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.

YEAR II, SEMESTER III

S.No.	COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
				L	T	P	CA	EE		
1.	MST301	FERMENTATION TECHNOLOGY	CC	3	0	0	30	70	100	3
2.	MST302	TISSUE CULTURE	CC	3	0	0	30	70	100	3
3.	MST303	GENETICS	CC	3	0	0	30	70	100	3
4.	MST304	BIOINFORMATICS	CC	3	0	0	30	70	100	3
5.	MST305	BIOENTREPRENEURSHIP	DSE*	3	0	0	30	70	100	3
	MST306	MOLECULAR DYNAMICS & BIOENERGETICS	DSE*							
6.	MST351	FERMENTATION TECHNOLOGY LAB	AEC	0	0	4	15	35	50	2
7.	MST352	TISSUE CULTURE LAB	AEC	0	0	4	15	35	50	2
8.	MST353	BIOINFORMATICS LAB	AEC	0	0	4	15	35	50	2
9.	MST355	SEMINAR III	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 II, SEMESTER IV

S.No.	COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
				L	T	P	CA	EE		
1.	MST 451	Project Work	AEC	0	0	28	0	300	300	28

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-III MST 301: FERMENTATION TECHNOLOGY	
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, MST151 Biochemistry, MST103, MST153 Molecular Biology, MST202, MST252 Microbiology & Industrial Applications, MST203, MST253 Genetic Engineering.

Course Objectives:

1. To understand the basic of fermentation, different bioreactor design, different media used for the fermentation of product, overview of product produced by biotechnological industries.
2. To learn the different instrumentation used for the downstream processing of different products.
3. To learn and have complete knowledge of type of enzymes and different fermented food products of different industries.
4. To understand how downstream processing instrumentation works or they can use like crystallization, during, liquid-liquid extraction, centrifugation, chromatography etc.
5. To learn the enzyme kinetics, microbial kinetics, thermal kinetics and the application of these in fermentation.
6. To expertise in the process involved in the effluents or waste of fermentation industries by latest technologies involved in treatment of waste like, Activated sludge process, Rotating Disk Biological Contractor (RBC) etc.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Understand various types of fermentation mode of operation and their kinetics.

CO2: Analyze the effect of various fermentation and downstream processes involved in the synthesis of products.

CO3: Understand the enzyme production and their application involved in modern world.

CO4: Understand the instrumentation involved in the downstream processing of products produced by different pharmaceutical and biotechnological industries.

CO5: Evaluate performance of different fermentation processes i.e., whose work in batch and continuous mode of operation.

CO6: Will understand the production and application of some enzymes used in food and biotechnological industries.

Detailed Syllabus:

Unit I: An introduction to fermentation processes
An introduction to fermentation processes- Range of fermentation process, microbial biomass, Microbial metabolites, Microbial growth kinetics- Batch culture, continuous culture, comparison of batch and continuous culture in industrial applications, fed-batch culture, variable and fixed volume fed batch culture,
Unit II: Isolation, preservation and improvement of industrially important microorganisms
Isolation, preservation and improvement of industrially important microorganisms, Screening methods, Isolation methods, enrichment liquid culture, enriched culture, Industrial fermentationtypical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle, buffers, precursors and metabolic regulators, oxygen requirement.
Unit III: Sterilization Methods
Media sterilization, sterilization of fermenter, sterilization of the feed. Inocula for industrial fermentation-development of inocula for yeast, bacteria, fungi and actinomycetes, the inoculation of fermenters, the use of spore inoculums, inoculation from a laboratory and plant fermenter .
Unit IV: Downstream processing
Downstream processing: Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal, anaerobic and aerobic treatment of effluents.
Unit V: Bioreactor
Bioreactor: Types of reactor: Batch culture bioreactor, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fixed and Fluidized bed, bubble column, air lift fermenter. Design of fermenter, basic functions, construction, aeration and agitation, oxygen requirements of industrial fermentation, Instrumentation and control of process parameters, Scale up and scale down process.

