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 2021-2022)

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	1	0	30	70	100	4
2.	MST102	CELL AND DEVELOPEMENTAL BIOLOGY	CC	3	1	0	30	70	100	4
3.	MST103	MOLECULAR BIOLOGY	CC	3	1	0	30	70	100	4
4.	MST104	IMMUNOLOGY	CC	3	1	0	30	70	100	4
5.	MST105	COMPUTER APPLICATIONS & BIOSTATISTICS	DSE*	3	1	0	30	70	100	4
	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**	**5**	**16**	**245**	**455**	**700**	**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

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	1	0	30	70	100	4
2.	MST202	MICROBIOLOGY & INDUSTRIAL APPLICATIONS	CC	3	1	0	30	70	100	4
3.	MST203	GENETIC ENGINEERING	CC	3	1	0	30	70	100	4
4.	MST204	IPR & BIOSAFETY	CC	3	1	0	30	70	100	4
5.	MST205	GENOMICS & PROTEOMICS	DSE*	3	1	0	30	70	100	4
	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**	**5**	**16**	**245**	**455**	**700**	**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

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	1	0	30	70	100	4
2.	MST302	TISSUE CULTURE	CC	3	1	0	30	70	100	4
3.	MST303	GENETICS	CC	3	1	0	30	70	100	4
4.	MST304	BIOINFORMATICS	CC	3	1	0	30	70	100	4
5.	MST305	BIOENTREPRENEURSHIP	DSE*	3	1	0	30	70	100	4
	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**	**5**	**16**	**245**	**455**	**700**	**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

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	350	350	14

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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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 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

M.Sc. Biotechnology: Semester-II MST201: ANALYTICAL TECHNIQUES	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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. Microbiology: 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

M.Sc. Microbiology: Semester-III MST 301: FERMENTATION TECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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.

M.Sc. Biotechnology: Semester-III MST302: TISSUE CULTURE	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

5. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F.,

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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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 include their types, gene transfer from one toanother 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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	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. Microbiology: 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	200
	Presentation and Viva Voce	150
Credits: 28	**Maximum Marks**	**350**

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.