



Goa University

P.O. Goa University, Taleigao Plateau, Goa 403 206, India

Syllabus of the B.Sc. (Biotechnology) Programme

(As approved by the Board of Studies on 17.03.'06, 16.01.'07 and 19.02.'07)

The Purpose : The B.Sc. (Biotechnology) is a self-financing programme offered in a few colleges affiliated to the University, with six units Biotechnology at the T.Y. level.

Pre-requisites : The course is open to students with HSSC (Science) eligibility.

Semesters & Coursework distribution : At the F.Y. and S.Y. level, students have the option of 2 units each in a combination of biotechnology/chemistry/zoology or biotechnology/chemistry/botany. In addition, as required for other B.Sc. programmes under Goa University, they would also need to opt for general foundation courses as offered in their respective colleges.

Dissertation / Project work : The students will carry out a group Project during the T.Y. and will be evaluated for the same as per the norms laid down by the University.

The overall Scheme of Instruction appears on Page 2 of this document. The last column of the table therein identifies the page location of the detailed contents of each of the courses.

SCHEME OF INSTRUCTION

Papers	Title of papers	Marks*			Grand Total	Page No.
		CIA	ESE	Practicals		
SEMESTER I						
I	Basic Biosciences I	15	60	25	100	3
II	Microbiology	15	60	25	100	5
SEMESTER II						
III	Basic Biosciences II	15	60	25	100	7
IV	Cell Biology	15	60	25	100	9
SEMESTER III						
V	Biological chemistry	15	60	25	100	11
VI	Immunology	15	60	25	100	13
SEMESTER IV						
VII	Biostatistics and Computational applications in Biology	15	60	25	100	14
VIII	Molecular Biology and Genetics	15	60	25	100	16
SEMESTER V						
IX	Concepts in Genetic Engineering	20	80	-	100	18
X	Plant tissue culture	20	80	-	100	20
	Lab course in Genetic Engineering and Plant Tissue Culture	-	-	100	100	
XI	Industrial Biotechnology	20	80	-	100	22
XII	Environmental Biotechnology	20	80	-	100	26
	Lab course in Industrial Biotechnology & Environ- mental Biotechnology	-	-	100	100	
SEMESTER VI						
XIII	Instrumentation	20	80	-	100	29
XIV	Animal Cell Culture	20	80	-	100	31
	Lab in Instrumentation & Animal Cell Culture	-	-	100	100	
XV	Applications of Biotechnology	20	80	-	100	33
XVI	Biodiversity of India: Range, Status and Concerns	20	80	-	100	36
	Lab in Applications of Biotechnology & Biodiversity	-	-	100	100	
	Project Work	50	50	-	100	

*CIA : Continuous internal assessment

*ESE : End semester examination

Syllabus of the B. Sc. Biotechnology Curriculum

Paper I : Basic Biosciences I (Theory)

Topics	No. of periods	Weightage (marks)
Introduction to the plant world. Plant Kingdom. classification up to the level of genus and species.	1	20
Algae (Uni- and multicellular), fungi, bryophytes, pteridophytes, monocots, dicots, angiosperm and gymnosperm with one example each	8	
Difference in angiosperms and gymnosperms. Anatomy: internal structures of stem, leaf and roots of angiosperm and gymnosperm	4	
Organization of plant body Flower: parts and their functions. Inflorescence- Types, Flowers as modified shoots. Physiology of flowering: Photoperiodism, vernalization and dormancy. Internal structure of anther and ovule Fruits: Types, fruit formation, parthenocarpy Seed : Structure, formation, dormancy, embryo structure	7	20
Morphological differences in monocots and dicots. Basic internal structure of roots, stems and leaves of dicot and monocot	2	
Hormonal (Auxin, cytokinin, Gibberellins, Ethylene and Abscissic acid) regulation of plant growth and development	2	
Mechanism of nitrogen fixation (symbiotic and non symbiotic)	1	
Chloroplast pigments, photosystem I and II, electron flow through cyclic and non cyclic photophosphorylation, CO ₂ fixation in C ₃ and C ₄ plants, CAM and glycolate pathways	6	20
Secondary plant metabolites: phenol, porphyrins, terpenoids and alkaloids	1	
Common insect pests affecting economically important plants: Paddy, cotton, sugarcane, coconut, mango. Biological control of insect pests.	2	
Mycorrhizae and Lichens: Characteristics and economic importance	2	
Total	36	

Practical I	No. of sessions
Study of algal types through temporary mounting and staining Nostoc, sargassum, and chlorella	1
<u>Action of plant growth hormone: IAA, GA, kinetin on germinating seeds</u>	1
<u>Microscopy study of thallus structures in Riccia, Nephrolepis & Cycas</u>	1
<u>Preparation of potato dextrose agar and growth of any one fungus</u>	1
<u>Identification of C3 and C4 plants By TS of leaves</u>	1
<u>Study of bacteria from root nodules with help of ethylene blue</u>	1
<u>T.S of monocot stem and root</u>	1
<u>T.S of dicot stem and root</u>	1
<u>Observation of permanent slides: Anther, ovules, embryo sac, embryo and endosperm</u>	1
<u>Anatomy of dorsiventral leaf and isobilateral leaf</u>	1
<u>Chlorophyll estimation</u>	1
<u>Test for alkaloids & phenol</u>	1
<u>Preparation of mycorrhizal slides by trypan blue method</u>	1
Total	13

Reference Books:

1. Bold, H.C., Alexopoulos, C.J. and Delevoryas, T. 1980. Morphology of Plant and Fungi (J,n Edition). Harper and Foul Co., New York.
2. Bold H.C. and Wynne M.J. 1978. Algae-Structure and Reproduction. Prentice hall Englewood cliffs, New Jersey.
3. Dube, H.C. 1990. An Introduction to Fungi. Vikas Publishing House Ltd., Delhi.
4. Gangulee and Kar, College Botany Vol.I and II.
5. Parihar N.S. 1967. An introduction to Bryophyta
6. Parihar N.S. 1967. An introduction to Pteridophyta.
7. Prescott G.W. 1981. Algae- A Review.
8. Sundarajan, College Botany, Vol.I and II.
9. Vasishta B.R. 1988. Algae S.Chand and Company New Delhi.
10. Webster J. (1970). Introduction to Fungi. Cambridge University Press, New York.
11. College Botany, Pandey, Mishra and Trivedi

Paper II : General Microbiology (Theory)

Topics	No. of periods	Weightage (marks)
Criteria for classification of bacteria, definition of species, examples of each major group.	3	20
Bacterial identification	2	
Classification of viruses with examples	2	
Bacterial structure: Gram + ve and –ve, cell wall, cytoplasmic membrane, cytoplasmic inclusion and nuclear material.	3	
Nutritional types of bacteria: Autotrophs, Heterotrophs, Phototrophs and Chemotrophs and obligate parasite with examples of each types.	2	
Reproduction of bacteria	1	20
Growth curve: lag, exponential, stationary and death phase	1	
Nutritional requirement, Bacteriological media, selective media, maintenance media, differential media	2	
Microbial diversity in extreme environments: Thermophiles, barophiles, halophiles, acidophiles and alkaliphiles	3	
Soil microbiology – Phosphate solubilization, Nitrification, Denitrification, Symbiotic /non symbiotic nitrogen fixing bacteria	4	
Bacteria in Biotechnology	1	20
Medical microbiology: Causative agent, Spread, Pathogenesis, Symptoms, Microbiological diagnosis, Prevention and control, Treatment of the following diseases: (i) Tuberculosis (ii) Plagu (iii) Bacterial meningitis (iv) Herpes (v) AIDS (vi) Flu	6	
Food Microbiology: examples of Beneficial and harmful bacteria	2	
Marine microbiology – Fresh and sea water Microbiology: Quality control and treatment	4	
Total	36	

