# M.Sc. BIOTECHNOLOGY

## SYLLABUS (CBCS PATTERN)
## (2021-22)

**D E P A R T M E N T  O F  B I O T E C H N O L O G Y**
**MAHARAJA SRIRAM CHANDRA BHANJA DEO UNIVERSITY**
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# Course Curriculum for M.Sc. Biotechnology

**SEMESTER-I**

| PAPER NO. | COURSE TITLE | Contact (hrs/week) | Credit | Exam (hrs) | MARKS | | Total |
|---|---|---|---|---|---|---|---|
| | | | | | Int | Ext | |
| BT 401 | Cell Biology & Genetics | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 403 | Biochemistry | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 405 | Microbiology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 407 | Biotechniques | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 409 | Practicals pertaining to Papers BT 401, BT 403, BT 405 & BT 407 | 5 | 5 | 6 | 0 | 100 | 100 |
| | Total | 25 | 25 | 18 | 80 | 420 | 500 |

**SEMESTER-II**

| PAPER NO. | COURSE TITLE | Contact (hrs/week) | Credit | Exam (hrs) | MARKS | | Total |
|---|---|---|---|---|---|---|---|
| | | | | | Int | Ext | |
| BT 402 | Molecular Biology (Supportive I) | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 404 | Enzymology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 406 | Immunology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 408 | Biostatistics and Bioinformatics | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 410 | Practical pertaining to papers BT 402, BT 404 & BT 406 & Seminars | 5 | 5 | 6 | 0 | 100 | 100 |
| OE-BT- 412 | Recombinant DNA Technology | 5 | 5 | 3 | 20 | 80 | 100 |
| | Total | 30 | 30 | 21 | 100 | 500 | 600 |

**SEMESTER-III**

| PAPER NO. | COURSE TITLE | Contact (hrs/week) | Credit | Exam (hrs) | MARKS | | Total |
|---|---|---|---|---|---|---|---|
| | | | | | Int | Ext | |
| BT 501 | Genetic Engineering (Supportive II) | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 503 | Plant Biotechnology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 505 | Animal Biotechnology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 507 | Environmental Biotechnology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT 509 | Practical pertaining to papers BT 402, BT 404, BT 406, BT 408, Seminar | 5 | 5 | 6 | 0 | 100 | 100 |
| | Total | 25 | 25 | 18 | 80 | 420 | 500 |

**SEMESTER-IV**

| PAPER NO. | COURSE TITLE | Contact (hrs/week) | Credit | Exam (hrs) | MARKS | | Total |
|---|---|---|---|---|---|---|---|
| | | | | | Int | Ext | |
| BT-502 | Industrial Biotechnology | 5 | 5 | 3 | 20 | 80 | 100 |
| BT -504 | Bioethics, IPR and Bio-Entrepreneurship | 5 | 5 | 3 | 20 | 80 | 100 |
| BT-506 | Practical | 5 | 5 | 6 | 0 | 100 | 100 |
| BT-508 | Dissertation | 5 | 5 | 6 | 0 | 100 | 100 |
| | Total | 25 | 25 | 75 | 40 | 360 | 400 |

| GRAND TOTAL | Contact (hrs/week) | Credit | Exam (hrs) | Marks | | Total |
|---|---|---|---|---|---|---|
| | | | | Int | Ext | |
| | 100 | 100 | 75 | 300 | 1700 | 2000 |

## PROGRAMME OUTCOMES (POs)

PO 1: The programme has been aligned with the National Biotechnology Development Strategy (2015-2020) aligned by DBT, Govt. of India, aiming at development of human resources in the field of biotechnology and promote human capital for education, advanced strategic research and entrepreneurship.

PO 2: The students in this program will acquire knowledge, skills and expertise in conducting cutting edge research, for higher studies/R&D activity.

PO 3: Acquire conceptual knowledge and comprehensive understanding of the fundamental principles in respective discipline.

PO 4: Apply knowledge, understand and critically evaluate the concepts and scientific developments to take up any challenge towards teaching and research, and cater to the industrial need.

PO 5: Visualize and gain practical knowledge on multidisciplinary aspects related to current research in the fields of biotechnology.

PO 6: Acquire various skills so as to get motivated to innovate, design methods and techniques to carry out research, in the field of plant animal on microbiology.

PO 7: Aims to train students in Biotechnology wherein through engineering use of principles to develop technologies, devices and systems that require substantive expertise in Biology, Agriculture, Pharmaceutical, Industrial, as well as Clinical Research components

PO 8: Promoting academic & research collaboration with institutes & industries at national & international level.

PO 9: Envisioning value based education for strengthening their professional carrier.

PO10: Students will develop research skills to make them competent for various opportunities in India & abroad.

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Will acquire adequate knowledge to compete national level examinations like NET, GATE, IOCL, DRDO, etc.

PSO2: Will have a strong foundation in interdisciplinary sciences such as computer sciences and biological sciences, to develop accelerated and precise technologies for industrial problems, and prepare them for productive careers in fields of biotechnology, pharmaceutical, bioinformatics, research, and healthcare industries

PSO 3: Will be able to demonstrate and apply their knowledge of cell biology, biochemistry, microbiology and molecular biology to solve the problems related to the field of biotechnology.

PSO4: Will be able to gain fundamental knowledge in animal and plant biotechnology and their applications. Students will be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

PSO5: Will be able to (a) To elaborate concepts of biochemistry with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

PSO6: Will be able to understand various facets of molecular procedures and basics of genomics, proteomics that could be employed in early diagnosis and prognosis of human diseases.

PSO7: Will be able to gain hands on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

PSO 8: Will evolve with recent innovations and scientific updates in the technological era in accordance with best scientific temperament, professional and research ethics throughout life.

PSO 9: Will have potential to test hypothesis, design of experiments, and interpret data analysis to solve the scientific problems in the field of

PSO10: Will help to apply computational modeling, proteins dry design & simulation to test the module and solve scientific problems.

PSO 11: The programme is designed to enhance the skill of students in the frontier areas of Biotechnology research, industrial employability, Bio-entrepreneurship and start-up initiatives. Courses are organized into four semesters. Course-wise programme objectives are semester I

[BT-401 (cell biology & genetics): Development of basic research skills for higher studies such as M.Phil and pre-PhDs, BT-403 (Biochemistry): Skills on basic and clinical miochemistry leading to employability in health sectors, BT-405 (Microbiology): Basic skills on research, employability in sectors of industrial and clinical microbiology, BT-407 (Biotechniques): Increasing technical skills of the students for handing of advanced instruments. It will train students for laboratory, industrial research in R&D divisions and clinical employments, BT-409 (Practicals pertaining to Papers BT 401, BT 403, BT 405 & BT 407)]: Hands on training of the students for skill enhancement and employability in industrial and health sectors. Semester II [BT 402 (Molecular Biology): Employability in teaching and research, BT 404 (Enzymology): Skill development in industrial enzyme purification and employment in research and industrial sectors , BT 406 (Immunology): Employability in sectors of antibody development and immunodiagnostics, BT 408 (Biostatistics and Bioinformatics): Employability in sectors of data analysts and bioinformatics, BT 410 (Practical pertaining to papers BT 402, BT 404 & BT 406): Skills for employment in industrial, research and clinical sectors, OE-BT- 412 (Recombinant DNA Technology): Skills for employment in industries involving gene cloning, protein engineering, protein purification, BT 501 (Plant Biotechnology): Employability in teaching and research, BT 505 (Animal Biotechnology): Employability in sectors of industry, research and teaching, Environmental Biotechnology (BT 507): Employability in sectors of environmental biotechnology, bioremediation technology, Environmental science, BT 509 (Practical pertaining to papers BT 402, BT 404, BT 406, BT 408): Hands on training for industrial and academic employment, Semester IV [ (BT-502 (Industrial Biotechnology): Employment in biotechnology industries and biotech product development, BT -504 (Bioethics, IPR and Bio-Entrepreneurship): Employability in patent filing agencies, BT-506 (Practicals pertaining to papers BT-502 (Industrial Biotechnology, BT -504 (Bioethics, IPR and Bio-Entrepreneurship): Skill developments for industrial and academic employments, BT-508 (Dissertation) (Skill development for industrial and research employments)

# SEMESTER-I

## BT-401 (CELL BIOLOGY & GENETICS)

Full Marks: 100 (80+20)
Credits: 5

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**COURSE OBJECTIVES**

(1) To acquire knowledge on the structure and function of cell organelles in eukaryotes, cell cycle and its regulation (generation of new cells via mitosis and meiosis, consequence of uncontrolled cell division), (2) To acquire basic understanding of mechanisms of inheritance of characters from parents to offspring is important.

