

Program: Integrated M.Sc. Microbiology

Semester I

S. No.	Course Code	Course Title	Credits
1.	CHEM 313	Organic Chemistry	3(2-0-2)
2.	CHEM 311	Inorganic Chemistry	3(2-0-2)
3.	CHEM 312	Physical Chemistry	3(2-0-2)
4.	MAS 303	Basic Mathematics I	3(3-0-0)
5.	COMP 302	Computer Application	2(1-0-2)
6.	PHY 309	Applied Physics	3(3-0-0)
7.	GPT 301	Moral & Value Education	2(2-0-0)
TOTAL			19(15-0-8)

Semester II

S. No.	Course Code	Course Title	Credits
1.	BIOL 403	Life Sciences I (Botany)	3(2-0-2)
2.	BIOL 404	Life Sciences II (Zoology)	3(2-0-2)
3.	MAS 304	Basic Mathematics II	3(3-0-0)
4.	MAS 331	Fundamental Statistics	3(2-0-2)
5.	MCE 301	Cell Biology	3(2-0-2)
6.	MBFT 349	Introductory Microbiology	3(2-0-2)
7.	MBFT 350	Basic Techniques in Microbiology	3(2-0-2)
TOTAL			21(15-0-12)

Semester III

S. No.	Course Code	Course Title	Credits
1.	CHEM 330	Analytical Chemistry	3(2-0-2)
2.	BCBT 401	Biochemistry I	3(2-0-2)
3.	MCE 302	Molecular Biology	3(3-0-0)
4.	MCE 303	Introductory Biotechnology	3(3-0-0)
5.	MBFT 412	Microbial Taxonomy & Diversity	3(3-0-0)
6.	MBFT 413	Microbial Ecology	2(2-0-0)
7.	SES 415	Environmental Studies I	2(2-0-0)
TOTAL			19(17-0-4)

Semester IV

S. No.	Course Code	Course Title	Credits
1.	MBFT 431	General Bacteriology	3(2-0-2)
2.	MBFT 432	Introduction to Virology	3(2-0-2)
3.	MBFT 433	General Mycology	3(2-0-2)
4.	CBBI 501	Applications of Bioinformatics	2(1-0-2)
5.	GPB 412	Genetics	3(2-0-2)
6.	BCBT 403	Biochemistry II	3(2-0-2)
7.	SES 416	Environmental Studies II	2(2-0-0)
TOTAL			19(13-0-12)

Semester V

S. No.	Course Code	Course Title	Credits
1.	MCE 406	Molecular Biology Techniques & Instrumentation	3(2-0-2)
2.	BCBT 404	Enzymology & Enzyme Technology	3(2-0-2)
3.	BCBT 405	Basic Immunology	3(2-0-2)
4.	MBFT 452	Microbial Metabolism	2(2-0-0)
5.	MBFT 453	Principles of Microbial Genetics	2(2-0-0)
6.	LNG 304	Professional Communication & Technical Writing	3(2-0-2)
7.	MCE 501	Biosafety, Bioethics & IPR issues	3(3-0-0)
TOTAL			19(15-0-8)

Semester VI

S. No.	Course Code	Course Title	Credits
1.	PPR 521	Nematology	2(1-0-2)
2.	PPR 522	Plant Disease & their Management	3(2-0-2)
3.	MBFT 434	Parasitology	3(2-0-2)
4.	MBFT 502	Industrial Microbiology	3(2-0-2)
5.	BCBT 501	Biochemical Engineering	3(2-0-2)
6.	MCE 503	Fundamentals of Nanotechnology	2(2-0-0)
7.	TE 401	Fundamentals of Tissue Culture	3(2-0-2)
8.	MBFT 488	Seminar I	1(0-0-2)
TOTAL			20(13-0-14)

Semester VII

S. No.	Course Code	Course Title	Credits
1.	MBFT 601	Fermentation Technology	3(2-0-2)
2.	MBFT 604	Microbial Enzyme Technology	3(2-0-2)
3.	MBFT 605	Microbial Technology in Food Industry	3(2-0-2)
4.	MBFT 610	Soil Microbiology	2(1-0-2)
5.	MBFT 611	Pharmaceutical Microbiology	3(2-0-2)
6.	BCBT 605	Immunotoxin & Drug Designing	3(3-0-0)
7.	BCBT 607	Biotransformation and Bioconversion	3(2-0-2)
8.	MBFT 589	Seminar II	1(0-0-2)
TOTAL			21(14-0-14)

Semester VIII

S. No.	Course Code	Course Title	Credits
1.	MAS 711	Statistics I	3(2-0-2)
2.	COMP 805	Computer Programming	3(2-0-2)
3.	MBFT 725	Environmental Microbiology	3(2-0-2)
4.	MBFT 726	Microbiological Techniques	3(2-0-2)
5.	MBFT 781	Microbial Genetics	4(3-0-2)
6.	MBFT 782	Microbial Physiology	3(2-0-2)
7.	CBBI 801	Bioinformatics	3(2-0-2)
TOTAL			22(15-0-14)
	MBFT 800	Training	1(0-0-2)

Semester IX

S. No.	Course Code	Course Title	Credits
1.	MAS 715	Statistics II	3(2-0-2)
2.	MBCE 806	Genetic Engineering	3(2-0-2)
3.	MBFT 811	Food & Dairy Microbiology	4(2-0-4)
4.	MBFT 812	Medical Microbiology	4(2-0-4)
5.	MBFT 813	Agricultural Microbiology	3(2-0-2)
6.	MBFT 814	Microbial Biotechnology	3(2-0-2)
7.	MBFT 782	Seminar III	1(0-0-2)
8.	MBFT 800	Training Evaluation	1(0-0-2)
		TOTAL	22(12-0-20)

Semester X

S.No.	Course Code	Course Title	Credits
1.	MBFT 899	Dissertation	15(0-0-30)

Integrated M.Sc. Microbiology

Semester I

1. Course Title: Organic Chemistry

Course Code: CHEM- 313

Credits: 3(2 – 0 – 2)

- Carbohydrates: - Introduction, Classification, Monosaccharides, Stereochemistry, Fischer Projection, Structure of D-glucose, Cyclic structure of D-glucose, Haworth Projection, Properties of Oligosaccharides, Structure of sucrose, Polysaccharides:- Structure of starch, Cellulose and glycogen
- Amino Acids:- Classification, Essential and Non essential Amino acids, Optical activity, synthesis, Properties, Zwitter ion and Isoelectric point.
- Proteins: - Classification, Primary, Secondary and Tertiary structure, Properties, Colloidal nature, Denaturation, Test for proteins.
- Fats & Oils: - Composition of fats, Introduction. Nomenclature of fats. Physical and Chemical properties of fats. Rancidity, Analysis of fats chemical constants, Saponification Number, Iodine Number, Acid value, Reichert Miessl value, Polenski value.
- Alkaloids: - Introduction, Classification, Determination of molecular structure of alkaloids, Properties, Properties, Nicotine, Coniine.
- Terpenoids:- Introduction, Classification, Structural feature of Terpenes or isoprene Rule, Mycene, Citral
- Nucleic Acids: - Chemistry of Nucleic acids, Structure and composition of purine and pyrimidines, Nucleosides, Nucleotides, general composition of DNA and RNA.

Practical

- Identification of sugars and organic acids
- Test for proteins and amino acid.
- Test for fats, fatty acids, acidity and saponification.
- Identification of phenols, acids, carbonyl compounds, hydrocarbons.

2. Course Title: Inorganic Chemistry

Course Code: CHEM –311

Credits: 3(2 – 0 – 2)

- Nature of Covalent Bond & shapes of molecules: - Valence bond theory, hybridization, VSEPR theory, Molecular Orbital Theory (MOT), LCAO (Linear combination of atomic orbital), Approximation for diatomic homo and heteroatom molecules
- Nuclear and Radiochemistry:- Nuclear shell model, Mass defect, Packing fraction, Binding energy, Natural radioactive disintegration, concept of half life, Group displacement Law, Artificial radioactivity, Induced radioactivity, Nuclear fusion and Nuclear fission reaction.
- Coordination Chemistry:- Legends, coordination number, complex ion, IUPAC rules for coordination compounds, Nomenclature, Werner's theory of coordination, Pauling theory, Crystal field theory.
- Organometallic Compounds:- Types, Classification, Nature of carbon metals bonds, preparation, properties.

- Biochemical significance of Inorganic metals system: - Introduction, Na, K, Cl, Fe, Zn, Co and their significance in plant and animal kingdom.
- Inorganic Polymers: - Classification of inorganic polymers, preparation, Silicones
- A general idea of Boranes, Metal carbides, Metal Carbonyls, Metal nitrosyls.

