

MITS SCHOOL OF BIOTECHNOLOGY

COURSES OF STUDY

M.Sc. (Applied Microbiology)

SEMESTER SYSTEM

(Effective from the session 2009-2010)



UTKAL UNIVERSITY

M. Sc. COURSE IN APPLIED MICROBIOLOGY (PGAM)
P.G. Dept. of Botany, Utkal University, Bhubaneswar-4
(SEMESTER SYSTEM)

To be effective from the session 2009-2010

Eligibility

Any graduate having passed B.Sc. with any of the following subject's viz. Botany/ Zoology/ Microbiology/ Biotechnology /Life science/ Agriculture/ Forestry/ Fishery/ Horticulture/ Environmental Science as Honours / Pass subject with 50% mark in aggregate are eligible.

Admission

The candidates are to take admission after qualifying in an entrance test conducted by the Department. The merit list will be prepared by taking 50% of marks in career plus 50% of marks secured by a candidate in the entrance test. The admission will be strictly as per the merit list in each category.

Course and Regulation

The course is of two years duration with four semesters for theory, laboratory practical work and Seminar-cum-practical and project works.

1. Theory papers each carrying 50 marks will have examination of three hours duration.
2. Practical paper each carrying 100 marks will have examination of six hours duration.
3. A Seminar-cum-Practical carrying 50 marks will be assessed by one internal and one external examiner together. Any expert who is not assigned teaching of that practical / Dissertation work can be considered as external examiner.
4. A Dissertation on the project work carrying 100 marks in the Fourth semester will be submitted by the students for assessments.

5. The Semester system of examination will have internal system of evaluation (Theory only) with internal members as suggested by the Board of Studies. For practical examination, evaluation will be made by one internal and one external examiner together.
6. For passing a semester examination a candidate must secure a minimum of 40% marks in Practical/ Dissertation and 33% marks in aggregate of the theory papers in each semester. If the marks secured in a theory paper are less than 25% then the said mark will not be included in the aggregates.
7. If a candidate passes all the four semester examination he / she will be declared to have passed the M.Sc. examination in Environmental Science.
 - i. in first class securing 60% or more
 - ii. in second class securing 48% or more but less than 60%
 - iii. in third class securing 33% marks or more but less than 48% marks in aggregate of all the semester examinations taken together.
8. Attendance in each semester shall be strictly adhered to University Rules.
9. A candidate may repeat only once in one or more papers of any semester examination within a period of one year of the said semester examination. However, if the candidate does not clear the 1st & 2nd semesters, his/her result will not be published even after successfully completing the 3rd and 4th semester. In case a candidate is unsuccessful in 3rd and 4th semester, he shall appear in the immediate next examination of the next batch for the same semester. A candidate failing on any semester examination will be allowed to appear once only in the examination for that semester conducted for the next batch of students and also be allowed to continue to the next semester. A candidate not appearing the first and second semester examinations will be considered to have discontinued his/her study and will not be allowed to appear the remaining semesters.
10. Merit list will be prepared as per university rules, from among the students those who have cleared all semester examinations in 1st chance in one time without repeat of any paper.
11. The candidates who have failed in one semester may be allowed to appear at the same in the immediate next chance, following the due provision. However, (s) he will be not given another chance to appear.

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Semester wise distribution of Papers				
Semester	Paper No.	Paper	Full mark	Duration of Examination
<u>First Semester</u>				
<i>Theory:</i>				
	Paper-I	Fundamentals of microbiology	50	3 hours
	Paper-II	Microbial diversity	50	3 hours
	Paper-III	Microbial physiology, Biochemistry, Molecular Biology and Genetics	50	3 hours
<i>Practical</i>				
	Paper-IV	Practical based on Paper-I, II, and III	100	6 hours
<u>Second Semester</u>				
<i>Theory</i>				
	Paper-V	Agricultural microbiology and Plant Pathology	50	3 hours
	Paper-VI	Environmental, Food and Industrial microbiology	50	3 hours
	Paper-VII	Medical microbiology and Immunology	50	3 hours
<i>Practical</i>				
	Paper – VIII	Practical based on theory Paper V, VI and VII	100	6 hours
<u>Third Semester</u>				
<i>Theory</i>				
	Paper-IX	Biostatistics, Computer Application and Instrumentation	50	3 hours
	Paper-X	Microbial biotechnology: Fundamentals	50	3 hours
	Paper- XI	Microbial biotechnology: Applications	50	3 hours
<i>Practical</i>				
	Paper-XII	Practical based on Paper IX, X and XI	100	6 hours

Fourth Semester				
The candidate shall choose one of the following elective courses.				
A. Agricultural Microbiology				
B. Industrial Microbiology				
C. Environmental Microbiology				
D. Pharmaceutical and Clinical Microbiology				
E. Plant Pathology				
<i>Theory</i>				
	Paper-XIII		50	3 hours
	Paper-XIV		50	3 hours
	Paper-XV: Seminar-cum-Practical		50 Marks	
	Paper-XVI: Project		100 Marks	

FIRST SEMESTER

Theory

PAPER I: FUNDAMENTALS OF MICROBIOLOGY

50 MARKS (3 HOURS)

Unit-I

Scope of microbiology, History and Landmark discoveries, Controversy over spontaneous generation. Classification of microbes: - numerical and molecular taxonomy, Whittaker's 5-kingdom classification, Woese *et al.*'s 3-kingdom classification, Bergey's manual for identification of various microbes, Important criteria used for classification in each taxon, Revolutionary relationship among taxa, Modern trends in nomenclature.

