MANONMANIAM SUNDARANAR UNIVERSITY TIRUNELVELI - 627 012
DEPARTMENT OF BIOTECHNOLOGY
Integrated M.Sc Biotechnology
Regulations, Scheme of Examinations and Syllabus
Effective from the Academic year 2018 - 2019

1. Objectives

- To impart theoretical and practical knowledge and skills that underpins the various branches of Biotechnology.
- To enable the students to have a thorough understanding and knowledge of different branches of Biotechnology.
- To make the students to develop the ability to think analytically in solving problems concerned with biotechnology.

2. Eligibility for Admission

The minimum eligibility conditions for admission to the M**.Sc., INTEGRATED COURSE in Biotechnology** program are given below.

The candidates for admission into the first semester of this course will be required to have qualified the Higher Secondary Examination with 60 % marks (5 % relaxation for SC, ST and physically challenged candidates) conducted by the Board of Higher Secondary Education, Government of Tamil Nadu/ CBSE/ ICS within the following Science subject groups:

1. Physics, Chemistry, Botany/Zoology or Relevant subjects
2. Physics, Chemistry or Relevant subjects

or any other Examination as equivalent thereto in Science subject. In addition, the candidate has to qualify the Entrance test conducted for admission in to this course.

Admission will be based on (i) the total marks obtained in the entrance test (50%) and the qualifying Higher Secondary examination (Physics, Chemistry, Botany, Computer science or relevant subjects only 50%) and (ii) by following the govt. norms of reservation.

3. Duration of the Course

The students shall undergo the prescribed course of study for a period not less than **five** academic years (Ten semesters) consisting of 6 semesters (I – VI) for studying fundamentals of Biotechnology (similar to Undergraduate Biotechnology) and 4 semesters (VII – X) for studying advanced Biotechnology (Post-graduate Biotechnology). Each semester contains 90 working days.

Scheme of the Course

Sem (1)	Pt. I/II/III/IV/V (2)	Sub No. (3)	Subject Status (4)	Subject Title (5)	Contact Hrs/Week (6)	Credits (7)
I	I	1	Language	Tamil/Other Language	4	4
	II	2	Language	English	4	4
	III	3	Core 1	Fundamentals of Biodiversity	4	4
	III	4	Core 2	Fundamentals of Cell Biology	4	4
	III	5	Major Practical-I	Biodiversity & Cell Biology	4	2
	III	6	Allied-I	Biochemistry-I	3	3
	III	7	Allied Practical-I	Biochemistry-I	3	2
	IV	8	Common: 1	Environmental Studies	2	2
	Subtotal				**28**	**25**
II	I	9	Language	Tamil/Other Language	4	4
	II	10	Language	English	4	4
	III	11	Core 3	Basic Microbiology	4	4
	III	12	Core 4	Fundamentals of Biotechnology	4	4
	III	13	Major Practical-II	Microbiology & Biotechnology	4	2
	III	14	Allied-I	Biochemistry-II	3	3
	III	15	Allied Practical-I	Biochemistry-II	4	2
	IV	16	Common:2	Value Based Education/Social Harmony	2	2
		Subtotal			**29**	**25**
III	I	17	Language	Tamil/Other Language	4	4
	II	18	Language	English	4	4
	III	19	Core 5	Introduction to Genetics	4	4
	III	20	Major Practical-III	Genetics	4	2
	III	21	Allied-I	Plant Physiology	3	3
	III	22	Allied Practical-I	Plant Physiology	4	2
	IV	23	Non Major Elective	Introduction to Computer	3	2
	IV	24	Mandatory	Yoga	2	2
		Subtotal			**28**	**23**
IV	I	25	Language	Tamil/Other Language	4	4
	II	26	Language	English	4	4
	III	27	Core:6	Principles of Molecular Biology	4	4
	III	28	Major Practical-IV	Molecular Biology	4	2
	III	29	Allied-II	Animal Physiology	3	3
	III	30	Allied Practical-II	Animal Physiology	4	2
	IV	31	Non Major Elective	Biostatistics	3	2
	IV	32	Mandatory	Computer for Digital Era	2	2
	V	33	Extension Activity	NCC, NSS, YRC,YWF	-	1
	Subtotal				**28**	**24**

V	III	34	Core:7	Microbial Physiology	4	4
	III	35	Core:8	Immunology	4	4
	III	36	Core:9	Nutritional Biotechnology	4	4
	III	37	Core:10	Basic Bioinformatics	4	4
	III	38	Practical V	Microbial Physiology, Immunology, Nutritional Biotechnology & Bioinformatics	4	2
	III	39	Skill Based Core:1	Mushroom culture and Vermiculture	4	4
	IV	40	Skill Based Common	Personality Development/Effective Communication/ Youth Leadership	2	2
	Subtotal				**26**	**24**
VI	III	41	Core:11	Medical Biotechnology	4	4
	III	42	Core:12	Enzyme Technology	4	4
	III	43	Skill Based Core:1	Floricultural Biotechnology	4	4
	III	44	Major Elective	Aquaculture Biotechnology	3	4
	III	45	Mini Project		8	8
	Subtotal				**23**	**24**
VII	III	46	Core : 13	Molecular Biology	4	4
	III	47	Core : 14	Applied Microbiology	4	4
	III	48	Core : 15	Analytical Techniques	4	4
	III	49	Core : 16	Genetic Engineering	4	4
	III	50	Practical-VI	Molecular biology, Applied Microbiology	2	2
	III	51	Practical-VII	Analytical Techniques and Genetics Engineering	2	2
	III	52	Electives	Electives: Select one		
				1. Marine Biotechnology	3	3
				2. Cancer Biology		
				Subtotal	**23**	**23**
VIII	III	53	Core : 17	Food Biotechnology	4	4
	III	54	Core : 18	Nano Biotechnology	4	4
	III	55	Core : 19	Genomics and Proteomics	4	4
	III	56	Core : 20	Agricultural Biotechnology	4	4
	III	57	Practical-VII	Food Technology & Nano Biotechnology	2	2
	III	58	Practical-VIII	Genomics and Proteomics & Agricultural Biotechnology	2	2
	III	59	Electives	Electives: select one	3	3
				Pharmaceutical Biotechnology		
				Gene Therapy		
	III	60	EDC	Extra Departmental Course (NPTEL Online Course)	3	3
				Subtotal	**26**	**26**

IX	III	61	Core : 21	Animal Biotechnology	4	4
	III	62	Core : 22	Plant Biotechnology	4	4
	III	63	Core : 23	Industrial Biotechnology	4	4
	III	64	Core : 24	Environmental Biotechnology	4	4
	III	65	Practical- IX	Animal Biotechnology, Plant Biotechnology	2	2
	III	66	Practical- X	Industrial Biotechnology & Environmental Biotechnology	2	2
	III	67	Electives	Electives: Select one	3	3
				Management in Biotechnology		
				Stem cells and regenerative biology		
	III	68	EDC	Extra Departmental Course (NPTEL Online Course)	3	3
				Subtotal	**26**	**26**
X	III	69	Core : 25	Research Methodology	4	4
	III	70	Core : 26	Bioethics, IPR and Entrepreneurship	4	4
	III	71	Project	PROJECT (Related to Biotechnology)	17	13
				Subtotal	**25**	**21**
				Grant Total	**263**	**241**

SEMESTER I

Fundamentals of Biodiversity (Core)

L	P	T	C
4	1	3	4

Preamble

To have an insight on biodiversity types, hot spots, bio resources, economic values of biodiversity.

Unit I.

Biodiversity - Definition: Genetic diversity, Species diversity, Ecosystem diversity: Structural and functional aspects. Ecosystem: Basic concepts, components of ecosystem. Trophic levels, food chains and food webs and ecological succession. Ecological pyramids, ecosystem functions. Energy flow in ecological systems, energy efficiencies. – 15 hrs

Unit II.

Value of Biodiversity: Intrinsic, consumptive, productive use, social, ethical, aesthetic and option values. Utilitarian values of biodiversity-goods, services and information. Biodiversity at global, national and local levels India as a Mega Diversity Nation, Hotspots of Biodiversity: Criteria for determining hot spots. – 15 hrs

Unit III.

Population: Basic concepts, population characteristics – density, natality, mortality, age-structure, population growth. Ecological niche and habitat. Positive and negative interactions of populations – competition, predation, parasitism, mutualism. – 15 hrs

Unit IV

Threats to Biodiversity: Habitat loss, pollution, species introduction, global climate change, overexploitation, poaching of wildlife. Extinction: mass extinction, extinction process, ecosystem degradation, over exploitation, invasive species. Human factors: social factors, economics, politics and action. Man-wildlife conflicts. Endangered and endemic species of India, – 15 hrs

Unit V

Conservation of Biodiversity: Strategies for conservation: In-situ and ex-situ conservation environmental assessment, protected areas-biosphere reserves, national parks, sanctuaries, tiger reserves project tiger. Ex situ conservation-Managed ecosystems, biological resources and gene banks, botanical gardens, bio-parks, simulated ex situ conservation strategies, valuing biological resources, ecotourism, Role of IUCN, Biodiversity International, IPGRI, WWF, FAO, BSI, ZSI, NBPGR, NBFGR, NBAGR, NFPTCR – 15 hrs

Fundamentals of Cell biology - Core

L	P	T	C
4	1	3	4

Preamble:

Understanding the origin of life on earth, knowing the plant and animal cell structures, biogenesis of cellular organelles, insight of prokaryotic cell structure, function and modes of transport occurring in the cells.

Unit I

Origin of life on Earth - The theory of Extraterrestrial contact - import of life through meteorites. Theory of Chemical Evolution, Primitive Earth Conditions - anoxic reductive atmosphere, relatively high temperature, Volcanic eruption, radioactivity, high frequency UV radiation. Abiotic formation of sugars, amino acids, organic acids, purines, pyrimidines, glycerol and formation of nucleotides and their polymerization to RNA on reactive Surfaces, polymerization of amino acids to Polypeptides and Proteins. Ribozymes and RNA World.Formation of DNA, Formation of nucleoproteins, Prions, Natural Selection of Self replicating Polymers – 15 hrs

Unit II

Basics of Cell Biology (structure & function)-Discovery of cell and Cell Theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus; Chemical components of a cell; Catalysis and use of energy by cells – 15 hrs

Unit III

Biogenesis of Cellular organelles-Biosynthesis of mitochondria, chloroplast, ER, Golgi complex; Biosynthetic process in ER and Golgi apparatus; Protein synthesis and folding in the cytoplasm; Degradation of cellular components – 14 hrs

Unit IV

Structure and function of Prokaryotic cell & its components - The Slime and the cell wall of bacteria containing peptidoglycan and related molecules; the outer membrane of Gram-negative bacteria, the cytoplasmic membrane. Mesosomes, flagella, Pilus, fimbriae, ribosomes, carboxysomes, sulfur granules, glycogen, polyphosphate bodies, fat bodies, gas vesicles; endospores, exospores, cysts. Mycelia of fungi and Actinomycetes, Cytoskeleton filament, heterocysts and akinetes of Cyanobacteria, Gliding and motility – 15 hrs

Unit V

Membrane structure & transport - Models of membrane structure, Membrane lipids, proteins and carbohydrates; Solute transport by Simple diffusion, Facilitated diffusion and Active transport – 15 hrs

References

1. Bruce Alberts *et al*., Essential Cell Biology, Taylor and Francis Group, 2014
2. John K. Young, Introduction to Cell Biology, World Scientific, 2010.

3. George Plopper, Principles Cell Biology, Jones & Bartlett Publishers, 2016
4. Aubrey Stimola, Cell Biology, The Rosen Publishing Group, 2011.

Major Practical –I

Biodiversity & Cell Biology

1. Prospecting of plants for alternative (non-conventional) energy sources.
2. Phytoremediation of polluted soils / water.
3. Biodiversity of a habitat.
4. Biodiversity of a selected sacred groove.
5. Study of a natural ecosystems around.
6. Micrometry - Use of Microscopes, Cameralucida, Stage and Ocular Micrometer.
7. Examination of live bacteria from curd.
8. Counting of RBC and WBC using Haemocytometer (Demonstration only)
9. Mounting buccal epithelium and observing living cells using vital siaining.
10. Mitosis in Onion root tip squash.