Suggested Readings:

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman, McNeul and Harvey.
2. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
3. Fermentation Biotechnology: Industrial Perspectives by Chand.
4. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.
5. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F.,

M.Sc. Biotechnology: Semester-III MST302: TISSUE CULTURE	
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, MST151 Biochemistry, MST103, MST153 Molecular Biology, MST201, MST 251 Analytical Techniques.

Course Objectives:

1. To understand the basic of tissue culture methods in respect to animal and plant cell culture system in lab.
2. To learn few culturing methods that will help to understand the methods to prepare tissue cultures by Enzymatic, mechanical etc.
3. To learn and have complete knowledge of type of organ culture and their scale up.
4. To understand the isolation, preservation and maintenance of important tissue culture used for various purposes.
5. To learn cloning methods for the improvement of culture and their application in modern world.
6. To expertise in the process involved in animal and plant tissue culture and their associated methodology.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: After completing the course, students will be able to:

1. Understand basics of tissue culture.
2. learn the methods involved for the isolation and preservation of animal and plant tissues.
3. Understand the concept to do the experimentation in aseptic condition and analyze the outcome of it.
4. Understand the principle and media used for culture of different cell lines.
5. Will learn the application of tissue culture methods adopted in the animal and plant cell lines.
6. Will analyze and learn the methods associated with the large scale production different tissue cultures.

Detailed Syllabus:

Unit-I: Animal tissue culture:
Animal tissue culture: Introduction- advantages and disadvantages of tissue culture; equipment for a tissue culture laboratory; aseptic techniques- sterile handling, standard procedures, sterilization; Culture vessels- substrates ; Media- properties, natural media, artificial media- serum containing media, serum free media , chemically defined media.
Unit-II: Primary culture
Primary culture- isolation of tissue by enzymatic methods, mechanical methods; Cell line- sub culture, routine maintenance, suspension culture, adherent culture, Cell quantitation- cell counting, Cytotoxicity- Viability assay using dye, cell proliferation assay, metabolic assay; Cryopreservation- need, methods and stages of cryopreservation. Contamination- source, monitoring for contamination.
Unit-III: Organ culture
Organ culture; Tumor cells & transformation; Scale up- batch culture, continuous culture, Scale up in monolayer; scale up in – suspension culture, Animal tissue culture products & application- vaccines, monoclonal antibodies, enzymes, hormones, factors.
Unit-IV: Plant tissue culture- Introduction
Plant tissue culture- Introduction ; Methods- media preparation, aseptic techniques, sterilization, pretreatment to explant tissue; Callus culture, Meristem culture, Organ culture, Cryopreservation. Somatic hybridization- isolation of protoplast, viability testing of protoplast ,protoplast fusion, regeneration of plant, selection of fusion hybrid.
Unit-V: Cloning, Large scale culture, Somatic embryogenesis
Cloning, Large scale culture, Somatic embryogenesis- development & application; Micropropagation – advantages, methods, application; Biochemical production, Somaclonal variation.

Suggested Readings:

1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
2. Ed. Martin Clynes, Animal Cell Culture Techniques., Springer, 1998.
3. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
4. Plant tissue culture: SS Bhojwani and M.K. Razdan, Elsevier Science, The Netherlands.
5. Cell culture methods and cell biology procedure: A. Doyle.
6. Plant Tissue Culture – A practical Apporch: R.A. Dixon, IRL press.
7. Cell and Tissue Culture: Lab procedures in biotechnology, Alan Doyal (ed) J.Bryan Griffth
8. Doods. J.H. & Roberts L.W. (1985). Experiments in plant tissue culture Cambridge Univ.
9. Animal or Animal cell & tissue culture techniques 5th freshness.

M.Sc. Biotechnology: Semester-III MST303: GENETICS	
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: Prerequisite: - MST103, MST153 Molecular Biology, MST102, Cell and development biology, MST105 Computer application and statistics.

