cell and Molecular Biology: Concepts and Experiments, 5th Edition, Gerald Karp: Wiley 2007
5. Essentials of Molecular Biology, David Friefilder, Jones and Barllett Publications.
6. Gene VII (7th Edition) Benjamin Lewin, Oxford University Press, U.K., 2000.
7. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc., New York, 1995.
8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios scientific Publishers Ltd., Oxford, 1991.
9. Molecular Biology of the Gene (4th edition), J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A. M. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
10. Molecular Biology of the Gene (7th Edition) by James D. Watson Tania A. Baker , Stephen P. Bell , Alexander Gann , Michael Levine , Richard Losick **.**Pearson, 2013
11. Molecular Cell Biology (4th edition) by Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H. Freeman; 2000.
12. Encyclopaedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-103: 1 Acquire the knowledge and understanding of the fundamentals of molecular process of life.

BT-103: 2 Analyse architecture of the genomes, genes, and the flow of genetic information through replication, transcription, translation.

BT-103: 3 Correlate between signal molecules and their role in various cellular activities.

BT-103: 4 Understand the genetic basis & causes of cancer and application of molecular biology to cancer prevention and treatment.

Table: CO-PO Mapping Matrix for the Course: BT-103 Molecular Cell Biology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-103.1	3	3	3	3	3	3
BT-103.2	3	3	2	3	3	3
BT-103.3	3	3	2	3	3	2
BT-103.4	3	3	3	3	3	2
Average	3	3	2.5	3	3	2.5

Table: CO-PSO Mapping Matrix for the Course: BT-103 Molecular Cell Biology

CO#	PSO1	PSO2	PSO3	PSO4
BT-103.1	3	3	2	3
BT-103.2	3	3	3	3
BT-103.3	3	3	3	2
BT-103.4	3	3	3	3
Average	3	3	2.75	2.75

Semester – I
Paper BT-104 Biotechniques (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The aim of the course is to create broad understanding of principles, applications and instrumentation of tools and techniques used in biotechnology.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Bioseparation, cell disruption, extraction, purification and storage techniques: Bioseparation; filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques, reverse osmosis and ultra-filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal

Centrifugation Methods: Principles of Sedimentation, centrifugation techniques and their applications, differential centrifugation, density gradient and ultracentrifugation techniques.

Unit - II

Microscopy: Light Microscopy – Magnification, resolving power, Numerical aperture, Limit of Resolution, Principles and applications of bright field, phase contrast, fluorescence, scanning and transmission electron microscopy.

Electrophoresis: Concept, Factors affecting electrophoresis, Agarose gel electrophoresis, Pulse field gel electrophoresis, PAGE, SDS-PAGE, Isoelectrofocusing, 2-Dimentional electrophoresis

Unit - III

Chromatography: Principles and applications of Paper, Thin layer, Gel-filtration, ion-exchange, Affinity chromatography, Gas liquid chromatography, High pressure liquid chromatography (HPLC); Reversed Phase chromatography, Hydrophobic interaction chromatography.

Unit - IV

Radioisotope Techniques: Radioactivity, Units of radioactivity, Radioactive decay, Rate of radioactive decay, Measurement of radioactivity- Geiger counter, Liquid scintillation counting, Autoradiography, Effect of radiations on biological system, Cerenkov radiations, Tracer technique-Principle and applications

Spectroscopy: Principles of biophysical methods used for analysis of biopolymer structure - X-ray diffraction, fluorescence, UV and visible, ORD/CD, NMR and ESR spectroscopy, Atomic absorption and Atomic emission spectroscopy.

Recommended Books:

1. Molecular Cloning: A Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000
2. Richard E. Venn (2003), Principal and Practice of Bioanalysis. Taylor and Francis.
3. Walker J. and Wilson K (2010), Principles and Techniques-Practical Biochemistry, 7th Edition, Cambridge University Press, London.
4. Slater R.J. (2002), Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York
5. Sawhney, S.K. and Singh R (2005), Introductory Practical Biochemistry, Alpha Science International.
6. Upadhayaye, A; Upadhyaye, K and Nath N. (2002), Biophysical Chemistry: Principles & Techniques, Himalaya Publication House, New Delhi.
7. David Sheehan, Physical Biochemistry; Principles and applications (2000): Wiley Press

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-104.1 Have knowledge of analytical tools and techniques of biotechnology for processing of biomaterials/products.

BT-104.2 Learn methods/tools for downstream processing and microscopy.

BT-104.3 Understand principles and applications of electrophoretic, chromatographic & radio isotopic techniques.

BT-104.4 Analyse different biological samples/products by choosing appropriate tool/biotechnique while handling different samples/products.

Table: CO-PO Mapping Matrix for the Course: BT-104 Biotechniques

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-104.1	3	3	3	3	3	2
BT-104.2	3	3	2	3	3	2
BT-104.3	3	3	3	3	3	3
BT-104.4	3	3	2	3	3	3
Average	3	3	2.5	3	3	2.5

Table: CO-PSO Mapping Matrix for the Course: BT-104 Biotechniques

CO#	PSO1	PSO2	PSO3	PSO4
BT-104.1	3	3	2	3
BT-104.2	3	3	3	3
BT-104.3	3	3	3	2
BT-104.4	3	3	3	3
Average	3	3	2.75	2.75

Semester – I

Paper BT-105 Lab. Course based on Biomolecules and Biotechniques (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three hours

Practical Exercises

1. Safety measures to be taken while handling Biochemicals.
2. Qualitative and quantitative estimation of various sugars.
3. To study enzyme inhibition potential of biomolecules against medically significant target enzymes.
4. Estimation of proteins by Biuret, Lowry and Bradford method.
5. Analysis of fats/oils – iodine number, saponification value, acid value, free fatty acids.
6. Determination of various metabolites in given biological samples.
7. Quantitative estimation of DNA and RNA content in the given sample by coloured reaction.
8. Paper and Thin Layer Chromatography
9. Gel Filtration, Ion-exchange and Affinity Chromatography
10. Agarose gel electrophoresis and PAGE
11. Centrifugation
12. Methods for preparation of nanobioparticles

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-105.1 Acquire knowledge and hands-on training of analytical tools and techniques of biotechnology & understanding of good laboratory practices.

BT-105.2 Learn Diagnostic, qualitative and quantitative and aspects of various biomolecules.

BT-105.3 Handle general & specific problems while processing of experimental material and learn to devise solution by choosing appropriate methodology/biotechnique for processing of biomaterials/products.

BT-105.4 Imbibe the value of team spirit while working together in team during practical sessions.

Table: CO-PO Mapping Matrix for the Course: BT-105 Lab. Course based on Biomolecules and Biotechniques

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-105.1	3	3	3	3	3	3
BT-105.2	3	3	3	3	3	3
BT-105.3	3	3	3	3	3	3
BT-105.4	3	3	2	2	2	2
Average	3	3	2.75	2.75	2.75	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-105 Lab. Course based on Biomolecules and Biotechniques

CO#	PSO1	PSO2	PSO3	PSO4
BT-105.1	3	3	3	2
BT-105.2	3	3	3	3
BT-105.3	3	3	3	3
BT-105.4	3	3	3	3
Average	3	3	3	2.75

Semester – I

Paper BT-106 Lab. Course based on Molecular Cell Biology & Microbiology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three Hours

Practical Exercises

1. Genomic DNA isolation from *E. coli* and blood.
2. RNA isolation from *E. coli* blood
3. Plasmid DNA isolation from *E. coli.*
4. Molecular weight determination of the DNA.
5. Spectrophotometric analysis of DNA/ RNA.
6. Determination of Tm value.
7. Plasmid purification using DNA binding membrane
8. Lab rules and safety measures in Microbiology lab.
9. Commonly used equipment for microbial work
10. Use of bright-field microscope
11. Preparation of cotton plugs and culture media
12. Aseptic techniques
13. Sub-culturing/ Picking off technique
14. Measurement of the growth of microbial culture.
15. Study of Thermal death point and thermal death time of microbes.
16. Micrometry.
17. Growth curve of bacteria.
18. Various staining methods – Gram staining, capsule, spore, fungal staining, Acid fast staining, Negative staining etc.
19. Isolation and enumeration of micro-organisms of air, water and soil.
20. Pure culture of micro-organisms.
21. Biochemical tests useful in bacterial taxonomy.

22. Parameters for identification of unknown micro-organisms.

23. Antibiotic sensitivity test and MIC value.

24. Evaluation of disinfectants and antiseptics, evaluation of sterilization methods.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-106.1 Isolate and analyse DNA and RNA.
BT-106.2 Learn DNA and RNA analysis techniques.
BT-106.3 Understand the working & handling of various equipment for microbial work, safety measures and protocols for microbial work.
BT-106.4 Exhibit the knowledge of testing the potency of antibiotics / disinfectants / antiseptics, understand the techniques for the isolation, and identification of microbial isolates.

Table: CO-PO Mapping Matrix for the Course: BT-106 Lab. Course based on Molecular Cell Biology & Microbiology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-106.1	3	3	3	3	2	3
BT-106.2	3	3	3	3	2	3
BT-106.3	3	3	3	3	3	3
BT-106.4	3	3	3	3	3	3
Average	3	3	3	3	2.5	3

Table: CO-PSO Mapping Matrix for the Course: BT-106 Lab. Course based on Molecular Cell Biology & Microbiology

CO#	PSO1	PSO2	PSO3	PSO4
BT-106.1	3	3	2	3
BT-106.2	3	3	2	3
BT-106.3	3	3	3	3
BT-106.4	3	3	3	3
Average	3	3	2.5	3

Semester -II
Paper BT-201 Genetic Engineering (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: This course aims to introduce the students to field of Genetic Engineering including introduction, basic principles, milestones, scopes and advances.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – I

Genetic Engineering

Introduction and scope of Genetic Engineering, Miles stones in Genetic engineering

Nucleic Acids

Purification of total cell DNA, plasmid DNA, phage DNA, Yield Analysis, , Nucleic acid blotting and hybridization

Manipulation of purified DNA

DNA modifying enzymes- Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases

Restriction Endonucleases- Host controlled restriction and modification, Nomenclature, types, Recognition sequence, blunt and sticky ends, applications.

Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing

Gene Cloning Vectors

General features, Types of cloning vectors- Plasmid, bacteriophage, phagemid, cosmid, artificial chromosomes (YAC, BAC, PAC)

Unit – II

Transformation of *E. coli*

Concept, Selection of transformed cells, Identification of recombinants (bacteria and phages)

Cloning of Specific Gene

Direct selection, identification from a gene library-genomic library, cDNA synthesis and cloning-Properties of cDNA, mRNA enrichment, cDNA library.

Methods for Clone Identification

Screening strategies-Colony and plaque hybridization, Abundancy probing, Heterologous probing, Immunological screening, Differential screening, Subtractive hybridization.

Protein-Protein Interactions-Phage display, Yeast two hybrid system, Yeast three hybrid system.

Unit – III

Nucleic Acid Sequencing

DNA Sequencing: Rapid DNA sequencing techniques and strategic details of range of methodologies e.g. Dideoxyribonucleotide chain termination, Chemical degradation, Automated DNA sequencing, Thermal cycle sequencing, Pyrosequencing.

Polymerase Chain Reaction

Concept, Basic PCR reaction, Factors affecting the PCR, Types of PCR (RT- PCR, Real time PCR, Allele specific PCR, Multiplex PCR) , Applications of PCR

Site Directed Mutagenesis

Oligonucleotide directed mutagenesis, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primers / nucleotide analogs.

Unit – IV

Gene expression and Regulation studies

Primer extension, S1 mapping, Gel retardation assay, Deletion analysis, Reporter genes, DNA foot printing, Modification interference assays, HRT, HART

Manipulation of gene expression in prokaryotes

Problems with production of recombinant proteins in *E coli*, optimizing expression of foreign genes in *E. coli*- Strong and regulatory promoters, Codon usage, Fusion proteins, Increasing protein stability and secretion, Translation expression vectors, Protease deficient host strains.