Biochemistry I – Allied

L	P	T	C
3	1	2	3

Preamble:

To have clear background information concerned with biomolecules - carbohydrates, lipids, proteins with their classifications coupled with enzyme kinetics.

Unit I

Carbohydrates: Structural aspects - Introduction & Occurrence, Classification of Mono, Di and Polysaccharides, Reducing & Non-reducing Sugars, Constitution of Glucose & Fructose, Osazone formation, Pyranose & Furanose forms, Determination of ring size, Inter-conversion of monosaccharides – 12 hrs

Unit II

Lipids: Structural aspects-General introduction, Classification & Structure of Simple & Compound lipids, Properties of Lipid aggregates, Biological membrane, Membrane protein - structural aspects, Lipoproteins – 12 hrs

Unit III

Proteins: Structural aspects-General introduction, Classification & General characteristics, Structure of Primary, Secondary, Tertiary & Quaternary proteins, α & β chains of proteins, Classification of Amino acids – 12 hrs

Unit IV

Nucleic acid: Structural aspects-Components of DNA and RNA, Nucleosides & Nucleotides (introduction, structure & bonding), Double helical structure of DNA (Watson-Crick model), various forms of DNA – 12 hrs

Unit V

Chemical & Enzymatic Kinetics: An introduction to enzyme; How enzyme works; Reaction rate; Thermodynamic definitions; Principles of catalytic power and specificity of enzymes; Enzyme kinetics-Approach to mechanism – 12 hrs

References

1. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Principles of Biochemistry, Wiley Interscience, 2008.

2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, Wiley Interscience, 2016.

3. Albert L. Lehninger, David Lee Nelson, Michael M. Cox, Principles of Biochemistry, W.H. Freeman, 2008.

Allied Practical –I

Biochemistry

1. Use of analytical balance and weighting.
2. Calculation, preparation of normal, molar and percentage solutions.
3. Preparation of buffers (acidic, neutral and alkaline) and determination of *p*H.
4. Titration curve of glycine and determination of *p*K and *p*I values.
5. Estimation of glucose – O T Method
6. Estimation of fructose –Seliwanoff's Method
7. Estimation of Pentose – Bial' s Method
8. Estimation of Protein – Biuret Method
9. Estimation of Urea – DAM Method
10. Estimation of Cholesterol – Zak's Method
11. Estimation of Phosphorus – Fiske Subbarow Method.
12. Preparation of Osazones and their identification.
13. Absorption maxima of colored substances- *p*-Nitrophenol, Methyl orange.
14. Absorption spectra of protein-BSA, nucleic acids- Calf thymus DNA.
15. Isolation of RNA and DNA from tissue/culture.
16. Qualitative Identification of DNA, RNA and Nitrogen Bases

Common: 1 Environmental Studies

SEMESTER II

Basic Microbiology (Core)

L	P	T	C
4	1	3	4

Preamble:

To create a thorough knowledge on microorganisms, their anatomy, mode of multiplication, metabolism, diagnosis and treatment.

Unit I

General Microbiology - History and Scope of Microbiology - Sterilization and Disinfection - different culture media - Cultivation of Bacteria - Identification of Bacteria - Principle, operation and maintenance of instruments in Microbiology – 15 hrs

Unit II

Bacterial Anatomy - Structure and Functions of cellular components of bacteria. Physiology of bacteria - Growth and nutrition of bacteria and their requirement. Bacterial metabolism - Respiration, fermentation and photosynthesis – 15 hrs

Unit III

Morphology, cultural characterisics, pathogenicity, Laboratory diagnosis and treatment of Gram Positive and Gram negative organisms. Gram Positive - *Staphylococcus, Streptococcus, Bacillus, Clostridium.* Gram Negative - *Neisseria, E. coli, Klebsiella* – 15 hrs

Unit IV

Classification and Nomenclature of Viruses - Virology - Morphology of Viruses - Properties of viruses - Viral multiplication - Amplificaion of viruses - Viral Genetics – 14 hrs

Unit V

Mycology - Features, Laboratory of diagnosis of treatment of pathogenic fungi- Superficial mycoses - Subcutaneous Mycoses - Systemic Mycoses - Opportunistic Mycoses. Parasitology - *Entamoeba histolytica* - Giardia, Taxoplasma, Plasmodium - Life cycle, Diagnosis and treatment – 15 hrs

References:

1. General Microbiology, Stanier, R. Y., Ingram, J.L.K., Wheelis, M.L and Painter, P.R, The Macmillan Press Ltd.,
2. Biology of Microorganisms, Brock, Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill
4. Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Jones, Bartlett Publishers.
5. Chemical Microbiology, An introduction to Microbial Physiology - AH Rose, Butterworth, London.
6. Microbiology - A Laboratory Manual, Cappucino, J.G and Sherman, N, Addison Wesley.

Fundamentals of Biotechnology – Core

L	P	T	C
4	1	3	4

Preamble:

To understand the fundamentals of biotechnology at molecular level in different fields concerned with medical and industrial concepts.

UNIT I

Introduction to Biotechnology Definitions: Historical perspectives, scope and importance - an interdisciplinary challenge, Classical versus Modern concepts. Conventional practice of brewing, domestic and fermented foods and milk. Introduction to prokaryotic cell and eukaryotic cell and its differences, origin of microbiology, types and importance of microorganisms. Developmental biology in evolution – 15 hrs

UNIT II

Introduction to Biomolecules and Bioinformatics. Structure and functions of nucleic acids, lipids, carbohydrates, amino acids in brief. Introduction to Bioinformatics, role of bioinformatics in biotechnology, biological databases and their applications example - Human Genome Project (PDB, Gene Data Bank) – 15 hrs

UNIT III

Molecular basis of Biotechnology. Basic laws of inheritance; Mendalian ratios, Identification of genetic material, classical experiments, extra nuclear inheritance, structure of chromosome and its functions, sex linked disorders. Central dogma of molecular biology, higher order chromatin organization. Basic concepts in plant tissue culture – 15 hrs

UNIT IV

Medical Biotechnology. Basic concepts in Animal tissue culture. Elements of Immunology - Types of immunity (Acquired and Innate), structure and functions of antigen, types of antibodies, Hybridoma technology. Etiology of cancer. Production of rDNA products, example - Insulin and Recombinant Vaccine (Hepatitis B) – 14 hrs

UNIT V

Process Biotechnology Upstream process - basic structure of fermenter, types of fermentation processes, aerobic and anaerobic process, construction of fermenter, Batch and Continuous fermentation. Downstream process - overview of downstream process in biotechnology. Case Studies - Process flowchart for the production of β-lactum antibiotic, bioethanol production and biofertilizer production, bioremediation. Stoichiometry and carbon recovery in product formation, example - ethanol, citric acid and lactic acid. – 15 hrs

References

1. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, Third Edition, Cambridge University Press, 2006.
2. Firdos Alam Khan, Biotechnology Fundamentals, CRC Press, Taylor & Francis Group, 2012.
3. W T Godbey, An Introduction to Biotechnology: The Science, Technology and Medical Applications, Elsevier, 2014.

Major Practical-II

Major practical for Microbiology & Biotechnology

1. Sterilization Techniques & sterilization of Media, Glass wares. 2. Media Preparation (solid & liquid).
2. Principles of laboratory Equipment(Microscope, laminar airflow chamber, incubator, hot air oven, spectrophotometer)
3. Measurement of Growth rate of bacteria - Turbidometric method.
4. Staining Techniques–Gram's staining, Spore Staining, Acid fast, Lacto phenol Cotton Blue Staining.
5. Characterization of microorganisms -IMVIC tests, Microscopic slide preparation –Fungi & Bacteria, Antibiotic sensitivity Test - Kirby Bauer method.
6. Isolation & Enumeration of Microorganism from water and Soil.
7. Estimation of CFU counts
8. Preparation of standard buffers and determination of pH of a solution.
9. Immobilization, vaccine production, antibody production,
10. Isolation of genomic DNA from bacteria.
11. To check PH in given sample.
12. TLC, paper chromatography.

Biochemistry – Allied

L	P	T	C
3	1	2	3

Preamble:

To provide basic informations on metabolism of carbohydrates, lipids, amino acids.

Unit I

Metabolism: Anabolism and catabolism, compartmentalization of metabolic pathways. Bio Energetics: Laws of Thermodynamics - First and second law. Concept of enthalphy, entropy and free energy. Standard free energy. Endergonic and exergonic reactions. Coupled reactions. High energy compounds - structural features of ATP and its free energy change during hydrolysis, other high energy compounds – 12 hrs

Unit II

Biological oxidation: Ultra structure of mitochondrion, electron transport chain. Electron transport complexes Complex I, II, III and IV. Uncouplers and inhibitors of respiration (Rotenone, Antimycin, Cyanide and 2,4 DNP) Oxidative Phosphorylation, P/O ratio. Formation of ATP - Outline of Mitchell's Hypothesis. Substrate level phosphorylation with examples – 12 hrs

Unit III

Metabolism of Carbohydrates: Glycogen metabolism - glycogenolysis, glycogen synthesis. Glycolysis, energetic of glycolysis.Entry of other carbohydrates into glycolytic pathway. Fates of pyruvate - conversion of pyruvate to lactae, alcohol and acetyl Co-A. Citric acid cycle and it's energetic. Amphibolic integrating roles of TCA cycle.Anaplerotic reactions.Pentose phosphate pathway and its significance. Cori cycle, Gluconeogenesis – 12 hrs

Unit IV

Metabolism of Lipids: Oxidation of fatty acid - α, β and ω types, β-oxidation of even number saturated fatty acids. Energetics of β-oxidation. Schematic representation of biosynthesis of even number saturated fatty acids and cholesterol biosynthesis. Formation of ketone bodies – 12 hrs

Unit V

Metabolism of Amino acids: General reaction of amino acid degradation - Transamination, deamination and decarboxylation. Ketogenic and glucogenic amino acids. Urea cycle and its significance. Nucleic acid metabolism – 12 hrs

References

1. Fromm, Herbert J., Hargrove, Mark, Essentials of Biochemistry, Springer, 2012.
2. Victor W. Rodwell, P. Anthony Weil, Kathleen M. Botham, David Bender, Peter J. Kennelly, Harpers Illustrated Biochemistry 30th Edition, McGraw-Hill Education, 2015.
3. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto, Biochemistry, Macmillan Learning, 2015.

Allied Practical – II

Biochemistry – II

1. Qualitative analysis of carbohydrates.
2. Estimation of sugar – Anthrone Method.
3. Estimation of reducing sugar – Dinitrosalicylic acid Method.
4. Chromatography (TLC, paper chromatography, Column chromatography.
5. Estimation of proteins by Bradford method.
6. Qualitative analysis of aminoacids.
7. Determination of pH value, MM equation.
8. Estimation of DNA by Diphenylamine method
9. Estimation of RNA by orcinol method
10. Quantitative determination of lipids.

Common:2 Value Based Education/Social Harmony.

SEMESTER III

Introduction to Genetics (Core)

L	P	T	C
4	1	3	4

Preamble:

To enrich the minds with concepts concerned with gene, chromosome, mutational types and human genetics.

Unit I

Mendelian Principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, Pseudoallele, complementation tests. Linkage: Concepts, recombination, gene mapping in prokaryotes and eukaryotes, fine structure mapping – 15 hrs

Unit II

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers - transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes – 15 hrs

Unit III

Mutation: Types, causes and detection, mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural

and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, Ploidy and their genetic implications – 15 hrs

Unit IV

Human Genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative Genetics: Polygenic inheritance, heritability and its measurements, QTL mapping – 14 hrs

Unit V

Extensions of Mendelian Principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Recombination: Homologous and non-homologous recombination including transposition – 15 hrs

References

1. Principles of Genetics Paperback - Student Edition by Gardner (Author), Simmons (Author), Snustad.
2. Concepts of Genetics 10e Paperback by Klug/Cummings/Spencer.
3. Genetics Paperback - Illustrated by P. S. Verma (Author), V K Agarwal (Author).
4. Principles of Genetics Paperback by Robert Tamarin (Author).