Practical

Semi-micro analysis of inorganic salts and mixtures

3. Course Title: Physical Chemistry

Course Code: CHEM- 312

Credits: 3(2 – 0 – 2)

- Ionic equilibria: concepts of acids and bases, their related strength, buffer solution and its pH, hydrolysis of salts, acids – base indicators oswalds and quinonoides theory, solubility product.
- Chemical kinetics: order and molecularity, differential rate laws and integrated rate laws equations for zero, 1st, 2nd and 3rd reactions (derivations included) significance of rate constant and its evaluation, time for definite fractional change of reaction, determination of order, Effect of temperature on the rate of reactions. Complex reactions (consecutive, side, parallel axis, chain reactions), collision theory, linderman theory enzyme kinetics.
- Electrochemistry: reversible and irreversible cells, EMF of a cell and free energy, nernst equation, equilibrium constant, standard electrode potential, types of reversible electrodes, Over voltage, Fuel cells, applications of EMF measurements, determination of solubility product, pH, dissociation constant of acids, hydrolysis constant, solubility of soluble salts, potentiometric titrations

Practical

- Determination of rate constant and order of reaction for hydrolysis of ester by an acid.
- To study the kinetics of dissociation of Magnesium in diluter HCl.
- To determine the order of saponification of ethyl acetate with NaOH.
- Determination of density of liquid by density bottle.
- To find surface tension of the given liquid.
- To find the relation and absolute viscosity of given liquid.
- Determination of carbonates, bicarbonates and total alkalinity in water

4. Course Title: Basic Mathematics – I

Course Code: MAS – 303

Credits: 3(3 – 0 – 0)

- ALGEBRA: Theory of quadratic and cubic equations. Partial-Fractions Binomial Theorem (for +ve index). Elementary concepts of Permutations and Combinations. Exponential and logarithmic series; Evaluation of Determinants using their properties. Solution of homogenous and non- homogenous simultaneous linear equations. Matrices: Types, addition, subtraction, multiplication, adjoint and inverse. Evaluation of rank.
- TRIGONOMETRY: Trigonometrical-ratios, sum and difference relations of two angles, relations between product and sum or difference of two angles, multiple and sub-multiple angle relations; trigonometrical-identities; relations between sides and angles of a triangle; properties of a triangle; height and distance.
- Complex numbers; De-Movires Theorem and its simple applications.

- COORDINATE GEOMETRY: Points on a plane; distance between two points; ratio-formula; angle of a triangle; equations of a straight line. Standard-equations of conics and their identification

5. Course Title: Computer Application

Course Code: COMP- 302

Credits: 2(1 – 0 – 2)

- Introduction to Computers
- H/W & S/W Concepts and Terminology
- Operating system
 - a. DOS
 - b. Windows
- Introduction to Commonly Used Application Software
 - a. MS Word
 - b. Ms Excel
- Computer Languages & Introduction to 'C' Programming Language
 - a. Input & Output Statements
 - b. Declaration of Variables, Constants
 - c. Operators
 - d. Control Statements(Branching & Looping)
- Introduction to Computer Networks
- Introduction to Internet
- Application of IT

Practical

- Working with operating systems like MS-DOS, Windows
- Study of software packages like MS-Word, MS-Excel and MS-Power point
- Packages related to Medical Applications
- How to search data, workable knowledge of Internet
- Simple programs in C language
 - To find the largest among three numbers
 - To check whether the given number is palindrome or not
 - To find whether the given number is the prime
 - To find sum and average of n integer using linear array
 - To generate the Fibonacci series
 - To find factorial of a given number using function

6. Course Title: Applied Physics

Course Code: PHY –309

Credits: 3(3 – 0 – 0)

- Optics
 - Interference: Coherent sources, conditions of interference, Fresnel's bi-prism experiment, interference in thin films, wedge shaped film, Newton's ring.
 - Diffraction: Single slit and double slit diffraction, diffraction grating, Raleigh's criterion of limit resolution, resolving power of telescope and microscope.
 - Polarization: Polarization of light, Brewster's law, Malus law, phenomenon of double refraction, geometry of calcite crystal, optic axis, principal section, ordinary and extraordinary rays, construction and

working of Nicol prism. Plane, circularly and elliptically polarized light. Their production and analysis. Retardation Plates, optical activity, specific rotation, polarimeters.

- Unit-II: X-rays
 - Origin of X-rays, continuous and characteristic X-ray spectra, Mosley's law, absorption of X-rays, Diffraction of X-rays, Bragg's law, Bragg's spectrometer, practical applications of X-ray, X-ray Machine.
- Laser
 - Spontaneous and stimulated emission of radiation, Einstein's Coefficients. Components of laser. Type of laser and their working and application. Classes of laser equipments.
- Electromagnetic Theory
 - Gauss's law, Poisson and Laplace equation, Maxwell's equations, Basic concepts of Electromagnetic waves and its solution in free space. Para, dia, ferro, antiferro and ferri magnetic materials. Hysteresis and magnetic circuits.

7. Course Title: Moral & Value Education

Course Code: GPT - 301

Credits: 2(2 – 0 – 0)

- Background of Value Education: What is value Education? Importance of Value Education, Definition of Values, Morals and Ethics, The aims and objectives of Value Education, Culture and Values and Values Crisis, Some areas of concern in value Education – Education for peace, respect for life, justice, issues of women, job-oriented education, faith in God, democracy, self-respect, ecology, the meaning of success, noble truths in all religions.
- My country and My people: Truly Indian, Really Modern, Deeply Human, Nationalism and Internationalism, The Fundamental Rights and Duties of a Citizen
- Interpersonal Relationship: Areas of interpersonal relationship (the home, among friends etc), Issues hindering Inter-personal relationship, Towards improving interpersonal relationship.
- Personality Development: Definition of Personality, Elements and Stages of Personality Development
- Motivations and Will power: Motivation for study, Motivation and Setting Goals, Decision Making.
- Choice of Vocation/Career Guidance: Sociologists and Psychologists Contribution, Implications for counseling, Youth and career (Objectives, components and career planning), Career Development activities.
- Some Issues and Concerns in Moral Education: Morality and Religion (Traditional morality and religious faith, views and debates on morality and religion), Spiritual nature of man, Marriage, Love and Sexuality, Aids, Abortion, War and Terrorism, Corruption and Omnibus, Drug Addiction and Alcoholism, Tobacco and its evils, Women issues (Gender inequalities), Ecological crisis, Human Right Issues, Media and its Impact, Value of Work and Value of Time, Indian Educational System, Human Communication.

Semester II

1. Course Title: Life Sciences I (Botany)

Course Code: BIOL – 403

Credits: 3(2 – 0 – 2)

- Study of plants and its parts (root, stem, leaf, inflorescence, flower and fruit). Study of different kind of seeds and their germination.
- Classification of angiosperm with particular reference of Bentham & hooker system of classification, its merits and demerits. Distinguishing characters of the following families and their economic importance: Leguminaceae, Liliaceae, Solaneaceae, Poaceae.
- Study of structure and function of various tissues
- Plant and environment: atmosphere, water, light, temperature, soil and biota. Ecosystem structure, abiotic and biotic components, food chain. Green house effect.
- Economic Botany (Specific names and precise plant parts used) of important plant used as cereals, pulses, vegetables, medicine and timber.

Practical:

- Study of primary structure of root, stem and leaves.
- Study of stomata
- Description and identification of important families:
(a) Leguminaceae (b) Liliaceae (c) Solaneaceae (d) Poaceae
- Study of economically important plants(cereals, pulses, vegetables, medicinal plants)
- Demonstration of osmosis, transpiration, photosynthesis, respiration

2. Course Title: Life Sciences II (Zoology)

Course Code: BIOL – 404

Credits: 3(2 – 0 – 2)

- General principles of classification of Animal Kingdom with special reference to orders of Agricultural importance
- Life history and control of important animals parasitic on man and animals.
- Economic importance of following animals:
(a) Indian snails (b) Slugs (c) Crabs
(d) Mammals (e) Birds (f) Earthworms
- Life history and brief rearing methods of some useful insects:
(a) Honey bee (b) Lac insect (c) Silkworm
- Identification of poisonous and non- poisonous insects of India. Symptoms of snakebite and antidotes.
- Crustacean and Molluscan, Fishery.
- Local fishes of economic importance, planning and implementation of fish farming.

Practical:

- Study of the life cycle of Honeybee, Silkworm and Lac insect by preparation of slides and charts
- Study of the general anatomy of an economically important insect by the procedure of dissection
- Studying microscopical preparation(permanent mounts) under the microscope

- Study of morphology (external form structure) of some the preserved animals in the laboratory.

3. Course Title: Basic Mathematics - II

Course Code: MAS – 304

Credits: 3(3 – 0 – 0)

- **Differential calculus:** Functions, Limit, Continuity and Differentiability, Differential coefficients of standard functions (algebraic, trigonometric, exponential, logarithmic etc.), rules for differentiation, differentiation of composite, inverse, implicit & parametric functions. Higher order derivatives. Tangent & Normal, Maxima and Minima.
- **Integral- Calculus:** Definite integration of standard functions, integration by substitution, parts, partial fraction. Integration of rational, irrational trigonometric functions etc. Definite Integrals & properties. Its application in evaluating area and volume.
- **Vector-Algebra:** Definition and identification of vectors & scalar, linear-operations in vectors, linear combination of vectors, linear independence & dependence. Dot & Vector products. Triple Product.