Heterologous protein production in Eukaryotes

Saccharomyces cerevisiae and *Pistia pastoris* expression systems, Baculovirus Insect cell expression systems, Mammalian cell expression system.

Recommended Books:

1. Gene cloning and DNA analysis – An Introduction (2015) 7th edition, T.A Brown, Blackwell publisher.
2. Essential genes (2006), Benzamin Lewin, Pearson education international.
3. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
4. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.
5. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur.
6. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.
7. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.
8. Molecular Biology of Gene (2008) 6th edition, Watson, Baker, Bell. Gann, Levine and Losick, Pearson education Inc.
9. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
10. Molecular Cloning: A Laboratory Manual (2000), J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York
11. DNA Cloning: A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford,

12. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998), S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-201.1 Understand concept and scopes of Genetic Engineering and central role of recombinant DNA technology in all fields of Biotechnology.

BT-201.2 Acquire the knowledge of basic concepts and different methodologies used for isolation, purification and manipulation of nucleic acids, gene cloning, transformation, selection of desired clones, protein-protein interactions, site directed mutagenesis, gene expression and regulation, and nucleic acid sequencing.

BT-201.3 Understand the concepts and methodology of PCR and its uses in diverse fields of life sciences.

BT-201.4 Work in the latest research areas of biotechnology like microbial, industrial, plant, animal, environmental, health etc. Using genetic engineering techniques.

Table: CO-PO Mapping Matrix for the Course: BT-201 Genetic Engineering

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-201.1	3	3	3	3	3	3
BT-201.2	3	3	3	3	3	3
BT-201.3	3	3	3	2	3	3
BT-201.4	3	3	3	2	3	3
Average	3	3	3	2.5	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-201 Genetic Engineering

CO#	PSO1	PSO2	PSO3	PSO4
BT-201.1	3	1	2	-
BT-201.2	3	1	-	1
BT-201.3	3	1	1	-
BT-201.4	3	3	2	3
Average	3	1.5	1.66	2

Semester - II

Paper BT-202 Animal Cell & Tissue Culture (*Core*)

Credits: 2
Marks: 40
Internal Assessment: 10
Time: 3 Hours

Objectives: The objective of this course is to teach students the different aspects of animal cell culture. Also, it is desired to make them understand that how a culture is established, propagated and characterized and what are the applications of animal cell cultures.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - 1

Animal cell and tissues culture: Historical background, development, advantages and limitations of cell & tissue culture.

Requirements of cell & tissue culture: aseptic area, incubation, preparation and sterilization, storage, specialized equipment, consumable items.

Aseptic techniques: elements of aseptic environment, sterile handling

Culture vessels and substrates: the substrate, choice of culture vessel, treated surfaces.

Unit - II

Techniques of cell culture – batch, batch fed and continuous cultures, cytotoxicity and viability assays, cell separation techniques, flow cytometry and fluorescence associated cell sorting.

Design and types of media: balanced salt solutions, complete media, role of serum and supplements, serum free media: advantages and disadvantages of serum and serum free media, replacement of serum, development of serum free media.

Unit - III

Primary culture: types of primary cell culture, isolation of the tissue, primary culture,

Sub-culturing of animal cells: Subculture and propagation, Criteria for subculture, Subculture of monolayer cells, growth cycle and split ratio, propagation and subculture in suspension.

Cloning and selection: dilution and suspension cloning, scaling up in suspension and monolayer, large scale production of cells using bioreactors, micro-carriers and perfusion techniques.

Cell line characterization: need for characterization, authentication, cell morphology, chromosome content, DNA content, RNA and protein expression, enzyme activity, antigen markers.

Unit - IV

Industrial products of animal cell cultures: enzymes, hormones, monoclonal antibody, cytokines, tissue plasminogen activators etc.

Applications of animal cell culture: virology, cancer research, gene therapy, drug development and cytotoxicity, animal cloning, genetic counselling, cryopreservation and cell banking

Recommended Books:

1. Animal Cell Culture - Practical Approach (3rd edition), Ed. John R.W. Masters, Oxford, 2000.
2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
3. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
4. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications.
5. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd. Oxford.
6. Cell Growth and Division: a Practical Approach. Ed. R. Basega, IRL Press.
7. Culture of Animal Cells, (6^{th} edition), R. Ian Freshney. Wiley-Liss, 2010.
8. Animal Cell Technology, Mukhopadhyay, A., 1st Edn, I.K. International Publishing House. 2009

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-202.1 Acquire potential to develop and establish and maintain an independent animal cell culture laboratory.

BT-202.2 Have knowledge of the maintenance and characterization of animal cell cultures.

BT-202.3 Explore animal cell culture for virology, cancer research, drug development and cytotoxicity testing, production of high value therapeutics as well as for various *in vitro* tests

BT-202.4 Develop potential for entrepreneurship and start up initiatives for industrial products of animal cell culture.

Table: CO-PO Mapping Matrix for the Course: BT-202 Animal Cell & Tissue Culture

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-202.1	3	3	2	3	3	3
BT-202.2	3	3	3	-	3	2
BT-202.3	3	3	3	2	3	3
BT-202.4	3	3	2	3	3	3
Average	3	3	2.5	2.66	3	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-202 Animal Cell & Tissue Culture

CO#	PSO1	PSO2	PSO3	PSO4
BT-202.1	3	3	2	3
BT-202.2	3	3	3	-
BT-202.3	3	3	3	3
BT-202.4	3	3	3	3
Average	3	3	2.75	3

Semester - II

Paper BT-203 - Plant Cell & Tissue Culture (*Core*)

Credits: 2
Marks: 40
Internal Assessment: 10
Time: 3 Hours

Objectives: To develop trained and skilled manpower in the field of plant tissue culture. To ensure better quality of education by continuous monitoring and review of performance and counselling students. To enhance problem-solving skills of students through applying state-of -art techniques. To supplement the academic input of students by way of interactive class sessions for their scientific personality development.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Introduction to plant cell tissue culture and historical perspective.

Laboratory organization setup (R & D level and industrial level); Aseptic manipulations and bio-safety aspects in PTC; Culture media – components, preparation and development/formulation of media for new plant system.

Callus culture: characteristics, significance and limitations; Initiation and maintenance of cell cultures: static techniques of single cell culture, suspension culture and types, assessment of growth and viability of cultured cells. Organogenesis and factors influencing organogenesis. Somatic embryogenesis: process of somatic embryos production, factors influencing and its importance in plant breeding and propagation. Production of synthetic seeds.

Unit - II

Large scale plant micropropagation – technique, factors affecting *in vitro* culture of plants (physical, chemical, genotypic and others), applications and limitations of micropropagation. Meristem, shoot tip culture, production and indexing of virus free plants. Somaclonal variations, molecular basis of variation and their significance in plant breeding.

Unit - III

In vitro production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis, Factors affecting androgenesis, ontogeny of androgenesis, diploidization of haploid plants. Significance and uses of haploids in agriculture. Wide hybridization and embryo rescue technique.

Unit - IV

Protoplast culture and somatic hybridization – Isolation, culture and fusion of protoplast, selection of fusion products, assessment of somatic hybrid plants, production of cybrids, applications of protoplast culture and somatic hybridization in the improvement of crop plants.

In vitro germplasm conservation and cryopreservation.

Recommended Books:

1. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
2. Elements of Biotechnology by P. K. Gupta, 4th Reprint (2nd Edition): 2019-2020, Rastogi pub.
3. Introduction to Biotechnology (2009) by H. S. Chawla, 3rd edition, Science publishers, USA
4. Plant cell, organ and tissue culture (1995) by Gamborg O.L. and Phillips G.C., Springer Verlag pub. Germany.
5. Plant Tissue Culture – Basic & Applied (2005) by Jha T.B. & Ghosh B., Universities press.
6. Plant cell culture – A practical approach (1994) Dixon R.A., Gonzales R.A. Oxford University press, UK.
7. Bhojwani S.S. (2003), Agrobiotechnology & Plant Tissue Culture
8. Smith R.H. (2000), Plant Tissue Culture, Academic Press
9. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis.
10. Malik Z. A., Usha K., Kamaluddin and Athar A. (2017) Plant Biotechnology: Principles and Applications. Springer Nature, Singapore.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-203.1 Understand the concepts, applications and recent theoretical knowledge of tools and techniques related to cell cultures and different modes of *in vitro* regeneration. Know how to develop and establish a PTC laboratory for small scale to industrial level.

BT-203.2 Attain knowledge about production of novel hybrid plants and their significance in agriculture and plant breeding. They would be able to launch start-ups and become entrepreneurs for various products and processes related to plant tissue culture.

BT-203.3 Understand bio-safety measures related to plant tissue culture techniques.

BT-203.4 Communicate and write effectively on scientific principles and ideas in the field of plant tissue culture.

Table: CO-PO Mapping Matrix for the Course: BT-203 - Plant Cell & Tissue Culture

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-203.1	3	3	2	3	3	3
BT-203.2	3	2	-	3	3	3
BT-203.3	3	-	3	-	-	-
BT-203.4	3	-	-	3	-	-
Average	3	2.5	2.5	3	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-203 - Plant Cell & Tissue Culture

CO#	PSO1	PSO2	PSO3	PSO4
BT-203.1	3	3	3	3
BT-203.2	3	3	-	2
BT-203.3	3	-	3	-
BT-203.4	3	2	-	3
Average	3	2.66	3	2.66

Semester - II
Paper BT–204 Bioinformatics (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The aim of this course is to introduce the students to the basics of bioinformatics. This includes teaching the basis of the biological system via information and technology.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – I

Bioinformatics and Biological Databases: Central Dogma of molecular biology. Basics of Human Genome project. Introduction**,** Goal, Scope, Applications of Bioinformatics. Introduction to Biological Databases and Information Retrieval systems. Introduction to Pairwise Sequence Alignment: Evolutionary Basis, Sequence Homology versus Sequence Similarity, Sequence Similarity versus Sequence Identity, scoring matrix. Database Similarity Searching: Exhaustive and Heuristic, Basic Local Alignment Search Tool (BLAST), FASTA. Multiple Sequence Alignment: Exhaustive Algorithms, Heuristic Algorithms. Position-Specific Scoring Matrices, Motifs and Domains, Regular Expressions, Protein Family Databases, Sequence Logos

Unit - II

Gene and Promoter Prediction: Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes, Gene Prediction in Eukaryotes, Promoter and Regulatory Elements in Prokaryotes, Promoter and Regulatory Elements in Eukaryotes, Prediction Algorithms.

Molecular Phylogenetics: Molecular Evolution and Molecular Phylogenetics, Terminology, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation, Finding a True Tree. Distance-Based Methods, Character-Based Methods, Phylogenetic Tree Evaluation, Phylogenetic Programs.

Unit - III

Structural Bioinformatics: Introduction to Protein Structure Database. Protein Structural Visualization, Protein Structure Comparison, Protein Structure Classification. Methods of Secondary and tertiary Structure Prediction for Globular Proteins: Homology Modelling, Threading and Fold Recognition, *Ab Initio* Protein Structural predictions. Introduction to Drug Discovery.

Unit - IV

Genomics and Proteomics: Genome Mapping, Genome Sequence Assembly, Genome Annotation, Comparative Genomics, Functional Genomics, Sequence-Based Approaches, Microarray-Based Approaches, Comparison of SAGE and DNA Microarrays, Introduction to Proteomics, various tools and techniques, application/significance of Proteomics to mankind.

Recommended Books:

1. Essential Bioinformatics, Jin Xiong,2006, Cambridge University Press.
2. Bioinformatics: Methods and Applications. 2013.Rastogi, Mendritta and Rastogi.Edition 4 th. PHI earnin publishers.
3. Introduction to Bioinformatics, edition 4 th Arthur M. Lesk, 2014, Oxford University Press
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition, Andreas D. Baxevanis, B. F. Francis Ouellette, 2001, Wiley- Interscience
5. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith,2016. Addison Wesley Longman ltd.
6. Bioinformatics: A Primer, Narayanam. 2005.New Age international Pub.
7. Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Des Higgins (Editor), Willie Taylor (Editor), 2000, Oxford Univ Press.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-204.1 Know about basic tools and concepts of Bioinformatics and their significance in applied and basic Biology. They will also learn application of various bioinformatics tools.