Unit-II

Basic techniques and functional mechanism of equipments used in microbial culture and study, Laminar Air Flow, Autoclave, Oven, pH meter, Colony counter, Incubator-Shaker, Nephelometer, Conductivity bridge, Centrifuge, Cyclomixer. Microscope: light microscopy, resolving power of different microscopes, Dark field, phase contrast, fluorescent and electron microscope, scanning and transmission microscope, image processing.

Unit-III

Nutritional requirements for microbes: Function of different nutrients and their stress on microbes. Mechanism of stress tolerance, Nutritional groups such as autotrophs, chemotrophs, chemolithotrophs, heterotrophs, methanogens, sulphur and non-sulphur reducing groups, Nutritional mobilizations in parasites, Preparation of artificial media, different types of media used for microbial culture.

Unit-IV

Principle and steps of *in vitro* culture of microbes and establishment of their nutritional needs, various methods for selection and isolation of microbes, purification, maintenance, preservation, enrichment, replacement of nutrients. Microbial staining techniques for bacteria and fungi. Various cultural characteristics of microbes, such as: colony appearance, forms, elevation, margin, colour, density, odour and consistency.

Unit-V

Growth of microorganisms, generation time, growth curve, factor affecting growth (O_2 , CO_2 , temperature, pH, humidity, metals etc.), Measurement of growth (mass, Volume, Cell number and indirect methods), growth in batch culture, synchronous growth, Diauxic growth, culture media, continuous culture, Design of chemostat, Death of microbes, control of microorganisms, sterilization and its various types. Effect of physical and chemical agents on microbes.

Unit-I

Microbial ecology: Microbes in water, air and soil environment, role of microbes in geo-biochemical cycles of carbon, nitrogen, phosphorous, sulphur and other inorganic elements. Interaction between microbial populations, Neutralism, commensalisms, mutualism, antagonism, competition, parasitism, and predation. Interaction between micro and macroorganisms, growth of microbes in plants and animals; Internal Air Quality Assessment.

Unit-II

Bacteria: Recent trends in classification of bacteria, metabolic groups, Structure and multiplication of bacteria, Structural organization and function of intracellular organelles, cell wall, cytoplasmic membrane, nuclear material, flagella, fimbriae, capsule, mitochondria, ribosomes, cytoplasmic inclusions, endospores, structure and function of cytoskeleton and its role in motility, Reproduction in bacteria.

Unit-III

Fungi and protozoa: Fungal cell structure, hyphae, septa, reproduction, heterothallism and heterokaryosis. Nature and role of major groups of fungi in ecosystem. Cell structure and function of organism under Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Degeneration of sexuality in fungi. General characters, classification and reproduction of protozoa.

Unit-IV

Cyanobacteria and microalgae: Distribution and classification of cyanobacteria, ultra structure of cyanobacterial cells and heterocysts, cell wall and sheath, gas vacuole, pigments and photosynthesis. Respiratory metabolism and reproduction. Basic biological features of microalgal cell, cell structure and function of organisms under Prochlorophyceae, Euglenophyceae, Bacillariophyceae, Tribophyceae, Chrysophyceae, Cryptophyceae and Dinophyceae.

Unit-V

Viruses and Molecules: Structure and composition of viruses, replication and transmission of viruses, regulation of phages and viruses. General symptoms of plant virus diseases, plant, animal and bacterial viruses. Virulent and temperate viruses, viroids, interferons, prions. Classification, ultrastructure, physiology, developmental cycle and pathogenicity of Mycoplasmas, Rickettsiae and Spirochaetes.

**PAPER –III: MICROBIAL PHYSIOLOGY, MOLECULAR BIOLOGY,
BIOCHEMISTRY AND GENETICS**

50 MARKS (3 HOURS)

Unit-I

Classification and features of photosynthetic bacteria, basic concept of microbial photosynthesis, visible radiations and photosynthetic pigments, Biochemical reactions of photosynthesis, light reaction and light harvesting complexes, Mechanism of electron transport, ATP synthesis, photoprotective mechanisms, Metabolism in photosynthetic bacteria, Substrate level photophosphorylation.

Unit-II

Respiration and metabolism in bacteria: respiratory organelles, Bioenergetics: breakdown and synthetic reactions, Glycolysis, Krebs's Cycle, electron transport chain, energy transfer system in bacteria, aerobic, anaerobic and microaerophilic microbes, Pentose Phosphate pathway, Entner-Doudorff pathway, phosphoketolase pathway, Glyoxalate pathway, Citric Acid cycle, Biosynthetic pathways for fatty acid synthesis, Common regulatory mechanism in synthesis of amino acids and vitamins.

