Vidyasagar University

Midnapore-721102, West Bengal

The SYLLABUS for

POST-GRADUATE Programme

in

MICROBIOLOGY

Under Choice Based Credit System (CBCS)
(Semester Programme)

[w.e.f. 2022-23]

Preamble

Post-graduate (M. Sc.) teaching of Microbiology in Vidyasagar University was initiated in the year 2001 under the Faculty of Science, and later a full-fledged department was established in the year 2004. The Microbiology Department started the Ph.D. programme as well in 2008. The Department is now well established, with four sanctioned faculty strengths. Extramural grants from DBT, DST, ICMR, CSIR, UGC, and DRDO, as well as intramural grants from the University, have strengthened the Department's research. The infrastructure facility of this department is quite good. Neat and clean lecture gallery, laboratory rooms, instrument room, faculty rooms and a big computer with bioinformatic facility fulfil up-to-date standards of this department. The M.Sc. The microbiology programme offered by the University is two years' duration and is divided into four semesters. The Choice-Based Credit System (CBCS) was initiated in 2018. The courses are assigned credits on the basis of teaching hours, which in turn is linked to course content and structure The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, seminars, community and industrial survey.

Program Outcomes (POs)

Post Graduates (M. Sc.) students after completion of the program will be able to achieve:

1. Acquired knowledge for the solution of complex natural and personal problems.
2. Attend profound knowledge to Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions.
3. Attend the ability to design solutions for the public health and safety, and the cultural, societal, and environmental considerations.
4. Understand the impact of the professional solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
5. Learn ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
6. Learn Individual and team work. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
7. Incorporated self-directed and life-long learning.
8. Communicated effectively with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Programme Specific Outcomes (PSOs)

The M. Sc. Microbiology course will help to develop skilled scientific manpower having comprehensive knowledge in microbiology with an understanding of research ethics. After completion of the course the student has:

1. State of art knowledge about various methodological and analytic approaches that are used within the specialization.
2. In-depth knowledge in the structure of a repertoire of microorganisms, metabolism in the cell, knowledge of the concepts of molecular genetics and biosynthesis of proteins, enzymology, physiology, microbial pathogenicity, environmental and agricultural microbiology, genetic engineering, bioengineering and a good theoretical and practical insight into methods used to obtain this knowledge.
3. Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.
4. Knowledge of the leading edge in a chosen specialized area of microbiology, based on own research experience from a master's project and literature review and develop ability to independently carry out a complete scientific work.
5. Can compete in national/international level competitive exams and can pursue career in higher studies.

CONTENT:

SEMESTER	COURSE	COURSE TITLES	FULL MARKS	No. of Lectures (hours)	CREDIT (Lecture – Tutorial - Practical) (L-T-P)
I	MCB 101	***DIVERSITY AND SYSTEMATICS OF PROKARYOTIC MICROBES*** MCB 101.1: BACTERIOLOGY MCB 101.2: VIROLOGY	50 (25) (25)	40	4(3-1-0)
	MCB 102	***DIVERSITY AND SYSTEMATICS OF EUKARYOTIC MICROBES*** MCB 102.1: MYCOLOGY MCB 102.2: PHYCOLOGY	50 (25) (25)	40	4(3-1-0)
	MCB 103	***BIOPHYSICAL AND BIOCHEMICAL PRINCIPLES*** MCB 103.1: BIOPHYSICS & INSTRUMENTATION MCB 103.2: FUNDAMENTAL BIOCHEMISTRY	50 (25) (25)	40	4(3-1-0)
	MCB 104	***MICROBIAL PHYSIOLOGY & METABOLISM*** MCB 104.1: MICROBIAL PHYSIOLOGY MCB 104.2: MICROBIAL METABOLISM	50 (25) (25)	40	4(3-1-0)
	MCB 195	MCB 195.1: ***ENUMERATION & IDENTIFICATION OF MICROBES***	25	20	2(0-0-2)
		MCB 195.2: ***MICROBIAL GROWTH AND PRESERVATION***	25	20	2(0-0-2)
	MCB 196	MCB 196.1: ***ANALYTICAL BIOCHEMISTRY***	25	20	2(0-0-2)
		MCB 196.2: ***REVIEW WORK/CASE STUDY & SEMINAR***	25	20	2(0-0-2)
	TOTAL		**300**	**240**	**24**
II	MCB 201	HOST-PATHOGEN INTERACTION & IMMUNITY MCB 201.1: HOST-PATHOGEN INTERACTION MCB 201.2: IMMUNOLOGY	50 (25) (25)	40	4(3-1-0)
	MCB 202	GENETICS, MOLECULAR BIOLOGY AND GENE REGULATION MCB 202.1: FUNDAMENTAL GENETICS MCB 202.2: MOLECULAR BIOLOGY & GENE REGULATION	50 (25) (25)	40	4(3-1-0)
	MCB 203	BIOMETHEMATICS AND BIOINFORMATICS MCB 203.1: BIOMATHEMATICS MCB 203.2: BIOINFORMATICS	50 (25) (25)	40	4(3-1-0)
	C-MCB 204	*MICROBIAL WORLD (CBCS)* MCB 204.1:BASIC MICROBIOLOGICAL CONCEPTS MCB 204.2: MICROBIAL GROWTH AND IMPACT	50 (25) (25)	40	4(3-1-0)
	MCB 295	MCB 295.1: GROUP PROJECT, REPORT PREPARATION AND	25	20	2(0-0-2)
		MCB 295.2: BIOMATHEMATICS AND BIOINFORMATICS	25	20	2(0-0-2)
	MCB 296	MCB 296.1: VISIT TO INSTITUTE AND PREPARATION OF REPORT	25	20	2(0-0-2)
		MCB 296.2: MICROBIAL GENETICS	25	20	2(0-0-2)
		T	**300**	**240**	**24**
III	MCB 301	CELL BIOLOGY & GENETIC ENGINEERING MCB 301.1: CELL BIOLOGY MCB 301.2: GENETIC ENGINEERING	50 (25) (25)	40	4(3-1-0)
	MCB 302	AGRICULTURAL AND MEDICAL MICROBIOLOGY MCB 302.1: AGRICULTURAL MICROBIOLOGY MCB 302.2: MEDICAL AND DIAGNOSTIC MICROBIOLOGY	50 (25) (25)	40	4(3-1-0)
	MCB 303	FERMENTATION TECHNOLOGY & FOOD MICROBIOLOGY MCB 303.1: FERMENTATION TECHNOLOGY MCB 303.2: FOOD MICROBIOLOGY	50 (25) (25)	40	4(3-1-0)
	C-MCB 304	*ENVIRONMENTAL MICROBIOLOGY (CBCS)* MCB 304.1: MICROBIAL BIODEGRADATION MCB 304.2: MICROORGANISMS : FRIENDS AND FOE	50 (25) (25)	40	4(3-1-0)
	MCB 395	MCB 395.1: DIAGNOSTIC TESTS	25	20	2(0-0-2)
		MCB 395.2: MICROBIAL PATHOLOGY	25	20	2(0-0-2)
	MCB 396	MCB 396.1: AGRICULTURAL MICROBIOLOGY & MOLECULAR	25	20	2(0-0-2)
		MCB 396.2: COMMUNITY SURVEY AND REPORT PREPARATION	25	20	2(0-0-2)
	TOTAL		**300**	**240**	**24**

