

APPENDIX-9 (R)
UNIVERSITY OF MADRAS
M.Sc. DEGREE COURSE IN APPLIED MICROBIOLOGY
(CBCS)
(To take effect from the academic year 2013-2014)

- I. That in the Regulations relating to M.Sc. Degree Course in Applied Microbiology – under Regulation No. 5 - **Scheme of Examinations** be modified to read as follows.

REVISED SCHEME OF EXAMINATIONS:

FIRST SEMESTER

Semester	Course Components	Name of the Subject	Inst. Hrs.	Credits	Exam Hours	Max. Marks		
						CIA	External	Total
I	Core Paper-I	Microbial Taxonomy	5	4	3	25	75	100
I	Core Paper-II	General Microbiology and Laboratory Animal Science	5	4	3	25	75	100
I	Core Paper-III	Immunology	5	4	3	25	75	100
I	Core Paper-IV	Practical - I * General Microbiology, Physiology and Immunology	6	4	6	40	60	100
I	Elective - I	Metabolic Pathways	4	3	3	25	75	100
I	Elective - II	Microbial Diversity	4	3	3	25	75	100
I	Soft Skill - I		1	2	3	40	60	100

SECOND SEMESTER

Semester	Course Components	Name of the Subject	Inst. Hrs.	Credits	Exam Hours	Max. Marks		
						CIA	External	Total
II	Core Paper-V	Virology	5	4	3	25	75	100
II	Core Paper-VI	Systematic Medical Bacteriology	5	4	3	25	75	100
II	Core Paper-VII	Mycology and Parasitology	5	4	3	25	75	100
II	Core Paper-VIII	Practical - II * Systematic Bacteriology, Mycology, Parasitology and virology	6	4	6	40	60	100
II	Elective-III	Industrial & Pharmaceutical Microbiology	4	3	3	25	75	100
II	Extra disciplinary Elective - I	Biostatistics & Bioinformatics	4	3	3	25	75	100
II	Soft Skill -II		1	2	3	40	60	100

THIRD SEMESTER

Semester	Course Components	Name of the Subject	Inst. Hrs.	Credits	Exam Hours	Max. Marks		
						CIA	External	Total
III	Core Paper-IX	Microbial Genetics	5	4	3	25	75	100
III	Core Paper-X	Genetic Engineering	5	4	3	25	75	100

III	Core Paper-XI	Molecular Biology	5	4	3	25	75	100
III	Core Paper-XII	Practical III* - Microbial Genetics, Molecular Biology & Genetic Engineering	6	4	6	40	60	100
III	Elective - IV	Soil and Agricultural Microbiology	4	3	3	25	75	100
III	Extra disciplinary Elective -II	Environmental Bio-technology	4	3	3	25	75	100
III	Internship*		-	2	-	-	-	100
III	Soft Skill-III		1	2	3	40	60	100

FOURTH SEMESTER

Semester	Course Components	Name of the Subject	Inst. Hrs.	Credits	Exam Hours	Max. Marks		
						CIA	External	Total
IV	Core Paper XIII	Food, Dairy and Environmental Microbiology	5	4	3	25	75	100
IV	Core Paper XIV	Practical IV* - Soil, Agricultural, Food and Environmental Microbiology -	6	4	6	25	75	100
IV	Core Paper XV	# Project	14	4	3	20	80	100
IV	Elective V	Research Methodology	4	3	3	25	75	100
IV	Soft Skill -IV		1	2	3	40	60	100

* University Practical Examinations will be conducted in even semester only.

** Internship will be carried out during the summer vacation of the second semester and the report will be evaluated by two examiners within the department of the College / Institution. The marks should be sent to the University by the College and the same will be included in the third semester statement of marks.

For the students undergoing M.Sc. (Applied Microbiology) in affiliated colleges, it shall be mandatory to do the project component of the curriculum only in the respective college, instead of doing it in Private / Commercial Laboratories.

II. The above amendment to the Regulations take effect from the academic year 2013-2014 and thereafter.

AC.S'12

APPENDIX-9(S)
UNIVERSITY OF MADRAS
M.Sc. DEGREE COURSE IN APPLIED MICROBIOLOGY
(CBCS)
REVISED SYLLABUS
(To take effect from the academic year 2013-2014)

SEMESTER - I

CORE PAPER I - MICROBIAL TAXONOMY

UNIT I

Taxonomy, systematics, identification: Taxonomical hierarchy-species- type strains: culture collections; binomial nomenclature; systems of classification- phenetic, numerical taxonomy- similarity matrix, dendrograms with examples; phylogenetic with examples; general characteristics used in classification- five kingdom, six kingdom and eight kingdom systems.