Practical II	No. of sessions
Introduction to microbiology laboratory: Concepts of sterilization	1
Microscopy	1
Preparation of media, autoclaving, isolation of bacteria by streak method	2
Enumeration techniques: spread plate method and neubauer chamber	2
Observation of microorganisms- Monochrome staining, gram staining, spore staining (Shaffer Fultons method), fungal staining (Lactophenol cotton blue)	4
Motility study by hanging drop method	1
Growth curve of bacteria	1
Use of biochemical test kits for pathogenic bacterial identification	1

Total 13

Reference Books:

1. Principle of Microbiology by Mehrotra & Sumbali
2. Brock Biology of Microorganisms by Madigan, Martinko & parker.
3. Microbiology by R C Dubey.
4. Microbiology by Prescott, Harley, Klein.
5. Essentials of Microbiology by Frobisher.
6. Microbiology by Pelczar.
7. General Microbiology by Stanier.
8. Textbook of Microbiology by Ananthanarayan.

Paper III : Basic Biosciences II (Theory)

Topics	No. of periods	Weightage (marks)
a) Introduction to animal world, classification and taxonomy of animals. Applications of systematic Zoology	2	20
b) Animal classification- importance, binomial nomenclature, five kingdom approach, taxonomy, concept of species, Introduction to molecular taxonomy	3	
c) study of animal types – Amoeba:Entamoeba histolytica, hydra, starfish, frog, earthworm, mosquitos- morphology, structure, classification upto generic level- adaptation locomotion, nutrition, respiration, reproduction, Bionomic importance	8	
d) Brief idea of morphogenesis and organogenesis & placentation in mammals, overview of mammalian reproductive Physiology: gametogenesis reproductive cycles fertilization, gestation, partuition & lactation and Introduction to Immunocontraception	10	20
Neurogenic and myogenic heart, Pacemaker, normal human ECG	1	
Nuclear and Embryo transplantation	1	
Hormones and Neurohormones, Pituitary, Feedback mechanism along Hypothalamo-Hypophysial-target organ axis (any one example) endocrine pathology (Gigantism, dwarfism, Polycystic ovaries, Edison's disease)	3	20
Composition of blood, cell types and their function	1	
Neuron – structure and types. Initiation and Transmission of nerve impulses, synaptic transmission	2	
Muscle proteins, mechanism and energetics of muscle contraction	2	
A brief idea of techniques of Apiculture, sericulture, Aquaculture, Vermiculture	2	
Biodiversity: concept, threats and conservation of Indian Biodiversity, Peoples biodiversity registers	1	
Total	36	

Practical III	No. of sessions
A study of representatives of phyletic hierarchy across the animal kingdom (General characters & adaptations to be stressed)	1
Preparation of vaginal smear to study oestrous cycle in rat (wistar strain)	1
Permanent slides (1) Transverse section of mammalian gonads (2) Frog – cleavage, blastula, gastrula (3) Chick embryos – 18 hrs., 24 hrs., 36 hrs., 48 hrs., 72 hrs., 96 hrs.	1
Study of extra embryonic membranes in chicks	1
Use of vital stains to demonstrate morphogenetic movements using a chick embryo model (aseptic window technique protocol)	1
Study of cellular components of blood (1) Total count (2) Differential count,.	1
Nerve – leg preparation in a suitable insect model to demonstrate irritability and conduction of impulse.	1
Preparation of a temporary slide to demonstrate neurosecretory cells in insects	1
Preparation of a vermicompost demonstration model	1
Formulation of fish feed for any culture fish speceis	1
Visit to a protected area of the state to understand and appreciate biodiversity/Field trip	1
Total	13

Reference Books:

1. Ayer Ekabaranath, M. (2000). A Manual of Zoology. Vol. I Part I & II. S. Viswanath, Madras.
2. Barnes, R. D. (2000). Invertebrate Zoology. Hall saunders International Editions.
3. Ganguly, B.B.; Sinha, A.K., & Adhikari, S. (2000). Introduction to Biology of Animals. New Central Book Agency, Calcutta.
4. Jordan, E. L. & Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
5. Kotpal, R. L.(2000). Invertebrates. Rastogi Publication, Meerut.
6. Ayer, Ekambaranath H and Anantha Krishnan, T. N. Manual of Zoology Vol. II (Chordata) S. Viswanathan (Printers and publishers) Pvt. Ltd., Madras.
7. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co.
8. Sinha, A.K., Adhikari, S., Ganguly, B.B., Biology of Animals. Vol. II New Central Book Agency, 8/1 Chintamoni Das Lane, Calcutta.

Paper IV: Cell Biology (Theory)

Topics	No. of periods	Weightage (marks)
Ultrastructure of prokaryotic and eukaryotic cell	1	20
Microtechniques: Fixation- stains and staining methods-vital staining	2	
Sub cellular fractionation and isolation of cellular components: Cytoskeletal structure: membrane bound & membrane independent	2	
Cell cycle and Mitosis and Meiosis	3	
Membrane composition, Membrane functions: Simple diffusion, facilitated transports, Active transport, Endocytosis, pinocytosis, phagocytosis, exocytosis	3	
Cytoskeletal architecture of cell	1	20
UltraStructure and function of Endoplasmic reticulum, Golgi complex, Lysosomes, Mitochondria, Chloroplast, Ribosomes, Microsomes, Peroxisomes, Glyoxisomes, Centrioles, Microtubules, Cilia and Flagella.	12	
Nucleus: Interphase nucleus, nucleoplasm, nuclear membrane, nucleolus and nuclear pore, giant chromosomes.	2	20
Chromosome banding: G- banding, C-banding Applications	2	
Protein targeting to intracellular compartments	2	
Cell-cell interaction & communication (signaling)	1	
Cancer: Definition, Factors responsible, protooncogenes, oncogenes, molecular mechanism of development of cancer	3	
Apoptosis and cell senescence	2	60
Total	36	

<u>Practical IV</u>	No. of sessions
Cell structure-prokaryotes & eukaryotes (Yeast, animal, Plant)	2
Separation of cell using sedimentation and velocity centrifugation	1
Cell harvesting and lysis- methodology: Osmotic/chemical	2
Cytological preparation: Fixation, dehydration and staining Blood smear Giemsa stain	1
Cell counting methods: Hemocytometer	1
Sub cellular fractionation	2
Study of cell division: Mitosis and Meiosis	2
Study of polytene chromosomes/Drosophila larvae	1
Observation & Interpretation of Electron micrographs	1
Total	13

Reference Books:

1. The Molecular Biology of the cell. (2002). Albert et al.
2. Molecular Cell Biology. (1986). Darnell, J. et al.
3. Genes X (2010). Lewin, B.
4. Molecular Biology of the Gene. (2003). Watson, J.D., Hopkins, N.H. et al.
5. Developmental Biology. (1997). Gilbert, S.F.

