

AC 27/2/13
Item no. 4.42

UNIVERSITY OF MUMBAI



Syllabus for Sem III and Sem IV
Program: M.Sc.
Course: Zoology-Environmental
Science

(Credit based semester and Grading System with
effect from the academic year 2013–2014)

UNIVERSITY OF MUMBAI
M.Sc. in Zoology: SEMESTER III and IV

Credit Based Semester and Grading System
to be implemented from the Academic Year 2013-2014.

PREAMBLE

BOS in Zoology during its meeting constituted a pyramid committee, to revise the syllabi in Zoology, with Dr. M. K. Pejaver as the Chairperson and Senior Teachers from affiliated Colleges as Jt. Chairperson, one each for UG and PG programmes. The class-wise syllabus committees were constituted in accordance with inclusive policy of the BOS with an aim to provide faculty at large hands on training and exposure to work on syllabus committees which will go a long way in taking our subject ahead in future when these experienced staff members would shape the subject after a decade. With the introduction of Credit Based Semester and Grading System and continuous evaluation consisting of components of internal assessment and external assessment by the esteemed University, the syllabus in Zoology was revised for M.Sc. Sem I and II to be implemented with effect from 2012-13, after approval by concerned authorities of the University.

Vide University Circular No. APD/Misc.-01/407/of 2011 dated 12/12/2011, contents of letter from K. P. Singh, Joint Secretary, UGC No. D.O.F1-1/2009-(CPP-II) dated 29/11/2011 were notified to the faculty in Zoology. As per the letter an expert committee was constituted by the UGC to look into the issue of discontinuation of dissection of live animals in the laboratory experiments in Zoology/ Life Sciences at UG and PG levels. The guidelines prepared by the expert committee and approved by UGC were notified with a viewpoint to ensure compliance of the guidelines.

A special meeting of Heads of Zoology Departments of all the Colleges affiliated to the University was convened on 17th August 2012 for deliberation on recommendation of expert committee appointed by the UGC regarding the discontinuation of dissection of live animals in laboratory experiments in Zoology / Life Sciences at UG and PG level.

In accordance with the deliberations in the above meeting, draft syllabus for M.Sc. SEMESTER-III and IV in Zoology, suitably revised, to be implemented in the Credit Based Semester and Grading System was

prepared by the committee under the guidance of pyramid committee. The draft was circulated among the heads and senior teachers of the Department of Zoology of various colleges for approval and suggestions.

In meeting of the BOS held on 12th December, the draft was approved and it was resolved to implement the revised syllabus of Zoology at M.Sc. SEMESTER-III and IV and make it effective from the Academic Year 2013-2014 after approval from concerned authorities of the University.

Chairman

Board of Studies in Zoology

University of Mumbai.

M.Sc.
Zoology Biotechnology and Environmental Science
 Credit Based and Grading System.
 To Be Implemented from the Academic Year 2013-2014.

Semester -III

Theory

Course	Unit	TOPIC	Credits	L / Week
PSZOBT301	I	The implications of recombinant DNA technology of commercial products and microbial synthesis	4	1
	II	Large scale culture & production from recombinant microorganisms & genetically engineered animal cells		1
	III	Medical Biotechnology		1
	IV	Environmental Biotechnology I		1
PSZOBT302	I	Genome management and analysis	4	1
	II	Manipulation of gene expression in prokaryotes		1
	III	Bioinformatics		1
	IV	Animal biotechnology and Human therapies		1
PSZOEVS303	I	Introduction to Environmental Science	4	1
	II	Environmental Chemistry I		1
	III	Environmental Physics I		1
	IV	Environmental Microbiology I		1
PSZOEVS304	I	Natural Resources	4	1
	II	Water Resource I		1

	III	Air pollution		1
	IV	Environmental Economics		1
Total			16	16

Practicals

PSZOBT3P1		Practicals based on PSZOBT301	2	4
PSZOBT3P2		Practicals based on PSZOBT302	2	4
PSZOEVS3P3		Practicals based on PSZOEVS303	2	4
PSZOEVS3P4		Practicals based on PSZOEVS304	2	4
Total			8	16
Grand Total			24	32