Major Practical – III

Genetics

1. Mendel's law of genetics - . Mono and Dihybrid crosses
2. Simple Mendelian trait and Pedigree analysis.
3. Mendelian Genetics, probability and statistics.
4. Polygenic inheritance with reference to height and weight – statistical analysis.
5. Chromatography of Drosophilia eye pigments.
6. Observation of Drosophila – wild type and mutant.
7. Observation of meiosis in *Hibiscus* , Plant Genetics module
8. Barr body identification in cells of Buccal smear.
9. Genetically Modified Foods and Plants
10. Karyotyping (process, methods, chromosome structure, mutation identification, chromosome deletion).
11. Mutagenesis in Bacteria: The Ames test
12. Preparation of polytene chromosomes (Chironomous larvae salivary gland)- squash preparation.

Plant Physiology

L	P	T	C
3	1	2	3

Preamble:

To nurture the students with plant cells, photosynthesis, respiration, transpiration, plant hormones and stress biology of plants.

Unit I

Plant Physiology (Importance of Plant Physiology); Plant cells (leaves, stem, roots, xylem & phloem) Water cells (water transport, water potential and transpiration through leaf), Osmosis. Photosynthesis-Structure and function of chloroplast, light and dark reactions, Cyclic and non-cyclic electron transfer, C_3, C_4 and CAM pathways (Crussulacean acid metabolism) – 15 hrs

Unit II

Respiration & Photo respiration: Respiration types, RQ, Citric acid cycle, Plant microbial electron transport and ATP synthesis, alternate Oxidase; Photo respiratory pathway. Nitrate & Ammonium assimilation. Nitrogen fixation, Amino acid Biosynthesis – 15 hrs

Unit III

Plant Hormones-Types & roles (Auxin, Gibberellins & Cytokinins, Ethylene, Abscissic Acid) Biosynthesis, Storage, breakdown & transport; Physiological effects& Mechanisms of action. Growth phases, Photoperiodism and Biological clocks – 15 hrs

Unit IV

Sensory Photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; Transpiration; mechanisms of loading and unloading of photo assimilates. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles – 15 hrs

Unit V

Plant stress Physiology-Responses of plants to Biotic and abiotic stress (Pathogens, insects, drought, heat, salinity, water, temperature salt). Mechanisms of resistance to biotic and abiotic stress. GMO in crops; Physiological aspects & problems of cereals, pulses, oilseeds, cotton sugarcane – 14 hrs

References

1. Rajiv Kumar Sinha, Modern Plant Physiology, Alpha Science International Ltd, 2004.
2. Hans Mohr, Peter Schopfer, Plant Physiology, Springer, 2012.
3. P. C. Trivedi, Advances in Plant Physiology, I.K. International Publishing House Pvt. Ltd. 2006.

Allied Practical – I
Plant Physiology

1. Systematic study of locally available plants belonging to the families prescribed in theory syllabus.

2. Demonstration of herbarium techniques & study about Photosynthesis - Light Reactions

3. Structure of pollen grains using whole mounts (Catharanthus, Hibiscus, Acacia, Grass) $ Demonstration of Pollen viability test using in- vitro germination (Catharanthus).

4. Study of ovule types and developmental stages of embryo sac using permanent slides /Photographs.

5. Developmental stages of onion root tip & Study of **PLASMOLYSIS** by using onion.

6. Section the parts of plants & Structure of endosperm (nuclear and cellular); Developmental stages of dicot and monocot Embryos using permanent slides / Photographs

7. Demonstration of Hydroponics System

8. Isolation and mounting of embryo (using Symopsis / Senna / Crotalaria)

9. Isolation of chloroplast DNA, Isolation of chlorophyll & Measuring chlorophyll in leaves & Study of plant hormone

Mandatory - Yoga

SEMESTER IV

Principles of Molecular Biology – Core

L	P	T	C
4	1	3	4

Preamble:

To understand the basic principles of molecular biology from DNA as genetic material to protein synthesis and regulation.

Unit I

DNA as Genetic Material, Griffith's Transformation, Forms of DNA and RNA, Types of restriction enzymes – 14 hrs

Unit II

Prokaryotic and Eukaryotic DNA replication, Experiments of Messelson and Stahl, Okazaki fragments, Enzymes and accessory proteins involved in DNA replication, C-value paradox – 15 hrs

Unit III

Genetic Code: Characteristic features of the Genetic Code, Transcription and translation in prokaryotes and eukaryotes, Mutations in genetic code – 15 hrs

Unit IV

Regulation of Gene Expression: Positive and Negative control, Operon concept, TVP, Operon control and catabolic repression – 15 hrs

Unit V

Molecular events of protein synthesis in prokaryotes and eukaryotes, Regulation of protein synthesis, gene pool and gene library – 15 hrs

References

1. Freifelder D and Malcinski GM Essential of Molecular Biology, 2nd Edition, Jones Barlett Publishers, 1993.
2. Watson JD, Molecular Biology of the Gene, 4th edition, Benjamin and Cummings Publishers, 1987.
3. Gerald Karp, Cell and Molecular Biology, John Wiley, 1996.

Major Practical – IV

Molecular Biology

1. To measure concentration of DNA & RNA by UV spectrophotometry
2. Using a hemacytometer to count cells.
3. SDS , Electrophorosis apparatus, structure, function.
4. Bacterial Transformation.
5. PCR principles, reaction electrophoresis, observation. (Demo)
6. Estimation of DNA (DPA method).
7. Estimation of RNA (Orcinol method).
8. Estimation of Protein (Lowry's method).
9. Separation of DNA by AGE.
10. Isolation and purification of protein (Dialysis).
11. Isolation of antibiotic resistant mutant.

Animal Physiology

L	P	T	C
3	1	2	3

Preamble:

To equip the mind with the entire systems viz., digestion, cardiovascular system, excretion, nerve and muscles and endocrine glands with a view to gain a thorough input.

Unit I

Structure & Function of Haemoglobin. Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, immunity, haemostasis. Transport of O_2 and CO_2 in mammals, Bohr and Haldane effect, Chloride shift. Digestion: Physiology of digestion in the alimentary canal; Absorption of carbohydrates, lipids, Proteins, gastric ulcers, BMR – 12 hrs

Unit II

Cardiovascular System: Structure of Heart; Origin and conduction of the heart impulse, heart as a pump, Cardiac cycle, Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance, neural and chemical regulation. Respiration: Comparison of respiration in different species, anatomical considerations, pulmonary ventilation, Respiratory

volume and capacities. Transport of O_2 and CO_2 in blood. Pulmonary diseases, neural and chemical regulation of respiration – 12 hrs

Unit III

Physiology of excretion-physiology of urine formation, urea cycle, nitrogenous wastes -ammonia, urea, uric acid, creatinine. Structure of Nephron, Counter current mechanism, Types of dialysis, ARF & CRF Physiology of osmo-regulation in vertebrates. Origin and propagation of nerve impulse through nerves, synaptic and neuro-muscular junctions, functional significance of Giant nerve fibers in mollusks – 12 hrs

Unit IV

Nerve and Muscle-Structure of Neurons, Resting membrane potential, Graded potential, Orgin of graded potential and its propagation in myelinated and non myelinated nerve fibre. Anatomy of the brain and spinal cord, central and peripheral nervous system. Molecular and chemical basis of muscle contraction – 12 hrs

Unit V

Reproduction and Endrocrine Glands: Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle; Structure and function of Pituitary, Thyroid, parathyroid, adrenal and pancreas, neuroendocrine regulation – 12 hrs

References

1 S. C. Rastogi, Essentials of Animal Physiology, New Age International Publishers, 2007.
2.Knut Schmidt-Nielsen, Animal Physiology: Adaptation and Environment, Fifth Edition, Cambridge University Press, 1997.
3.Lauralee Sherwood, Hillar Klandorf, Paul Yancey, Animal Physiology: From Genes to Organisms, Cengage Learning Pvt Ltd. 2012.

Allied Practical – II

1. Blood cells isolation (centrifuge), staining, examine under microscope.
2. Blood pressure determination, blood sugar level examination.
3. Dissection of animal body, identify the parts and sectioning, sperm structure observation, egg structure observation.
4. Dialysis process, methods, application. (Demo).
5. Skeletal muscle mechanics, and the electromyogram (EMG).
6. Cardiac cycle and the electrocardiogram (ECG).
7. Effect of autonomic neurotransmitters on the function of myogenic heart.
8. Regulation of arterial blood pressure, Energy Metabolism.

9. Body fluid compartments and the ionic composition of body fluids.
10. BMR determination

Biostatistics - Non Major Elective

L	P	T	C
4	1	3	4

Preamble:

To gather information's on collection of data, regression analysis, theories of probabilities and mathematical expectations.

Unit I

Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives. Mean, median, mode, Standard deviation – 12 hrs

Unit II

Correlation and Regression analysis: Correlations and regressions-Relation between two variables, scatter diagram, definition of correlations, curve fitting, principles of least squares, Two regression lines, Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks – 12 hrs

Unit III

Probability theory: Random experiments, sample space, probability theory, conditional probability. Baye's theorem – 12 hrs

Unit IV

Random variable (discrete and continuous), Probability density function (discrete and continuous), Distribution function for discrete random variable. Distribution function for continuous random variable, Joint probability distribution, Conditional and marginal distribution – 12 hrs

Unit V

Mathematical expectations: Introduction, The expected value of random variable, moments, Moment generating functions, Product moments, Conditional expectations. Standard distributions-Uniform distribution. (Discrete & continuous). Exponential distribution Gamma distribution, Beta distribution. Binomial distribution, Poisson distribution, Normal distributions. Standard normal distributions – 12 hrs

References

1. Bernard Rosner, Fundamentals of Biostatistics, Seventh Edition, Cengage Learning, 2010.
2. Lisa Marie Sullivan, Essentials of Biostatistics, Jones and Bartlett Publishers, 2008.
3. Veer Bala Rastogi, Fundamentals of Biostatistics, Second Edition, Ane Books. Pvt. Ltd. 2010.

Mandatory-Computer for Digital Era

Extension Activity

SEMESTER V

Microbial Physiology (Core)

L	P	T	C
4	1	3	4

Preamble:

To understand the nutritional requirements of microorganisms coupled with their growth phases, different metabolic pathways in addition to photosynthesis and anaerobic respiration.

Unit I

Nutrition: Nutritional requirements of microorganisms - Autotrophs, Heterotrophs, Photoautorophs, Chemoautotrophs, Copiotrophs, Oligotrophs, Endospore formation in Bacteria – 15 hrs

Unit II

Different phases of growth-growth curve-generation time- factors influencing microbial growth-temperature, pH, pressure, salt concentration, nutrients-synchronous growth and continous cultivation. Diauxic growth – 15 hrs

Unit III

Metabolism-EMP-HMP-ED Pathways-TCA cycle - Electron Transport Chain - Oxidative & Substrate level Phosphorylation – 14 hrs

Unit IV

Anaerobic respiration - Sulphur, Nitrogenous compounds and CO_2 as final electron acceptor-Fermentation - Alcoholic, Propionic and Mixed acid fermentation – 15 hrs

Unit V

Photosynthesis-Oxygenic & Anoxygenic, Carbon dioxide fixation, Biosynthesis of bacterial cellwall, biosynthesis of aminoacids (Glutamic acid family) – Bioluminescence – 15 hrs

References

1. Albert G. Moat, John W. Foster, Michael P. Spector, Microbial Physiology, Wiley Interscience, 2003.
2. Daniel R. Caldwell, Microbial Physiology and Metabolism, Star, 2000.
3. Robert K. Poole, Advances in Microbial Physiology, Academic Press, 2002.

