Master of Science (M.Sc. Biotechnology)
Course Structure

INVERTIS UNIVERSITY
Invertis Village, Delhi Lucknow Highway
NH-24, Bareilly, Uttar Pradesh Pin - 243
123, India |

M.Sc Biotechnology

Programme outcome of M.Sc Biotechnology is to produce competent biotechnologist's who can employ and implement their knowledge base in premium processes and applications which will profoundly influence or utilized for existing paradigm of agriculture, industry, healthcare and restoration of degraded environment to provide sustainable competitive edge to present society. Students will exhibit contemporary knowledge in Biotechnology and students will be eligible for doing jobs in various sectors of pharmaceutical and biotechnological industry.

PROGRAMME OUTCOMES:

1. Students will be able design, conduct experiments, analyze and interpret data for investigating problems in Biotechnology and allied fields.
2. Students will think creatively about the use of Biotechnology to address local and global problems.
3. Higher studies (M.Phil, Ph.D) can be pursued in order to attain research positions. Various examinations such as CSIR-NET, ARS-NET GATE, ICMR, DBT and many other opens channels for promising career in research.
4. Students can become Junior Production Officer and Technical Assistant in biotechnology, pharmaceutical Companies, bio fertilizer industry, aquaculture industries, environmental units, crop production units, food processing industries, national bio-resource development firms, banking and KPO.
5. Entrepreneurship ventures such as consultancy and training centres can be opened.
6. Some of the major pharmaceutical and drug companies' highering biotechnological professionals include Dabur, Ranbaxy, Hindustan Lever and Dr Reddy's Labs, food processing industries, chemical industry and textile industry as well. Beside this industries also employ bio-technological professionals in their marketing divisions to boostup business in sectors where their products would be required.
7. Beside industrial sector there are ample opportunities in academics as well. Students will be able to understand the potentials, and impact of biotechnological innovations on environment and their implementation for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.
8. Several career opportunities are available for students with biotechnology background abroad especially in countries like Germany, Australia, Canada, USA and many more where biotechnology is a rapidly developing field.

STUDY AND EVALUATION SCHEME
Master of Science [M.Sc. Biotechnology]
(Effective from Session 2020-2021)

YEAR I, SEMESTER I

S.No.	COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
				L	T	P	CA	EE		
1.	MST101	BIOCHEMISTRY	CC	3	0	0	30	70	100	3
2.	MST102	CELL AND DEVELOPEMENTAL BIOLOGY	CC	3	0	0	30	70	100	3
3.	MST103	MOLECULAR BIOLOGY	CC	3	0	0	30	70	100	3
4.	MST104	IMMUNOLOGY	CC	3	0	0	30	70	100	3
5.	MST105	COMPUTER APPLICATIONS & BIOSTATISTICS	DSE*	3	0	0	30	70	100	3
	MST106	FOOD BIOTECHNOLOGY	DSE*							
6.	MST151	BIOCHEMISTRY LAB	AEC	0	0	4	15	35	50	2
7.	MST152	MOLECULAR BIOLOGY LAB	AEC	0	0	4	15	35	50	2
8.	MST153	IMMUNOLOGY LAB	AEC	0	0	4	15	35	50	2
9.	MST155	SEMINAR I	SE	0	0	4	50	0	50	2
TOTAL				**15**	**0**	**16**	**245**	**455**	**700**	**23**

CC-Core Course; **DSE**-Discipline Specific Elective; **AEC**-Ability Enhancement Course; **SE**-Skill Enhancement
L – Lecture; **T –** Tutorial; **P –** Practical; **C –** Credit; **CA**-Continuous Assessment; **EE –** End Semester Exam
DSE*= Elect any one of the prescribed

YEAR I, SEMESTER II

S.No.	COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
				L	T	P	CA	EE		
1.	MST201	ANALYTICAL TECHNIQUES	CC	3	0	0	30	70	100	3
2.	MST202	MICROBIOLOGY & INDUSTRIAL APPLICATIONS	CC	3	0	0	30	70	100	3
3.	MST203	GENETIC ENGINEERING	CC	3	0	0	30	70	100	3
4.	MST204	IPR & BIOSAFETY	CC	3	0	0	30	70	100	3
5.	MST205	GENOMICS & PROTEOMICS	DSE*	3	0	0	30	70	100	3
	MST206	ADVANCEMENTS IN APPLIED BIOTECHNOLOGY	DSE*							
6.	MST251	ANALYTICAL TECHNIQUES LAB	AEC	0	0	4	15	35	50	2
7.	MST252	MICROBIOLOGY LAB	AEC	0	0	4	15	35	50	2
8.	MST253	GENETIC ENGINEERING LAB	AEC	0	0	4	15	35	50	2
9.	MST255	SEMINAR II	SE	0	0	4	50	0	50	2
TOTAL				**15**	**0**	**16**	**245**	**455**	**700**	**23**

CC-Core Course; **DSE**-Discipline Specific Elective; **AEC**-Ability Enhancement Course; **SE**-Skill Enhancement

L – Lecture; **T –** Tutorial; **P –** Practical; **C –** Credit; **CA**-Continuous Assessment; **EE –** End Semester Exam

DSE*= Elect any one of the prescribed

M.Sc. Biotechnology: Semester-I MST101: BIOCHEMISTRY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Student should have basic knowledge of chemistry & Biotechnology.