IV	MCB 401	ECOLOGY & ENVIRONMENTAL MICROBIOLOGY MCB 401.1: ECOLOGY MCB 401.2: ENVIRONMENTAL MICROBIOLOGY	50 (25) (25)	40	4(3-1-0)
	MCB 402	MICROBIAL THERAPEUTICS & BIOSAFETY MCB 402.1: NATURAL THERAPEUTICS MCB 402.2: ADVANCED PRODUCTS AND BIOSAFETY	50 (25) (25)	40	4(3-1-0)
		MCB 493.1 PHARMACEUTICAL & ENVIRONMENTAL	25	20	2(0-0-2)
		MCB 493.2 FOOD & BIOPROCESS TECHNOLOGY	25	20	2(0-0-2)
	MCB 494	MCB 494.1 COMPREHENSIVE VIVA	25	20	2(0-0-2)
		MCB 494.2 INDUSTRY SURVEY AND REPORT PREPARATION	25	20	2(0-0-2)
	MCB 495	PROJECT WORK	100	80	8(0-0-8)
	TOTAL		**300**	**240**	**24**
	GRANT TOTAL		**1200**		**96**

Distinctive Features of the M. Sc. Microbiology Program

SPECIAL FEATURES	COURSE NUMBER	% of total
Value-added content :	**MCB 101.2; 104.1;202**	**8.33**
Employability / entrepreneurship/ skill development :	**MCB 102.1; 103.1; 195; 196; 295.1; 296; 302; 303 ; 495 (8 Credits)**	**37.5**
Digital content:	**MCB 203; 295.2**	**6.25**
Ethics, gender, human values, environment & sustainability:	**MCB101.1; 102.2; 201; 301.2; 304; 401.2**	**16.67**
New course introduced:	**MCB 204; 304**	**8.33**
Field & Industry survey; & academic excursions:	**MCB 296.1 (Institute visit); MCB 396.2 (Community survey); MCB 494.2 (Industry survey)**	**6.25**
Review writing & Project work :	**MCB 196.2; 295.1, 493.1**	**6.25**
Internships :	**MCB 495 (8 Credits)**	**8.33**
Biosafety norms & IPR:	**MCB 301.1, 402.2**	**4.17**

[Few courses are belonging to more than one features listed above]

Semester - I

MCB101: Diversity and Systematics of Prokaryotic microbes

Course Objectives (COBs)

- Knowledge on the theories on the evolution
- Knowledge on character, structure, taxonomy, occurrence and diversity of bacteria and viruses
- Knowledge on the classical and modern methods of identification and estimation of prokaryotes

Course Outcomes (COs)

- Know the process by which the life began
- Understand the systematics, diversity of bacteria and virus
- Understand the distribution of bacteria and virus in nature
- Familiar with the method of enumerate bacteria and virus

MCB 101.1: Bacteriology [25 marks]

1. Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes.
2. General description and classification of bacteria according to Bergey's Manual of Systematic Bacteriology.
3. Recent trends in Microbial Taxonomy: a) Chemotaxonomy: cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition. b) Molecular method: DNA homology, DNA-RNA homology, G + C ratio, rRNA sequencing. c) Numerical taxonomy d) Genetic methods in taxonomy.
4. Archea: systematics, diversity, characteristics, significance, potential application.
5. Unculturable and culturable bacteria- conventional, metagenomic approaches and modern methods of studying diversity.
6. General account of cyanobacteria.