Unit-III

Principle of microbial genetics: DNA as genetic material, conformations of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA and their structure. DNA replication, RNA synthesis and processing, splicing, m-RNA transport, Protein synthesis and processing, Control of gene expression at transcription and translation level in prokaryotes and in eukaryotes, repression, induction, operon model, Gene silencing.

Unit -IV

Molecular basis of DNA damage and repair mechanisms, Mutation, mutagenic agents, its types, cause and detection, Molecular mechanism of gene mutation: transition and transversion; frame-shift, missense and non-sense mutations. Methods for isolating mutants, mutant types:- lethal, conditional, biochemical, loss of function, gain of function, Insertional mutagenesis, *in vitro* mutagenesis and detection techniques, Gene knock out in bacterial and eukaryotic microbes.

Unit -V

Genetic recombination in bacteria: Homologous, non-homologous recombination including transposition, Site-specific recombination, transformation, transduction, conjugation, sexduction. Practical application of microbial genetics. Plasmids, Cell properties determined by the plasmid genes, Expression of recombinant proteins.

Practical

Paper-IV: Practicals pertaining to Paper- I, Paper II and Paper-III. 100 Marks (6 hours)

SECOND SEMESTER

Theory

Paper V: AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY

50 MARKS (3 HOURS)

Unit-I

Distribution of microorganism in soil, organic matter decomposition, humus formation, degradation of cellulose, hemicellulose, lignin, pectin and chitin. Role of microbes in the biodegradation of agricultural chemicals, removal of heavy metals and bioremediation of soil using microbes, Role of microbes in soil fertility.

Unit-II

Nitrogen cycle, ammonification, nitrification, denitrification, Molecular basis of biological nitrogen fixation, Symbiotic and non-symbiotic association, N₂ fixation, Mechanism in legume *Rhizobium* symbiosis and heterocystous cyanobacteria, Nitrogen fixation in nodulating non-legumes, Biofertilizers and its environmental impact.

Unit-III

Microorganisms in transformation of phosphorus & sulphur, Phosphobacteria and mycorrhizae, Microbial interactions and their affect on plant growth, Rhizosphere, phyllosphere and spermophere microorganisms.

Unit-IV

General symptoms of plant diseases, pathogenic and non pathogenic diseases, Principles of plant diseases, Biochemical aspects of disease development, Principle of biotrophic, hemibiotrophic and perthotrophic colonization, Host-parasite relationship, Biochemical and genetic aspect of disease resistance, Defense mechanism in plants.

Unit-V

Antibiosis and biological control of soil borne plant pathogens, Microbial pest management. Toxins (bacterial and fungal) its type, aflatoxin. Some important plant diseases. Diseases caused by fungi, bacteria and viruses: mildews, smuts, blight, rust, mosaic disease, leaf curl, little leaf, blast of rice etc. Molecular detection of pathogens.

PAPER VI: ENVIRONMENTAL, FOOD AND INDUSTRIAL MICROBIOLOGY

50 MARKS (3 HOURS)

Unit I

Water bodies as habitat for microorganisms, Nutritional classification of water bodies, Factors affecting growth and activity of microbes in water, waste water treatment and disposal, Self purification of water bodies, Methods to study the microbiological quality of waste water. Domestic and industrial waste management using microbes.

Unit-II

Biodegradable and non-biodegradable pollutants of soil, Microorganism in copper, uranium mining, Recycling of heavy metals, oil pollution control, Microorganism in mine waste soil and solid waste recycling.

Unit -III

Microbes in food, Principle of food preservation, asepsis, high temperature, low temperature, cryopreservation, drying, chemical preservatives and radiations. Contamination and spoilage of cereals and cereal products, sugar and sugar products, fruits, vegetables, meat, fish, sea foods, milk and milk products, milk processing.

Unit -IV

Microbes for industrial exploitation, Biological and biochemical features of chemical transformation of materials into industrial products. Industrial production of ethyl alcohol, butyl alcohol, vinegar, wine, Vitamin B-12, Gibberellins.

Unit- V

Fats and polysaccharides, Antibiotics in food, feed and plant disease control. Organic acids: citric acid, gluconic acid and lactic acid. Industrial production of enzymes, such as amylase, cellulase, protease, pectinase, lipase, phosphatase etc.

Paper -VII: MEDICAL MICROBIOLOGY AND IMMUNOLOGY 50 Marks (3 hrs)

Unit-I

Microorganisms and diseases in man, Koch's postulate for infectious diseases, Normal microbiota in human and animals, classification of infectious diseases, different stages of disease. History, Epidemiology, causative organism, pathogenesis, laboratory diagnosis, immunity, prophylaxis and treatment of Tuberculosis, Tetanus, Diphtheria, Polio, Influenza, Smallpox, Cholera, Hepatitis, Typhoid, Rabies and Leprosy.