BT-204.2 Learn role of various *in silico* tools in managing large data generated by various Biotechnological techniques and tools.

BT-204.3 Develop concept of sequence alignment, matrix, algorithms and tools to generate more accurate predictions of various Biological data.

BT-204.4 Have overview about molecular level phylogenetics, Proteomics, Genomics and Human Genome Project.

Table: CO-PO Mapping Matrix for the Course: BT-204 Bioinformatics

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-204.1	3	2	1	3	2	2
BT-204.2	3	3	1	3	3	-
BT-204.3	2	2	1	3	3	1
BT-204.4	3	3	3	3	3	2
Average	2.75	2.5	1.5	3	2.75	1.25

Table: CO-PSO Mapping Matrix for the Course: BT-204 Bioinformatics

CO#	PSO1	PSO2	PSO3	PSO4
BT-204.1	3	3	2	2
BT-204.2	3	3	1	2
BT-204.3	3	3	-	2
BT-204.4	3	3	3	3
Average	3	3	2	2.25

Semester II

Paper BT-205 Enzyme Technology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: This Enzyme-Technology oriented course covers the applications of enzymes in various industries; classification of enzymes and their salient features; How enzymes work and their regulation; Strategies being adopted for production, isolation, purification and Characterization of enzymes; Strategies for immobilization and engineering of enzymes and how their structure can be modified to make them industrially suitable. This foundation course on Enzyme Technology will help the students to understand the nature, structure, function, kinetics, specificity, categories and regulation of enzymes.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

History of Enzymology; General characteristics of enzymes; advantages of enzymes over chemical catalysts, Nomenclature and classification of enzymes, Significance of Enzyme Commission number; Determination of three dimensional structure of enzyme by X-ray crystallography and NMR spectrometry, importance of 3-D structure of an enzyme; Classification of enzyme structures, structures adopted by enzymes, principles that govern the 3-D structure adopted by enzymes; Forces for stability of 3-D structure; Denaturation and renaturation; Isoenzymes, enzyme specificity, monomeric and oligomeric enzymes, multienzyme complex, holoenzyme, apo-enzyme, cofactor, coenzyme, prosthetic group; enzyme activity unit, turn over number and specific activity, Ribozymes and Abzymes – A brief account.

Unit – II

Enzyme action; effect of enzyme on the rate and equilibrium of a reaction; principles that explain catalytic power and substrate specificity of enzymes; enzyme substrate complex(Lock & Key Model, Induced Fit Theory, Substrate Strain Theory), factors responsible for catalytic efficiency of enzyme; proximity and orientation effect, acid-base catalysis, covalent catalysis, strain and distortion theory; Nature of active site, identification of functional groups at active sites; regulatory enzymes- covalently modulated enzymes, allosteric enzymes and their mode of action; regulation of enzyme activity in the living system.

Unit - III

An introduction to enzyme kinetics and its importance, Methods used for investigating the kinetics of enzyme catalysed reactions; factors that influence the velocity of enzyme catalysed reaction(effect of substrate concentration, enzyme concentration, pH, temperature, presence of activator/inhibitor etc.); Michaelis-Menten equation, Vmax, Km and its significance; Lineweaver Burk plot- its advantages and limitations, Eadie- Hofstee and Hanes plots; enzyme

inhibition, types of enzyme inhibitions- competitive, uncompetitive, non-competitive, mixed type inhibition and determination of Ki, Determination of K_m and V_{max} in the presence and absence of inhibitor; feed- back inhibition; Bisubstrate reactions- brief introduction to sequential and Ping-Pong mechanism with examples.

Unit - IV

Strategies used for enzyme production, isolation and purification at laboratory and industrial scale from plant, animal and microbial sources , method of calculating the purification fold; estimation of enzyme activity; characterization of an enzyme, criteria of enzyme purity, determination of the molecular weight (MW) and the number of sub-units of an enzyme; enzyme immobilization and its importance; protein engineering; enzyme therapy, enzyme inhibitors and drug design; enzymes as biosensors, enzyme reactors; Applications of enzymes in medicine, textile, leather, detergent, paper, bakery, dairy industry, beverage and fruit processing, food processing and preservation, clinical applications of enzyme estimation.

Recommended Books:

1. Segal, L.H. (1975) Enzyme Kinetics, Wiley Interscience, USA
2. Walsh, C. (1979) Enzymatic reaction mechanism, Freeman and Company, USA.
3. Gerhartz, W. (1990) Enzyme in Industry, Production and Application, VCH.
4. Shultz, A.R. (1994) Enzyme Kinetics, Cambridge Press.
5. Fresht (1995) Enzyme structure and mechanism, 2nd edition, Freeman and Company.
6. Palmer, T. and Bonner P.L. (2007) Enzymes, Woodhead Publishing Limited.
7. Dixon, M and Webb E.C. (1997) Enzymes, 3rd edition, Academic Press, New York.
8. Price N.C. and Stevens L. (2001) Fundamentals of Enzymology, Oxford University Press

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-205.1 Understand and analyse the importance of enzymes, classification, their salient features & categories of enzymes and exhibit the knowledge of enzyme activity-specific activity calculation, correlate the structural framework with catalytic power of enzyme.

BT-205.2 Describe what enzymes do and how they do and their regulation in the living system.

BT-205.3 Describe and analyse the factors affecting enzyme activity, exhibit the knowledge of enzyme kinetics, & describe different types of enzyme inhibitions.

BT-205.4 Judge the scope and importance of enzymes in various sectors, understand the various strategies for the production- purification of enzymes, and the techniques to modify and increase the stability and reusability of enzymes.

Table: CO-PO Mapping Matrix for the Course: BT-205 Enzyme Technology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-205.1	3	3	3	2	3	2
BT-205.2	3	3	3	3	3	3
BT-205.3	3	3	3	3	3	3
BT-205.4	3	3	3	3	3	3
Average	3	3	3	2.75	3	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-205 Enzyme Technology

CO#	PSO1	PSO2	PSO3	PSO4
BT-205.1	3	2	3	3
BT-205.2	3	3	3	3
BT-205.3	3	3	2	3
BT-205.4	3	3	3	3
Average	3	2.75	2.75	3

Semester-II

Paper BT-207 Biotechnology and Human Welfare-I (*Open Elective*)

Credits: 2
Marks: 40
Internal Assessment: 10
Time: 3 Hours

Objectives: The course will provide a basic knowledge of applications of Biotechnology in industrial and medical fields.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Industrial Biotechnology

Introduction, Isolation and screening of microbes, strain development, process development, Bioreactors, Fermentation Media, Types of fermentation, Downstream processing

Production of organic compounds, enzymes and antibiotics by microbes, Microbial transformation, SCP, Probiotics

Enzyme Technology, Enzyme immobilization, Ribozyme, Abzyme, Industrial applications of enzymes

Protein and enzyme engineering

Unit - II

Medical Biotechnology

Molecular Diagnostics- DNA/RNA probes, PCR to detect infectious diseases

Monoclonal antibodies- their production and applications, production of recombinant antibodies

Vaccines*:* live, attenuated, killed, subunit, conjugate and DNA vaccines

Gene Therapy-Types of gene therapy, Augmentation Gene therapy, Targeted gene therapy, Ethical issues

DNA fingerprinting and forensic analysis, Stem cell technology, Tissue Engineering, Disease treatment using microbial products.

Recommended Books

1. Singh B.D. Biotechnology: Expanding Horizon (2010)3rd edition. Kalyani Publishers.
2. Gupta P.K. Biotechnology and Genomics (2013) 1st Edition. Rastogi publishers
3. Clark D.V and Pazdernik,N.J Applying Genetic Revolution(2009) Academic Press
4. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings, (2007).
5. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001

6. David S L. Genetics to Gene Therapy – the molecular pathology of human disease (1st Ed.) BIOS scientific publishers, (1994).
7. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
8. Jogdand S. N. Medical Biotechnology 2nd Edition Himalaya publishers 2008
9. Niemeyer C.M. and Mirkin C.A, Introduction to Nanobiotechnology, Wiley VCH publishers 2003
10. Glick B.R, Delovitch, T. L. and Patten,C.L. Medical Biotechnology,ASM press, (2014).
11. Palmer T. and Bonner P. L. Enzymes, East-West Press.
12. Price, N. C. and stevens L. Fundamentals of Enzymology, Oxford University Press.
13. Nelson, D. L. and Cox, M.M. Lehninger: Principles of Biochemistry, W.H. freeman and Company, NY
14. Stansbury P.F. et al., Principles of Fermentation Technology, Pergamon Press Oxford.
15. Glazer and Nikaido, Microbial Biotechnology by WH Freeman &Company, New York.
16. Cruger and Cruger, Biotechnology – A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-207.1 Know the tools and techniques used in industrial and medical biotechnology.
BT-207.2 Learn about basics of fermentation and downstream processing, uses of microbes, Probiotics, industrial application of enzymes and enzyme engineering.
BT-207.3 Understand basic concepts of molecular diagnostics, vaccines, gene therapy, Stem cell technology, DNA fingerprinting etc.
BT-207.4 Get acquainted with the latest knowledge of different areas of biotechnology and will be able to solve problems requiring interdisciplinary approach.

Table: CO-PO Mapping Matrix for the Course: BT-207 Biotechnology and Human Welfare-I

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-207.1	3	3	3	3	3	3
BT-207.2	3	3	3	3	3	3
BT-207.3	3	3	3	2	3	3
BT-207.4	3	3	3	3	3	3
Average	3	3	3	2.75	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-207 Biotechnology and Human Welfare-I

CO#	PSO1	PSO2	PSO3	PSO4
BT-207.1	3	3	2	1
BT-207.2	3	3	2	2
BT-207.3	3	3	3	1
BT-207.4	3	3	2	3
Average	3	3	2.25	1.75

Semester-II

Paper BT-209 Lab Course based on Genetic Engineering and Cell and Tissue Culture Technology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three Hours

Practical Exercises

1. Restriction Digestion of DNA
2. Ligation of DNA fragments
3. Preparation of competent cells, Bacterial transformation
4. To perform gene amplification using PCR
5. Gene cloning in plasmid vector
6. Gene expression in *E. coli* and analysis of gene product
7. Components of an animal cell culture lab, aseptic techniques used in animal cell culture
8. Preparation of medium and primary cell culture
9. Staining and counting of animal cells, viability/cytotoxic/Proliferative assays in animal cells
10. Trypsinization/Disaggregation of cells
11. Estimation of lipid peroxides in cytotoxicity induced animal cells
12. Freezing and thawing of cells
13. To study the PTC laboratory organization setup
14. Aseptic manipulations and bio-safety measures in PTC lab.
15. Preparation of MS medium stocks, hormones, autoclaving, filter sterilization of hormones and antibiotics.
16. Preparation of Murashige and Skoog's basal and regeneration media.
17. Preparation of aseptic plant material via seed germination.
18. Callus induction using various explants.
19. Regeneration of shoots (micro-propagation), root induction, role of hormones in morphogenesis.
20. Acclimatization of tissue culture plants and establishment in pots.
21. Anther culture.
22. Protoplast isolation and culture.

23. Initiation and maintenance of cell suspension cultures of plant cells.

24. Development of synthetic seeds.

25. To study development of Somatic Emryogenesis.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-209.1 Get acquainted with different tools and techniques used in Genetic Engineering Experiments, and Plant Tissue Culture such as cell culture, micro propagation etc.