4. Course Title: Fundamental Statistics

Course Code: MAS - 331

Credits: 3(2 – 0 – 2)

- Definition and applications of Statistics
- Testing of Hypothesis: Concept of Hypothesis, Degrees of Freedom, Level of significance
- Measurement of Central – Central Tendency
- Measurement of Dispersion
- Standard Errors of Mean
- Co-efficient of Variation Probability: Definition and applications, numerical problems.
- Simple-correlation between two variables (definition, properties and numericals)
- Regression-Lines: Definition and uses, Method of least square
- Concept of Regression coefficient

5. Course Title: Cell Biology

Course Code: MCE 301

Credits: 3(2-0-2)

- An introduction to cell biology: History of cell biology. Development of cell theory. Modern cell biology.
- Diversity of cell size and shape: Structure of prokaryotic cells (bacteria, fungi, virus, cyanobacteria, mycoplasma etc.). General organization of eukaryotic cells, cell shape, cell size, cell volume and cell number.
- Organization of cell: Cell wall, plasma membrane, their structural organization and functions. Membrane bound cell organelles - nucleus, endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and vacuoles. Non-membrane bound cell organelle- ribosome. Cytoskelton- microtubules, intermediate filaments and microfilaments.

- Cell growth and division: Cell cycle, kinds of cell division, amitosis, mitosis, meiosis, comparison between mitosis and meiosis, crossing over, significance of cell division.

Practicals

- Microscopy- simple and compound microscope
- Preparation of stains
- Grams staining
- Study of cell division - different stages of mitosis
- Differential staining of blood cells
- Hanging drop method for motility of bacteria

6. Course Title: Introductory Microbiology

Course Code: MBFT 349

Credits: 3(2 – 0 – 2)

- Definition, Scope and History of Microbiology
- Cellular organization of prokaryotic and eukaryotic cells
- Difference between prokaryotic and eukaryotic cells
- General characteristics and nature of Bacteria, Mycoplasma, Rickettsiae, Chlamydiae, Actinomycetes, Protozoa, Fungi, Algae & Viruses

Practical

- Familiarity with equipment to be used in Microbiology Laboratory.
- Cleaning, washing and sterilization of glass wares
- Observation of permanent slides to study the structural characteristics of common bacteria , fungi, algae & protozoa

7. Course Title: Basic Techniques in Microbiology

Course Code: MBFT 350

Credits: 3(2–0–2)

- Microscopy: Principles and applications of simple, compound, bright field, dark field, phase contrast, fluorescent and electron microscopy.
- Principles of staining: Nature of dyes, types of staining- simple, differential, spore and negative staining.
- Sterilization: Principles and methods.
- Types of media with specific examples for each type.
- Methods of maintenance and preservation of cultures.

Practical

- Handling and care of Microscopes
- Staining techniques
- Preparation and sterilization of different media types.

Semester III

1. Course Title: Analytical Chemistry

Course Code: CHEM - 330

Credits: 3(2 – 0 – 2)

- **General principles of Analytical Chemistry:** Volumetric analysis, Solutions, Preparation of primary and secondary standard solutions. Neutralization (Acid Base) titration, Iodometry, Iodimetry, Permagnetometry, Volumetric determination of calcium. Gravimetric analysis: Principles and methodology, Estimation of calcium.
- **Colorimetry:** Principle, Lambert's and Beer's Law, Absorption law (Derivation required), Methodology and applications.
- **Thermometric analysis:** Thermogravimetric analysis - types, Instrumentation, methodology and applications.
- **Potentiometric titration:** Electrode system, Ion selective electrodes, Ion selective membrane electrode, Advantage of potentiometric titrations, Applications of potentiometric titrations.
- **Polarimetry and Flourimetry:** Instrumentation, methodology and applications
- **Spectrophotometry:** Principle, instrumentation, methodology and applications.
- **Spectroscopic Techniques:** Introduction of UV, IR & Mass Spectroscopy

Practical:

- Preparation of primary and secondary standard solutions
- Standardization of secondary standard solution.
- Preparation and standardization of an acid solution.
- Preparation of standard solution of KMnO_4
- Volumetric determination of Fe by KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$ -solution
- Determination of calcium volumetrically
- Gravimetric determination of sulphate and calcium.
- Verification of Beer's Law

2. Course Title: Biochemistry - I

Course Code: BCBT 401

Credits: 3(2 – 0 – 2)

- Chemical structure of proteins and their properties, cellular membrane and transport phenomenon
- Intermediary metabolism- concept of anabolism and catabolism. Metabolism of carbohydrates, lipids and amino acids and their interrelationships.
- Biological oxidation, Electron transport system (ETS), Oxidative phosphorylation, and free energy changes in biochemical reactions. Energy rich compound.
- Metabolism of nucleic acid and proteins.
- Hormones: Regulation of metabolism by various hormones

Practical:

- Specific group tests for carbohydrates
- Specific group tests for amino acids
- Specific tests for lipids
- Determination of mil protein, fat and lactose
- Determination of acidity in sample

3. Course Title: Introductory Biotechnology

Course Code: MCE 303

Credits: 3(3 – 0 – 0)

- Introduction: Historical development of biotechnology. Basic concepts of biotechnology. Definition and descriptions of some important terminology in biotechnology.
- Branches of biotechnology: Study of various branches of Biotechnology including Plant, Animal, Medical, Industrial, Environmental, Marine Biotechnology, Bioinformatics, etc.
- Biotechnology in India: Biotechnology and developing world- concerns and consequences. Role of biotechnology in Indian industry. Impact on agricultural sector.
- Biotechnology and other disciplines: Biotechnology- an interdisciplinary pursuit, a three component central core, product safety. New trends in biotechnology.
- Applications and scope of biotechnology: Practice of biotechnology in medicine, industry, agriculture, live stock improvement and environment. Future perspectives.

4. Course Title: Molecular Biology

Course Code: MCE 302

Credits: 3(3 – 0 – 0)

- Introduction: Development of molecular biology. Historical perspectives. Concepts in molecular biology.
- Structure and properties of nucleic acids: Structure of nucleotides, DNA double helix, helical conformations and DNA topology. Types of DNA and RNA-A, B, Z forms of DNA, mRNA, tRNA, rRNA, hnRNA, snRNA. Physical and chemical properties of DNA.
- DNA protein interaction: Molecular aspects of protein-nucleic acid binding. DNA binding motifs in proteins- Helix- turn - helix, Zinc finger motifs, Leucine zipper, HMG box, etc.
- Gene organization: Gene structure and architecture, gene clusters, split genes, overlapping genes, pseudogenes, operon, open reading frames, transposons, oncogenes.
- Range of genome size. C value and gene numbers. Reassociation kinetics, Repetitive DNA -satellite DNA.

5. Course Title: Microbial Taxonomy & Diversity

Course Code: MBFT 412

Credits: 3(3 – 0 – 0)

- General principles of microbial taxonomy
- Detailed classification and study of major groups of bacteria, fungi and viruses
- Introduction to microbial diversity, distribution, abundance and ecological niche.
- Culturable and Unculturable bacteria.
- Conventional and molecular methods of studying microbial diversity

6. Course Title: Microbial Ecology

Course Code: MBFT 413

Credits: 2(2 – 0 – 0)

- Microbial habitats (Soil, aquatic, air)
- Ecological groups of microorganisms (based on O₂ requirements, Carbon sources, temperature, extremophiles, nutritional basis.
- Microbial population and community interactions.
- Microorganisms and transformation involved in the major geochemical cycles in marine, freshwater and terrestrial ecosystem.
- Bioremediation, Biodegradation and Biodeterioration.

7. Course Title: Environmental Studies - I

Course Code: SES- 415

Credits: 2(2 – 0 -0)

- **The multidisciplinary nature of environmental studies:** Definition, scope and importance.
- **Ecosystems**
 1. Concept of an ecosystem
 2. Structure and function of an ecosystem
 3. Producers, consumers and decomposers
 4. Energy flow in an ecosystem
 5. Ecological succession
 6. Food chains, food webs and ecological pyramids
 7. Introduction, types, characteristic feature, structure and function of the following ecosystem:
 - (a) Forest ecosystem
 - (b) Grassland ecosystem
 - (c) Desert ecosystem
 - (d) Aquatic ecosystem
- **Social issues and the environment**
 1. From unsustainable to sustainable development
 2. Urban problem related to energy
 3. Water conservation, rain water harvesting, watershed management.
 4. Resettlement and rehabilitation of people, its problems and concerns-Case studies
 5. Environmental ethics: Issues and possible solutions
 6. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies
 7. Wasteland reclamation
 8. Consumerism and waste products
 9. Environment Protection Act
 10. Air (Prevention and control of pollution)
 11. Visit to local polluted site-Urban/Rural/Industrial/Agricultural
 12. Study of common plants, insects and birds
 13. Study of simple ecosystem-ponds, river, hill slopes etc.
 14. Issues involved in enforcement of environmental legislation; Public awareness

Semester IV

1. Course Title: General Bacteriology

Course Code: MBFT 431

Credits: 3(2 – 0 – 2)

- Morphology and fine structure of bacterial cell.
- Cultivation of bacteria: Nutritional requirements, Nutritional types of bacteria, Physical conditions required for growth
- Pure cultures and Cultural characteristics
- Reproduction and growth of bacteria: Modes of cell division, Growth curve, Quantitative measurement of growth.