Unit-II

Principles of Immunology, Innate and Adaptive immunity, Cells and organs of immune system, effect response of cell mediated and humoral immunity, hematopoiesis, immunoglobulin, antigens, antigen-antibody interaction, immune response against infectious diseases, agglutinations, immunoprecipitations, serological test, antigen processing and presentation, hypersensitivity and allergy, Vaccines and its role in combating diseases.

Unit-III

General characteristic of antimicrobial drugs (antibacterial, antifungal and antiviral), Antibiotics and its classification, generation of antibiotics, mode of action and resistance, Antibiotics affecting cell wall, cell membrane, protein and DNA synthesis. Probiotics and their mode of action.

Unit-IV

Cytokines, structural and functional aspects, clinical significance, MHC, structure, polymorphic distribution, variation and function, complement system, Hybridoma Technique and monoclonal antibody production, application in biomedical and agricultural fields, microbial diseases and their control. Bioinformatics in drug designing.

Unit- V

Pathogen entering the body through the respiratory tract and its infections, gastrointestinal tract diseases, intracellular pathogens, food related illness, food infections and poisoning. HIV, HIV therapeutics.

Practical:

Paper-VIII: *Practicals pertaining to Paper-V, Paper-VI and Paper-VII.*

100 Marks (6 hours)

THIRD SEMESTER

Theory

Paper -IX: BIOSTATISTICS, COMPUTER APPLICATION AND INSTRUMENTATION
50 MARKS (3 HOURS)

Unit-I

Statistical methods and Developmental models: Graphical representation of statistical data, Mean, Poisson and Binomial, Distribution, Arithmetic, Geometric and Harmonic means, Median, Mode; Design of experiments, Analysis of Variance, Standard Deviation, Standard error of mean, Correlation and regression of two variables, Test of significance, Probability, sampling, measurement and distribution of attributes, t-test, chi-square test, F-test.

Unit II

Computer application, DOS command, MS-Office, MS-Access, MS-Excel, MS-Power point, Assessing Internet. Services: Browsing, Downloading, e-correspondence.

Unit-III

Electromagnetic spectrum, Beer Lambert's Law, Absorption, Transmission, Extinction coefficient, UV-Visible Spectrophotometry, Atomic Absorption Spectrophotometry, X-ray Fluorescence, X-ray diffraction, Flame photometry, Bomb calorimetry, Polarography, Radioisotopes, their detection and measurement, Tracer techniques.

Unit-IV

Chromatographic techniques, Paper Chromatography, Thin layer Chromatography, Column Chromatography, Gas Chromatography, Affinity Chromatography, HPLC, Gel Filtration, Electrophoresis, Immuno-Electrophoresis, Flow cytometry, Immunofluorescent Microscopy, Isoelectric focusing.

Unit- V

Molecular Techniques: PCR, RT-PCR, Micro-array, ELISA, RIA, FISH, GISH, RAPD, RFLP, AFLP, Mass Spectroscopy, MALDI-TOF

Paper - X: MICROBIAL BIOTECHNOLOGY: FUNDAMENTALS

50 MARKS (3 HOURS)

Unit-I

Biotechnological application of microorganisms in industry, Characteristics of industrial microorganisms, Biosynthetic pathways of secondary metabolites in industrial microorganisms, Genetics of microbes in relation to industrial requirements, pure culture methods and sources of industrial microbes, Selection criteria of industrial microbes.

Unit-II

Fermentation: media sterilization, development of inocula, assay of fermentation products, types of fermentation, Batch, Continuous and Feed back processes, Principles of Chemostat and Turbidostat, Growth and fermentation Kinetics. Bioreactors: modes of operations, Design of bioreactors, downstream processing, product separation, concentration, purification and finishing of products.

Unit-III

Optimization of microbial products: parameters in scaling-up, carbon substrate as energy source and terminal electron acceptor, macro and micronutrients, pH and temperature, absence and control of toxic materials, Bioavailability of desired microbes, Germplasm collection and maintenance.

Unit-IV

Microbes in recombinant DNA technology: Isolation and purification of DNA, DNA manipulating enzymes, Genomic and cDNA libraries, Cloning vectors, Construction of recombinant DNA molecules, Transport of recombinant DNA molecules into bacteria, Selection and identification of recombinant clones; Insertional inactivation, Restriction and PCR analysis, Sense and anti-sense cloning.

Unit- V

Genetic engineering of microbes for plant improvement: Ti and Ri plasmids of *Agrobacterium*, mechanism of T-DNA transfer to plants, Binary and co-integrate vectors, Hairy root culture and their applications; Methods for direct gene transfer, Transgenic plants, Detection of transgene and its expression: Southern, northern and western blotting, Intellectual Property Rights, Patenting genetically modified microbes and plants.

Paper –XI: MICROBIAL BIOTECHNOLOGY: APPLICATIONS

50 MARKS (3 HOURS)

Unit-I

Biofertilizers: methods of production, strain Improvement, application and economics of *Rhizobium*, *Azospirillum*, PGPR, Mycorrhizae, Cyanobacteria (BGA) and *Azolla*.