BT-209.2 Manipulate DNA for its diverse use in different Biotechnology areas. They will be able to analyses and solve various problems related to plant tissue culture and will be able to setup PTC laboratory

BT-209.3 Get hand on Training in different techniques of cell culturing such as media preparation, Cell isolation, primary culture, trypsinization, sub culturing cryopreservation of cells, various cell viability/cytotoxicity assays

BT-209.4 Understand bio-safety measures related to Plant Tissue Culture

Table: CO-PO Mapping Matrix for the Course: BT-209 Lab Course based on Genetic Engineering and Cell and Tissue Culture Technology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-209.1	3	3	3	3	3	3
BT-209.2	3	3	2	3	3	3
BT-209.3	3	-	3	-	-	-
BT-209.4	3	-	-	3	-	3
Average	3	3	2.66	3	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-209 Lab Course based on Genetic Engineering and Cell and Tissue Culture Technology

CO#	PSO1	PSO2	PSO3	PSO4
BT-209.1	3	3	3	3
BT-209.2	3	3	2	2
BT-209.3	3	3	3	3
BT-209.4	3	2	-	3
Average	3	2.75	2.66	2.75

Semester – II

Paper BT-210 Lab. Course based on Enzyme Technology and Bioinformatics (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three Hours

Practical Exercises

1. Lab rules and safety measures to be taken in Enzyme Technology Lab.
2. Important points to remember for Enzyme Technology work
3. To estimate the quantity of protein by UV-absorption method
4. To estimate the activity of amylase enzyme in serum/urine, saliva
5. Assaying of alkaline phosphatase activity
6. To study the Time course of enzyme catalysed reaction
7. To study the effect of substrate concentration on the activity of enzyme
8. To determine the Km and Vmax values of enzyme catalysed reaction
9. To study the effect of enzyme concentration on the activity of enzyme
10. To determine Temperature optima for the enzyme
11. To determine pH optima for the enzyme
12. Partial purification of enzyme by change of pH, temperature, addition of organic solvents and ammonium sulphate fractionation technique and to determine the specific activity of the enzyme
13. Purification of enzyme by Adsorption/ Affinity/ Ion exchange/ gel-filtration chromatography and to determine the specific activity of the enzyme
14. Immobilization of the enzyme
15. Detailed study of NCBI Homepage.
16. To perform BLAST for Nucleotide Sequence
17. To perform virtual library via NCBI
18. To perform BLAST for a protein sequence
19. To perform multiple sequence alignment via CLUSTAL
20. To perform phylogenetic analysis
21. To display PDB structure using Rasmol
22. Comparative study of the two formats: Gene Bank/ Genepept and FASTA

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-210.1 Work independently and freely on enzymes, their activity estimation part, and kinetics and will be able to analyse, how enzymes activity can be affected.

BT-210.2 Understand the various strategies & analyse the strategy to be taken for the production- purification and immobilisation of particular enzyme

BT-210.3 Know the concept of virtual Library, format of various biological databases and Bioinformatics tools.

BT-210.4 Work on various computational tools for analysing, alignment, phylogenetics of biological data.

Table: CO-PO Mapping Matrix for the Course: BT-210 Lab. Course based on Enzyme Technology and Bioinformatics

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-210.1	3	3	3	3	3	3
BT-210.2	3	3	3	3	3	3
BT-210.3	3	3	2	3	3	3
BT-210.4	3	3	2	3	3	3
Average	3	3	2.5	3	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-210 Lab. Course based on Enzyme Technology and Bioinformatics

CO#	PSO1	PSO2	PSO3	PSO4
BT-210.1	3	2	3	3
BT-210.2	3	3	3	3
BT-210.3	3	3	-	3
BT-210.4	3	3	-	3
Average	3	2.75	3	3

Semester - III
Paper BT-301 Plant Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: To develop trained and skilled manpower in the field of Plant Biotechnology and particularly in the field of transgenics, plant metabolites and related IPR issues, this is the current demand in the field of Agriculture/Plant biotechnology.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Plant genetic transformation: Organization of plant genome – Nuclear genome, Chloroplast genome and mitochondrial genome. Gene tagging.

Chloroplast transformation – vector designing, method and advantages. *Agrobacterium* mediated transformation – Ti and Ri plasmids, role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids – cointegrate and binary vectors, technique and factors affecting *Agrobacterium* mediated transformation of plants.

Direct gene transfer – particle bombardment, ArF excimer laser, electroporation, microinjection and alternative methods.

Screen able and selectable markers, Analysis of transgenic plants: for the presence, integration and expression of transgenes and by biological assays. Gene silencing in transgenic plants. Gene stacking in plants: methods, advantages and drawbacks of each method.

Unit - II

Strategies for introducing biotic and abiotic stress resistance/tolerance: Viral resistance; Fungal resistance; Insect resistance; Herbicide resistance; Various abiotic stresses (like drought, salinity, temperature).

Genetic engineering of plants for molecular farming/pharming: Production of antibodies, vaccines and other medically related proteins in plants. Nutritional enhancement of plants (carbohydrates, seed storage proteins, vitamins), manipulation of flower colours and production of enzymes of industrial importance.

Unit - III

Plant cells as bio factories for the production of secondary metabolites: Secondary metabolites, types of cell culture systems used for production of secondary metabolites and advantages of their *in vitro* production.

Strategies used for high yield of product – development and selection of high yielding cell line cultures, optimization of factors affecting yield of plant cells (physical culture conditions, media and other biochemicals), Immobilization of plant cells, Bioreactors for plant cell, organ and immobilized plant cell cultures, biotransformation, permeabilization of cells and removal of secreted products.

Unit - IV

Intellectual Property Rights, Biosafety and Ethical Issues: Intellectual property rights (IPR): Patents, trade secrets, copyright, Geographical indications, trademarks; GATT & TRIPPS; Patenting of biological material; Plant breeders rights (PBRs) and farmers rights; Clean gene technology; Current status of transgenic crops; Bane and boon of GM crops; Concerns about GM crops– environmental, biosafety and ethical issues**.**

Recommended Books:

1. Malik Z. A., Usha K., Kamaluddin and Athar A. (2017) Plant Biotechnology: Principles and Applications. Springer Nature, Singapore.
2. Elements of Biotechnology by P. K. Gupta, 4th Reprint (2nd Edition): 2019-2020, Rastogi pub.
3. Plant Genetic Engineering Vol. 1 - 6 (2003) Singh R. P and Jaiwal P. K. (Eds.), Sci tech publishing LLC, USA.
4. Introduction to Biotechnology (2009) by H. S. Chawla, 3rd edition, Science publishers, USA Gene transfer to plants by Potrykus I. and Spangenberg G., Springer Verlag, Germany.
5. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
6. Plant biotechnology (2000) by Hammond J, Mc Garvey P. and Yusibov V. (Eds.) Springer Verlag, Germany.
7. Plant Biotechnology – The genetic manipulation of plants (2nd edition, 2008) by Slater A., Scott N. and Fowler M., Oxford pub.
8. Practical application of Plant Molecular Biology (1997) by Henry R.J., Chapman and Hall.
9. Plants, genes and agriculture (2002) by Chrispeels M.J., Sadava D.E, 2nd ed. Jones & Bartlett pub., UK.
10. Nigel G Halford (2018) Crop Biotechnology: Genetic Modification and Genome Editing. World Scientific publishing Europe Ltd., London.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-301.1 Acquire recent knowledge and learn techniques related to organization of plant genome, vectors, methods of genetic transformation and other aspects that are important for raising and molecular analysis of transgenics. Understand the gene silencing and gene stacking.

BT-301.2 Understand genetic engineering strategies for quality improvement and other value added transgenic. They would be able to launch start-ups and become entrepreneurs for various products and processes related to plant biotechnology.

BT-301.3 Attain knowledge for strategies of high yielding of plant bioactive/therapeutic biomolecules of industrial importance. Have an overview of different cell culture systems, bioreactors for them and technologies for extraction and isolation of secondary metabolites.

BT-301.4 Understand IPR, bio-safety and ethical issues related to GM crops.

BT-301.5 Communicate and write effectively on scientific principles and ideas in the field of plant biotechnology.

Table: CO-PO Mapping Matrix for the Course: BT-301 Plant Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-301.1	3	3	3	3	3	3
BT-301.2	3	3	2	3	3	3
BT-301.3	3	-	3	-	-	-
BT-301.4	3	-	-	3	-	-
Average	3	3	2.66	3	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-301 Plant Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-301.1	3	3	3	3
BT-301.2	3	3	2	2
BT-301.3	3	2	3	-
BT-301.4	3	2	-	3
Average	3	2.5	2.66	2.66

Semester - III
Paper BT-302 Microbial Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The objective of the course is to create general understanding amongst the students in the subject of Microbial Biotechnology. This course will take an in-depth look at how microbes and their metabolic pathways and products can be used in biotechnology. The objective of the course is to understand them a general overview, concepts and basic principles in the subject of Microbial Biotechnology with emphasis on how to apply the knowledge in bio processing.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – I

Microbial Biotechnology: Scopes application and challenges. Biology of industrial micro-organisms: Industrial microorganisms, growth metabolism regulation, substrate assimilation/ product formation. Isolation and preservation of industrially important microorganisms. Fermentation system; batch and continuous system, fed batch system, multistage system. Solid state fermentation and its applications.

Unit – II

Overproduction of primary & secondary metabolites: Use of mutation selection and recombination techniques. Fermentation raw materials: Media for industrial fermentations; criteria used in media formulation. Fermenter/bioreactor design and operation; types of fermenter, stirred tank reactor, bubble column reactor, airlift reactor, packed bed reactor, fluidized bed reactor and trickle bed reactor, agitation and aeration in a reactor, mass transfer. Foam formation and control.

Unit - III

Industrial production of alcoholic beverages (whisky, wine and beer) and improvement by genetic engineering. Microbial production of food additives: amino acids, nucleosides and vitamins. Microbial production of industrial chemicals: Bulk organic chemicals ethanol, citric acid, acetic acid, gluconic acid, glycerol acetone and butanol. Microbial production of healthcare products: antibiotics (Penicillin & tetracyclines), Vaccines (Bacterial cells and bacterial toxins)

Unit – IV

Microbial inoculants: Food starter cultures; baker's yeast, starter cultures for the dairy industry, meat starter cultures, Biomass production: single cell protein (SCP) production; microbial inoculants; Microbial transformation of steroids and sterols. Down-stream processing: separation processes for microbial cells and other solids, cell disruption, centrifugation, solvent recovery, drying and crystallization. Recovery schemes for non-volatile metabolites, biomass, extracellular polysaccharides and enzymes.

Recommended Books:

1. Stansbury P.F. et al. (1997), Principles of Fermentation Technology, Pergmon Press Oxford.
2. Ward O.P., (1998), Fermentation Biotechnology – Principles, Process and Products. Prentice Hall Publishing, New Jersey.
3. Microbial Biotechnology: Basic Research and Applications (2020). Edit. Singh *et al*. Pub. Springer
4. Modern Industrial Microbiology and Biotechnology (2007) by Nduka Okafor. Science Publishers
5. Arnold I. Demain and Julian E. Davies (1999), Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press, Washington D.C.
6. Glazer and Nikaido (1998) Microbial Biotechnology by WH Freeman & Company, New York.
7. Cruger and Cruger (2002), Biotechnology – A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-302.1 Evaluate the role of micro-organisms in specific biotechnological processes. Have insight about industrially important microbes, recent developments in fermentation processes and various types of fermentations.

BT-302.2 Attain knowledge about designing of industrial strains and various media optimization strategies, strategies for overproduction of industrial important metabolites structure and functioning of fermenter.

BT-302.3 Get introduced to various strategies of product recovery from a fermentation broth.