**UNIT-1:**

An overview of Cell: Structural organization of Prokaryotic and Eukaryotic cells, Structure of model cell membrane, Membrane organization, Properties and functions of cell membrane, Transport across cell membrane: Active and passive transport, Fick's law and Energetic of membrane diffusion, Protein mediated transport: Pumps, Channels and Transporters.

**UNIT-2:**

Extracellular Matrix (ECM) and Cell Organelles (Mitochondria, Chloroplast, Nucleus, Golgi apparatus, ER, Glyoxysome, Peroxisome, Ribosome), Cell cycle and its regulation, Cell division (Mitosis and Meiosis), Consequence of un-controlled cell division.

**UNIT-3:**

Mendel's Principle: Monohybrid Cross (Law of Dominance & Law of Segregation), Dihybrid cross (Law of Independent assortment). Variation to Mendelism (Intragenic interaction: Co-dominance, In-complete dominance; Intergenic gene interaction: epistasis and non epistasis interaction; sex limited traits, sex influenced traits) Multiple alleles, Pleotropy

**UNIT-4:**

Non-mendelism: Cytoplasmic inheritance, Maternal effect and genomic imprinting. Linkage and crossing over. Genetic and physical mapping: Linkage analysis, Tetrad analysis (Ordered and un ordered). Sex determination (Chromosomal, Genetic and Environmental), Pedegree analysis (Autosomal recessive, Autosomal dominant & Sex linked inheritance). Karyotype and genetic disorders in human.

**COURSE OUTCOMES**

After completion of the course, students will be able to

- ✓ To explain the structural organization of prokaryotic and eukaryotic cells
- ✓ To explain
- ✓ To elaborate the fundament principles of genetics (Mendelian and non-Mendelian principles of inheritance)
- ✓ To answer the relationship between phenotype and genotype in human genetic traits, pedigree construction and analysis, basics of genetic mapping, mutation, and epigenetic phenomena (heritable alternate states of gene activity that do not result from mutations)

**Text/Reference Books:**


1) The Cell: A Molecular approach. Cooper, G.M., Hausman, R.E.. Oxford University Press. 6th Edition, 2013
2) Essential Cell Biology. Alberts, B., Hopkin, K., Johnson, A.D., Morgan, D., Raff, M., Roberts, K., Walter P. W. W. Norton & Company, 5th Edition, 2019
3) Karp's Cell and Molecular Biology. Karp, G., Iwasa, J., Marshall, W. Wiley, 8th Edition, 2015
4) Genetics from Genes to Genomes. Hartwell, L., Goldberg, M., Fischer, J., Hood, L. Mc Graw Hill; 6th Edition, 2017
5) Concepts of Genetics. Klug, W.S., Cummings, M., Spencer, C. A., Palladino, M. A., Killian, D., Pearson; 12th Edition, 2018
6) Genetics: Analysis and Principle. Brooker, R. Mc Graw Hill 6th Edition, 2017


## BT-403 (BIOCHEMISTRY)

Full Marks: 100 (80+20)
Credits: 5

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COURSE OBJECTIVES

(1) To understand the basic biochemical reactions inside the cell and organism as a whole, (2) Application of the laws of thermodynamics in biochemical reactions, (3) To enhance the theoretical skills on biochemistry that will increase the employability of students in the fields of clinical bichemistry

**Unit 1**

Biomolecules: Structure and configuration of biomolecules (carbohydrates, Amino acids, proteins, Lipids, nucleic acids and Vitamins), Chemical bonding, Non-covalent interactions, Water, pH, Buffers in Biological System, Colligative properties, Laws of thermodynamics: Gibb's free energy (G), Enthalpy (E) and Entropy (S) changes in Biological reactions.

**Unit 2**

Metabolism of Sugars: Glycolysis, TCA cycle, HMP pathway, Gluconeogenesis, Biosynthesis of starch and glycogen. Oxidation of fatty acids (β-oxidation, Oxidation of unsaturated fatty acids, α-oxidation, ω-oxidation), Ketogenesis, Biosynthesis of fatty acids (long chain and unsaturated), Biosynthesis and regulation of triacylglycerol and cholesterol. ETC and oxidative

phosphorylation, Hormonal Regulation of Carbohydrate and Lipid metabolisms. Disorder of carbohydrate and lipid metabolism

**Unit 3**

Protein Metabolism: Amino acids, an overview (essential and non-essential), Ramachandran Plot, stability of proteins, Biosynthesis of amino acids and its regulation, Amino acid degradation, Urea cycle, Disorders of Amino acid catabolism. Metabolism of Vitamins and their disorders.

**Unit 4**

Nucleic Acid and their Metabolism: Super coiling of nucleic acids, Interaction of nucleic acids and proteins: Biosynthesis of Purines and Pyrimidines. Formation of Deoxyribonucleotides. Nucleic Acid Degradation: Degradation of Purines and Pyrimidines, Disorders of nucleic acid metabolism.

**COURSE OUTCOMES**

After completion of the course, students will be able to

- ✓ To answer the basic biochemical organization of cells, draw molecular structure and mechanism of biomolecules
- ✓ To explain different bio-molecules (e.g. carbohydrates, lipids, proteins and nucleic acids)
- ✓ To illustrate the metabolism of carbohydrates through various anabolic and catabolic pathways like glycolysis, Kreb's cycle, Glycogen metabolism, glucuronic acid cycle etc. and to describe/recognize lipid structures, oxidation and energy yield during beta, alpha and omega oxidation
- ✓ To explain the amino acids and their properties, to understand structure and metabolism of amino acids and proteins.
- ✓ To relate the structure of DNA with its function such as replication and gene expression and biosynthesis as well as degradation of nucleotides
- ✓ Explain common disorders of biochemical pathways

**Text/Reference Books**


1. Molecular Cell Biology, Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. and James Darnell, Freeman, 7th edition 2013.
2. Lehninger Principles of Biochemistry, Nelson, D. L. & Cox, M. M. Freeman, 6th edition, 2013
3. Biochemistry, Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Addison Wesley, 4th edition, 2012
4. Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. & Walker, J.. CUP, 7th edition, 2010
5. Principles of Biochemistry, Voet, D., Voet, J. G. & Pratt, C. W., Wiley, 4th edition, 2013
6. Biochemistry, J. M. Berg, J. L. Tymoczko, L. Stryer, W. H. Freeman; 6th Edition, 2006

# BT-405 (MICROBIOLOGY)

Full Marks: 100 (80+20)
Credit: 5

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COURSE OBJECTIVES
(1) To develop clear understanding of microbial taxonomy, culture conditions, physiology and biochemical properties, (2) To study the biotechnological application of microbes, (3) To understand the common microbial pathogens and their disease causing mechanisms, (4) To enhance the employability of students in clinical pathology and diagnostics

**Unit 1**

Microbial World: Discovery of the microbial world, controversy over spontaneous generation, development of microbiology in twentieth century and microbiology in the present century. Evolution of earth's earliest life forms, Evolution and classification of microbes, New approaches to bacterial taxonomy, nomenclature, Bergey's manual and Molecular identification of microbes; Ribotyping microbes ribotyping, Bacteria: Eubacteria, Cynobacteria, Mycobacteria, Rickettsia, Chlamidia, Mycoplasma, Actinomycetes (overview). Eukarya: Algae, fungi, slime moulds and protozoa (overview)

**Unit 2**

Microbial nutrition: Culture media and their types. Isolation and pure culture techniques, Nutritional types of microorganisms (autotrophs, heterotrophs, lithotrophs, chemo-autotrophs, chemo-heterotrophs and photosynthetic microorganisms), Mechanism of nutrient uptake by bacteria (passive and active absorption of nutrients), Microbial growth: Growth curve, measurement of growth, growth yields, synchronous growth, continuous culture, factors such as temperature, pH, salinity, water availability and oxygen affecting microbial growth, Archea: Halophyles, Methanogens, Thermophyles.