Paper V: Biological Chemistry (Theory)

Sr. No.	Topics	No. of periods	Weightage (marks)
	THEORY		
1.	Urey -Miller's experiment. Molecular interactions: covalent, hydrogen, ionic, hydrophobic and vander waal's interactions. Water structure and unique properties.	3	6
2.	Buffers used in biochemical techniques, concept of pH, pK', nucleophiles and electrophiles.	1	
3.	Monosaccharides: classification, configuration and conformation. Structure and occurrence of storage and structural polysaccharides. glycosamines and glycoproteins. Lipids: fattyacids, triacylglycerol, cholesterol glycerophospholipids, sphingolipids and their functions. Amino Acids: Structure and nomenclature, General properties. Protein structure: classification of proteins, Structure: Primary, Secondary, Tertiary and Quaternary. Nucleic Acids: Structure of DNA and RNA, differences between DNA and RNA, forces stabilizing the structure of DNA.	3 3 3 2	20
4.	(Outlines of pathway and structures of intermediates, name of the enzymes and their regulatory aspects) Carbohydrate metabolism: Glycolysis, tricarboxylic acid cycle, pentose-phosphate pathway, gluconeogenesis, glycogen synthesis and breakdown. Oxidative degradation of proteins: Urea cycle. Lipid metabolism: Synthesis and degradation of fatty acids, glyoxylate cycle. Nucleic-acid metabolism: <i>denovo</i> and salvage pathways. Separation techniques for Biomolecules ETC and ATP production	5 2 2 2 2	20
5.	Enzymes: enzymes as catalysts, nomenclature and classification, , enzyme kinetics, mechanism of enzyme action (Michaelis menton's equation), enzyme specificity, enzyme inhibition, factors affecting enzyme activity, industrial applications of enzymes.	4	14
6.	Vitamins and their coenzyme forms	2	
7.	Hormones: Types and their physiological role	2	
	Total	36	60

Practical V

Topics	No. of sessions
Preparation of 1 N/M solutions / buffers (Any 2)	1
Principle and working of a colorimeter and spectrophotometer, Concept of complementary colors.	1
Determination of λ_{\max} and Molar extinction coefficient of a given compound	1
Estimation of reducing sugar -DNSA method.	1
Estimation of protein – Folin-Lowry's method.	1
Estimation of DNA – DPA method.	1
Isolation of lecithin and cholesterol from egg yolk.	1
Determination of peroxide value of oil.	1
Effect of pH and temperature on amylase activity.	2
Separation of amino acids by paper chromatography.	1
Separation of fatty acids by TLC	1
Separation of plant pigments by column chromatography	1
Total	13

Reference Books:

1. Lehninger, 2000. Principles of Biochemistry, CBS Publishers.
2. Stryer, L., 2002. Biochemistry. W.H. Freeman.
3. Harper, 2003. Biochemistry. McGraw-Hill.
4. Voet, D. and Voet, J.G. 1995. Biochemistry.
5. Wilson, K. & Walker, J., 2000. Practical Biochemistry.
6. Sadasivam, S. & Manickam, A., 1996. Biochemical methods. New Age International Publishers

Paper VI : Immunology (Theory)

Topics	No. of periods	Weightage (marks)
Immune system – historical perspective, Innate Passive, Active and Acquired immunity,	4	20
Cells and organs of the immune system, myeloid and lymphoid lineage	4	
Antibodies – structure, classes, properties and variants	4	
Antigens – Antigenicity, haptens, adjuvants	2	20
1° and 2° response, Antigen-antibody interactions – affinity, avidity, cross-reaction, precipitation, Assays used in immunocytochemistry	4	
B-Cell maturation & activation	3	
T-Cell maturation & activation	3	
The complement system – Functions, components and activation pathways (classical, alternate & lectin)	2	20
Immune response to bacterial infection	2	
Immune response to viral infection	2	
Immunodeficiency – Types , AIDS	2	
Vaccination	2	
Polyclonal & monoclonal Ab (Hybridoma)	2	
Total	36	60

Practical VI

Topics	No. of sessions
Differential count of WBC	1
Preparation of serum	1
Single Radial Immunodiffusion	1
Ouchterlony's double diffusion method	2
Blood grouping and Rh factor	1
Immuno-electrophoresis	1
ELISA (Demonstration)	1
Serological tests involving precipitations (Pregnancy and WIDAL)	2
Total	10

Reference Books:

1. Kuby, J., 2000. Immunology. W.H. Freeman.
2. Herzenberg LA, Weir DM, 1986, *Weir's handbook of experimental immunology*; 5th edition, Blackwell Publishing, Oxford.
3. Essential Immunology (2005) Roitt I.M. and Delves P.J. Acheson NH., Fundamentals of Molecular Virology, Wiley, 2007.

Paper VII: Biostatistics and Computer applications in Biology (Theory)

S.No	Topics	No. of periods	Weightage (marks)
Section A			
1	Scope of Biostatistics, population and sample.	2	15
2	Measures of central tendency and dispersions – Mean, Median, Standard Deviation	2	
3	Data representation – Tabulation bar, histogram & OJIV	3	
4	Analysis of variance	2	
5	Probability distribution: binominal distribution	4	15
6	Linear regression and correlation	3	
7	Chi-square test	2	
Section B			
9	Types of operating systems , Linux as an alternative to Window	1	15
10	Internet and www, FTP, HTTP, and Telnet	2	
11	Search engines, web indexes, meta search engines, Boolean operators	2	
12	Basic word processing in Microsoft excel and powerpoint	4	
13	Concept of database	1	15
14	Biological databases: Nucleotide, protein, protein structure and others	4	
15	Searching Sequence databases	1	
16	Online journal databases: Pubmed, medline	2	
17	Emerging areas in bioinformatics	1	
	Total	36	60

Practicals

Topics	No. of sessions
Collection of data & statistical calculations	6
Making a presentation in power point	1
Graphical presentation of data using MS excel	2
Using search engines and use of Boolean operator	2
Accessing DNA/proteins sequence database	1
Total	12

Reference Books:

- 1) Bryan Bergeson, M.D . Bioinformatic Computing (2003) Pearson Education
- 2) Murthy, C.S.V Bioinformatics (2003) Himalaya Publishing House
- 3) Glover and Mitchel.(2002). An Introduction to Biostastics McGrewHill Publishers

Paper VIII: Molecular Biology & Genetics (Theory)

Topics	No. of periods	Weightage (marks)
Overview of Mendelian Genetics, dominance, co-dominance, segregation and independent assortment. Chromosomes as Mendelian units of heredity	3	18
Structure of eukaryotic chromosomes	1	
DNA Mutation: Spontaneous and Induced mutation, Mutagens, DNA repair systems	4	
DNA replication in prokaryotic and eukaryotic system	3	
RNA : m-RNA, t-RNA and r-RNA Promoters in prokaryotes and eukaryotes, Transcription : Initiation and termination. Post transcriptional modification of mRNA	4	18
Protein synthesis: Ribosomes, Initiation, elongation and termination. Protein factors involved in translation	2	
Genetic code: Discovery of genetic code, Characteristics of code Proof reading and accuracy of translation	2	
Regulation of gene expression at the level of transcription Prokaryotes (Operon – <i>lac</i> , <i>trp</i>) and eukaryotes	3	
Genetic diseases Gene action and related diseases (Alkaptonuria, Phenylketonuria, Sickle Cell Anaemia). Autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes.) Oncogenes and malignancy- Involvement of genes in cancers. Oncogenes classes, tumor suppressor genes.	8	24
Gene transfer in bacteria: Transformation, transduction and conjugation	6	
Total	36	60