Course Objectives:

1. To understand the basic of bacterial mutation which includetheir types, gene transfer from one to another etc.
2. To learn about the association of gene in the genome and how they are expressed in other parts of genome like transposable elements or jumping genes.
3. To learn and have complete knowledge of type of plasmids and their important in genetics and recombinant DNA technology.
4. To understand how Mendelian Genetics plays important role in understand the concept, by the virtue of different laws that he proposed.
5. To learn the basic terminology and concept of cytogenetics, bow cell divide? How information transfer from one to another etc .
6. To expertise themselves in understanding the concepts of evolution and how population genetics works.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Understand basics of genetics by experiencing the experimentation used by Mendal.
CO2: Analyze the bacterial transformation and gene transfer.
CO3: Understand the importance of mutation and how the mutation can be fruitful for the human kind.
CO4: Understand the principle of cytogenetic and learn different kind of genetic disorders.
CO5: Will learn how gene function can be judged, importance of human genome project.
CO6: Will analyze and learn to determine the changes in genes in population genetics.

Detailed Syllabus:

Unit I: Mendelism: The Basic Principles of Inheritance
Mendelism: The Basic Principles of Inheritance: The Birth of Genetics: A Scientific Revolution, Mendel's Study of Heredity: Mendel's Experimental Organism, The Garden Pea, Monohybrid Crosses: The Principles of Dominance and Segregation, Dihybrid Crosses: The Principle Of Independent Assortment, Applications of Mendel's Principles, The Punnett Square Method, The Forked-Line Method, The Probability Method, Testing Genetic Hypotheses: The Chi-Square Test, Mendelian Principles in Human Genetics: Pedigrees, Mendelian Segregation in Human Families, Genetic Counseling.

Unit II: Extensions of Mendelism
Extensions of Mendelism: Genetics Grows Beyond Mendel's Monastery Garden, Allelic Variation and Gene Function, Incomplete Dominance and Co-dominance, Multiple Alleles, Allelic Series, Testing Gene Mutations for Allelism, Variation Among the Effects of Mutations, Genes Function to Produce Polypeptides. Gene Action: From Genotype to Phenotype; Influence of the Environment, Environmental Effects on the Expression of Human Genes, Penetrance and Expressivity, Gene Interactions, Epistasis, Pleiotropy, Inbreeding: Another Look at Pedigrees; The Effects of Inbreeding, Genetic Analysis of Inbreeding, Measuring Genetic Relationships
Unit III: The chromosomal basis of Mendelism
The chromosomal basis of mendelism: Sex, Chromosomes, and Genes, Chromosomes, Chromosome Number, Sex Chromosomes, The Chromosome Theory of Heredity, Experimental Evidence Linking The Inheritance of Genes to Chromosomes, Nondisjunction as Proof of the Chromosome, Theory the Chromosomal Basis of Mendel's Principles, Segregation and Independent Assortment Sex Chromosome Nondisjunction, Tracking XLinked, and Autosomal Inheritance, Sex-Linked Genes in Humans, Hemophilia, An X-Linked Blood- Clotting Disorder, Color Blindness, An X-Linked Vision Disorder.
Unit IV: Linkage, Crossing Over, and Chromosome Mapping in Eukaryotes
Linkage, Crossing Over, and Chromosome Mapping in Eukaryotes: The World's First Chromosome Map, Linkage, Recombination, and Crossing, Over: Early Evidence for Linkage and Recombination, Crossing Over as the Physical Basis of Recombination, Evidence that Crossing Over Causes, Recombination, Chiasmata and the time of Crossing Over, Chromosome Mapping: Crossing Over as a Measure of Genetic Distance, Recombination Mapping with a Two-Point, Testcross, Bacteriophages And Plasmids BacteriophagE–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid Restriction-modification systems History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications.
Unit V: Population Genetics
Population Genetics: A Remote Colony, The Theory of Allele Frequencies, Estimating Allele Frequencies, Relating Genotype Frequencies To Allele, Frequencies: The Hardy–Weinberg Principle, Applications Of The Hardy–Weinberg Principle, Exceptions To The Hardy–Weinberg Principle,The Effects of Inbreeding on Hardy-Weinberg Frequencies:, Using Allele Frequencies In Genetic Counseling, Natural Selection: The Concept of Fitness, Natural Selection At The Level of The Gene, Selection Against a Harmful Recessive, Allele, Random Genetic Drift: Random Changes In Allele Frequencies, The Effects Of Population Size, Applying Genetic Drift, to Pitcairn Island, Populations in Genetic Equilibrium, Balancing Selection, MutationSelection Balance, Mutation- Drift Balance.

