SYLLABUS FOR THE

MASTER OF SCIENCE
IN
BIOTECHNOLOGY

TWO -YEAR FULL-TIME PROGRAMME

(Choice Based Credit System)

Department of Biotechnology

FACULTY OF SCIENCE

DEEN DAYAL UPADHYAYA, GORAKHPUR UNIVERSITY,

GORAKHPUR – 273009

2019

MASTER OF SCIENCE

(BIOTECHNOLOGY)

TWO-YEAR FULL-TIME PROGRAMME

AFFILIATION

The proposed programme shall be governed by the Department of Biotechnology, Faculty of Science, D.D.U. Gorakhpur University, Gorakhpur– 273009.

PROGRAMME STRUCTURE

The M.Sc.Programme is divided into two Parts as under. Each part will consist of two Semesters as given below.

		Semester – Odd	**Semester – Even**
Part I	First Year	Semester – 1	Semester – 2
Part II	Second Year	Semester – 3	Semester – 4

For semester-1 and 2 would consist of four theory papers of 4 credits each, one laboratory course of 8 credits and one seminar of 1 credit. In semester 3 one elective course of 4 credits would also be offered for other Departments of Faculty of Sciences besides four theory papers (core courses), one laboratory course and seminar. In semester 4, students have to select three out of four papers (elective) along with dissertation (core) and one seminar of 1 credit. **Dissertation/project work will be carried out by students under supervision of faculty members.**

The schedule of papers prescribed for various semesters shall be as follows:

PART I: Semester – 1

1	MBT 101	Microbiology
2	MBT 102	Molecular Biology
3	MBT 103	Biochemistry
4	MBT 104	Cell Biology
5	MBT 105	Laboratory course-
		6. MBT 106 Seminar

PART I: Semester – 2

1	MBT 201	Recombinant DNA technology

2	MBT 202	Enzyme Technology
3	MBT 203	Immunology
4	MBT 204	Bioinformatics, Biostatistics and Genomics
5	MBT 205	Laboratory course-II
		MBT-206 Seminar

PART II: Semester – 3

MBT 301	Plant Biotechnology
MBT 302	Animal Biotechnology
MBT 303	Bioprocess Technology
MBT 304	Environmental Biotechnology
	MBT 305 Introductory Biotechnology (Elective for other department)
MBT 306	Laboratory course-III
	MBT-307 Seminar

PART II: Semester – 4 (Elective course)

- **Students will select three papers (courses) out of four papers from MBT-401, MBT-402, MBT-403 and MBT-404.**
- **Each student will have to submit an allotted dissertation (MBT-406), which would be based on research works and will submit a report on which Viva-voce will be conducted.**

MBT 401	Genomics for crop improvement(Elective)
MBT 402	Proteomics and Nanobiotechnology (Elective)
MBT 403	Biosafety, IPR and Bioethics (Elective)
	MBT 404 Animal Cell and Tissue Culture (Elective)
	MBT 405 Seminar
MBT 406	Dissertation

M. Sc. Biotechnology

Course No.	Course Title	Type (Core/Elective)	Credit
Semester 1			
MBT-101	MICROBIOLOGY	**Core**	**04**
MBT-102	MOLECULAR BIOLOGY	**Core**	**04**
MBT-103	BIOCHEMISTRY	**Core**	**04**
MBT-104	CELL BIOLOGY	**Core**	**04**
MBT-105	LABORATORY COURSE-I (Based on MBT-101, 102, 103 & 104)		**08**
MBT-106	SEMINAR		**01**
		Total	**25**
Semester 2			
MBT-201	RECOMBINANT DNA TECHNOLOGY	**Core**	**04**
MBT-202	ENZYME TECHNOLOGY	**Core**	**04**
MBT-203	IMMUNOLOGY	**Core**	**04**
MBT-204	BIOINFORMATICS, BIOSTATISTICS AND GENOMICS	**Core**	**04**
MBT-205	LABORATORY COURSE-II (Based on MBT-201, 202, 203 & 204)		**08**
MBT-206	SEMINAR		**01**
		Total	**25**
Semester 3			
MBT-301	PLANT BIOTECHNOLOGY	**Core**	**04**
MBT-302	ANIMAL BIOTECHNOLOGY	**Core**	**04**
MBT-303	BIOPROCESS TECHNOLOGY	**Core**	**04**
MBT-304	ENVIRONMENTAL BIOTECHNOLOGY	**Core**	**04**
MBT-305	INTRODUCTORY BIOTECHNOLOGY	**Elective for other**	**04**

		department)	
MBT-306	LABORATORY COURSE-III (Based on MBT-301, 302, 303 & 304)		**08**
MBT-307	Seminar		**01**
		Total	**25**
Semester 4			
MBT-401	GENOMICS FOR CROP IMPROVEMENT	**Elective**	**04**
MBT-402	PROTEOMICS AND NANOBIOTECHNOLOGY	**Elective**	**04**
MBT-403	BIOSAFETY, IPR AND BIOETHICS	**Elective**	**04**
MBT-404	ANIMAL CELL AND TISSUE CULTURE	**Elective**	**04**
MBT-405	SEMINAR	**Core**	**01**
MBT-406	DISSERTATION	**Core**	**12**
		Total	**25**
GRAND TOTAL			**100**

Programme Specific Outcomes of M.Sc. Biotechnology:

PSO1. Understand the biological system at cellular and molecular level.
PSO2. Analyze the interaction between plants & animals with microbes.
PSO3. Understand the interaction and roles of biomolecules in cell as well as in organisms.
PSO4. Understand the principles and methods at molecular level for qualitative and quantitative improvement in agriculture sector.
PSO5. Analyze the causes and impact of environmental changes/degradation and its possible solution.
PSO6. Understand the role of modern biotechnological developments in health sector.
PSO7. Understand the state of art techniques developed in biotechnology.
PSO8. Understand the production of biomolecules for human welfare at industrial scale.
PSO9. Practically examine and analyze the methodology established in the field of biological science.