UNIT II

Classification of bacteria according to Bergey's Manual of systematic bacteriology 9th edition (up to level of section); characteristics of major sections; classification of archaea, photosynthetic bacteria, *Entrobacteriaceae*, *Mollicutes*.

UNIT III

Classification of Fungi - characteristics of zygomycetes, ascomycetes, basidiomycetes and dueteromycetes.

UNIT IV

Classification of Protozoa - classical 1980; official system & 1993 Cavalier- Smith. Distinguishing characteristics of ciliates; flagellates; sporozoa; heliozoans; amoeba.

UNIT V

Classification of Algae - major characteristics of chlorophycophyta, crisophycophyta, cryptophycophyta, euglinophycophyta & rhodophycophyta. Classification of viruses - animal viruses, plant viruses and phages.

CORE PAPER II - GENERAL MICROBIOLOGY AND LABORATORY ANIMAL SCIENCE

UNIT I

Microscopy – Its principles and application in the field of Microbiology including the following: Dark field, Phase contrast, Fluorescence microscopy. TEM and SEM. Principles, operation and maintenance of: refrigerated and ultracentrifuges, Spectrophotometer. Lyophilizers. Staining methods – Simple, differential and special methods. Sterilization and disinfection methods and their quality control.

UNIT II

Bacterial Anatomy, Structure, properties and biosynthesis cellular components of bacteria – Sporulation – Growth and nutrition – Nutritional requirements – Growth curve – Kinetics of growth – Batch culture – Synchronous growth – Measurement of growth and enumeration of cells – Pure culture techniques.

UNIT III

Distribution of Algae - Thallus structure in algae - Reproduction in alga - Life cycle patterns in algae - *Chlamydomonas* – *Volvox* (Green algae) - *Nostoc* – *Spirogyra* (BGA) - *Ectocarpus* – *Sargassum* (Brown algae) - *Poly siphonia* – *Batrachospermum* (Red algae).

UNIT IV

Laboratory Animal Science. Modern methods of care, management, breeding and maintenance of laboratory animals. Detailed account of nutrition, handling, uses of different laboratory animals - rabbits, mice, rats, guinea pigs, monkeys, hamsters, fowl, sheep.

UNIT V

Breeding and handling of specific pathogen free Gnotobiotic animals and their maintenance and uses. Transgenic animal models – Methodology and uses. Disposal of animal house wastes and used animals. Laboratory uses of animals with special reference to microbiology, pathogenicity testing, antibody production, toxin/toxoid testing, hypersensitivity testing, maintenance of microbes in animals.

CORE PAPER III – IMMUNOLOGY

UNIT I

History and scope of immunology: types of immunity – Innate, acquired, passive and active, Physiology of immune response – Humoral immunity and cell mediated immunity – Lymphoid organs.

UNIT II

Antigen: Types – properties and functions: Immunoglobulin: structure, function and techniques of purification, - Antibody production – regulation and diversity – polyclonal and monoclonal antibodies.

UNIT III

Antigen – antibody reaction including agglutination and precipitation reactions – Enzyme immunoassays –Radio immune assays, Immunofluorescence, Immunoperoxidase. Immunohaematology of blood groups. ABO and RH incompatibility.

UNIT IV

Complement and its role in immune responses. Hypersensitivity – types and manifestations. Autoimmunity. Transplantation immunology and tumor immunology. HLA tissue typing – Major histocompatibility complex – structure and types.

UNIT V

Vaccines: Principles and types. Immunization - its rationale, schedules and importance in public health.

CORE PAPER IV - PRACTICALS - I - GENERAL MICROBIOLOGY, PHYSIOLOGY AND IMMUNOLOGY

UNIT I

Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Dark field microscopy: To show motility of spirochetes and others. Phase contrast microscopy: To show Eukaryotic Cell division, morphology etc. Fluorescence microscopy: Fluorescent staining for Mycobacteria, auramine, staining, Fluorescent antibody techniques.

UNIT II

Washing and cleaning of glass wares: Sterilization principles methods: moist heat, dry heat, filtration. Quality control check for each method:

UNIT III

Staining Techniques: Smear preparation, simple staining, Gram's staining, Acid fast staining, Metachromatic granule staining, Cell wall, spore, capsule, Flagella, Silver impregnation methods.

