# Vidyasagar University

Post Graduate Syllabus

in

***Microbiology***

under Choice Based Credit System

(CBCS)

[ w.e.f.: 2018-2019 ]

# Syllabus for the Master of Science Course in

# MICROBIOLOGY

*Effective from 2018-19*

(Semester Based, in CBCS system)

**Vidyasagar University**

Midnapore – 721 102

# Content:

| SEMESTER | COURSE | COURSE TITLES | | FULL MARKS | CREDIT |
|---|---|---|---|---|---|
| I | MCB 101 | DIVERSITY AND SYSTEMATICS OF PROKARYOTIC MICROBES | | 50 | 4 |
| | MCB 102 | DIVERSITY AND SYSTEMATICS OF EUKARYOTIC MICROBES | | 50 | 4 |
| | MCB 103 | BIOPHYSICAL AND BIOCHEMICAL PRINCIPLES | | 50 | 4 |
| | MCB 104 | MICROBIAL PHYSIOLOGY & METABOLISM | | 50 | 4 |
| | MCB 195 | MCB 195.1 | STAINING & IDENTIFICATION | 25 | 2 |
| | | MCB 195.2 | BIOCHEMICAL TESTS & GROWTH | 25 | 2 |
| | MCB 196 | MCB 196.1 | ANALYTICAL BIOCHEMISTRY | 25 | 2 |
| | | MCB 196.2 | GROUP PROJECT | 25 | 2 |
| | TOTAL | | | 300 | 24 |
| II | MCB 201 | HOST-PATHOGEN INTERACTION & IMMUNITY | | 50 | 4 |
| | MCB 202 | GENETICS AND GENE REGULATION | | 50 | 4 |
| | MCB 203 | BIOMETHEMATICS AND BIOINFORMATICS | | 50 | 4 |
| | *C-MCB 204* | *ENVIRONMENTAL MICROBIOLOGY-I (CBCS)* | | 50 | 4 |
| | MCB 295 | MCB 295.1 | REVIEW WORK AND SEMINAR | 25 | 2 |
| | | MCB 295.2 | BIOMATHEMATICS AND BIOINFORMATICS | 25 | 2 |
| | MCB 296 | MCB 296.1 | VISIT TO INSTITUTE AND PREPARATION OF REPORT | 25 | 2 |
| | | MCB 296.2 | MICROBIAL GENETICS AND MOLECULAR BIOLOGY | 25 | 2 |
| | TOTAL | | | 300 | 24 |
| III | MCB 301 | CELL BIOLOGY & GENETIC ENGINEERING | | 50 | 4 |
| | MCB 302 | AGRICULTURAL AND MEDICAL MICROBIOLOGY | | 50 | 4 |
| | MCB 303 | BIOPROCESS & FOOD MICROBIOLOGY | | 50 | 4 |
| | *C-MCB 304* | *ENVIRONMENTAL MICROBIOLOGY-II (CBCS)* | | 50 | 4 |
| | MCB 395 | MCB 395.1 | DIAGNOSTIC TESTS | 25 | 2 |
| | | MCB 395.2 | MICROBIAL PATHOLOGY | 25 | 2 |
| | MCB 396 | MCB 396.1 | AGRICULTURAL MICROBIOLOGY | 25 | 2 |
| | | MCB 396.2 | COMMUNITY SURVEY AND PREPARATION OF REPORT | 25 | 2 |
| | TOTAL | | | 300 | 24 |
| IV | MCB 401 | ECOLOGY & ENVIRONMENTAL MICROBIOLOGY | | 50 | 4 |
| | MCB 402 | ADVANCED MICROBIOLOGY | | 50 | 4 |
| | | MCB 493.1 | ENVIRONMENTAL MICROBIOLOGY | 25 | 2 |
| | | MCB 493.2 | BIOPROCESS TECHNOLOGY | 25 | 2 |
| | MCB 494 | MCB 494.1 | COMPREHENSIVE VIVA | 25 | 2 |
| | | MCB 494.2 | INDUSTRY SURVEY | 25 | 2 |
| | MCB 495 | PROJECT WORK | | 100 | 8 |
| | TOTAL | | | 300 | 24 |
| | GRAND TOTAL | | | 1200 | 96 |

# Semester - I

## MCB 101 : Diversity and Systematics of Prokaryotic microbes

### Gr. A: Bacteriology [25 marks]

1. Origin of basic biological molecules; Abiotic synthesis of organic monomers andpolymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell;Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes.
2. Introduction to microbial taxonomy – morphological taxonomy, biochemical taxonomy, and molecular taxonomy. Numerical taxonomy – basic concepts oftaxonomy.
3. Chemotaxonomy - fatty acid, protein finger printing ,Isozyme typing, pigments & polyamines. Biochemical phylogeny. Molecular taxonomy –- G +C content, DNA – DNA hybridization, Plasmid profiles, RFLP, RAPD, STRR & LTRR, REP –PCR, DNA fingerprinting method based on 16SrRNA
4. Archea: systematics, diversity, characteristics, significance, potential application.
5. General discussion on the occurrence, diversity, characteristic features, significance of various groups of bacteria according to Bergey's Manual of Systematic Bacteriology.
6. Unculturable and culturable bacteria- conventional, metagenomic approaches and modern methods of studying diversity.
7. General account of cyanobacteria.