Semester-1

MBT-101: MICROBIOLOGY
(Core)
THEORY

Course Objectives: To understand the microbes, their taxonomy, physiology, biochemistry, genetics, management of diseases caused by them and their applications.

Unit-1:
Microbial diversity and systematics, Modern approaches to bacterial taxonomy, polyphasic classification, General characteristics of primary domains and of taxonomic groups belonging to Bacteria, Archaea and Eukarya, Nomenclature and outline of bacterial classification as per

Bergey's Manual, Accessing microbial diversity using molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rRNA restriction analysis, terminal Restriction Fragment Length Polymorphism (T-RFLP), 16S rDNA sequencing, metagenomics.

Unit-2:
Methods in Microbiology: Theory and practice of sterilization, Pure culture techniques, Principles of microbial nutrition, Construction of culture media, Enrichment culture techniques, Isolation and culture of aerobic and anaerobic bacteria, Culture collection, preservation and maintenance of microbial cultures.

Unit-3:
Metabolic Diversity among Microorganism: Microbial Nutrition: nutritional types and modes of nutrition in bacteria, Extremophiles.Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth and Continuous culture.

Unit-4:
Chemotherapy/Antibiotics Antimicrobial agents; Antibiotics: Penicillins and Cephalosporins and Broad- spectrum antibiotics, sulfa drugs, Antifungal antibiotics, Mode of action, Molecular mechanism of drug resistance. Bacterial Genetic System: Transformation, Conjugation, Transduction, Recombination, bacterial genetic map with reference to *E coli.*

Books Recommended:

- Brock Biology of Microorganisms, 9th Edition. By *Michael T. Madigan, John M.Martinko, Jack Parker*. Prentice Hall, Inc.
- Microbiology, 4th Edition. By *Lansing M. Prescott, John P. Harley, Donald A. Klein*. WCB McGraw Hill.
- General Microbiology, 5th Edition by *Roger Y. Stanier, John L. Ingraham, Mark L.Wheelis, Page R. Painter*, Macmillan Press Limited.
- Microbiology: Principles and Explorations, 5th Edition. By *Jacquelyn G. Black*, John Wiley& Son, Inc.

Course Outcomes:

1.To get an insight into microbiological techniques related with isolation, identification and characterization.

2. To understand the classification of microbes based on different parameters and to update the modern molecular tools used for classification and identification of microbes.

3. To know how microbes grow and what the parameters are which influence the microbial growth and how it could be applied in industrial processes.

4. To assess the importance of microbes in different industries and also for maintaining the sustainability of the environment.

5. To get an insight into how microorganisms play an integral role in diseases and the relevant microbial methodologies used in disease treatment.

MBT- 102: MOLECULAR BIOLOGY
THEORY
(Core)

Course Objectives: To understand the molecular basis of life and to understand the fundamental processes at molecular level.

Unit 1:
Prokaryotic and eukaryotic genome organization, structural elements of chromosome and construction of artificial chromosome. DNA replication: Enzymes, accessory proteins and mechanisms of prokaryotic and eukaryotic DNA replication.

Unit 2:
Fine structure of gene, molecular basis of spontaneous and induced mutations and their role in evolution; DNA damage and repair, DNA amplification and rearrangement. Anti-sense and Ribozyme Technology: Inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, applications of anti-sense and ribozyme technologies.

Unit 3:
Transcription: Organization of transcriptional units, mechanisms of transcription and its regulation in prokaryotes and eukaryotes, Operon concept, attenuation and antitermination controls, RNA processing (capping, polyadenylation, splicing), DNA methylation, heterochromatization, General and specific transcription factors, regulatory elements and mechanism of transcription regulation, transcriptional and post-transcriptional gene silencing, environmental regulation of gene expression.

Unit-4:
Translation: Genetic code, Prokaryotic and Eukaryotic translation, mechanisms for initiation, elongation and termination, regulation of translation, co-and post- translational modifications of proteins. Homologous Recombination and Site-specific recombination.

Books Recommended:

- 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
- Molecular Biology of the cell (3rd Edition) by *Bruce Alberts, Dennis Bray, JulianLewis, martin Raff, Keith Roberts and James D. Watson*, Garland Publishing, Inc,New York & London
- Gene Cloning and DNA Analysis (4th Edition) by *T.A Brown*, Blackwell Science
- Essential of Molecular Biology (3rd edition) by *G.M. Malacinski& D. Freifelder*, Jones & Bartlett Publisher

Course Outcomes:

1. Learn the structure & properties of prokaryotes and eukaryotes genome and its structural elements
2. Learn the role of different proteins in replication, nature of DNA replication and the structure of DNA polymerase
3. Learn the process of transcription, types of polymerases, promoter, Enhancers and transcription factors
4. Learn nature of codon, anticodon, genetic code, mechanism of polypeptide synthesis, structure of tRNA and ribosome.

MBT- 103: BIOCHEMISTRY
THEORY
(Core)

Course Objectives: To understand the biomolecules and their involvement in metabolic processes and to get an insight about tools and techniques involved in it.

Unit 1

Amino acids and proteins: Classification, structure and properties of amino acids; primary,secondary, tertiary, quaternary and domain structure of proteins, forces stabilizing protein structure, Ramachandran plot, DNA-protein and protein-protein interactions, protein folding, protein misfolding and related diseases; protein sequencing.

Nucleic acids: Primary and secondary structure of nucleic acids, Watson-Crick model ofDNA, structural polymorphism of DNA and RNA, three dimensional structure of RNA, biosynthesis of purines and pyrimidines.

Unit 2

Carbohydrates: Classification and structure of carbohydrates, polysaccharides,glycoproteins and peptidoglycans, glycolysis, TCA cycle, oxidative phosphorylation, glycogen synthesis and breakdown, gluconeogenesis, interconversion of pentoses and hexoses. **Lipids :**Classification, structure and functions, biosynthesis of fatty acids, oxidation of lipids, triglycerides, phospholipids, sterols.