Immunology (Core)

L	P	T	C
4	1	3	4

Preamble:

To know the basics on immune cells, immunity, antigen antibody reactions, hypersensitivity to allergens and major histocompatibility complex.

Unit I: Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in immune system - T-cells, B-cells, Lymphoid organ, spleen and bone marrow. Antigenic properties, T and B cell epitopes, chimeric peptides, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and natural killer cells; immune responses - cell mediated and humoral, clonal selection and nature of immune response – 15 hrs

Unit II: Antigen and Antibodies: Types, Structure and Properties of Antigens, Haptens; Adjuvant - Antigen specificity. Immunoglobulins - Structure, Types and subtypes, properties, primary and secondary responses, Antibody diversity. Complement system - Structure, Components, Properties and Functions, Complement Fixation and Complement Pathways, Biological consequences. Inflammation- Effector Mechanisms – 15 hrs

Unit III: Antigen-Antibody Reactions: Agglutination, Precipitation, Immunoelectrophoresis, Immunofluorescence, ELISA, RIA; Flow Cytometry, Montaux Test. Applications of these methods in diagnosis of microbial infections, Autoimmunity mechanisms, altered antigens, Systemic Lupus erythematosus, Graves‟s diseases, Rheumatoid arthritis, Myasthenia gravis, Multiple sclerosis. Immunodeficiency - phagocytic, humoral, CMI, combined HLA association – 15 hrs

Unit IV: Hypersensitivity Reactions: Allergy, Type I-Anaphylaxis; Type II-Antibody dependent cell mediated cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity. Symptoms and Immunological methods of diagnosis of hypersensitive reactions. Lymphokines and cytokines - Assay methods. Immunological tolerance and modulation – 14 hrs

Unit V: Major Histocompatibility Complex(MHC): Structure and functions of MHC and the HLA systems. Gene regulation and Ir-genes; HLA and tissue transplantation - Tissue typing methods for transplantations in humans; graft versus host reaction and rejection. **Tumor immunology:** tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors - detection of tumor markers - alphafoetal proteins, carcinoembryonic antigen, Cancer therapeutics. Types of vaccines and its application, Production of Monoclonal and Polyclonal antibodies – 15 hrs

References

1. Werner Luttmann, Kai Bratke, Michael Kupper, Daniel Myrtek, Immunology, Elsevier, 2006.
2. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby, Immunology, W. H. Freeman, 2007.
3. Ivan Maurice Roitt, Essential Immunology, Blackwell Scientific Publications, 1994.

Nutritional Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble:

To provide a basic knowledge on the nutritional biotechnology especially concerned with the carbohydrates, proteins, nucleic acids, vitamins and minerals.

Unit I

Carbohydrates: Glycolysis, Citric acid cycle, Electron transport chain, glycogenesis, gluconeogenesis, HMP shunt. Lipids: Synthesis and utilization of ketone bodies, ketosis, causes of fatty liver – 15 hrs

Unit II

Protein: Types of Structures, amino acid metabolism. Enzymes: Definition and classification, kinetics, Michalies-Menten equation, substrate specificity, enzyme inhibition, isoenzymes, coenzymes-definition, Biochemical function of NAD, NADP, FAD – 15 hrs

Unit III

Nucleic acid: Structure of purines and pyrimidines, nucleosides and nucleotides, Types of RNA and their functions, codons, replication, transcription and translation – 14 hrs

Unit IV

Vitamins: Structure and Biochemical roles of vitamins, Deficiency disorders of Vitamin A, D, E, K, B1, B_2, B_6, Folilc acid, Pantothenic acid, Niacin and Vitamin C – 15 hrs

Unit V

Minerals: Biochemical functions of Na, K, Ca, P, I, Fe and Se-Deficiencies and Disorders related to hyperactivity, Diseases related to nutritional deficiency-Carbohydrates, lipids, proteins, vitamins and minerals – 15 hrs

References

1. MS Swaminathan, Nutritional Biochemistry.
2. Tom Brody, Nutritional Biochemistry, 2nd Edition, Academic Press.
3. Ruth L. Pike and Myrtle L. Brown, Nutrition-An integrated approach, 3rd edition.

Basic Bioinformatics (Core)

L	P	T	C
4	1	3	4

Preamble:

To enrich the students with basic bioinformatics information's such as data types, data storage, retrieval, sequence alignments and gene expression patterns in pro and eukaryotes.

Unit I - Introduction to Bioinformatics and Data Generation

Bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software(RASMOL, Ligand Explorer). Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics – 15 hrs

Unit II - Biological Database and its Types

Introduction to data types and source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum) – 15 hrs

Unit III - Data Storage and Retrieval and Interoperability

Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE – 15 hrs

Unit IV - Sequence Alignments and Visualization

Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical Visualization – 15 hrs

Unit V - Gene Expression and Representation of Patterns and relationship

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models including Marcov chain and Bayes notes. Genetic variability and connections to clinical data – 14 hrs

References

1. Claverie, Jean-Michel and Cedric Notredame, Bioinformatics for Dummies, 2nd Edition, 2007.
2. Wiley (required text) Westhead, D.R., J.H. Parish and R.M. Twyman, Instant Notes: Bioinformatics, 2002.
3. BIOS Scientific Publishers Ltd. Xiong, Jin, Essential Bioinformatics, 2006, Cambridge University Press.
4. Campbell, A. Malcolm and Laurie J. Heyer, Discovering Genomics, Proteomics & Bioinformatics, 2nd edition, 2007, Pearson Benjamin Cummings.

Practical V

Practical V - Microbial Physiology, Immunology, Nutritional Biotechnology and Bioinformatics

1. Determination of growth curve of bacteria.
2. Bacterial population count by turbidity method.
3. Effect of pH on bacterial growth, Anaerobic respiration and fermentation
4. Biochemical characterization of bacterial cultures: catalase, urease, cytochrome oxidase and sugar fermentation, citrate utilization, gelatin liquefaction, sulfide indole,motility test.
5. Colony identification of microbes, Microbial nutrition, nutritional types & Enrichment culture.
6. Agglutination tests: a. ABO Blood grouping. b. WIDAL test. c. ASO test. d. Pregnancy test. e. RPR test.
7. Preparation of plasma and serum, Blood cell analysis – total count, differential count.
8. ELISA, FACS, Flow cytometry
9. Blotting techniques (Southern Blotting, Western Blotting, and Northern Blotting).
10. Immune diffusion methods (Radial immunodiffusion) (double immunodiffusion) , (single immunodiffusion), Rocket electrophoresis, Immuno electrophoresis
11. Enzyme-Linked Immunosorbent Assay, vaccination- definition, production, principles, application.
12. Fundamentals of proximate composition of foods
13. Protein estimation of foods by conventional method
14. Estimation of factor affecting nutrients composition of foods by Chemical and microbiological methods
15. Estimation of calorific values of foods
16. Database searching against a query sequence and selection of orthologous sequences using BLAST & database searching
17. Multiple Sequence Alignment using Clustal W.
18. Prediction of Open Reading Frames using ORF Finder
19. 3 Dimensional Structure of protein using Deep View, UCSC Genome Browser.

20. NCBI databases, Databases at EBI: EMBL-Bank, UniProt, ArrayExpress, InterProEnsembl- genome browser.

MUSHROOM CULTURE and **VERMICULTURE (Skill Based Core)**

L	P	T	C
4	1	3	4

Preamble

The paper includes the advantages and disadvantages of biotechnology in various disciplines such as bioinformatics, medicine, agriculture and environment. Also, it covers the applications of nanomaterials in biotechnology. Additionally, the paper contains gene therapy, GMO, overview about human genome research and IPR. This paper offers fine opportunity to do research work in various area of biotechnology at reputed institutions and laboratories.

Unit I

History and introduction: Edible mushrooms and Poisonous mushrooms. Systematic position, morphology, distribution, structure and life cycle of Agaricus and Pleurotus. Nutritional value, medicinal value and advantagestypes- milky, straw, button and poisonous mushrooms. Nutritional value, medicinal value and advantages- types- milky, straw, button and poisonous mushrooms

Unit II

Cultivation: Paddy straw mushroom – substrate, spawn making. Methods – bed method, polythene bag method, field cultivation. Oyster mushroom cultivation –Substrate, spawning, pre-treatment of substrate. Maintenance of mushroom. Cultivation of white button mushroom – Spawn, composting, spawning, harvesting.

Unit III

Classification – different species of earth worms. Morphology, anatomy and Physiology of earthworms. Types of Vermicomposing – Roll of earth worms in soil fertility – vermiculture – vermi-cast – vermi-technology and applications – Physical, chemical and biological properties of vermi-compost.

Unit IV

Raw materials for composting – requirements of vermicomposting. Maintenance of composting – Collection of vermicompost – Efficiency of vermicomposting – General problems in production of vermi-composting. Advantage of vermicomposting – Applications of vermicomposting – Vermicomposting of Agricultural and Urban Solid Wastes – Recycling of wastes through vermicomposting.

Unit V

Small Scale or Indoor vermicomposting – Large scale or outdoor vermicomposting. Effects of vermicompost on soil properties. Vermicompost – Quality & Economics. Prospects of vermi-culture as self employment venture.

References

1. Pandey B P 1996. A textbook of fungi. Chand and company N Delhi.

2. Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N.Delhi
3. Gupta P.K. Elements of Biotechnology.
4. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.
5. Indian Journal of Mushrooms. Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan

References

1. Biotol Series: Techniques for Engineering genes Strategies for Engineering Organisms.

2. Glick and Pasternark: Molecular Biotechnology.

3. Maniatis: Molecular Cloning-A Lab Manual Vol. I, II & III.

4. Primrose and Twyman: Principles of Genome analysis and Genomics, Third edition.

5. David M.Glover: The Mechanisms of DNA Manipulation.

Skill Based Common

SEMESTER VI

Medical Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper contains an overview, scope and benefits of medical biotechnology, infectious diseases, mechanism of drugs against the diseases and future of medical biotechnology. This paper provides excellent opening for students to carry research work in medical biotechnology at reputed institutions

Unit-I

Introduction and History of Medical Biotechnology, Scope and Benefits, Host pathogen interactions in disease process, PCR and Array based techniques in diagnosis, Bioinformatic tools for molecular diagnosis, Biotechnology in biomedicine, biopharmaceuticals – 15 hrs

Unit II

Infections of the gastrointestinal tract-Amoebiasis; Giardiasis and cryptosporidiosis, Intestinal infection by nematodes; Intestinal infection by cestodes (Taeniasis), Trematodes; Food poisoning: *E. coli* Diarrhoea; Cholera; Bacillary dysentery; Hepatitis. Infections of the Respiratory system Streptococcal infections;

Viral infections; Diphtheria; Whooping cough; Bacterial pneumonias (Haemophilus and GNB, Pneumococcus/Legionella) – 15 hrs

Unit III

Infections of the Nervous System Viral encephalitis and Aseptic meningitis; Rabies; Cysticercosis and other CNS parasitic infections; Tetanus. Sexually Transmitted Diseases and Congenital Infections Herpes Simplex virus infections; HIV infection and AIDS; Chlamydial infection; Syphilis; Mycoplasma and Ureaplasma infection; Gonorrhea and other bacterial STD; Congenital viral infections; Toxoplasmosis – 15 hrs

Unit IV

Drug and their mechanism (i)Aspirin, Paracetomol, antibiotics, antiviral drugs, drugs for metabolic disorder, anticancer drugs, antihypertensive drugs, broncho diluted drugs and their mode of action, Rationale vaccine design based on clinical requirements, DNA based vaccines, current strategy for development of vaccine against HIV, Malaria, TB – 15 hrs

Unit: V

Future of Medical Biotechnology-individualized medicine, gene therapy nano medicine, nano particles, nano devices-(nano robotics, nano medicine and nano surgery for cancer, neurological disorder, stem cell therapy – 14 hrs

References

1. Betty Forbes, Daniel Sahm, Alice Weinfield, Bailey-Scott's Diagnostic Microbiology, 12th Edition, Mosby. 2007.
2. Gerald Collee J, Andrew G Fraser, Barrie P Marmion, Mackie and McCartney's Practical Medical Microbiology, Elsevier. 2006.
3. Elmer W Koneman *et al*., Koneman's, Color Atlas and Text Book of Diagnostic Microbiology, 6th Edition, Lippincott Williams and Wilkins, 2005.