Practical

- Methods of isolating pure cultures
- Identification of common bacteria on the basis of cultural and biochemical characters.
- Test for motility of bacteria
- Quantitative measurement of growth

2. Course Title: Introduction to Virology

Course Code: MBFT 432

Credits: 3(2–0–2)

- Introduction: Definition, History of virology
- General properties of viruses: Classification, Structure and Replication.
- Animal Viruses: Morphology, Cultivation, Pathogenesis, Laboratory diagnosis and Treatment of major animal viruses(Rinder pest, Foot & Mouth Disease, Herpes, HIV, Hepatitis); Viral Vaccines, Antiviral Agents
- Plant Viruses: Cultivation and Study of common plant viral diseases(TMV, Bunchy top of banana, Cauliflower mosaic virus, etc.) , Viroid
- Bacterial viruses: Discovery , significance, and general characteristics of bacteriophages; Lytic and Lysogenic life cycles.

Practical

- Symptomatology of potato virus, peanut bud necrosis, viruses on pulses, Tomato leaf curl, Mung bean yellow mosaic virus, Sunflower necrosis (Tobacco streak virus) and other viral diseases of available plants.
- Local lesion assay methods(including isolation and maintenance of plant viruses)
- Conversion factor and formulas in centrifugation
- Study of inclusion bodies of available viruses by light microscopy.

3. Course Title: General Mycology

Course Code: MBFT 433

Credits: 3(2–0–2)

- History and scope of mycology
- Morphology, taxonomy, life cycle, ultra-structure, and reproduction of different groups of fungi
- Evolutionary trends in fungi.

Practical

- Exercise on detailed comparative study of morphology of various representative groups of fungi.
- Collection of cultures and live specimens

4. Course Title: Applications of Bioinformatics

Course Code: CBBI 501

Credits: 2(1 – 0 – 2)

- **Bioinformatics and Internet:** Internet Basics, FTP, www, connecting to Internet, Electronic mail, internet resources.
- **The NCBI data model:** Introduction, Seq-id, Sequence, collection of sequence, annotation of sequence, describing sequence.
- **GenBank Sequence Database:** Introduction to structure, Primary and secondary database
- **Sequence Alignment And Database Searching :** FASTA , BLAST , Multiple Sequence Alignment
- **Phylogenetic Analysis:** Fundamental of Phylogenetic model, Tree interpretation, Tree building and tree evaluation, Phylogenetic software.
- **Introduction to Structure,** PDB, MMDB, Structure file format, visualizing structure information, Structure viewers, structure similarity searching, advanced structure modeling.
- **Comparative Genome Analysis:** Introduction, application, genome analysis and annotation.

Practicals:

- Understanding Linux Operating System and Commands.
- Introduction to NCBI.
- Using Entrez to search Literature Databases.
- Retrieving DNA sequence from GenBank and analyzing various formats of the data stored.
- Retrieving Protein sequence from GenPept (NCBI) and Expasy.
- Analyzing Protein Sequences.
- Analyzing DNA sequence.
- Sequence alignment using BLAST (Basic Local Alignment Search Tool).
- Sequence alignment using FASTA.
- Multiple sequence alignment using ClustalW.

5. Course Title: Genetics

Course Code: GPB-412

Credits: 3(2–0–2)

- Terminology of Genetics: Gene, Allelomorphs or alleles, Phenotype, Genotype, Homozygous, Heterozygous, Pureline, Hybrid, Dominant and recessive alleles, Test cross and backcross. Mendel's Laws of heredity: Mono, dihybrid ratios
- Linkage: Types, linkage maps, linkage groups, coefficient of coincidence, coefficient of Interference, Sex linkage, inheritance of sex-linked traits
- Crossing over: Theories of crossing over, Cytological basis of crossing over, Factors effecting crossing over
- Gene interactions: Kinds of Gene interactions. Sex determination in plants
- Multiple alleles: Characteristics, some examples. Mutations: Characteristics, types of mutagens, mode of action of mutagens.

Practical:

- Simple and Compound Microscope
- Practice of mitotic and meiotic cell division
- Monohybrid and dihybrid ratios
- Numericals on Epistatic interactions
- Probability and Chi-square
- Two point test cross linkage analysis
- Three point test cross linkage analysis

6. Course Title: Biochemistry - II

Course Code: BCBT 403

Credits: 3(2 – 0 – 2)

Unit I: Protein Chemistry: Structure of proteins, methods for determining the 3-D structure of a protein-X-ray Diffraction, NRM, Mass spectrometry, Protein Homology among species, Protein Denaturation and folding, Assisted folding, Edman Degradation, Glycoprotein, lipoproteins, proteoglycans, phospo protein, chromoprotein, bacterial and viral protein (HIV, HBV, toxins, etc.)

Unit II: Biomembranes: Molecular constituents of membranes, Movement of molecules through membranes, Energrtics of membrane transport system, Biosignalling, Voltage gated ion channels, Transporters and group translocation with examples.

Unit III: Sensory System: Olfaction, Taste, Vision, Hearing and Touch with their biochemical mechanisms.

Unit IV: Physicochemical properties of nucleic acids: Hydrogen bonding, bond length, tautomerism and its significance in nitrogen bases, DNA denomination, and factor responsible for hypochromicity. Renaturation of DNA, Annealing, Renaturation kinetics, Britten Kohon's equation, Walloce's Rule, Hybridization. Ionization, enzymatic of nucleic acids, effect of acids and alkalis on nucleic acids, DNA supercoiling and nucleic acid mutations.

Practical :

1. Fractionation of egg proteins
2. Detection of α -amylase activity in saliva

3. Determination of Sugar/Glucose in Urine (Benedict's Trirometric method)
4. Identification of blood constitution
5. Extraction of total Nucleic acid from plant tissues
6. Extraction of RNA from yeast
7. Assay of protein by Biuret's Method

7. Course Title: Environmental Studies - II

Course Code: SES 416

Credits: 2(2-0-0)

- **Natural Resources**

- | | | |
|----------------------|----------------------|----------------------|
| (a) Forest resources | (b) Water resources | (c) Mineral resource |
| (d) Food resources | (e) Energy resources | (f) Land resources |
- Role of an individual in conservation of natural resources
Equitable use of resources for sustainable life style

- **Biodiversity and its conservation:**

- a. Introduction- Definition: genetic, species and ecosystem diversity
- b. Biogeographical classification of India
- c. Value of Biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
- d. Biodiversity at Global, National and Local levels.
- e. India as a mega diversity nation.
- f. Hot-spots of biodiversity
- g. Threats to biodiversity: habitat loss, poaching of wild life, man-wild life conflicts.
- h. Endangered and endemic species of India
- i. Conservation of Biodiversity: In situ and ex situ conservation of Biodiversity.

- **Environmental pollution:**

Definition

Causes, effect and control measures of:

- | | | | |
|---------------------|-----------------------|---------------------|----------------------|
| (a) Air pollution | (b) Water pollution | (c) Soil pollution | (d) Marine pollution |
| (e) Noise pollution | (f) Thermal pollution | (g) Nuclear hazards | |

Solid waste management: causes, effect and control measures of urban and industrial wastes.

Role of an individual in prevention of pollution

Pollution case studies

Disaster management: Floods, earthquake, cyclone and landslides.

Semester V

1. Course Title: Molecular Biology Techniques & Instrumentation

Course Code: MCE 406

Credits: 3(2 – 0 – 2)

- **Molecular biology techniques:** Cell fractionation. Isolation and purification of genomic DNA. Polymerase Chain Reaction. Nucleic acid blotting. DNA sequencing techniques.
- **Instrumentation in biotechnology:** Working principles, instrumentation and applications of pH meter, centrifuge, colorimeter, spectrophotometer, autoclave, distillation unit, lyophilizer, flame photometer.
- **Methods for separation of macromolecules:** Chromatography- column, thin layer, paper, ion exchange, gel filtration, affinity. Electrophoresis- agarose gel electrophoresis and poly acrilamide gel electrophoresis.
- **Microscopy:** Principles and applications of microscopy - simple, compound, phase contrast and electron microscopy. Yeast-2 Hybrid system, MS, tandem MS and MS imaging

Practical:

- Measurement of hydrogen ion concentration of a given solution
- Separation techniques-centrifugation and electrophoresis
- Study of working principles and operation of some important equipments used in biotechnology laboratory viz., spectrophotometer, pH meter, centrifuge, electrophoresis apparatus (AGE and PAGE), PCR machine, Distillation unit, autoclaves etc.