Unit 3

Biophysical techniques: Principles and applications of thin layer chromatography, gaschromatography, HPLC and FPLC, Principles and applications of X-ray diffraction, NMR, ESR, ORD/CD, fluorescence, UV, IR, visible and mass spectroscopy.

Unit 4

Principles and applications of tracer techniques in biology: Effect of radiation onbiological systems, radioactive isotopes and their half-life, autoradiography, radiation dosimetry, Cerenkov radiation, liquid scintillation spectrometry.

Books Recommended:

- Biochemistry by Stryer, Freeman publisher
- Biochemistry, Vol I, II, III by GeofferyZubey, WCB press
- Fundamentals of Biochemistry by Voet, Voet& Pratt, John Wiley publisher

- Principles of biochemistry by Albert Lehninger, David L Nelson & Michael M Cox, Mac Milan worth publisher.

Course Outcomes:

1. The structure of the important biological macromolecules: proteins, carbohydrates, lipids nucleic acids.
2. The relationship between structure and function in the biological macromolecules.
3. The basic chemical reactions involved in the synthesis and degradation of the biological macromolecules.
4. The biochemistry involved in the regulation of cellular metabolism.

MBT- 104: CELL BIOLOGY

THEORY

(Core)

Course Objectives: To understand the basic concepts about cells, cell organelles and cellular processes.

Unit 1:

Structure of prokaryotic and eukaryotic cells,Cellular organelles: Plasma membrane, cell wall, cytoskeleton- their structural organization; Mitochondria; Chloroplast; Nucleus and other organelles and their organization and function, genetic constitution of mitochondria and chloroplast, artificial membrane Liposomes.

Unit 2:

Microscopic techniques: Principles and application of light, phase contrast, fluorescence, confocal, scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining, Fluorescence *in-situ* hybridization (FISH), GISH (Genomic *in-situ* hybridization).

Unit 3:

Transport of nutrients, ions and macromolecules across membranes, Cell cycle: Mitosis, meiosis, role of cyclins and cyclin dependent kinases, regulation of Cdk-cyclin activity, Cdk inhibitors, induction of cancer with respect to cell cycle, molecular events and regulation in model systems, cell surface receptors, second messenger system, MAP kinase pathways, mechanism of signal transduction pathway.

Unit 4:

Molecular biology and biochemistry of cancer, oncogenes, tumor suppressor genes, chemical carcinogenesis, Cellular basis of differentiation and development- cell division, gametogenesis

and fertilization, differential gene activity and cell differentiation, Morphogenetic determinants in egg cytoplasm, genetic regulation of early embryonic development in Drosophila, homeotic genes.

Books Recommended:

- Essential Cell Biology by *Bruce Albertset.al*., Garland Publisher.
- Cell and Molecular Biology by *F. D P deRobertes,* LW & W Publisher.
- Molecular Biology of the Cell by *Alberts, Bray, Lewis, Raff, Roberts and Watson*, Garland Publishers.
- Molecular Cell Biology by *H. Lodish, D. Baltimore, A. Bark, S. L. Zipursky, P.Matsudaira and J. Darnell,* Scientific American Books.

Course Outcomes:

1. Cell structure and the functions of organelles and the mechanisms of vesicular and protein transport to various subcellular sites.
2. The mechanisms of cell to cell signaling, including intracellular second-messenger pathways. Analyze and interpret data and graphs related to cell biology and its malfunction in disease.
3. The cell cycle and its regulation, including the mechanism of mitosis.
4. The molecular pathways that are altered in cancers, including oncogenes, tumor suppressors, apoptosis, angiogenesis, and DNA repair.

MBT-105: LABORATORY COURSE-I(Core)

(PRACTICALS BASED ON COURSES MBT 101-MBT104)

Objectives:

Students will be able to learn the basic techniques related to 101, 102,103 &104.

- Cleanliness, media preparation, sterilization, culturing methods, dilution techniques.
- Staining techniques in microbiology; simple staining, gram staining, spore staining capsule staining,flagella staining.
- Isolation of pure culture by different techniques.
- Replica plating technique.
- Transformation of *E.coli* host strain with provided plasmid DNA using $CaCl_2$ method.
- Minipreparation of plasmid DNA by Alkaline Lysis method.
- Quantitative and qualitative estimation of DNA by Agarose gel electrophoresis.
- Isolation of genomic DNA from plant, fungal and bacterial sources.
- Determining the purity of isolated genomic/plasmid DNA using UV-Vis spectrophotometer.
- Isolation of protein from the given sample.
- Estimation of protein by Lowry-Folin method.
- Estimation of protein by Biuret method.

- Separation of protein by SDS-PAGE.
- Quantification of total sugar by Anthron method.
- Identification of reducing and nonreducing sugars.
- Blood group identification of M.Sc. students.

Course Outcomes:

MBT 101: Students will be able to isolate, culture, identify and characterize microbes.They will be also able to analyse the applications of microbes.

MBT 102: The students will get exposed to the isolation and characterization of genomic and plasmid DNA.

MBT 103: The students will be able to estimate and analyse the quantitative as well as qualitative aspects of biomolecules.

MBT 104: Students will be able to visualize and analyse cells and cellular organells.

Semester 2

MBT-201: RECOMBINANT DNA TECHNOLOGY

THEORY

(Core)

Course Objectives: To understand the basics of molecular cloning of DNA strand.

Unit 1:

Molecular tools and their applications: Restriction endonucleases, polymerases, nucleases, kinases, topoisomerases, gyrases, methylases and ligases. Cloning vectors: Plasmids, Bacteriophages, Cosmids, Phagemids, Artifical chromosomes (BAC, PAC, MAC).

Unit 2:

Construction and screening of genomic and cDNA libraries, EMSA (Electrophoretic mobility shift assay), DNA footprinting, Primer extension, SI mapping, RNase protection assay, Reporter assays, Principles and techniques of nucleic acid hybridization, Southern, Northern and Western hybridization/blotting, DNA microarray-fabrications, variations and applications, Serial Analysis of Gene Expression (SAGE).