Unit-II

Microbes as food, Single cell proteins, use of microbes as source of food, fungal protein- Yeast, Algal protein-*Chlorella* and *Spirulina*, Mushroom cultivation, Agar agar extraction from *Gracillaria*, and marketing, Microbial polysaccharides.

Unit-III

Microbes in waste management: Management of solid waste from industries, Agriculture, mining sector and urban waste management using microorganisms. Energy from renewable sources, biogas and ethanol production. Biosensors.

Unit-IV

Bio-control of pests and diseases, microorganisms used in control of pest and diseases, basic features and mode of action of BT (*Bacillus thuringensis*), *Trichoderma harzianum*, Nematodes and protozoa for pest control, Microbial control of diseases of crop and forest species.

Unit- V

Microbiology in archaeology: Microorganisms deteriorating objects, glasses, ceramics, wood and stone monuments, Methods of control of microbes for preservation of archaeological objects, Sunscreen pigments of microbes, use of sun screen pigments for protection from UV injury.

Practical

Paper-XII: Practicals pertaining to Paper-IX, Paper-X and Paper-XI.

100 Marks (6 hours)

FOURTH SEMESTER

The candidate has to choose one of the following elective courses.

ELECTIVE A: AGRICULTURAL MICROBIOLOGY

ELECTIVE B: INDUSTRIAL MICROBIOLOGY

ELECTIVE C: ENVIRONMENTAL MICROBIOLOGY

ELECTIVE D: PHARMACEUTICAL AND CLINICAL MICROBIOLOGY

ELECTIVE E: PLANT PATHOLOGY

ELECTIVE A: AGRICULTURAL MICROBIOLOGY

Theory

Paper - XIII: THEORY-1

50 MARKS (3 HOURS)

Unit I

General consideration on role of microbes in soil fertility, Rhizospheric microbial activity and plant nutrition uptake, factors affecting rhizospheric microbial activity, Phyllospheric microbial activity and their role in nutrient uptake, Role of PGPR in plant growth, Role of saprophytic microbes in plant protection.

Unit-II

Biological nitrogen fixation, symbiotic nitrogen fixation-physiology, biochemistry and genetic factors affecting legume-*Rhizobium* symbiosis, Biological N₂ fixation under stress, N₂ in nodulated non-leguminous plants, *Anabaena- Azolla* system, leaf nodules, free living and associative N₂ fixation.

Unit-III

Phosphate solubilization by soil microorganism, PSB, PSM, mycorrhizae, taxonomy, quantification, application of mycorrhizal fungi in agriculture, horticulture and forestry.

Unit-IV

Organic transformation of nitrogen, nitrification, denitrification, mineralization under tropical and temperate conditions, soil microbial activity under aerobic and anaerobic conditions.

Unit- V

Sulphate reducing and sulphate oxidizing bacteria: Methanogenic and methanotropic bacteria-their role in rice fields and other wetland systems.

Paper – XIV: THEORY-2

50 MARKS (3 HOURS)

Unit-I

Bioconversion of lignocellulosic materials into food and feed, Fungal protein production, Microbes in agriculture waste management, Microbes in composting, Microbiology of vermiculture.

Unit-II

Microbes for renewable energy production: Biogas production, Alcohol from agricultural waste, Production of ethanol from cellulose, pentoses, Utilization of solid waste as source of agricultural manure.

Unit-III

Biology and cultivation of mushrooms: Edible and poisonous mushrooms. morphology and classification, nutritional value, conservation of mushrooms, microbiology of mushroom cultivation, cultivation of different types of mushrooms such as *Agaricus* species, *Pleurotus* sp., *Volvartella* sp., Pest and diseases of mushroom, Genetics and cytology of mushroom.

Unit-IV

Biofertilizers, types, *Rhizobia*, selection of *Rhizobia*, mass production of inoculums, industrial production and commercialization of PSB mycorrhizae, *Azotobacter* and *Azospirillum*. Isolation, culture and mass production of inoculum, BGA and *Azolla* culture and production. Economics of biofertilizer use.

Unit- V

Transgenic manipulation: Introduction of alien genes in to crop plants through prokaryotic vector molecules; genetic engineering for herbicide tolerance, resistance to biotic stress (insects, viruses, fungal/bacterial pathogens, nematodes) and abiotic stress (salinity, drought, oxidative, temperature); Male sterility, Quality improvement, Transgenic crops with genetic improvements.

Paper-XVI: Project 100 Marks

Paper-XV: Seminar-cum-Practical 50 Marks

ELECTIVE B. INDUSTRIAL MICROBIOLOGY

Theory

Paper – XIII: THEORY-1

50 MARKS (3 HOURS)

Unit-I

Microbial application in industry, Scope and Characteristics of industrial microorganisms, Growth and basic metabolic processes, Biosynthetic pathways of secondary metabolites of industrial microorganisms, Genetic engineering in relation to industrial requirements.