MCB 101.2: Virology [25 marks]

1. Virus evolution and classification, properties of viruses, virus structure. Subviral particles: viroids, virusoids, prions, satellite viruses.
2. Cultivation of plant and animal viruses. Purification and maintenance of viruses. Quantitation of viruses (viral assays).
3. Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral- host interaction, Host response to viral infection. Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses. Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, VSV, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retroviruses.
4. Antiviral agents (chemical and biological) and their mode of actions.

MCB102:Diversity and Systematics of Eukaryotic microbes

Objective

- Knowledge on the classification of algae, fungi and protozoa
- Knowledge on general characters, structure, nutritional and reproductive pattern of algae, fungi and protozoa
- Agricultural and economic importance of algae and fungi or their metabolites

Outcome

- Know the process classification and diversity of algae, fungi and protozoa
- Aware about the structural, reproductive, nutritional diversity of algae, fungi and protozoa
- Understand the importance (beneficial and detrimental) of algae and fungi

MCB 102.1: Mycology [25 marks]

1. Fungi: Implications of molecular and biochemical methods including rRNA gene analysis, RFLP, RAPD and other fingerprinting techniques, fatty acids, polysaccharides and lipids and role of secondary metabolites in systematics.
2. Agriculturally important fungi: Biodiversity, Chemical and biological characterization, fungi in sustainable agriculture with special emphasis on biopesticides.
3. Secondary metabolites from fungi: Terpenes, Non-ribosomal peptides, hydrophobins, peptaibols, indole, alkaloids, detailed emphasis on polyketides.
4. Genomics and Biodiversity of yeast: Gene duplication leading to adaptation and biodiversity, functional evolution, case of aerobiosis/anaerobiosis, changes in regulatory circuits for adaptation to new environments and physiology.
5. Mycorrhiza - ecto, endo, and VA mycorrhiza; applications.

MCB 102.2: Phycology [25 marks]

1. Algae: classification, algal pigments, thallus structure, nutrition, ecology, sexual and asexual reproduction and their importance. Cultivation of algae.
2. Details about green algae, diatom, euglenoids, brown algae, red algae, pyrrophyta, micro-algae.
3. Biotechnological application of algae: Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment.
4. Protozoa: classification, structure, nutrition and reproduction. Characteristics of Flagellates, Amoeboids, Sporozoans and Cilliates.

MCB103: Biophysical and Biochemical Principles

Objective

- Scientific understanding of the principle and application of various instruments, biophysical techniques and sequencing methods
- Basic knowledge about the biomolecules, their structure and the bonds associated with them
- Knowledge on enzyme kinetics and bioenergetics

Outcome

- Familiar with the modern bio-instrumentation and biophysical techniques
- Know the process of enzyme and membrane action
- Acquainted with the basic biomolecules and their structural features

MCB 103.1: Biophysics & Instrumentation [25 marks]

1. Covalent and non-covalent bonds.
2. Properties of water.
3. pH and buffer.
4. Law of thermodynamics, entropy and free energy concept.
5. Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
6. Principle and uses of UV/visible, fluorescence, circular dichroism, Centrifugation techniques. Molecular structure determination using X-ray diffraction and NMR, mass spectrometry. Microscopy: compound, scanning, transmission and electron microscopes. Principle and application of TLC, ion exchange, affinity, reverse phase, gel filtration. High Performance Liquid Chromatography, Gas Chromatography.

MCB 103.2: Fundamental Biochemistry [25 marks]

1. Composition, structure and function of biomolecules [carbohydrates, lipids, nucleic acids, t-RNA, micro-RNA and vitamins].
2. Chemistry of amino acids, four level proteins structure, Ramachandan plot, domain, folds and motifs of protein. Chemical modification of protein. Denaturation and renaturation of proteins structure.
3. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
4. Biophysical energy transduction, bioenergetics, electron transport chain and oxidative phosphorylation.
5. Structure of model membrane, channels and transport mechanisms, electrical properties of membrane, membrane transport system of bacteria.

MCB104: Microbial Physiology & Metabolism

Objective

- Understanding about the growth requirement, growth pattern, method of estimation and control of microbial growth
- Basic knowledge about cell-cell communication, stress responses and signaling of microbes
- Understand the basic metabolic patterns and metabolic diversity of microbes

Outcome

- Familiar with the microbial growth and the associated determinants
- Know the process of cell-cell communication and responses in microbes
- Acquainted with the metabolic diversity and coordinate control of metabolism

MCB 104.1: Microbial Physiology [25 marks]

1. Growth and cell division: growth physiology, cell division, growth yields, growth kinetics, steady state growth, batch and continuous growth. Control of bacterial growth - physical and chemical agents, preservation methods.
2. Cultivation of microbes: aerobic, anaerobic and facultative. Pure culture and its characteristics. Nutritional types, culture media. Measurement of growth (direct and indirect) and factors affecting growth.
3. Physiological adaptation to extreme environmental conditions, Microbial stress responses: Osmotic stress and osmoregulation, Aerobic to anaerobic transitions, Oxidative stress, pH stress and acid tolerance, Thermal stress and heat shock response, Nutrient stress and starvation stress.
4. Intercellular signaling, concept of two component system. Quorum sensing in bacteria, sporulation in *Bacillus subtilis*, mechanism of bacterial competence.