Unit 3

Polymerase chain reaction: principle, different ingredients of PCR, primer-designing, variations-standard PCR, Touch down PCR, Hot- start PCR, Asymmetric PCR, Inverse PCR, Long PCR, High Fidelity PCR, Multiplex PCR, Nested PCR, Reverse transcriptase PCR, Real Time quantitative PCR, Applications of PCR in different fields.

Unit 4

Expression strategies for heterologous genes: vector engineering, codon optimization, host engineering, expression in bacteria, yeast, insects, mammalian cells and plants, *in-vitro* transcription and translation, T-DNA and transposon tagging.

Books Recommended:

- iGenetics by *Peter J Russell*, Benjamin/ Cummings, New York
- From Genes to Clones: Introduction to gene technology, by *Ernst-L Winnacker*, VCH Publication, Germany
- Principles of Gene Manipulation: An Introduction to genetic Engineering (6th Edition) by R.W. *Old and S.B. Primrose*, Blackwell Publication
- Genes IX by *Benjamin Lewin*, Oxford University Press, U.K.

Course Outcomes:

1. To understand the principles of molecule biology techniques associated with identification isolation, cloning and characterization of genes.

2. To get an insight into the diversity of cloning vectors and construction of genomic or cDNA library.

3. To understand the principles, application and variations in the polymerase chain reaction technology.

4. To understand the role of different enzymes used in the recombinant DNA technology.

5. To know how the recombinant DNA technology could be used in agriculture, health and environment sector for overall human welfare.

MBT-202: ENZYME TECHNOLOGY

THEORY

(Core)

Course Objectives: To understand the classification and nature of enzymes, their mechanism of action and industrial applications.

Unit 1

Nomenclature and classification of enzymes, general properties of enzymes, active sites, cofactors and specificity.

Isolation, purification and large scale production of enzymes with principles and applications of the involved techniques, viz gel filtration, ion exchange and affinity chromatography, centrifugation and electrophoretic techniques.

Unit 2

Enzyme kinetics: Enzymatic reaction mechanisms, Michaelis-Menten equation, Effect of substrate, pH, temperature and inhibitors on enzyme activity.
Mechanism of enzyme action and regulation: Active and regulatory sites, chemical modification, feedback inhibition, positive and negative cooperativity, allosteric enzymes.

Unit 3
Isozymes, multienzyme complexes, artificial enzymes, catalytic antibodies.
Enzyme engineering-strategies, directed evolution, degradation of unnatural substrates.

Unit 4
Industrial enzymes: In detergent, food, leather, dairy, medicines and chemical industries.
Enzyme immobilization: Introduction, methods, applications and limitations.

Books recommended:

- Enzymes: Biochemistry, Clinical Chemistry by T. Palmor, Harwood press
- Fundamentals of Enzymology: The cell and molecular biology of catalytic proteins, by NC Price and Steven, Oxford press.
- Biochemistry, Vol I, II, III by GeofferyZubey, WCB press
- Fundamentals of Biochemistry by Voet, Voet& Pratt, John Wiley publisher

Course Outcomes:

1. Students will be able to know basics about enzymes, their nomenclature and classification.
2. They will be able to learn about isolation, characterization and purification of enzymes.
3. They will be able to know mechanism of action of enzymes and their regulation.
4. They will also be able to know various applications of enzymes in different fields.
5. Students will be knowing about immobilization of enzymes and its effect.

MBT-203: IMMUNOLOGY

THEORY

(Core)

Course Objectives: To understand the immune system and its various components, immunological disorders, basic principles of its functioning and vaccination.

Unit 1:

Introduction: Phylogeny of Immune System, Innate and acquired immunity, Clonal nature of immune response, Primary and secondary immune response, Organization and structure of lymphoid organs, Cells of the immune system:Haematopoesis and differentiation, lymphocyte trafficking, B lymphocytes, T- lymphocytes, Macrophages, dendritic cells, natural killer and lymphokine activated killer cells, Eosinophils, Neutrophils and mast cells.Antigens and superantigens.Structure and function of immunoglobulins.

Unit 2:
Major histocompatibility complex; Antigen processing and presentation, BCR and TCR, generation of immunological diversity, Complement system.Cell- mediated cytotoxicity : Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, effector mechanism.

Unit 3:
Regulation of immune response:Generation of humoral and cell medicated immune responses, Activation of B-and T-lymphoeytes, cytokines and their role in immune regulation, Immunological tolerance, Genetic control of immune responses. Immunoprophylatic intervention: Basic concepts of vaccination and different types of vaccines.

Unit 4:
Hypersensitivity, Autoimmunity, Tumor immunology, AIDS and other immune-deficiencies.Antigen and antibody interactions, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, Hybridoma technology and monoclonal antibodies.

Books Recommended:
- Cellular and Molecular Immunology by *Abbas et al.*, Saunder Publication.
- Essential Immunology by *Roitt*, Blackwell Publisher.
- Immunology by *Kuby*, Freeman Publisher.
- Immunology-a short course by *Benjamini*, Wiley-Liss Publisher.

Course Outcomes:
1. The basic knowledge of the Immunological system.
2. Students should obtain a general competence about the human body's resistance to interventions from bacteria and viruses
3. Explain the basic regulation mechanisms of the immunological responses, various immunological diseases and concept of vaccines development
4. Learn different types of hypersensitivity and the basic principal of techniques of antigen-antibody interaction.

MBT-204: BIOINFORMATICS, BIOSTATISTICS AND GENOMICS
THEORY
(Core)

Course Objectives: To understand the biological data (DNA, Protein, molecules etc) and its applications. Principles and applications of statistics in biology.To understand mapping, sequencing and characterization of genome.