Suggested Readings:

1. S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.
2. N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.
3. Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006.
4. Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.

M.Sc. Biotechnology: Semester-III MST304: BIOINFORMATICS	
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: Computer fundamentals, Computer Applications & Biostatistics, Concepts on biomolecules and function, Molecular Biology, MST103.

Course Objectives:

1. To give an overview on computing methods and the bioinformatics tools commonly used for analyzing the sequencing data.
2. To provide basics knowledge on unix and the fundamentals in networking.
3. To describe the importance of phylogenetic analysis and the mathematical models as a prerequisite to calculate the evolutionary linkages.
4. To explain the computing models and concepts to understand the computational techniques
5. To explain the annotation to the study proteins, protein coding genes and DNA and genomes.
6. To understand the structure prediction methods for the proteins and nucleic acids.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Understand the importance of bioinformatics and the computational techniques.
CO2: Analyze the sequencing data generated and available in the databases and to interpret these results.
CO3: Identify the important mathematical models and techniques for biological data analysis.
CO4: Understand importance of techniques for structure and function prediction of proteins and genes.
CO5: Understand the nucleic acid and protein structure prediction tools.
CO6: Understand the genome annotation methods and some of the techniques.

Detailed Syllabus:

Unit-1: Introduction to computers and bioinformatics

Introduction to computers and bioinformatics- Types of operating systems, concepts of networking and remote login, basic fundamentals of working with unix/Linux. Biological databases- Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST, modes of database search, mode of data storage (Flat file format, db-tables), flatfile formats of GenBank, EMBL, DDBJ, PDB. Sequence alignment –Concept of local and global sequence alignment, Pairwise sequence alignment, Structure alignment, STAMP: structural alignment of multiple proteinsscoring an alignment, substitution matrices, multiple sequence alignment.. Principle of Protein structure and conformational space, pfam (Protein family prediction).

Unit-II: Phylogenetic analysis

Phylogenetic analysis- Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbor joining, Maximum parsimony, Maximum likelihood). Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Hidden Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods.

Unit-III: Methods for modeling

Methods for modeling: Homology modeling; Loop modeling, Comparative modeling, Threading, Refinement of model,Protein structure prediction; Structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation, Protein Modeling, Molecular Simulations_basic information.

Unit-IV: Generation and analysis of high throughput sequence data

Generation and analysis of high throughput sequence data- Assembly pipeline for clustering of HTGS data, format of ".ace" file, quality assessment of genomic assemblies, International norms for sequence data quality, Clustering of EST sequences, concept of Unigene. Annotation procedures for high through-put sequence data- Identification of various genomic elements (protein coding genes, repeat elements, strategies for annotation of whole genome,
functional annotation of EST clusters, gene ontology (GO) consortium.

Unit-V: Structure predictions for nucleic acids and proteins

Structure predictions for nucleic acids and proteins- Approaches for the prediction of RNA secondary and tertiary predictions, energy minimization and base covariance models, Basic approaches for protein structure predictions, comparative modeling, fold recognition/threading and ab-initio prediction. Drug Designing- Molecular Docking, Virtual Screening, ADMET analysis, click chemistry.

Suggested Readings:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005.
2. Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004.
3. Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
4. Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.

M.Sc. Biotechnology: Semester-III MST305: BIOENTERPENURESHIP	
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: - , MST105 Computer application and statistics

Course Objectives:

1. To understand the basic of accounting and finance for the start up of any industry.
2. To learn the procedure for deciding the marketing strategies for the product and analyze the product demand and supply.
3. To learn and have complete knowledge about the management and entrepreneurship.
4. To understand how Information technology and software has a regulatory role in entrepreneurship.
5. To learn the organization of human resource for the upliftment of the organization.
6. To get expertise in entrepreneurship by understand a case study of any organization about the various pits and falls.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Understand basics of entrepreneurship.