UNIT IV

Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective, enrichment media. Quality control and uses. Preparation of Biochemical test media, media to demonstrate enzymatic activities.

UNIT V

Microbial Physiology: Purification and maintenance of microbes. Streak plates, pour plate, and slide culture technique. Aseptic transfer, growth and growth requirements: Cell number, and cell proteins. Direct counts, viable counts, pour plate, streak plate. Bacterial growth curve – Turbidimetry, Anaerobic culture methods.

UNIT VI

Preparation of Bacterial Antigens (Crude preparation) by homogenization or sonication. Raising polyclonal antisera in experimental animals - rabbit or mouse with bacterial antigens, RBC (Demonstration).

UNIT VII

Agglutination & Haemagglutination reactions: Latex Agglutination - RF, ASLO, CRP. Blood grouping, RH -Typing/IHA/RPHA. Precipitation reactions in gels: SRID -Single radial immunodiffusion. Double immunodiffusion. Immuno electrophoresis and staining of precipitation lines. ELISA technique –HbsAg / or other Viral Markers.

UNIT VIII

Preparation of Lymphocytes from peripheral blood by density gradient centrifugation. Purification of Immunoglobulins: Ammonium sulphate precipitation. Separation of IgG by chromatography using DEAE cellulose or Sephadex. Anaphylactic reactions in Guinea pigs; Arthus reaction in rabbits (Demonstration only). Skin tests.

ELECTIVE – I - METABOLIC PATHWAYS

UNIT I

Enzymes – nomenclature, components - Mechanism of enzyme reactions - Factors influencing enzymatic activity - Inhibition of enzyme action - Metabolic channeling – Control of enzyme activity – Regulation of enzyme synthesis.

UNIT II

Principles of Bio energetics - Oxidation –reduction reactions - Generation of energy –Substrate Level and oxidation phosphorylation - Electron transport chain

UNIT III

Carbohydrate catabolism – Glycolysis – Pentose phosphate pathway – ED pathway – The Kreb`s cycle – Energy yield in glucolysis and aerobic respiration – Anaerobic respiration – Lactic acid fermentation – Alcohol fermentation.

UNIT IV

Lipid Metabolism – Oxidation of lipids; biosynthesis of fatty acids; triglycerides; phospholipids; sterols. Protein and amino acid catabolism – Oxidation of inorganic molecules – Photophosphorylation.

UNIT V

Bio chemical pathways of energy use – Photosynthetic fixation of CO₂ – Biosynthesis of peptidoglycan – Biosynthesis of lipids – Biosynthesis of amino acids -proline, arginine, aspartic acid, histidine- Interconversions - therionine, isoleucine and methionine; isoleucine ,valine and leucine; serine and lysine; Aspartate and pyruvate. Bio synthesis of purines and pyrimidines.

ELECTIVE – II - MICROBIAL DIVERSITY

UNIT I

Biodiversity: Introduction to microbial biodiversity- distribution, abundance, ecological niche. Types – Bacterial, Archael and Eucaryal

UNIT II

Thermophiles: classification, hyperthermophilic habitats and ecological aspects. Extremely Thermophilic Archaeobacteria, Thermophily, commercial aspects of thermophilies, Applications of thermozyms. Methanogens: Classification, Habitats, applications.

UNIT III

Alkalophiles and Acidophiles - Classification, discovery basin, cell walls and membranes- purple membrane, compatible solutes. Osmoadaptation/ halotolerance. Applications of halophiles and their extremozymes. Barophiles: Classification, high pressure habitats, life under pressure, barophily, death under pressure. Halophiles - Classification, discovery basin, cell walls and membranes- purple membrane, compatible solutes.

UNIT IV

Space Microbiology - Aim and objectives of space research. Life detection methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic and heterotrophic) c) ATP production d) phosphate uptake e) sulphur uptake.

UNIT V

Martian environment (atmosphere, climate and other details). Antarctica as a model for Mars. Search for life on Mars, Viking mission, Viking landers, and Biology box experiment. Gas exchange, label release and pyrolytic release experiments. Monitoring of astronauts microbial flora: Alterations in the load of medically important microorganisms, changes in mycological and bacterial autoflora.

