Syllabus for the Master of Science Course in

MICROBIOLOGY

Effective from 2014-15

(Semester Based)

Vidyasagar University

Midnapore – 721 102

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Content :

Semester	Paper	Subject (s)	Marks
I	101 (I)	Microbial systematics - Bacteria & Virus	50
	102 (II)	Microbial systematics – Eukaryotic organisms	50
	103 (III)	Biophysics and Instrumentation	50
	104 (IV)	Biochemistry	50
	105 (V) (Pract)	General Microbiology	50
	106 (VI) (Pract)	**Gr. A:** Analytical Biochemistry **Gr. B:** Group project	30 20
II	201 (VII)	Pathology & Immunology	50
	202 (VIII)	Genetics, Gene regulations and Molecular biology	50
	203 (IX)	Biomathematics	50
	204 (X)	Computer and Bioinformatics	50
	205 (XI) (Pract)	**Gr. A:** Review Work and Seminar **Gr. B:** Computer & Biomathematics	20 30
	206 (XII) (Pract)	**Gr. A:** Visit to Institute and preparation of report **Gr. B:** Microbial Genetics & Molecular Biology	20 30
III	301 (XIII)	Cell Biology & Genetic Engineering	50
	302 (XIV)	Medical and Diagnostic Microbiology	50
	303 (XV)	Agricultural & Food Microbiology	50
	304 (XVI)	Fermentation Technology and Industrial Microbiology	50
	305 (XVII) (Pract)	Medical and Diagnostic Microbiology	50
	306 (XVIII) (Pract)	Gr. A: Plant-microbe interactions Gr. B: Community survey	30 20
IV	401 (XIX)	Ecology & Environmental Microbiology	50
	402 (XX)	Pharmaceutical microbiology and Nanobiology	50
	403 (XXI) (Pract)	Environmental microbiology and Bioprocess technology	50
	404 (XXII) (Pract)	Comprehensive Viva	30
	405 (XXIII) (Pract)	Industry survey and preparation of report	20
	406 (XXIV) (Pract)	Project Work	100

N.B. 20% marks of each paper are allotted for Internal Assessment.

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Semester – I

Paper 101(I): Microbial Systematics -Bacteria&Virus

Gr. A (25 marks)

1. Origin of life, World of bacteria.
2. Salient features and modern trends of bacterial classification. Phylogenetic and numerical taxonomy
3. Unculturable and culturable bacteria- conventional, metagenomic approaches and modern methods of studying diversity.
4. Ultra-structure of bacteria: Cytoplasmic and outer membrane,capsule, flagella, pilli, endospore and special organelle. Gram-negative, Gram-positive and acid-fast bacteria. Wall deficient organism including L-form.
5. Cultivation of bacteria: aerobic, anaerobic and facultative. Pure culture and its characteristics. Nutritional types, culture media. Strategies of cell division, growth kinetics, generation time, asynchronous, synchronous, batch, continuous culture, measurement of growth and factors affecting growth. Control of bacterial growth - physical and chemical agents, preservation methods, stress responses.
6. General account of cyanobacteria.
7. Archea: systematics, diversity, characteristics, significance, potential application.

Gr. B (25 marks)

1. Virus: Nomenclature and classification; morphology and ultrastructure: capsids and their arrangements; types of envelops and composition; genome: types and structures. Subviralparticles:viroids, virusoids, prions,satellite viruses.
2. General idea about cyanophages, actinophages and mycophages.
3. Cultivation of plant and animal viruses. Purification and maintenance of viruses. Quantitation of viruses (viral assays).
4. Structure, Genome organization and Replication strategies of Bacteriophages: Lytic ds linear DNA viruses (T4, T7); Lysogenic ds linear DNA virus (Lambda); ss Circular DNA virus (Φ X 174); Male specific filamentous phage (M13), TMV, CaMV, Adeno virus.
5. Lysogenic conversion, host response to viral infection.
6. Antiviral agents (chemical and biological) and their mode of actions.

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Paper 102(II) :Microbial Systematics - Eukaryotic Organisms

Gr.A :(25 marks)

1. Fungi (mold and yeast): General characteristics, somatic structure, classification,and method of identification (classical and molecular approach).Heterothallism, sex hormones in fungi. Symbiotic association and parasexual life cycle.Asexual and sexual reproduction of fungi.Growth and its measurement.
2. Evolutionary trends and impact on ecosystem.
3. Mycorrhiza - ecto, endo, and VA mycorrhiza; applications.
4. Idea about some fungi with economic importance.