CO2: Analyze the marketing strategies of the product.

CO3: Understand the problems associated with the negotiation and their strategies.

CO4: Understand the Human resource structure of an organization and its regulation as required.

CO5: Will learn how research and development is important for the knowing the strategies.

CO6: Will analysis and learn how a particular industry works in terms of service, manufacturing etc.

Detailed Syllabus

Unit-I: Accounting and Finance
Accounting and Finance Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

Unit-II: Marketing & Fundamentals of Entrepreneurship
Marketing Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/ Advertising; Services Marketing **Fundamentals of Entrepreneurship** Support mechanism for entrepreneurship in India.
Unit-III: Negotiations/Strategy & Information Technology
Negotiations/Strategy With financiers, bankers etc.; With government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking. **Information Technology** How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management.
Unit-IV: Human Resource Development (HRD) & Role of knowledge centre and R&D
Human Resource Development (HRD) Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up. **Role of knowledge centre and R&D** Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.
Unit-V: Case Study
Case Study 1. Candidates should be made to start a 'mock paper company', systematically following all the procedures. • The market analysis developed by them will be used to choose the product or services. • A product or service is created in paper and positioned in the market. As a product or services available only in paper to be sold in the market through the existing links. At this juncture, the pricing of the product or the service needs to be finalized, linking the distribution system until the product or services reaches the end consumer. • Candidates who have developed such product or service could present the same as a project work to the Panel of Experts, including representatives from industry sector. If the presented product or service is found to have real potential, the candidates would be exposed to the next level of actual implementation of the project. 2. Go to any venture capital website (like sequoiacap.com) and prepare a proposal for funding from venture capital.

Suggested Readings:

1. Human Resource Management (14th Edition) By Gary Dessler.
2. Digital Business and E-Commerce Management, Pearson, 6th Edition by Dave Chaffey Fundamentals of Entrepreneurship. Author, H. Nandan. Publisher, PHI Learning Pvt. Ltd., 2011.

M.Sc. Biotechnology: Semester-III MST306: MOLECULAR DYNAMICS AND BIOENERGETICS	
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 Biochemistry.

Course Objectives:

1. To understand the basic and molecular level of the biochemistry.
2. To learn concept of enthalpy entropy and Gibbs free energy.
3. To explore the basic knowledge of amino acid and its biosynthetic pathways.
4. To understand the knowledge of high energy energy molecules such as ATP, GTP, NADP and FAD.

Course Outcomes:

After completing the course, students will be able to:

CO1: This course will familiarize the students with the major thermodynamic principles in biology and basic metabolic pathways of the living systems.

CO2: This course will helpful for beginner learners in biochemistry.

CO3: Students are coming from various fields at this initial semester, they all must be made introduced to the basic concepts of metabolism and bioenergetics.

CO4: This course of metabolism and bioenergentic studies will cover maximum part of bioenergetics.

Detailed Syllabus:

Unit-I: Carbohydrates
Carbohydrates –Glycolysis, citric acid cycle, its function in energy production and biosynthesis of energy richbond, pentose phosphate pathway.Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate shunt pathways, Coricycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway.Metabolism of disaccharides.Hormonal regulation of carbohydrate metabolism.Energetics of metabolic cycle.

Unit-II: Amino Acids
Amino Acids –General reactions of amino acid metabolism -Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine,tryptophan, lysine, valine, leucine, isoleucine and polyamines.Urea cycle and its regulation. Intermediary Metabolism –Approaches for studying metabolism Coenzymes and Cofactors –Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with examples.
Unit-III: Bioenergetics
Bioenergetics –Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials and free energy change (derivations and numericals included). High energy phosphate compounds –introduction, phosphate group transfer, freeenergy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy charge.
Unit- IV: Catabolism and the Generation of Chemical Energy
Catabolism and the Generation of Chemical Energy. Metabolic Strategies: General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis. Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway & their regulation, Tricarboxylic Acid Cycle: Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereo-chemical aspects of TCA Cycle Reactions, Thermodynamics of the TCA Cycle,
Unit- V: Mitochondria Electron Transport Chain
Mitochondria Electron Transport Chain, Oxidative Phosphorylation, Electron Transport and ATP Synthesis in Bacteria.