SEMESTER II

CORE PAPER V - VIROLOGY

UNIT I

Brief outline of virology- discovery of virus- general properties of viruses- general methods of diagnosis and serology- virioids, prions, satellite RNAs and virusoids.

UNIT II

Bacterial viruses - Φ X 174, M13, MU, T4, lambda, Pi; structural organization, lifecycle and phage production. Lysogenic cycle-typing and application in bacterial genetics.

UNIT III

Plant viruses-TMV- general characters- morphology-replication-RNA as its initiator of infection. Cauliflower mosaic virus; Transmission of plant viruses; common viral diseases of crop plants- paddy, cotton, tomato, and sugarcane. Viruses of cyanobacteria, algae, fungi and insects.

UNIT IV

DNA Viruses- Pox viruses, Herpes viruses, Adeno viruses, Papova viruses and Hepadna viruses; RNA Viruses- Picorna, Orthomyxo,

Paramyxovirus, Toga and other arthropod borne viruses, Rhabdovirus, Rotavirus, HIV and other Hepatitis viruses.

UNIT V

Epidemiology, Diagnosis and Treatment of Viral Diseases; Viral Vaccines and Antiviral agents.

CORE PAPER VI – SYSTEMATIC MEDICAL BACTERIOLOGY

UNIT I

Philosophy and General approach to clinical conditions of various syndromes – general and specific syndromes. Indigenous normal microbial flora of human body. General attributes and virulence factors of bacteria causing infections.

UNIT II

Host Parasite relationships – Nonspecific host immune mechanisms. Ground rules for collection and dispatch of clinical specimens for microbiological diagnosis.

UNIT III

Morphology, classification, cultural characteristics, Pathogenicity, pathology, Laboratory diagnosis and prevention – Control and treatment of diseases caused by the following organisms: Staphylococci, Streptococci, Pneumococci, Neisseriae (Gonococci & Meningococci), Corynebacterium, Mycobacterium, Clostridium, Bacillus.

UNIT IV

Studies on Salmonella, Shigella, Vibrios, Brucella, Gram negative anaerobes, Spirochetes, Rickettsiae, Chlamydiae, Mycoplasmas and ureoplasmas.

UNIT V

Zoonotic diseases and their control – Hospital acquired infections – Hospital Infection control committee – functions – Hospital waste disposal – Ethical committee – functions.

CORE PAPER VII - MYCOLOGY AND PARASITOLOGY

UNIT I

Historical introduction to mycology - Structure and cell differentiation. Lichens – ascolichens, basidiolichens, deuterolichens. Fungi as insect symbiont. Morphology, Taxonomy, Classification of fungi.

UNIT II

Dermatophytes and agents of superficial mycoses. Yeasts of medical importance. Dimorphic fungi causing systemic mycoses. Dimatiaceous fungi, opportunistic hyaline hyphomycetes, agents of zygomycosis. Fungi causing Eumycotic mycetoma.

UNIT III

Detection and recovery of fungi from clinical specimens. Newer methods in diagnostic mycology. Immunity to fungal infections. Mycotoxins. Antifungal agents - testing methods and quality control.

UNIT IV

Introduction to Medical parasitology – classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, lab diagnosis, treatment, etc. for the following: Protozoa causing human infections – Entamoeba, Aerobic and Anaerobic amoebae. Toxoplasma, Cryptosporidium, Leishmania, Trypanasoma, Giardia, Trichomonas, Balantidium.

UNIT V

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for the following parasites: Helminths: cestodes – Taenia solium, T.saginata, T. echinococcus. Trematodes – Fasciola hepatica, Fasciolopsis buski, Paragonimus, Schistosomes. Nematodes: Ascaris, Ankylostoma, Trichuris, Trichuris, Trichinella, Enterobius, Strongyloides, Wuchereria. Other parasites causing infections in immunocompromised hosts and AIDS.

CORE PAPER VIII – PRACTICAL-II - SYSTEMATIC BACTERIOLOGY, MYCOLOGY, PARASITOLOGY AND VIROLOGY

UNIT I

Collection and transport of clinical specimens -Prerequisites - Proforma -Methodologies. Direct examinations - wetfilms/stainings for Faeces (V.cholerae, Shigella, Salmonella) Pus, Sputum,

throat/ear/nasal/wound swabs, CSF and other body fluids. Simple, differential and special staining methods.

UNIT II

Cultivation methods -Transport media - Isolation methods – Basal, differential enriched, selective media & special media for the pathogenic bacteria. Biochemical identification. Tests for the respective bacteria up to species level.