Unit-II

Theory of aerobic and anaerobic fermentation, production and preservation of starter culture, Development of inocula, Assay of fermentation products, Types of fermentation, surfaces, submerge and solid state fermentation, Batch and continuous culture, Growth and fermentation kinetics.

Unit-III

Bioreactors: Designs, mode of operation and ideal reactors, optimization conditions, aeration, agitation, foam control, process control equipments. Downstream processing, Product separation, concentration, purification and recovery.

Unit-IV

Single cell protein-fats and polysaccharides, culture of *Spirulina*, Yeast technology.

Unit- V

Fermented food from cereals and legumes, pickles, sauerkraut, partially fermented juice, preparation of cheese and yogurt.

Paper - XIV: THEORY-2

50 MARKS (3 HOURS)

Unit-I

Anaerobic fermentation of wine, beer, ethyl alcohol, acetone, butyl alcohol, lactic acids.

Unit-II

Aerobic fermentation of vinegar, Production of organic acids (citric acid, glutamic acid, Fumaric acid), Production of amino acids (glutamine and tryptophan).

Unit-III

Biotechnological production of microbial biomass for synthesis of enzymes (amylase, pectinase and cellulase), Culture selection, submerged fermentation.

Unit-IV

Microbial production of therapeutic compounds, Antibiotics in food, feed and in disease control: production of penicillin and streptomycin, Production of gibberellins, ergot, alkaloids and steroid transformation.

Unit- V

Microbial production of insecticides, Bacteria for insect pest control, fungi for pest control, Viruses for insect pest control, Protozoa for control of insects and pests.

Paper-XV: Seminar-cum-Practical

50 Marks

Paper-XVI: Project

100 Marks

Elective C: ENVIRONMENTAL MICROBIOLOGY

Theory

Paper - XIII-THEORY-1

50 MARKS: (3 HOURS)

Unit-I

Microbes in ecosystem, Historical background and modern breakthrough, Specific role of microbes in ecosystem. Microbial classification based on nutrition and their inter action in nature. Factors affecting microbial community.

Unit-II

Biogeochemical cycle and microbial diversity in soil, organic matter decomposition by soil microbes, Factors affecting microbial community in soil, Organic composting.

Unit-III

Aeromicrobiology: occurrence and epidemiology of aerofungi, aeromicroflora in pharmacy, Microbes in spoilage of heritage materials e.g. temples, library and wall paintings, Phylloplane microflora and pathogens, microbial interactions, *Hydrogenomonas*.

Unit- IV

Aquatic microbiology: marine and fresh water microbes, microbiology of potable water, water purification and eutrophication, waste water and sewage disposal, biofilms, remediation of water pollutants using biofilms, Algal toxins, Methane producing microbes in aquatic environment, Microbes as indicator of water pollution.

Unit- V

Extremophiles-their nature and applications. thermophilic bacteria and archaea, properties of thermophiles, ecology of thermophiles, thermoenzymes, deep-sea extremophilic microorganisms, acidophiles and basophiles, halophiles, active oxygen intermediates in halophiles, psychrophilic and psychrotrophic, Proteolytic microorganisms.

Paper: - XIV: THEORY-2

50 MARKS (3 HOURS)

Unit-I

Microbes in soil environment, Biofertilizers, Microbes in soil pollution, lignolytic fungi and degradation of xenobiotics, Microbes in solid waste management, waste stabilization, heavy metal pollution, Reclamation and waste land development through application of microbes in agriculture and afforestation.

Unit-II

Water bodies as habitat for microorganisms, domestic and industrial waste water-nature of pollutants, associated microflora, effects, treatment and disposal. Microbes in sewage treatment, waste water treatment, Sludge treatment and hyacinth pond. Methods to study microbiological quality of waste water.

Unit-III

Microbes in air pollution, sources of microorganisms in air, factors influencing the population and distribution of microorganisms in air, pathogenic microorganisms in air, green house effect, microbial indicators for air pollution, Allergy, Hay fever, Monitoring of air pollution, Methods to collect and analyze aerosol samples.

Unit-IV

Bacteria leaching and Biomining, bioremediation of marine oil spills, Microbes and heavy metal tolerance, abatement of heavy metal pollution, degradation of pesticides, methane production and biogas production.

Unit- V

Biotechnology and environment management, stabilization of mine waste through microbes, Microbes in waste land development and forestry, environmental laws, impact assessments, precautions and patenting the technology related to development and release of genetically engineered microbes to environment.

Paper-XV: Seminar-cum-Practical
Paper-XVI: Project

50 Marks
100 Marks

Elective C: PHARMACEUTICAL AND CLINICAL MICROBIOLOGY

Theory

Paper - XIII- THEORY-1

50 MARKS (3 HOURS)

Unit-I

Microbes and human diseases, host parasite relations in bacterial infections, pathogenic microbes, enteric bacteria, oral microbiology, skin microbiology, microbial culture, staining characteristics, identification of pure cultures, sterilization.