Semester –IV

Theory				
Course	Unit	TOPIC	Credits	L / Week
PSZOBT401	I	Microbial synthesis of commercial products	4	1
	II	Large scale culture & production for industrial biotechnology		1
	III	Agricultural Biotechnology		1
	IV	Environmental Biotechnology II		1
PSZOBT402	I	Genome management	4	1
	II	Manipulation of gene expression in eukaryotes		1
	III	The human genome project		1
	IV	Regulations and patents in biotechnology		1
PSZOEVS403	I	Ecosystem & Biodiversity	4	1
	II	Environmental Chemistry II		1

	III	Environmental Physics II		1
	IV	Environmental Microbiology II		1
PSZOEVS404	I	Natural Resources II	4	1
	II	Water Resource II		1
	III	Solid Wastes Pollution		1
	IV	Environmental Education & Legislation		1
			16	16
Practicals				
PSZOBT4P1		Practicals based on PSZOBT4P1	2	4
PSZOBT4P2		Practicals based on PSZOBT4P2	2	4
PSZOEVS4P3		Practicals based on PSZOEVS4P3	2	4
PSZOEVS4P4		Practicals based on PSZOEVS4P4	2	4
Total			8	16
Grand Total			24	32

M. Sc.

SEMESTER III

Zoology – Biotechnology Environmental Science

THEORY

PSZOBT301: Basics of Industrial & Environmental Biotechnology I

Unit I: The implications of recombinant DNA technology of commercial products and microbial synthesis

15

- 1.1. The implications of recombinant DNA technology
 - 1.1.1 *General account on applications of biotechnology
 - 1.1.2 *Commercialization of biotechnology & biotech companies
 - 1.1.3 Prospects of novel food technology
 - 1.1.4 Economics of microbial biotechnology
 - 1.1.5 Areas of significant public concern: Antibiotic resistance marker gene, transfer of allergies, pollen transfer from GM plants, social, moral & ethical issues associated with GMOs.
- 1.2 Amino acids & their commercial use – production strain, process of L-glutamate, L-aspartate, L-phenylalanine, L-tryptophan.

Unit II: Large scale culture & production from recombinant microorganisms 15 & genetically engineered animal cells

- 2.1. Large scale culture & production from recombinant microorganisms:
 - 2.1.1 Batch fermentation
 - 2.1.2 Fed batch fermentation
 - 2.1.3 Continuous fermentation
 - 2.1.4 *Maximizing the efficiency of fermentation process
 - 2.1.5 Harvesting, disrupting & downstream processing
- 2.2. Large scale culture & production from genetically engineered animal cell cultures:
 - 2.2.1 Design of bioreactors for large scale animal cell culture-Batch, Fed batch
 - 2.2.2 Mammalian cell lines & their characteristics
 - 2.2.3 Media for the cultivation of mammalian cells
 - 2.2.4 *Commercial products produced with mammalian cell culture

Unit III: Medical Biotechnology 15

- 3.1. Sub-unit vaccines
 - 3.1.1 *Sub-unit Vaccine production against viruses-Herpes simplex, Bovine foot & mouth disease virus
 - 3.1.2 Peptide vaccines-synthetic drugs (engineered proteins)
 - 3.1.3 Genetic immunization-DNA vaccines, Antisense DNA, Therapeutic ribozymes
 - 3.1.4 *Live recombinant vaccines
 - 3.1.5 *Attenuated vaccines against Cholera, Salmonella sp.
 - 3.1.6 Vector vaccines-Vaccine directed against viruses-Rabies virus G-protein, Hepatitis B surface antigen
 - 3.1.7 Anti-idiotypic vaccine for cancer treatment
- 3.2. Monoclonal antibodies (mAbs) & therapeutic applications:
 - 3.2.1 mAbs for prevention of rejection of transplanted organs
 - 3.2.2 Treatment of bacterial blood infection
 - 3.2.3 Human monoclonal antibodies
 - 3.2.4 Hybrid human-mouse monoclonal antibodies
 - 3.2.5 HIV therapeutic agents
 - 3.2.6 Anti-tumour antibodies

Unit IV: Environmental Biotechnology I 15

- 4.1. Biomass utilization
 - 4.1.1 Microorganisms in lignocellulose degradation
 - 4.1.2 Isolation of prokaryotic & eukaryotic cellulase gene

