Syllabus
M.Sc Environmental Biotechnology

Semester-I	Full nomenclature of paper	Max. Marks
ENV-201	Environmental Toxicology	80
ENV-202	Environmental Biology	80
ENV-203	Analytical Techniques	80
ENV-204	Solid Waste Management	80
ENV-205	Environmental Pollution	80
	Seminar-I	50
	Lab course I	150
	Internal Assessment	20 in each theory paper
Total Marks (Semester-I)		**700**

Semester-II

ENV-206	Natural Resources	80
ENV-207	Environmental Microbiology	80
ENV-208	Environmental Chemistry	80
ENV-209	Biostastics and Modelling	80
ENV-210	Biodiversity	80
	Seminar-II	50
	Lab course II	150
	Internal Assessment	20 in each theory paper
Total Marks (Semester-I)		**700**

Syllabus
M.Sc Environmental Biotechnology

Semester-III	Full nomenclature of paper	Max. Marks
ENV-221	Immunology	80
ENV-222	Cell and Molecular Biology	80
ENV-223	Biotechnology	80
ENV-224	Microbial and Industrial Applications	80
ENV-225	Water and waste water treatment technology	80

Seminar-III	50
Lab course III	150
Internal Assessment	20 in each theory paper

Total Marks (Semester-III) **700**

Semester-IV	Full nomenclature of paper	Max. Marks
ENV-226	Genetic Engineering	80
ENV-227	Bioremediation	80
ENV-228	IPR and Biosafety	80
ENV-229	Biochemistry	80
ENV-230	Project Report	80

Seminar-III	50
Lab course III	150
Internal Assessment	20 in each theory paper

Total Marks (Semester-IV) **700**

Syllabus for M.Sc Environmental Biotechnology (1st and 2nd Semester)

Semester-I

ENV - 201 Environmental Toxicology

Max. Marks : 80
Time : 3 Hours.

Note : 1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight question will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

Unit - I

Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

Unit - 2

Mode of entry of toxic substance, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.

Unit - 3

Insecticides, MIC effects, Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements

Unit- 4

Biogeochemical factors in environmental health. Epidemiological issues goiter, fluorosis, arsenic poisoning.

References :

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry - Manhan
3. Environmental hazards & human health R.B. Philip
4. Toxicology - principles & applications - Niesink & Jon devries
5. Parasitology - Chatterjee
6. Preventive & Social medicines – Perk

M.Sc. Environmental Biotechnology
Semester-I
ENV - 202 Environmental Biology

Max. Marks : 80
Time : 3 Hours.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering th entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

UNIT - I

Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and specification, Ecosystem stability-cybernatics and ecosystem regulation, evolution of biosphere.

UNIT - II

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes.

UNIT - III

Population ecology- density, natality, mortality, survivorship curves, age distribution, growth curves and models, r & k selection, population interactions- Mutualism, Parasitism, Predator- Prey relations, System Theory and Ecological Model.

UNIT - IV

Earths major ecosystem - terrestial and aquatic ecosystem, soil microorganism and their functions, coastal management, criteria employed for disposal of pollutants in marine ecosystem, coastal water system and man-made reservoirs, biology and ecology of reservoirs.

References

1. Basic ecology - E. P. Odum
2. Ecology and field biology - R.L. Smith
3. Ecology - P.D. Sharma
4. Fundamentals of ecology -E.P. Odum
5. Principles of ecology – Rickleff

M.Sc. Environmental Biotechnology
Semester-I

ENV - 203 Analytical Techniques

Max. Marks : 80
Time : 3 Hours.

Note : 1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

Unit - I

Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Titrimetry, Gravimetry, Colourimetry, NMR, ESR, Microscopy-phase, light and flourscence microscopes, Scanning and Transmission electron microscopes.

Unit - 2

Chromatographic techniques (Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography), Atomic absorption spectrophotometry, cytophotometry and flow cytometry, Fixation and staining, Principles and techniques of nucleic acid hybridization and Cot curves, Principle of biophysical method used for analysis of biopolymer structure, Hydrodynamics methods, Plasma emission spectorocopy.

Unit - 3

Electrophoresis, solid and liquid scintillation, X-ray florescence, X-ray diffraction. Flame photomtery, Gas-liquid chromatography, High pressure liquid chromatography - auto radiography, Ultracentrifugation.

Unit- 4

Methods for measuring nucleic acid and protein interactions, DNA finger printing Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques, PCR polymerase chain reaction.