**Unit 3**

Prokaryotic cell structure: Prokaryotic plasma membrane, cell wall, cilia and flagella, cell inclusions like endospores, gas vesicles, Gram-staining: Gram positive and Gram negative bacteria. Metabolic diversity among microorganisms: Photosynthesis, Chemo-organotrophy, chemolithotrophy, syntrophy, nitrogen metabolism, nitrogen fixation and biofertilizers, Fermentation in bacteria and yeast. Bacterial genetic system,: Transformation, Transduction and Conjugation in bacteria, Plasmids and transposons, Genes mutation and mutagenesis, Genetic system of yeast and Neurospora. Viruses: Discovery, classification and structure of viruses, Bacterial, plant, animal and tumor viruses, Viral replication: lytic and lysogenic life cycle, viroids and prions.

**Unit 4**

Microbial Diseases: Host-pathogen interaction, causative agents, symptoms, , virulent factors and their transmission of infectious diseases with special reference to bacteria (food borne and respiratory), fungi (Skin), protozoan (diarrhea, malaria) and virus (Small pox, Hepatitis, HIV). Microbial toxins: Exo, Endo and Entero toxins, mode of action of toxins, virulence and pathogenesis. Prophylaxis and control of Diseases: Antimicrobial drugs (antibacterial, antiviral, antifungal, antiparasitic) and their mode of action, Resistance to antibiotics. Applied Microbiology: Microbial production of Biopolymers, Biofuel, Probiotics, Bio-film.

**COURSE OUTCOMES**

After completion of the course, students will be able to

- ✓ To answer the important and diversified groups of microorganism in nature and molecular techniques for characterization of microorganisms
- ✓ To answer the metabolic diversity, molecular adaptations of extremophiles, quorum sensing and biofilm formation,
- ✓ To discuss about microbial pathogenesis, antibacterial agents, multidrug resistance pattern and contribution of epidemiology in relation to public health.

**Text/Reference Books:**


1) Brock Biology of Microorganisms, Maidgan, Martinko and Perker, Prentice Hall Inc., New York
2) Microbiology, Prescott, Harley and Klein, William C Brown Press.
3) Microbiology, Pelczar, Chan and creig, Tata Mc Graw Hill Publications.
4) General Microbiology, Stainer, R.Y,ingraham,J.L, wheelis, M.L, and Painter, P.R The McMillan Press Lte.
5) Fundamentals of Microbiology by D.E,Alcamo,Jones and Bartiett, boston.
6) Microbiology- Principles and Applications by J.G. Black, John Wiley & Sons, New York.


## BT-407 (BIOTECHNIQUES)

Full Marks: 100 (80+20)
Credits: 5

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**OBJECTIVES**

(1) To develop theoretical knowledge on basic techniques applied in handling of biotechnological instruments, (2) To understand the principles of microscopy, spectroscopy, chromatography and immunological techniques, (3) To enhance student's skills in instrument handling that will facilitate their employability in the applied fields such as (i) industries, (ii) higher education institutions, (iii) research centers, (iv) Pathological laboratories and diagnostic centers

**Unit 1**

Microscopy: Basic principles and Instrumentation of Light microscopy, fluorescence microscopy, Phase contrast and confocal microscopy, Electron (transmission and scanning) microscopy. Atomic absorption microscopy, Different staining and fixation techniques for EM, Freeze etch and Freeze fracture technique.

**Unit 2**

Biophysical Techniques: Principle and Instrumentation of UV-Visible, Fluorescence, Circular dichroism, NMR and ESR spectroscopy, X - ray diffraction, Light scattering, Mass spectrometry and surface Plasmon spectroscopy, Patch clamping and ECG, Brain activity recording, PET, MRI, FMRI and CAT

**Unit 3**

Bio-separation: Principle and basic instrumentation of Centrifugation, Ultra Centrifuge, Principle and application of Chromatography, TLC, Ion exchange, Size exclusion, Gas and High Performance Liquid Chromatography, Affinity chromatography.

**Unit 4**

Electrophoresis & Immunochemical Techniques: Principles of Electrophoresis, PAGE (SDS and Native), Agarose, Blotting (Southern, Northern and Western) techniques, Flow Cytometry, Immunoprecipitation, Enzyme Immunoassay (EIA), ELISA, Radioimmunoassay (RIA), Fluorescence Immuno assay (FIA), Radioisotopes Techniques: nature of radioactivity, safety and handling of radioactivity sample, preparation for Radioactive Sample, Common Isotopes in Biology.

**COURSE OUTCOMES**

After completion of the course, students will be able to

- ✓ Explain different types of microscopes , their principles and imaging techniques used in biological research
- ✓ Describe different spectroscopic techniques such as UV-VIS spectrophotometer, fluorescence spectrophotometer, NMR, XRD and AAS
- ✓ Differentiate different types of chromatography , their principles and application
- ✓ Answer the principles of electrophoretic and immunological methods applied in biochemical analysis

**Text/Reference Books:**

1) Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed.Wilson K and Walker J ,Cambridge University Press.

2) Biotechniques Theory & Practice 3rd Edition, Rana S V S, Rastogi publications

3) Molecular Biomethods Handbook, Walker J M. and Rapley R, Human Press.

4) Practical Biochemistry by Keith Wilson and John Walker, Cambridge University Press.

5) Modern Experimental Biochemistry by Rodney Boyer, Pearson publications.

6) Lab Manual in Biochemistry,Immunology and Biotechnology by Nigam A and Ayyagari A. Tata McGrow Hill.

## BT-409 (PRACTICALS)

Full Marks: 100
Credits: 5

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**OBJECTIVES**

(1) To provide hands-on training to the students of 1st semester on basic biochemical methods, (2) To inculcate the basic microbial techniques such as microbial culture and identification, (3) To analyze genetic data to draw linkage map and pedigree analysis, (4) Use of microscopes to analyze different cell types, (5) Enhance technical skills of the students

**LIST OF PRACTICALS**

1. Microscopy-techniques and observation of samples
2. Preparation of buffers and measurement of pH
3. Determination of absorption maxima and validation of Beers-Lambert law
4. Quantitative estimation of carbohydrate, protein, lipids and nucleic acids
5. Chromatography of bio-molecules (paper chromatrography, TLC and column chromatography)
6. Cell division
7. Preparation of liquid and solid media for growth of microorganisms
8. Isolation, characterization and maintenance of microbes
9. Growth curve of bacteria
10. Staining of microorganisms (Gram stain, acid-fast stain and staining of spores)
11. Biochemical characterization of selected microbes
12. Assay of antibiotics and determination of antibiotic resistance
13. Determination of total microbial load in different samples
14. Linkage mapping
15. Pedigree analysis

**COURSE OUTCOMES**

After completion of the course, students will be able

- ✓ To use compound microscope for microbial identification and analysis
- ✓ To quantitate biomolecules such as carbohydrates, proteins, lipids and nucleic acids
- ✓ To perform various pure culture methods as well as the staining techniques for microbial and cellular identification
- ✓ To handle basic instruments such as centrifuge, UV-VIS spectrophotometer, fluorescence spectrophotometer, gel electrophoresis etc
- ✓ To relate the theoretical principles with practical hands-on training

# SEMESTER-II

## BT-402 (MOLECULAR BIOLOGY)

Full Marks: 100 (80+20)

Credit: 5

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**COURSE OBJECTIVE**

(1) Understanding the complexity of genome organization and their relevance in regulation of gene expression, (2) To understand replication of DNA, transcription of RNA and translation into proteins, (3) To understand regulation of gene expression at transcription and translation level, (4) To understand various post transcriptional modification of RNA and post translational modification of proteins

**Unit 1**

Fine structure of gene: Anatomy of genome (prokaryotic and eukaryotic), Fine structure of chromosomes, Characteristics of genetic material, Proof of DNA as genetic material (viral genome: DNA and RNA), structure of DNA and RNA: super coiling in genome.