- 4.1.3 Manipulation of cellulase gene
- 4.1.4 Production of single cell proteins by using biomass as raw material
- 4.1.5 Commercial production of fructose and alcohol from biomass
- 4.1.6 Improvements of fructose and alcohol production
- 4.1.7 Fuel ethanol from biomass
- 4.2. Bioremediation of xenobiotic compounds
 - 4.2.1 Characteristics of xenobiotics in the environment
 - 4.2.2 Characteristics of aerobic microorganisms for degradation of organic pollutants
 - 4.2.3 Genetic engineering of biodegradative pathways-
Manipulation by transfer of plasmid, manipulation by gene alteration
 - 4.2.4*Degradation of xenobiotic compounds-petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organic compounds (aliphatic & aromatic)

***marked topics are to be taken for seminar**

PSZOBT302

PSZOBT302: GENETIC ENGINEERING TECHNIQUES AND ITS APPLICATIONS

Unit I: Genome management and analysis

15

1.1 The Basic tools of genetic engineering

- 1.1.1 Chemical Synthesis of DNA-Oligonucleotide synthesis by Phosphoramidite method, Synthesis of genes
- 1.1.2 *DNA Sequencing -- Maxam-Gilbert method, Sanger's dideoxynucleotide method, By using bacteriophage M13 By Primer walking
- 1.1.3 Polymerase chain reaction and its advantages

1.2 Cloning Vectors

- 1.2.1 *General purpose plasmid vectors (pUC19, pBR322)(Bacterial Vectors)
- 1.2.2 Bacteriophage and cosmid vectors
- 1.2.3 Yeast artificial chromosomes (YACs)

1.3 Analysis of genome/proteome

- 1.3.1 DNA fingerprinting/physical mapping/pulsed field gel electrophoresis

- 1.3.2 Analysis of the proteome
- 1.3.3 Analysis of mRNA transcripts

Unit II: Manipulation of gene expression in prokaryotes

15

2.1 Promoters of gene expression in prokaryotes

- 2.1.1 Prokaryotic gene expression
- 2.1.2 Isolation of functional promoters
- 2.1.3 Promoter selection with E.coli plasmid pBR316
- 2.1.4 *Promoter selection with plasmid pKO1
- 2.1.5 Gene expression from strong and regulatable promoters

2.2 Expression of cloned genes in prokaryotes

- 2.2.1 Increasing protein production and secretion
- 2.2.2 *Inclusion bodies and fusion proteins
- 2.2.3 Unidirectional tandem gene arrays
- 2.2.4 Translation expression vectors
- 2.2.5 Increasing protein stability

Unit III: Bioinformatics

15

- 3.1 Uses and application of computers in biological sciences
- 3.2 *DNA profiling: cDNA and EST's (expressed sequence tags)
- 3.3 Basic research with DNA microarrays and its application in healthcare.
- 3.4 Biomedical genome research and pharmaco genomics
- 3.5 *Random amplified polymorphic DNA (RAPD)
- 3.6 Human genomic variation-SNP's (single nucleotide polymorphisms, SNP's and disease; QTL (quantitative trait loci) and its relation to SNP's
- 3.7 Satellite DNA and its types

Unit IV: Animal biotechnology and Human therapies

15

4.1 Animal Biotechnology

- 4.1.1 *Transgenic animals and their applications:
Mice as model system for human diseases and as test case model, Cows, pigs, sheep, goats as biopharmaceuticals
Transgenic insects and birds
- 4.1.2 Recombinant DNA technology to prevent animal diseases
- 4.1.3 Conservation biology-Embryo transfer
- 4.1.4 Regulation of transgenic animals and patenting genetically engineered animals

4.2 Human therapies

- 4.2.1 Tissue engineering: Skin, liver, pancreas
- 4.2.2 *Xenotransplantation
- 4.2.3 Antibody engineering
- 4.2.4 Cell adhesion based therapies: Integrins, Inflammation, Cancer and metastasis
- 4.2.5 Targeted gene replacement for correcting a mutated gene
- 4.2.6 Site directed mutagenesis

***marked topics are to be taken for seminar**

USZOEVS303: CONCEPTS IN ENVIRONMENTAL SCIENCE I

Unit I Introduction to Environmental Science 15

- 1.1 *Ecosphere & Biosphere
- 1.2 Lithosphere - Physico-chemical characteristics;
Weathering & Soil Formation: Types of Soil; Soil Profile, Geomorphological processes.
- 1.3 Atmosphere - Physico-chemical characteristics; Division, composition & significance of components.
- 1.4 Hydrosphere - Physico-chemical characteristics, Range of aquatic habitats, comparison aquatic and terrestrial habitats.
- 1.5 *Interrelationship between the divisions of Ecosphere.