UNIT III

Antibiotic sensitivity tests -Stokes & Kirby Bauer methods - Disc diffusion -Dilution -Agar dilution & broth dilution -MBC/MIC - Quality Control for antibiotics and standard strains.

UNIT IV

KOH preparation of skin / nail scrapings for fungi and scabies mites. Examination of hair infection under UV light. LPCB mount. Special stains for fungi -Gomori, PAS and Methanamine silver stain for sections. Cultivation of fungi and their identification -Mucor, Rhizopus, Aspergillus, Penicillium, Candida, Trichophyton, Microsporum, Epidermophyton - Slide culture method - Germ tube method, Sugar assimilation / fermentation tests for yeast.

UNIT V

Examination of parasites in clinical specimens - Ova/cysts in faeces - Direct and concentration: methods – Formal, Ether and Zinc sulphate methods - Saturated salt solution method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain - Thick smear by J.B. stain. Wet film for Microfilariae. Identification of common arthropods of medical importance - spotters of Anopheles, Glossina, Phelbotomus, Aedes, etc. Ticks and mites.

UNIT VI

Isolation and characterization of bacteriophage from natural sources – phage titration - T4. Study of virus infected plants. Isolation of viruses - chick embryo - animal tissue culture - fibroblast culture – preparation (demonstration). Spotters of viral inclusions and CPE-stained smears. Viral serology- HAI-ELISA, Western Blotting.

ELECTIVE III - INDUSTRIAL & PHARMACEUTICAL MICROBIOLOGY

UNIT I

Isolation, preservation and improvement of industrially important micro organisms; Raw materials and media design for Fermentation processes; Sterilization; Development of inoculums for industrial

fermentations; Types of fermentation: Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

UNIT II

Fermenter – Design and types. Instrumentation and control - aeration and agitation. Recovery and purification of fermentation products. Enzyme and cell immobilization, production of recombinant proteins having therapeutic and diagnostic applications: Vaccines, Insulin, Interferon, Somatotropin, Single cell protein.

UNIT III

Biology of industrial micro organisms. *Streptomyces*, Yeasts (*Saccharomyces*, *Hansenella*) *Spirulina* and *Penicillium*. Mushroom cultivation. Biosensors and Biochips. Biofuels from microbial sources.

UNIT IV

Production of primary metabolites: Alcohols (Ethanol and Butanol); Beverages (Beer and Wine); Aminoacids (Glutamic acid and Lysine); Organic acids (Citric acid and acetic acid).

UNIT V

Production of secondary metabolites: Antibiotics (Penicillin and Streptomycin); Vitamins (Riboflavin and Cyanocobalamin); Steroids; Production of enzymes (Protease, amylase and lipase); Biopolymers (Xanthan gum and PHB); Biopreservatives (Nisin).

EXTRA DISCIPLINARY ELECTIVE I – BIOSTATISTICS AND BIOINFORMATICS

UNIT I

Nature and scope of statistical methods and their limitations compilation, classification, tabulation and applications in life sciences. Graphical representation – measure of average, dispersion - stem and leaf plots; box and whisker plots, coplots. Introduction to probability theory and distributions (concepts without derivation) binomial, poisson and normal (only definition and problems).

UNIT II

Correlation and regression – concepts of sampling and sampling distribution – tests of significance based on t-test, chi-square and F-test for means, proportions, variations and correlation efficient, theory of attributes and tests of independence of contingency tables.

UNIT III

Sampling methods- simple, random, stratified, systemic and cluster sampling procedures. Sampling and non-sampling errors. Principles of scientific experiments- analysis of variance- one way and two way classification.

UNIT IV

Overview of bioinformatics- database types. Genomics and human genome project. Computational tools for sequence analysis and similarity searching.

UNIT V

Pair wise and multiple sequence alignment. Macromolecular structure function relationships. DNA micro array. Next generation sequencing. Systems medicine.

SEMESTER - III

CORE PAPER IX - MICROBIAL GENETICS

UNIT I

Historical perspectives of microbial genetics. Nucleic acid as genetic information carriers: experimental evidence. DNA – types, structure and properties topology, super helicity, linking number.

UNIT II

Organization of genes and chromosomes: Definition of gene. Operon – Positive regulation. Structure of chromatin and chromosomes - unique and repetitive DNA, heterochromatin, euchromatin, transposons.