BT-302.4 Understand the basic principles of microbial commercial fermentations, knowledge to solve critical problems

Table: CO-PO Mapping Matrix for the Course: BT-302 Microbial Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-302.1	3	3	3	2	2	2
BT-302.2	3	3	2	3	2	3
BT-302.3	3	3	2	1	1	2
BT-302.4	3	3	2	2	3	3
Average	3	3	2.75	2	2	2.5

Table: CO-PSO Mapping Matrix for the Course: BT-302 Microbial Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-302.1	3	3	-	3
BT-302.2	3	3	2	2
BT-302.3	3	3	2	2
BT-302.4	3	3	2	2
Average	3	3	2	2.25

Semester - III
Paper BT-303 Molecular Genetics (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time:3 Hours

Objectives: The purpose of the course is to teach the students about basics and advanced concepts of Molecular Genetics and ensuring that students acquire an extensive and sound knowledge base for future studies.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – I

Eukaryotic Genome Structure and Organization: Genome sequence and chromosome diversity, variation in chromosome number, Special features of metaphase chromosomes, Chromosome banding, Genome size and complexity, organization and content of human genome, Repetitive DNA, Microsatellites, genome wide repeats, Split genes, overlapping genes, cryptic genes, Retrogenes, Multigene families, Pseudo genes

Nucleosome-Basic Structure, spatial arrangements of histones, chromatosome, Solenoid model, Chromatin domains, Chromatin modifications

The Mutability of DNA: An overview of mutation and polymorphism, VNTR polymorphism, DNA damage- spontaneous, Induced (Alkylation, oxidation, radiation), Genotoxicity/ mutagenicity test systems - Ames test, Sister Chromatid exchanges, Micronucleus, Comet assay

Unit – II

Transcription Regulation in Prokaryotes: Positive and Negative control of transcription, Repression and activation, Organization and regulation of Lac, Trp and Ara operon in *E. coli.*, Organization of genome in lambda phage (early, middle and late genes), Regulation of lytic cascade, Antitermination, Repressor proteins (c1, c11, c111, cro), Establishment of lysogeny, cooperative binding of repressor, maintenance of autogenous circuit by c1 repressor

Transcription Regulation in Eukaryotes: Eukaryotic activators, DNA binding domains, Transcriptional repressors, positive and negative regulation of Yeast galactose utilizing genes Signal transduction and control of transcriptional regulators, Gene silencing, Epigenetic gene regulation

Regulatory RNAs: Riboswitches, Interfering RNA (RNAi) and gene expression, Short interfering RNA (siRNA) and its functions, Micro RNA and its functions, Antisense RNA and gene expression

Unit – III

Site-Specific Recombination: Concept, Recombinases and their function, cre-lox recombination, Biological role and applications of site-specific recombination in genome manipulation

Genome Mapping: DNA markers for genetic mapping, RFLP, SSP, SNPs, Physical Mapping-Restriction mapping, Florescent *in situ* hybridization (FISH), Sequence tagged sites (STS) mapping

Genome Sequencing: High throughput sequencing, Clone by clone approach, whole genome shot gun sequencing

Unit - IV

Comparative Genomics: Concept, Orthologs and paralogs, exon shuffling, comparative genomics of eukaryotes

Transcriptome Analysis: Transcriptome, SAGE, Rapid Amplification of cDNA ends (RACE), DNA microarrays

Metabolic Engineering: Principle of engineering metabolic pathways, Directed production of molecules, production of novel compounds, Case studies on rerouting of metabolic pathways

Recommended Books:

1. Essential genes (2007), Benjamin Lewin, Pearson education international 2.
2. Genomes-4 (2017) T.A Brown. Garland science, Taylor & Francis, New York.
3. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primrose and R.M Twyman, Blackwell publishing.
4. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2017) 5th edition, Bernard R Glick and Jack J Pasternak. ASM press, Washington.
5. Human Molecular Genetics (2011) 4thedition, Tom Strachan & Andrew P Read, Garland science.
6. Molecular Biology of Gene (2007) 6th edition, Watson, Baker *etal*, Levine and Losick, Pearson education Inc.
7. Principles of Genetics (2006), 8th Edition, Gardener *et.al*, John Wiley, New York.
8. Genes XII, (2017) (Ed.12th), Lewin, B. Jones and Bartlett Publishers
9. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
10. Principles of Genetics (2006), 8th edition, Snustad and Simmons, Wiley
11. Analysis of Genes and Genomes, (2017) 9th edition Daniel L. Hartl and Bruce Cochrane, Jones and Bartlett Publishers.
12. Biotechnology and Genomics (2013) Gupta P. K. 1st Edition. Rastogi publishers

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-303.1 Acquire the knowledge of genome structure and organization in eukaryotes, DNA mutability, genotoxicity assays, transcription regulation in prokaryotes and eukaryotes, site specific recombination and its applications in genome manipulation.

BT-303.2 Learn advanced techniques of genome mapping and sequencing, comparative genomics and transcriptome analysis.

BT-303.3 Know fundamentals and applications of metabolic engineering

BT-303.4 Get acquainted with methodological concepts and tools needed to acquire top-level skills in the field of molecular genetics

Table: CO-PO Mapping Matrix for the Course: BT-303 Molecular Genetics

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-303.1	3	3	2	2	3	2
BT-303.2	3	3	2	2	3	2
BT-303.3	3	3	2	2	3	2
BT-303.4	3	3	2	2	3	2
Average	3	3	2	2	3	2

Table: CO-PSO Mapping Matrix for the Course: BT-303 Molecular Genetics

CO#	PSO1	PSO2	PSO3	PSO4
BT-303.1	3	-	2	3
BT-303.2	3	-	-	3
BT-303.3	3	3	-	3
BT-303.4	3	3	2	3
Average	3	3	2	3

Semester - III
Paper BT-304 Immunology (*Elective*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objective: The objective of this course is to introduce the students the basics and applied aspects of Immunology which include introduction and overview, fundamentals of the immune system including cells and tissues of the immune system, generation of immune cells and their responses and applications of Immune system in health and disease.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Introduction and overview: Introduction and overview of immunology, cells of immune system, innate and cellular immunity, physical and chemical barriers, cellular defences, inflammation, receptors involved in innate immune system, cells and organs involved in adaptive immune response, fate of antigen after penetration, interrelationship between innate and acquired immunity.

Unit – II

Antigens, antibodies and their interactions: Requirements of immunogenicity, primary and secondary responses, major classes of antigens, basic structure of antibodies, antibody classes and biological activity, antigenic determinants on immunoglobulins, immunoglobulin super family, organization and expression of immunoglobulin genes, antigen-antibody interactions: immunoprecipitation, agglutination, ELISA, immunofluorescence, flow cytometry

Unit - III

Generation of B-cell and T-cell responses: Complement system and its activation, Structure and role of Major Histocompatibility Complex, T-cell receptor- structure, complex and accessory membrane molecules, thymic selection of T-cells, T-cell activation and differentiation, B-cell maturation, activation and proliferation, humoral response, Cytokines-properties and receptors.

Unit - IV

Immune system in health and disease: Hypersensitivity reactions-their types and mechanism, Cancer and the immune system, Cancer immunotherapy, Hybridoma technology: commercial production of antibodies using monoclonal antibodies. Vaccines*:* live attenuated, killed, subunit, conjugate and DNA vaccines. Production of recombinant antibodies and edible vaccines, development of diagnostics using biotech and nanotech tools.

Recommended Books:

1. Benjamin E. Immunology – A short course 4th Edition, John Wiley, New York
2. Kuby J. Immunology,8th Edition, W.H. Freeman & Co., New York
3. Roitt, I.M. Essential Immunology, 12th Edition, Oxford Black Well Science, London
4. Tizard I.R. Immunology – An introduction, 9th Edition, Philadelphia Saunders College press.
5. Gupta P.K. Biotechnology and Genomics, Rastogi Publications Meerut
6. Ommerville et al. Alcamo's Fundamentals of Microbiology, Jones and Barteett Publishers.

Course Outcome: After the completion of this course the students will be able to:

BT-304.1 Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens.

BT-304.2 Understand and describe antigen, antibodies interactions, and generation of immune cells responses, and hybridoma technology for the production of monoclonal antibodies, recombinant antibodies, and different types of vaccines.

BT-304.3 Know about problems emerging in health sector and how to solve them with the knowledge of this subject.

BT-304.4 Learn about different diagnostic and therapeutic techniques in treatment of diseases.

Table: CO-PO Mapping Matrix for the Course: BT-304 Immunology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-304.1	3	3	2	3	3	2
BT-304.2	3	3	3	3	3	3
BT-304.3	3	3	3	3	3	3
BT-304.4	3	3	3	3	3	3
Average	3	3	2.75	3	3	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-304 Immunology

CO#	PSO1	PSO2	PSO3	PSO4
BT-304.1	3	2	1	-
BT-304.2	3	3	2	1
BT-304.3	3	3	3	1
BT-304.4	3	3	2	1
Average	3	2.75	2	1

Semester – III
Paper BT-305 Molecular Medicine and Diagnostics (*Elective*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The purpose of the course is to teach the students about basics and advanced concepts in Molecular medicine and Diagnostics and ensuring that students acquire an extensive and sound knowledge base for future studies.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Chromosomes Anomalies and Disorders - Numerical (polyploidy, aneuploidy, autosomal, sex-chromosomal) & Structural (deletion, duplication, translocation, inversion, isochromosome, ring chromosome). Single gene disorders – Sickle cell anaemia, Haemophilia, Cystic Fibrosis, Tay-Sachs disease, Huntington disease- Genetics, Prevalence, Diagnosis and prognosis, Polygenic disorders – Type 1 Diabetes, Breast Cancer, Alzheimer disease -Genetics, Prevalence, Diagnosis and prognosis

Mitochondrial disorders – Mitochondrial Homeostasis and Parkinson disease

Unit - II

Immunological approaches to detect protein biomarkers of disease-ELISA, Sandwich ELISA for measuring disease associated proteins, diagnosing autoimmune diseases by indirect ELISA, Immunoassays for infectious disease, protein arrays to detect polygenic disorder, DNA based approaches to disease diagnosis -Hybridization probes, allele specific hybridization, Oligonucleotide ligation assay, Padlock probes, Allele specific PCR, Real Time PCR to detect infectious disease, Detection of multiple disease associated mutations using Microarrays

Unit - III

Introduction to metabolic disorders and metabolic profiling. Cardiovascular diseases. Disorders in hormonal action. Insulin dependent and independent diabetes. Ligand induced signalling and gene expression in eukaryotic cells. Importance of intracellular trafficking& its related pathogenesis. Molecular endocrinology in health and disease. Cancer and cell cycle, Gene therapy as a potential tool to cure human diseases. Recombinant molecules in medicine

Unit - IV

Free Radicals and Metal ions in Medicine: Mechanisms of lipid, protein and DNA oxidation, Antioxidants-small molecules and enzymes, Reactive Oxygen Intermediates (ROI), Transition metals in oxidative processes, Involvement of oxidative processes in ageing, cancer and atherosclerosis, Metal ions in gene regulation, Iron in human diseases-anaemia, and

thalassemia, Metals and free radicals in Alzheimer's disease and other neurodegenerative diseases.

Recommended Books

1. Glick B.R, Delovitch, T. L and Patten, C. L. Medical Biotechnology, ASM press 2014
2. Rob Elles, Molecular Diagnosis of Genetic Diseases (Methods in Molecular Medicine), (Ed. 2nd), Humana Press (2003).
3. Dennis, W. Ross, Introduction to Molecular Medicine, (Ed. 3rd), Springer (2002).
4. Tent R.J., Molecular Medicine: Genomics to Personalized Healthcare (Ed. 4th), Academic Press (2012).
5. Runge, Marschall S., Patterson, Cam. Principles of Molecular Medicine (Ed. 2nd), Humana Press (2006).
6. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2009
7. Jogdand S. N. Medical Biotechnology 2nd Edition Himalaya publishers 2011
8. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
9. Bartram G. Katzung, Basic & Clinical Pharmacology, 9th Edition, Mc Graw Hill Publications, 2004.
10. Devlin TM, Text book of biochemistry with Clinical Correlations (5th edition), 2002

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-305.1 Gain thorough understanding of various chromosomal, gene and mitochondrial disorders, different approaches to detect these disorders,

BT-305.2 Get insight into molecular basis of metabolic disorders and role of gene therapy and recombinant molecules as a potential tool in medicine, role of free radicals and metal ions in medicine

BT-305.3 Have a broad understanding of the biomedical research for biotechnological applications. They would gain insight in to clinical aspects of Biotechnology

BT-305.4 Get a springboard to develop their creative thinking and explore their ideas of Molecular Medicine and Diagnostics.