MCB 104.2: Microbial Metabolism [25 marks]

1. Metabolic patterns of photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs.
2. Pathway and regulation of major metabolism - glycolysis (EMP pathway), TCA cycle, glyoxalate cycle, Entner-Daudoroff pathway, pentose phosphate cycle. Fructose-bisphosphate-aldolase pathway; Phosphoketolase pathway. Utilization of sugar other than glucose and complex polysaccharides.
3. Metabolism of energy reserve compounds (polyglycans, polyhydroxybutyric acid).
4. Inorganic nitrogen metabolism. Glutamine, lysine and histidine biosynthesis.
5. Biochemistry of N_2 fixation. Regulation of nitrogenase activity, concept of nif gene.
6. Microbial Photosynthesis.
7. Biosynthesis and metabolism of fatty acids, biosynthesis of phospholipids.
8. Purine and pyrimidine biosynthesis (de novo).

MCB195:

Objective

- Practical idea about the growth of microbes and isolation and handling of microorganisms
- Practical idea about determination of different morphological and biochemical activity of microbes
- Experimental determination of bacterial growth and the factor affects it
- Practical ideal about the structure of important fungi and algae

Outcome

- Able to perform microbial isolation, cultivation and preservation of microbes
- Able to evaluate the morphological and metabolic features of microbes
- Understand the methods of estimation of microbial growth and microbial activity

MCB 195.1: Enumeration & Identification of microbes [25 marks]

1. Enumeration of microorganisms [bacteria and fungi] from soil, water and air using selective media.
2. Identification of bacteria through biochemical tests
3. Identification and study of important taxa of algae and fungi
4. Isolation and enumeration of bacteriophage from sewage sample

MCB 195.2: Microbial growth and preservation [25 marks]

1. Evaluation of alcohol as skin disinfectant, study of effectiveness of hand washing during microbial work
2. Selective, differential and enrichment culture of microbes.
3. Bacterial (cell count, turbidometry, plate count) and fungal (spore count, biomass weight) growth measurement
3. Study of bacterial and fungal growth kinetics and effect of different factors on growth
4. Microbial culture preservation and maintenance

Paper196:

Objective

- Practical knowledge about the working principles and procedure of different techniques and associate instruments
- Practical idea to assay biomolecules and study enzyme kinetics
- Gather scientific information in a specific topic from internet and preparation of coincided review article

Outcome

- Bridge the gap between academics and application of various instruments in scientific experiments.
- Able to determine qualitative and quantitative estimation of biomolecules, perform enzyme assay at varied condition and determine the kinetic parameters
- Able to write an article by collecting all information from various resources and present the report

MCB 196.1: Analytical Biochemistry [25 marks]

1. Demonstration of analytical instruments (principles and applications) available in the Department as well as in USIC of VU.
2. Estimation of total protein, carbohydrate, DNA and RNA of a bacterial cell.
3. Chromatography: Paper, TLC for sugar / lipid / amino acid.
4. Determination of activity of amylase/ protease. Effect of pH, temperature on enzyme activity. Determination of Km and Vmax.
5. Purification of protein (demonstration only).
6. Determination of molecular weight of protein by PAGE.
7. Study of enzyme by native gel electrophoresis (zymogram).
8. Demonstration of 2D – gel electrophoresis and Gel documentation system.

MCB 196.2: Review work/case study & Seminar [25 marks]

Semester - II

MCB201: Host-pathogen interaction & Immunity

Objective

- To provide knowledge about pathogen, their mode of infection and pathogenesis both plant and animal
- To understand the process of disease resistance and concept of immunity
- To know various components and phenomena associated with immunity

Outcome

- Familiar with the concept of disease development
- Students acquire the information about immunity development
- Able to understand the immunological reactions

MCB 201.1: Host-pathogen interaction [25 marks]

1. Host range of pathogens, Koch's rules; parasitism and pathogenicity, Recognition and entry processes of different pathogens into host cells, chemical weapons of pathogens.
2. Mechanism of tissue injury in relation to microbial infection: direct damage by microorganisms, microbial toxin, enzymes and indirect damage through inflammation,
3. Microbial strategies in relation to immune response, virus-induced cell transformation, cell-cell fusion in both normal and abnormal cells.
4. Stages in the development of disease. Biofilm formation, Recovery from disease, tissue repair and resistance to infections.

MCB 201.2: Immunology [25 marks]

1. Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes.
2. Inflammation; Humoral and cell-mediated immune responses.
3. Structure and function of antibody molecules, generation of antibody diversity, antibody engineering, antigen-antibody interactions.
4. Concept of - a) lymphoid organs, b) primary and secondary immune responses, c) antigen processing and presentation, d) major histocompatibility complex (MHC) antigens, e) Toll-like receptors, f) complement systems, g) Transplantation, h) Hypersensitivity, i) Tolerance and autoimmunity, j) Immunosuppression, and k) congenital and acquired immunodeficiencies.
5. Comparative immunology from fish to mammals.

