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

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

M.Sc. Microbiology

Programme outcome of M.Sc Microbiology is to produce competent microbiologist'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 Microbiology and allied fields.
2. Students will think creatively about the use of Microbiology 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 Microbiology, pharmaceutical Companies, bio fertilizer industry, aquaculture industries, environmental units, crop production units & food processing industries.
5. Entrepreneurship ventures such as consultancy and training centres can be opened.
6. Some of the major pharmaceutical and drug companies' highering Microbiologists 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 microbiological 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 microbiology background abroad especially in countries like Germany, Australia, Canada, USA and many more where biotechnology is a rapidly developing field.

YEAR II, SEMESTER III

S.No.	COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
				L	T	P	CA	EE		
1.	MMB 301	Fermentation Technology	CC	3	0	0	30	70	100	3
2.	MMB 302	Medical Microbiology	CC	3	0	0	30	70	100	3
3.	MMB 303	Microbial Genetics	CC	3	0	0	30	70	100	3
4.	MMB 304	Bioinformatics	CC	3	0	0	30	70	100	3
5.	MMB 305	Plant Pathogen Interaction	DSE*	3	0	0	30	70	100	3
	MMB 306	Molecular dynamics and bioenergetics	DSE*							
6.	MMB 351	Fermentation Technology Lab	AEC	0	0	4	15	35	50	2
7.	MMB 352	Medical Microbiology Lab	AEC	0	0	4	15	35	50	2
8.	MMB 353	Bioinformatics Lab	AEC	0	0	4	15	35	50	2
9.	MMB 355	Seminar III	SE	0	0	4	50	0	50	2
TOTAL				**15**	**0**	**16**	**245**	**455**	**700**	**23**

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

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

DSE*= Elect any one of the prescribed

YEAR II, SEMESTER IV

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

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

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

DSE*= Elect any one of the prescribed

M.Sc. Microbiology: Semester-III MMB 301: FERMENTATION TECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Knowledge of basic Biochemistry, Industrial Microbiology, Enzymology.

Course Objectives:

1. To understand Fermentation technology.
2. To understand microbial growth kinetics.
3. To develop insights about bioreactor processes.
4. To understand media preparation and sterilization.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Students will be able design, conduct experiments, analyze and interpret data for investigating problems in Microbiology and allied fields.

CO2: 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.

CO3: 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.

Detailed Syllabus:

Unit I: An introduction to fermentation processes
An introduction to fermentation processes- Range of fermentation process, microbial biomass, Microbial metabolites, Microbial growth kinetics- Batch culture, continuous culture, comparison of batch and continuous culture in industrial applications, fed-batch culture, variable and fixed volume fed batch culture,

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

Suggested Readings:

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman, McNeul and Harvey.
2. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
3. Fermentation Biotechnology: Industrial Perspectives by Chand.
4. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.
5. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
6. Bioprocess Engineering Principles by Doran, Acad. Press, London.
7. Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N, Y.

M.Sc. Microbiology: Semester-III MMB 302: MEDICAL MICROBIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: - Knowledge of basic and Industrial Microbiology.

Course Objectives:

1. To understand basic of Medical microbiology.
2. To understand koch's postulate and pathogenesis.
3. To develop insights about systematic microbiology.
4. To understand diseases caused by microbes and their pathophysiology with respect to different organisms.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Students will be able design, conduct experiments, analyze and interpret data for investigating problems in Microbiology and allied fields.

CO2: 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.

CO3: 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**.**

Unit I: General topics on Medical Microbiology
General topics on Medical Microbiology: History and development, Koch's postulates, classification of medically important bacteria. Infection: source, modes of transmission, portal of entry into the susceptible host and prevention.
Unit II: Bacterial pathogenicity, identification of bacteria
Bacterial pathogenicity, identification of bacteria: staining methods, culture methods, biochemical tests and other recent methods. Sterilization and disinfection. Normal microbial flora, antimicrobial agents, drug resistance and drug sensitivity test.