References :

1. Principles of Biophysical chemistry - Uppadahay -Uppadahay
- and Nath.
2. Analytical Techniques - S.K. Sahani

M.Sc. Environmental Biotechnology
Semester-I

ENV - 204 Solid Waste Management

Max. Marks : 80
Time : 3 Hours.

Note : 1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

Unit - I

Sources, generation, classfication & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

Unit - 2

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit - 3

Hospital Waste Management, Hazardous Waste Management & Handling rules, 1989 & 2000 (amendments)

Unit- 4

Disaster Management, Fly ash generation & utilization, Primary, secondary & tertiary & advance treatment of various effluents.

References :

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental manage
ment - By R.K. Trivedi & Arvind Kr.
3. Basic Environmental Technology - J.A. Nathanson

M.Sc. Environmental Biotechnology
Semester-I

ENV - 205 Environmental Pollution

Max. Marks : 80
Time : 3 Hours.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering th entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

UNIT - I

Air pollution- natural and anthropogenic sources of pollution, primary and secondary pollutants, transport and diffiusion of pollutants, gas laws governing the behaviour of pollutants in the atmosphere, Methods of monitoring and control of air pollution, SO_2, NOx, CO, SPM.

UNIT - II

Water pollution - types sources and consequences of water pollution, physico-chemical and bacteriological sampling, Analysis of water quality, standards, sewage and wastewater treatment and recycling, water quality and standards.

UNIT - III

Soil pollution chemical and bacteriological sampling as analysis of soil quality, soil pollution control, industrial waste effluents and heavy metals and their intreactions with soil components.

UNIT - IV

Noise pollution - sources of noise pollution, measurement and indices. Marine pollution, sources of marine pollution and its control. Effects of pollutants on human beings, plants, animals and climate. Air quality standards and air pollution.

References

1. Air pollution and control - K.V.S.G. Murlikrishan
2. Industrial noise control - Bell & Bell
3. Environmental engineering -Peary
4. Introduction to environmental engineering and science
- Gilbert Masters.

M.Sc. Environmental Biotechnology
Semester-II

ENV - 206 Natural Resources

Max. Marks : 80
Time : 3 Hours.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

UNIT - I

Sun as a source of energy, solar radiations and its spectral characteristics, fossil fuels-classification, composition, physico- chemical characteristics and energy content of coal, petroleum and Natural gas.

UNIT - II

Principles of generation of hydroelectric power, tidal power, thermal energy conversion, wind, geo thermal energy, solar collectors, photovoltaic, solar ponds, oceans.

UNIT - III

Nuclear energy- fission and fusion, bio energy -energy from biomass and biogas, anaerobic digestion, energy use patterns in different parts of the world. Impacts of large scale exploitation of solar, wind, hydro and ocean energy.

UNIT - IV

Mineral resources and reserves, ocean ore and recycling of resources, Environmental impact of exploitation, processing and smelting of Mineral, oceans as need areas for exploitation of Mineral resources.

References

1. Living in the environmental - T.J. Miller.
2. Natural resource conservation - Owen & Chiras.
3. Encyclopedia Energy - I & II.

M.Sc. Environmental Biotechnology
Semester-II

ENV - 207 Environmental microbiology

Max. Marks : 80
Time : 3 Hours.

Note : 1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

Unit - I

Microbiology- organisms in nature & their importance, sampling, culture & cultivation of microorganisms, microbes in service of nature & mankind, batch culture & continuous culture of microbes for commercial use.

Unit - 2

Microbial Reactors, genetically modified microbes & their uses in Environmental management recycling & up gradation technologies, Production of products, energy form waste.

Unit - 3

Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, land fills, microbiology of anaerobic fermentation.

Unit- 4

Biotransformation, bioconversion, bioremediation, phytoremediation technology, fermentation technology, development of stress tolerant plants, Environmental problems & Environmental monitoring through microorganism, microbiology of water, air and soil, microbes as pathological agent in plant, animal and man.

References :

Principles of microbiology - Pelzar
Microbial bio technology - A.N. Glazer
Microbial ecology - R.M. Atlas
Molecular biology - H.D. Kumar
Environmental bio Technology - Sayler & Fox

M.Sc. Environmental Biotechnology
Semester-II

ENV - 208 Environmental Chemistry

Max. Marks : 80
Time : 3 Hours.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

UNIT - I

Stochiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid-base, reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides.

UNIT - II

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere.

UNIT - III

First law of thermodynamics, enthalphy, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium, third law of thermodynamics, enzymes catalysis, Michaelis/ Menten equation.