Practicals

Topics	No. of sessions
Isolation of DNA from bacterial and eukaryotic cells (plant/animal systems).	2
Isolation of RNA from bacterial and eukaryotic cells (plant/animal systems)	2
Agarose gel electrophoresis of DNA and RNA	1
UV survival curve for <i>E.coli</i>	1
Chemical mutagenesis and isolation of auxotrophic mutants	1
Transformation of <i>E.coli</i>	1
Titration of phages P1 and λ , studying plaque morphology	1
Karyotype analysis of numerical and structural chromosomal aberrations using printed material (Normal, Cri-du-chat, Turner, Duch syndrome, Barr, Klinefelter	4
Total	13

Reference Books:

- 1) Principle of Genetics (1991). Gardner, E.J., Simmons, M.J. & Snustad, D.P.
- 2) Genetics (1990). Strickberger, M.
- 3) Genes VIII (2002), Lewin B
- 4) Molecular Biology of the Cell (1989) Alberts. *et al.*
- 5) Molecular Biology of the Gene (1987) Watson *et al.*
- 6) Cell and Molecular Genetics (1987) Schlesf, R.
- 7) Microbial Genetics (1987). Friefelder, D
- 8) Experiments in Molecular Genetics (1972) Miller J.H.
- 9) Laboratory manual in Molecular Genetics (1979). Ja yaraman, K & Jayaraman, R.

Paper IX: Concepts in Genetic Engineering (Theory)

	Topic	No. of periods	Weightage (marks)
Unit I			
1	Milestones in Genetic engineering, Definition of Gene and Recombinant DNA, Steps in Genetic Engineering	2	20
2	Restriction enzymes, Types, Recognition sequences, cleavage pattern, restriction mapping. DNA ligases.	3	
3	Other DNA modifying Enzymes Polymerases- Reverse transcriptase, Klenow polymerase Nucleases- Exonuclease, RNases Polynucleotide kinases Alkaline phosphatase. Nucleotidyl transferase	3	
4	Cloning of Foreign DNA; ligation by cohesive, blunt-end and homopolymer tailing	2	
5	Introduction of recombinant DNA into suitable host CaCl ₂ induced competence in <i>E.coli</i> In vitro packaging (Viral vectors)	2	
Unit II			
6	Principle of DNA and Plasmid Isolation. Analysis of DNA and RNA yields agarose gel. Spectrophotometric -Orcinol and DPA analysis	4	20
7	Separation of DNA Centrifugal Separation: Velocity and Equilibrium Sedimentation. Gel electrophoresis: agarose and PAGE, DNA molecular weight markers	4	
8	Studying gene regulation. Southern, Northern and Western Blotting	4	
Unit III			
9	Vectors Properties of ideal cloning vectors Characteristic of Plasmid, Bacteriophage Lambda and cosmid vectors with 2 examples Plasmid Vectors: pSC101, pUC series, pBR 322 Bacteriophage life cycle Bacteriophage Vectors: Lambda insertion(λ gt 10, λ gt 11), Lambda replacement (λ EMBL3, λ EMBL 4),	8	20

	M13vectors (M13mp series) Cosmid vectors any 2 examples. Definition of Phasmid and Phagemid vectors.		
10	Preparation of genomic library Library and its Screening, Brief mention of vectors used for Library Constuction	2	
11	mRNA isolation and cDNA Preparation of mRNA and cDNA Problems encountered in the preparation of cDNA Preparation and Screening of Libraries.	3	
Unit IV			
12	Selection/screening of Recombinants -Use of reporter genes (Amp, Tet) Colony hybridization, Functional Complementation	4	20
13	DNA sequencing Maxam Gilbert's method, Dideoxy Sequencing	3	
14	Genetic Engineering Guidelines. Level of Physical and Biological containment Risks Groups of Micro-organisms Physical Containment (BSL-1, BSL-2, BSL-3, BSL-4) Biological Containment (Vector and Host Mechanisms)	6	
Total		50	80

Reference books:

1. Gene Biotechnology (2006) S.N. Joganand
2. Biotechnology: Fundamentals and applications (2004) S.S. Purohit
3. Biotechnology : Expanding Horizons (2004). B. D. Singh Kalyani Publications
4. Gene Cloning T. A Brown Blackwell Science Publications.
5. Principles of Gene Manipulatings Old and Primrose Blackwell Science Publications.
6. Textbook of Biotechnology By H.K. Das

Practicals		No. of sessions
1	Plasmid isolation by i) Alkaline lysis ii) Boiling method	2
2	Analysis of plasmid DNA by agarose gel electrophoresis	1
3	Restriction digestion of plasmid and gel electrophoresis, Molecular Size Determination	1
4	Ligation of λ / HindIII fragments and gel electrophoresis	1
5	Transformation of pUC 18 in JM109 and α complementation study using Xgal and IPTG	2
6	Deciphering the DNA sequence from a sequencing gel photograph (Maxam and Gilbert's method and Sanger's method)	1

Paper X: Plant Tissue Culture (Theory)

Unit	No.	Topic	No. of periods	Weightage (marks)
01	01	Conventional Breeding methods: Introduction of following concepts: Inbreeding, Selective breeding, cross hybridization, hybrid vigour, production of pure lines, Role of male sterility in plant breeding, Green revolution.	04	20
	02	History of plant tissue culture- International and Indian	01	
	03	Laboratory organization and requirement:- Washing and drying room, media preparation room, culture room, various sterilizing techniques used in plant tissue culture work, Green house	03	
	04	Plant tissue culture media i. major and minor inorganic nutrients, vitamins, carbon source, growth regulators, complex organic additives and their functions ii. examples of some commonly used plant tissue culture medium. iii. Ideal conditions for incubation of cultures	04	
02	05	Totipotency and its importance: Various parts of plant serving as explants, Surface sterilization of explants.	03	

	06	Organ culture: Root, shoot tip/meristem, ovary culture	04	20
	07	Somaclonal variation: Concept, isolation of variants, mechanisms of somaclonal variation and applications	03	
	08	Callus culture: Principle, morphology and structure of callus, significance	03	
03	9	Regeneration: Definitions, general account of shoot and root regenerations, factors affecting, applications.	01	20
	10	Somatic Embryogenesis: Principle, protocol and applications, artificial seeds	02	
	11	Embryo culture : Types, Principle and applications	02	
	12	Anther culture: Principle, Androgenesis, advantage of pollen culture over anther culture, importance of haploid plants	02	
	13	Applications of tissue culture in plant sciences: Micropropagation , plant improvement, production of biochemicals, Gene conservation banks, applications in forestry	04	
	14	<i>Agrobacterium tumefaciens</i> and <i>A. rhizogenes</i> and their applications in plant biotechnology -General account of TI and RI plasmid and role of T-DNA and applications.	02	
04	15	Cell suspension culture: Principle and isolation, growth pattern, concept of batch and continuous culture, viability test, culture of single cell using filter paper raft nurse technique, applications	04	20
	16	Protoplast culture: Isolation and culture, enzymes used in protoplast isolation, viability, application of protoplast culture, protoplast fusion: spontaneous and induced, hybrid identification and applications	06	
	17	Production of secondary metabolites in culture	02	
Total			50	80