Course Objectives:

- The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.
- Students who complete this course will be able to understand fundamental properties of elements, atoms, acids and bases, metals, non-metals, alloys and composites. They will appreciate the role of metals and radioisotopes in biology and will understand the applications of rare earth metals, transition metals and X-rays.
- Students will analyze the properties of common organic reagents and compounds, carry out selective reactions of organic functional groups and verify reactivity of organic functional groups.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand various applications of Biomolecules,their structure and function

CO2: Analyze the Gibbs frees energy and enthalpy

CO3: Identify different types of biosynthetic pathways of different biomolecules

CO4: Understand the concept of lipids and their significance

CO5: Knowledge of Electron-Transfer Reactions in Mitochondria. ATP Synthesis, Regulation of Oxidative Phosphorylation.

CO6: Understand various aspects of metabolism of biomolecules

Detailed Syllabus

Unit - I : Introduction of Biomolecules
Chemical basis of life; Composition of living matter; Water–properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Unit – II: Enzyme
Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes
Unit – III: Carbohydrates, Lipids and Proteins
Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins
Unit – IV: Biomembrane organization
Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma
Unit – V: Bioenergetics
Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.

Suggested Readings:

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

M.Sc. Biotechnology: Semester-I MST102: CELL AND DEVELOPEMENTAL BIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Knowledge of basic Cell.

Course Objectives: The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Students will know about the cell and its biology, which will help the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function.
CO2: How cells obtain energy, synthesize new molecules, communicate, proliferate and survive.
CO3: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
CO4: Students will understand the cellular components underlying mitotic cell division.
CO5: The understanding of cells is used for learning the processes such as, absorption, how electrical signals are carried, secretion, why some things such as lack of oxygen can cause death, etc.

Detailed Syllabus

Unit I: Cell Theory, Membrane Structure and Function & Biomembranes and cell architecture
Cell theory, membrane structure and function: Evolution of life, The Diversity and Commonality of Cells, The Molecules of Cell, The Work of Cells, Investigating Cells and Their Parts. Biomembranes and cell architecture: Bio membranes: Lipid Composition and Structural Organization, Bio membranes: Protein Components, and Basic Functions, Organelles of the Eukaryotic Cell, Purification of Cells and Their Parts, Visualizing Cell Architecture, Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging.

Unit II: Integrating cells into tissues & membrane transport
Integrating cells into tissues: Cell–Cell and Cell–Matrix Adhesion: An Overview, Sheet like Epithelial Tissues: Junctions and Adhesion Molecules, The Extracellular Matrix of Epithelial Sheets, The Extracellular Matrix of Nonepithelial Tissues, Adhesive Interactions and Nonepithelial Cells, Plant Tissues, Growth and Use of Cultured Cells, Microfilaments, Intermediately filaments and Microtubules **Membrane transport:** ATP-Powered Pumps and the Intracellular Ionic Environment, Non-gated Ion Channels and the Resting Membrane Potential, Co-transport by Symporters and Antiporters, Movement of Water, Transepithelial Transport, Voltage-Gated Ion Channels and the Propagation of Action Potentials in Nerve Cells, Neurotransmitters and Receptor and Transport Proteins in Signal Transmission at Synapses
Unit III: Cell signalling & Moving proteins into membranes and organelles
Cell signalling: Signalling Molecules and Cell-Surface Receptors, Intracellular Signal Transduction, G Protein–Coupled Receptors That Activate or Inhibit Adenylyl Cyclase, TGF-Receptors and the Direct Activation of Smads, MAP Kinase Pathways, Receptor Tyrosine Kinases and Activation of Ras, Cytokine Receptors and the JAK-STAT Pathway, Down-Modulation of Receptor Signaling, Experimental Approaches for Building a Comprehensive View of Signal-Induced Responses **Moving proteins into membranes and organelles**: Translocation of Secretory Proteins Across the ER Membrane, Insertion of Proteins into the ER Membrane, Protein Modifications, Folding, and Quality Control in the ER, Export of Bacterial Proteins, Sorting of Proteins to Mitochondria and Chloroplasts, Sorting of Peroxisomal Proteins
Unit IV: Overview of the cell cycle and its control
Overview of the cell cycle and its control: Biochemical Studies with Oocytes, Eggs, and Early Embryos, Genetic Studies with S. pombe, Molecular Mechanisms for Regulating Mitotic Events, Genetic Studies with S. cerevisiae, Cell-Cycle Control in Mammalian Cells, Checkpoints in Cell-Cycle Regulation, Meiosis: A Special Type of Cell Division, The Birth of Cells, Cell Death and Its Regulation, Cancer
Unit V: Cellular movements and pattern formation laying of body axis planes
Cellular movements and pattern formation laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

Suggested Readings:

1. Lodish *et al*., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson *et al.,* Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

M.Sc. Biotechnology: Semester-I MST-103: MOLECULAR BIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Knowledge of basic Biochemistry & Cell biology.