Gr. B :(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: SCP;biofuels; food, chemical and pharmaceutically important products.
4. Protozoa: classification, structure, nutrition and reproduction. Characteristics of Flagellates, Amoeboids, Sporozoans and Cilliates.

Paper 103(III):Biophysics& Instrumentation

Gr.A :(25 marks)

1. Covalent and non-covalent bonds.
2. Properties of water.
3. pH and buffer. determination of pKa. Buffer in biological systems, isoelectric point.
4. Structural organization of plasma membrane, channels and transport mechanisms, electrical properties of membrane, model membrane, liposomes.
5. Law of thermodynamics, entropy and free energy concept.
6. Osmotic pressure, Donnan-membrane equilibrium.
7. Principle and application of tracer techniques in biology, radioactive isotope and half life of isotopes, effect of radiation on biological system, cerenkov radiation, measurement of radioactivity - ionisation chambers, GM counter, liquid and solid scintillation counters, autoradiography, radiation dosimetry,radiation protection and safety measures .

Gr. B :(25 marks)

1. Microscopy: Principle and applications of light, phase contrast and fluorescence, Electron microscopy -scanning, transmission, confocal, atomic force microscope. Methods of sample processing for EM.

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2. Spectroscopic techniques – UV and visible absorption spectroscopy, fluorescence spectroscopy, IR and Raman Spectroscopy, light scattering techniques, NMR and ESR spectroscopy, ORD/CD.
3. Chromatography- TLC, ion exchange , affinity , reverse phase, gel filtration.
4. Electrophoresis – principle, paper, gel, SDS PAGE, disc gel, gradient gel, isoelectric focussingandPulse field gel electrophoresis.
5. Principle and application of High Performance Liquid Chromatography, Gas Chromatography, Mass spectrometry, GC-MS.
6. Methods of protein and DNA sequencing.
7. Principles of X-ray diffraction and Protein crystallography.

Paper 104(IV) :Biochemistry

Gr. A: (25 marks)

1. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids 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. Enzyme kinetics, regulation of enzyme activity, activators and inhibitors, Allosteric enzyme, Rate limiting enzymes in multistep reaction, ribozyme and abzyme.
4. Biophysical energy transduction, bioenergetics, electron transport chain and oxidative phosphorylation.
5. Synthesis of cells wall and membrane transport system of bacteria.
6. Bacterial photosynthesis and its mechanism.
7. Metabolic patterns of photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs.

Gr. B: (25 marks)

1. 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.
2. Metabolism of energy reserve compounds (polyglycans, polyhydroxybuteric acid).
3. Inorganic nitrogen metabolism. Glutamine, lysine and histidine biosynthesis.
4. Biochemistry of N_2 fixation. Regulation of nitrogenase activity, concept of nif gene.
5. Biosynthesis and metabolism of fatty acids, biosynthesis of phospholipids and isoprenoids.
6. Purine and pyrimidine biosynthesis (de novo).
7. Coordinate control of metabolism.

Paper 105 (V)(Practical): General Microbiology

Gr.A :(25 marks)

1. Preparation of media and cultivation of bacteria, algae, fungi and protozoa.

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2. Qualitative and quantitative enumeration of microorganisms [algae, bacteria (aerobes and anaerobes) 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.*
5. Germination efficiency of fungal spores.
6. Isolation, cultivation and quantification of phage from soil/sewage/other source.

Gr. B :(25 marks)

1. Characterization of bacteria: (i) morphological: shape, Gram stain, endo-spore stain, capsule stain, acid-fast stain, flagella 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, 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, MIC & MBC.

Paper 106(VI)(Practical)

Gr.A:Analytical Biochemistry (30 marks)

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

Gr. B :Group project (20 marks)

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Semester – II

Paper 201(VII) :Pathology and Immunology

Gr. A :(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. Plants defense mechanism: structural and chemical defenses. Local and systemic acquired resistance, Horizontal and vertical resistance, Development of genetically engineered disease resistance plant.