### Gr. B: 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.

## MCB 102: Diversity and Systematics of Eukaryotic microbes

### Gr.A : Mycology [25 marks]

1. Fungi: Implications of molecular and biochemical methods including rRNAgene analysis, RFLP, RAPD and other fingerprinting techniques, fatty acids, polysaccharides and lipids and role ofsecondary metabolites in systematics.
2. Agriculturally important toxigenic fungi: Biodiversity, Chemical and biological characterization of toxicmetabolites, toxigenic 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, functionalevolution, case of aerobiosis/anaerobiosis, changes in regulatory circuits foradaptation to new environments and physiology.
5. Mycorrhiza - ecto, endo, and VA mycorrhiza; applications.

### Gr. B : Phycology [25 marks]

1. Algae: classification, algal pigments, thallus structure, nutrition, ecology, sexual and asexual reproduction and their importance. Culturing media 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.

## MCB 103 :Biophysical and Biochemical Principles

### Gr.A: 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 inbiology, incorporation of radioisotopes in biological tissues and cells, molecularimaging of radioactive material, safety guidelines.
3. Principle and uses of UV/visible, fluorescence, circular dichroism, NMR and ESRSpectroscopy. Centrifugation techniques. Molecular structure determination using X-ray diffraction and NMR,different types of mass spectrometry. Resolving powersof different microscopes, microscopy of living cells, scanning and transmissionmicroscopes. Principle and application of TLC, ion exchange, affinity , reverse phase, gel filtration. High Performance Liquid Chromatography, Gas Chromatography.

### Gr. B: Fundamental Biochemistry [25 marks]

1. Composition, structure and function of biomolecules [carbohydrates, lipids, proteins, nucleic acids (helix (A, B, Z), 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.
6. Protein and DNA sequencing methods.

# MCB104 :Microbial Physiology & Metabolism

### Gr. A: Microbial Physiology [25 marks]

1. Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth.Control of bacterial growth - physical and chemical agents, preservation methods, stress responses.
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 Adaptations and Intercellular signaling: Introduction to two component system, regulatory systemsduring aerobic- anaerobic shifts: Arc, Fnr, Nar, FhlAregulon, response to phosphate supply: The Pho regulon
   - Heat-Shock responses
   - pH homeostasis, osmotic homeostasis.
4. Quorum sensing: A and C signaling system, sporulation in Bacillus subtilis, control of competence in Bacillus subtilis.

### Gr. B: 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. Photosynthesis and its mechanism.
7. Biosynthesis and metabolism of fatty acids, biosynthesis of phospholipids.
8. Purine and pyrimidine biosynthesis (de novo).

# MCB 195:

### MCB 195.1: Staining & Identification [25 marks]

1. Preparation of media and cultivation of bacteria, algae, fungi.
2. Qualitative and quantitative enumeration of microorganisms [bacteria and fungi] from soil, water and air.
3. Study of algae: *Diatom, Volvox, Oedogonium, Spirulina,Nostoc,Anabaena*.
4. Study of fungi: *Aspergillus, Candida, Fusarium,Puccinia, Alternaria.*

### MCB 195.2: Biochemical tests & growth [25 marks]

1. Characterization of bacteria: (i) morphological: shape, Gram stain, endo-spore stain, capsule stain, acid-fast stain, (ii) cultural: growth in different carbon source (media); (iii) biochemical test: catalase, peroxidase, IMViC, nitrate reduction, fermentation of sugar.
2. Enrichment culture technique for specific bacterial types: endospore forming, Nitrogen fixing (free living and symbiotic), nitrifying, starch degrading, cellulose degrading, casein degrading, phosphate solubilizing.
3. Study of bacterial growth kinetics, effect of inhibitors and stimulators on growth.
4. Assay of antibiotic

# Paper 196:

### 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.
5. Purification of protein (demonstration only).
6. Determination of MW 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: Group project [25 marks]

# Semester - II

## MCB 201 :Host-pathogen interaction & Immunity

### Gr.A: 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, Mechanism of tissue injury in relation to microbial infection: direct damage by microorganisms, microbial toxin, enzymes and indirect damage through inflammation,
2. Microbial strategies in relation to immune response, virus-induced cell transformation, cell-cell fusion in both normal and abnormal cells.
3. Stages in the development of disease. Recovery from disease, tissue repair and resistance to infections.
4. Plant diseases: Enzymes and toxins in plant diseases, phytoalexins. Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants.