Course Objectives:

The objectives of this course are to sensitize the students about the recent advances in molecular biology and various facets of molecular medicine which has the potential to profoundly alter many aspects of modern medicine including the pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Students will learn DNA replication, recombination and repair, transcription and translation.
CO2: Students will be aware of the modern tools and techniques of genomics and isolation and identification of genes.
CO3: Understand Genomic organization
CO4: Learn Transposable genetic elements in prokaryotes and eukaryotes
CO5: Learn Transport of proteins and molecular chaperones
CO6: Students will understand the biology and application of antisense technologies and biology of cancer.

Detailed Syllabus:

Unit I : Genome organization
Genome organization : Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; Dnase I hypersensitive regions; DNA methylation & Imprinting.

Unit II: DNA Structure; Replication; Repair & Recombination
DNA Structure; Replication; Repair & Recombination Structure of DNA – A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair-enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.
Unit III: Prokaryotic & Eukaryotic Transcription
Prokaryotic & Eukaryotic Transcription : Prokaryotic Transcription; Transcription unit; Promoters-Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing.
Unit IV: Post Transcriptional Modifications
Post Transcriptional Modifications : Processing of mRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. **Translation & Transport** Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation .
Unit V: Mutations; Oncogenes and Tumor suppressor genes
Mutations; Oncogenes and Tumor suppressor genes: Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frame shift mutations; Physical, chemical and biological mutagens; Transposition – Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Suggested Readings:

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

M.Sc. Biotechnology: Semester-I MST104: IMMUNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Biochemistry, Molecular Biology.

Course Objectives:

The objectives of this course are to make students learn about the structural features of the components of the immune system as well as their function. The major emphasis of this course will be on the development of the immune system and mechanisms by which our body elicit the immune response. This will be imperative for the students as it will help them to think like an immunologist and predict about the nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Evaluate the usefulness of immunology in different pharmaceutical companies.

CO2: Students will understand the basic concept of innate and acquired immunity.

CO3: Understand Hypersensitivity reactions.

CO4: Students will gain knowledge about immunoglobulin structures and diversity of antibodies, morphology and functions of various immune cells such as dendritic cells, macrophages, neutrophils and their association with MHC molecules will be studied.

CO5: This study will make the students to understand the basic mechanisms of hypersensitivity responses and their associations with different diseases.

CO6: The main goal of the course is to provide basic understanding of immunology and immune responses in response to various infectious and non infectious diseases.

Detailed Syllabus:

UNIT I: Immune Response
Immune response: Innate and adaptive immune system: Inflammation and that Stimulates Immune Responses, Toll-like receptor-component of innate immune system; Antigen presenting cells, Artigens, Heptanes: factor effecting immunogenicity. Adaptive Immunity: Antigenic specificity, Diversity, Immunologic memory, Self / nonself recognition. B lymphocytes and T lymphocytes; Antigenicity and immunogenicity. Immune dysfunction and Its Consequences.
UNIT II: Cells and organs of the immune system
Cells and organs of the immune system: Hematopoiesis and its control, Clonal selection theory. Programmed Cell Death; Lymphoid Cells: lymphocytes and their subsets, natural killer cell, Mononuclear Phagocytes. Antimicrobial and cytotoxic activities. Lymphoid Organs: Primary (thymus, bone marrow) and secondary lymphoid organs (Lymph nodes, spleen).
UNIT III: Antigens and Epitopes
Antigens and epitopes: immunogenicity, antigenicity and haptens; factors affecting immunogenicity. Lipids as antigens. Adjuvants, epitopes, or antigenic determinants, ag recognition by t cells and b cells, properties of b-cell epitopes and t-cell epitopes, blood group antigens. Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins.
UNIT IV: Antigen-Antibody Interactions
Antigen-Antibody Interactions: Strength of Antigen-Antibody Interactions, Cross-Reactivity, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-Linked Immunosorbent Assay, Western, Blotting, Immunoprecipitation. Production and application of monoclonal antibody: hybridoma technology. Major histocompatibility systems: Structure of MHC I and II molecule, Association of MHC with disease. Recognition of antigens by T and B Cells: Antigen processing, role of MHC molecules in antigen presentation. T-cell receptor complex, B-cell receptor complex.
UNIT V: Compliment system
Compliment system, components, Activation pathway and regulation of activation pathway, complement deficiency, role of complement system in immune responses opsonization (opsonin). Hypersensitivity: Definition, lgE mediated Hypersensitivity, mechanism of mart cell degranulation, mediators of type I reactions and consequences type II reaction, immune complex mediated Hypersensitivity and delayed type Hypersensitivity. Autoimmunity and Cancer.