2. Course Title: Enzymology and Enzyme Technology

Course Code: BCBT 404

Credits: 3(2 – 0 – 2)

- **Introduction to enzymes:** General properties and significance, classification and nomenclature.
Terms and definitions in Enzymology: Enzyme activity, specific activity, turnover number, active site, isoenzyme, marker enzyme etc.
- **Factors affecting enzyme activity:** pH, temperature, substrate concentration etc. Isolation, purification and localization of enzyme, techniques involved in enzyme assays.
- **Enzyme kinetics:** Steady rate kinetics, Derivation of Michaelis-Menten equation using steady state/equilibrium kinetics, plots of Lineweaver-Burke etc. mechanisms of substrate and multisubstrate enzyme catalyzed reactions
- **Regulation of Enzyme activity:** Covalent modification, Enzyme inhibition and kinetics.
Allosteric enzymes: Feed back inhibition, allosteric model concerted and sequential, cooperativity.
- **Mechanism of Enzyme action and concept of active site:** Vis-à-vis lysozyme, chymotrypsin, alcohol dehydrogenase, glyceraldehyde 3 phosphate dehydrogenase, proteases.
Mode of action of: Multienzyme complex, extracellular enzymes, extremozymes, abzymes, ribozymes

- **Enzyme technology:** Commercial production of enzymes, preference of extracted enzymes over whole organism, immobilization of enzymes, example of enzyme engineering, application of enzyme (therapeutic uses, analytical uses, manipulative uses, etc.), uses of enzyme in solutions, enzyme reactors, biphasic systems, Bi and poly functional enzymes, synzymes, solvent engineering

Practical:

- Determination of protein
- Determination of Salivary amylase
- Effect of salt on Salivary amylase
- Effect of pH on enzyme activity
- Determination of Acid/alkaline phosphatase
- Determination of Enzyme kinetics
- Separation of protein by PAGE
- Identification of Extracellular enzymes like Protease, Oxidase, Urease, Catalase and Lipase.

3. Course Title: Basic Immunology

Course Code: BCBT 405

Credits: 3(2 – 0 – 2)

- **Basic Terminology:** Infection, pathogen, Antigen, Antibody, Bacterial and viral antigens, Haptens, Adjuvant, Immunogen, Interferons, Epitopes, Paratopes, Lymphokines
 - **Specific and non-specific immune response:** cellular basis of immunity, Humoral and cell mediated immunity, bio-chemistry of immunoglobulins (structure, property and function),
 - **Cells of immune system:** Cells involved in adaptive immune responses i.e. B & T cells. Cells involved in innate immune response i.e. Macrophages, dendritic cells, phagocytes, mast cells, granulocytes, etc.
- **Organs of immune system:** Primary lymphoid and secondary lymphoid organs, their structure and function. Major Histo compatibility complex (MHC CLASS –I, MHC II) their structure and function. Chemistry of antigen-antibody interactions, precipitation and agglutination.
- Structure of T-cell Receptors and their comparison with analogous antibody molecules. Natural killer cells –their structure and function, superantigens and antibody dependent cell mediated cytotoxicity (ADCC).
- **Immunodeficiency diseases:** Primary B&T deficiency, Auto-immunity, Hypersensitivity, Principles of RIA, ELISA and immunoelectrophoresis (Rocket immunoelectrophoresis), use of monoclonal antibodies used in immunodiagnostics and immunotherapy.

Practical :

- To prepare blood smear
- Separation of serum and plasma from blood
- Qualitative tests of important constituents of plasma and serum
- Separation of serum proteins (i.e. Fibrinogen, globulin and albumin)
- Determination of ESR of any blood sample
- Preparation of antigen from blood
- Determination of blood group
- Determination of haemocrit value of the blood sample

- Use of Widal test for rapid quantitative slide test
- Determination of density of blood
- Determination of bleeding and clotting time of blood
- Preparation of haematin crystals

4. Course Title: Microbial Metabolism

Course Code: MBFT 452

Credits: 2(2–0–0)

- Bacterial Enzymes: Classification, Properties, Factors affecting enzyme activity, Inhibition of enzyme action, Regulation of enzymes.
- Carbohydrate metabolism: Anabolism- Photosynthesis (oxygenic and anoxygenic). Catabolism- EMP pathway, Pentose pathway, Krebs's cycle, Fermentation Electron transport system, ATP production
- Metabolism of proteins: Metabolic pathways of nitrogen utilization, Urea cycle, Protein synthesis.
- Catabolism of lipids.

5. Course Title: Principles of Microbial Genetics

Course Code: MBFT 453

Credits: 3(2 – 0 – 2)

- History-Experiments of Hershey Chase and Griffith; DNA as genetic material; Discovery of DNA structure, RNA as genetic material, Genetic code.
- Organization and function of genetic material-Bacterial and Viral
- Brief account of plasmids-Structure and types.
- Replication of DNA- Rolling circle model; Replication of RNA- Reverse transcriptase.
- Concept of genes-Lac operon, Tryptophan operon; Attenuation control-Promoters- Repressors- Gene Expression and control.
- Gene transfer mechanisms- Conjugation, Transformation, Transduction.
- Mutagenesis-Mutation, Mutants, IS elements, Transposons, Repair mechanisms

Practical

- Isolation of antibiotic resistant strains; Replica plate technique for isolation of mutants
- Isolation and purification of chromosomal and plasmid DNA and RNA
- Chemical mutation, Non-ionizing radiation UVR, its effects on morphology and Biochemical analysis

6. Course Title: Professional Communication & Technical Writing

Course Code: LNG-304

Credits: 3(2 – 0 – 2)

- **Language:** Syntax
 - a. Word enrichment (Autonyms, Synonyms, Homonymns, Homophone, Spelling, and Usage)
 - b. Concord (Course, Verb Agreement)
 - c. Modifiers (Proper placement)
 - d. Preposition (Usage)
 - e. Inflection (Noun, Verb)
 - f. Determiners (General, Specific)
 - g. Voice

- **Communication:**
 - a. Role of body language in communication
 - b. Self Introduction
 - c. Conversation in different situations
 - d. Use of specific expressions
 - e. Group Discussions
 - f. Role Plays
 - g. Interviews
 - h. To cater different type of audience

- **Technical writing:**
 - a. Resume
 - b. Curriculum vitae
 - c. Letters
 - d. Memos
 - e. Report
 - f. Proposals
 - g. Usage of Graphics
 - h. Different administrative documents (Notices, Circulars, Memos, Agenda, Minutes)

- **Speech skills:**
 - a. Accent
 - b. Intonation
 - c. Different types of speeches
 - d. Delivering of different speeches

7. Course Title: Bio-safety, Bioethics & IPR issues

Course Code: MCE 501

Credits: 3(3-0-0)

- The legal and socioeconomic impact of biotechnology, public education of the process of biotechnology involved in generating new forms of life for informed decision making, biosafety regulation and national and international guidelines, r-DNA guidelines, experimental protocol approvals, levels of containment, regulatory bodies in biotechnology, biosafety committee.
- Ethical issues, moral values on experimental animals, ethical implications of biotechnological products and techniques.
- Intellectual property rights, WTO, TRIPS, International conventions, patents and copy rights, patent claims, methods of applications of patents.
- Legal implications, biodiversity and farmers right. Beneficial application and development of research focus to the need of the poor, identification of directions for yield effect in agriculture, aquaculture etc.

Semester VI

1. Course Title: Nematology

Course Code: PPR- 521

Credits: 2(1 – 0 – 1)

- History and development of Nematology
- Economic importance of nematodes in Agriculture
- General characters, morphology, taxonomy and classification of important nematodes
- Symptoms of nematode attack
- Principles of nematode management
- Nematode problems of important crops and their control
- Entomopathogenic nematodes

Practical

- Techniques for nematode extraction; counting & estimation of population; killing, fixing and preparing mounts
- Study of body systems
- Identification of common genera
- Symptoms of nematode diseases

2. Course Title: Plant Diseases & Their Management

Course Code: PPR- 522

Credits: 3(2 – 0 – 2)

Symptoms, nature and prevalence, etiology, life cycle and management of important diseases.

Practical

- Detailed study of symptoms and host parasite relationship of representative diseases.

3. Course Title: Parasitology

Course Code: MBFT 434

Credits: 3(2 – 0 – 2)

- General Parasitology: Parasite, Host, Host-Parasite relationships, Sources of infection, Pathogenicity, Immunity in parasitic infection, Laboratory diagnosis.
- Study of Morphology, Important development stages, Symptoms, Pathogenicity, Epidemiology, Diagnosis, Treatment and Prevention of the following:
 - a) Amoebae: *Entamoeba histolytica*, *Naegleria fowleri*.
 - b) flagellates: *Giardia*, *Trichomonas*, *Leishmania* and *Trypanosomes*
 - c) sporozoa: Malarial parasite, *Toxoplasma gondii*, *Isospora*, *Cryptosporidium parvum*
 - d) *Balantidium coli*.
 - e) Helminths: *Taenia saginata*, *Taenia solium*, *Echinococcus*, *Schistosomes* (blood flukes), *Ascaris*, *Ancylostoma*, *Trichuris trichuria*, *Enterobius vermicularis*, *Wucheria bancrofti*, *Dracunculus* and *Trichella spiralis*.

Practical

- Collection, preservation and transportation of faecal material for laboratory examination.
- Concentration technique of stool for ova and cyst.
- Wet preparation of faecal sample for ova and cyst.
- Identification of ova and cyst in stool sample.
- Staining technique for malarial parasite.
- Laboratory diagnosis of Kala-azar.
- Laboratory diagnosis of Sleeping sickness.
- Laboratory diagnosis of microfilariae.