UNIT III

Plasmids as extrachromosomal genetic elements; types and properties. Structure and replication of different plasmids: Col E1, F1 and Ti plasmids. Plasmid amplification and curing; Gene transfer mechanisms: Transformation, conjugation and transduction.

UNIT IV

Mutation and Mutagenesis – mechanisms, biochemical basis, mutagens. Molecular basis of spontaneous and induced mutations. Reversion and suppression. Environmental Mutagenesis and toxicity testing; Carcinogenicity - chemical carcinogenesis and their testing. Isolation of Mutants.

UNIT V

Molecular recombination - Mechanism, control and models. Transposition; regulatory sequences and transacting factors. Genetic mapping in *E. coli* and Yeast. Genetics of Lambda, M13, Mu, T₄ and OX174 Genetic systems of yeast and *Neurospora*.

CORE PAPER X - GENETIC ENGINEERING

UNIT I

Principles and methods in genetic engineering: Host cell restriction - restriction modification. Restriction enzymes - types and applications, restriction mapping; Enzymes used in genetic engineering - Nucleases, Ribonucleases, DNA ligases, Tag DNA Polymerases, Methylases, Topoisomerases, Gyases and Reverse Transcriptases.

UNIT II

Vectors - Plasmid vectors: pSC101, pBR322, pUC series and Ti plasmids based vectors - Bacteriophage vectors: Lambda phage based vectors, phagemids, cosmids, and M13 based vectors - Viral vectors: Vaccinia, Retroviral, SV40 and Baculoviral system; Bacterial and yeast artificial chromosomes. Expression vectors.

UNIT III

Cloning techniques - Genomic DNA and cDNA library Construction - Screening methods. Cloning in *E. coli*, *Bacillus*, *Pseudomonas*, *Streptomyces* and yeast. Expression systems. Gene fusion and Reporter genes. Gene targeting. Methods of gene transfer - transformation, transfection; electroporation, microinjection and biolistics.

UNIT IV

Analysis of Recombinant DNA. Polymerase chain reaction. Principles and techniques of nucleic acid hybridization and cot curves - Southern, Northern, Western and South-Western blotting techniques. Dot and Slot blotting.

UNIT V

DNA and protein sequencing. Protein engineering. Protoplast fusion. Hybridoma Technology. DNA finger printing - RFLP, RPAD and AFLP techniques. Applications of genetic engineering in agriculture, health and industry including gene therapy.

CORE PAPER XI - MOLECULAR BIOLOGY

UNIT I

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins and nucleic acids). Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds). Conformation of nucleic acids (A-, B-, Z-, DNA), t-RNA, micro-RNA. Stability of protein and nucleic acid structures. Molecular approaches to diagnosis and strain identification.

UNIT II

DNA replication, repair and recombination - unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra-chromosomal replications. DNA damage and repair mechanisms.

UNIT III

RNA synthesis and processing: Transcription factors and machinery - formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination. RNA processing - RNA editing, splicing, polyadenylation, RNA transport.

UNIT IV

Protein synthesis - formation of initiation complex, elongation and termination – machineries and their regulation. Genetic code. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translation inhibitors. Post-translational modification of proteins.

UNIT V

Control of gene expression at transcription and translation level - Regulation of phages, viruses, prokaryotic and eukaryotic gene expression - Role of chromatin in regulating gene expression and gene silencing.

CORE PAPER XII - PRACTICAL - III - MICROBIAL GENETICS, MOLECULAR BIOLOGY AND GENETIC ENGINEERING

UNIT I

Isolation of genomic DNA from bacteria and demonstration in agarose gel electrophoresis. Isolation of plasmid DNA by alkali lysis

method. Estimation of DNA by diphenyl amine method. Determination of T_m value of DNA. Quantitation of nucleic acids by UV Spectrophotometer.

UNIT II

Isolation of RNA from yeast. Estimation of RNA by orcinol method. Induced mutagenesis - Isolation of antibiotic resistant auxotrophic mutants.

UNIT III

Estimation of proteins by Lowery *et al* method. SDS-PAGE. 2D-Gel electrophoresis. Isoelectric focussing. Separation of amino acids by TLC and paper chromatography.

UNIT IV

Separation of proteins using Gel filtration and Ion exchange chromatography. Immobilization of enzymes and whole cells. Western blotting. Protoplast and spheroplast isolation. Induction of beta-galactosidase activity in *E. coli* using IPTG.