Enzyme Technology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper covers historical perspective and nomenclature of enzymes, enzymes kinetics, catalysis, molecular mechanisms of enzyme catalysis and regulation of enzyme activity. This paper provides fine chance for students to do innovative research work in enzymes at reputed institutions and laboratories – 15 hrs

Unit I

Enzymes-Historical Perspective-Nomenclature-Methods of isolation and purification-enzyme units- substrate specificity. Hypothesis-Induced fit model, Lock and key hypothesis – 14 hrs

Unit II

Enzyme Kinetics- Factors affecting enzyme activity-Michaelis-Menten equation analysis of kinetic data-Lineweaver-burk plot-Catalytic efficiency-Haldane relationship- Hill's Plot-Bisubstrate reactions-sequential-ping-pong reactions rate equations and examples. Enzyme inhibition-Irreversible- reversible-competitive-non-competitive-uncompetitive inhibition-Graphical analysis – 15 hrs

Unit III

Enzymatic Catalysis- acid-base catalysis- covalent catalysis- metal ion catalysiselectrostatic catalysis- catalysis through proximity and orientation effectscatalysis by transition state binding. Co-enzymes- A, B-complex, C, D, E and K- structure and function- IsoenzymesLD- CK- Applied Enzymology-Immobilized enzymes- methods and applications in industry- medicine- enzyme electrodes – biosensors – 15 hrs

Unit IV

Molecular mechanism of enzyme catalysis Carboxypeptidase- Lysozyme- enzyme structure-catalytic mechanism- Phillips mechanism – 15 hrs

Unit V

Regulation of enzyme activity- allosteric control- reversible covalent modification- proteolytic activation- sequential- concerted and cumulative feedback control- importance of compartmentation- Allosteric enzymes- Jacob and Monod model of allosteric enzymes- Koshland model- subunit interaction and regulation of enzyme activity – ATPase – 15 hrs

References

1. Anil Kumar and Sarika Garg, Enzymes and Enzyme Technology, Viva Books, 2015.
2. Khan, M. Y and Khan, Farha, Principles of Enzyme Technology, PHI Learning Pvt. Ltd., 2015.
3. Eric J. Toone, Advances in Enzymology and Related Areas of Molecular Biology, Wiley Interscience, 2011.

Floricultural Biotechnology (Skill based core)

L	P	T	C
4	1	3	4

Unit 1: Avenues and scope of floriculture, emerging trends in floriculture biotechnology, Floriculture in the era of WTO, National and International status of floriculture industry.

Unit 2: Cultivation of floriculture crops: Anthurium, Bird of Paradise, Carnation, Chrysanthemum , Gladiolus, Gloriosa, Iris, Jasmine, Lily, marigold, Orchids, Rose, Tulip. Nutritional aspects of Floricultiral crops.

Unit 3: Package of Practices for management of Pest and disease for floricultural crops, Role of Green House in improving the quality and productivity of floricultural plants. Eco-Friendly cultivation of floricultural crops, Compatibility for Inter cropping of floricultural crops with other agricultural crops,

Unit 4: Research and Development in Floriculture: Modern floriculture Industries. Improvement of aesthetic values, Genetic Improvement programmes through biotechnological approaches, Production of F1 hybrids, rapid propagation methods. Role of Tissue Culture in Floriculture Industry.

Unit 5: Floriculture Industries (National and International Status). Harvesting, Packing, Marketing, Revenues, Avenues for employments in Floriculture Industries, Socioeconomical aspects of floricultural industry, Sustainability.

References: Floriculture: Technology, Trades and Trends by Prakash J and Bhandary K.R. New Dlehi, Oxford and IBH Publication

Aquaculture Biotechnology (Elective)

L	P	T	C
4	1	3	4

Preamble

The paper includes an introduction about the aquatic environment, methods of floatation, collection and preservation of phytoplankton, economic importance of marine micro flora, single cell protein, pollution and genetically modified organisms. This paper provide an excellent opportunity to do innovative research in aquaculture and marine biotechnology at reputed institutions and laboratories – 12 hrs

Unit I

The aquatic environment: Physical and chemical properties of sea water, zonation, characteristics of planktonic, benthic, pelagic and abyssal life – 12 hrs

Unit II

Characteristics, Different groups and methods of floatation, Factors regulating phytoplankton, production and measurement, Methods of collection and preservation – 12 hrs

Unit III

Economic importance of Marine micro flora-industries, Antibiotics, Vitamins, Food, Dyes, Biopolymer and Agar-Agar – 12 hrs

Unit IV

Laboratory and Mass culture of Algae, Method of production of unicellular algal food, Single Cell Protein, Sea weeds Cultivation, Algal food in the field of Aquaculture – 12 hrs

Unit V

Pollution due to heavy metals, radioactive wastes, thermal, algal blooms and oil-possible remedies, oil degrading bacteria, GMO and pollution abatement, Conservation of coastal ecosystem-coral reefs, islands and mangroves – 12 hrs

References

1. Pringshem, Pure cultures of Algae, Hafner Publishing Company, 1987.
2. Tait, Elements of Marine Ecology, Butterworth and Co. Pub. Ltd, 1978.

MINI PROJECT

SEMESTER VII

MOLECULAR BIOLOGY (Core)

L	P	T	C
4	1	3	4

Preamble

The paper covers an introduction about molecular biology, structure of prokaryotic and eukaryotic gene, translation, recombination, applications of structural genomics and construction of genomic library. This paper provides an excellent opportunity for students to do research work in molecular biology at reputed institutions and laboratories

Unit I

Introduction to Molecular Biology: Chromosome-Number, size, Molecular organization of chromosome (Nucleosome model). Chemisty of Genetic material (Chargraff's rule of DNA composition and Watson-Crick Model), physical and chemical properties of DNA: Denaturation and Melting point, C-Value Paradox, DNA conformation. Mechanism of DNA Replication. Enzymes and accessory proteins involved in DNA replication. DNA proof reading. Extra chromosomal DNA – 15 hrs

Unit II

Structure of Prokaryotic and eukaryotic gene. General and specific transcription factors, Regulatory elements: TATA, CAT and Enhancers. Transcription: Mechanism of Gene expression, mRNA processing – 15 hrs

Unit III

Translation: Ribosomes, Structure and Component of Ribosomes. Differences between Prokaryotic and eukaryotic **ribosome** and **Translation:** Initiation, elongation and termination of protein synthesis. Regulation of gene expression at translational level – 15 hrs

Unit IV

Molecular basis of Recombination: Concept, General and Site specific recombination, Transposons, Significance of mobile DNA. DNA Repair Mechanism: Direct, Mismatch, Base excision repair – 15 hrs

Unit V

Genomics: Structural genomics and its application. Construction of Genomic library. Genome sequencing and its application. DNA marker and its application in genome analysis – 14 hrs

References

1. *Molecular Cloning: a Laboratory Manual,* J. Sambrook, E., F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. *Introduction to Practical Molecular Biology,* P .D. Dabre, John Wiley & sons Ltd., New York, 1988.
3. *Molecular Biology LabFax,* T.A. Brown (Ed,), Bios Scientific Publishers Ltd., Oxford, 1991.
4. *Molecular Biology of the Gene* (4th Edition), J.D. Watson, N.H. Hopkins, J. W. Roberts, J.A. Steitz and a.M. Weiner, The Benjamin/Cummings Publ.Co., Inc., California, 1987.
5. *Molecular Cell Biology* (200 Edition) J. Darnell, H. Lodish and D. Baltimore, Scientific Americal Books, Inc., USA, 1994.
6. *Molecular Biology of the Cell* (2nd Edition) B.Alberts, D.Bray, J.Lewis, M.Raif, K. Roberts, and J.D. Watson. Garland publishing, Inc., New York, 1994.
7. *Gene VI* (6th Edition) Benjamin Lewin,Oxford University Press., U.K., 1998.
8. *Molecular Biology and Biotechnology*. A comprehensive desk reference, R.A Meyers (Ed.) VCH Publishers, Inc., New York, 1995.

Applied Microbiology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper includes an introduction about the airspora of indoor and outdoor environment, techniques to trap air borne microorganisms, concept and scope of agricultural microbiology, soil microbiology, food microbiology, principles of food preservation, dairy microbiology and clinical microbiology. This paper offers job opportunity in food industries and to do research work in the microbiology, food microbiology and biotechnology at reputed institutions

Unit I

Microbiology of Air: Airspora of indoor and outdoor environment, Factors affecting airspora, Techniques of trapping air borne microorganisms. **Agricultural Microbiology**: Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution – 15 hrs

Unit II

Soil Microbiology: Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists. Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition – 15 hrs

Unit III

Food Microbiology: Definition, Concepts and Scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. **Principles of Food Preservation**-Chemical preservatives and Food additives, Asepsis- Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures,drying). Canning, processing for Heat Treatment. Contamination and food spoilage: Cereals, **s**ugar products, vegetables, fruits, meat and meat products, Fish and sea foods- poultry spoilage of canned foods – 15 hrs

Unit IV

Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Cream and butter bacteriology – 14 hrs

Unit V

Clinical Microbiology: Role of Microbiologists in Diagnostic Laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification – 15 hrs

References

1. Sanjai Saxena, Applied Microbiology, Springer, 2015.
2. Geoffrey M. Gadd, Sima Sariaslani, Advances in Applied Microbiology, Elsevier, 2012

3.Daham I. Alani, Murray Moo-Young, Perspectives in Biotechnology and Applied Microbiology, Elsevier, 1986.

Analytical Techniques (Core)

L	P	T	C
4	1	3	4

Preamble

The paper deals about microscopy and its types, radioisotope techniques, chromatographic methods, electrophoresis and centrifugation techniques. This paper offers an opportunity to do excellent research work in biotechnology at various esteemed research institutions.

Unit I

Microscopy - Dark-Field, Phase Contrast, Fluorescence, Confocal, Polarization Microscopy; Electron Microscopy: TEM & SEM – 15 hrs

Unit II

Radioisotope Techniques-Basic concepts, GM and Scintillation Counter, Autoradiography, RIA, Applications in Biological Science. Polymerase Chain Reaction, DNA sequencing, ELISA – 15 hrs

Unit III

Chromatographic Methods-General Principles, Ion Exchange, Gel Filtration, Affinity and Gas Chromatography Techniques – 14 hrs

Unit IV

Electrophoresis-General principles, Horizontal & Vertical Gel electrophoresis, Isoelectric focusing, 2D, Pulse Field and immuno electrophoresis – 15 hrs

Unit V

Centrifugation Techniques- Basic Principles, Different types of Centrifuges, Analytical and Preparative Ultracentrifugation Methods. Spectroscopic Techniques- Electromagnetic radiations; UV-Visible, Fluorescence, CD, NMR, X-ray, Atomic Absorption and Flame Emission Spectroscopic Techniques, Mass Spectrometry – 15 hrs

References

1. Wilson K and Walker J "Principles and Techniques of Biochemistry and Molecular Biology" 6th Ed. Cambridge University Press, 2005.
2. Willard, H.H., Merritt L.L. Dean J.A. and Settle F.A.,"Instrumental Methods of Analysis", 7th Ed., Wadsworth Publishing Co., 1986.
3. Van Holde, K E, Johnson, W. and Ho, P. S., "Principles of Physical Biochemistry",Â Â Prentice Hall, 1981.

4. Cantor, C. R. and Schimmel, W.H., "Biophysical Chemistry Part-II", Freeman & Co., 1981.
5. Campbell, I.D. and Dwek, R. A., "Biological Spectroscopy", Benjamin CurmmingsÂ Publication Co. Inc., 1984.