4. Course Title: Industrial Microbiology

Course Code: MBFT 502

Credits: 3(2 – 0 – 2)

- Production of amino acids
- Production of vinegar
- Manufacture of various chemicals: Lactic acid, citric acid
- Industrial production of therapeutic compounds: penicillin, vitamins, vaccines
- Microbial transformation of steroids
- Production of microbial enzymes
- Microbial deterioration of materials: textile, paper, paint and painted surfaces etc.
- Production of vaccines
- Use of microorganisms in bioassays

Practical

- Demonstration of fermentor its parts and maintenance
- Screening for antibiotic production
- Screening for enzyme production
- Assay of antibiotics

5. Course Title: Biochemical Engineering

Course Code: BCBT – 501

Credits: 3(2-0-2)

- **Biochemical Engineering:** Bioreactors- definition, classification of chemical reactors, residence time, bioreactors design and their function, types of bioreactors. Application of bioreactors in bio-fertilizer production, alcohol production, antibiotic production, plant cell culture, animal cell culture, waste management
- **Control of bioprocess parameters in bioreactors:** temperature, pressure, oxygen supply, agitation, nutritional on/off control, PID control, control of heating of bioreactors, flow measurement control, chemical and electrical methods of foam control, off line control parameters (measurement of properties analysis of cell population and composition), use of computer technology in bioprocess control system
- **Engineering principles:** Transport phenomenon in bioprocess, mass transfer coefficient in gases and liquids, heat transfer principles, coefficient of heat transfer, applied enzyme catalysis, biomass production in cell culture

- Upstream and downstream processing: Media formulation, sterilization of equipments, gas compressor types and principles of compression, air filtration, solid and liquid handling. Industrially fermented broth (filtration and ultra filtration), centrifugation, solvent extraction, chromatographic separation, liquid extraction of biopolymers and antibiotic ion exchange recovery of antibiotics and proteins

Practical

- To estimate dimensionless mixing time in a batch reactor
- To study the pH control system of bioreactor
- To understand the functioning of bioreactor and to carry out its blank sterilization
- To study the operation of a bioreactor
- To study the dissolved oxygen in bioreactor

6. Course Title: Fundamentals of Nanotechnology

Course Code: MCE 503

Credits: 2(2 – 0 – 0)

- Nanotechnology: an overview
- Nanomaterial, their chemistry and synthesis
- Carbon nano tube and their applications
- Study of analyzing tools for nanostructures (STM, TEM, AFM)
- Applications of nanotechnology in semi conductors, composites, ceramics, catalysis and photocatalysis, biosensor development, drug delivery and gene therapy, NEMS and MEMS,
- environmental biotechnology
- Health and safety issue, ethical, legal and societal implications

7. Course Title: Fundamentals of Tissue Culture

Course Code: TE 401

Credits: 3(2-0-2)

- Plant Tissue Culture: A historical view, organization of tissue culture laboratory, aseptic techniques, media formulation, clonal propagation vs tissue culture, totipotency, growth differentiation and morphogenesis in tissue culture, various types of aseptic cultures and culture techniques.
- Animal Tissue Culture: Basic techniques, organ culture, media formulation for animal cell, initiation of cell culture, evolution & maintenance of cell lines, Suspension culture & Immobilized culture.
- Application of tissue culture techniques: Somoclonal and gametoclonal variation, protoplast fusion and somatic hybridization, cybridization, haploid and monoploid production, secondary transformation, production of metabolites, artificial seeds, preservation of genetic resources, cryopreservation, application of tissue culture for plant improvement.

Practicals:

- Laboratory equipments used in Plant Tissue culture
- Plant Growth Hormones
- Media preparation
- Preparation and Sterilization of explants
- Callus induction
- Meristem culture

Semester VII

1. Course Title: Fermentation Technology

Course Code: MBFT 601

Credits: 3(2-0-2)

- **Fermentation equipment and its use:** (i) Basic functions of a fermenter, body construction, aeration, agitation, theories of aeration, oxygen transfer kinetic, baffles. Design of fermentation vessels viz. Airlift Fermenter, tower fermenter, continuous fermenter, fed batch fermenter, waldhof type fermenter.
- **Growth and product formation:** concept of primary and secondary metabolites, and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency).
- **Development of microbial processes:** (i) Screening (ii) Strain improvement (iii) Scale up in fermentations (iv) Inoculum preparations (v) Stock culture maintenance (vi) Contamination problems in fermentation industry
- **Control of metabolic pathways-**Environmental control and genetic control of metabolic pathways
- **Fermentation media-**Types of fermentation media, sources of carbon, nitrogen, trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media, screening for fermentation media
- **Computer applications in fermentation technology-**General applications and specific applications
- **Process validation and quality assurance** Current Good Manufacturing Practices (CGMP), and Current Good Laboratory Practices (CGLP)

Practical :

- To study about fermentors
- To isolate yeast cells from fruit juice and rice flour
- Demonstration of fermentation by using Yeast
- Demonstration of wine production
- To produce citric acid by solid state fermentation
- Production of lipase by submerged fermentation

2. Course Title: Microbial Enzyme Technology

Course Code: MBFT 604

Credits: 3(2-0-2)

- Introduction to enzymes and its classifications
- Specificity of enzyme action
- Bacterial and Fungal enzymes, Recent developments and present position
- Production of microbial enzymes, Strain selection and development, Fermentation, Recovery and finishing
- Cell and enzyme immobilization
- Applications of microbial enzymes
- Detergent, starch, paper, leather and textile industries
- Synthesis of fine chemicals, medical, pharmaceutical and environmental applications
- Regulation and specifications of enzymes

- Extremozymes and their structural modifications
- Thermostable enzymes and cold active enzymes
- Alkalophilic and halophilic enzymes

Practical:

- To study the hydrolysis of starch by microorganisms
- To study the hydrolysis of gelatin by microbes
- Fermentative production and extraction of amylase by *Aspergillus niger*
- Estimation of reducing sugars by DNS method
- Production of lipase by submerged fermentation

3. Course Title: Microbial Technology in Food Industry

Course Code: MBFT 605

Credits: 3(2-0-2)

- Food as a substrate for microorganisms
- Primary Sources of Microorganisms in Foods
- General principles underlying spoilage of foods and different methods of preservation of foods
- Starter Cultures
- Fermented milk product and other food: types, production and defects.
- Fermented beverages: Brewing, malting, mashing, hops & primary and secondary fermentation
- New protein foods – SCP, mushroom, food yeasts, algal proteins
- Quality and safety assurance in food and dairy industry

Practical:

- Familiarity with bacteria and fungi important in food industry
- Evaluation of milk sample by Direct Microscopic Count
- Starter Activity test
- Microbiological analysis of Dahi
- Isolation and identification of microorganisms involved in food spoilage (vegetable, fruit)
- Enumeration of microorganisms in different food products (fruit juice, sugar etc)

4. Course Title: Soil Microbiology

Course Code: MBFT 610

Credits: 2(1-0-2)

- Classification of soil; Physical and Chemical characteristics of soil; Microbial flora of soil
- Interaction among soil microorganisms
- Biogeochemical cycles: Carbon, Nitrogen Phosphorous and Sulphur

Practical

- Isolation and identification of soil microorganisms

5. Course Title: Pharmaceutical Microbiology

Course Code: MBFT – 611

Credits: 3 (2-0-2)

- **The nature of microorganisms and their role in causing diseases**
- **Antibiotics and Synthetic antimicrobial agents:**
 - Types of antibiotics and antimicrobial agents
 - Mechanism of action, microbial resistance, therapeutic, prophylactic usage and adverse reactions
 - Antibiotic and Synthetic antimicrobial agents: β -lactam, aminoglycosides, tetracyclines, ansamycins, macrolides
 - Antifungal antibiotics: Griseofulvin
 - Antiviral drugs: Amantidines, Nucleoside analogues, Interferons
 - Peptide antibiotics
 - Synthetic antibiotics: Sulphonamides, Chloramphenicol, Quinolone
- **Microbial aspects of pharmaceutical products**
 - Microbial contamination (atmosphere, water, operator, raw material, packaging, buildings, equipments)
 - Microbial spoilage (Types & factors affecting) & preservation
 - Sterilization of pharmaceuticals (survivor curve, D, Z, F value)
 - i. Methods: Heat, Gaseous, Radiation, Filtration
 - ii. Disinfectants
- **Quality assurance and validation**
 - Quality control in pharmaceuticals: In-process & final product control
 - Sterilization control: physical, chemical & biological indicators
 - Sterility testing (sampling & methods)
 - Good Manufacturing Practices
 - Regulatory aspects for Quality Control

Practical

- Sterilizing techniques and their validation
- Evaluation of antiseptics and disinfectants
- Testing the sterility of pharmaceutical products as per IP requirements
- Microbial assay of antibiotics.