Suggested Readings:

1. Smith and Vannes. Introduction to Chemical Engineering thermodynamics (Mcgraw Hill)
2. Y.V.C. rao. Chemical engineering thermodynamics (New age international)
3. J.B.Hawkins. Engineering Thermodynamics (University Press)
4. Spading and Cole. Engineering Thermodynamics (ELBS).
5. Biochemistry by Lehninger. McMillan publishers
6. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY.

M.Sc. Biotechnology: Semester-III MST351: FERMENTATION TECHNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment - 35 Marks

Prerequisite: - MST151 Biochemistry, MST103, MST153 Molecular Biology, MST202,MST252 Microbiology & Industrial Applications.

Course Objectives:

CO1: Understand basics of fermentation and media used for the process.
CO2: Analyze the product formation from specific microorganism and methods employed for its purification.
CO3: Understand the importance and application of different bioreactors.
CO4: Understand industry specific product and there orientation in the market.
CO5: Will learn instrumentation involved in the downstream processing of any product produce by fermentation.
CO6: Will analysis and learn methods involves in enzyme production and their kinetics.

Detailed Syllabus:

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
2. Determination of mixing time and fluid flow behaviour in bioreactor under variety of operating conditions.
3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.
4. Production of microbial products in bioreactors.
5. Studying the kinetics of enzymatic reaction by microorganisms.
6. Production and purification of various enzymes from microbes.
7. Comparative studies of Ethanol production using different substrates.
8. Microbial production and downstream processing of an enzyme, e.g. amylase.
9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.

M.Sc. Biotechnology: Semester-III MST352: TISSUE CULTURE LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment – 35 Marks

Prerequisite: - MST103, MST153 Molecular Biology, MST202, MST252 Microbiology & Industrial Applications.

Course Objectives:

1. To understand the basic of tissue culture system.
2. To learn the procedure for the isolation and maintenance of cell lines.
3. To learn and have complete knowledge media optimization and formulation for plant and animal cultures.
4. To understand technical difference between the animal and plant cell cultures.
5. To learn the effect of various stresses like, pH, temp etc on tissue culture (do's and don'ts).
6. To get expertise in methodology and instrumentation used for animal and plant tissue culture.

Course learning outcomes:

After completing the course, students will be able to:

CO1: Understand basics of tissue culture and media used for the process.

CO2: Analyze the precaution and measure for optimal growth of cell lines.

CO3: Understand the importance and application of animal and plant cultures.

CO4: Understand how these cultures can increase the yield and productivity of plant breeds.

CO5: Will learn instrumentation involved in maintaining the aseptic conditions for better growth.

CO6: Will analyze and learn different culture system, when and which to be used.

Detailed Syllabus:

1. Media preparation and sterilization for tissue culture.
2. Slant preparation of prepared media (MS/White media) and maintenance.
3. Culture of axillary meristems for clonal multiplication.
4. Embryo culture and Shoot tip culture.
5. Isolation of protoplasts from given tissue.
6. Effect of different stress (thermal, hypoxia, light, pH) on plant growth.
7. Artificial seeds.

M.Sc. Biotechnology: Semester-III MST 353 - BIOINFORMATICS LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment – 35 Marks

Prerequisite: - Computer fundamentals, Computer Applications & Biostatistics, Concepts on biomolecules and function, Molecular Biology..

Course Objectives:

1. To give an overview on computing methods and the bioinformatics tools commonly used for analyzing the sequencing data.
2. To provide basics knowledge ORF prediction and tools for protein data analysis
3. To explain the computing models and concepts to understand the computational techniques
4. To explain the annotation to the study proteins, protein coding genes and DNA.
5. To understand the structure prediction methods for the proteins.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Understand the importance of bioinformatics and the computational techniques.