### Gr. B: 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.

## MCB 202 : Genetics and Gene regulation

### Gr. A: 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. C-value paradox. Chromosome structure and organization. Heterochromatization. Extra chromosomal genetic material. Transposons – types and function.
3. Molecular mechanism of recombination. Linkage and genetic mapping.
4. Bacterial gene transfer and mapping: conjugation, transformation, transduction. Complementation (cis-trans) test.

### Gr. B: 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.

## MCB 203: Biomathematics andBioinformatics

### Gr. A: Biomathematics [25 marks]

1. Definition of sample and population, concept of variable, Frequency distribution & its graphical representation, Recapitulation of mean, median, mode, standard deviation, standard error.
2. Tests of statistical significance. Simple correlation and regression, t-test, Analysis of variance.
3. Mathematical modeling of bacterial growth curve, fermentation, control of microorganism.

### Gr. B: 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

## MCB 204 : Environmental Microbiology-I (CBCS)[50 marks]

1. Contribution of pioneer worker (Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff and Edward Jenner) in the field of microbiology. Basic structure and function of microorganisms.
2. Familiarity with the science of microbiology and its significance in everyday life: Microorganisms drive the biogeochemical cycles that sustain all living things, and can be used to ameliorate environmental degradation, in food industry/ biotechnology.
3. Microbial habitats and mechanism of their survival (terrestrial, aquatic, and extreme conditions).
4. Preparation of media, Isolation, and cultivation of microbes (autotrophs, heterotrophs, aerobes, anaerobes etc.), sterilization techniques (Physical and chemical methods), Pasteurization.
5. Microbial contribution in i) biofuel production; ii) changes in global climate; iii) pollutant degradation.

## MCB 295 :

### MCB 295.1: Review work 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 and other softwares.
3. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
4. Pair wise alignment, multiple alignment and data-base searching.

## MCB 296:

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

### MCB 296.2: Microbial genetics and molecular biology [25 marks]

1. Isolation of mutant (UV/ NTG / $HNO_2$/ Dyes).
2. DNA isolation (plasmid & chromosomal).
3. Agarose gel electrophoresis for DNA.
4. Amplification of DNA / RNA by PCR.
5. Restriction analysis of bacterial DNA.
6. Study of transformation and transduction process.
7. Induction of β –galactosidase in *E. coli*.
8. Demonstration of DGGE.

# Semester - III

## MCB 301: Cell Biology &Genetic Engineering

### Gr. A: 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.

### Gr. B: Genetic Engineering [25 marks]

1. Principles and procedures of protein and nucleic acid sequencing, southern, northern and western blotting, polymerase chain reaction,RT –PCR, real time PCR, gel electrophoresis, chemical synthesis of gene. Automated DNA sequencing, pyrosequencing. RFLP and RADP analysis.
2. Techniques : Microarrays, Interaction between DNA-Protein DNA-bimolecules, andprotein-protein.
3. Isolation and selection of suitable gene – from known specific proteins, with tissue specific expression, coding for unknown product, transposon tagging, mutant complementation, chromosome walking, exon-trapping
4. Cloning – restriction enzyme and mapping, joining of DNA fragments, construction of chimeric DNA, molecular probes. Construction and screening of genomic and cDNA libraries. Vehicles for gene cloning, Shuttle and Expression vector.
5. Application of genetic engineering - in medicine, agriculture, forensic science, environment.

## MCB302 : Agricultural and Medical Microbiology

### Gr. A: Agricultural Microbiology [25 marks]

1. Plant-microbe interactions –Endophytic organisms, Common plant pathogenic bacteria, virus and fungus.
2. Beneficial association between plant and microorganisms. Different symbiosis including rhizosphere and phyllosphere microorganisms and their effect.
3. Important roles of soil microbe: nutrient transformations, organic matter cycling, biogeochemical cycles, $N_2$ cycling.
4. Biofertilizer: Types, production and application (*Rhizobium, Azotobacter, Azolla*). Liquid biofertilizer.

5. Biopesticides – type , production (BT) and application. *Trichoderma* as biocontrol agent.
6. Microbes in composting: Farmyard manure, Method of composting (aerobic, anaerobic), enrichment of compost with microbial inoculants. Super digested compost, biogas production.
7. Vermiculture: Vermiculture process, Vermicomposting materials, Advantages of vermicompost.
8. Concept of plant tissue culture, micropropagation and protoplast technology.