MCB202:Genetics, Molecular biology and Gene regulation

Objective

- To provide knowledge on the genetic principles and chromosome
- To understand the principles of gene transfer, mutation and repair
- To learn gene regulation and expression mechanisms

Outcome

- Receive elaborate knowledge on classical genetics and chromosomal organization
- Get thorough knowledge on gene transfer mechanisms in microbes
- Better understanding about gene regulation, mutation and repair

MCB 202.1: Fundamental Genetics [25 marks]

1. Basic principles of Heredity, deviation of Mendelian inheritance, gene interaction, pleiotropy, sex-linked and autosomal linked characters, dosage compensation. population genetics.
2. Type of DNA (A, B & Z). Law of DNA constancy, C value paradox and genome size. Chromosome structure and organization. Heterochromatization. Extra chromosomal genetic material. Transposable elements – types and function.
3. Molecular mechanism of recombination. Linkage and genetic mapping.
4. Bacterial gene transfer mechanisms and mapping: conjugation, transformation, transduction. Significance of horizontal gene transfer.
   Complementation (cis-trans) test.

MCB 202.2: Molecular Biology & Gene regulation [25 marks]

1. Molecular mechanism of DNA replication, transcription and translation. Post transcriptional (capping, polyadenylation, splicing, intron and exons) and post translational modification.
2. DNA damage and repair: photoreactivation, excision – BER and NER, recombination. SOS repair, mismatch, Methyl-directed mismatch repair.
3. Site directed mutagenesis. siRNA, microRNA and RNAi mediated gene silencing.
4. Regulation of prokaryotic gene expression: lac and trp operon. Lytic & lysogenic regulation in phage and virus.
5. Regulation of gene expression in Eukaryotes. Epigenetics.

MCB203: Biomathematics and Bioinformatics

Objective

- To understand the application of statistical principles in biological data analysis
- To learn mathematical modeling of microbial growth and control
- An in-depth study on bioinformatics, microbial genomics and proteomics

Outcome

- Receive idea how to validate biological data through statistics
- Acquire knowledge on mathematical modeling of growth kinetics
- Obtain knowledge about the computational tools for analyzing genomic and proteomic data

MCB 203.1: Biomathematics [25 marks]

1. Need for statistical techniques for biological applications. Concept of sample and population, variable, Frequency distribution & its graphical representation
2. Measurement of central tendencies, standard deviation, co-efficient of variation, standard error of biological data.
2. Statistical analysis of biological data: Testing of significance, t-test, chi-square test, Simple correlation and regression
3. Mathematical modeling of bacterial growth, fermentation, control of microorganism.

MCB 203.2: Bioinformatics [25 marks]

1. Introduction to bioinformatics.
2. Biological sequence database, sequence comparison, pairwise alignment, multiple alignment, database searching, algorithms of FASTA and BLAST, molecular phylogeny.
3. Mutation matrix and its application.
4. Ligand-protein interaction.
5. System biology: approaches and application.

MCB204:Microbial world (CBCS) [50 marks]

Objective

- To know the contribution of pioneer worker in microbiology
- To learn about microbial diversity and their habitat
- To provide knowledge about the applicative potential of microbes

Outcome

- Receive idea about the historical foundation of microbiology
- Acquire knowledge on microbial growth at varied habitat and in laboratory
- Obtain knowledge about real life applications of microbes

MCB 204.1: [25 marks]

1. Contribution of pioneer workers in the field of microbiology.
2. General characteristics, structure and function of different types of microorganisms.
3. Basic instruments in microbiological study.
4. Different types of techniques of control of microbial growth.

MCB 204.2: [25 marks]

1. Preparation of media, Isolation, and cultivation of microbes (autotrophs, heterotrophs, aerobes, anaerobes etc.)
2. Microbial growth and its measurement. Factors affecting microbial growth.
3. Impacts of microbes towards plant and animal kingdoms.
4. Concept of biosafety in microbiological laboratory

MCB295:

Objective

- To perform collective research work and learn the art of report writing
- To learn computerization of data and statistical analysis of biological data
- Hands-on exercise on basic tools of bioinformatics

Outcome

- Able to gather experience to carry out planned research work and capable to write report
- Capable to computerize biological data and validate the same through statistics
- Able to analyze biological information through bioinformatics

MCB 295.1: Group project, report preparation and seminar [25 marks]

MCB 295.2: Biomathematics and Bioinformatics [25 marks]

1. Operation Microsoft word, Microsoft excel, Microsoft Power Point and internet.
2. Preparation of graph of experimental data using MS Excel/software.
3. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
4. Database searching, pairwise alignment – global and local, multiple sequence alignment, construction of phylogenetic tree, evaluation of secondary structure of protein, homology modelling.

MCB296:

Objective

- Receive idea about the research goal and focus of an research institute and interact with the scientists/researchers
- Practical learning of basic tools and techniques of microbial genetics

Outcome

- Gather knowledge on research planning and execution of any research institute
- Able to gather knowledge about the principles and processes to analyze nucleic acid and protein

MCB 296.1: Visit to Institute and preparation of report [25 marks]

MCB 296.2: Microbial genetics [25 marks]

1. Isolation of mutant (UV/ NTG / HNO_2/Dyes).
2. DNA isolation (plasmid & chromosomal).
3. Agarose gel electrophoresis for DNA.
4. Study of transformation and transduction process (demonstration only).
5. Induction of β–galactosidase in *E. coli*.
6. Demonstration of DGGE.