Unit III: Systematic Microbiology
Systematic Microbiology: Diseases caused by Gram positive cocci - sore throat, pneumonia etc., Diseases caused by Gram negative cocci - meningitis, gonorrhoea etc. Diseases caused by Gram positive bacilli - Tuberculosis, Diphtheria, Tetanus, Gas gangrene etc., Diseases caused by Gram negative bacilli of Entrobacteriaceae - Enteric fever, Bacillary dysentery, UTI etc.
Unit IV: Diseases caused by other Gram negative bacilli
Diseases caused by other Gram negative bacilli - Cholera, Plague, Whooping cough, Wound infection, Septicemia etc. Sexually Transmitted Diseases. Diseases caused by mycoplasma, Chlamydia, Rickettsia. Overview of Medical Mycology, Important Fungal Diseases – Superficial, Subcutaneous, Systemic and Opportunistic Mycosis.
Unit V: Overview of Medical Parasitology
Overview of Medical Parasitology, Important Protozoan Diseases- Malaria, Leishmaniasis, Amoebiasis, Giardiasis etc. Important Helmenthic Diseases- Ascariasis, Ankylostomiasis, Filariasis, Taeniasis, Echinococcosis, Schistosomiasis etc. Overview of Medical Virology, Important Viral Diseases– Herpesvirus, Poliovirus, Rabies virus, Arboviruses Hepatites, HIV etc. Opportunistic Microbial Infection, Water, Milk and Food borne diseases, Microbial Vaccine.

Suggested Readings:

1. Greenwood D (2007). Medical Microbiology. I.K. International.
2. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
3. Talaro KP and Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.
6. Nester E.W, Anderson DG and Nester MT (2006). Microbiology. A Human Perspective. McGraw Hill.
7. Harvey, R.A., Champe, P.C. and Fisher, B.D. 2007. Lippincott's Illustrated Reviews : Microbiology. Lippincott Williams and Wilkins, New Delhi/New York.

M.Sc. Microbiology: Semester-III MMB 303: MICROBIAL GENETICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: Basic concepts of genetics, microbiology and genomics

Course Objectives:

1. To give an overviewof basic principles of genetics, inheritance and the hypothesis testing to study heredity.
2. To give overview of genes and the allelic variations.
3. To describe the inheritance pattern of genes to chromosomes and the genetic disorders.
4. To explain the chromosome mapping techniques and the genetic distance.
5. To explain the allelic frequency and concepts of population genetics and genetic drift.
6. To explain the effects of inbreeding and the genetic analysis of inbreeding and measuring the genetic relationships.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Understand the concepts of genetics and the role of inheritance and the genetic variations. CO2: Analyze the effect of crosses and the principles in heredity.

CO3: Identify the allelic variation and the gene functions such as of multiple alleles. CO4: Understand normal and abnormal combustion gene and gene functions.

CO5: Evaluate the linkages and the chromosomes mapping and evaluations.

CO6: Understand the population genetics, genetic influences and the mutation drift.

Detailed Syllabus:

Unit- I: Bacterial mutants and mutations
Bacterial mutants and mutations Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations(base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames

test) Gene transfer in bacteria History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr

Unit-II: Bacteriophages and Plasmids

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-III: Mendelian Genetics

Mendelian Genetics Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases. **Non Mendelian inheritance patterns** Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic. Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits

Unit-IV: Cytogenetics

Cytogenetics Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH). **Developmental genetics** Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules. **Immunogenetics** Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system.

Unit-V: Genetic variation

Genetic variation Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism. **Gene mapping and human genome project** Physical mapping; linkage and association **Population genetics and evolution** Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups.

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. Microbiology: Semester-III MMB304: BIOINFORMATICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: Computer fundamentals, Computer Applications & Biostatistics, Concepts on biomolecules and function, Molecular Biology, MMB103, MMB105.

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. Microbiology: Semester-III MMB305: Plant Pathogen Interaction	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: MMB101, MMB-302**,** Basic concepts of microbiology, plant and the functional role of microorganism, plant pathology.

Course Objectives:

1. To give an overview on disease, disease triad and the plant physiology and microbial interaction with plants.
2. To give overview of pathogen infecting the plants, interaction and infection and progression.
3. To describe the biochemical basis of plant disease and the pathogen infecting various plant.
4. To explain the genetic basis of plant disease, disease resistance or susceptibility concept and genes and mechanisms in disease controls.
5. To explain approaches for plant protection and the disease forecasting.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Understand plant and microorganism interaction and pathogenesis.
CO2: Understand the current agriculture practices and factors and basis for the diseases.
CO3: Understand the genetic basis of disease, its progression and the basis to control.
CO4: Identify the techniques that are useful to control some the common diseases in plants.
CO5: Identifying the plant biocontrol and the strains or microorganisms for effective and plant growth promotion and the chemical and physical control methods.
CO6: Understand the disease forecasting methods and its relevance in Indian farming.