Genetic Engineering (Core)

L	P	T	C
4	1	3	4

Preamble

The paper covers introduction about nuclease enzymes, types on restriction enzymes, cloning vectors, polymerase chain reaction, blotting techniques, DNA sequencing, mutagenesis and genome editing. This paper provides fine opportunity to do research in the field of genetic engineering and molecular biology at reputed institutions.

Unit I

Nucleases: Exonucleases and Endonucleases, Restriction Enzymes (Type I, Type II, Type III, Type IV & Type V), RNases Methylases: CpG Methylase, Dam Methylase, Dcm Methylase Polymerases: DNA Pol I, Klenow Fragments, Reverse Transcriptase, Taq & Pfu Polymerases Ligases: T4 DNA Ligase, *E.coli* DNA Ligase, T4 RNA Ligase Topoisomerases: Type I(A, B) & Type II(A,B) End Modifying Enzymes: Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases – 15 hrs

Unit II

Introduction to cloning vectors-Desirable properties of vectors-Prokaryotic & Eukaryotic Expression Systems (Constitutive & Inducible) Plasmid Vectors-Phage Vectors-Cosmids-Phagemids-BACs-Yeast Vectors-YACs-Lentiviral Vectors-Adenoviral Vectors-Plant Vectors Insect Vectors (Optional Reading) – 15 hrs

Unit III

Polymerase Chain Reaction-Quantitative Real Time PCR-Gel Electrophoresis: AGE & PAGE-Blotting Techniques: Southern, Western & Northern Methods of gene transfer in Plants and Animals: Chemical, Physical & Viral mediated DNA transfer Construction of Genomic & cDNA Libraries – 15 hrs

Unit IV

DNA Sequencing- Protein Engineering: Site Directed Mutagenesis-Reporter Gene Assays- DNA Protein Interactions: EMSA, DNA Footprinting-Protein-Protein Interactions: Y2H, Y3H, B1H, B2H – 15 hrs

Unit V

Targeted Genome Editing: ZFNs, TALENs, CRISPRs-Gene Targeting: Knock-ins & Knock-outs-DNA Finger Printing – 14 hrs

References

1. Principles of Gene Manipulation and Genomics -7th Edition-Sandy B. Primrose, Richard Twyman - Blackwell Publishing.
2. Gene Cloning and DNA Analysis: An Introduction-6th Edition-T. A. Brown-John Wiley & Sons.
3. An Introduction to Genetic Engineering - 3rd Edition-Desmond S. T. Nicholl- Cambridge University Press.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA-4th Edition-Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten-ASM Press.

Practical- VI

Molecular Biology

1. Electrophoresis: Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis (AGE), native PAGE, SDS-PAGE.
2. Isolation and purification: (a) DNA (genomic and plasmid) (b) RNA and (c) proteins.
3. Gene Cloning: Cloning vectors, molecular cloning and construction of DNA libraries.
4. DNA amplification: Polymerase chain reaction (PCR), RT- PCR. Genome mapping: RFLPs, RAPD, AFLP and FISH. Genome expression analysis: Microarray and EST.
5. Restriction digestion & Ligation of DNA
6. Histology, Immunohistochemistry, Immunoblot

Applied Microbiology

1. Fermentation technology (wine production, ethanol production, cheese)
2. Insulin production, antibiotics production, Single cell proteins.
3. Application of microbe in recombinant DNA Technology, Structure and function of biomolecules: Carbohydrates, proteins, lipids
4. Microbial growth kinetics- Batch culture, continuous culture, industrial applications of continuous culture processes, fed-batch culture.
5. Enzyme production: lactase enzyme production, Characteristics, Ribozymes, co-enzymes, kinetics-M-M equation, determination of Km and Vmax, enzyme inhibition. kinetics of immobilized enzymes.

Practical- VII

Analytical Techniques

1. **Microscopy-** Dark-field, Phase contrast, Fluorescence Confocal, Polarization microscopy; Electron microscopy: TEM & SEM.
2. **Radioisotope techniques-** Basic concepts, principles & application.

3. Chromatographic methods- principles, TLC, paper chromatography, column chromatography, Ion exchange.
4. **Electrophoresis-** principles & method, H o r i z o n t a l & Vertical Gel electrophoresis; SDS principle & method.
5. **Centrifugation techniques-** Basic principles, Different types of centrifuges, Analytical and Preparative Ultracentrifugation methods.
6. Principles and application of UV-Visible, fluorescence, CD, NMR, X-ray, Atomic absorption and Flame emission spectroscopic techniques, Mass spectrometry.
7. Principles and application of PCR, DNA sequencing, ELISA, *flow cytometry*,

Genetic Engineering

1. Isolation of plasmid DNA and size analysis
2. Restriction, digestion, Ligation & Transformation in to bacteria (CaCl2, electric shock & heat shock methods)
3. Cloning and amplification.
4. Types of cloning vector (pbr322, bacteriophage, cosmid vectors, phasmid vector, *M13 phage vectors*.) & their application.
5. Transformations of recombinants in *E.coli* (Preparation of competent cells).
6. Selection & screening of rDNA antibiotic resistance, blue – white colony.
7. PCR amplification (demo).

Marine Biotechnology – Elective

L	P	T	C
4	1	3	4

Preamble

The paper includes fine introduction about marine environment, characterization and identification of marine fauna, types and classification of marine microbes, microbial nitrogen fixation and biofouling. Also, it includes metabolites from marine flora and fauna. This paper provides job opportunity in sea food companies and it offer innovative idea to do research reputed laboratories.

Unit I

Introduction to Marine Environment; Marine Flora-Phytoplankton, Seaweeds, Sea grasses and Mangroves-their characteristics & identification; Biology – 12 hrs

Unit II

Marine Fauna-Zooplankton; Major Marine Invertebrates; Vertebrates and Marine Mammals-Characteristics and identification, Biology – 12 hrs

Unit III

Marine Mcrobes-Types, Classification, Methods of culturing and identification; Methods of Preservation – 12 hrs

Unit IV

Microbial Nitrogen Fixation, their role in Carbon, Phosphorous and Sulphur cycle, Degradation of Organic Matter; Microbial Leaching and Biofouling – 12 hrs

Unit V

Marine Pharmacology -Microbial Metabolites; Metabolites from Marine Flora and Fauna – 12 hrs

References

1. Se-Kwon Kim, Handbook of Marine Biotechnology, Springer, 2015.
2. Y. Le Gal, H.O. Halvorson, New Developments in Marine Biotechnology II, Springer, 1998.

Cancer Biology (Elective)

L	P	T	C
4	1	3	4

Preamble

The paper deals about the fundamental of cancer biology, principles of carcinogenesis, molecular biology of cancer, principles of cancer metastasis and new molecule for cancer therapy. This paper offer fine research opportunity to do innovative research in cancer biology at esteemed institutions.

Unit I

FUNDAMENTALS OF CANCER BIOLOGY-Regulation of Cell cycle, Mutations that cause changes in signal molecules, Effects on receptor, Signal switches, Tumour suppressor genes, Modulation of cell cycle in cancer, Different forms of cancers, Diet and Cancer, Cancer screening

and early detection, Detection using biochemical assays, Tumor markers, Molecular tools for early diagnosis of Cancer – 12 hrs

Unit II

PRINCIPLES OF CARCINOGENESIS-Theory of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Principles of Physical Carcinogenesis, X-ray radiation-Mechanisms of Radiation Carcinogenesis – 12 hrs

Unit III

PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER-Signal targets and cancer, Activation of Kinases; Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, Detection of Oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation, Telomerases – 12 hrs

Unit IV

PRINCIPLES OF CANCER METASTASIS-Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion – 12 hrs

Unit V

NEW MOLECULES FOR CANCER THERAPY-Different forms of therapy, Chemotherapy, Radiation therapy, Detection of cancers, Prediction of aggressiveness of cancer, Advances in cancer detection. Use of signal targets towards therapy of Cancer; Gene therapy – 12 hrs

References

1. Maly B.W.J, "Virology A Practical Approach", IRLl Press, Oxford, 1987.
2.Dunmock N.J and Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, Oxford, 1988.
3."An Introduction Top Cellular And Molecular Biology of Cancer", J. Oxford Medical Publications, 1991.

SEMESTER VIII

Food Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper contains scope of food biotechnology, source of food, preservation techniques, fermentation, types of fermentation, food quality and control, food waste disposal and methods to analyze the food samples. This paper provides fine job opportunity in food processing industries.

Unit I

Introduction and scope of food biotechnology. Source of food - food of plant, animal and microbial origin. Food spoilage: microbiological, enzymatic, chemical and physical spoilages and their effects on food quality. Preservation: Basic principles and importance of food preservation, canning, dehydration, ultrafiltration, sterilization, and microwave processing of foods – 15 hrs

Unit II

Microbes of importance in food fermentations, Types of fermentation- Batch, fed batch and continuous, conventional fermentation v/s biotransformation, solid substrate, surface and submerged fermentation. Single Cell Proteins (SCPs). Medical foods, Probiotics, Fermentative production of food: breads, idli, soy products, meats, fermented milk, pickles and alcoholic beverages – 15 hrs

Unit III

Food quality and control. Analysis of food, major ingredients present in different products, Food additives-colour, flavour, vitamins. Microbial safety of food products: Detection & Enumeration of microbes in foods; Indicator organisms and microbiologica criteria; Rapid and automated microbial methods. Chemical safety of food products: heavy metal, fungal toxins, pesticides and herbicides – 15 hrs

Unit IV

Food waste disposal-solid and liquid waste; Effluent treatment, valorization and value addition, rodent and insect control; use of pesticides – 14 hrs

Unit V

Methods of analysis: Introduction and scope of various analytical methods for food samples such as food color, pH value, turbidity, etc. Uses and applications of HPLC, GC-MS in food analysis Food standards and Specifications: Compulsory and voluntary trade and Company standards. HACCP, ISO 22000, Quality Management Systems – 15 hrs

References

1. Bioprocess Engineering-Basic Concepts by M.L.Shuler & F. Kargi Second Edition, Prentice Hall 2002, ISBN : 0-13-081908-5
2. Bioprocess Engineering Principles by P. Doran Academic Press 3. Biochemical Engineering by H. Blanch & D. Clark.
3. M. Shafeiur Rahman (1999). Handbook of Food Preservation, Marcel Dekker, Inc.
4. Vickie A. Valdavik and Elizabeth, W. Christian (2003). Essentials of Food Science. Springers. BFE 252
5. Michael J. Pelezar, J.R.E.C.S Chan, Noel R. Erieg,(2005), Microbiology (5thEd) TATA McGraw Hill.
6. James M. Jay (1993). Modern Food Microbiology (4th Ed). CBS Publishers Delhi.
7. W. C. Frazier & D.C. Westhoffs, (1993). "Food Microbiology" (4th Ed) TMH.
8. G. Reed, Prescott and Dunn's Microbiology,(1987) 4. Desrosier, Technology of food preservation, CBS Publishers.

Nanobiotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper contains the applications of nanomaterials in biotechnology. It includes general introduction about nanomaterials, classification of nanomaterials, characterization techniques to examine nanomaterials, biosensors and consumer care products. Also, it includes environmental issues and risks of nanomaterials. This paper offers an excellent research opportunities for the students to do innovative research at reputed institutions.