Semester - III

MCB301:Cell Biology & Genetic Engineering

Objective

- To learn about the various aspects of cell science and cell culture
- To know the principle, process and applications of various tools and techniques used in genetic engineering
- Making aware about the applications of recombinant products/organisms

Out come

- Students come out with basic ideas on molecular basis of cell science
- Enable them to know about the tools and techniques of DNA manipulation
- Familiar in the construction of recombinant product

MCB 301.1: *Cell Biology* [25 marks]

1. Structure, function and assembly of cellular and organic components in prokaryotes/ eukaryotes.
2. Cell division and cell cycle: mitosis and meiosis, their regulation, steps in cell cycle and control, check points of cell cycle.
3. Programmed cell death(apoptosis), ageing and senescence.
4. Molecular basis of signal transduction in prokaryotes (quorum sensing) and eukaryotes, General principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission.
5. Cancer and molecular mechanism of oncogenesis.
6. Concept of animal cell culture, Stem cell and its applications.

MCB 301.2: *Genetic Engineering* [25 marks]

1. Principles and procedures of protein and nucleic acid sequencing, southern, northern and western blotting, polymerase chain reaction: types and applications, gel electrophoresis. Automated DNA sequencing, pyrosequencing. RFLP and RADP analysis.
2. Techniques : Microarrays, Interaction between DNA-Protein, and protein-protein.
3. Cloning – restriction enzyme and mapping, joining of DNA fragments, construction of chimeric DNA, molecular probes. Vehicles for gene cloning, Shuttle and Expression vector.
4. Construction and screening of genomic and cDNA libraries. Isolation and selection of suitable gene – from known specific proteins or coding for unknown product, colony hybridization, chromosome walking, exon-trapping.
5. Application of genetic engineering - in medicine, agriculture, forensic science, environment.
6. Ethical issues in genetic engineering.

MCB302:Agricultural and Medical Microbiology

Objective

- To create awareness on plant-microbe interactions
- To give knowledge on biofertilizers and biopesticides
- To inculcate on medical microbiology, vaccines and diagnostic principles

Outcome

- Acquire knowledge on soil microbiology and plant microbe interaction
- Understand the recent trends of biofertilizers and biopesticides
- Able to know about principles vaccination, common disease causing microbes and diagnostics

MCB 302.1: Agricultural Microbiology [25 marks]

1. Plant-microbe interactions, Endophytic organisms, Importance and role of different rhizosphere and phyllosphere microorganisms.
2. Biofertilizer: Types, production and application (*Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, phosphate solubilising microorganisms, Azolla*). Liquid biofertilizer. PGPR. Carrier-based inoculants - production and applications.
3. Biopesticides – types and applications (*Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viridae*, Nuclear Polyhedrosis Virus). Integrated pest management.
4. Role of microbes in composting, vermicomposting and biogas production.
5. Plant diseases: Different plant pathogenic microorganisms and their pathogenesis. Enzymes and toxins in plant diseases, phytoalexins. Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants.
6. Concept of plant tissue culture, micropropagation and protoplast technology.

MCB 302.2: Medical and Diagnostic Microbiology [25 marks]

1. Disease control by vaccination, national vaccination schedules. Types of vaccine: live microorganism, attenuated organism, genetically modified organism, protein, edible, synthetic, naked DNA, recombinant and anti-idiotype vaccine. Hazards of immunization.
2. Monoclonal antibody - production and application.
3. AIDS: HIV testing, vaccine design.
4. Immunohaematology – blood groups, blood transfusion and Rh incompatibilities.
5. Epitope design and its application in immunodiagnosis tests. Immunotechniques – agglutination, precipitation, complement fixation, immunoflurosence, ELISA, RIA, Western blot, FACS. Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH, immunohistochemical methods.
6. Epidemiology, symptomatology. General description of microbial pathogens, diagnosis, prevention and therapy of - meningitis, tuberculosis, leprosy, urinary tract infection, cholera, ring-worm, syphilis, diphtheria, mycotoxicosis, opportunistic fungal pathogens, dermatophytes, malarial parasite, *Giardiasis*, *Leishmaniasis* and Covid-19.

MCB303:Fermentation Technology & Food Microbiology

Objective

- To give knowledge on fermenter and fermentation
- To learn about upstream and downstream fermentation process
- To understand about microbes in food, their beneficial and detrimental effects

Outcome

- Students will get knowledge on strain improvement
- Enable them to work in fermentation industry
- Students will get idea on food fermentation, spoilage and quality assurance

MCB 303.1: Fermentation Technology [25 marks]

1. Industrially important strain and their development, types of fermentation and fermenters, bioreactor configurations, monitoring and control of bioreactors, Batch, fed-batch, and continuous operation of bioprocess.
2. Sterilization of bulk medium and bioreactor.
3. Fluid flow and mixing: classification of fluids, viscosity, non-Newtonian fluids, Rheological properties of fermentation broth; heat transfer; mass transfer: molecular diffusion, oxygen uptake in cell culture, oxygen transfer in fermentor and measurement of oxygen transfer coefficient.
4. Bioprocess engineering: Bioprocess development; stoichiometry of growth and product formation; energy balances: basic energy concept, energy balance equation for cell culture. homogeneous and heterogenous reactions.
5. Factors depending on scale up process of fermentation. Different techniques association with downstream processing.
6. Solid-state fermentation: process and application.
7. Immobilization techniques : cell and enzyme. Industrial applications of immobilization: merits and demerits.