Detailed Syllabus:

Unit-I: Concepts and physiology of plant diseases
Concepts and physiology of plant diseases: What is a disease, its causes, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation.
Unit-II: Biochemical basis of plant diseases
Biochemical basis of plant diseases: Enzymes and toxins in plant diseases, phytoalexins. **Some important plant diseases and their etiological studies:** Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops.

Unit-III: Genetically basis of plant diseases and molecular approach
Genetically basis of plant diseases and molecular approach: Genetics of host-pathogen interactions, resistance mechanism and resistance genes in plants. Molecular diagnosis, its futuristic vision, applications and constraints. Transgenic approach for plant protection.
Unit-IV: Disease control
Disease control: Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, Trichoderma as biocontrol agent, biocontrol agents – uses and practical constraints.
Unit-V: Disease forecasting
Disease forecasting: History and important milestones in disease control, disease forecasting and its relevance in Indian farming.

Suggested Readings:

1. Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969.
2. Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press,1993.
3. Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press,1993.
4. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.
5.The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited,1993.
6.Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji & K.L. Garg: CRC Press, Inc., Boca Raton,Florida,1988.

M.Sc. Microbiology: Semester-III MMB306: MOLECULAR DYNAMICS & BIOENERGETICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 3	Attendance – 12 Marks
	End Semester Exam – 70 marks

Prerequisite: MMB 101 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 andnon-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, thiaminepyrophosphate, 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. Relationshipbetween equilibrium constant and standard free energy change, biological standard state & standard free energychange in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation betweenstandard reduction potentials and free energy change (derivations and numericals included). High energyphosphate compounds –introduction, phosphate group transfer, freeenergy of hydrolysis of ATP and sugarphosphates alongwith reasons for high ΔG. Energy charge.

M.Sc. Microbiology: Semester-III

MMB351:FERMENTATION TECHNOLOGY LAB

Teaching Scheme	Examination Scheme
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment - 35 Marks

Prerequisite: MMB101, MMB-302, Basic concepts of microbiology and functional role of microorganism, plant pathology**.**

Course Objectives:

The objectives of this laboratory course are to make students develop an understanding about practical aspects of fermentation technology lab.

Course Learning Outcomes

After completing the course, students will be able to:

CO1: Students will be able design, conduct experiments, analyze and interpret data for investigating problems in Microbiology and allied fields.

CO2: 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.

CO3: 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.

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 MMB352: MEDICAL MICROBIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 4 hr/Week	Internal Assessment -15 Marks
Credits: 2	External Assessment – 35 Marks

Prerequisite: MMB101, MMB202 MMB302, Basic concepts of microbiology and functional role of microorganism pathology**.**

Course Objectives: The objectives of this laboratory course are to make students develop an understanding about practical aspects of microbiology lab.

Course Learning outcomes:

After completing the course, students will be able to:

CO1: Students will be able design, conduct experiments, analyze and interpret data for investigating problems in Microbiology and allied fields.

CO2: 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.

CO3: 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.

Detailed Syllabus:

1. To study cultural characteristics of pathogenic bacteria on following selective / differential media: TCBS agar; Hektoen Enteric agar; XLD agar; Endo agar; *Salmonella-Shigella* agar; Deoxycholate citrate agar
2. Isolation of soil-borne pathogens from plant tissue and soil.
3. Molecular methods for detection and identification of pathogens in plants and soil. By monoclonal antibody based tests and PCR.
4. Quantification of population of pathogens in soil and estimation of inoculum potential by MPN and Dilution End Point methods.
5. To study cultural and microscopic characteristics of selected pathogenic fungi viz. *Microsporum* sp.*Candida albicans*, and *Aspergillus* sp.

M.Sc. Microbiology: Semester-III MMB353: 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, MMB103, MMB105, MMB 304.

Course Objectives: The objectives of this laboratory course are to make students develop an understanding about practical aspects of bioinformatics lab.

Course Learning Outcomes:

After completing the course, students will be able to:

CO1: Students will be able design, conduct experiments, analyze and interpret data for investigating problems in Microbiology and allied fields.

CO2: 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.

CO3: 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.

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

Prerequisite: - MMB 101 Biochemistry, MMB103 Molecular Biology, MMB 202 Microbiology & Industrial Applications, MMB 203 Genetic Engineering, MMB 301 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

MMB 451: PROJECT WORK		
Teaching Scheme	**Examination Scheme**	
Tenure: 12 to 16Week/	Dissertation	150
	Presentation and Viva Voce	150
Credits: 28	**Maximum Marks**	**300**

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

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

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

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

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

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

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

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

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

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

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

Future prospects (if applicable)

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

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

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