**Unit 2**

Replication and repair of Genome: Chromosomal and Cytoplasmic DNA Replication in prokaryotes and Eukaryotes, DNA Repair (Nucleotide Excision, Base Excision, Mismatch and Double-strand Break).

**Unit 3**

Translation: The Genetic Code, Components of protein synthesis, Initiation factors, their regulation and formation of initiation complex, elongation and termination of protein synthesis, post translational modifications, translational inhibitors, protein folding, disorders of protein folding. Transcription: The Central Dogma of Life, Formation of transcription initiation complex, transcription activator and repressor, Transcription in Prokaryotes, Transcription in Eukaryotes (by RNA polymerase I, II and III), Regulation of Transcription, RNA processing: editing and splicing, capping and polyadenylation.

**Unit 4**

Control of gene expression: Regulation of gene expression in phages, viruses, prokaryotic and eukaryotic genes, Role of chromatin in gene expression and gene silencing, targeting of proteins to different cell compartments.

**COURSE OUTCOMES**

After completion of this course, students will be able

- ✓ To explain genome organization in prokaryote and eukaryote, fine structure of gene, DNA replication (nuclear and extra-nuclear) and repair, flow of genetic information (central

dogma) between the cells and within the cells and gene regulation at various levels of expression (such as from chromatin remodelling to transcription, translation).

- ✓ To describe protein synthesis, post-translational modifications, protein folding, disorder of protein folding, protein sorting to different compartments and secretion.
- ✓ To explain the basic mechanism of gene expression
- ✓ To answer various post translational modifications proteins and their biochemical relevance

**Text/Reference Books**


1) Lewin's Genes XII. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T., Jones & Bartlett Learning, 12th Edition, 2018
2) Molecular Biology. Clark, D., Pazdernik, N., McGehe, N. Academic Press. 3rd Edition, 2018
3) Molecular Biology of the Cell. Alberts, B., Johnson. A. D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. Gerald Science, 6th Edition, 2014
4) The Cell: A Molecular approach. Cooper, G.M., Hausman, R.E. Oxford University Press. 6th Edition, 2013
5) Molecular Cloning: A Laboratory Manual. Sambrook, J.F., Russel, D. W. Cold Spring Harbor *Laboratory* Press. 3rd Edition, 2001
6) Frei Felder's Essentials of Molecular Biology. Malacinski, G.M., Narosa, 4th Edition, 2008


## BT-404 (ENZYMOLOGY)

Full Marks: 100
Credit: 5

**OBJECTIVES**

(1) To learn different enzymes, their classification, working principle and forces of enzyme-substrate interaction, (2) To understand the rate of enzyme catalyzed reaction in the light of Michaelis-Menten equation, (3) To learn the basic catalytic principles and their application to common enzymes, (4) To understand various methods of enzyme regulation

**Unit 1**

Properties and Kinetics of enzymes: General characteristics of enzymes, Nomenclature and Classification of enzymes. Common enzymes (Biology of lysozyme, RNAseA, Chymotrypsin, glutathione reductase and carbonic anhydrase), Isozymes and their biological significance prosthetic groups, concept of enzyme-substrate interaction. Forces of enzyme-substrate interaction

**Unit 2**

Enzyme Kinetics: Rate of an enzymatic reaction (Rate determinants and rate constants), Michaelis-Menten equation, Determination of $V_{max}$ and $K_m$ of an enzyme from Line-Weaver-Burk plot, Turnover rate of enzymes, Enzyme inhibition (reversible, irreversible), Reversible: competitive, uncompetitive, non-competitive and mixed inhibition. Important drugs based on enzyme inhibition

**Unit 3**

Energetics of Enzyme Action: Laws of thermodynamics, Energy diagram of enzyme catalyzed reaction, Enthalpy and Entropy changes in enzymatic reactions, Basic enzymatic reactions and their mechanisms. Mechanism of action of common enzymes: Mechanism of biochemical reactions, Basic catalytic principles of enzymes, Details of the mechanism of action for Lysozyme, Chymotrypsin, Glutathione Reductase and Carbonic anhydrase,

**Unit 4**

Regulation of enzymes and Enzyme related disorders: Allosteric regulation of enzymes: characteristics of allosteric regulation (regulation of aspartate transcarbamoylase), Covalent modification of enzymes (regulation of protein phosphatase and protein kinase A), Regulation by proteolytic cleavage (chymotrypsinogen), Disorders of enzyme deficiency in human.

**COURSE OUTCOME**

After completion of the course students will be able

- ✓ Explain different properties of enzymes exemplified with some common enzymes, characteristics of enzyme-substrate interaction
- ✓ To describe the kinetics of enzyme-catalyzed reaction, determination of Michelis constant and maximal velocity, inhibition of enzymes and drugs based on enzyme inhibition
- ✓ To explain the energy changes during enzymatic reactions in terms of thermodynamics, enthalpy and entropy changes in enzymatic reactions.
- ✓ To answer the basic principles of enzyme action and mechanism of action of chymotrypsin, lysozyme, glutathione reductase etc.
- ✓ To describe different regulatory mechanisms of enzymatic reactions with examples, disorders in human due to enzyme deficiency

**ext/Reference Books:**


1) Introduction to Enzyme and Coenzyme Chemistry, Bugg, T, Blackwell Science, 3rd edition, 2012
2) Proteins, Creighton, T. E. Freeman, 2nd edition, 1992.
3) Protein Structure, Darby, N. J. & Creighton, T. E. IRL Press, 1993
4) Fersht, A. R. Structure and Mechanism in Protein Science. Freeman, 3rd Rev edition 1999.
5) Biochemistry, J. M. Berg, J. L. Tymoczko, L. Stryer, W. H. Freeman; 6th Edition (14 July 2006), ISBN-13 : 978-0716767664
6) Lehninger Principles of Biochemistry, Nelson, D. L. & Cox, M. M.. Freeman, 6th edition, 2013

# BT-406 (IMMUNOLOGY)

Full Marks: 100 (80+20)
Credit: 5

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**OBJECTIVES**

(1) To understand the components and mechanism of immune system, (2) Role of different immune cells, antibodies, complement system and MHC in immunity against various antigens, (3) Role of compromised immune system in auto immune and other disorders, (4) To enhance immunological skills of students for handling of pathological and clinical laboratories

**Unit 1**

Introduction to defense system, Immune system, Organization and structure of lymphoid organs of the immune system, primary and secondary lymphoid organs. Innate and acquired immunity. Haematopoeisis, Cells and molecules involved in innate and aquaired immunity; B and T lymphocytes, Macrophases, Neutrophils, Mast cell, NK cells, dendritic cells, Effector Responses of cell mediated and humoral Immunity, Cytokines and chemokines.