UNIT - IV

Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog, Chemistry of water, concept of D.O., B.O.D., and C.O.D, water treatment : Sedimentation, Coagulation, Filtration, tertiary and advanced treatment, redox potential, Inorganic and organic components of soil, nitrogen pathways and NPK in soils.

References

1. Environmental Chemistry - G.S. Sodhi
2. Environmental Chemistry - Mannhan
3. Fundamantals of soil science - Henry D. Futh
4. Textbook of limnology - G.A. Cole
5. Environmental Chemistry - Sharma and Kaur

M.Sc. Environmental Biotechnology
Semester-II
ENV - 209 Environmental modelling and Biostatistics

Max. Marks : 80
Time : 3 Hours.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering th entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

UNIT - I

Measurement of central tendency - mean (Geometric and Harmonic), median, mode, Measurement of dispersion moments, standard deviation, skewness and kurtosis, Correlation and linear regression of one independent variable, Basic laws and concepts of probability

UNIT - II

Definition of random variable, density function, Basic concepts of binomial and normal distributions, Sampling measurement and distribution of attributes, Moments, matrics and simultaneous linear equations, tests of hypothesis and significance.

UNIT - III

Role of modelling in environmental sciences, Model classification deterministic models, stochastic models, steady state models, dynamic models, Different stages involved in model building. Simple microbial growth kinetics monod equation, Methods for formulation of dynamic balance equations mass balance procedures.

UNIT - IV

Models of population growth and interactions Lotka Volterra model, Leslies matrix model, Point source stream pollution, Box model, Gaussian plume model, Linear, simple and multiple regression models, validation and forecasting.

References

1. Dynamics of Environmental Bioprocesses-Modelling and simulation-Snape and Dunn.
2. Environmental Modeling - Jorgensen

M.Sc. Environmental Biotechnology
Semester-II

ENV - 210 Biodiversity

Max. Marks : 80
Time : 3 Hours.

Note : 1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

Unit - I

Biodiversity - definition, hot spots of Biodiversity, strategies for Biodiversity Conservation, National Parks, Sanctuaries and Biosphere reserves, gene pool.

Unit - 2

Aquatic common flora and fauna in India - phytoplankton, zooplankton and macrophytes, terrestrial common flora and fauna in India - forests, endangered and threatened species.

Unit - 3

Strategies for Biodiversity Conservation, cryopreservation, gene banks, tissue culture and artificial seed technology, new seed development policy 1988, conservation of medicinal plants.

Unit- 4

International conventions, treaties and protocols for Biodiversity Conservation, Biodiversity in the welfare of mankind, Species concept, Biological nomenclature theories of biological classification.

References :

1. Global Biodiversity - W.R. L.IUCN
2. Ecology of natural resource - Ramade
3. Ecology - P.D. Sharma

M.Sc Environmental Biotechnology
Semester - III

ENV – 221 Immunology

M.M. : 80
Time : 3 Hrs.

Note
1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system-primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Unit II

Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Immunological basis of self – non-self discrimination; Kinetics of immune response, memory; B-cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system.

Unit III

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasma resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptotosis, Microarrays, Transgenic mice, Gene knock outs.

Unit IV

Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

References

1. William E. Paul, Fundamental Immunology, Wolters Kluwer/ Lippincott Williams & Wilkins.
2. Stephen K Wikel, The Immunology Host-Ectoparasitic arthropod relationships. Cabinternational.
3. Herman N. Eisen, MD, General Immunology. J.B. Lippincott Company. F.M. Burnet, Immonology. W.H. Freeman and company
4. Jack G. Chirikjian, Plant Biotechnology, Animal cell culture Immunobiotechnology. Jones and Bartlett Publishers.

M.Sc Environmental Biotechnology

Semester- III

ENV–222 Cell and Molecular Biology

M.M. : 80
Time : 3 Hrs.

Note
1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit I

Genome Organisation

Organization of bacterial genome; Structure of eucaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics(Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting

Unit II

DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties- Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage;

Transcript processing; Processing of tRNA and rRNA Eucaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing

Unit IV

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

References

David Freifelder, Essentials of Molecular Biology, Narosa Publishing House.

George M. Malacinski, Essentials of Molecular Biology, Jones and Bartlett Publishers.

Cornel Mulhard, Molecular Biology and Genomics Academic Press is an imprint of Elsevier.

Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris-A. Kaiser, Monty Krieger, Mathew P. Scott, S.Lawrence Zipursky, James Darnell, Molecular Cell Biology (Fifth adition), W.H.Freeman and company New York.