Unit 1:
Introduction to Bioinformatics, use of Internet and search engines (WWW, HTML, URLs, Netscape, Explorer, Google, PUBMED), database management system, database browsing, data retrieval, sequence and genome database, databases such as GenBank, EMBL, DDBJ, Swissprot, PIR, TIGR, TAIR, Searching for sequence database like FASTA and BLAST algorithm, multiple sequence alignment, phylogenetic analysis and detection of open reading frames (ORFs).

Unit 2:
Molecular evolution and phylogenetic tree, Gene predictions, Introduction to computational structural biology, *in-silico* methods for structural predictions, Homology threading and modeling, *ab-initio* modelling; Validation of *in-silico* determined 3D structures of proteins, Computer aided drug design-tools and applications.

Unit 3:
Selection of sample or sampling, theory: qualitative, random and non-random sample. Collection of data, their classification, tabulation, graphic representation and diagrammatic representation, measures of central tendency and dispersion: mean, median, mode, range, standard deviations, variance, idea of two types of errors and level of significance, test of significance (F & I test); chi-square tests, sample linear regression and correlation.

Unit 4:
Introduction to science of omics-genomics, proteomics, metabolomics, transcriptomics, comparative genomics, nutrigenomics, lipidomics, cytomics, toxicogenomics, pharmacogenomics;whole genome sequencing strategies, first, second, third and fourth generation sequencing technologies, genome mapping-physical and genetic mapping techniques.

Books Recommended:

- Introduction to Bioinformatics by *Stephen A Krawetz and David D. Womble*, Humana Press.
- Bioinformatics: Sequence and Genome Analysis by *David W. Mount*, Cold Spring Harbor Laboratory Press
- Fundamental of Biostatistics (5^{th} edition) by *Bernard Rosner,* Duxbury Thomson Learning.
- Basic Statistics (2^{nd} edition) by *B. L. Agrawal*, Wiley Eastern India.
- Introductory Statistics for Biology Students by *T. A Hall*, Chapman & Hall publisher.
- Statistical Methods in Biology by *N. T. J Bailey*, Cambridge Press.
- Genomes by *T.A. Brown*, John Wiley & Sons Ltd, New York
- Genome analysis (Volume I, II, III and IV) a Laboratory Manual by *Bruce Birren, Eric D.Green, Sue Klapholz, Richard M. Myers and Jane Roskams,* Cold Spring Harbor LaboratoryPress.

Course Outcomes:

1. Describe bioinformatics and its tools, and explain the biological databases as well as describe how bioinformatics literature and data is stored and organized
2. Build UPGMA, NJ, and ML phylogenetic tress and explain its algorithms. Analyze how secondary and 3-D structures of proteins are predicted and describe the process of homology modeling
3. Learn the different statistical parameters and interpretation in Biological studies
4. Learn the different science of omics and physical and genetic mapping techniques.

MBT-205

LABORATORY COURSE-II
(Core)

(PRACTICALS BASED ON COURSES BT-201-204)

- PCR amplification using different template DNA and different sets of primers.
- Analysis of PCR amplified DNA using Agarose gel Electrophoresis.
- Gel elution of expected size PCR amplicons.
- Cloning of gel eluted amplicons in suitable vector.
- Analysis of cloned product by Restriction analysis.
- Isolation of enzyme from the given sample.
- Purification of enzyme from the crude extract.
- Effect of substrate concentration on enzyme activity.
- Effect of temperature on enzyme activity.
- Effect of pH on enzyme activity.
- Effect of metals and chemical reagents on enzyme activity.
- Performing enzyme immobilization by Calcium alginate entrapment method.
- Search for different web-based biological databases.
- Retrieval of nucleotide /protein sequences from different databases.
- BLAST analysis of provided sequences.
- Multiple sequence alignment of retrieved sequences using suitable *in-silico* tools.
- Construction of phylogenetic tree by different methods (NJ method, Maximum Likelihood, etc.)
- Motif analysis using *in-silico* tools.
- Physio-chemical characterization of sequences using *in-silico* tools.
- Gene structure and chromosomal localization of genes using in-silico tools.
- Homology based 3D structural determination and validation of given protein.
- I-TASSER based 3D structural determination and validation of given protein.
- Genome wide *in-silico* prediction and identification of transcription factor gene families.
- Primer designing using different *in-silico* tools.
- Solving problems related with mean, median, mode, range, standard deviations, variance etc.
- Display of lymphoid organs in rat/mouse.

- To perform ouchterlony double immunodiffusion and analysis of antigen-antibody precipitation pattern.
- To perform radioimmunoassay to measure the concentration of antigen by using antibodies.
- To perform ELISA for quantitative and qualitative estimation of antigens.
- To perform western blotting for qualitative estimation of protein.

Course Outcomes:

MBT-201: Ability to isolate and clean desired DNA fragment into suitable cloning vector.

MBT-202: Ability to Isolation, purification, characterization, immobilization and know about various applications of industrially important enzymes.

MBT-203: Students will be exposed to techniques based on antigen-antibody interaction.

MBT204: Will be able to learn the tools & software applied in analysis of biological data. Use of biostatistics in experimental results. Analysis of genome sequences in evolutionary relationship.

Semester-3

MBT-301: PLANT BIOTECHNOLOGY

THEORY

(Core)

Course Objectives: To understand the biotechnology approaches for crop improvement and crop disease management.

Unit 1:

History of plant cell and tissue culture; Culture media; various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation; organogenesis and somatic embryogenesis.Micropropagation; Anther and microspore culture; Somaclonal variation; *Invitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites;Synthetic seeds.

Unit 2:

Embryo culture and embryo rescue; Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular markers, transformation and genomic tools for crop improvements. Molecular marker-aided breeding, QTL, molecular marker assisted selection.

Unit 3:

Plant transformation technology: *Agrobacterium*mediated, Particle bombardment, Electroporation; transgene stability and gene silencing. Chloroplast Transformation, Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc.) and biotic (insect pest, fungal, viral and bacterial diseases, weeds, etc.) stresses; Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, minerals nutrients, etc.) etc.