Reference Books :

- 1) Plant cell and Tissue Culture Narayanswamy S.
- 2) Methods in plant tissue culture Kumar U.
- 3) An introduction to plant tissue culture, Kalyankumar De, New Central Book Agency.
- 4) Introduction to Plant Biotechnology, 2nd Edition, H.S Chawla, Oxford and IBH publishers.
- 5) Expanding horizon in Biotechnology, B.D Singh.
- 6) Plant Tissue Culture, T.B Jha, Biswajit Ghosh, Universities press.
- 7) Cytogenetics, plant breeding and Evolution, Sinha & Sinha.

Lab course in Genetic Engineering and Plant Tissue Culture		No. of sessions
1	Washing and sterilization of glassware and culture vessels	1
2	Preparation of culture media and sterilization	1
3	Induction of callus from carrot cambial explants	1
4	Induction of callus from <i>Phaseolus mungo</i> hypocotyl	1
5	Regeneration of shoots and roots from callus culture	2
6	Single cell isolation and checking viability	1
7	Somatic embryogenesis	2
8	Preparation of artificial seeds	1
9	Shoot tip culture	1

Paper XI : Industrial Biotechnology (Theory)

No.	Topic	No. of periods	Weightage (marks)
1.	Introduction and scope of Industrial Microbiology: a) Definition of Industrial Microbiology b) Scope c) Historical developments of Industrial Microbiology	1	Unit 1 (20)
2.	Fermentation Equipment and its use: a) Definition of Fermentor/Bioreactors b) Structure of Ideal Fermentor c) Definition and uses of <ul style="list-style-type: none"> • Impellers and their types • Spargers and their types • Baffles • Headspace d) Controls and Sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor) e) Types of reactors (Definition, description, diagram and uses) <ul style="list-style-type: none"> • Stirred Tank reactors • Bubble columns • Airlift Bioreactors (internal and external loop) • Fluidised bed • Packed Bed column • Photobioreactors • Tray bioreactors 	5	
3.	Screening and selection of micro-organisms: A)Primary Screening- Definition and techniques		

	<ul style="list-style-type: none"> • Crowded Plate • Auxanography • Enrichment • Indicator dye <p>B)Secondary Screening- Definition and features</p> <p>Stock cultures:</p> <p>A)Aims of preservation of cultures</p> <p>B)Definition of working and primary stock cultures</p> <p>C)Techniques of preservation</p> <ul style="list-style-type: none"> -Serial subculture -Sterile soil, water, silica gel -Sterile mineral oil -Lyophilisation -Storage in liquid Nitrogen 	5	
4.	<p>Fermentation media :</p> <p>A) Characteristics of an ideal Production media</p> <p>B) Media Composition</p> <p>i). Crude.</p> <p>ii). Synthetic.</p> <p>C) Raw materials and examples of</p> <ul style="list-style-type: none"> • Saccharine materials. • Starchy materials. • Cellulosic materials. • Hydrocarbons. • Nitrogenous materials. • Antifoam. • Buffers. <p>D) Media Sterilization and contamination</p> <ul style="list-style-type: none"> • Sterilization of production media: • Heat, radiation, chemical methods and filtration. • Batch and continuous sterilisation • Sterilization of air. <p>E) Inoculum preparation</p>	3	
5.	<p>Detection and assay of fermentation products:</p> <p>A). Physical or chemical assay.</p> <p>i). Titration and gravimetric assay.</p> <p>ii). Turbidity analysis and cell determination.</p> <p>iii). Spectrophotometric assay.</p> <p>iv). Chromatographic partition assay.</p> <p>B). Biological assay-Definition benefits and drawbacks.</p> <p>i) Diffusion assay.</p>	3	Unit 2 (20)

	Matrices and uses. ii) Ion Exchange:Principle, types of resins(cationic and anionic). iii) Molecular sieve:Principle and applications. iv) Partition:Principle,uses and types of reverse phase v) Affinity:Principle,ligands and counter ligands with eggs and applications J. Drying: i) Convection drying eg. spray dryers. ii) Freeze drying	2 1 2 2 1	
8.	Anaerobic Fermentation : Brief concept of organisms, fermentation conditions, media, recovery and uses of A) Industrial alcohol B) Wine	3	Unit 4 (20)
9.	Antibiotic Fermentation: Brief concept of organisms, fermentation conditions, media, recovery and uses of A)Penicillin B)Streptomycin	3	
10.	Microbial cells as Fermentation Products: Brief concept of organisms, fermentation conditions, media,recovery and uses of A) Mushroom Cultivation. B) Bakers Yeast	4	
11	Organic acid Production: Brief concept of organisms, fermentation conditions, media, recovery and uses of A)Citric acid B) Kojic acid	4	
Total		50	80

Reference Books:

- 1) A text book of Industrial Microbiology by Wulf Cruger and Anneliese Cruger
- 2) Fundamentals of Biotechnology by P.Prave, U. Faust, W. Sitting and D.A. Sukatsch
- 3) Industrial Microbiology by L.E. Casida
- 4) Food processing: Biotechnological Applications by S.S. Marwaha and J. K. Arora.
- 5) Industrial Microbiology by Prescott and Dunn
- 6) Industrial Microbiology by A.H.Patel
- 7) Bioseparations Principles and techniques by B.Sivasankar.
- 8) Basic Biotechnology by Collin Ratlege.

Lab course in Industrial Biotechnology	No of sessions
Growth curve using fermentor	1
Setting up a Batch and fed batch fermentation	2
Production of alcohol using jaggery	2
Production of vinegar	1
Production of wine	1
Screening for antibiotic producers and assay	1
Industrial visit to a Brewery/Wine Making unit	1

Paper XII: Environmental Biotechnology (Theory)

Topics	No. of periods	Weightage (marks)
The meaning & scope of Environmental Biotechnology -History of Environmental Biotechnology. -Current status of Biotechnology in environmental protection.	1	20
Ecosystem approach in Environmental Management A brief idea of: -Ecosystem structure & function. Definition, Structure of abiotic –Physical & Chemical element & biotic -Producers, Consumers. -Ecosystem types and their developmental history. -Eco-energetics Terrestrial (Forest), Aquatic (pond)-concept of succession. Food chain, Food web, Ecological Pyramids (Upright), 10% law Biogeochemical cycles. Schematic Representation-C, O, P, N, S. -Environmental Impact Assessment (EIA). Definition, Methods of Assessment -Environmental Management Plan (EMP). Definition, Concept of sustainable development,	4	