Unit I

Nanobiology, definition and Scope, Recent Development and Applications, Nanoparticles, Nanowires and Thin films, Types of Nanomaterials and their classifications, Applications of nanotechnology viz. Bio imaging, separation of cells and cell organelles, drug delivery, gene therapy etc – 15 hrs

Unit II

Techniques to construct Nanostructures, Scanning probe instruments, Techniques to predict nanostructures, TEM, SEM, AFM. Characterization techniques – 14 hrs

Unit III

S-layers, Chemistry and structure, Microbial Nanoparticles Production, Magnetosomes-Bacteriorhodopsins, Liposomes, Cubosomes and Hexosomes, biopolymers, chitosan, drug targeting and Iron oxide nanoparticles for functional MRI – 15 hrs

Unit IV

Biosensors, definition and classification. Nanofibers and their application in tissue engineering, Nanomaterials and drug delivery, cancer diagnosis and therapy, biologically inspired nanocomposites, nanotechnology and Tissue engineering, Scaffolds, nanotechnology in Agriculture (Fertilizers and pesticides) – 15 hrs

Unit V

Nanomaterials in consumer markets, Is nanotechnology bad or good?, Implications of nanotechnology: Health and safety implications from Nanoparticles: Environmental issues, Need for regulation, Potential benefits and risks for developing countries, Criticism of Nanotechnology – 15 hrs

References

1. Nanobiotechology: Concepts, Applications and perspectives, Christ of M.Neimeyer, Chad.A.Mirkin (eds.,) Wiley VCH Weinheim (2004)
2. Bionanotechnology: concepts, Lessons from Nature, by David.S.Goodsell, Wiley-Liss (2004)
3. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
4. Protein Nanotechnology Protocols, Instrumentation and Application, Tuan Vo-Dinh, Series ; Methods in Molecular Biology (2005)

5. Nanocomposite Science & Technology Ajayan, Schadler& Braun
6. Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co.

Genomics & Proteomics (Core)

L	P	T	C
4	1	3	4

Preamble

The paper covers introduction about genome, protein, gene and protein sequence analysis methods, gene and protein data bank. This paper opens an excellent opportunity for students to do innovative research in genomic and proteomics at reputed institutions.

Unit I

Genome- Overview of genome; sequence of genome acquisition and Analysis - homologies - snps - genetic analysis, linkage mapping, high Resolution chromosome mapping and analysis - physical mapping, YAC, Hybrid mapping, strategies, sequence specific tags (SST), sequence tagged Sites(STS), ISH, FISH, RFLP, RAPD – 15 hrs

Unit II

DNA sequencing - methods, maxam and gilbert method, ladder, Flourescent, shot gun, mass spectrometry, automation dequencing - find Gene mutations, implications of DNA - sequencing and sequening genomes – 14 hrs

Unit III

Genome data bank, Metabolic Pathway Data - Construction and Screening of cDNA, Libraries and Microarrays - Application of DNA Arrays - PCR -Variations in PCR - Gene Distruptions - Sage and Sade, Pharmacogenomics – 15 hrs

Unit IV

Protein Sequence Analysis - introduction - Sequence data banks - WBRF – PIR - SWISSPORT - databases, Data mining - Algorithms of proteomics and its Applications - Protein expression profilling - Protein - protein interaction - Protein modifications. Automation - Nucleic acid data bank - EMBL Nucleotide sequence data bank - AIDS virus sequence data bank - RNA data Bank – 15 hrs

Unit V

Tools for Data bank - Pairwise Alignment - Needleman and Wusch algorighm - Smith Waterman - Multiple Alignment - CLUSTRAL - PRAS - BLAST - FAST, Algorithms to analyse sequence data - pdb, Cambridge structure data base (lsd), 2d electrophoresis, IEF, HPLC, Protein digestion technique, Mass Spectrometry, MALDI, TOF, Peptides, Mass fingerprinting – 15 hrs

Agricultural Biotechnology – Core

L	P	T	C
4	1	3	4

Preamble

The paper includes the application of biotechnology in agriculture. It deals about the physical and chemical characterization of soil, micro flora, microbial interaction, biopesticides and bio-geo chemical cycles. This paper provides fine job opportunities in agriculture based industries.

Unit I

Physical and Chemical Characteristics of soil, Microbial flora of soil biota (Bacteria, fungi, algae and nematodes) – 15 hrs

Unit II

Microbial Interactions-Symbiosis, Mutualism, Commensalisms, Competition, Amensalism and Synergism – 14 hrs

Unit III

Biofertilizers, Biological nitrogen fixation, Symbiotic and asymbiotic nitrogen fixation, Associated symbiosis, Cyanobacteria – 15 hrs

Unit IV

Rhizosphere, Rhizobium, infection, inoculation and nodule formation, Phylloplane association with animals, Plant diseases-Symptoms, etiology, life cycle and management, Biopesticides – 15 hrs

Unit V

Major bio-geochemical cycles-Carbon, Nitrogen, Phosphorous and Sulphur, Xenobiotic degradation – 15 hrs

References

1. Talaro KP and Talaro A, Foundations in Microbiology WCB Me Graw Hili, 1999.
2.Atlas and Bartha, Microbial Ecology-Fundamentals and applications, Benjamin and Cummings, 2003.

Practical- VII

Food Technology & Nano Biotechnology

1. Determination of microbiological quality of water by MPN method.
2. Presumptive and confirmatory tests for coliform bacteria in water.
3. Enumeration of microorganisms from bread.
4. Food coloring and food preserving technique, Pasteurization technique and method.
5. Determination of TDT&TDP.

6. Production and estimation of Biomass (SCP) using dry and wet weight methods.
7. Synthesis of silver and titanium oxide Nano materials using chemical method
8. Synthesis of silver Nano particles using plants
9. Synthesis of silver Nano particles using Bacteria
10. Characterization of silver Nano particles using UV spectrophotometer
11. Characterization of silver Nano particles using XRD.

Practical- VIII

Genomics and Proteomics and Agricultural Biotechnology

1. Studying the Genome: Genetic Mapping - Markers for Genetic Mapping; RFLP, SSLP - VNTR's, STR's, SNP's; Physical Mapping - In situ hybridization, Sequence Tagged Sites Mapping. DNA data bases.
2. Hybridization based marker system – RFLP, PCR based marker systems – RAPD, AFLP, CAPS, SCAR, SSRs, Microarray based SNP detection techniques,
3. Microarray technology, SAGE – principles and application.
4. Mass spectrometry and analysis (ESI, MALDI and Hybrid), LC/MS-MS; Applications of mass spectrometry (PMF and PTMs)
5. ORF scanning – Codon bias, Exon-Intron boundaries - Exon trapping, CpG island, Gene location – Southern and Northern blotting hybridization, Zoo blotting. Studying a transcriptome – Microarray or chip analysis, SAGE.
6. Proteomics - ID–SDS-PAGE, 2D-PAGE. Detection and quantitation of proteins in gels. Protein staining techniques. Affinity purification of proteins.
7. Basics of Mass Spectroscopy- MALDI-TOF and ESI and their applications in proteomics. Tandem MS/MS spectrometry. HPLC.
8. Isolation of soil microorganisms- azotobacter, Cyanobacteria and mycorrhiza.
9. Estimation of soil alkalinity.
10. Estimation of Micro and macro nutrient from soil
11. Isolation of rhizobium from root nodules.

Pharmaceutical Biotechnology (Elective)

L	P	T	C
4	1	3	4

Preamble

The paper contains general introduction about culture media, antimicrobial agents, plant, bacteria, insects and animal based drugs, antitumor agents, blood factors and routes of drug administration. In addition, it includes methods to develop a new drug, docking and toxicity studies. This paper provides an excellent job opportunity for students in pharmaceutical industries.

Unit I

Sterilization, Pure culture techniques, Culture media, Isolation of Pharmaceutically important microorganisms. Antimicrobial agents: Antibiotics (common drugs, their spectrum and mode of action). *in vivo* and *in vitro* methodologies for testing of antibacterial compound, Microbial, Recombinant, Biochemical and Molecular level screening, Conventional Process; Bio-prospecting. Search of database/data mining for Drug designing. – 12 hrs

Unit II

Substances derived from bacteria, plants, insects and animals. Drugs derived from plants, natural resources of medicine, Antitumor agent-Etoposide, Colchicine, Demecolcine, Irinotecan, Lapachol, Taxol, Vinblastine, Vincristine. Cardiotonic-Convallatoxin, Acetyldigoxin, Adoniside, Antiinflammatory-Aescin, Bromelain, Local anaesthetic-Cocaine, Choleretic-Curcumin, Cynarin, Topical antifungal-Thymol, Antihypertensive, tranquilizer- Rescinnamine, Reserpine, Rhomitoxin – 12 hrs

Unit III

Blood factors and Thrombolytic agents, Hormones (insulin, glucagon, growth hormone, gonadotrophins), Haematopoietic growth factors (Erythropoietin, colony stimulating factors), Interferons, Interleukin-based products, tumour necrosis factor, therapeutic enzymes, Antibody drug conjugates. Need for developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR – 12 hrs

Unit IV

Routes of administration, Scope and limitation of bioassay, bioassay of some official drugs Sources of active principles; Biological evaluation of drugs-Screening and evaluation (including principles of screening, development of models for diseases: In vivo models/In vitro models/cell line study. Assay systems and models (e.g., Knock-out Mice) Protein molecular modeling by computer: Docking studies; Structure based drug designing using software (Insight II LS) – 12 hrs

Unit V

Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity. Various

guidelines for toxicity studies. Animal experiments assessing safety of packaging materials – 12 hrs

References

1. Industrial Pharmaceutical Biotechnology, Heinrich Klefenz, Wiley-Vch Publication, Germany, 2002.
2. Pharmaceutical Biotechnology, Daan Crommelin, Robert D Sindelar, 2002, Tailor and Francis Publications, Newyork, 2002.
3. Hand book of Pharmaceutical Biotechnology, Jay P Rho, Stan G Louie, 2003, Pharmaceutical products press, Newyork, 2003
4. Theory and practice of industrial pharmacy, Lachman L Lieberman, HA, Kanig, J, 1986, 3rd edition, Varghese publishing & Co, New Delhi, 2000.
5. Remington's Pharamaceutial sciences, Joseph Price Remington , 18th edtion, Mack publishing & Co., Easton, 1980.
6. Nanoparticles as Drug carriers, Vladimir P Torchilin, Imperial College Press, USA, 2006
7. Nanomedicine, Parag Diwan and Ashish Bharadwaj, pentagon press, India, 2006.
8. Harpum P. Portfolio, Program and Project Management in the pharmaceutical and biotechnology industries. 2010.
9. M.J. Roy. Biotechnology operations: Principles & Practices. CRC Press. 2011.
10. Biren N Shah, Bhavesh S Nayak, Vineet C Jain; Textbook Of Pharmaceutical Industrial Management; 2010; 1st edition; Elsevier India; ISBN: 9788131225394.

Gene Therapy (Elective)

L	P	T	C
4	1	3	4

Preamble

This paper covers an introduction about somatic and germ line gene therapy, in vivo and ex vivo gene therapy methods, viral vectors and recent advancement in gene therapy. This paper offers research opportunity to do innovative research in genetic engineering, cancer biology and molecular biology at esteemed institutions.

Unit I

Introduction, Somatic and Germ line gene therapy, Gene replacement and Gene addition – 12 hrs

Unit II

In vivo, ex vivo and in vitro gene therapy, Transgenic animal models, Vehicles for gene transfer-viral vectors: Retrovirus, Adenovirus, Adeno-associated virus – 12 hrs

Unit III

Viral Vectors: Lentivirus, Recombinant SV40 Virus, Nonviral vectors, DNA vaccines, Liposomes and Lipoplexes, Naked DNA, Transposon – 12 hrs

Unit IV

Cancer Gene Therapy, RNA-DNA chimera, Gene therapies for Criglar-Najjar syndrome I – 12 hrs

Unit V

Gene Therapy and diseases: Cystic fibrosis, Duchnne muscular dystrophy, Bleeding disorders, Tyrosinemia, Severe combined immunodeficiency syndrome (SCID), Gene therapy of nonheritable disorders, Recent advancement in Gene Therapy – 12 hrs

References

1. Friedman T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor,NY: Cold Spring Harbor Lab.Press.
2. Knipe DM, Howley PM, eds. 2001. Fields Virology. Philadelphia,PA: Lippincott Williams & Wilkins.
3. Hackett NR, Crystal RG. 2000.Adenovirus vectors for gene therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker.

SEMESTER IX

Animal Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

This paper deals about the basic introduction about animal cell culture, media, and growth factors for animal cell culture. It includes stem cells, tissue engineering, transgenic animals, animal cloning and applications of animal biotechnology. This paper provides job opportunity in animal cell culture laboratories and it offers novel ideas to do innovative research in animal biotechnology.