**Unit 2**

Complement System: Complement system as a part of innate & adaptive immune system, complement activation by classical, alternatives and lectin pathway, complement mediated lysis and other effects of complement activation. Maturation, activation and differentiation of B and T cells, Structure organization of BCR and TCR Major Histocompatibility Complex; Organisation and structure of class 1 and class 2 MHC. Antigen processing and presentation, interaction between peptide and MHC molecules. Generation of antibody diversity. antibody engineering.

**Unit 3**

Antigens and Antibodies: antigen, antigenicity and immunogens, contribution of the immunogen and biological system towards immunogenicity. Haptens and Superantigens. Structure and functions of Antibody; Basic and fine structure of immunoglobulin classes. Monoclonal antibody, Antigen and Antibody interaction: Antibody affinity and avidity,forces stabilizing antigen antibody interaction, precipitation reaction, immunodiffusion, immunoelectrophoresis, agglutination, precipiatation Reaction ELISA, Immunoflourenence, Western blotting. Elispot assay.

**Unit 4**

Hypersensitivity: IgE- mediated type 1 hypersensitivity mechanism and molecular events in the mast cell degranulation by IgE, Mechanisms behind type 2, 3 & 4 hypersensitive reactions; Inflammation, Autoimmune diseases. Immunology of tumors, Immune therapy of Cancer. Transplantation immunology: Graft Rejection, tissue and organ transplantation.

Immunosupressive therapy during Transplantation. Immunology of tolerance. Immunodeficiency diseases. vaccines.

**COURSE OUTCOMES**

After completion of the course the students will be able

- ✓ To explain various components of the immune system including organs, cells and receptors, antigens and antibodies
- ✓ To describe the key mechanism of innate and adaptive immunity
- ✓ To explain the application of immunology in various diagnostic and therapeutic techniques
- ✓ To explain the principles governing vaccination and the mechanisms of protection against infectious diseases, immunological tolerance, autoimmunity, tumor immunology and immunotherapy

**Text/Reference Books:**


1) Kuby Immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
2) Cellular and Molecular Immunology, Abul Abbas, Andrew H. Lichtman, Shiv Pillai 9 th Edition 2017 Elsevier.
3) Janeway's Immunobiology, Kenneth M. Murphy, Casey Weaver 8th Edition 2011 W. W. Norton & Company
4) Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth Roittand Mosby, USA. Roitt's Essential Immunology (2011), 12th edition, Wiley and Black Well.
5) The Elements of Immunology, F.H. Khan (2009), Pearson Education.
6) Textbook of Basic and Clinical Immunology**,** 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India.


## BT 408 (BIOSTATISTICS AND BIOINFORMATICS)

Full Marks: 100 (80+20)
Credit: 5

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OBJECTIVES

(1) To apply the statistical methods in biological data analysis, (2) Determination of result quality based on statistical parameters, (3) Application of statistics to various biological experiments, (4) Applying bioinformatics to understand the relationship between sequence and structure of biomolecules, (5) Development of data analysis skill of the students and enhance their employability as data analysts

**Unit 1**

Basic Statistical Concepts: Sampling, presentation of data and dispersion: Application of statistics, variables, sampling method, Frequency distribution, Pie diagram, Bar diagram,

Frequency polygon, Histogram, Frequency distribution curve, Scatter diagram, Variability, Range, Mean deviation, Standard Deviation, Variance, Coefficient of variation, Coefficient of dispersion.

**Unit 2**

Probability and Testing of Hypothesis: Addition rules; Permutations; Combinations; Inclusion-exclusion rule, Conditional probability, Probability mass function for discrete random variables and probability density function for continuous random variables, Null and alternative hypotheses, Levels of significance. Type of errors, testing means (*t*- test, chi-square test, F-test), Significance of difference between means using Z score. Probability distribution: Bionomial, poison and normal.

**Unit 3**

Nonparametric methods: signed rank test, rank sum test; Kruskal-Wallis test; Wilcoxon's rank test and Spearman's rank correlation Analysis Of Variance: One way and two way classifications of Anova. Regression and correlation: Simple linear regression; logistic, and multiple regression, Analysis of enzyme kinetic data; Michaelis-Menten; Lineweaver-Burk and the direct linear plot, Polynomial curve fitting.

**Unit 4**

Use of computation in biology: Application of sequence based and structure based approaches to assignment of gene function: Recognition of coding and non-coding sequences and gene annotation, Exon- Intron boundaries, other features of nucleic acid sequencing, Protein motifs & domains, Databanks: Protein and gene data banks. Methods in Bioinformatics: Algorithims used in Biological sequence analysis, Pair-wise and multiple sequence alignment, local and global alignment of protein and DNA sequences. Phylogenetic analysis of proteins and genes, Homology modeling and docking. Basic Alignment Search Tool (BLAST), Psi and Phi BLAST, protein-protein BLAST.

**COURSE OUTCOMES**

**After completion of the course the students will be able**

- ✓ To explain the basic concepts of Probability and Probability Distribution.
- ✓ To explain the Statistical Quality Control, Correlation and regression analysis, Testing of Hypothesis and Analysis of variance.
- ✓ To apply the methods while working on a research project work through the appropriate statistical methods required for a particular research design and choose the appropriate research design and develop appropriate research hypothesis for a research project
- ✓ To explain the role of bioinformatics in biological data analysis, computational methods, tools and algorithms employed for Biological Data Interpretation
- ✓ To predict biomolecular structures and binding

**Text/Reference Books**

1) Fundamentantals of Biostatistics" by B. Rosner.

2) Essential Bioinformatics by Jin Xiong, Texas A & M University.
3) Introductory Biostatistics by Chap T. Le, Lynn E. Eberly, Wilkeys publications.
4) Introductory Biological Statistics, Fourth Edition by John E. Havel, Raymond E. Hampton, Scott J. Meiners.
5) Bioinformatics - Tools & Applications by Kunwar Singh Vaisla & Rajendra Bharti
6) Lesk M.A. Introduction to Bioinformatics. Oxford publication,3rd International Student Edition.

## BT 410 (PRACTICALS)

Full Marks: 100 (80+20)
Credit: 5

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**OBJECTIVES**

(1) To receive hands-on training on various methods on (i) molecular biology, (ii) enzymology, (iii) Immunology, (iv) Bio-statistics and (v) Bio-informatics to solve biological problems, (2) To inculcate the sudents with research and industrial skills pertaining to the above theory papers

**LIST OF PRACTICALS**

1. Isolation and purification of genomic DNA
2. Determination of Tm value of nucleic acids
3. Blotting techniques
4. Electrophoresis (agarose, native and SDS-PAGE)
5. Detection of enzyme acivity (amylase, lipase, protease, DNAse and RNAse)
6. Effect of pH and temperature on enzyme activity
7. Determination of Km and Vmax of enzymes
8. Zymographic determination of enzyme activity
9. Blood film preparation and identification of cells/blood cell counting
10. Lymphoid organs and their microscopic organization
11. Immunization and collection of serum
12. Antigen-antibody reaction
13. ELISA
14. Measurement of central tendency, determination of SD, ANOVA
15. Docking analysis

**COURSE OUTCOMES**

After completing the above practicals the students will be able

- ✓ To gain the technical skills involved in extraction, manipulation and application of biomolecules and enzymes.
- ✓ To develop and apply the modern technology of molecular biology in industries and research.
- ✓ To understand and define the fundamental concepts of immunology and disease diagnosis.
- ✓ To Develop and apply the recent technology involved in diagnostic techniques of immunology and Examining and analyzing the results involved in immune techniques.
- ✓ To examine, analyze and interpret the experimental results using biostatistics and bioinformatics software's.