CO2: Analyze the sequencing data generated and available in the databases and to interpret these results.

CO3: Identify the important mathematical models and techniques for biological data analysis.

Detailed Syllabus:

1. Construction of database for specific class of proteins / enzymes, genes/ORF/EST/Promoter sequences/ DNA motifs or protein motifs using oracle.
2. Access and use of different online protein and gene alignment softwares
3. Gene finding related search for a given nucleotide sequence in order to predict the gene
4. ORF prediction for different proteins out of some given nucleotide sequences.
5. Exon identification using available softwares for a given nucleotide sequences.
6. Secondary structure prediction for amino acid sequences of a given protein.

M.Sc. Biotechnology: Semester-III MST 355: SEMINAR III	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment – 35 Marks

Prerequisite: - MST101 Biochemistry, MST103 Molecular Biology, MST202 Microbiology & Industrial Applications, MST203 Genetic Engineering, MST301 Bioprocess Engineering etc.

Course Objectives:

1. To understand and learn the concepts of any topic.
2. To learn how to present a scientific topic in front of examiner.
3. To understand basic principle of the technique.
4. To learn and explain the application of the methods.
5. To enhance the computational skills.
6. To get to know the various technical objective and conclusion of topic.

Course learning outcomes:

After completing the course, students will be able to:

CO1: Will enhance his communication and computational skills.

CO2: Will leads to enhance the confidence and personal aptitude.

CO3: Analyze the procedure and instrumentation required for proving his hypothesis.

CO4: Will teach him to boldly accept the outcomes and conclusion of topic.

CO5: Will teach him how to represent a data.

CO6: Will learn to present research data.

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

MST451: PROJECT WORK		
Teaching Scheme	**Examination Scheme**	
Tenure: 12 to 16Week/	Dissertation	150
	Presentation and Viva Voce	150
Credits: 28	**Maximum Marks**	**300**

Every student will be required to undertake a research project (minimum tenure three months) based on any of the areas of virology, proteomics, genomics, animal, plant, medical microbiology, and bioinformatics or preferably related to major biotechnology/microbiology research. The project report will be submitted in the form of dissertation duly certified by the supervisor of the dissertation by any research organization, industry, national institutes and/or Universities in India, by seeking the placement. The student then shall have to appear for the viva voce examination.

GUIDELINES FOR DISSERTATIONS REPORT LAYOUT:
The report should contain the following components:

Title or Cover Page: The title page should contain the following information: Project Title; Student's Name; Course; Year; Supervisor's Name.

Acknowledgements (optional): Acknowledgment to any advisory or financial assistance receive in the course of work may be given.

Abstract: It should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to objectives. The abstract have to be concise summary of the scope and results of the project.

Table of Contents: Titles and subtitles are to correspond exactly with those in the text.

Introduction: A brief introduction to the problem that is central to the project and it should aim to catch the imagination of the reader, so excessive details should be avoided.

Materials and Methods: This section should aim at experimental designs, materials used. Methodology should be mentioned in details including modifications if any.

Results and Discussion: Present results, discuss and compare these with those from other workers, etc. In writing these section, emphasis should be given on what has been performed and achieved in the course of the work, rather than discuss in detail what is readily available in text books. Avoid abrupt changes in contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter could be included to aid in smooth flow.

Note during writing, all figures & tables should as far as possible be next to the associated text, in same orientation as main text, numbered, & given appropriate titles.

Conclusion: This is the final section in which outcome of the work is mentioned briefly.

Future prospects (if applicable)

References / Bibliography: This should include papers and books referred to in the body of the report. These should be ordered alphabetically on the author's surname.

Appendices: This contains material which is of interest to reader but not an integral part of the thesis and may be useful to document for future reference.

Assessment of the Project File:
Essentially, marking will be based on the following criteria: the quality of the report, the technical merit of the project and the project execution. Technical merit attempts to assess the quality and depth of the intellectual efforts put into the project.