UNIT V

Preparation of competent cells. Transformation and Blue-White selection for transformants. DNA amplification by PCR. Separation of PCR amplified product on PAGE and determination of product size. Restriction mapping / Restriction analysis.

ELECTIVE-IV - SOIL AND AGRICULTURAL MICROBIOLOGY

UNIT I

Characteristics and classification of soils; Soil Microorganisms; Interactions between microorganisms - Mutualism, commensalism, ammensalism, synergism, parasitism, predation, competition. Interaction of microbes with plants - rhizosphere, phyllosphere and mycorrhizae.

UNIT II

Symbiotic and Asymbiotic Nitrogen fixation – mechanism and genetics of Nitrogen Fixation. Biogeochemical cycles - carbon, nitrogen, phosphorus, sulfur. Biofertilizers - *Rhizobium*, *Azotobacter*, *Azospirillum*, VAM, Phosphobacteria, *Azolla* Cyanobacteria. Biopesticides. Interrelationships between microorganisms, plants and soil - Enzymes of microbial origin and their role in release of available plant nutrients.

UNIT III

Plant pathogens and classification of plant diseases. Host-pathogen recognition and specificity. Principles of plant infection and defense mechanisms - entry of pathogen in to host, colonization of host; role of enzymes, toxins and growth regulatory substances. Defense mechanisms in plants - Structural and biochemical - Molecular aspects of host defense reactions - Lipoxygenase and other enzymes in the expression of disease resistance.

UNIT IV

Symptoms, Etiology, Epidemiology and management of the following plant diseases: Mosaic disease of tobacco; Bunchy top of banana; Leaf roll of potato; Bacterial blight of paddy; Angular leaf spot of cotton, Late blight of potato; Damping off of tobacco, Downy mildew of bajra; Powdery mildew of cucurbits; Head smut of sorghum; Leaf rust of coffee; Blight of maize/sorghum; Leaf spot of paddy, Grassy shoot of sugar cane; Root knot of mulberry.

UNIT V

Plant disease management – exclusion, evasion, eradication, crop rotation. Sanitation - physical, chemical and biological control. Plant disease forecasting. Biotechnological approaches to disease management.

EXTRA DISCIPLINARY ELECTIVE-II - ENVIRONMENTAL BIOTECHNOLOGY

UNIT I

Biofilm – occurrence causes and effects - control measures. Biofilm reactor-soluble microbial products and inert biomass – principle and applications.

UNIT II

Bioreactors - principles and designing. Reactor types – batch, continuous-flow, stirred-tank reactor, plug-flow reactors. Effluent recycle - reactors with recycle of settled cells - alternate rate models - Reactors in series.

UNIT III

Denitrification – physiology, types and microbes involved - sludge denitrification. Waste water treatment systems - anaerobic and aerobic- Special factors for the design of anaerobic sludge digesters. Drinking-water treatment: principles - anaerobic treatment by methanogenesis.

UNIT IV

Detoxification of Hazardous chemicals - factors causing molecular recalcitrance. Synthetic organic chemicals - Energy metabolism versus co-metabolism - Electron donor versus electron acceptor - Biodegradation of environmental contaminants.

UNIT V

Bioremediation: Strategies for bioremediation - Pollution monitoring, control and remediation (petroleum industry, paper industry, chemical industry etc.). Biomass from the wastes.

SEMESTER - IV

CORE PAPER XIII - FOOD, DAIRY AND ENVIRONMENTAL MICROBIOLOGY

UNIT I

Food Microbiology: Occurrence of microorganisms in food - Factors influencing microbial growth - extrinsic and intrinsic. Principles and methods of food preservation - high Temperature, low Temperature, drying, irradiation and chemical preservatives. Food borne diseases - Bacteria, Fungi, Viruses, Algae and Protozoa. Spoilage of fruits, vegetables, meat, poultry, fish and sea foods.

UNIT II

Dairy Microbiology: Microflora of milk - sources of contamination. Spoilage and preservation of milk and milk products. Fermented foods - Sauerkraut, Pickles, Buttermilk, Yogurt and Cheese. Probiotics and Prebiotics. Milk borne diseases. Food sanitation - food control agencies and their regulations.