Suggested Readings:

1. Immunology by Kuby J et al. W. H. Freeman & Company.
2. Immunology, L.M. Roitt, J. Brestoff and D.K. Male, 1996.
3. Immuno-biology, Janeway CA and Paul Travers 1994.
4. Immunological techniques, D.M. Weir, 1992.
5. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.

M.Sc. Biotechnology: Semester-I MST 105: COMPUTER APPLICATION AND BIOSTATISTICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: MST101, MST 151 Biochemistry, MST103, MST153 Molecular Biology.

Course Objectives:

The objective of this course is to give conceptual exposure of essential contents of mathematics, statistics and basic concepts of computer hardware to students.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Gain broad understanding in mathematics and statistics.

CO2: Recognize the importance and value of mathematical and statistical thinking, training and approach to problem solving, on a diverse variety of disciplines.

CO3: Have thorough knowledge of statistical techniques and application of computer in microbiology.

CO4: Understand the practice of statistical methods with specific reference to problems in microbiology.

Detailed syllabus:

Unit-I: Definition of selected terms Scale of measurements Related to statistic
Definition of selected terms Scale of measurements Related to statistic, Methods of collecting data, Presentation of data, statistical Tables, Calculation of basic statistical parameters (mean, median, mode, standard deviation, standard error etc.). Correlation concept and applications; Regression concept and application; Concepts of statistical population and sample need for sampling studies; Simple procedures of random sampling; Methods of sampling, Estimation of sample size for clinical experiments Basic concepts of Probability , Basic theorems of probability addition and multiplication theorems; Conditional probability of Bayes Theorems; Probability distribution definition & applications.

Unit –II: Critical region and level of significance
Critical region and level of significance, Test of a simple hypothesis against simple alternative, composite hypothesis, Neymen Pearson test of hypothesis, UMP test, UMP unbiased test, Likelihood ratio test, Test on the mean of normal population, Difference between the mean of two normal populations, Test on the variance of normal populations, $\chi 2$ test, $\chi 2$ goodness of fit test and test of independence of contingency tables. Test of proportion, Test of correlation and regression coefficient, , Test based on t and f, Multiple comparisons.
Unit-III: Non-parametric tests-Wilcoxon Mann Whitney
Non-parametric tests-Wilcoxon Mann Whitney, Kolmogorov Smirnov tests (two sample tests)Planning of experiments, Basic principles of experimental design, uniformity trails, analysis of variance, one-way, two-way and three-way classification models, completely randomized design (CRD), randomized block design (RBD) latin square design (LSD) and Graeco-latin square designs, Analysis of covariance (ANCOVA), ANCOVA with one concomitant variable in CRD and RBD.
Unit-IV: Introduction to MS Excel
Introduction to MS Excel, creating a data file, data manipulations, simple statistical analysis using Excel, making graphs and charts.MS PowerPoint, different types of statistical software for analysis (introduction) MINITAB, MATLAB, R, SAS.
Unit-V: Introduction of Statistical package (SPSS)
Introduction of Statistical package (SPSS), Data view and variable view, importing a file, Data transformations (compute, recode, count, If,). Sort cases, merging and appending data, Frequencies, descriptive statistics, cross tabulations. Statistical analysis: independent samples‘t’ test, paired ‘t’ test, ANOVA, chi square, Fisher’s exact test, McNemar chi-square test, correlation and regression, Multiple Linear Regression, Principal Component Analysis (PCA). Non-parametric methods: Mann Whitney U test, Wilcoxon Signed rank test, Spearman’s correlation.

Suggested Readings:

1. Principles of Biostatistics- M. Pagano, Cengage Learning Publishers, 2ndEdition, 2008.
2. Kempthorne, O(1966): The Design and Analysis of Experiments, John Wiley and Sons.
3. Introduction to Biostatistics. Glover T. and Mitchell K. (2002). McGraw Hill, New York.
4. Fundamentals of Biostatistics. Rosner Bernard (1999), Duxbury Press.
5. R Cookbook. Paul Teetor (2011), United States of America.

M.Sc. Biotechnology: Semester-I MST 106: Food Biotechnology	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: Basic Knowledge of Biotechnology and genetic engineering in food.

Course Objectives: The objective of this course is to give conceptual exposure of fermentation, probiotic and single cell proteins.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Students can understand: Applications of biotechnology in food production..

CO2: Enhancing the quality and quantity of food materials through genetic engineering.