Unit-II Environmental Chemistry I 15

- 2.1 Laws of thermodynamics - Thermodynamic systems; Free energy and changes in free energy; *application of thermodynamic principals to life.
- 2.2 Concept of chemical equilibrium; colloidal chemistry; absorption and catalysis; Electrochemistry.
- 2.3 Chemical and photochemical reactions in atmosphere.

Unit-III: Environmental Physics I 15

- 3.1 Radiation - Introduction and types; Physical and Biological half life; Radioactivity & measurement.
- 3.2 Absorption of Radiation & units of dose.
- 3.3 Nuclear power generation & hazards associated with nuclear fuel
- 3.4 *Radiations as a tool in biological & environmental investigations.

Unit-IV: Environmental Microbiology I 15

- 4.1 Prokaryotes - Major taxonomic groups, microbial nutrition
Physiological adaptations
- 4.2 *Symbiotic microbes and their significance
- 4.3 Microbial growth - Environmental parameters influencing growth &

measurement of growth.

4.4 Study of growth characteristics

***marked topics are to be taken for seminar**

PSZOEVS304 POLLUTION, CONSERVATION & RESOURCE MANAGEMENT I

Unit I Natural Resources **15**

- 1.1 Classification of natural resources
- 1.2 Exploration & economic growth
- 1.3 Resource demand
- 1.4 Sustainable development
- 1.5 *Conservation and management of natural resources.

Unit II Water Resource I **15**

- 2.1 Human use and control of water:
Storing water by dams, cloud seeding, water from icebergs, *desalination.
- 2.2 Water pollution - Types of water pollution:
- 2.3 Organic pollution - Oxygen consumption & Organic nutrients.
- 2.4 Inorganic pollution - Mineral Nutrients, acid mine drainage, toxic industrial waste minerals & *heavy metals

Unit III Air pollution **15**

- 3.1 Air pollution - Metrology & climatology of air pollution
- 3.2 Sources of air pollution - Mobile and non-mobile combustion sources, aerosols, refrigerants.
- 3.3 Indoor air pollution – Ventilation, heating, air-conditioning.
- 3.4 Forest fires & volcanic eruption
- 3.5 *Acid rain, green house gasses, photochemical smog (PAN), nuclear winter, ozone depletion.
- 3.6 *Sampling & analysis of air & Monitoring of air pollution.
- 3.7 Case studies – Meuse valley-Belgium, London smog, Bhopal gas tragedy.

Unit IV Environmental Economics **15**

- 4.1 Impact Assessments of environmental problems.
- 4.2 Economics of environmental pollution & its control in India.
Role of Indian Standard Institution (ISI)
- 4.3 Environmental consideration in public project planning.
- 4.4 *Tools for environmental policy; Basic pollution control, Industrial pollution control & Effluent Standards.
- 4.5 Industrial health: Administration of environmental health programs;

*Environmental & integrated health care in India.

***marked topics are to be taken for seminar**

PRACTICAL

Semester III

Practicals

Course Code PSZOBT3P1 & PSZOBT3P2 (Based on PSZOBT301 and PSZOBT302)

- 1) Demonstration of aseptic technique: Work place for aseptic handling, packing glassware (flasks, test tubes, pipettes, petridish) for sterilization, aseptic transfer of liquids (pipetting from flask to test tube)
- 2) Preparation of LB agar plate, slant, butt & demonstration of streaking technique using bacterial culture to obtain isolated colonies.
- 3) Determination of viable cell count in the given culture of bacteria by dilution & spreading technique.
- 4) Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis.
- 5) To estimate the number of bacteria in the given culture by nephelometry.