Unit 4:
Metabolic Engineering and Industrial Products: Plant secondary metabolites, control mechanisms and mainipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, biodegradable plastics, therapeutic proteins, edible vaccines, purification strategies.

Books Recommended:

- Plant Tissue Culture: Application and Limitation by *S. S. Bhojwani and M. K.Razdan,* Elsevier Publication
- Plants, Genes and Agriculture by *Maarten J Chrispeels and David E. Sadava,* Jones & Bartlett Publishers
- An Introduction to Plant Tissue Culture by *M. K. Razdan*, Oxford & IBH Publishing Co. Pvt. Ltd.
- Plant Biotechnology: The genetic manipulation of plants by *Adrian Slater, NigelScott, and Mark Fowler,* Oxford University Press

Course Outcomes:

1. Understand basic concept of plant cell, tissue culture, Culture media of for Micropropagation and application in germplasm conservation.
2. Different methods of Conventional versus non-conventional methods of tissue culture and compare different molecular marker aided breeding methods
3. Estimate plant transformation mechanism and derive transgene stability and gene silencing
4. outline various application of plant biotechnology in Metabolic Engineering and Industrial Products

MBT-302: ANIMAL BIOTECHNOLOGY
THEORY
(Core)

Objectives: To understand the concepts of animal cell and tissue culture and transgenic animal production.

Unit 1
Introduction to animal cell and tissue culture, its advantages and limitations, Applications of animal cell and tissue culture.

Basic techniques in animal cell culture: Disaggregation of tissue and setting up of primary culture, established cell line cultures, maintenance of cell culture, culture media and role of serum in cell culture, organ culture.

Unit 2

Biology and characterization of the cultured cells, measurement of growth, measurement of viability and cytotoxicity.

Scale up of animal cell culture, cell cloning, cell synchronization and transformation.

Unit 3

Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications, animal cloning.

Transgenic animals: Construction of transgenic animals, gene knockouts, ethical and biosafety considerations.

Unit 4

Gene therapy: Genetic disorders, vector engineering, types of gene therapy, strategies of gene delivery, targeted gene replacement/augmentation, gene editing, gene correction, gene silencing.

Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling and pedigree analysis.

Books recommended:

- Animal Cell Culture: A practical approach by R.I. Freshney, IRL press.
- Culture of animal cells: A manual of basic techniques by R.I. Freshney, Willy-Liss and Sons publication.
- Animal cell culture technique by Martin Clynes, Springer publication.

Outcomes:

1. Understand the basic principle of animal cell and tissue culture media and its application
2. Understand the various types of Synchronization methods, Differentiation of cells, Transformation, Bioreactor design and analysis
3. Summarize the stem culture techniques, transgenic animals and its ethical issues.
4. Understand the gene therapy concept Molecular markers linked to disease resistance genes

MBT-303: BIOPROCESS TECHNOLOGY

THEORY

(Core)

Objectives: To understand the optimization and production of industrially important molecules used in human welfare.

Unit 1:

Introduction to bioprocess technology, bioreactors, Isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media for industrial fermentation, air and media sterilization.

Unit 2:
Types of fermentation processes: Analysis of batch, fed-batch, and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, photobioreactors etc.), measurement and control of bioprocess parameters.

Unit 3:
Downstream processing: Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and crystallization, Whole cell immobilization and its industrial application.

Unit 4:
Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline). Amino acids (lysine, glutamic acid), Single cell protein, Use of microbes in mineral beneficiation and oil recovery, Introduction to food technology:Elementary idea of canning and packing, Sterilization and pasteurization of food products.,Technology of typical food/ food products (bread, cheese, idli), Food preservation.

Books recommended:
- Principles of fermentation technology by *PF Stanbury, A Whitekar and SJ Hall*, Aditya Books.
- Bioprocess Engineering; Basic Concept by *ML Suler& F Kargi*, PHI Press.
- Operational modes of bioreactors (BIOTAL Series), ButterworhHeineman.
- A Textbook of Industrial Microbiology by *W Cruger&ACruger*, W. H Freeman (Panima) Publisher.

Course Outcomes:
1. Understanding of biological basics and bioprocessing
2. Bioprocess design and operation
3. To evaluate the bioreactors, design features and the instrumentation and control of bioreactors
4. To understand the role of downstream processing in biotechnology

MBT-304: ENVIRONMENTAL BIOTECHNOLOGY
THEORY
(Core)

Course Objectives: To understand the role of biotechnology in mitigating environmental issues.

Unit 1:
Introduction to Environmental Science: Environmental Pollution: Classification of pollutants, Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles. Air, Water, Soil, Noise and Thermal

pollution: Their source, Effect and biotechnology based control measures. Solid waste pollution and its management.

Unit 2:
Waste water Treatment: Biological treatment system (Oxidative ponds, aerobic and anaerobic ponds,facultative ponds, aerated ponds), Biological waste treatment, activated sludge treatment, microbialpollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers, Refinery, Chemical and Antibiotic waste.

Unit 3:
Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation. Microbial Leaching and biomining, Recovery of metals from solutions, Microbes in petroleum extraction, Microbial desulfurization of coal, microbial transportation of toxic metals, Biodegradation of chlorinated hydrocarbons and xenobiotic compounds, pesticides, oil spills, and toxic dyes industrial effluents.

Unit 4:
Biofertilizers, biopestisides and Integrated pest management (IPM). Energy & Biofuels: Non-conventional or renewable sources of energy, Energy from Biomass, Biosensors and biochips. Ozone depletion, UV-B, Green-house effect and acid rain, their impact andbiotechnological approaches for management.

Books recommended;

- Biotechnology – Expanding Horizons by *B.D. Singh*. 2nd Edition Kalyani Publishers.
- Microbial Ecology: Fundamentals & Applications by *Atlas, R.M.*Wc Brown.
- Environmental Microbiology by *A.H. Varman*, ASM Press.
- Biodegradation and Bioremediation by *Alexandar, M*. Wiley International.