UNIT III

Microbiology of air: Occurrence - number and kinds of microbes in air. Distribution and sources of air borne organisms - aerosol and droplet nuclei. Assessment of air quality -Air Sanitation - Airborne diseases. Microbiology of water: Aquatic habitats - their microflora and fauna - lake, ponds, river, estuary and sea. Biology and ecology of reservoirs and influence of environmental factors on the aquatic biota.

UNIT IV

Environmental Microbiology: Waste treatment - Wastes - types and characterization. Treatment of solid wastes - composting, vermiform composting, silage, pyrolysis and saccharifications. Treatment of liquid wastes - primary, secondary (anaerobic and aerobic) - trickling,

activated sludge, oxidation pond, and oxidation ditch-tertiary - disinfection.

UNIT V

Degradation of Xenobiotic compounds: Simple aromatics, chlorinated polyaromatic petroleum products, pesticides and surfactants. Biodeterioration of materials - paper, leather, wood, textiles and paint. Metal corrosion - Bioaccumulation of heavy metals. Biofouling and Bioleaching.

CORE PAPER XIV - PRACTICAL-IV - SOIL, AGRICULTURAL, FOOD AND ENVIRONMENTAL MICROBIOLOGY

UNIT I

Isolation and enumeration of soil microorganisms (fungi, bacteria and actinomycetes). Isolation of phosphate solubilizer from soil. Isolation of Nitrogen fixers - *Rhizobium* from root nodule and - *Azotobacter* from rhizosphere. Screening of antagonistic bacteria in soil by agar overlay method. Isolation of Cyanobacteria and Photosynthetic bacteria from soil/water.

UNIT II

Estimation of foliar infection by Stoyer's method. Cultivation of oyster mushroom. Study of the following diseases: Tobacco mosaic; Bacterial blight of paddy; Downy mildew of bajra; Powdery mildew of cucurbits; Head smut of sorghum, Leaf rust of coffee; Leaf spot of mulberry, Red rot of sugarcane, Root knot of mulberry.

UNIT III

Detection of number of bacteria in milk by breed count. Determination of quality of milk sample - methylene blue reduction test and Resorzurin method. Detection of number of bacteria in milk - standard plant count. Isolation of yeast and molds from spoiled nuts, fruits, and vegetables. Bacteriological examination of specific foods - curd, raw meat, fish, Ice cream.

UNIT IV

Extracellular enzyme activities - phosphatase. Quantification of microorganisms in air-solid and liquid impingement techniques.

UNIT V

Physical, chemical and microbial assessment of water and potability test for water. Physical and chemical - colour, pH, alkalinity, acidity, COD, BOD, anions and cations. Microbiological - MPN index - presumptive, completed and confirmatory tests.

CORE PAPER XV - PROJECT AND VIVA VOCE

OBJECTIVE OF THE COURSE

To impart advanced practical knowledge in conducting a research project.

To plan and design statistically, retrieve relevant literature, organize and conduct, process the data, photograph relevant observations, evaluate by statistical programmes. Present the project in any regional/national conference/seminar during the Second year of the course and submit for final semester Examinations. The work has to be conducted in department under the guidance of the project supervisor. Interdisciplinary collaborations from external departments / institutions can be organized only for essential areas of the project. The method of valuation of project report submitted by the candidate is outlined as follows:

Internal (2 out of 3 presentations)	-	20 Marks
Viva	-	20 Marks
Project Report	-	60 Marks

ELECTIVE V - RESEARCH METHODOLOGY

UNIT I

Research Methodology - Meaning and objectives and types of research. Research approaches - research Process. Defining the research problem - research design. Sampling – types and design. Data collection - methods - processing and analysis of data. Testing of Hypothesis. Fundamentals of Bioethics.

UNIT II

Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography.

UNIT III

Molecular biology methods: In vitro mutagenesis and detection techniques. Gene knock out in bacterial and eukaryotic organisms. Methods for analysis of gene expression - RNA and protein level - micro array based techniques. Isolation, separation and analysis of protein, carbohydrate and lipid molecules.

UNIT IV

Histochemical and immunotechniques: Flowcytometry and immunofluorescence microscopy. Detection of molecules in living cells - FISH and GISH. Biophysical methods: Analysis of biomolecules - UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy. Structure determination - X-ray diffraction, mass spectrometry and surface plasma resonance methods.

UNIT V

Radiolabeling techniques: Radioisotopes used in biology – properties, detection and measurement. Molecular imaging of radioactive material and safety guidelines. Microscopic techniques: Microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM - Image processing methods in microscopy.

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AC.S'12