CO3: Understand the rules and regulations in genetic modification of food.

CO4: Students will gain knowledge about safety assessment of food.

CO5: The main goal of the course is to provide basic understanding the student can be able to setup the industry of food materials.

Detailed Syllabus:

Unit-I: Introduction of Food Production
Food production through fermentation-Bread making, cheese production-process, starter culture, types of cheese. Other fermented dairy products-buttermilk, acidophilus milk, yogurt, butter, paneer, kefir, marine fermented foods, koji, tempeh. Fermented bevarages-beer and wine. Enzymes in food processing: amylase, protease,chymosin, lipase, cellulase, hemicellulase, pectinase, pectin lyase, catalase, glycosidase, invertase, glucose oxidase, glucose isomerase.
Unit-II: Single cell protein-from bacteria and algae-spirulina and probiotics
Single cell protein-from bacteria and algae-spirulina, probiotics-significance, role in health, prebiotics, Edible mushrooms, Steps of mushroom production, microbial production of vitamins-riboflavin, vitamin C, lite beer, HFCS(High Fructose corn syrup).Buffalo cloning in India
Unit-III: Transgenic plants
Transgenic plants-Flavr savr tomato; Methionine-enriched oil; Frost-resistant food; -Starlink corn, Btmaize; Fungal Resistant potatoes; Transgenic Fish -Atlantic salmon.Plant Pharmaceuticals, Biopharming -beta -carotene in rice; Edible vaccines -Hepatitis B vaccine in maize-Cholera vaccine in potatoes; Bovine Somatotropin in Milk; Chymosineand mycoproteins. Growth hormone gene in pigs -alpha-lactalbumin and lactoferrin in milk;

Unit-IV: Food preservation
Food preservation:, contamination of milk, Preservation of milk, microbial contamination and spoilage of food, foodborne illness-salmonellosis, listeriosis, botulism, staphylococcal infection, preservation methods: Effect of low temperature, freezing, effect of heat, drying, concentration, fermentation, canning, radiation, chemical preservatives..
Unit-V: Significance of food safety assessments & surveillance.GM food
Significance of food safety assessments & surveillance.GM food: Regulations, Risks, possible danger to individuals, society or nature-Terminator genes and loss of biodiversity.HACCPconcepts and risk assessment. Government regulatory agencies and food policies -Food and Drug Administration, The Centers for Disease Control and Prevention, The Environmental Protection Agency.

Suggested Readings:

1.Biotechnological innovations in foodprocessing: Editor : Dr. J Green, Butterworth-Heinman Pub.
2.Food-Facts and PrinciplesII Ed: N Shakuntala Manay, M. Shadakshara Swamy. New Age International Pub:
3.Bioprocess Technology: P T Kalaichelvan, I Arul Pandy : MJP Publishers.
4.George J.B., "Basic Food Microbiology", CBS Publishers & Distributors, 1987
5.Roger A., Gorden B., and John T., " Food Biotechnology", 1989

M.Sc. Biotechnology: Semester-I MST151: BIOCHEMISTRY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15Marks
Credits: 2	External Assessment - 35Marks

Prerequisite: - MST101 Biochemistry.

Course Objectives:

The objectives of this course are to teach students with various approaches to analyze Biochemical test that they can apply to their future career in biological research as well as in biotechnology industries.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Understanding good laboratory practices in a chemistry/biochemistry laboratory, safety and precautions.

CO2: Proficiency in preparation of laboratory reagents,

CO3: Experimentation/demonstration of basic oxidation and reduction reactions,

CO4: Primary and secondary standards.

Detailed Syllabus:

1. Preparation of different buffers and pH measurement.
2. Qualitative tests for Biomolecules. Like carbohydrates, alkaloids, fatty acids, etc.
3. Quantitative estimation of proteins by Lowry's / Bradford method.
4. Estimation of total soluble sugars.
5. Quantitative estimation of nucleic acids by spectrometry.
6. Determination of saponification number of lipids.
7. Qualitative estimation of different amino acids.
8. Separation and identification of sugars and amino acids by chromatography.
9. Determination of amylase, peroxidase, catalase activity using spectrophotometer.

M.Sc. Biotchnology: Semester-I MST152: MOLECULAR BIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	**Internal Assessment -15Marks**
Credits: 2	**External Assessment - 35Marks**

Prerequisite: MST101, MST151 Biochemistry, MST103 Molecular Biology.

Course Objectives:

The objectives of this course are to provide students with the experimental knowledge of molecular biology laboratory.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Gain hands-on experience on gene cloning, protein expression and purification.

CO2: 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.