Course Code PSZOEVS3P1

Based on PSZOEVS303

- 1) Study of Physical properties of water: Colour, Odour, Temperature, Conductivity, Total Suspended Solids, Total dissolved Solids & Total Solids.
- 2) Study of Chemical properties of water: pH, Dissolved oxygen, Free carbon dioxide, Salinity & Hardness.
- 3) Microbiology: Study of Gram's staining, Growth characteristics, SPC, MPN total plate count in soil microbes & Nitrogen fixing microbes in soil.

Course Code PSZOEVS 3P2

Based on PSZOEVS304

- 1) Estimation of BOD, COD, Ammonical Nitrogen, Organic Nitrogen, Total Kjeldhal Nitrogen.

- 2) Estimation of metals-Chromium, Copper, Zinc & Iron.
- 3) Estimation of non-metals-Acidity, Alkalinity, Sulphites, Sulphides, Fluorides, Chlorine demand, Residual Chlorine, Oil & Grease.
- 4) Biological assessment of water pollution using diversity indices: Kothe's species deficit index, Odum's species per thousand individuals Shanon's diversity index, Good Nights's & Whitem's index for benthic fauna, Nygaard's algae index.
- 5) Measurement of dust fall & allergens in air.

SEMESTER IV.

PSZOBT401: Basics of Industrial & Environmental Biotechnology II

Unit I: Microbial synthesis of commercial products 15

1.1. Microbial synthesis of commercial products

1.1.1 Organic acids & their commercial applications – Citric acid, gluconic acid, lactic acid.

1.1.2 Antibiotics – Cloning antibiotic biosynthetic gene by complementation & other methods.Synthesis of novel antibiotics & improving antibiotic production.

*Aminoglycosides & their uses

1.1.3 Polysaccharides:

Bacterial polysaccharides: General properties & their commercial applications-Dextran, Xanthan, Alginate.

Genetic engineering for the large scale production of Xanthan gum & its modification.

*Marine polysaccharides: General properties & their commercial application- Agar & agarose, Chitosan

1.1.4 Polyesters: Polyhydroxyalkanoates (PHA)-Biosynthesis of PHA, Biopol-commercial biodegradable plastic

Unit II: Large scale culture & production for industrial biotechnology 15

2.1. Biotransformations

2.1.1 Selection of biocatalyst-screening & use of novel existing biocatalyst

2.1.2 Genetic modification of existing biocatalyst (Indigo biosynthesis)

2.1.3 Biocatalyst immobilization-

Methods of immobilization- Cross linking, supported immobilization, adsorption & ionic binding, covalent coupling, lattice entrapment

2.1.4 Immobilized soluble enzymes & suspended cells

2.1.5 Immobilization of multi-enzyme systems & cells

2.1.6 *Immobilized enzyme reactors- Batch reactors, continuous reactors

2.1.7 Analytical enzymes-

Enzymes in diagnostic assays: Test strip systems & Biosensors-
Electrochemical & optical type

Unit III: Agricultural Biotechnology

15

3.1. Agricultural Biotechnology:

3.1.1 *Nitrogen fixation

3.1.2 Nitrogenase-Component of nitrogenase; Genetic engineering of nitrogenase cluster

3.1.3 Hydrogenase-Hydrogen metabolism

3.1.4 Genetic engineering of hydrogenase gene

3.1.5 Nodulation-Competition among nodulation organisms, genetic engineering of nodulation gene

3.1.6 Microbial insecticides-Toxins of *Bacillus thuringiensis*, mode of action & use of thuringiensis toxins, thuringiensis toxin gene isolation, genetic engineering of *Bacillus thuringiensis* strains & cloning of thuringiotoxin gene.

3.1.7 *Developing insect resistant, virus resistant & herbicide resistant plant

3.1.8 Algal products: Fuels from algae, marine natural products & their medical potential-anticancer, antiviral compounds, antibacterial agents.