<p>Environmental Resources & Perturbations -A brief idea of atmosphere, hydrosphere and lithosphere; with reference to their composition, ecosystem services and resources. -Anthropogenic impacts (Man made pollution) on the air, water and soil. <u>Types of Pollution</u> 1) Sources of Air pollution & Ambient air quality standards - Air Quality- NEY, RSPM, SPM, NO, 2) Sources of water pollution 3) Sources of soil pollution</p>	4	
<p>Global Environmental Problems: Causes, impact & control. -Greenhouse effect, Global warming, Ozone depletion, Kyoto protocol, UV radiations, Acid rains, Biological magnification. -Malthusian increase in human population and over-exploitation of natural resource base.</p>	3	
<p>Biotechnological methods of Pollution Detection -Bioassay in pollution monitoring: Visual rating, Genotoxicity, Metabolic rating, plant test Systems, Animal Test Systems. -Tests for assessing Genetic damage: Ames Test, Cyto-genetic assay, Membrane damage. Biosensors & reporter Gene for pollution detection</p>	5	15
<p>Biotechnological methods of Pollution Abatement -Biological treatment of air pollutants: Bioscrubbers, Biofilters(Biobeds), Biotrickling filters -Microbial desulphurization of coal. -Secondary treatment of waste water: Aerobic treatment, degradation by fungi, bacteria, yeast, mixed cultures. -Activated sludge -Fixed Film Bioreactors, Rotating Bioreactors -Stabilisation Ponds -Treatment of Solid Wastes: Vermitechnology</p>	12	20
<p>Bioremediation, Biodegradation and Biosorption <i>Biodegradation</i> : Principle and applications. -Biodegradation of Xenobiotics (with 2 e.g.), Biosafety of GMOs <i>Biosorption</i> : Meaning and applications. -Use of Fungi and Algae (2 Examples each). -Use of GEMs in treatment of wastes: Super Bugs. -GEMs and Biosafety</p>	7	25
<p>Ecofriendly Bio-products <i>Bioenergy</i>: Merits against conventional fuels -Biomass for fuel conversion, process and organisms. -Biogas (Biomethanisation), Fuel alcohol (Ethanol) production, Hydrogen gas production.</p>	10	

<i>Biofertilisers</i> : Merits against chemical fertilizers- Azolla, Anabena, Azospirillum, Rhizobia-Legume, Mycorrhizal Fungi, Aquatic Green Manure <i>Biopesticides</i> : Merits against chemical pesticides- Bacillus thuringensis, Entomo-pathogenic Fungi, Plant Alkaloids <i>Bioplastics</i> : Merits against synthetic plastics- Biopol and Biolac		
TOTAL	50	80

Reference Books :

- 1) Introduction to Environmental Biotechnology. By A.K.Chatterji . Prentice Hall of India Pvt. Ltd. New Delhi 110 001
- 2) Environmental Biotechnology (Industrial Pollution Management). By B.N.Jogdand. Himalaya Publishing House, Mumbai
- 3) Environmental Biotechnology. By S.K.Agarwal. APH Publishing Corporation New Delhi.
- 4) Environmental Biotechnology: Basic concepts and applications. By Indu Shekar Thakur. I.K.International Pvt. Ltd. New Delhi
- 5) Biotechnology. By B.D.Singh. Kalyani Publishers .

Lab course in Environmental Biotechnology	No of sessions
Industrial visit to an effluent treatment plant	1
Detection of coliforms in given water sample <ul style="list-style-type: none"> • MPN • Presumptive • Confirmed • Completed 	1
Determination of total dissolved solids- TSS, TDS, TS DO, BOD- Winkler's Iodometric method COD- KMnO_4 / $\text{K}_2\text{Cr}_2\text{O}_7$ Nitrates in given water sample- Brucine sulphate method/ Cd column	5
Isolation of any xenobiont degrading bacteria by selective enrichment	1

Paper XIII: Instrumentation (Theory)

S.No	Topic	No. of periods	Weightage (marks)
Unit I	Safety in Laboratories :	2	20
1	<ul style="list-style-type: none"> • General safety measures, • Hazards – chemical, physical, biological, • Spillage and waste disposal . First aid. 		
2	Principle of pH indicators & pH electrodes: <ul style="list-style-type: none"> • Henderson and Hasselbalch equation • Buffering capacity • pH indicators with egs. • Hydrogen electrode • Calomel electrode • Silver /silver chloride electrode Glass electrode(combined pH electrode).	2	
3	Principles of Microscopy: <ul style="list-style-type: none"> • Optics, Kohler illumination, Numerical aperture, resolving power. • Different parts of the microscope-objectives(10x 40x and 100x Achromats,Fluorites,apochromats),stages,condensers(Abbe,Aplanatic,Achromat)eyepieces(compensating,Huygens,Kellner and Ramsden) • Types of Light Microscopes – binocular, inverted, phase contrast, fluorescence, bright field, dark field, confocal and their uses. • Electron microscopy –Scanning and transmission – principles, magnification and resolving power. 	8	
Unit II	Separation methods:	12	20
4	Principles, instrumentation and applications of chromatographic column, Paper chromatography – ascending and descending, Thin-layer, adsorption, ion exchange, affinity chromatography Introduction to GLC & HPLC Application of chromatography		
5	Gel filtration: - Principles, methods and applications	2	
Unit III	Measurement of colours and Spectrophotometry:	3	20
5	<ul style="list-style-type: none"> • Quantitation of absorption:Beer lamberts law and its limitations. • Photoelectric colorimeter and use of filters UV and Visible Spectrophotometry(source of light,wavelength selectors ie.filters prisms,diffraction grating),sample containers and detectors • Single and double beam Spectrophotometer • Applications of colorimetry and Spectrophotometry. Fluorescence & Quenching:spectrofluorimetry		

6	Electrophoresis: <ul style="list-style-type: none"> • Basic concepts and electrophoresis apparatus • Polyacrylamide gel electrophoresis (native and SDS) • Agarose gel electrophoresis Applications.	3	
7	<ul style="list-style-type: none"> • Centrifugation: Principles – sedimentation and centrifugal force • Centrifuges and their use-types (small bench, large capacity refrigerated, high speed refrigerated). • Preparative and analytical ultracentrifuges • Design and operation of rotors a) swinging-bucket b) fixed-angle and c) vertical tube rotors. Differential and density gradient centrifugation.	6	
8	Remote sensing: Introduction to remote sensing	1	
Unit IV	Nature of radioactivity: <ul style="list-style-type: none"> • Atomic structure, • Types of radioactivity decay • Rate of radioactivity decay • Units of radioactivity • Detection and measurement of radioactivity :Methods based upon gas ionization, Methods based upon excitation(scintillation counting), methods based on exposure of photographic emulsions (autoradiography) • Safety aspects • Application of radioisotopes in the biological sciences with problems 	6	20
9			
10	Elementary spectroscopy : Principle and instrumentation: NMR, ESR, ORD, IR, Raman Spectroscopy	5	
	Total	50	80

Reference Books:

- 1) Practical Biochemistry 5th Edition by Wilson and Walker
- 2) Laboratory Manual in Biochemistry by J.Jayaraman
- 3) An Introduction to Practical Biochemistry by David T. Plummer
- 4) Biotechnology: Expanding Horizons by B.D. Singh.
- 5) Biophysical Chemistry: Principles and techniques by Upadhyay and Upadhyay (Himalaya Publishing house).
- 6) Microbiology by Precott, Harley and Klein
- 7) Environmental Science by S.C. Santra