Table: CO-PO Mapping Matrix for the Course: BT-305 Molecular Medicine and Diagnostics

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-305.1	3	3	2	2	3	2
BT-305.2	3	3	2	2	3	2
BT-305.3	3	3	2	2	3	2
BT-305.4	3	3	2	2	3	2
Average	3	3	2	2	3	2

Table: CO-PSO Mapping Matrix for the Course: BT-305 Molecular Medicine and Diagnostics

CO#	PSO1	PSO2	PSO3	PSO4
BT-305.1	3	2	-	3
BT-305.2	3	2	2	3
BT-305.3	3	3	2	3
BT-305.4	3	3	2	3
Average	3	2.5	2	3

Semester - III

Paper BT-307 Biotechnology and Human Welfare-II (*Open Elective*)

Credits: 2
Marks: 40
Internal Assessment: 10
Time: 3 Hours

Objectives: The course will provide a basic knowledge of applications of Biotechnology agricultural and environmental fields.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Agricultural Biotechnology

Animal cell culture and hybridoma technology. Cell culture products, Plant tissue culture, micropropagation, virus free plants, Biochemical production from culture plant cells, Biotransformation. Transgenic plants for enhanced yield, insect and herbicide resistance and quality modifications, Molecular Farming, Biopharmaceuticals, edible vaccines, status of transgenic research, safety regulations for transgenic plants, Transgenic animals- mice, cattle, sheep, pigs, fish etc, Biopharming, pharmaceutical products, IVF and embryo transfer technology for livestock improvement, Animal cloning, Bioethics

Unit - II

Environmental Biotechnology

Role of Biotechnology in the treatment of waste water, Solid waste management using biotech approaches, Bioremediation: Concept and principles, Bioremediation using microbes and plants, Bioinsecticides, Biofertilizers, Biosensors, Biosafety- Introduction, Risk assessment, containment, Biosafety guidelines in India, IPR- Introduction, protection of IPR, Protection of Biotechnological inventions.

Recommended Books:

1. Singh B.D. Biotechnology: Expanding Horizon (2010)3rd edition. Kalyani publishers.
2. Gupta P.K. Biotechnology and Genomics (2013) 1st Edition. Rastogi publishers
3. Clark D.V and Pazdernik, N. J Applying Genetic Revolution (2009) Academic Press
4. Gistou, P and Klu, H. Hand book of Plant Biotechnology (Vol. I & II). John Publication.2004
5. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiely Publishers.2006
6. Ballinic C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon press, New York. 1989.
7. Watson J. D. et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings.2007.
8. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001

9. Glazer and Nikaido, Microbial Biotechnology by WH Freeman &Company, New York.
10. Chawla, H. S. Biotechnology in crop improvement, International Book distributing company.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-307.1 Understand the basic concepts of cell and tissue culture and its applications.

BT-307.2 Get acquainted with the uses of transgenic plants and animals, cloning IVF and embryo transfer technology.

BT-307.3 Learn about role of biotechnology in waste management and bioremediation

BT-307.4 Describe various concepts and principles of biofertilizers, bioinsecticides, biosensors, biosafety and IPR

Table: CO-PO Mapping Matrix for the Course: BT-307 Biotechnology and Human Welfare-II

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-307.1	3	3	3	3	3	3
BT-307.2	3	3	3	2	3	3
BT-307.3	3	3	3	3	3	2
BT-307.4	3	3	3	3	3	3
Average	3	3	3	2.75	3	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-307 Biotechnology and Human Welfare-II

CO#	PSO1	PSO2	PSO3	PSO4
BT-307.1	3	3	2	2
BT-307.2	3	3	3	-
BT-307.3	3	3	1	2
BT-307.4	3	2	3	2
Average	3	2.75	2.25	2

Semester-III

Paper BT-310 Lab Course Based on Plant Biotechnology and Microbial Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three Hours

Practical Exercises

1. Working of fermenter, Fermentation
2. Production of wine, beer, ethanol
3. Isolation of industrially important micro-organisms
4. Screening for lignocellulolytic and pectinolytic micro-organisms
5. Isolation of protease/lipase/amylase producing micro-organisms
6. Isolation of keratinase producing micro-organisms
7. Production of xylanase/Cellulase/Pectinase by microbes and activity estimation
8. Development of selection system for transformants
9. *Agrobacterium* mediated transformation
10. Reporter gene (GUS) assay.
11. Isolation of Plant genomic DNA from the leaves tissue
12. Isolation of plasmid vector from *Agrobacterium*
13. Restriction digestion of plant genomic DNA
14. Transgene detection by amplification
15. Southern blotting of DNA
16. Plants crude extracts preparation from plant tissues**.**
17. Isolation of essential oils from plant tissues.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-310.1 Develop practical skill and acquaint with recent knowledge and techniques in the field of microbial and plant biotechnology. They will be able to understand various biological aspects related to organismal, cellular, biochemical and molecular biological.

BT-310.2 Analyse and solve various problems related to microbial and plant biotechnology, launch start-ups and become entrepreneurs for various products and processes.

BT-310.3 Understand bio-safety measures related to microbial and plant biotechnology techniques.

BT-310.4 Imbibe the value of team spirit and as well as work independently to write and manage their research experimentation.

Table: CO-PO Mapping Matrix for the Course: BT-310 Lab Course Based on Microbial and Plant Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-310.1	3	3	3	3	3	3
BT-310.2	3	3	2	3	3	3
BT-310.3	3	2	3	-	-	-
BT-310.4	3	-	-	3	-	3
Average	3	2.66	2.66	3	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-310 Lab Course Based on Microbial and Plant Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-310.1	3	3	2	3
BT-310.2	3	3	2	2
BT-310.3	3	2	3	-
BT-310.4	3	2	-	3
Average	3	2.5	2.33	2.66

Semester-III

Paper BT-311 Lab Course Based on Molecular Genetics and Immunology /Molecular Medicine and Diagnostics (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three Hours

Practical Exercises

1. Spontaneous and induced mutations
2. Metaphase chromosome preparation, chromosome banding techniques.
3. Sister chromatid exchange assay using peripheral blood lymphocytes for genotoxicity studies
4. Single Cell Gel Electrophoresis to detect DNA damage
5. Analysis of Micronucleus as biomarker of genotoxicity using buccal epithelial cells
6. To determine IC50 of a toxic compound
7. To determine TLC and DLC in human blood smear
8. Isolation of Lymphocytes from peripheral blood
9. Serum preparation and serological reactions-Agglutination and Precipitation
10. To perform Enzyme-linked Immunosorbent assay
11. To perform immunodiffusion by Mancini and Ouchterlony method (single or double)
12. To perform immuno-electrophoresis with a given antigen-antibody system
13. To perform DNA fingerprinting analysis
14. PCR-RFFLP for SNP detection

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-311.1 Learn techniques such as induction of mutations, replica plating, metaphase chromosome preparation, banding techniques, various assays such as comet, SCE and micronucleus as biomarkers of genotoxicity to detect genetic damage

BT-311.2 Work with techniques such as PCR-RFLP for SNP detection, DNA Fingerprinting, isolation of peripheral blood lymphocytes, determination of TLC and DLC for use in clinical and medical fields

BT-311.3 Get trained in diagnostic techniques for detection of different diseases. BT-311.4 Get acquainted with the qualitative and quantitative estimation of antigen.

Table: CO-PO Mapping Matrix for the Course: BT-311 Lab Course Based on Molecular Genetics and Immunology /Molecular Medicine and Diagnostics

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-311.1	3	3	3	3	2	3
BT-311.2	3	3	3	3	2	3
BT-311.3	3	3	-	3	3	3
BT-311.4	3	3	-	-	2	3
Average	3	3	3	3	2.25	3

Table: CO-PSO Mapping Matrix for the Course: BT-311 Lab Course Based on Molecular Genetics and Immunology /Molecular Medicine and Diagnostics

CO#	PSO1	PSO2	PSO3	PSO4
BT-311.1	3	3	3	3
BT-311.2	3	3	3	3
BT-311.3	3	3	-	-
BT-311.4	3	3	-	-
Average	3	3	3	3

Semester – IV

Paper BT-401 Food Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: To convey better knowledge among the students about modern day food biotechnology, its associated techniques like packaging etc and Food safety and Quality control. To ensure better quality of education by continuous monitoring and review of performance and counselling students. To enhance problem-solving skills of students through applying state-of -art techniques. To enhance their scientific and entrepreneur personality, by way of interactive class sessions and industry-oriented visits.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – 1

Biotech foods and supplements: Introduction to food biotechnology and related industries; transgenic plant foods: carbohydrates, proteins, vitamins nutritional quality improvement of the food crops by genetic engineering, safety of GM food crops. Dietary supplements; Single cell Protein (SCP) production, mushrooms production technology, large scale production of algae and yeast.

Unit – II

Food additives & preservation techniques: Food additives- definitions, need for food additives, classification and functions of different additives: thickeners, antioxidants, colouring agents, flavouring agents, sweeteners, emulsifiers, flour improvers; Probiotics: Production & importance of probiotics; Preservation techniques: refrigeration & freezing, dehydration, heating, irradiation, antimicrobial agents used in food preservation.

Unit – III

Fermented foods and Food Packaging: Cheese production technologies; Fermented foods of India: dairy products, cereal and legume foods, vegetables/fruits, meat and fish; Introduction to Food Packaging: definition, factors involved in the evolution and selection of a food package. Types of packaging materials and their functioning properties; Aseptic packaging of foods: sterilization techniques of packaging materials; Methods for the microbiological examination of foods. Advantages/ functions and disadvantages associated with packaging of foods.

Unit – IV

Food Safety and Quality Control: Introduction to concepts of food safety and food quality assurance; Food adulteration, nature of adulterants, methods of evaluation of food adulterants and toxic constituents. Hazard analysis and critical control point (HACCP), Role of international regulatory agencies: USFDA and International Organization for Standards (ISO).

Indian food laws and standards: Prevention of Food Adulteration (PFA) Act, Fruit Products Order (FPO), Meat Products Order (MPO), Cold Storage Order (CSO), Role of AGMARK Standard, Bureau of Indian Standards (BIS) and Food Safety and Standards Authority of India (FSSAI).

Recommended Books:

1. Skariyachan S and Abhilash M. (2012) Introduction to Food Biotechnology. CBS publishers, New Delhi.
2. Sivasankar, B (2002): Food Processing and Preservation. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Khetarpaul N. (2005). Food Processing and Preservation, Dya Publishing House, New Delhi.
4. Robertson, G.L. (2012). Food Packaging: Principles and Practice (3rd ed.), Taylor and Francis
5. Ahvenainen, R. (Ed.) Novel Food Packaging Techniques, CRC Press, (2003).
6. Han, J.H.(Ed.) Innovations in Food Packaging, Elsevier Academic Press, (2005).
7. Food and Agricultural Organization: Manuals of Food Quality Control.
8. Gould, W.A. and Gould, R.W. (2001) Total Quality Assurance for the Food Industries, 3rd edition, CTI Publications Inc. Baltimore.
9. V.K. Josh (2009). Biotechnology: Food fermentation in Microbiology, Biochemistry and Technology, Vol. 1 and 2.
10. Adams M R and Moss M.O. (2008) Food Microbiology. 3rd edition, RSC Publishing Cambridge, UK.
11. Marwaha S.S. and Arora J. K. (2000) Food Processing: Biotechnological Applications. Asiatech Publishers Inc., New Delhi.
12. Frazier W. C. and Westhoff D. C. (2013) Food Microbiology. 5th edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-401.1 Understand the scope of food biotechnology and acquaint with recent theoretical knowledge and techniques related to production and processing of biotech foods and supplements.