Unit IV: Environmental Biotechnology II

15

4.1. Bioabsorption of metals (Recovery from effluents)

4.1.1 *Bioabsorption by fungi, algae, moss & bacteria

4.1.2 Mechanism of bacterial metal resistance & genetic engineering for specific proteins

4.1.3 Bioreactors for bioabsorption-packed bed, fluidized bed, rotating disc, single blanket, sequential reactors

4.1.4 Phytoremediation & its use in biotechnology

4.2. Bioleaching of metals

4.2.1 Biochemical mechanism of bioleaching

4.2.2 Extraction from mixtures

4.2.3 Types of bioleaching

4.2.4 Methods for bioleaching-Tank & heap bioleaching

4.2.5 *Microorganisms used for bioleaching

***marked topics are to be taken for seminar**

PSZOBT402: Genome management, manipulation, regulations and patents in biotechnology

Unit I: Genome management

15

1.1 The Basic tools of genetic engineering

- 1.1.1 Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation, liposome, ligand mediated, gene gun or biolistic approach, viral mediated
- 1.1.2 Selection and screening of recombinants
- 1.1.3 *Nucleic acid probes and hybridization, Southern blotting and Northern blotting
- 1.1.4 Immunological assays for identification of gene product, Western blot

1.2 Cloning Vectors

- 1.2.1 *Retrovirus and SV40 vectors
- 1.2.2 Special purpose vectors- Expression vectors, Secretion vectors, Shuttle or bi-functional vectors, single stranded phage and phagemids

Unit II: Manipulation of gene expression in eukaryotes

15

- 2.1 Eukaryotic gene expression
- 2.2 *Introduction of DNA into fungi-yeast and filamentous fungi (fungal transformation)
- 2.3 Heterologous proteins production in yeasts
- 2.4 Heterologous proteins production in filamentous fungi
- 2.5 Cultured insect cells expression systems- Baculovirus transfer vector
- 2.6 *Mammalian cell expression systems- Human Papova BK virus shuttle vector

Unit III: The human genome project

15

- 3.1 *The human genome, scope and goals of the project
- 3.2 Genetic linkage maps, chromosome walking, restriction mapping
- 3.3 Polymorphic DNA markers
- 3.4 Restriction fragment length polymorphism (RFLP) and its uses
- 3.5 Physical maps, Sequence tagged sites
- 3.6 Integrating genetic linkage and physical maps
- 3.7 *Mapping human diseases

- 3.8 Positional cloning: Getting closer to a disease causing gene
- 3.9 Testing for exons
- 3.10 Limitations of positional cloning

Unit IV: Regulations and patents in biotechnology

15

- 4.1 Regulating recombinant DNA technology
- 4.2 *Regulatory requirements – safety of genetically engineered foods Chymosin, tryptophan, bovine somatotropin
- 4.3 Regulation environmental release of genetically engineered organism(GEO). Ice minus Pseudomonas syringae
- 4.4 Regulatory agencies and laws for product regulation
- 4.5 Risk assessment: How much risk?
- 4.6 *Open field tests of GEO
- 4.7 Development of policy for Human gene therapy
- 4.8 Patenting biotechnology inventions
 - a) What constitutes the patent?
 - b) The patent process
 - c) The conditions to be satisfied for an invention to be patentable :Novelty, Inventiveness, Usefulness
 - d) Patenting in different countries, types of inventions that are not patentable in India
 - e) What is Paris convention? Principal features of Paris convention
 - f) Patenting multicellular organisms
 - g) Patenting and fundamental research

***marked topics are to be taken for seminar**

PSZOEVS403 CONCEPTS IN ENVIRONMENTAL SCIENCE II

Unit I Ecosystem & Biodiversity

15

- 1.1 Concept of Ecosystem: Interaction between matter and energy; Hydrological cycle; Gaseous & Sedimentary nutrient cycles.
- 1.2 Energy flow through ecosystem; food chain; food web & Energy pyramids.
- 1.3 Biotic community; concept of ecological niche.
- 1.4 Population dynamics: Synecology & Autecology: Physical, physiological & behavioral adaptation of organisms.
- 1.5 *Present Status of biodiversity in India & *Bio-indicators of pollution.

Unit II Environmental Chemistry II

15

2.1 Elements in Earth's crust:

Major elements - Silicon, Iron, Aluminum, Calcium, Magnesium, Sodium & Potassium.

Minor elements - Lead, Mercury, Zinc & Cadmium
(Chemical & Biochemical role to be emphasized).