Outcomes:

1. To understand the basics of environmental pollution and how biotechnology could be used for the mitigating or controlling different pollutions.

2. To get an insight into the physical, chemical and biological methods of waste water treatment.

3. To understand the principles, methodology and application of bioremediation and phytoremediations.

4. To understand the important global environmental issues like global warming, acid rain etc.

5. To identify and evaluate the role of biotechnology in advocating biofuels and organic farming.

MBT-305: INTRODUCTORY BIOTECHNOLOGY
THEORY

(Elective for other Department)

Objectives: To understand the basic concepts of biotechnology and its applications.

Unit 1:
Biotechnology: An overview-definition, scope and importance of Biotechnology, Concept of Recombinant DNA technology and Gene Cloning. Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.

Unit 2:
Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering. Introduction to animal cell and tissue culture and its applications, production oftransgenic animals, cell transformation and cell lines, animal cloning.

Unit 3:
Medical Biotechnology: (A brief account) Biotechnology in medicine, Vaccines, Diagnostic, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy. Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.

Unit 4:
Bioinformatics: (A brief account) Importance, Scope of Bioinformatics, world wide web as a tool, Bioinformatics institutes and databases, Bioinformatics training & limitations. Bio-business and Bio-safety, Biotechnology for developing countries and IPR

Books recommended;

- Das H.K. (2004), Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.
- Kumar H.D. (2004), A Text Book of Biotechnology, Eastern Willey Press, New Delhi.
- Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.
- Biotechnology – Expanding Horizons by *B.D. Singh*. 2nd Edition KalyaniPublishers .
- Black J.G (2008) Microbiology- Principles and Explorations, 7th edition, John Wiley & Sons

Course Outcomes:

1. They will be able to understand basic tools & techniques related to biotechnology.
2. They will get the understanding about implications of biotechnology in plant science.
3. They will be exposed to basics of applications of biotechnology in human health.
4. They will be able get equipped with the understanding of production of biomolecules at industrial scale.
5. Will be able to know modifications in DNA, proteins and enzymes.

MBT-306
LABORATORY COURSE-III

(Core)
(PRACTICALS BASED ON COURSES MBT301-304)

- Plant tissue culture lab set up.
- Media preparation and sterilization.
- Explant sterilization.
- Callus induction of provided explants in suitable media.
- Regeneration of explants using different media.
- Setting up of animal tissue culture laboratory.
- Introduction to the equipments used in animal tissue culture laboratory.
- Isolation of macrophages from mouse peritoneum and their culture.
- Primary culture of spleenocytes isolated from mouse.
- Cell counting using nauber's chamber/hemocytometer.
- Cell viability testing using trypan blue dye.
- Cell cloning by dilution method.
- Sub culturing/splitting of monolayer culture.
- Isolation of metagenomic DNA from soil samples/water samples.
- PCR amplification of metagenomic DNA with 16S/18S primers/ gene specific primers.
- Detection of coliforms for determination of the purity of potable water.
- Determination of total dissolved solids of water
- Determination of Hardness and alkalinity of water sample.
- Determination of dissolved oxygen concentration of water sample
- Determination of biological oxygen demand of sewage sample
- Determination of chemical oxygen demand (COD) of sewage sample.
- Production of enzymes by solid state fermentation (SSF) and submerged fermentation (SmF).
- Characterization of enzymes produced by SSF/SmF (pH optima, pH stability, temperature optima &stability, effect of metal ions, inhibitors)
- Ammonium sulfate precipitation.
- Purification of enzymes by chromatography techniques.

Course Outcomes:

MBT-301: To get exposed to basic tools and techniques of Plant Tissue Culture.
MBT-302: Culture of animals cells, setting up of primary cell culture and maintenance of culture &cell lines
MBT-303: They will understand the principle and process of upstream and downstream processing.
MBT304: To know and understand the quantitative and qualitative analysis of environmental pollution.

Semester-4
MBT-401: GENOMICS FOR CROP IMPROVEMENT
THEORY
(Elective)

Course Objectives:To understand the genome and techniques involved in genome analysis.

Unit 1:
Introduction to science of omics for crop improvement, Introduction to the plant genome-nuclear, chloroplast and mitochondrial genomes, genome size and complexity, mapping of genome: genetic and physical maps, map-based cloning, molecular markers in plant genome analysis; RFLP, RAPD, STS, Microsatellite, SCAR (Sequence characterized amplified regions), SSCP (single strand conformational Polymorphism), and AFLP analysis, FISH and GISH for genome analysis.

Unit 2:
Plant gene expression and regulation, functional genomics-expression analysis using microarrays, transposon tagging and Insertional mutagenesis - methods and significance, TILLING and EcoTILLING, Diversity Array Technology, transcriptomics.

Unit 3:
Whole genome analysis: Genome size, strategies for sequencing genome, ordered genomic libraries (Cosmid, YAC, BAC libraries), Genome sequencing in plants–Principles and Techniques; Next generation sequencing technologies, Applications of sequence information in plant genome analyses; Comparative genomics, Detection of Single Nucleotide Polymorphism; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome.

Unit 4:
Marker assisted selection (MAS), Genomic assisted breeding approaches, Genomics andgenoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding, tagging of agronomically important traits, RNA interference in crop improvement.

Books recommended;

- Genomes by *T.A. Brown*, John Wiley & Sons Ltd, New York
- Genome analysis (Volume I, II, III and IV) a Laboratory Manual by *Bruce Birren,Eric D. Green, Sue Klapholz, Richard M. Myers and Jane Roskams,* Cold SpringHarbor Laboratory Press.
- Discovery Genomics, Proteomics and Bioinformatics, *Campbell AM &Heyer L*, 2004, Pearson Education.

Course Outcomes:

1. To understand the basics of prokaryotes and eukaryotes genomes as well as application of forward and reverse genetics.