Detailed Syllabus:

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps
2. Restriction digestion
3. Preparation of competent cells.
4. Agarose gel electrophoresis
3. Restriction Enzyme digestion of DNA
4. Purification of DNA from an agarose gel
5. DNA Ligation
6. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency
7. Cloning of genomic DNA in standard plasmid vectors
8. Confirmation of the insert, Miniprep of recombinant plasmid DNA, Restriction mapping
9. Polymerase Chain reaction, using standard 16srRNA eubacterial primers
10. RFLP analysis of the PCR product
11. Transformation of yeast Saccharomyces cerevisiae.

M.Sc. Biotechnology: Semester-I MST153: IMMUNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment - 35 Marks

Prerequisite: - MST101, MST151 Biochemistry, MST103, MST152 Molecular Biology.

Course Objectives:

The objectives of this laboratory course are to make students develop an understanding about practical aspects of the components of the immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells etc. and how they can be used in respective research work.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Evaluate the usefulness of immunology in different pharmaceutical companies.

CO2: Identify proper research lab working in the area of their own interests.

CO3: Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.

Detailed Syllabus:

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from serum.
6. SDS-PAGE, Immunoblotting, Dot blot assays
7. Blood smear identification of leucocytes by Giemsa stain
8. Separation of leucocytes by dextran method
9. Demonstration of Phagocytosis of latex beads
10. Separation of mononuclear cells by Ficoll-Hypaque
11. Flowcytometry, identification of T cells and their subsets
12. Lymphoproliferation by mitogen / antigen induced
13. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)
14. Hybridoma technology and monoclonal antibody production.
15. Immunodiagnostics using commercial kits.

M.Sc. Biotechnology: Semester-I MST155: SEMINAR I	
Teaching Scheme	**Examination Scheme**
Lectures: 4 hrs/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment - 35 Marks

Prerequisite: - MST101, MST151 Biochemistry, MST103, MST153 Molecular Biology.

Course Objectives: The objectives of this course are to train the students to evaluate research papers, to assess quality of the papers and how the papers are refereed and published as well as learn how to get the papers published.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Critically analyze the research papers from different upcoming topics.

CO2: Understand the weaknesses and strengths of the paper and what additional experiments could have been done to strengthen the research study.

CO3: Understand the context of the paper and identify important questions. - Acquire the skills in paper writing and getting it published.

Detailed syllabus:

It's compulsory for all the students to give a seminar on the topic assigned by the Department of Biotechnology in the staring of the semester, in the supervision of the assigned supervisor. If the discussion session of seminar / presentation is not found satisfactory then the next date for the said presentation will be given immediately.
Presentation Time duration : 30 - 45 minutes
Discussion duration : 15 - 20 minutes

M.Sc. Biotechnology: Semester-II MST201: ANALYTICAL TECHNIQUES	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Biochemistry, Molecular Biology.

Course Objectives:

The objective of this laboratory course is to teach students various techniques used in molecular clinical biology. The course is designed to teach students the utility of set of experimental methods in biochemistry in a problem oriented manner.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: To elaborate concepts of biochemistry so as to easily conduct experiments.

CO2: To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry..

Detailed syllabus:

Unit I: Basic Techniques
Basic Techniques Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques. **Spectroscopy Techniques** UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy.
Unit II: Chromatography Techniques
Chromatography Techniques TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity. **Electrophoretic techniques** Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

Unit III: Centrifugation
Centrifugation Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.
Unit IV: Microscopic Techniques
Microscopic Techniques: History, basic types of light microscopy and their applications in brief; Simple, compound, inverted, stereo, fluorescence, dark field and bright field microscope. Phase contrast microscopy: Amplitude and phase objects, wave terminology, positive or dark phase contrast and negative or bright phase contrast microscopy. Electron microscopy: Transmission Electron Microscope and Scanning Electron Microscope, sample preparation for EM, basic concept of confocal microscope.
Unit V: Advanced Techniques
Advanced Techniques: Protein crystallization- X-ray diffraction and X-ray crystallography and their application. **Mass Spectrometry:** Theory and methods; Different components of a mass spectrometer, types of ionization techniques and types of mass analyzers. MALDI-TOF. Mass precision, mass measurement accuracy, mass resolution, ionization energy and appearance energy.

Suggested Readings:

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H.
Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge
University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

M.Sc. Biotechnology: Semester-II MST202: MICROBIOLOGY AND INDUSTRIAL APPLICATIONS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Biochemistry, Molecular Biology and cell development.

Course Objectives: The objectives of this course are to introduce the students to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Identify the major categories of microorganisms and analyze their classification, diversity, and ubiquity.

CO2: Identify and demonstrate the structural, physiological, and genetic similarities and differences of the major categories of microorganisms.

CO3: Identify and demonstrate how to control microbial growth. - Demonstrate and evaluate the interactions between microbes, hosts and environment.

Detailed syllabus:

Unit I: Microbial Diversity & Systematics
Microbial Diversity & Systematics : Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.
Unit II: Microbial Growth & Physiology
Microbial Growth & Physiology Ultrastructure of Archaea (Methanococcus); Eubacteria (*E.coli*); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with example from each group).