# OE BT-412

## RECOMBINANT DNA TECHNOLOGY

Full Marks: 100 (80+20)
Credit: 5

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OBJECTIVE
(1) To inculcate the technical skills among students from allied areas (e.g. Zoology, Botany, Wildlife and Chemistry) on advanced tools and techniques in molecular biology (2) To learn the basic molecular techniques such as DNA sequencing, PCR, site-directed mutagenesis, Southern and Northern blotting, (3) To understand the application of R-DNA technology in society and human welfare

**Unit 1**

Concept of gene cloning: Molecular tools and methods in gene cloning. DNA ligases and their mechanism of action, important steps used in gene cloning and clone selection. Cloning vectors (plasmids, lambda phage, M13 phage, BAC and YAC) and expression vectors (pET, GFP- and pGEX and pMAL)

**Unit 2**

Methods of genome sequencing: Sanger's method of DNA sequencing, High throughput and automated DNA sequencing methods, mapping of the genome (genetic and physical), arrangement of contigs by chromosome walking, construction of genomic DNA library, c-DNA library and its implications

**Unit 3**

Functional genomics and proteomics: Southern and Northern hybridization, Polymerase chain reaction (PCR), Real Time PCR, Site directed mutagenesis, Transfection and stable integration of genes in cell lines. Heterologous expression of genes in mammalian and insect cell lines, transfection and transient expression of genes in cell lines. Reporter assays to detect gene expression

**Unit 4**

Applications of recombinant DNA technology: Mutagenesis: site-directed mutagenesis DNA finger printing, gene therapy and its implications, Production of disease resistant and drought

resistant plants, recombinant production of industrially important enzymes and proteins, vaccines and antibodies. Animal cloning, Knockout and transgenic animals and plants

**Text/Reference Books:**


1) Gene Cloning and DNA analysis: an introduction, Brown, T. A. Blackwell Science, 6th edition 2010
2) Genomes, Brown, T. A. Bios, 3rd edition, 2006
3) Gene Cloning and Manipulation, Howe, C. J., CUP, 2nd edition, 2007
4) Genes XIII, Lewin, B. Pearson Higher Education, 2003
5) Molecular Biology of the Gene, Watson, J. D. et al. 7th edition 2013
6) The Cell Cycle, Morgan, David O. OUP 2006


**COURSE OUTCOMES**

After attending the course, students from the allied departments (e.g. Zoology, Botany, Wildlife and Chemistry) will be able

- ✓ To explain basic tools of recombinant DNA technology, restriction enzymes, vectors, DNA manipulating enzymes , Expression Systems and Molecular Markers, and methods of genome sequencing
- ✓ To isolate genomes and plasmids and construction of DNA libraries
- ✓ Apply of R-DNA technology and use of Restriction enzymes in construction of various vectors and libraries such as c-DNA & Genomic libraries
- ✓ To screen the libraries with the help of "Reporter Genes" and Molecular Markers such as RFLP, RAPD, AFLP.
- ✓ To describe the application of DNA technology to solve various societal problems (e.g. forensic science), gene therapy, development of vaccines and genetically modified organisms

# SEMESTER-III

## BT-501 (GENETIC ENGINEERING)

Full Marks: 100 (80+20)
Credit: 5

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OBJECTIVE
(1) To inculcate the students with skills on tools and techniques in molecular biology for cloning of genes, (2) To learn the basic molecular techniques such as DNA sequencing, PCR, site-directed mutagenesis, Southern and Northern blotting, (3) To understand the application of R-DNA technology in society and human welfare, (4) To enhance the employability of M.Sc students from Biotechnlogy in research laboratories (as JRFs, SRFs) and industries

**Unit 1**

Concept of gene cloning: Molecular tools and methods in gene cloning. DNA ligases and their mechanism of action, important steps used in gene cloning and clone selection. Cloning vectors (plasmids, lambda phage, M13 phage, BAC and YAC) and expression vectors (pET, GFP- and pGEX and pMAL)

**Unit 2**

Methods of genome sequencing: Sanger's method of DNA sequencing, High throughput and automated DNA sequencing methods, mapping of the genome (genetic and physical), arrangement of contigs by chromosome walking, construction of genomic DNA library, c-DNA library and its implications

**Unit 3**

Functional genomics and proteomics: Southern and Northern hybridization, Polymerase chain reaction (PCR), Real Time PCR, Site directed mutagenesis, Transfection and stable integration of genes in cell lines. Heterologous expression of genes in mammalian and insect cell lines, transfection and transient expression of genes in cell lines. Reporter assays to detect gene expression

**Unit 4**

Applications of recombinant DNA technology: Mutagenesis: site-directed mutagenesis DNA finger printing, gene therapy and its implications, Production of disease resistant and drought

resistant plants, recombinant production of industrially important enzymes and proteins, vaccines and antibodies. Animal cloning, Knockout and transgenic animals and plants

**COURSE OUTCOMES**

After attending the course, students will be able

- ✓ To explain basic tools of recombinant DNA technology, restriction enzymes, vectors, DNA manipulating enzymes , Expression Systems and Molecular Markers, and methods of genome sequencing
- ✓ To isolate genomes and plasmids and construction of DNA libraries
- ✓ Apply of R-DNA technology and use of Restriction enzymes in construction of various vectors and libraries such as c-DNA & Genomic libraries
- ✓ To screen the libraries with the help of "Reporter Genes" and Molecular Markers such as RFLP, RAPD, AFLP.
- ✓ To describe the application of DNA technology to solve various societal problems (e.g. forensic science), gene therapy, development of vaccines and genetically modified organisms

**Text/Reference Books:**


7) Gene Cloning and DNA analysis: an introduction, Brown, T. A. Blackwell Science, 6th edition 2010
8) Genomes, Brown, T. A. Bios, 3rd edition, 2006
9) Gene Cloning and Manipulation, Howe, C. J., CUP, 2nd edition, 2007
10) Genes XIII, Lewin, B. Pearson Higher Education, 2003
11) Molecular Biology of the Gene, Watson, J. D. et al. 7th edition 2013
12) The Cell Cycle, Morgan, David O. OUP 2006


## BT-503 (PLANT BIOTECHNOLOGY)

Full Marks: 100 (80+20)

Credit: 5

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**OBJECTIVES**

(1) To learn about various biotechnological tools and techniques to be applied in the field of crop improvement, plant breeding, micropropagation and tissue culture, (2) To apply the principle of recombinant DNA technology in production of genetically modified improved quality of plants, (3) Enhance the skills of M.Sc. students from Biotechnology with skills of plant tissue culture

**Unit 1**

Crop improvement: Totipotency of plant cells, Organogenesis, Somatic embryogenesis, Artificial seed production, Micropropagation, Somaclonal variation, Androgenesis and its applications ingenetics and plant breeding including marker and assisted selection, Germplasm conservation and cryopreservation.

**Unit 2**

Plant Genomics: Identification of candidate genes using genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics);

transformation, mutant populations, knockout systems; Heterologous expression systems; Protein analysis.

**Unit 3**

Recombinant DNA technology of plants: Indirect Gene transfer Methods: *Agrobacterium* and $T_i$ plasmid, Direct gene transfer methods: Particle bombardment mediated transformation. Mechanism, Particle gun design, parameter for effective transformation; silicon carbide fiber mediated transformation and alternative methods, Reporter genes, Selectable and scorable markers.

**Unit 4**

Application of Plant rDNA technology: Production resistant plant varities (Herbicide, Biotic and Abiotic Stress), Producing (vitamins, hormones and edible vaccines), Bioenergy generation, Terminator technology, Plastid engineering. Virus induced gene silencing in plants, and its application.