Lab in Instrumentation

No.	Practicals	No of sessions
1	Calibration and use of pH meter	1
2	Titration curves of aminoacids (glycine,glutamic acid,histidine,lysine) and determination of pKa values.	1
3	lysis of bacterial cells (<i>E.coli</i>) by i) detergents(SDS) and ii)Ultrasonic waves(demonstration)	2
4	Ammonium sulphate fractionation of the proteins and PAGE	2
5	Preparation of sucrose density gradient and purification of nuclei.	1
6	Chromatography: Gel filtration or ion exchange(demonstration)	1
Total		8

Paper XIV- Animal Cell Culture

No.	Topics	No of periods	Weightage (marks)
UNIT I			
1	Structure and organization of animal cell. Introduction to animal cell culture	1	20
2	Historical background	1	
3	Developmental biology of the cell	9	
4	Requirement for animal cell culture technology: Washing room, Media preparation and sterilization room, Inoculation and culture room., Equipments, culture vessels for tissue culture	2	
UNIT II			
5	Growth media: Natural and artificial media, Artificial media: basal salt solution and other constituents such as aminoacid, vitamins and antibiotics, serum as complex supplement: growth factors, other complex supplements Serum free and protein free media, their applications, Advantages and disadvantages. Influence of culture condition and media on protein expression Role of CO ₂	6	

6	Primary and established cell line cultures Historical background, Primary cultures from various sources, Advantages/disadvantages Characteristics of Established cell lines/continuous cell lines, Establishment of continuous cell lines: spontaneous, chemical transformation and viral transformation	6	20
UNIT III			
7	Basic techniques of mammalian cell cultures: Material source: isolation of cells, enzyme digestion of tissue, mechanical disaggregation, subcultures, Explant cultures Characteristics of normal and transformed cells Maintenance of stock cultures, Antibiotic free stock cultures Cell separation: Physical method of cell separation, separation based on cell size/cell density/cell surface charge and affinity, Separation by cytofluorometry	8	20
9	Characterization of cultured cells: Cytogenetics, karyotyping, Isoenzymes and immunological tests	2	
10	Growth measurement: Direct method: Particle counter, dye exclusion test, cytotoxicity assay Indirect method: MTT assay	3	
UNIT IV			
8	Phases of cell growth, population doubling level, morphology	1	20
11	Eukaryotic cell cycle, Synchronization: G ₁ , G ₁ /S and selective detachment synchronization	2	
12	Phenotypic properties of transformed cells	1	
13	Organ: Types of organ culture Whole embryo culture Histotypic culture	2	
14	Concept of tissue engineering: Artificial skin and Artificial cartilage	2	
15	Stem cell cultures and applications	2	
16	Applications of cell culture: cell culture based vaccine and valuable products from cell cultures	2	
Total		50	80

Reference Books:

- 1) Animal cell and Tissue culture (2006) Mathur Shivangi.
- 2) Animal cell culture A Practical Approach (2000) Masters John
- 3) Text book of Biotechnology (2005) Das H.K.
- 4) Biotechnology: Expanding horizons (2004) B.D. Singh
- 5) Principles and Practice of Animal Tissue Culture-Sudha Gangal (Universities Press)
- 6) Culture of animal cell –A Manual of Basic Techniques- R.Ian Freshney (Wiley- Liss Publications).
- 7) Cell and Molecular Biology- E.D.P.De Robertis (CBS Publishers)

Laboratory in Animal Cell Culture

8	Washing of glassware and culture wares, preparation of animal cell culture media, sterilization	2
9	Preparation of serum from goat blood for cell culture	1
10	Establishing a primary culture : disaggregation and setting up a monolayer culture, Observation of cell culture(chick embryo)	2
11	Subculturing of monolayer culture	1
12	Macrophage culture (peritoneal fluid or spleen cells)	1
13	Viability study of cell using trypan blue	1
Total		8

Paper XV : Applications of Biotechnology (Theory)

Topic	No. of periods	Weightage (marks)
Gene transfer in plants: <i>Agrobacterium</i> based vectors and direct gene transfer, Original Ti plasmid and organization of T-DNA, Applications of transgenic plants: insect resistance, herbicide resistance and increasing shelf life of fruit	6	UNIT 1 20
Gene transfer in animals: transfection methods: calcium phosphate, DEAE, lipofection, electroporation, retroviral, microinjection Applications of transgenic animals: gene farming/molecular farming, improved wool production/ quality, increased and desirable body growth	3	

Principals of PCR, Applications of PCR: Real time, reverse transcriptase, nested, hot-start, overlap extension.	3	
IPR, protection of IPR, plant breeder's right, geographical indications, Case studies: patenting basmati rice in USA, revocation of turmeric patent, Revocation of neem patent	6	UNIT 2 20
GMP, GLP principals for uniform quality, concepts of ISO certification and standard	3	
Use of monoclonal antibodies in disease diagnostics	1	
Concept of gene therapy and recombinant vaccines- Somatic and germline: augmentation and replacement - In-vivo and ex-vivo - Applications: - Recombinant vaccines: hepatitis surface antigen	2	
Ethical considerations of GMO: Positive and negative features of GMOs	1	
Scope and importance, commercial potential and major biotechnological industries in India	3	UNIT 3 20
Biocontrol of plant diseases using bacteria and viruses (one eg each) - Bacteria: <i>Bacillus thuringiensis</i> - Viruses: <i>Baculoviruses</i> / NPV	2	
Recombinant bacteria/ animal cell culture in production of pharmaceutically important proteins (one eg each) insulin, human factor VIII	2	
Biofuels: Biogas, bioethanol and biodiesel- Biofuels: merits v/s conventional fuels, -Biogas:substrate, digester design, microorganisms and biochemical changes. -Bioethanol: production and recovery - Biodiesel: lipids and hydrocarbons as a source	4	
Use of enzymes in detergents, leather and food processing industries. Immobilized enzymes in production of high fructose corn syrup	5	UNIT 4 20
Use of microbes Production of bioplastic Biotransformation (any 2 commercial examples) Ore leaching, Desulphurisation of coal	6	

Biosensors: principal, types and applications- Definition and general features - Generations of Biosensors: first, second and third. -Types: Calorimetric biosensor, potentiometric biosensor, amperometric biosensor, conductimetric biosensor, optical biosensor, acoustic wave biosensor, whole cell biosensor	3	
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Reference books :

- 1) Plant Genetics and Biotechnology Karanth B
- 2) Biotechnology: Fundamentals and applications (2004) S.S. Purohit
- 3) Biotechnology: Expanding horizons (2004) B.D. Singh
- 4) Genetic Engineering and applications (1999) P. Joshi
- 5) Text book of Biotechnology (2005) Das H.K
- 6) Plant Biotechnology: Chawla
- 7) Practical Biochemistry: Wilson and Walker
- 8) Medical Biotechnology: S. N. Jogdand
- 9) Gene Cloning by T. A. Brown
- 10) Molecular Biotechnology by Glick and Pasternak
- 11) Biotechnology by Satyanarayan