Unit III: Microbial Interactions and Infection
Microbial Interactions and Infection Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence
Unit IV: Microbes and Environment **Microbes and Environment *:*** Role of microorganisms in natural system and artificial system; Influence of
Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.
Unit V: Industrial Applications
Industrial Applications Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting downstream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc. Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformationssteroids, antibiotics, alkaloids, enzyme/cell electrodes.

Suggested Readings:

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

M.Sc. Biotechnology: Semester-II MST203 - GENETIC ENGINEERING	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Biochemistry, Molecular Biology.

Course Objectives:

The objectives of this course are to teach students with various approaches to conducting genetic engineering that they can apply to their future career in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course. This technology has revolutionized the way modern biological research is done and has impacted mankind with a number of biological products and processes.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Students will become familiar with the tools and techniques of genetic engineering- DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.

CO2: This course exposes students to the applications of genetic engineering in biological research.

CO3: Students will be able to perform basic genetic engineering experiments at the end of course.

CO4: Students will acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.

Detailed syllabus:

Unit I: Basics Concepts
Basics Concepts DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions- Electromobility shift assay; DNaseI footprinting; Methyl interference assay.

Unit II: Cloning Vectors
Cloning Vectors Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors
Unit III: Cloning Methodologies
Cloning Methodologies Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression
Unit IV: PCR and Its Applications
PCR and Its Applications Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)
Unit V: Sequencing methods
Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- *in vivo* and *ex-vivo*; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Suggested Readings:

1. S.B.Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc

M.Sc. Biotechnology: Semester-II MST204: IPR & BIOSAFETY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: Biochemistry, Molecular Biology, Microbiology & Industrial Applications, Genetic Engineering.

Course Objectives:

1. To give a background on the history of science, emphasizing the methodologies used to do research.
2. To use the framework of these methodologies for understanding effective lab practices and scientific communication.
3. To use the framework of these methodologies to understand and appreciate scientific ethics.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Students will gain knowledge about the basics of the four primary forms of intellectual property rights, the right of ownership, scope of protection as well as the ways to create and to extract value from IP.

CO2: Students will able to compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.

CO3: Students will gain knowledge to analyze the effects of intellectual property rights on society as a whole.

CO4: This course will provide complete package to the students to identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development**.**

Detailed Syllabus:

Unit I: Introduction to Intellectual Property
Introduction to Intellectual Property Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

Unit II: Concept of 'prior art'
Concept of 'prior art' Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation
Unit III: Basics of Patents
Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application
Unit IV: Patent filing and Infringement
Patent filing and Infringement Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples
Unit V: Biosafety
Biosafety Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Important Links for reference:

http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html www.patentoffice.nic.in
www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

Suggested Readings:

1. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
2. Intellecutla property rights – Ganguli – Tata McGrawhill
3. Intellectual property right – Wattal – Oxford Publishing House.

M.Sc. Biotechnology: Semester-II MST205: GENOMICS AND PROTEOMICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Molecular Biology, Genetic Engineering.

Course Objectives: The objectives of this course are to provide introductory knowledge concerning **genomics** & proteomics and their applications.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: The student will be aware with a basic knowledge of modern molecular biology and genomics.

CO2: The student will understand how theoretical approaches can be used to model and analyze complex biological systems..

Detailed syllabus:

Unit I: Introduction & Structural organization of genome
Introduction: Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II: Genome sequencing projects
Genome sequencing projects Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.
Unit III: Proteomics
Proteomics Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.
Unit IV: Pharmacogenetics
Pharmacogenetics High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development
Unit V: Functional genomics and proteomics
Functional genomics and proteomics Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

Suggested Readings:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3.Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

M.Sc. Biotechnology: Semester-II MST206: ADVANCEMENTS IN APPLIED BIOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: Basic Knowledge of Biotechnology and Its applications.

Course Objectives: The objectives of this course are to provide knowledge about advancement of applied Biotechnology.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: The student will be aware the application of biotechnology in different field such as health, medicine and conservation of biodiversity.

CO2: The student will able to understand advance knowledge in different field of biotechnology.

Detailed Syllabus:

Unit I: Genetically modified organisms
Genetically modified organisms: Genetically modified microbes, crop plant and animals with example and applications. Genetically modified commercial products: Insulin, Golden rice, BT Cotton, BT Brinjal, Mustard, Status of genetically modified crops, commercialization and regulation in India
Unit II: Stem cells
Stem cells: Definition, properties, classification, culture of stem cells, hematopoietic and non hematopoietic stem cells, applications of stem cells, organogenesis and organ transplant, legal and ethical issues of stem cells. 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 III: Nano- biotechnology
Nano-biotechnology: Introduction, definition, nano-fluids, application in medicine, agriculture, Biotechnology in medicine, vaccine, Gene therapy, drug delivery and tissue engineering.
Unit IV: Biotechnology in bioremediation
Biotechnology in bioremediation, restoration of degraded land and conservation of ex situ and in situ biodiversity, improvement of soil fertility by microbes, application of selected and engineered microbes for heavy metal removal, development of abiotic stress plant (salinity, temperature and aluminum toxicity).