2. To know the state of the art sequencing technologies used for genome sequencing and mapping of genomes.

3. To get an insight into the application of genomics in crop improvement especially for the development of appropriate molecular markers and identification of novel genes for developing biotic and abiotic stress tolerant crops.

4. To understand the importance of biological sequence data for its utilization for developing appropriate strategies for crop improvement.

5. To understand the pros and cons of transgenic technology relevant in the era of genomics.

MBT-402: PROTEOMICS AND NANOBIOTECHNOLOGY

THEORY
(Elective)

Objectives: To understand the proteome and techniques involved in proteome analysis. To know about biomaterials and nano-materials and their applications.

Unit 1
Proteomics technology: Gel electrophoresis of protein- SDS-PAGE, Native gel electrophoresis, zymography, identification and analysis of proteins by 2D analysis, mass spectrometry, MALDI-TOF, NMR and X-ray crystallography.

Unit 2
Differential display proteomics, protein-protein interactions, yeast two hybrid system and phage display, GFP and RFP, western blot, metabolic engineering.

Unit 3
Chemical, physical and biological properties of biomaterials and bioresponse, biomineralization, biosynthesis and properties of natural materials (protein, DNA &polysaccharides).

Unit 4
Preparation and characterization of nanoparticles : nanoparticular carrier system, micro and nano fluidics, drug and gene delivery system, microfabrication, chip technologies, biosensors, nano-imaging.

Books recommended:

- Discovery genomics, proteomics and bioinformatics, Campbell AM &Heyer L, 2004, Pearson education.
- Methods in proteome and protein analysis, Kamp RM, 2004, Springer.
- Handbook of nanostructured biomaterials and their applications in Nanobiotechnology, Nalwa HS, 2005, American Scientific Publication.
- Nanobiotechnology, Niemeyer CM &Mirkin CA, 2005, Wiley Interscience.

Outcomes:

1. Students will be able to learn techniques related to protein analysis and their expression profile.
2. They will also learn various imaging techniques.
3. They will be able know about biomaterials and their applications in medical field.

4. They will learn about manufacture, properties and characterization of nanoparticles/materials and their applications.

MBT-403: BIOSAFETY, IPR AND BIOETHICS

THEORY

(Elective)

Course Objectives: To understand about biosafety measures to be taken during trials of biotechnological products. To learn about requirements, steps of patenting. Also to understand the bioethical guidelines followed during experiments.

Unit 1:

Biosafety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety; Cross border movement of germplasm; Risk management issues-containment.

Unit 2:

General principles for the laboratory and environmental biosafety; health aspects; toxicology, allergenicity, antibiotic resistance etc.Impact on environment; gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses etc.

Unit 3:

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-isotopic procedures; Benefits of transgenics to human health, society and the environment.

Unit 4:

The WTO and other international agreements; Intellectual properties , copyrights, trademarks, trade secret, patents, geographical indications, etc.; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings:

Singh BD, 2007. Biotechnology: Expanding Horizons. Kalyani
http://patentoffice.nic.in

Course Outcomes:

1. Define Biosafety and bioethics in the context of modern biotechnology
2. Explain the principle and laboratory of biosafety level. Insight into the Cartagena protocol and implementation in India

3. Indepth Knowledge on biosafety regulatory frame work for GMO's
4. Discuss the relevance of intellectual property rights to modern biotechnological innovations

MBT-404: ANIMAL CELL AND TISSUE CULTURE

THEORY

(Elective)

Course Objectives: To understand the process and principles related to in-vitro culture of animal cells.

Unit 1:

Introduction of Animal Cell and Tissue Culture, History of development of Animal cell culture techniques, Significance and Applications of tissue culture techniques.

Unit 2:

Requirements in Animal Cell Culture, Equipments used in Cell culture, Culture vessels, Aseptic techniques, Culture media, designing of culture media, Serum free media development.

Unit 3:

Primary culture, secondary culture, cell line, cryopreservation, contaminations, organotypic culture, Insect Cell Culture: An Overview, In vitro transformation of animal cells, Types of cell culture. Cell culture in vaccine production and drug/therapeutics development.

Unit 4:

Cell cycle analysis and Synchronization of cultures, cancer studies using cell culture, production of hybridoma and monoclonal antibody production. Animal cloning, Therapeutic cloning, Tissue engineering, Knock out animals.

Books recommended:

- Freshney, R.I : Culture of Animal cells , Wiley Publications , New York.
- Edi. Jhon R.W. Masters : Animal cell culture- practical approach , Oxford University press, Oxford.
- Ed. R. Basega : Cell growth and division : A practical approach , IRL press,Oxford University press, Oxford.
- Ed. Martin Clynes : Animal cell culture techniques , Springer- Verlag, New York.
- F.Grasveld, George V. Kallias: Transgenic Animals, Academic press, Sandiego, USA.
- AsokMukhopadhyay: Animal cell technology, IK International publishing House, New Delhi.

Course Outcomes:

1. The students will be able to know how to set up primary culture.
2. They will also be able to know different types of culture media used in animal cell culture.
3. They will also know about preservation animal cell culture and maintenance of cell lines.
4. They will be able to know about various applications of cell culture techniques in human welfare.

MBT-405: SEMINAR (Core)

Course Objectives: To understand how to prepare power point presentation and deliver it in front of audience.

Course Outcomes:

1. Students will get in depth knowledge about the topic they will present.
2. They will be able to understand how to face the questions from the audience.
3. They will also be able to learn about presentation of talk through ppt.
4. It will also give opportunity for them to grasp about the topic in short time.

MBT-406: DISSERTATION

(Core)

Course Objectives: To perform a short project to understand the research techniques & methodology.

Each Student will have to submit an allotted Dissertation, which would be based on research works and will submit a report on which Viva-Voce will be conducted.

Course Outcomes:

1. They will be able to learn how to design a problem and devise the solution.
2. They will be able to perform experiments independently.
3. They will be able to organize the experiments independently.
4. They will learn to write a mini thesis which will be very helpful during their Ph.D.