Lab in Applications of Biotechnology	No. of sessions
IPR databases and search for patents	2
Screening of microorganisms for industrially important enzymes <ul style="list-style-type: none"> • Amylase • Lipase • Protease • Cellulase 	1
Isolation and staining of PHB producers <ul style="list-style-type: none"> • isolation and staining with Nile Blue/ Sudan Black B 	1
Immobilization of microbial cells <ul style="list-style-type: none"> • calcium alginate • agarose • carragenan ➤ estimation of reducing sugar from starch by immobilized <i>Bacillus</i> ➤ estimation of utilization of reducing sugar by immobilized <i>Yeast/Bacillus</i> .	1
Visit to Biogas plant	1
Visit to pharmaceutical industry (diagnostic)	1

Paper XVI : Biodiversity of India: Range, Status And Concerns (Theory)

UNIT I

No.	TOPICS	No. of periods	Weightage (marks)
1	<p>Introduction to Biodiversity:</p> <ul style="list-style-type: none"> -Origins of life and its diversity – Biological evolution, Diversity and distribution, Concept in Biosphere, -Definition of biodiversity, three levels of biodiversity -India's living heritage – From respecting biodiversity to prospecting biodiversity. -Biodiversity for Ecological and Livelihood Security -Conservation, sustainable use and equity – Changing priorities vis a vis development 	6	20
2	<p>Causes of Loss of Biodiversity in India.</p> <p>Proximate Causes</p> <p><i>Declining wild biodiversity</i></p> <ul style="list-style-type: none"> -Habitat degradation and loss, Unsustainable exploitation, Bio-invasions, Decimating factors and climate change. <p><i>Loss of Agricultural & domesticated biodiversity</i></p> <ul style="list-style-type: none"> -Genetic dilution, Habitat destruction and homogenization, Invasion by exotics & hybrids, Loss of wild stock, Changing cultivation triggered by market orientation, GMO and LMO <p>Root Causes</p> <ul style="list-style-type: none"> -Inappropriate economic & development models, Development versus Environment debacle, Non-stringent implementation of law and policy, Erosion of customary rights, Marginalisation of artisanal and small-scale workers. Increasing socio-political and economic inequities, Changing cultural, ethical and moral values, Undervaluation of biodiversity values, Inappropriate law & policy, Inappropriate trade, Demographic pressures. 	7	

UNIT II

No.	TOPICS	No. of periods	Weightage (marks)
3	<p>Evolutionary, Physical and Historical aspects of India's Biodiversity:</p> <ul style="list-style-type: none"> -Geological zonation -Paleobiology: Prehistoric flora and fauna -History of human settlements and domestication -Demographic features and cultural/ethnic diversity -Indigenous traditional knowledge 	4	20

4	Profile of Indian biodiversity: Ecosystem diversity: -Biogeographic zones and their spatial extent <i>Terrestrial Ecosystems:</i> Types and current status of Forests, Grasslands and Deserts <i>Aquatic Ecosystems:</i> Types and status of marine and wetland (Fresh water & Brackish) ecosystem. -An overview of Species Diversity, Endemism and conservation status of Indian flora, fauna and microbes.	8	
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UNIT III

No.	Topics	No. of periods	Weightage (marks)
5	Policy, Programmes & Legal instruments for Biodiversity conservation, Sustainable use & Equity A brief idea of the following:- -UN Convention on Biodiversity (UN-CBD) -Johannesburg Declaration on Sustainable Development (RIO+10-WSSD) -The Biological Diversity act, 2002 -Legal protection for Forest and Wildlife in India Forest Act, 1927, Wildlife Protection Act, 1972 -National Biodiversity Strategy and Action Plan – India. (NBSAP) -People’s Biodiversity Register (PBR) -Bio-piracy and IPR regimes in India. -‘Bare feet Ecologists’ – Indigenous Ecological Knowledge and People’s conservation initiatives	8	20
6	Domesticated Plants, Animals and Cultured Micro-organisms -India as a centre of Agro-biodiversity, Domesticated livestock diversity of India, Cultured microorganisms.	3	

UNIT IV

No.	Topics	No. of periods	Weightage (marks)
7	Conservation Strategies -Gap analysis: Understanding and information, BSI, ZSI, TEKS - <i>in situ</i> conservation: PAN, CCA, ESA, Ramsar sites, Biosphere reserves - <i>ex situ</i> conservation: role of Zoos, Aquaria, Captive breeding, Gardens, Seed banks, Germplasm collections. -Sustainable use: Resisting overexploitation, resting of resource, strengthening artisanal livelihoods, Biodiversity based livelihoods, Ecofriendly products -Ensuring equity: Ensuring tenurial security of traditional communities, JFM, CFM	10	20

	-Education, Awareness & Training: Use of media, Capacity building, NEC/NIC in Pas, Involvement of the armed forces, Intersectoral coordination -Policy and law: Review and research for practical implementation. -Financial measures: Reorienting budgets towards biodiversity sensitizing. -Promoting biodiversity friendly technology		
8	Importance and Values of Biodiversity -Ecosystem services, Ethical value, Economic value, Livelihoods, health and food security value, Scientific value, Cultural value, Aesthetic value.	4	

Reference Books:

1. The Green Reader - An introduction to environmental concerns and issues. A CEE Publication, Ahmedabad.
2. Living in the Environment. By G. Tyler Miller International Thomson Publishing 1993.
3. Environmental Law in India. By Gurdip Singh Macmillan India Ltd..
4. Environmental Science. By S.C. Santra. New Central Book Agency (P) Ltd. Kolkata.
5. Introduction to Environmental Science. By Y Anjaneyulu BS Publications Hyderabad. 2005.
6. The National Biodiversity Strategy and Action Plan-India. 2202, Document of the MoE&F, Govt. of India.
7. Ecology and Environment by P D Sharma, Himalaya Publications
8. Ecology by M P Arora, Himalaya Publications
9. Text book of Environmental Sciences by A. K Aasthana and M Aasthana, S Chand Publications.

Lab in Biodiversity

No. of sessions

Prepare floral and faunal inventory of your campus using any standard field guide.* (Restrict to only angiosperms and butterflies) By observing, the plant-insect interactions determine the preferred food sources. *Besides common names, scientific nomenclature to be encouraged. <ul style="list-style-type: none"> • 10 common angiosperms, classification upto genera, description, common, scientific and local names. • Butterflies: 10 common butterflies, description (habit, habitat), Scientific and common name. (Reference: Butterflies of Goa by Parag Rangnekar) 	2
To study the Frequency, Density and Abundance of different species of a plant community using Quadrata sampling	1

<p>Visit the Fish Landing centres and conduct Basket Surveys, to establish a database for marine Ichthyo-faunal diversity and traditional fishing crafts and gears.</p> <ul style="list-style-type: none"> • Description, scientific name, common name and local name Of Fin fish (Mackerel, Sardine, White Sardine, Scienid, Pomfret, Sole fish, Cat fish, Pearls spot.) and Shell fish (tiger prawn, white shrimp, Scylla, Clam, Oyster and Squid) • Fishing crafts and gears : Description 	1
<p>To identify pollution tolerant taxa in a fresh water pond by Calculating Diversity Index (Sequential Comparison Index and Shannon-Weiner index) and biotic index of macro-invertabrates.</p>	1
<p>Document the local traditional conservation practices of Goa. (Elements of nature worship, biodiversity friendly cultural expressions)</p> <ul style="list-style-type: none"> • Descriptions 	2