M.Sc Environmental Biotechnology
Semester- III

ENV - 223 Biotechnology

M.M. : 80
Time : 3 Hrs.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit-I

The scope of environmental biotechnology; Biodegradation of macromolecules; biodegradation of genobiotics; Vermicomposting. Heavy metal pollution; Bioremediation of metal contaminated soils, spilled oil and grease deposits and synthetic pesticides. Biosensors to detect environmental pollutants. Microorganisms and organic pollutants; Extremophiles. Fermentation technology (Bioreactors).

Unit-II

Basic techniques in genetic engineering: Genetic manipulation, Restriction endonucleases, Introduction of cloned genes into new hosts using plasmid and phage vector systems. RFLP, Polymerase chain reaction, Environmental genomics/metagenomics-a general account, Microbes and environmental management.

Unit-III

Basic concept of genetic engineering of plants and its applications- herbicide and stress tolerant plant.Biotechnology strategies in forestry and wasteland management. Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA Banks.Genetically modified organisms and Biosafety- a general account.

Unit-IV

Bioenergy, ethanol fermentation.Liquid waste treatment; Biofilters, activated sludge systems; membrane bioreactors. Biotechnological approaches for solid waste management, Phytotechnology-terrestrial phytosystems, metal phytoremediation, Phytotechnology-aquatic phytosystems, nutrient film techniques, algal treatment systems.

References

1. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York.
2. Metcalf and Eddy (Eds). 2003, Wastewater Engineering: Treatment and Reuse, Tata McGraw-Hill, New Delhi.
3. Nelson, G.C. 2001. Genetically Modified Organisms in Agriculture: Economics and Politics. Academic Press.
4. Evans, G.M. and Furlong J.C. 2003. Environmental Biotechnology: Theory and Application. John Wiley and Sons.
5. Thomas, J.A. and Fuchs, R. 2002. Biotechnology and Safety Assessment. Academic Press.
6. Wang L.K. Hung Y.T. nad Shammas N.K.(Eds). 2006. Advanced Physicochemical Treatment Processes. Springer-Verlag New York, LLC

M.Sc Environmental Biotechnology

Semester- III

ENV – 224 Microbial and Industrial Applications

M.M. : 80
Time : 3 Hrs.

Note
1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit I

Microbial Diversity & Systematics Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit II

Microbial Growth & Physiology Ultrastructure of Archaea (Methanococcus); Eubacteria (*E.coli*); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group).

Unit III

Microbial Interactions and Infection Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence

Microbes and Environment Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.

Unit IV

Industrial Applications Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformations-steroids, antibiotics, alkaloids, enzyme/cell electrodes.

References

1. Michael J. Pelczar, Microbiology, Tata McGraw-Hill

2. L.E Casida, JR, Industrial Microbiology, New Age International , PJ Limited, Publisher.

3. Prescott and Dunn, Industrial Microbiology, C BS Publisher and Distributor

4. Gerand J. Tortora, Berbell R. Funke, Christine L. Case, Microbiology, Pearson

M.Sc Environmental Biotechnology

Semester- III

ENV– 225 Water and Waste Water Technology

M.M. : 80
Time : 3 Hrs.

Note
1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit-I

Water microbiology and analytical tools in assessment of water pollution

Overview of standards of water in relation to public health - Detection and control of micro-organisms in environmental fresh water, in source and drinking water; Potable and nonpotable water; Methods of water sampling for pollution analysis; Biosensors - types and applications in environmental pollution detection and monitoring; Biological treatment: stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment.

Water Pollution

Principal forms of Water Pollutants and their sources; Pollution of stream, lakes and phenomenon of eutrophication; Water pollution monitoring and water quality standards; Ocean pollution – oil pollution; Ground water pollution and its control; Water pollution prevention.

Unit II

Water Pollution Monitoring

Methods of monitoring; Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; Other emerging techniques such as enzyme detection, hybridization, PCR, Gene probe technology etc.; Strategies for controlling pathogen transfer; Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.; Biosensors of pollution

Unit III

Effluent treatment systems

Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms; Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment.

Unit IV

Removal of specific pollution

Physicochemical characteristics and treatment strategies for effluent generated by Distillary and fermentation industry; Fertilizers and pesticide manufacturing industries; Dyes and dye intermediate producing industries and textile industries; Paper and pulp industries; Tanneries; Pharmaceuticals; Thermal power plants; Food and dairy industries; Iron and steel industries; Organic solvents; Chlorinated minerals and inorganic chemical industries and petrochemicals; Biotechnological application of hazardous waste management of water; Use of microbial systems; Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment; Development of new biocatalysts to be applied in waste water biotechnology.