MCB 303.2: Food Microbiology [25 marks]

1. Microorganisms associated with food (milk, meat, fish, cereals, vegetables and fruits).
2. Spoilage of foods and factors governing the spoilage
3. Food preservation methods: physical, synthetic, natural and biological.
4. Microbial food processing: role of indicating microorganisms like lactic acid and other bacteria, yeast and molds. Starter cultures.
5. Lactic acid, acetic acid, citric acid, bacterocins and other metabolites, their applications.
6. Fermented food: Production and beneficial effects.
7. Oriental fermented foods (preparation, microbes and benefits).
8. Food deterioration by mycotoxins. Characteristics of food borne diseases caused by *Clostridium, E. coli, Listeria, Salmonella, Shigella*
9. Current and future implications concerning food safety, hazards and risks.
10. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.
11. Genetically modified foods and their acceptability.

MCB304:Environmental Microbiology (CBCS) [50 marks]

Objective

- To create awareness on microbial roles in environment
- To give knowledge on applied aspects of microbes in environment protection
- To inculcate on beneficial and harmful impact of microbes

Outcome

- Acquire knowledge on environmental microbiology
- Understand the biogeochemical cycles prevail in environment
- Able to know about principles and techniques in waste treatment, bioremediation etc.

MCB 304.1:

1. Microbiology of soil, water and air. Waste treatment: waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments.
2. Biomagnifications, Eutrophication, Bioremediation of Xenobiotics (PCB, TNT), biodegrdation of hydrocarbon, bioventing, bioaugmentation.
3. Bioleaching of metals

MCB 304.2:

1. Airborne microbes and its control, metal-microbes interaction (biomining).
2. Biofertilizers and biopesticides. Basic principles of microbiology for production of alternative fuels (Biodiesel).
3. Health hazards and microbial infections, human transmitted diseases.

MCB395:

Objective

- To provide technical knowledge on collection and processing of blood
- To prepare them to work in clinical laboratory
- To learn the technique for isolation and identification of pathogens

Outcome

- Get practical knowledge in blood collection and processing
- Become technically expert which will helpful to work in clinical laboratory
- Able to identify pathogenic organisms

MCB 395.1: Diagnostic tests (25 marks)

1. Separation and characterization of blood cell.
2. Estimation of TC & DC.
3. Separation of macrophage and examination of phagocytosis.
4. Ouchterlony double diffusion technique.
5. Quantification of immunoglobulins by ELISA.
6. Precipitation techniques: immunodiffusion, immuno electrophoretic method.
7. Agglutination reactions : Widal, Haemagglutination, Haemagglutination Inhibition
8. Estimation of blood sugar, urea, SGOT & SGPT.

MCB 395.2: Diagnostic microbiology (25 marks)

1. Characterization of *E. coli, P. aeruginosa, S. aureus, Salmonella* sp. by biochemical tests.
2. Identification of pathogenic fungi *Aspergillus niger* and *Candida albicans*.
3. Enumeration and identification of microbes associated with urine / pus.
4. Antibiotic sensitivity of microbes associated with urine / pus.
5. Study of resident and pathogenic microbes of skin and oral cavity.
6. Study of pathogenicity of *Staphylococcus aureus* by coagulase test.

MCB396:

Objective

- To familiarize in soil and agricultural microbiology techniques
- To learn the plant pathogens and identification of infected plant parts
- To know about microbial aspects of community survey
- To perform collective research work and learn the art of thesis writing

Out come

- Expertise in basic techniques of microbiology and biochemistry
- Knowledge in the analysis and estimation of soil nutrients
- Able to carry out survey to understand community based infectious diseases
- Experience to execute planned research work which help to grow up research mind

MCB 396.1: Agricultural Microbiology & Molecular biology [25 marks]

1. Production of vermicompost. Enumeration of microbes and level of N, P, & K before and after composting.
2. Isolation of VAM spores from soil and its study.
3. Isolation and cultivation and application of *Rhizobium, Azotobacter.*
4. Study of N_2 fixing capacity of microbes using gas chromatography (demonstration).
5. Production and estimation of IAA from microorganism.
6. Isolation of endophytic fungi and fungal pathogen from plant specimen.
7. Comparative study of stomatal frequency of normal and virus infected plants.
8. Restriction digestion of bacterial DNA and analysis of restriction fragments.
9. Amplification of DNA/RNA by PCR.

MCB 396.2: Community survey and report preparation [25 marks]

Semester - IV

MCB401:Ecology & Environmental Microbiology

Objective

- To create awareness on ecosystem and ecosystem management
- To inculcate on environmental microbiology
- To provide students a basic understanding on role of microbes in environment pollution management

Outcome

- Acquire knowledge on environmental ecology, biodiversity and energy flow
- Understand the biogeochemical cycles prevail in environment.
- Able to know about principles and techniques in waste treatment, bioremediation etc.

MCB 401.1: Ecology (25 marks)

1. Concept of ecosystem and ecosystem management, trophic structure of the ecosystem; ecotone and edges; ecosystem diversity; classification of ecosystems; stability of ecosystem; examples of ecosystem: A pond; agro-ecosystem.
2. Energy flow through ecosystem, Concept of productivity; energy partitioning in food chain and food webs;
3. Population properties, population growth curve, density dependent and density independent mechanism of population regulation. Concept of habitat and niche, r and k selection.
4. Types of interactions between two species; co-evolution. Biodiversity.
5. Idea of different biomes.
6. Principles of conservation, major approaches to management.