**COURSE OUTCOMES**

**After completion of the course, the students will be able**

- ✓ To apply biotechnology in plant science for plant tissue culture, crop-improvement
- ✓ To develop skill on production of artificial seeds, transgenic and disease resistant varieties
- ✓ To develop skills on molecular mechanisms of gene transfer methods in plant
- ✓ To describe bioenergy production from plant materials and terminator technology to restrict the use of transgenic crop production.
- ✓ To have adequate skill to establish tissue culture from the explants of different medicinal and aromatic plants

**Text/Reference Books:**


1) Plant Biotechnology: The Genetic Manipulation of Plants. Adrian Slater, Nigel Scott, Mark Fowler. Oxford University Press. 2nd Edition, 2008
2) Introduction to Plant Biotechnology. H. S Chawla. CRC Press, 3rd Edition, 2009
3) Principles of Gene Manipulation and Genomics.S B Primrose and RM Twyman. Wiley-Blackwell. 7th Edition, 2006
4) Brown T.A. Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell. 7th Edition, 2016
5) Plant Biotechnology: Principles and Applications. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. Springer, 2017
6) Plant Biotechnology and Genetics: Principles, Techniques, and Applications. C. Neal Stewart, Jr. Wiley, 2nd Edition, 2016

# BT-505 (ANIMAL BIOTECHNOLOGY)

Full Marks: 100 (80+20)
Credit: 5

**OBJECTIVES**

(1) To develop biotechnological skills on handling and culture of animal cells in the laboratory, (2) To learn the skills on establishment of primary and secondary cell cultures, (3) To develop theoretical knowledge on production of valuable animal products such as monoclonal antibodies, enzymes and proteins

**Unit 1**

Establishment of animal cell culture Laboratory: Instrumentation, Equipments and materials for animal cell culture technology, safety measures (sterilization of lab, equipments, media and accessories) and biohazards, contamination: types of contamination, detection of microbial contamination and cross contamination.

**Unit 2**

Growth media and culture conditions: Types of media (serum and serum free media), balanced salt solution, antibiotics and buffers (role of $CO_2$ and $NaHCO_3$), Conditions for mammalian cell culture: pH, Humidity, Temperature

**Unit 3**

Establishment of cell lines: Disintegration of tissue (enzymatic and mechanical methods) and isolation of primary cell lines, Adherent and non-adherent cell lines, transformation to secondary cell lines, Maintenance and characterization of cell culture *in vitro*, subculture: trypsinization methods, storage and Revival of cell lines, three dimensional tissue culture and tissue engineering, Production of hybridoma cells and monoclonal antibodies, induction of cell differentiation in terminally differentiated cells,

**Unit 4**

Application of animal cell culture: Stem cell culture, Cell synchronization, measurement of cell viability, cytotoxicity, apoptosis assay, Scaling-up of animal cell culture, transfection methods: stable and transient transfections, heterologous expression of recombinant proteins in animal cells

**COURSE OUTCOMES**

After completion of the course, the students will be able

- ✓ To comprehend the basic concepts, techniques, procedure, growth and establishment of different types of animal cell cultures
- ✓ To understand cloning and its importance, transgenic animals, their application in industry;.
- ✓ To pursue research related to animal cell/tissue culture at national & international level.
- ✓ To develop skill on engineering the animals to improve sustainability, productivity and suitability for pharmaceutical, agricultural and industrial applications.
- ✓ To acquire practical skill to establish various cell lines from different animals for research

**Text/Reference Books:**


1) Immunotechnology: Principles, Concepts and Applications by Anthony Moran
2) Culture of Cells for Tissue Engineering by G. Vunjak-Novakovic, & R. Ian Freshney
3) DNA Transfer to Cultured Cells by Katya Ravid & R. Ian Freshney:
4) Animal Cell and Tissue Culture by Mathur Shivangi
5) Animal Cell Culture and Technology by Michael Butler
6) Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney


## BT-507 (ENVIRONMENTAL BIOTECHNOLOGY)

Full Marks: 100 (80+20)
Credit: 5

OBJECTIVE

(1) To understand the effect of various environmental pollutants and ecological damages, (2) To apply various biotechnological methods for bioremediation of key environmental pollutants, (3) To explore sustainable, renewable and green energy resources and (4) To apply microbial, plant and green technologies for conservation of ecosystem

**Unit 1**

Environment: Basic concepts and issues, systems ecology, Ecosystem, Environmental pollution: Types (Air, Water and Soil pollution, radioactive pollution and noise pollution). Air pollution: sources of air pollution, Effects of air pollution on human health and agriculture, Methods for air pollution measurement, control of air pollution through Biotechnology. Global environmental problems: Ozone depletion, green house effect, global warming and acid rain.

**Unit 2**

Water pollution: source and effect of water pollution, control measures methods for water pollution measurement: Biological oxygen demand, Biological indicators, Wastewater treatment: Biological (aerobic and anerobic processes) chemical and physical treatment of water,

Characteristics of marine environment, coastal regulatory zones. Soil pollution: Measurement of soil quality, Pestiside pollution, Biodegradable and non-Biodegradable soil pollutants, Bio-magnification, Oil pollution, Major soil bacteria and their roles in degradation of soil pollutants.

**Unit 3**

Ecosystem management: Renewable resources; solid waste management (Composting, Vermiculture and biogas production), degradation of toxic xenobiotics, Bioremediation of contaminated soil and water, Macrophytes in water treatment, Phytoremediation of heavy metals.

**Unit 4**

Sustainable development though Biotechnology: Biofertilizers, Vermiculture, Organic farming, Bio-mineralization, Biofuels (Bioethanol and biohydrogen), Bioprospecting of marine organisms: Seaweeds as food, Phycocolloids and source of pharmaceuticals compounds.

**Text/Reference Books:**

1) Environmental Biotechnology: Concepts and Applications By Hans-Joachim Jördening, Josef Winter; Wiley-VCH.

2) Environmental Biotechnology: A biosystems approach By Daniel A. Vallero; Academic Press, Elsevier.

3) Ecology & Field Biology-R.L.Smith , San Francisco : Benjamin Cummings.

4) Fundamentals of Ecology- E.P. Odum, Belmont,CA:Thomson Brooks/Cole

5) Environmental Science- Cunningham Saigo, McGraw-Hill Science

6) Ecology of Natural Resources-Ramade**,** Wiley-Blackwell

**COURSE OUTCOMES:**

After completion of the course the students will be able

- ✓ To explain the current perspectives in ecological issues to address environmental problems.
- ✓ To address certain difficult environmental problems such as gene-environment interaction, detection of pollutants and elimination and treatment of toxic wastes.
- ✓ To apply biotechnology in environmental management, concepts and strategies of Metagenomics and Biofuel production with an emphasis to cleaner and sustainable environment.
- ✓ To employ and ensure the quality (good or bad) of the environmental samples for the betterment of society.
- ✓ To explain the relevance of basic analysis performed in environmental quality assessment.

# BT-509 (PRACTICAL)

Full Marks: 100
Credit: 5

OBJECTIVES

(1) To learn various skills on (i) plant and (ii) animal tissue culture , (2) To isolate DNA from plants, animals and bacteria, (3) restriction mapping and cloning techniques, (4) Callus and explant culture, (5) Evaluation of pollution level in air, water and soli

**LIST OF PRACTICALS**

1. Preparation of animal tissue culture medium
2. Preparation of single cell suspension
3. Cell counting and cell viability
4. Trypsinization of monolayer and sub-culturing
5. Explant and primary culture of animal cells
6. MTT assay for cell viability and growth
7. Isolation of endophytes
8. Bacterial culture and antibiotic selective media, preparation of competent cell
9. Isolation of plasmid DNA
10. restriction mapping of DNA
11. PCR, RT-PCR, PCR-RFLP, RAPD
12. Preparation of plant tissue culture medium
13. Callus culture and induction of callus
14. Synthetic seed production
15. Estimation of pollutants in soil and water

**COURSE OUTCOMES**

After completion of the above practicals the students will be able

- ✓ To acquire skill on performing recent techniques of genetic engineering.
- ✓ To develop and apply the modern technology of genetic engineering in industries and research.
- ✓ To execute the recent technology involved in plant tissue culture and clonal propagation.
- ✓ To acquire skill on media preparation, explant preparation of animal cell culture and to develop and apply the recent technology involved animal cell culture
- ✓ To examine and analyze the environmental parameters of air, water and soil of different habitats.