References

1. Nicolas P Cherewsinott, Handbook of water and waste water Treatment Technology, Boston Oxford Auckland Johannesburg Melbourne ,N Delhi
2. Frederick W Pontinus, Water Quality and Treatment. American water works Association, MC Graw Hill Inc.
3. S K Agarwal, Water Pollution, APH Publishing Corporation.
4. Ronald L Dooste, Theory and Practical of water and waste water Treatment.
5. Bill T. Ray, Environmental Engineering, PWS Publishing company.

M.Sc Environmental Biotechnology

Semester- IV

ENV – 226 Genetic Engineering

M.M. : 80
Time : 3 Hrs.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit I

Basic Concepts

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

PCR and Its Applications Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test).

Unit IV

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

References

1. David P. Clark, Nanette J Pazdernik, Biotechnology Applying the Genetic Revolution, Elsevier.
2. Jack G. Chirikjian, Genetic Engineering Mutagenesis Separation Technology, Jones and Bartlett Publishers.

3. U. Satyanarayana, Biotechnology, Books and ALLIED (p) Limited.
4. Michael P. Tombs, Biotechnology and Genetic Engineering Reviews volume 10. Intercept.
5. Danniel L. Hart, Elizabeth W. Jones, essential Genetic (Second Edition) Jones and Batlett Publishers.
6. E Johansen Nange, Arthur P Nange, Basic Human Genetics (Second Edition) Sinauer Association, Ins Publisher Sunderland, Massachusetts.

M.Sc Environmental Biotechnology

Semester- IV

ENV – 227 Bioremediation

M.M. : 80
Time : 3 Hrs.

Note
1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit I

Bioremediation- I Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation

Unit II

Bioremediation – **II** Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.

Unit III

Hazardous Waste Management biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management – cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics -phenols.

Unit IV

Concept of bioremediation (in-situ & ex-situ), Bioremediation of toxic metal ions-biosorption and bioaccumulation principles. Concepts of phytoremediation. Microbial leaching of ore-direct and indirect mechanisms. Mining and metal. Use of microorganisms in augmentation of petroleum recovery. Biotechnology-with special reference to Copper and Iron.

References:

1. Environmental Biotechnology by S. K. Agarwal
2. Biodegradation & Bioremediation (1999), Martin Alexander, Academic press.
3. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 1989.
4. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.
5. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.
6. Bioremediation engineering; design and application 1995 John. T. cookson, Jr. Mc Graw Hill, Inc.
7. Environmental Biotechnology by A.K. Chatterjee
8. Environmental Biotechnology by S.N.Jogdand Himalaya Publishing

M.Sc Environmental Biotechnology

Semester – IV

ENV – 228 IPR and Biosafety

M.M. : 80
Time : 3 Hrs.

Note
1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit I

Introduction to Intellectual Property Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit II

Basics of Patents and Concept of Prior Art Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.)

Unit III

Patent filing procedures

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies

Unit IV

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

References

1. P. Narayanan, Intellectual Property Laws, Eastern Law House.

2. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.

3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.

M.Sc. Environmental Biotechnology
Semester - IV

ENV- 229 Biochemistry

M.M. : 80
Time : 3 Hrs.

Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

Unit - I

Organisation of Biomolecules, Buffers, Principle and biological application of diffusion osmosis, viscosity and Donnan membrane equilibrium. Carbohydrates : structure and classification of carbohydrates, metabolism of carbohydrates : glycoysis, TCA ycle HMP pathways.

Unit - 2

Lipids : Classification, structure and nomenclature of lipids, Biological significance of lipids, physico- chemical properties of fattyacids and triacyl glycerol.

Unit - 3

Aminoacids : classification, structure and nomenclature of aminoacids, physico-chemical properties of aminoacids. proteins: confirmation of proteins and polypeptides secondary, tertiary and quartenary and domain structure of proteins, denaturation of proteins and Ramchandran plots.

Unit- 4

IUB Classification and nomenclature of enzymes, general properties of enzymes, enzyme kinetics- Michaelis Menten equations, Coenzymes - structure and biological fucntion of coenzymes A, TPP, FMN, FAD, NAD and lipoic acid, structure of purine and pyrimidine bases, nucleosides and nucleotides. Primary structure of nucleic acid, Three dimensional structure of t-RNA.

References :

1. Principles of Biochemistry Lehninger.