MCB 401.2: Environmental Microbiology (25 marks)

1. Extremophile: anaerobes, halophiles, acidophile, alkalophile, thermophile, barophile; Community structure and organization. Effect of heavy metal and xenobiotic substances on microbes; biological magnification of toxic substances. Microbial deterioration of paper, leather, wood, textile, stone and monument.
2. Aeromicrobiology: Microbes of indoor and outdoor environment, pathways, enumeration, Extramural and intramural, control, bioterrorism. Eutrophication, Biosafety.
3. Water microbiology: Significance of microbes in water quality. Test for portability of water. Microbial treatment of sewage; application of wastewater in land; composting of biosolids and domestic solid waste. Microbes related to fish growth. Common microbial diseases of fish.
4. Marine microbes and their applications.
5. Microorganism and metal pollutants; biodegradation of TNT, PCB; Bioremediation: bioventing, biofiltration, bioaugmentation, problems and advantages.
6. Bioleaching: mineral extraction, oil recovery.

MCB402:Microbial Therapeutics & Biosafety

Objectives

- To understand the basics of drug action
- To understand different microbial products of pharmaceutical importance
- To create knowledge on nanoparticles and nanomedicine

Outcomes

- Have well versed with the different microbial products used in pharmaceutical applications
- Better understanding of good laboratory practices and regulations for utilizing microbial product in pharmaceutical applications
- Understand the concept of natural therapeutics

MCB 402.1: Natural Therapeutics [25 marks]

1. Molecular principles of drug targeting.
2. Drug delivery system: concept of pharmacokinetics and pharmacodynamics.
3. Antibiotics (antibacterial and antifungal): classification, mode of action
4. Production of therapeutic agents from microbial origin: steroid, antibiotics, recombinant proteins, enzymes, vitamins, lactic acid, phenolics, sugar, etc.
5. Mushroom: nutraceuticals, cultivation, toxins.
6. Probiotics: Characteristics of Probiotics organism, application for curing enteric disease and induction of host immunity. Functional properties of probiotics, prebiotics and synbiotics.
7. Microbial diseases in fisheries, poultry and dairy sector, and control by applications of microbes and/or their metabolites.

MCB 402.2: Advanced products and Biosafety Norms [25 marks]

1. Advances and applications of nanotechnology. DNA based nano-structure, organic and inorganic (homo and hetero) nano-particles. Microbial synthesis of nanoparticles, uses of nanoparticles in agriculture and Medicine. Toxicity of nanoparticles.
2. Biosensor : principle and applications.
3. Drug resistance in Bacteria and its effect in the society.
4. QA and QC in manufacturing and in process control of pharmaceuticals.
5. Biosafety - requirements, decontamination and waste management, risk assessment, biosafety rules in India.
6. Biorisk management, laboratory biosecurity, code of conduct, code of ethics, code of practice, international biosecurity issues.
7. Concept of intellectual property right (IPR).

MCB493:

Objective

- To provide technical knowledge on collection and processing of environmental samples
- To prepare them to work in bioprocess industry
- To learn the technique for isolation and application of industrially important microbes.

Outcome

- Get practical knowledge in specimen collection and processing
- Become technically expert which will helpful to work in water industry
- Able to identify a bioactive microbe.

MCB 493.1: Pharmaceutical & Environmental Microbiology [25 marks]

1. Research proposal writing
2. Demonstration of maintenance of biosafety in microbiology lab.
3. Sterility testing of a pharma product.
4. Isolation of antibiotics producing microbes.
5. Testing of water sample to determine total microbial and coliform bacterial (total and fecal) load in the different places of urban/ rural locality.
6. Determination of Biochemical Oxygen Demand (BOD) of water.

MCB 493.2: Food & Bioprocess Technology [25 marks]

1. Isolation and characterization of microorganisms from fermented foods.
2. Production of alcohol by fermentation from molasses.
3. Preparation of baker's yeast using molasses.
4. Measurement of endotoxin in food products.
5. Production of curd with respect to microbial load and organic acid formation.
6. Determination of microbial contamination and pasteurization efficiency of milk.
7. Microbial production of amylase (Solid & Submerged fermentation).

MCB494:

Objective

- To acquire knowledge on subject microbiology reading and to face a interview board
- To understand the usefulness of microbes in industry
- To understand how an industry maintain the environment and product quality.

Outcome

- Acquire overall knowledge on the subject and experienced how to face a interview board
- Impart knowledge of their service sectors.
- Knowledge on industrial system including production, processing and environment.

MCB 494.1: Comprehensive Viva [25 marks]

MCB 494.2: Industry Survey and report preparation [25 marks]

MCB495:Projectwork (100 marks)

Objective

- To acquire knowledge on how to solve a problem
- To understand the review writing, data collection, processing and presentation.
- To expertise on the presentation of a report.

Outcome

- Acquainted with a research environment
- Impart knowledge to write a thesis.
- Acquire knowledge how to .write a manuscript / thesis.

[Students have to complete their training cum dissertation work in different national institutes/ Laboratories / Universities / industries within tenure of 3 months]