# SEMESTER-IV

## BT-502 (INDUSTRIAL BIOTECHNOLOGY)

Full Marks: 100 (80+20)
Credit: 5

OBJECTIVES

(1) To learn skills of industrial scale bacterial growth using bioreactors, (2) To develop various skills on downstream processing used in product development and purification, (3) To learn the basic skills of producing alcohols, acids, antibiotics etc., (4) To develop skills on industrial biotechnology for value added products such as mushroom culture and milk products, (5) To enhance employability of M.Sc. biotechnology students in biotech industries

**Unit 1**

Industrially important organisms (Bacteria, yeast and animal cells), growth conditions (media and parameters) and their optimization, growth curve of microbes and mammalian cells *in vitro*, Major instruments: shake flask and Bio-reactors: design of bioreactors (pulsed, fluidized and photobioreactors)

**Unit 2**

Operating Mode of Bioreactors: Fed-batch and continuous culture, Dynamic Nutrient Feeding. Cell Culture Bioreactors: Simple Stirred Tank Bioreactor, Airlift Bioreactor, Fluidized Bed Bioreactor Membrane Bioreactor, Multiple Membrane Plate Bioreactor, Vibromixer, spin filter stirred tank bioreactor. Downstream Processing: Collection of cultured cells, removal of solid matter, centrifugation and ultrafiltration techniques, cell lysis, protein purification (concentration, lyophilization, drying and crystallization)

**Unit-3**

Production of industrially important chemicals: Alcohol (ethanol), Acids (citric, acetic, gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid), Single cell protein production.

**Unit-4**

Industrial food technology: Elementary idea about canning and packing, sterilization and pasteurization of food products. Technology for typical food products (bread cheese), Food preservation, Mushroom culture.

**COURSE OUTCOMES:**

**After completion of the above course the students will be able**

- ✓ To use microbes for industrial production of food, ethanol and acids
- ✓ To isolate, screen and identify various microbes of industrial importance
- ✓ To work on lab bench fermenter, UP stream and Downstream processing methods
- ✓ To acquire the skill involved in the production of bioproducts and methods to improve modern biotechnology and can apply basic biotechnological principles, methods and models to solve industrial tasks.

- ✓ To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology and design and deliver useful modern biotechnology products to the Society.

**Text/Reference Books:**


1) Industrial Biotechnology By M.S. Ranganathan, Sriram Sridhar Published by Wisdom Press
2) Industrial Biotechnology Problems and Remedies By Indu Shekher Thakur Published by I.K. International Publishing House Pvt. Ltd
3) Industrial Biotechnology by Varun Shastri
4) Industrial Microbiology by A.H.Patel
5) Industrial microbiology by Prescott, Samuel Cate, 1872-1962
6) Industrial Microbiology: An Introduction. By Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton


## BT-504 (BIOETHICS, IPR AND BIO-ENTERPRENEURSHIP)

Full Marks: 100 (80+20)
Credit: 5

OBJECTIVES

(1) To develop awareness on ethical aspects of biotechnology and it's societal implication, (2) To learn about the development of intellectual property rights and patents, (3) To learn the methods about development of sustainable bio-enterpreneurship, (4) To inculcate professional ethics among students

**Unit 1**

Introduction to bioethics: -Introduction to biosafety and health hazards concerning biotechnology, Social and ethical issues in biotechnology. Principles of bioethics, Ethical conflicts in biotechnology, Biosafety in laboratory institution: General guidelines for rDNA research., Ethics in experimentation, laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety.

**Unit 2**

Introduction to Intellectual Property: Introduction to IPR, WTO, WIPO – Establishment and function. Intellectual property rights concepts, Types of IP (Trademarks, Copyright, design, Traditional knowledge, Geographical indications), Patenting and fundamental research, Patenting - definition of patent. Product and process patents, patenting multicellular organisms, Intellectual Ethical issues in human gene therapy and human cloning.

**Unit 3**

Basics of patents: types of patents; Indian Patent Act 1970; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; patent application-

forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications.

**Unit 4**

Scope in bio-entrepreneurship; Integration of Science, technology and business ; concepts and opportunities for bioentrepreneurship; Entrepreneurship and principles of entrepreneurial development, Types of bio-industries – biopharma, bioagri, bioservices and bioindustrial; Importance of entrepreneurship; Organization types, control and management; Conceptual framework and characteristics for being an entrepreneur in biotechnology

**COURSE OUTCOMES**

After completion of the course, the students will be able

- ✓ To gain awareness about Intellectual Property Rights (IPRs) and get more insights into the regulatory affairs.
- ✓ To understand the basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.
- ✓ To understand basic concepts of ethics and safety that are essential for different disciplines of science and to interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life.
- ✓ To recognize importance of biosafety practices and guidelines in research
- ✓ To recognize importance of protection of new knowledge and innovations and its role in entrepreneurship development.

**Text/Reference Books:**


1) Bioethics and Biosafety, by Sateesh, M.K., IK International Publishers (India)
2) Patent law and Entrepreneurship by Singh I. and Kaur, B, Kalyani Publishers (India).
3) Law of Patents, by Srinivasan, K. and Awasthi, H. K. Jain Book Agency (India)
4) Patent Law by Narayan, P, Eastern Law House ( ).
5) Anthology of Biosafety (Vols. 1-4), by Jonathan, Y.R., American Biological Safety Association.
6) Handbook on intellectual property rights in India. by Adukia, R.S. (India).

# BT-506 (PRACTICAL)

Full Marks: 100
Credit: 5

OBJECIVES

(1) To learn various skills on microbial production of industrial products such as ethanol, (2) To receive hands-on training on development of value added products such as mushroom culture, (3) To develop skills on production of single cell proteins, (4) canning and packing of foods

**LIST OF PRACTICALS**

1. Handling and disposal of hazardous materials
2. Stater culture and Fermentation: bio-ethanol production from different sources
3. Screening of industrially important microbes.
4. Beer production technology
5. Production of spawn for mushroom cultivation
6. Production mushroom at laboratory scale
7. Production of single cell protein
8. Preparation of different food product

## COURSE OUTCOME

After completion of the practicals the students will be able to

- ✓ To apply the concepts involved in microbial, plant and animal technology for industrial applications.
- ✓ To demonstrate the techniques involved in bioreactor operation technology in industrial sector.
- ✓ To understand the downstream processing technology, production antibiotics from microbes.
- ✓ To gain knowledge and practical skill for packaging and preservation of food items in industrial scale.
- ✓ To acquire knowledge on bioethics, biosafety in biological laboratories and to understand the IPR and patent filing process in research.

# BT-508 (PROJECT DISSERTATION)

Full Marks: 200
Credit: 10

**OBJECIVES**

(1) To train the students with basic laboratory techniques, (2) To enhance the thought-inducing ability among the students for development of scientific ideas, their execution and interpretation of results, (3) Data analysis methods and presentation skills of research data to enhance the research skills among the young students, (4) To prepare the young minds for building a career in research, industry or start-up initiatives

**COURSE OUTCOMES:**

- To train students organize ideas, material and objectives for their dissertation and to begin development of communication skills.
- To facilitate the students to present their topic of research and explain its importance.
- To formulate a scientific question and present scientific approach to solve the problem.
- To interpret, discuss and communicate scientific results in written form.
- To gain experience in writing a scientific proposal and learn how to present and explain their research findings to the audience effectively.