Gr. B :(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-antibodyinteractions.
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. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infection.
6. Comparative immunology from fish to mammals.

Paper 202(VIII):Genetics, Gene Regulation& Molecular biology

Gr. A: (25 marks)

1. Basic principles of Heredity, dominance, segregation, independent assortment, deviation of Mendelian inheritance, co-dominance, incomplete dominance, gene interaction, pleiotropy, phenocopy, sex-linked and autosomal linked characters, dosage compensation.

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2. The law of DNA constancy and C-value paradox. Chromosome structure and function. Nucleoproteins, Histones. Extra chromosomal genetic material. Transposons – types and function.
3. Structural polymorphism of DNA and RNA. Structure and organization of gene.
4. Genomics: Structural genomics; genetic maps; physical maps. Human Genome Project. Functional genomics: function prediction; gene expression and microarrays, reporter sequences, genomewide mutagenesis. Comparative genomics of prokaryote and eukaryote.
5. Bacterial gene transfer and mapping: conjugation, transformation, transduction. Complementation (cis-trans) test.
6. Molecular recombination. Linkage and genetic mapping, pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
7. Brief idea about Population growth curve and population geneticsand evolution.

Gr. B: (25 marks)

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

Paper 203(IX) :Biomathematics

Gr. A: (25 marks)

1. Basic Calculus, limit, derivative and integration.
2. Mathematical modeling of bacterial growth curve, fermentation, microbial genetics, control of microorganism.

Gr. B: (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. Probability distribution (normal, binomial and poisson).
3. Tests of statistical significance. Simple correlation and regression, t-test, Analysis of variance.

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Paper 204(X) :Computer& Bioinformatics

Gr. A: (25 marks)

1. General mode of computer system. Generation of computer. Brief description of various components of computer. Function of an operating system. Types of operating systems. Basic knowledge about various programming languages and packages.
2. Fundamentals of WINDOWS. Basics of programming language, HTML, JPEG etc.
3. Introduction to C.

Gr. B :(25 marks)

1. Introduction to bioinformatics.
2. Biological sequence database.
3. Sequence comparison, pairwise alignment, multiple alignment.
4. Mutation matrix and its application.
5. Database searching, algorithms of FASTA and BLAST.
6. Basic molecular phylogeny.
7. Ligand protein interaction.
8. Gene regulatory networks : Dynamic nature of E. coli genome, Transcriptional network in S. cerevisiae, Mathematical modeling and computer simulation.

Paper 205(XI) : (Practical)

Gr. A: Review work and seminar (20 marks)

Gr. B: Computer &Biomathematics (30 marks)

1. Working knowledge of WINDOWS, operating system.
2. Operation Microsoft word, Microsoft excel, Microsoft Power Point and internet.
3. Preparation of graph of experimental data using MS Excel and other softwares.
4. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
5. Pair wise alignment, multiple alignment and data-base searching.

Paper 206(XII): (Practical)

Gr. A: Visit to Institute and preparation of report (20 marks)

Gr. B: Microbial genetics & molecular biology (30 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.

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Semester – III

Paper 301(XIII) :Cell Biology &Genetic Engineering

Gr. A: (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. Cytopathy.
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.
7. Stem cell and its applications.

Gr. B: (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, synthesis of gene. Automated DNA sequencing, pyrosequencing. RFLP and RADP analysis.
2. Isolation and selection of suitable gene – from known specific proteins, with tissue specific expression, coding for unknown product, transposon tagging, mutant complementation, chromosome walking.
3. Cloning – restriction enzymes, joining of DNA fragments, construction of chimeric DNA, molecular probes. Construction and screening of genomic and cDNA libraries. Vehicles for gene cloning – plasmid, bacteriophages, adenovirus, baculovirus, adeno-associated virus, cosmid, phagemid, Mu. Yeast vectors development – Yep, YRP, Yip, YAC (yeast artificial chromosome), retrovirus like vector (Ty) in yeast, shuttle vector. Expression vector.
4. Application of genetic engineering - in medicine, agriculture, forensic science, environment.
5. Transgenic animals and plants.Gene knock out technique.