Unit-II

Medical pathology, Blood chemistry- clinical significance, blood groups, Blood coagulation, haemoglobin structure and functions, Urine Chemistry, physical and microbial study (Albumin test, reducing sugar test, bile test, bile pigment test, ketone body test and blood pigment test, microbial test).

Unit-III

Fundamentals of chemotherapy, Chemotherapy and their principles, Principles of extracellular and intracellular parasitism, bacteriostatic, bacteriocidal, fungicidal, vivicidal drugs. Limitations to effective chemotherapy, Local tissues factors, Systemic host factors and super infections and drug resistance. Aspects of antimicrobial therapy, tropical therapy, combined therapy, Chemoprophylaxis, Microbial sensitivity to antimicrobial drugs.

Unit- IV

General principle of immunology and their application, classification of immunity, natural and acquired immunity, chemical nature of antigen, antibodies, antigen-antibody reaction and their applications, Bacterial exotoxins and endotoxins, Significance of toxoids in active immunizations, importance of booster dose, Antibody formation, Acquired immunity and immunization, hypersensitivity, allergy.

Unit- V

General methods of preparation, storage and standardization of bacterial and viral vaccines, Immunodiagnostic agents, antitoxic sera, vaccine, serum and monoclonal antibody production. Eradication programme of important diseases of India- Malaria, Leprosy and Polio.

Unit-I

General principle of infection and communicable diseases, Disease causing agents, classification, general mode of transmission and basic treatment of the communicable and infectious diseases.

Bacterial and fungal diseases: Air borne diseases (tuberculosis, diphtheria, meningitis, portusis), Food borne and Water borne diseases (cholera, botulism, shigellosis, typhoid fever), Soil borne diseases (tetanus and anthrax), Sexually Transmitted diseases (gonorrhoea and syphilis), contact diseases (leprosy-Tuberculoid and Lymphomatous), Fungal diseases, mycoses, mycotoxicoses, dermatitis, aspergillosis, otomycosis.

Unit-II

Viral and protozoan diseases: Air borne viral diseases (influenza, measles, mumps, Rubella, smallpox), Insect borne diseases, (yellow fever, Dengue fever), food and water borne diseases (Polio), Direct contact diseases (viral Hepatitis, hepatitis-B, rabies, cold sores, AIDS), prevention and control of AIDS, protozoan diseases caused by *Toxoplasma gondii*, *Balantidium coli*, *Trichomonas vaginalis*, *Giardia*, *Trypanosoma*, *Entamoeba histolytica*.

Unit-III

Human cancer: causes of cancer, environmental factors, chemical carcinogenesis, mutagenicity test, DNA tumor virus, Papilloma virus, SV-40 virus, RNA tumor virus, Retrovirus, provirus in germ line, Cellular and viral oncogenes, oncogene families, oncogene proteins, tumor suppressors, detection of human cancer DNA, factors affecting the incidence of cancer.

Unit-IV

Study of different class of drugs, their classification, mode of action, medicinal use, steroids, Bacterial production of B-12, penicillin, streptomycin and tetracycline, microbial assay of vitamin B-12 and antibiotics. Antibiotic production, Antibiotic sensitivity to bacteria, fungi and Actinomycetes, Use of monoclonal antibodies, Detection of human pathogens using monoclonal and polyclonal antibodies.

Unit- V

General concept of clinical pharmacology, Clinical pharmaceutical considerations including indications, contra indications, adverse reactions, side effects, toxicity, doses and dosage regime of drug used in the health disorders like ENT, skin, oral, gastro intestinal and hepatic diseases, cardiovascular, neurological, viral, Sexually transmitted diseases.

Paper-XV: Seminar-cum-Practical
Paper-XVI: Project

50 Marks
100 Marks

ELECTIVE-E: PLANT PATHOLOGY

Theory

Paper - XIII- THEORY-1

50 MARKS (3 HOURS)

Unit-I

Plant pathogens: Diversity and nature, nutrition and culture methods. carbon nutrition, nitrogen nutrition, mineral requirements. Principles of study of pathogens, Koch's postulate establishment.

Unit-II

Plant infection: Avenues and mechanism, physiological and biochemical aspects of disease development. Host compatibility and recognition factors. Effect of pathogenic infection on host physiology, energy correlation in disease development.

Unit-III

Process of defense mechanism in plants, static and infectional defense, dynamic defense, biochemical aspects of defense mechanism, theory of disease resistance, phytonoides, plasmatic defense mechanism, lysosomes, hypersensitivity.

Unit- IV

Chemicals involved in disease resistance and defense mechanism, role of phenols in disease resistance. synthesis of phenolic substances, production of secondary metabolites, Phytoalexins, mechanism of phytoalexin action, phytotoxins, phytoagglutinins.

Unit- V

Genetics of disease resistance, inheritance of pathogenicity, vertical and horizontal resistance. Breeding for disease resistance, production of new races, induction of disease resistance through genetic engineering technique.