BT-401.2 Comprehend about the food additives that are relevant to processed food industry for shelf-life extension, processing aids and sensory appeal.

BT-401.3 Gain the knowledge of food packaging, its importance and its interaction with food products. They would be able to launch start-ups and become entrepreneurs for huge different types of products and processes related to food and packaging.

BT-401.4 Learn about food preservation techniques, methods for the microbiological examination, concepts of food safety, quality control, ethical issues and regulatory compliances related to food biotechnology.

BT-401.5 Develop biotech savvy integrated personality with ability to communicate and write effectively on scientific principles and ideas in the field of food biotechnology.

Table: CO-PO Mapping Matrix for the Course: BT-401 Food Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-401.1	3	3	3	3	3	3
BT-401.2	3	3	2	3	3	3
BT-401.3	3	3	3	-	-	-
BT-401.4	3	-	-	3	-	-
Average	3	3	2.66	3	3	3

Table: CO-PSO Mapping Matrix for the Course: BT-401 Food Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-401.1	3	3	3	3
BT-401.2	3	3	3	2
BT-401.3	3	3	3	-
BT-401.4	3	2	-	3
Average	3	2.75	3	2.66

Semester – IV
Paper BT-402 Environmental Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: The proposed course is designed to teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society. Also, it is desired to make them understand the role of biotechnology in environment for prevention, remediation and monitoring of pollutants.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit – I

Environmental Biotechnology: An overview, concept, scope and market Biological control of air pollution. Bacterial examination of water for potability. Testing of water for physiochemical parameters including BOD & COD. Solid waste: Sources and management (composting, vermicomposting and methane production).

Unit – II

Waste water: origin, composition and treatment. Physical, chemical and biological treatment of waste water. Aerobic processes: activated sludge, oxidation ponds, trickling filter towers, and rotating discs. Anaerobic processes: anaerobic digesters, anaerobic filters and up flow sludge blanket reactors. Microbiology and biochemistry of aerobic and anaerobic waste water treatment processes.

Treatment of industrial effluents: distillery effluent, paper and pulp mill effluent, tannary effluent, textile dye effluent, removal of heavy metals from waste waters.

Unit – III

Bioremediation: Introduction of Bioremediation; advantages and applications; Types of bioremediation, Natural (attenuation), Ex-situ and In-situ, Bioaugmentation and biostimulation, Solid phase and slurry phase bioremediation.

Biodegradation: Aerobic vs. anaerobic Degradation; Microbial basis of Biodegradation; Biodegradation of Xenobiotics; Microbial degradation of pesticides

Biotechnological methods of pollution detection: General bioassays in pollution monitoring, cell biology in environmental monitoring, molecular biology in environmental monitoring and biosensors in environmental analysis.

Unit – IV

Microbial Insecticides: Bacteria, fungi and viruses. Use of R-DNA technology to enhance the efficacy microbial insecticides. Biofertilizers, Microbes in oil recovery and bioleaching. Biodeterioration of stored plant food materials, leather, wool, metals, textiles, stone & related building. Control of microbial biodeterioration.

Recommended Books:

1. Environmental Biotechnology: Principles and Applications, Second Edition (2020). By Bruce E. Rittman, Perry L. McCarty. Pub. Mc Graw Hills
2. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold.
3. Advanced Environmental Biotechnology by S.K. Agarwal. APH Publishing, New Delhi, (2005).
4. Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. By Jeyabalan Sangeetha, Devarajan Thangadurai, Muniswamy David, Mohd Azmuddin Abdullah (2016) Pub. Apple Academic Press
5. Environmental Science and Technology. Stankey E.M. (1997), Lewis Publishers, New York.
6. Microbial Biotechnology: Basic Research and Applications (2020). Edit. Singh *et al.* Pub. Springer
7. Biodegradation and Bioremediation: Soil Biology. Singh A. and Ward O.P. (2004), Springer

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-402.1 Have an overview of the developments in the field of environmental biotechnology with special emphasis on the role of microbes in mitigating environment pollution as well as potability of water and its quality control.

BT-402.2 Describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.

BT-402.3 Understand the role of microbes in bioremediation of environmental pollutants and also utility of microbes in mineral and oil recovery

BT-402.4 Understand applications of biotechnology in environment monitoring

Table: CO-PO Mapping Matrix for the Course: BT-402 Environmental Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-402.1	3	3	3	3	3	2
BT-402.2	3	3	3	3	2	3
BT-402.3	3	3	2	1	1	2
BT-402.4	3	3	2	2	3	3
Average	3	3	2.5	2.25	2.25	2.5

Table: CO-PSO Mapping Matrix for the Course: BT-402 Environmental Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-402.1	3	3	2	3
BT-402.2	3	3	2	2
BT-402.3	3	3	2	2
BT-402.4	3	3	2	2
Average	3	3	2	2.25

Semester – IV

Paper BT-403 Animal and Medical Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time:3 Hours

Objectives: This course is designed to teach students about the different scientific aspects of Animal and Medical Biotechnology and their applications

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Animal Cloning

Concept of animal cloning, cloning from embryonic and adult cells, Creation of Dolly, Molly and Polly

Transgenic Animals

Transfection methods-DNA microinjection, Retroviral and embryonic stem cell methods, Application of transgenic animals-mice, sheep, pigs, goats, cows, fish

Unit - II

Embryo transfer Technology

Superovulation and embryo transfer in cattle, artificial insemination, advantages of embryo transfer

Stem Cell Technology

Definition and meaning of stem cells, function, adult and embryonic stem cells, hematopoietic, mesenchymal and neural stem cells, therapeutic cloning for embryonic stem cells, ethical issues.

Unit - III

Nucleic Acid Therapeutics -Antisense RNA, Ribozyme, Aptamers, DNAzymes, RNAi, Zinc Finger Nucleases

Protein Therapeutics-Pharmaceuticals (Tumour Necrosis Factor, Human Growth Hormone, Interferon etc), Recombinant Antibodies (Human Monoclonal Antibodies, Hybrid Human-Mouse Monoclonal Antibody, Anticancer Antibodies), Enzymes (DNase, Alginate Lyase, Alpha 1 Antitrypsin, Phenyl Ammonia Lyase, Glycosidases); Use of Lactic Acid Bacteria for delivery of therapeutic agents (Interleukin-10, Leptin, An HIV Inhibitor, Insulin)

Gene Therapy-Types of gene therapy, Augmentation Gene therapy, Targeted gene therapy, gene therapy for SCID, Cancer, Neurological disorders, Ethical issues

Unit - IV

Nanobiotechnology- Introduction, types and synthesis of Nanoparticles, Protein based nanostructures, applications of nanoparticles – Nanobiosensors, drug and gene delivery, disease diagnostics and therapy; risk potential of nanomaterials

Pharmacogenomics-concept, Role of Genetic Variations in different responses of individuals to drugs, Pharmacogenomics and industry, personalized Medicine, DNA fingerprinting in Forensic sciences

Recommended Books:

1. Ian Freshney, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (Ed. 7th), Wiley-Blackwell (2016).
2. Ranga M.M., Animal Biotechnology, (Ed. 3rd) Agrobios (2018).
3. Glick B.R, Delovitch, T.L and Patten, C.L. Medical Biotechnology, ASM press 2014
4. MarshakL. Stem Cell biology, Cold spring Harbor (2001).
5. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2009
6. Jogdand, S. N. Medical Biotechnology 2nd Edition Himalaya publishers 2011
7. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
8. Balasubramanian, D., Bryce, C.F.A., Jayaraman, K., Green, J. &Dharmalingam, Concepts in Biotechnology, (Ed. 2nd), University Press (2004).
9. Satyanarayan, U., Biotechnology, Books and Allied (P) Ltd. (2008).
10. Singh B.D. Biotechnology: Expanding Horizon (2010), 3rd edition. Kalyani Publishers.
11. Gupta P.K. Biotechnology and Genomics (2013) 1st Edition. Rastogi publishers
12. Niemeyer C.M. and Mirkin C. A., Introduction to Nanobiotechnology, Wiley VCH publishers 2003
13. Primose, S.B. and Twyman, R.M. Principles of Gene manipulation and Genomics (7th edition), Blackwell Publisher 2006
14. Bartram G. Katzung, Basic & Clinical Pharmacology, 9th Edition, Mc Graw Hill Publications, 2004.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-403.1 Learn techniques of animal cloning, embryo transfer, production of transgenic animals and their applications for human welfare.

BT-403.2 Gain thorough understanding of Nucleic acid and protein therapeutics, role of stem cells in biomedical research, gene therapy and DNA fingerprinting

BT-403.3 Learn advanced techniques such as nanobiotechnology and pharmacogenomics and gain insight into clinical aspects of Biotechnology

BT-403.4 Have a broad understanding of the animal and biomedical research for biotechnological applications and explore their ideas of new vision of animal and medical biotechnology.

Table: CO-PO Mapping Matrix for the Course: BT-403 Animal and Medical Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-403.1	3	3	3	2	3	2
BT-403.2	3	3	3	2	3	2
BT-403.3	3	3	3	2	3	2
BT-403.4	3	3	3	2	3	2
Average	3	3	3	2	3	2

Table: CO-PSO Mapping Matrix for the Course: BT-403 Animal and Medical Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-403.1	3	-	2	3
BT-403.2	3	3	2	3
BT-403.3	3	3	2	3
BT-403.4	3	3	2	3
Average	3	3	2	3

Semester – IV

Paper BT-404 Genomics, Proteomics and Metabolomics (*Elective*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objectives: During the course students would learn about genomics including genetic features of nuclear genomes of prokaryotes and eukaryotes, eukaryotic organelle genomes, genome evolution and molecular phylogenetics. The course also aims to introduce the students to the fields of proteomics and metabolomics.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Genetic Features of Eukaryotic Nuclear Genomes -Where are the genes in a nuclear genome? How are the genes organized in a nuclear genome? How many genes are there and what are their functions?

Genetic Features of Prokaryotic Genomes-How are the genes organized in a prokaryotic genome? How many genes are there and what are their functions? Prokaryotic genomes and the species concept

Eukaryotic Organelle Genomes-The origins of organelle genomes, Physical features of organelle genomes, The genetic content of organelle genomes

Unit - II

Genome Evolution-Genomes: the first ten billion years- the origins of genomes, Acquisition of new genes- by duplication events, from other species, Non coding DNA and genome evolution: Transposable elements and genome evolution, The human Genome: the last five million years Molecular Phylogenetics -origin of molecular phylogenetic, phonetics and cladistics, key features of DNA based phylogenetic trees, Applications of molecular phylogenetics-Evolutionary relationships between humans & other primates, the origins of AIDS, molecular phylogenetic as a tool in the study of human prehistory.

Unit - III

An introduction to Proteomics, Proteome; Areas of Proteomics – Structural proteomics, Functional proteomics, Expression proteomics.

Approaches for study of Proteomics: Separation of proteins by Two-dimensional electrophoresis; Mass spectrometry (ESI and MALDI); Amino acid sequencing of protein by Edman method (Traditional approach); Identification of proteins by tandem mass spectrometry; Shot gun proteomics; Protein Sequence databases; Peptide fingerprinting/mapping; Determination of 3D structure of protein by X-ray diffraction and NMR spectroscopy.

Protein expression profiling – 2D differential in–gel electrophoresis, Isotope-coded affinity tag (ICAT) method for quantitative proteome analysis; Various approaches for determining the

function of a protein; Protein-protein interaction using two hybrid system, complementation, tandem affinity purification (TAP) tag method; Protein-protein interaction mapping; Protein microarrays – Analytical, reverse phase, functional.

Unit - IV

Introduction to metabolism, metabolic pathways, metabolite, metabolomics; Methods/ approaches employed to study metabolism; Inter-relationship between genome, transcriptome, proteome and metabolome; Methods for measurement of metabolites level / concentration.