2.2 Instrumental techniques in environmental and chemical analysis:-
Photometry, Gravimetry, NMR, ESR, *AAS, *HPLC
(Principles of working & applications)

Unit III Environmental Physics II **15**

- 3.1 Heat & heat flow in biological systems - Heat capacity, heat exchange, waste heat & its environmental implications.
- 3.2 Sound - Its nature, Energy & intensity of sound waves, ear & hearing.
- 3.3 *Noise - its measurement & effects.
- 3.4 Energy - Types and resources. Energy utilization & its environmental impact.
- 3.5 *Conventional & non-conventional energy resources.

Unit IV Environmental Microbiology II **15**

- 4.1 Microbes in air - Types and pathogens, droplet borne and air borne infection, carcinogenic effects.
- 4.2 *Microbial indicators of air pollution.
- 4.3 Microbes in water - Their types, Role in eutrophication and biodegradation, Microbes in sewage, Sludge - Types and role.
- 4.4 *Microbial indicators of water pollution.
- 4.5 Potential role of microbes in pollution control.

***marked topics are to be taken for seminar**

PSZOEVS404 POLLUTION, CONSERVATION & RESOURCE MANAGEMENT II

Unit I Natural Resources II **15**

- 1.1 Land Resources: Soil and agricultural - *Green Revolution, Soil erosion, impact of chemical fertilizers, weedicides and pesticides, soil conservation, manures, biofertilizers, *biological pest control.
- 1.2 Non agricultural uses of land - Wet lands aquaculture & mineral development (Mining) & its environmental impact.
- 1.3 Case Studies - Chernobyl

Unit II Water Resource II **15**

- 2.1 Water pollution & treatment:
Pollution of Ground water, streams, estuaries, lakes and oceans.

- 2.2 *Euthrophication
- 2.3 Case studies - Torry Canyon, Minamata
- 2.4 Preventive measures and treatment - Effluent requirement:
Primary, Secondary and Tertiary water quality management in India.

Unit III Solid Wastes Pollution **15**

- 3.1 Solid Wastes
- 3.2 Sources & quantities
- 3.3 Modern trends in waste management
- 3.4 *Energy from refuse

Unit IV Environmental Education & Legislation **15**

- 4.1 Environmental Education: Need for environment awareness
- 4.2 Social environmental programs &
*Role of NGOs in environmental education & protection.
- 4.3 Environmental Legislation: Concept of environmental law.
Right to good environment as a fundamental right.
Environmental protection under common law.
- 4.4 *Implementation of environmental laws in India.

***marked topics are to be taken for seminar**

SEMESTER IV

PRACTICAL

Course Code PSZOBT4P1 & PSZOBT4P2

Based on PSZOBT401 and PSZOBT402

- 1) Immobilize Yeast cells in calcium alginate & prepare a bioreactor column to demonstrate Invertase activity in the bioreactor column.
- 2) Restriction-digest the given DNA sample & demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided.
- 3) Demonstrate the western blotting technique for the given sample of protein.
- 4) To plot a growth curve for the microorganisms provided.
- 5) Demonstrate the effect of medium on growth curves of given microorganism, using two different media (minimal & enriched).

Course Code PSZOEVS 4P3

- 1) Estimation of nutrients: Phosphates, Nitrates, Nitrites, Silicates & Sulphates.
- 2) Population analysis by Quadrant method for grass & Sub-sampling method, estimation of frequency, density & diversity.
- 3) Study of interactions: Obligate mutualism in lichens & termites, Facultative mutualism in commensalisms, Mimicry, Social behavior, Territoriality.
- 4) Detection of Salmonella.
- 5) Demonstration of Antibiosis.

Course Code PSZOEVS 4P4

- 1) Study of physical properties of soil: Soil temperature & Soil texture.
- 2) Study of chemical properties of soil: pH, Moisture, Organic matter, Calcium carbonate, Chlorides & Iron.
- 3) Study of Primary production by Chlorophyll method, Biomass method & Winkler's method.
- 4) Vegetation analysis: Associations, Correlation & Non-randomness.
- 5) Bioassay studies: Fish avoidance study, Algal bioassay.
- 6) Toxicity testing – Acute/Chronic/Cumulative Toxicity Curve, LC₅₀ or TL_m.

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N.B :

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees :

- 1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
- 2) A Dissection Monitoring Committee (DMC)

Composition of DMC shall be as follows :

- i) Head of the Concerned Department (Convener/Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
- iv) One or two members of related department from neighboring colleges.