Paper: - XIV: THEORY-2

50 MARKS (3 HOURS)

Unit-I

Plant diseases (Pathogenic): Types of plant pathogens, bacteria, fungi, viruses, nematodes, mycoplasma as plant pathogen, general symptoms of plant diseases, transmission of different diseases, Etiology, some important plant diseases, rust, smuts, crown gall, Wilts Tungro, citrus canker, root knot disease.

Unit-II

Plant diseases (Non-pathogenic): Nutritional, deficiency diseases, diseases due to meteorological stress, rainfall, wind, agrichemicals, heavy metals, and industrial pollutants and genetic defects.

Unit-III

Epidemiology: Factors affecting disease development, soil, water and air borne disease. survival and perination of plant pathogen in nature, disease forecasting for epiphytotics, biomonitoring.

Unit-IV

Control of plant diseases: Prevention, sanitation, crop rotation, chemical control (pesticides, fungicides, insecticide application) and management, Biocontrol of plant disease and genetic engineering for disease control.

Unit- V

Seed pathology, seed sheath, seed type vis-a-vis nature of microbial contamination, maturation, and viability, seed borne diseases, nature and types, effect of seed contaminating microbes on seed viability, method transmission of seed diseases, seed storage and control of seed borne diseases, Quarantine and seed certification.

Paper-XV: Seminar-cum-Practical
Paper-XVI: Project

50 Marks
100 Marks

First Semester

Theory

Paper I: **50 Marks (3 hours)**

FUNDAMENTALS OF MICROBIOLOGY

Paper II: **50 Marks (3 hours)**

MICROBIAL DIVERSITY

Paper –III **50 Marks (3 hours)**

MICROBIAL PHYSIOLOGY, MOLECULAR BIOLOGY, BIOCHEMISTRY AND GENETICS

Practical:

Paper-IV: *Practicals based on Paper- I, Paper II and Paper-III.* **100 Marks (6 hours)**

Second Semester

Theory:

Paper V: **50 Marks (3 hours)**

AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY

Paper VI: **50 Marks (3 hours)**

ENVIRONMENTAL, FOOD AND INDUSTRIAL MICROBIOLOGY

Paper -VII: **50 Marks (3 hours)**

MEDICAL MICROBIOLOGY AND IMMUNOLOGY

Practical:

Paper-VIII: *Practicals based on Paper-V, Paper-VI and Paper-VII.* **100 Marks (6 hours)**

Third Semester

Theory:

Paper -IX: 50 Marks (3 hours)

BIOSTATISTICS, COMPUTER APPLICATION AND INSTRUMENTATION

Paper - X: 50 marks (3 hours)

MICROBIAL BIOTECHNOLOGY: FUNDAMENTALS

Paper –XI: 50 Marks (3 hours)

MICROBIAL BIOTECHNOLOGY: APPLICATIONS

Practical:

Paper-XII: Practicals based on Paper-IX, Paper-X and Paper-XI. 100 Marks (6 hours)

Fourth Semester

The candidate has to choose one of the following elective courses.

Elective A: Agricultural Microbiology

Elective B: Industrial Microbiology

Elective C: Environmental Microbiology

Elective D: Pharmaceutical and Clinical Microbiology

Elective E: Plant Pathology

Elective A: Agricultural Microbiology

Theory

Paper - XIII: Agricultural Microbiology (THEORY-1) 50 marks (3 hours)

Paper – XIV: Agricultural Microbiology (THEORY-2) 50 marks (3 hours)

Paper-XV: Seminar-cum-Practical 50 Marks

Paper-XVI: Project 100 Marks

Elective B: Industrial Microbiology

Theory

Paper – Xiii: Industrial Microbiology (THEORY-1) 50 Marks (3 hours)

Paper - Xiv: Industrial Microbiology (THEORY-2) 50 Marks (3 hours)

Paper-XV: Seminar-cum-Practical 50 Marks

Paper-XVI: Project 100 Marks

Elective C: Environmental Microbiology

Theory

Paper - XIII- Environmental Microbiology (THEORY-1) 50 Marks: (3 hours)

Paper - XIV: Environmental Microbiology (THEORY-2) 50 Marks (3 hours)

Paper-XV: Seminar-cum-Practical 50 Marks

Paper-XVI: Project 100 Marks

Elective D: Pharmaceutical and Clinical Microbiology

Theory

**Paper - XIII- Pharmaceutical and Clinical Microbiology THEORY-1)
50 Marks: (3 hours)**

**Paper- XIV: Pharmaceutical and Clinical Microbiology (THEORY-2)
50 Marks (3 hours)**

Paper-XV: Seminar-cum-Practical 50 Marks

Paper-XVI: Project 100 Marks

Elective E: Plant Pathology

Theory

Paper - XIII- Plant Pathology (THEORY-1) 50 Marks: (3 hours)

Paper - XIV: Plant Pathology (THEORY-2) 50 Marks (3 hours)

Paper-XV: Seminar-cum-Practical 50 Marks

Paper-XVI: Project 100 Marks