Metabolic regulation and control – Homeostasis and metabolic control, metabolic flux, metabolic control Analysis, Demand –Supply Analysis, mechanisms of flux control, Regulation of glycolysis in muscle as an example of metabolic regulation.

Metabolic engineering – Transfer of gene/s, partial pathways, entire biosynthetic pathways for creating new products. Metabolic engineering for altering / redirecting metabolite flow. Limitations in Metabolic Engineering.

Recommended Books:

1. Brown T. A. Genomes 3 (2007) Garland Science Publishing, New York, USA.
2. Strachan Tom and Andrew Read, Human Molecular Genetics 4th Edition (2011). Garland Science, Taylor & Francis Group LLC, USA.
3. Primrose, S.B. and Twyman, R.M. Principles of Gene manipulation and Genomics (7th edition), Blackwell Publisher
4. Voet , D and Voet , J.G. Biochemistry, John Wiley and Sons, USA
5. Satyanarayana, U and chakrapani, U. Biochemistry, Books and allied (P) Ltd, India.
6. Nelson, D.L. and Cox, M.M. Lehninger principles of Biochemistry, W.H. freeman and Company, NY
7. Gupta, P.K. Elements of Biotechnology, Rastogi publications, India.
8. Sawhney, S.K. and Singh, R. Introductory Practical Biochemistry, Narosa publishing house Pvt. Ltd. India.
9. Dubey, R.C. A Text book of Biotechnology, S. Chand & company Ltd, India.
10. Price, N.C. and stevens L. Fundamentals of Enzymology, Oxford University Press.
11. Wilson, K. and walker, J. Principles and Techniques of Biochemistry & Molecular Biology, Cambridge University Press.
12. Glick, B.R., Pasternak, J.J. and patten C.L. Molecular Biotechnology, ASM Press. Washington DC.
13. Devasena, T. Enzymology, Oxford University Press.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-404.1 Understand the concept of genome, proteome and metabolome and their correlation with each other.

BT-404.2 Learn about genetic organization of nuclear genomes of prokaryotes and eukaryotes, features of eukaryotic organelle genomes, genome evolution and molecular phylogenetics.

BT-404.3 Conceptualize about different techniques used for proteomics and metabolomics.

BT-404.4 Learn application of techniques for further research studies in Genomics, Proteomics and Metabolomics.

Table: CO-PO Mapping Matrix for the Course: BT-404 Genomics, Proteomics and Metabolomics

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-404.1	3	3	-	3	3	3
BT-404.2	3	3	2	3	-	3
BT-404.3	3	3	-	3	-	3
BT-404.4	3	2	2	2	2	3
Average	3	2.75	2	2.75	2.5	3

Table: CO-PSO Mapping Matrix for the Course: BT-404 Genomics, Proteomics and Metabolomics

CO#	PSO1	PSO2	PSO3	PSO4
BT-404.1	3	3	-	2
BT-404.2	3	2	2	2
BT-404.3	3	3	-	2
BT-404.4	3	3	-	2
Average	3	2	2	2

Semester – IV
Paper BT-405 Biosafety, Bioethics and IPR Issues (*Elective*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: 3 Hours

Objective: The objective of the course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in biotechnology and development of new products.

Note: Nine questions will be set in all. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit. All questions will carry equal marks.

Unit - I

Biosafety: Introduction; Historical background; Biosafety in the laboratory; Laboratory associated infections and other hazards; Biosafety management for environmentally safe use of biotechnology; Biosafety guidelines; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Definition of GMOs & LMOs; Good manufacturing practices (GMP) and Good lab practices(GLP); Overview of National Regulations and relevant International Agreements including Cartagena Protocol; Roles of Institutional Biosafety Committee (IBSC), RCGM, GEAC, MEC, SBCC, DLC and RDAC; Guidelines for research in transgenic sciences and release of GMOs to environment; Bioterrorism and convention on biological weapons

Unit - II

Bioethics: Ethical issues related to biotechnology research; Ethical issues associated with consumptions of genetically modified foods and other products, Ethical implications of human genome project, Social and ethical implications of biological weapons, Bioremediations and environmental impacts of using GMOs; Ethics of patenting- and its impact on biodiversity rich developing countries; Use of animals for research and testing and Alternatives for Animals in Research.

Unit - III

Social, economic and legal issues related to biotechnology: Public education of the processes of biotechnology involved in generating new forms of life for informed decision making; Testing of drugs on human volunteers; Human cloning and Gene therapy - ethical and social issues; Organ transplantation- ethical and legal implications; Research focus to address the need of the poor and of environment.

Entrepreneurship: Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneur.

Project Management: Formulation, Identification and selection based on size, Technological assessment, Project cost and market potential and marketing concepts.

Industrial licensing, venture capital, Biotechnological industries in India and potential job opportunities.

Unit - IV

Intellectual Property Rights: Intellectual property rights and IPR protection; Patenting and the procedure involved in the application of patents and granting of a patent; Compulsory licenses; Legislations covering IPR's in India, Patent search; Patent Cooperation Treaty (PCT); Traditional knowledge commercial exploitation; Farmers rights; Plant breeder's rights; International and National conventions on Biotechnology and related areas- GATT, TRIPS, Biodiversity convention, etc.

Recommended Books:

1. Thomas, J. A. and Fuch, R. L. Biotechnology and Safety Assessment. Academic Press. (2002).
2. Fleming, D. A., Hunt, D. L., Biological safety Principles and practices. ASM Press. (2000).
3. Sateesh, M. K. Bioethics & Biosafety, IK Publishers. (2008).
4. Singh B. D. Biotechnology: Expanding Horizon. Kalyani; edition (2015)
5. Singh K., Intellectual Property Rights on Biotechnology BCIL, New Delhi. (2008).
6. Desai, V., Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).
7. Singh, I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).
8. Goel and Prashar, IPR, Biosafety and Bioethics, Pearson education, India (2013)
9. Important Web Links:

   http://www.w3.org/IPR/

   http://www.wipo.int/portal/index.html.en

   http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html

   www.patentoffice.nic.in

   www.iprlawindia.org

   http://www.cbd.int/biosafety/background.shtml

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-405.1 Understand the basic issues of biosafety, bioethics and IPR arising from the commercialization of biotech products.

BT-405.2 Follow the regulatory framework in their future venture to ensure product safety and benefit the society

BT-405.3 Assess their personal characteristics and interests to that of the "successful" entrepreneur, identification and assess sources of support for small businesses and entrepreneurs.

BT-405.4 Perform project management and choosing & processing the most appropriate form of IPR for protection of their research/ end product.

Table: CO-PO Mapping Matrix for the Course: BT-405 Biosafety, Bioethics and IPR Issues

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-405.1	3	3	3	-	3	-
BT-405.2	3	-	3	2	3	2
BT-405.3	2	-	3	3	3	3
BT-405.4	3	-	3	3	2	3
Average	2.75	3	3	2.66	2.75	2.66

Table: CO-PSO Mapping Matrix for the Course: BT-405 Biosafety, Bioethics and IPR Issues

CO#	PSO1	PSO2	PSO3	PSO4
BT-405.1	3	3	3	-
BT-405.2	3	3	3	-
BT-405.3	3	3	3	3
BT-405.4	3	3	3	3
Average	3	3	3	3

Semester – IV

Paper BT-406 Lab Course Based on Food and Environmental Biotechnology (*Core*)

Credits: 4
Marks: 80
Internal Assessment: 20
Time: Three Hours

Practical Exercises

1. Preparation of synthetic medium for yeast culture.
2. To study the production of yeast.
3. To study the cultivation of mushrooms.
4. To study the various sterilization and food preservation techniques.
5. Estimation of (a) Iodine value, (b) Saponification value (c) acid value of fats and oils.
6. Determination of moisture, total crude fat in a given food sample.
7. Determination of Acidity & pH in food sample/beverages.
8. Determination of total, non-reducing and reducing sugars.
9. To determine TDS, DO, COD, BOD of given water sample.
10. Total bacterial population of given samples of water by standard plate count technique (SPC)
11. To check the potability of given water sample.
12. To check the presence of coliform in given water sample by Multiple- tube fermentation test or most probable number test (Presumptive, confirmed and completed test)
13. To check the presence of coliforms using membrane filter method.
14. To check the presence of faecal and non- faecal coliforms in the given water sample and confirmation of faecal coliforms.
15. To determine the quality of given milk sample.
16. Microbial production of Sauerkraut.

Course Outcomes (COs): After the completion of this course the students will be able to:

BT-406.1 Have knowledge and hands-on training of techniques for culture of yeast and mushrooms.

BT-406.2 Learn practical knowledge of methods to test the potability of different water samples

BT-406.3 Have practical understanding of techniques to test various qualitative aspects of diverse water & food samples.

BT-406.4 Choose most appropriate technique for food and water testing and imbibe the value of team spirit while working together during practical sessions.

Table: CO-PO Mapping Matrix for the Course: BT-406 Lab Course Based on Food and Environmental Biotechnology

CO#	PO1	PO2	PO3	PO4	PO5	PO6
BT-406.1	3	3	3	2	3	2
BT-406.2	3	3	3	3	3	3
BT-406.3	3	3	3	3	3	3
BT-406.4	3	3	3	3	3	3
Average	3	3	3	2.75	3	2.75

Table: CO-PSO Mapping Matrix for the Course: BT-406 Lab Course Based on Food and Environmental Biotechnology

CO#	PSO1	PSO2	PSO3	PSO4
BT-406.1	3	3	3	2
BT-406.2	3	3	3	3
BT-406.3	3	3	3	3
BT-406.4	3	3	3	3
Average	3	3	3	2.75

Table: CO-PO-PSO Mapping Matrix for all the Courses of M. Sc. Biotechnology

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
BT-101	3	3	2	2.25	2.75	1.66	2.75	3	2	2.5
BT-102	3	3	3	3	3	2.75	3	2.75	3	3
BT-103	3	3	2.5	3	3	2.5	3	3	2.75	2.75
BT-104	3	3	2.5	3	3	2.5	3	3	2.75	2.75
BT-105	3	3	2.75	2.75	2.75	2.75	3	3	3	2.75
BT-106	3	3	3	3	2.5	3	3	3	2.5	3
BT-201	3	3	3	2.5	3	3	3	1.5	1.66	2
BT-202	3	3	2.5	2.66	3	2.75	3	3	2.75	3
BT-203	3	2.5	2.5	3	3	3	3	2.66	3	2.66
BT-204	2.75	2.5	1.5	3	2.75	1.25	3	3	2	2.25
BT-205	3	3	3	2.75	3	2.75	3	2.75	2.75	3
BT-207	3	3	3	2.75	3	3	3	3	2.25	1.75
BT-209	3	3	2.66	3	3	3	3	2.75	2.66	2.75
BT-210	3	3	2.5	3	3	3	3	2.75	3	3
BT-301	3	3	2.66	3	3	3	3	2.5	2.66	2.66
BT-302	3	3	2.75	2	2	2.5	3	3	2	2
BT-303	3	3	2	2	3	2	3	3	2	3
BT-304	3	3	2.75	3	3	2.75	3	2.75	2	1
BT-305	3	3	2	2	3	2	3	2.5	2	3
BT-307	3	3	3	2.75	3	2.75	3	2.75	2.25	2
BT-310	3	2.66	2.66	3	3	3	3	2.5	2.33	2.66
BT-311	3	3	3	3	2.25	3	3	3	3	3
BT-401	3	3	2.66	3	3	3	3	2.75	3	2.66
BT-402	3	3	2.5	2.25	2.25	2.5	3	3	3	3
BT-403	3	3	3	2	3	2	3	3	2	3
BT-404	3	2.75	2	2.75	2.5	3	3	2	2	2
BT-405	2.75	3	3	2.66	2.75	2.66	3	3	3	3
BT-406	3	3	3	2.75	3	2.75	3	3	3	2.75