### Gr. B: 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, *Giardia* and *Leishmania*.

## MCB 303: Bioprocess& FoodMicrobiology

### Gr. A: Fermentation Technology [25 marks]

1. Types of Fermentation; bioreactor configurations: stirred tank, bubble column, airlift reactor, stirred and air driven reactors, packed bed, fluidized bed, trickle bed; monitoring and control of bioreactors; Ideal reactor operation: batch, fed-batch, and continuous operation.
2. Sterilization of bulk medium and fermentor.
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 ($k_La$), measurement of $k_La$.
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.
6. Down stream processing: filtration, centrifugation, cell disruption, ideal stage concept, aqueous two-phase liquid extraction, adsorption, chromatography;
7. Solid-state fermentation : process and application.
8. Immobilization techniques : cell and enzyme

### Gr. B: 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.

## MCB 304: Environmental Microbiology-II(CBCS) [50 marks]

1. Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments.
2. Biomagnifications, Eutrophication, Bioremediation of Xenobiotics (PCB, TNT) and biodegrdation of hydrocarbon, bioventing, bioaugmentation.
3. Basic principles of microbiology for production of alternative fuels (Biodiesel).
4. Air pollutants and its control, metal-microbes interaction (biomining).
5. Biofertilizers (compost, vermicompost) and biopesticides (BT), biosafety issue
6. Health hazards and microbial infections, human transmitted diseases.

## MCB 395:

### 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: Microbial pathology (25 marks)

1. Characterization of *E. coli, P. aeruginosa, S. aureus, Salmonella* sp. by biochemical tests.
2. Identification of pathogenic fungi *Aspergillusniger* and *Candida albicans*.
3. Enumeration and identification of microbes associated with urine / pus.
4. Antibiotic sensitivity of microbes associated with urine / pus.

# MCB 396:

## MCB 396.1: *Agricultural Microbiology* [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 study of Mycorrhiza.
3. Isolation and cultivation and application of *Rhizobium, Azotobacter.*
4. Measurement of $N_2$ fixing capacity of microbes using gas chromatography / total $N_2$ estimation by Kjeldahl method.
5. Anatomical and microbial study of legume nodule.
6. Production and estimation of IAA from microorganism.
7. Isolation of fungal pathogen from diseased plant specimen.
8. Study of virus infected plants: study of inclusion bodies in viral infected plants; study of stomatal nature in virus-infected plants; biochemical tests for plant pathogens.
9. Identification of pathological plant specimen (Demonstration of sheet preparation).

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

# Semester - IV

## MCB 401: Ecology& Environmental Microbiology

### Gr. A: Ecology (25 marks)

1. Concept of ecosystem and ecosystem management, trophic structure of the ecosystem; ecotones and edges; ecosystem diversity; classification of ecosystems; stability of ecosystem; examples of ecosystem: A pond; agroecosystem.
2. Energy flow through ecosystem, energy environment. 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.

### Gr. B: Environmental Microbiology (25 marks)

1. Extremophile: anaerobes, halophiles, acidophile, alkalophile, tharmophile, 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.

## MCB 402: Advanced Microbiology

### Gr. A: 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: 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. Utilization of probiotics in different sectors: humans, fish culture, and poultry etc. Functional properties of probiotics, prebiotics andsynbiotics
7. Drug resistance in Bacteria and its effect in the society

### Gr. B: Advanced bioproducts and 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.
2. Antibacterial and antifungal nanoparticles, toxicity of nanoparticles.
3. Biosensor : general idea.
4. Production of biopolymer (dextran, alginate, pullunan, xanthan gum, PHB) and bioplastic.
5. Steroid biotransformation for preparation of useful drugs.
6. QA and QC in manufacturing and in process control of pharmaceuticals.
7. Concept of intellectual property right (IPR).

## MCB 493:

### MCB 493.1: Environmental Microbiology [25 marks]

1. Testing of water sample to determine microbial load in the different places of urban/ rural locality. Enumeration of coliform bacteria (total and fecal) of water through multiple tube fermentation technique (MPN).
2. Determination of Biochemical Oxygen Demand (BOD)
3. Identification of enteric bacilli by IMViC Test.
4. Determination of phosphatase activity of milk.

### MCB 493.2: Bioprocess Technology [25 marks]

1. Isolation and characterization of microorganisms from fermented foods.
2. Production of alcohol by fermentation from molasses.
3. Preparation of bakers yeast using molasses.
4. Microbial production of amylase (Solid, Liquid & Submerged fermentation).
5. Production of curd with respect to microbial load and organic acid formation.

## MCB 494:

### MCB 494.1: Comprehensive Viva [25 marks]

### MCB 494.2: Industry Survey [25 marks]

## MCB 495: Project work [100 marks]

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