Suggested Readings:

1. The Cell - A molecular Approach, Geoffrey M. Cooper and Robert E. Hausman, ASM Press
2. Molecular Biology and Biotechnology, 4th Edn, J.M Walker and R. Rapley, Panima Books
3. Cell Biology, David. E. Sadava, Panima Books, Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
4. Environmental Microbiology, 2nd Edition, Ian L .Pepper and Charles P. Gerba, Elsevier Pub.
5. Environmental Biotechnology – Concepts and Application, Hans – Joachim Jordening and Jesefwinter – Wiley – VCH

M.Sc. Biotechnology: Semester-II MST251: ANALYTICAL TECHNIQUES LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15Marks
Credits: 2	External Assessment - 35Marks

Prerequisite: - Enzyme Technology, Biochemistry, Molecular Biology.

Course Objectives:

1. To understand the basics of Enzyme functioning
2. To learn the enzyme kinetics
3. To learn and have complete knowledge of enzyme inhibition
4. To understand how enzyme and substrate reaction occurs.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Isolate enzymes from various sources.

CO2: Determine the Km and Vmax of the enzymatic reactions.

CO3: Perform ELISA & Blotting techniques.

CO4: Purify and preserve enzymes.

Detailed syllabus:

1. Preparation of buffers for protein isolation.
2. Study of mitosis by microscopic technique.
3. Quantitative estimation of proteins by spectrophotometer.
4. Spectrophotometric estimation carbohydrate.
5. Determination of molecular weight of protein sample by SDS-PAGE.
6. Characterization of protein samples by coomasiebrilliant blue and silver staining
7. Analysis of affinity difference by paper chromatography.
8. Dot blot and Western blotting techniques – demonstration
9. Hormone estimation by ELISA.

M.Sc. Biotechnology: Semester-II MST252: MICROBIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15Marks
Credits: 2	External Assessment - 35Marks

Prerequisite: Microbiology.

Course Objectives:

The objective of this laboratory course is to provide the students practical skills on basic microbiological techniques.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Ability to isolate, characterize and identify common bacterial organisms.

CO2: Determine bacterial load of different samples.

CO3: Perform antimicrobial sensitivity test.

CO4: Preserve bacterial cultures.

Detailed Syllabus:

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms.
8. Determination of thermal death point and thermal death time of microorganisms.

M.Sc. Biotechnology: Semester-II MST253: GENETIC ENGINEERING LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assesssment -15Marks
Credits: 2	External Assessment - 35Marks

Prerequisite: Molecular Biology & Genetic Engineering.

Course Objectives:

The objectives of this course are to provide students with the experimental knowledge of molecular biology & genetic engineering.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Students should be able to gain hands on experience on gene cloning, protein expression and purification.

CO2: 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.

Detailed syllabus:

1. Isolation of genomic DNA from *Bacillus subtilis** genome.
2. PCR amplification of *scoC* gene and analysis by agarose gel electrophoresis
3. Preparation of plasmid, pET-28a from *E.coli* and gel analysis.
4. Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI
5. a. Vector and Insert ligation
   b. Transformation in *E.coli* DH5.
6. Plasmid isolation and confirming recombinant by PCR and RE digestion.
7. Transformation of recombinant plasmid in *E.coli* BL21 (DE3) strain.
8. Induction of ScoC protein with IPTG and analysis on SDS-PAGE
9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE
10. a. Random Primer labeling of scoC with Dig-11-dUTP
    b. Southern hybridization of *B. subtilis* genome with probe and non-radioactive detection.

- *Any other bacterial strain can be used.

M.Sc. Biotechnology: Semester-II MST255: SEMINAR II	
Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment - 35 Marks

Course Objectives:

The objectives of this course are to train the students to evaluate research papers, to assess quality of the papers and how the papers are refereed and published as well as learn how to get the papers published.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Critically analyse the research papers from different upcoming topics.

CO2: Understand the weaknesses and strengths of the paper and what additional experiments could have been done to strengthen the research study.

CO3: Understand the context of the paper and identify important questions.

CO4: Acquire the skills in paper writing and getting it published.

Detailed Syllabus:

It's compulsory for all the students to give a seminar on the topic assigned by the Department of Microbiology in the staring of the semester, in the supervision of the assigned supervisor. If the discussion session of seminar / presentation is not found satisfactory then the next date for the said presentation will be given immediately.		
Presentation Time duration	:	30 - 45 minutes
Discussion duration	:	15 - 20 minutes