Paper 302(XIV) :Medical and Diagnostic Microbiology

Gr. A: (25 marks)

1. Man-microbe interactions - normal microflora in human body and their beneficial effect. Parasites and pathogenesis in human health and disease.
2. Epidemiology, symptomatology. General description of microbial pathogens, diagnosis, prevention and therapy of - meningitis, tuberculosis, leprosy, urinary tract infection,

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cholera, ring-worm, syphilis, diphtheria, mycotoxicosis, opportunistic fungal pathogens, dermatophytes,malarial parasite, *Giardia* and *Leishmania*.

3. Antibiotic resistant microbes – concept and mechanisms. Hospital acquired pathogens and their prevention. Management and biosafety.

Gr. B: (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. AIDS: HIV testing, vaccine design.
3. Immunohaematology – blood groups, blood transfusion and Rh incompatibilities.
4. 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.
5. Monoclonal antibody - production and application.
6. Enzyme immunohistochemical methods. Enzyme immuno - assays after immuno blotting.

Paper 303 (XV) :Agricultural & Food Microbiology

Gr. A: (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.
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: (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, bacterocins and other metabolites, their applications.
6. Fermented food: Production and beneficial effects.
7. Oriental fermented foods (preparation, microbes and benefits).

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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.

Paper 304(XVI): Fermentation Technology& Industrial microbiology

Gr. A: (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.

Gr. B: (25 marks)

1. Isolation, selection and utilization of industrial microbes.
2. Improvement of Industrial strain (genetic & environmental); its preservation and maintenance.
3. Sterilization process in Industrial level.
4. Immobilization: Enzyme and whole-cell.
5. Production of microbial enzymes (glycosyl hydrolases, protease, lipase), antibiotics (streptomycin, tetracycline), steroids, vitamins, amino acids, organic acids (citric acid, acetic acid) and solvents (alcohols).
6. Production of bio-pigments, bio-hydrogen, important bioactive molecules.
7. Production of beer and wine.
8. Industrial effluent treatment techniques : Types, microbes used, types of Effluent Treatment Plants
9. Concept of Intellectual Property Right and patent formulation.Bioethics.

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Paper 305(XVII) (Practical)

Medical and Diagnostic Microbiology

Gr. A: (25 marks)

1. Separation and characterization of blood cell.
2. Estimation of TC & DC.
3. Separation of macrophage and examination of phagocytosis.
4. Rising of antisera in animals. 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.

Gr. B: (25 marks)

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

Paper 306 (XVIII) (Practical)

Plant - Microbe Interactions & Community survey

Gr. A: (30 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).

Gr. B: (20 marks)

Community survey and preparation of report

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Semester – IV

Paper 401(XIX) :Ecology& Environmental Microbiology

Gr. A: (25 marks)

1. Environmental complex, interaction of ecological factors: light, temperature, precipitation (rainfall), humidity of air, atmospheric gases and wind; topographical factors; edaphic factors.
2. 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.
3. Energy flow through ecosystem, energy environment. Concept of productivity; energy partitioning in food chain and food webs;
4. Population properties, density dependent and density independent mechanism of population regulation. Concept of habitat and niche, r and k selection.
5. Types of interactions between two species; co-evolution. Biodiversity.
6. Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds, seasonality and phenology of the subcontinent. Major terrestrial biomes, theory of island biogeography, biogeographical zones of India.
7. Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy.

Gr. B: (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.

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Paper 402(XX) :Pharmaceutical Microbiology andNanobiology

Gr. A: (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, 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

Gr. B: (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.
7. Biosensor : sensor based on enzymes and whole cell, clinical and environmental uses.
8. Production of biopolymer (dextran, alginate, pullunan, xanthan gum, PHB) and bioplastic.
9. Steroid biotransformation for preparation of useful drugs.
3. Microbial contamination and spoilage of pharmaceutical products (sterile injectable, noninjectable, ophthalmic preparations and implants) and their sterilization.
4. QA and QC in manufacturing and in process control of pharmaceuticals

Paper 403(XXI)(Practical)

Environmental microbiology and Bioprocess technology

Gr. A: (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.

Gr. B: (25 marks)

1. Isolation and characterization of microorganisms from fermented foods.
2. Production of alcohol by fermentation from molasses.

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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.

Paper 404 (XXII)(Practical)

Comprehensive Viva [30 marks]

Paper 405 (XXIII) (Practical)

Industry survey and report preparation [20 marks]

Paper 406 (XXIV)(Practical)

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]

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