6. Course Title: Immunotoxin & Drug Designing

Course Code: BCBT 605

Credits: 3(3 – 0 –0)

- **History of Drug Discovery & Molecular Biology for Drug:** - Early and recent history of drug discovery, enzymes/receptor as drug target. Molecular Biology for drug discovery (Recombinant proteins and monoclonal antibodies as drug). Molecular basis of disease processes. Target identification and Validation.
- **Organic synthesis for Drug Discovery:** - Target oriented organic synthesis and retrosynthetic analysis. Diversity oriented organic synthesis and evolving synthetic analysis, solid phase synthesis for drug discovery (Parallel vs split pool strategy). Combinatorial chemistry and high through-put screening (HTS).
- **Combinatorial Chemistry for Drug Discovery:** - Combinatorial biocatalysis for drug discovery, synthesis of Bergin in derivatives. Drug discovery in cancer research/New target based drugs in clinical trials.

- **Introduction of Pharmacogenomics:** - Microbial Genomics for new antibiotics, Immunotoxins as drugs (Eg. Ricin, a plant toxin). Drug designing for blocking enzyme activity through blocking hormones receptor through inhibition of nucleic acid synthesis against heterogenous targets.

7. Course Title: Biotransformation and Bioconversion

Course Code: BCBT – 607

Credits: 3(2-0-2)

- Introduction to biotransformation, characteristics of biotransformation reaction.
- Biotransformation techniques, biotransformation by growing cells, biotransformation by stationery cells, biotransformation by spores, biotransformation with immobilized cells, Biotransformation by purified enzymes.
- Biotransformation of various L-amino acids, biotransformation of L-lysine, biotransformation of L-glutamic acid, biotransformation of L-aspartic acids, Biotransformation of vitamins like L-ascorbic acid, alpha tocopherol, biotin, Biotransformation of steroids, Biotransformation of antibiotics, i.e. penicillin.
- Pre-treatment processes of Raw starchy materials, acid treatment, Milling operation, dry and wet milling operations. Conversion of lignocellulosic material to sugars. Lignocellulosic biotechnology-issues of bioconversion and enzyme production.

Practical

- Demonstration of urease production i.e. urea hydrolysis
- Degradation of sulphur containing aminoacid
- Demonstration of carbohydrate metabolism
- Indole production by bacterial sample
- Production of ammonia from organic compounds
- Bioconversion of ammonia to nitrate i.e. nitrification

Semester VIII

1. Course Title: Statistics I

Course Code: MAS-711

Credits: 3(2 – 0 – 2)

- Standard –deviation, Coefficient of Variation, Standard error of mean
- Theory of Probability: equally likely, mutually exclusive events, definitions of probability, addition and multiplication theorems of probability and problems based on them
- Normal and Binomial Distributions
- Simple Correlation and regression, Multiple-regression, Multiple and partial correlation.
- Testing of Hypothesis: Concept of Hypothesis, Degrees of freedom, Level of significance. Type I and Type II errors. χ^2 , t, z and F-tests (definition, applications and problems based on these tests.

Practical:

- Coefficient of variation, SE of mean, Skewness and Kurtosis
- Fitting of Normal, Binomial and Poisson distribution
- Simple Correlation, Multiple and Partial Correlation with three variables only
- Regression lines between two variables
- χ^2 , t and F tests

2. Course Title: Computer Programming

Course Code: COMP 805

Credits: 3(2-0-2)

- Algorithms and Flow charts
- C programming
 - Preliminaries
 - Constants and variables
 - Arithmetic expressions
 - Input-Output statements
 - Control statements
 - Looping statements
 - Subscripted Variables
 - Elementary Format Specifications
 - Logical Statements and Decision Tables
 - Functions and Subroutines
- Computer Oriented Numerical Methods
 - Solution of Non Linear Equation
 - Bisection method
 - Newton method
 - Numerical Integration
 - Trapezoidal Method
 - Simpson's 1/3 and 3/8 rule
 - Curve Fitting
 - Construction of forward, backward difference table
 - Interpolation
 - Application of Statistical packages

Practical

- To find the largest among three numbers
- To check whether a given string is a palindrome or not
- To find factorial of a given number by iteration
- To find whether the given integer is a prime number
- To find sum of n terms of series
 - $N - n^2/2! + n^3/3! - n^4/4! + \dots$
- To find sum and average of n integers using a linear array
- To read n numbers from the keyboard and display these numbers in the reverse order their entry.
- To search a given number within a linear array
- To generate the fibonacci series.
- To find factorial of a given number using a function
- To deduce error involved in polynomial equation
- To find out the root of the Algebraic and Transcendental equations using Bisection, Regula-falsi, Newton Raphson and Iterative Methods. Also give the rate of convergence of roots in tabular form for each of these methods.
- To implement Newton's Forward and Backward Interpolation formula.
- To implement Gauss Forward and Backward, Bessel's, Sterling's and Evertt's Interpolation formula
- To implement Newton's divided difference and lang ranges Interpolation formula
- To implement Numerical differentiations.
- To implement numerical integration using Trapezoidal, Simpson 1/3 and Simpson 3/8 rule.
- To implement least square method for curve fitting.

3. Course Title: Environmental Microbiology

Course Code: MBFT 725

Course Code: 3(2 – 0 – 2)

- Microbial Diversity: Introduction, abundance, ecological niche. Conventional and molecular methods of studying microbial diversity. Microbial population and community interactions. Culturable and Unculturable bacteria. Extremophiles.
- Microbiology of Air: Sources and types of micro organisms in air, sampling techniques for microbial populations, air pollution, significance of air borne micro organisms in human and plant diseases.
- Microbiology of water: Water environment, types of micro organisms in water, sampling techniques for microbial population in water, water pollution, algal blooms, eutrophication, indicators of excreted pollutants, important water borne diseases of man
- Types of wastewater, bacteriological analysis of wastewater, chemical tests for dissolved oxygen, chloride, BOD and COD. Primary, secondary and tertiary treatment of waste-water.
- Microbial Ecology: Micro organisms and transformations involved in the major geochemical cycles in marine, freshwater and terrestrial ecosystem. Bio-remediation, bio-degradation and bio-deterioration.

Practical:

- Isolation of extremophiles (acidophiles, alkalophiles, psychrophiles and thermophiles)

- Study of air borne micro organisms using various methods
- Study of microbial contaminants from water and waste water
- BOD and COD estimation
- Effect of chlorination on microbial counts of water.

4. Course Title: Microbiological Techniques

Course Code: MBFT 726

Credits: 3(2-0-2)

- Methods of sterilization: principles and their limitations
- Growth media
- General methods of isolation of microorganisms
- A general knowledge of techniques used in identification of various types of microorganisms
- Staining techniques: principles, and their applications (Gram stain, acid fast stain, spore stain, capsule stain)
- Microscopy: General knowledge of principles involved in various types of microscopy, phase contrast microscopy, fluorescence microscopy and electron microscopy
- Principles and applications of centrifuge
- Chromatographic techniques: Types and uses of chromatography, paper, thin layer and column chromatography
- Gel filtration, electrophoresis and its applications in identification and purification of proteins and enzymes
- Principles and applications of spectrophotometry
- Bioassay of vitamins, antibiotics and hormones

Practical:

- Preparation of reagents and stains
- Special staining methods
- Sterilization techniques
- Microscopy
- Micrometry
- Pure culture techniques
- Identification of Bacterial isolates by flow chart
- Hanging drop technique for demonstration of motile bacteria.
- Isolation of bioactive compounds by column chromatography
- Separation of proteins using gel electrophoresis
- Bioassay technique

5. Course Title: Microbial Genetics

Course Code: MBFT 781

Credits: 4(3-0-2)

- Introduction to nucleic acids, chemistry of DNA, replication, transcription, translation and genetic code
- Genetics of bacteria and bacteriophages, bacterial phenotypes, genotypes. Transformation, Transduction and Conjugation. Regulation of bacterial gene activity, transposable elements and mapping of bacterial chromosomes
- Bacteriophages: characteristics, fine structure and mapping of genes
- Mutation: characteristics, and types in bacteria and viruses

- Introduction to genetic engineering: vectors, plasmids, cosmids, phage derivatives, phagemids. Restriction and modification systems, restriction endonucleases, enzymes used in gene cloning and their applications. Recombinant DNA technology and nucleotide sequencing.
- Genetics of Nitrogen fixation.
- Genetic control of sexual development and macromolecular structures
- Molecular markers

Practical:

- Induction of mutation by chemical and physical methods
- Isolation and characterization of mutants
- Plasmid detection and isolation
- Transformation in bacteria
- Fractionation of nucleic acid by centrifugation

6. Course Title: Microbial Physiology

Course Code: MBFT 782

Credits: 3(2-0-2)

- Structure and functions of various cellular components
- Nutritional requirement of different group of microorganisms
- Bacterial growth, effect of environment and chemicals on growth
- Transport in microorganisms
- Enzymes: classification, mechanism of action, enzyme kinetics
- Bacterial photosynthesis
- Aerobic and anaerobic respiration
- Regulation in microorganisms

Practical:

- Demonstration of sugar (glucose, sucrose and lactose) fermentation
- Sugar, mannitol fermentation by bacteria
- IMViC test for enteric bacteria
- Catalase activity for H₂O₂ production
- Oxidase activity of a given bacterial sample
- Demonstration of carbohydrate metabolism by Hugh Leifson's test
- Determination of nitrate reduction by bacteria
- Demonstration of starch hydrolysis by given bacterial culture
- Demonstration of protein (gelatin) hydrolysis
- Fat hydrolysis by bacterial culture
- Phenylalanine deaminase production
- Demonstration of lysine decarboxylase activity of bacteria
- Degradation of sulphur containing amino acids for H₂S production
- Demonstration of urease production
- Measurement of bacterial growth curve

7. Course Title: Bioinformatics

Course Code: CBB1 801

Credits: 3(2-0-2)

- Introduction to Bioinformatics, philosophical, directional and application oriented background of bioinformatics.
- HGP – influence area in Bioinformatics, Application in different industries, and its Indian scenario, as a business, problem and future aspects.
- Information network – Internet, web Browser and address (NCBI, EBI etc).
- Databases – information resources for Proteins and Genomics.
- SRS, Algorithms, Alignment.
- Phylogenetic Analysis: Fundamental of Phylogenetic model, Tree interpretation – Paralogues and orthologues, Tree building and tree evaluation, Phylogenetic software.
- Comparative Genome Analysis: Introduction, application, genome analysis and annotation.
- Molecular structure Predication and visualization (X-ray crystallography/NMR/Bioinformatics).
- Micro array data analysis.
- Different analysis packages and other Miscellaneous Tools etc.

Practical

1. Introduction to NCBI

- Familiarity with the tools available at NCBI.
- Searching using author's name.
- Retrieval of Sequence in FASTA format.
- Working with Sequences
- From Expasy
- Retrieving list of related proteins
- Retrieving DNA sequences

2. Working with Protein Sequences

- Computing amino acid composition, molecular weight, isoelectric point and other properties.
- Computing hydrophobic / hydrophilic profile
- Predicting antigenic sites
- Locating membrane spanning segments.
- Predicting element of Secondary structure.
- Finding all protein sharing sequence similarity.
- Classifying protein into families.
- Finding best alignment between two or more proteins.
- Finding Evolutionary relationship between protein, Tree Drawing.

3. Analyzing DNA/RNA

- Retrieving DNA sequence from database.
- Computing Nucleotide composition.
- Identifying restriction sites.
- Designing PCR Primer.
- Identifying open reading frames.
- Computing the optimal alignment between two or more DNA sequence.
- Finding Polymorphic sites in genes.
- Assembling sequence fragments.

4. Working with entire Genome.

- Finding which Genome is available.
- Analyzing sequence in relation to specific Genome.
- Locating Gene homologous in a genome.
- Displaying Genomes.
- Parsing a microbial genome sequence (ORF).
- Parsing a eukaryotic genome sequence, GenScan.
- Finding orthologues and Paralogues Genes.
- Discovering unknown Genes.
- Finding Repeats.

Semester IX

1. Course Title: Statistics II

Course Code: MAS-715

Credits: 3(2-0-2)

- Analysis of variance: Definition and assumptions, One way classification, two way classification with more than one observation per cell
- Design Experiments: Principles of experimental design, Randomized Block Design (R.B.D)
- Latin Square Designs (L.S.D), Missing plot technique in R.B.D and L.S.D, Critical difference (C.D), Split plot design.
- Factorial –Experiments : 2², 2³, 2³, 2³ factorial-designs (Yates method of Analysis) 2X3 & 2X4 factorials.
- Durcan's Multiple Range Test. Newman's Kuel's Test
- Sampling Techniques: Simple random sampling, stratified random sampling and Systematic sampling

Practical:

- Analysis variance, Randomized block design

2. Course Title: Genetic Engineering

Course Code: MCE 806

Credits: 3(2-0-2)

- Biology of cloning vectors: Plasmids, cosmids, phagemids, Agrobacterium tumefaciens based vectors, binary and shuttle vectors, enzymes used in genetic engineering, restriction endonucleases, reverse transcriptase, terminal transcriptases, ligases, exonucleases, SI nucleases, kinases, polymerases, alkaline phosphatases
- Principles of recombinant DNA technology: Gene splicing, construction of recombinant DNA selection and screening of desired clones by hybridization method, genetic method and immunological method
- Recombinant DNA expression: Genomic and cDNA libraries, YAC and BAC, expression of heterologous genes in bacteria (E.coli), detection of expression of foreign genes, maximizing the expressions of recombinant DNA applications of recombinant DNA technology
- Gene cloning in mammalian cells: Requirements of gene expression vectors, transient vs. stable expression, reporter gene assays-luciferase, β galactosidase, CAT, selectable and scorable markers, transfection methods, electroporation, protoplast fusion, microinjection.

Practical:

- Digestion of DNA with restriction endonuclease
- Ligation of DNA fragments by ligation reaction
- Preparation of competent cells
- Transformation of bacterial cell with foreign DNA
- Selection of transformed cells by blue white selection techniques

3. Course Title: Food and Dairy Microbiology

Course Code: MBFT 811

Credits: 4(2-0-4)

- Systematic study of major groups of microorganisms of importance in food industry
- Principles and methods of food preservation
- Food spoilage (cereals, vegetables, egg, meat and fish) and its causes
- Food in relation to diseases
- Sources and types of microorganisms in milk
- Starter culture
- Role of microorganisms in the manufacture of milk and milk products
- Microbial spoilage of dairy products and their control
- Principles of Food safety and food hygiene.
- Food regulations, grades and standards, Concept of Codex alimentarius/ HACCP/USFDA/ISO 9000 series etc.

Practical:

- Isolation and identification of microorganisms involved in food spoilage
- Enumeration and diagnosis of food poisoning organisms
- Isolation of microorganisms from milk and milk products and their identification
- Microbiological grading of milk and milk products

4. Course Title: Medical Microbiology

Course Code: MBFT 812

Credits: 4(2-0-4)

- History of medical microbiology
- Host parasite relationship, defence mechanisms of host, immunoglobulins, antigen antibody reactions, complement, toxin and antitoxins
- Hypersensitivity, preliminary knowledge of blood cells and serum
- Pathogenic microorganisms, diseases caused by them, laboratory diagnosis, epidemiology, prevention and treatment
- Principles of chemotherapy, role of antimicrobial agents synthetic compounds and antibiotics, their mechanism of action, drug resistance in bacteria, drug sensitivity tests

Practical:

- Laboratory examination of blood and identification
- Antigen and antibody reactions to identify the serotypes of pathogenic bacteria
- Staining techniques for identification Mycobacterium in sputum
- Biochemical tests for identification of enteric bacteria
- Morphological studies of pathogenic fungi
- Identification of pathogenic bacteria by urine culture
- Drug sensitivity tests

5. Course Title: Agricultural Microbiology

Course Code: MBFT 813

Credits: 3(2-0-2)

- History and development of agricultural microbiology. Microbiota of soil, interrelationship between soil microorganisms and higher plants
- Transformation of nitrogen compound. Nitrogen cycle, symbiotic and non-symbiotic nitrogen fixation. Microbiological methods of evaluation of soil fertility. Biofertilizers

- Degradation of organic residues in soil
- Microbiological control of plant pathogens
- Important diseases of crop plants and their management

Practical:

- Isolation and enumeration of microbes from soil
- Demonstration of different steps in nitrogen cycle
- Isolation of symbiotic and non symbiotic nitrogen fixing bacteria
- Isolation and characterization of PGPR
- Isolation and identification of field and storage fungi from cereal grains and oil seeds
- Isolation of plant pathogenic bacteria and fungi from diseased plants
- Study on important bio-control agents

6. Course Title: Microbial Biotechnology

Course Code: MBFT 814

Credits: 3(2 – 0 – 2)

- History and scope of Biotechnology. Bioreactors: Types of Bioreactors e.g. packed bed, bubble column, air lift, fluidized bed bioreactor, membrane/hollow fiber, photo-bioreactor etc.
- Industrial production of alcohol, glycerol, solvents (acetone, butenol, isopropyl alcohol), vinegar, acids (lactic, citric, gluconic acid), vitamins (Riboflavin, B12), antibiotic (penicillin, streptomycin, tetracycline, griseofulvin) by micro-organisms.
- Concept of various types of fermentation: Batch, continuous, semisolid and solid state etc.
- Methods of enzyme production, their immobilization and application in therapeutic, analytical manipulation and industrial uses.
- Use of microbes in producing SCP, substrates used in producing SCP, their nutritional value.
- Biotransformation

Practical:

- Study of fermentor and fermentor operation.
- Isolation and purification of important microbial enzymes.
- Production of lipase by submerged fermentation.
- Production of lipase by semisolid fermentation.
- Effect of pH and temperature on enzyme production.
- Isolation of yeast from fruit juice and rice flour.
- Quantitative estimation of ethanol produced during yeast fermentation.
- Production of wine from grapes by using yeast
- Citric acid production by solid state fermentation
- Preparation of fungal spore in large scale by bread culture method.
- Immobilization of cell on sodium alginate gel