Unit I

Animal Cell Culture: Introduction, Cell culture laboratory-Design, Layout and Maintenance. Equipment and Instrumentation. Methods of Sterilization, Types of culture media, Composition, Preparation and metabolic functions. Role of CO_2, Serum, Supplements, Growth factors (EGF, PDGF, NGF, Gap-43). Serum and Protein free defined media – 15 hrs

Unit II

Culture and Maintenance of Primary and Established cell lines. Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, Gene Transfer, cytotoxicity, growth parameters, cell death and Apoptosis, Expression of culture efficiency – 14 hrs

Unit III

Stem cells and Tissue Engineering: Scope, Embryonic and Adult Stem cells, Properties, Identification, Stem cells culture, Techniques and their applications in Modern Clinical Sciences.

Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - Skin, Bone and Neuronal Tissues – 15 hrs

Unit IV

Transgenic Animals and Animal cloning: Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for live stock and humans – 15 hrs

Unit V

Applications of Animal Biotechnology: Improvement of biomass, disease resistant, recombinant vaccines for poultry, live stock - pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines – 15 hrs

References:

1. Ballinic C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon press, New York. 1989.

2. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings.2007. 3. Berger S. L. and A.R. Kimmel.Methods in enzymology guide to molecular cloning techniques (Vol 152). Academic Press Inc. San Diego.1996

4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC.2003.

5. Jenni,P, Mather and David Barnes, Methods in Cell Biology (Vol 57) Academic Press.2001.

6. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001.

7. Watson J.D et al. Molecular Biology of the Gene (6th Ed), The Benjamin Cummings Pub.Co.Inc.USA.2008.

Plant Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper contains plant tissue culture, techniques in preparation of nutrient media for plant tissue culture, germplasm conservation and micropropagation. Also, it includes about genetically modified foods and crops, problems in gene transfer, merits and demerits of genetically modified foods and crops. This paper provide fine job opening for students at plant tissue culture laboratories.

Unit I

Introduction to Plant Tissue Culture. Historical account, General techniques in Plant Biotechnology, Totipotency. Preparation of stock solutions and Nutrient media for Callus culture initiation and Plant regeneration. Processing of various explants (mature seed, leaf base, node) for culture initiation. Aseptic techniques-Sterilization of nutrient media. Pretreatment and surface sterilization of various explants collected from field for aseptic culture initiation – 15 hrs

Unit II

Establishment and Maintenance of Callus and Suspension Culture. Subculture and Regeneration of shoots and roots from callus cultures through Organogenesis and Somatic embryogenesis. Shoot tip culture. Protoplast isolation and fusion. Transfer and establishment of whole plants in soil – 14 hrs

Unit III

Germplasm Conservation: Cryopreservation-Methodology and steps, Synthetic Seed Preparation from intact regenerable explants of medicinal plants using sodium alginate. Plant conversion from synthetic seeds. Micropropagation of medicinal plants by various explants. Secondary metabolites from plant cells – 15 hrs

Unit IV

Genomic DNA extraction and purification - Principle and Methods. Isolation and purification of Ti-plasmid DNA. Agrobacterium mediated transformation of plants - Culture initiation, explant preparation, co cultivation, selection, and regeneration. PCR analysis of transformed plants. Transient ß- glucuronidase (GUS) gene expression assays in transformed intact explants and callus tissues by histochemical method – 15 hrs

Unit V

Genetic improvement: Insect Resistance: Cry genes and BT crops. Other genes for insect resistance (PDR and non PDR)-Virus resistance-(antisense RNA approach); Resistance to Fungal and Bacterial disease; Herbicide resistance: Resistance to abiotic factors (Drought/salt). Transgenic plant with modified quality (Improved starch, oil, seed protein quality). Plant derived vaccines; Plants with improved nutrient value (Golden Rice). Problems in Gene Transfer: Gene Silencing. GM crops-current status-concerns about GM crops- regulations of GM crops – 15 hrs

References

1. Robert N. Trigiano. Dennis J. Gray, 1996, Plant Tissue Culture Concept and Laboratory Excersises. CRC Press, London.
2. P.S.Srivasta, 1998. Plant Tissue Culture and Molecular Biology, Narosa Publishing House,

New Delhi.
3. David W.Galbraith, Hans J.Bohnert and Don P.Bourque, 1995, Methods in Plant Cell Biology, Academic Press, New York.
4. John H. Dods and Lorrin W.Roberts, 1995, Experiments in Plant Tissue Culture, Cambridge University Press, USA.
5. J. Hammond, P. McGarvey and V. Yusibov (Eds): Plant Biotechnology. Springer Verlag, 2000.
6. T-J. Fu, G. Singh, and W.R. Curtis (Eds.): Plant Cell and Tissue Culturefor the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.
7. H.S. Chawla: Biotechnology in Crop Improvement. International Book distributing Company. 1998.
8. R.J. Henry: Practical Application of Plant Molecular Biology. Chapman and Hall. 1997.

Industrial Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

The paper covers industrial related applications of biotechnology. It includes the preparation process of fermented products, types of fermenters, downstream processing and industrial production of ethyl alcohol, vitamins and enzymes. This paper offers an excellent job opportunity in biotechnology based companies, food and beverage industries.

Unit I

Bioreactor - Types and operation of Bioreactors, Physico-chemical standards used in bioreactors, Limitations of bioreactors, Stages of fermentation processes, Media design for fermentation processes, Solid Substrate fermentation, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged and agitated fermentation), Advantages and Disadvantages of Solid substrate & Liquid fermentations – 15 hrs

Unit II

Downstream Processing - extraction, separation, concentration, recovery and purification, operations (Insulin, Vitamins, Metabolites), Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid, α-amylase, protease penicillin, tetracycline and vitamin B_{12}, with reference to easily available raw materials, Production of herbal drugs – 14 hrs

Unit III

Enzyme technology - nature of enzymes, application of enzymes, limitations of microbial cells used as catalysts in fermentation, multi-enzyme reactors, genetic engineering & protein engineering of enzymes, cloning strategy for enzymes, technology of enzyme production, use of immobilized cells and enzymes (Ca-alginate beads, polyacrylamide), industrial applications of immobilized enzymes – 15 hrs

Unit IV

Bioconversions - Biomining and bioleaching of ores (Use of thermophilic microorganisms in industrial microbiology Bio-gas, Bio-leaching, Bio-diesel, Bioremediation - Petroleum prospecting and formation of oil spills,, Wastewater treatment, chemical degradation, heavy metals – 15 hrs

Unit V

Biotechnology in specific medical & industrial applications - Retting of jute, microbial process for immunization (Production of monoclonal antibodies), Deterioration of paper, textiles, painted surfaces and their prevention, Biofilms, microbial biopolymers, Biosurfactants, Microbial culture selection with high yield potential – 15 hrs

References

1. Wim Soetaert, Erick J. Vandamme, Industrial Biotechnology: Sustainable Growth and Economic Success, Wiley-VCH, 2010
2. Christoph Wittmann, James C. Liao, Sang, Industrial Biotechnology: Products and Processes, Wiley-VCH, 2017
3. Indu Shekar Thakur, Industrial Biotechnology: Problems and Remedies, I.K. International Pvt. Ltd., 2013
4. P. Hambleton, T. Salusbury, Biosafety in Industrial Biotechnology, Springer Science, 2012

Environmental Biotechnology (Core)

L	P	T	C
4	1	3	4

Preamble

This paper covers an interaction between the environment and biota, food chain and environmental pollution. It includes the methods to eradicate the heavy metals, oil and pest by using the biotechnological techniques. It provides an idea about mushroom cultivation and vermiculture. Also, it includes biotechnology approaches to overcome the global environmental problems. This paper offers job opportunities in effluent treatment companies and biogas plant.

Unit I

Interactions between environment and biota, Concept of habitat and ecological niches, Limiting factor, Energy flow, food chain, food web and tropic levels, Ecological pyramids and recycling, biotic community, concept, structure, dominance, fluctuation and succession, N,P,C and S cycles in nature. Concepts and theories of evolution, Population ecology, community structure, Environmental management and Impact Assessment – 15 hrs

Unit II

Environmental Pollution, Types of Pollution, Air and Water Pollution and their Control Strategies through Biotechnology: Need for Water Management, Assessment of water and air Pollution,

Source of water and air pollution, Waste Water Treatment - Physical, Chemical and Biological Treatment Processes – 15 hrs

Unit III

Microbiology of degradation of Xenobiotics in environment. Ecological considerations. Degradation of Hydrocarbons, Substituted hydrocarbons, Oil pollution and Surfactants – 14 hrs

Unit IV

Bioremediation of contaminated soils and waste land, Eco-friendly bio-processed single cell protein, Bio-fertilizer, Bio pesticides in Integrated Pest and Disease Management (IPM & IDM), Solid Wastes Management: Composting, Vermiculture, Mushroom Cultivation and Biogas Production – 15 hrs

Unit V

Global Environmental Problems: Ozone depletion, UV-B, green - house effect and Acid rain and their impact on environment. Biotechnological Approaches for Management – 15 hrs

References

1. *Wastewater Engineering - Treatment, Disposal and Reuse.* Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. *Comprehensive Biotechnology,* V 01.4, M. Moo- Young (Ed-in-chief), Pergamon Press, Oxford.
3. *Environmental Chemistry,* A.K. De, Wiley Eastern Ltd., New Delhi
4. *Introduction to Biodeterioration.* D. Allsopp and K.J.Seal, ELBS/Edward Arnold

Practical- IX

Animal Biotechnology

1. Preparation of animal cell culture media.
2. Preparation & sterilization of balanced salt solution and DBSS.
3. Disaggregation of tissues – trypsinization.
4. Culture of chick embryo fibroblast (monolayer).
5. Single cell suspension culture, Viability test and cell counting.
6. In vitro & In vivo Fertilization
7. Monoclonal antibody production.
8. Applications of Co2 incubator & inverted microscope.
9. Membrane filter.
10. Isolation of genetic DNA from animal tissue.

Plant Biotechnology

11. MS media preparation & Sterilization technique.
12. Establishment of shoot tip culture using MS medium
13. Isolation of protoplasts using enzymatic method.
14. Establishment and maintenance of callus culture.
15. Establishment and maintenance of suspension culture.
16. Establishment and maintenance of somatic embryogenesis (Demo).
17. Synthetic seeds (Entrapment method).
18. Isolation of genomic DNA from plant.
19. Extraction & Separation of Chlorophyll A & B using Column Chromatography.
20. Seed germination.

Practical- X
Industrial Biotechnology

INDUSTRIAL BIOTECHNOLOGY

1. Principles of fermentation technology, Media formulation, Sterilization, Batch and continuous culture systems, Types of fermentation, Stoichiometry of cell growth and kinetics.
2. Bioreactor - Design, parts and their function. Types of bioreactors, (Temperature, pH and DO).
3. Algal and fungal culture - Spiraling, Agarics, Yeast and Aspergillums.
4. Estimation of citric acid from Aspergillums Culture, Estimation of lactic acid and lactose.
5. Immobilization of Yeast cells.
6. Preparation of wine, Estimation of Alcohol by Specific gravity method.
7. Purification and precipitation secreted proteins from spent broth
8. Estimation of cellulase activity of cellulose degraders, xylanase activity in broth and precipitated protein fraction.
9. Production of algal biomass.
10. Detection of GMO food
11. Microbial load of canned foods
12. Analysis of preserved food stuff for presence of pathogens
13. Detection of coli forms for determination of the purity of potable water

14. Determination of total dissolved solids of water
15. Determination of dissolved oxygen concentration of water sample
16. Determination of biological oxygen demand (BOD) of sewage sample
17. Determination of chemical oxygen demand (COD) of sewage sample
18. Determine the efficiency of removal of air pollutant using fibrous air filter
19. Isolation of xenobiont degrading bacteria by selective enrichment technique
20. Test for the degradation of a aromatic hydrocarbons by bacteria
21. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry
22. Estimation of nitrate in drinking water

Management in Biotechnology (Elective)

L	P	T	C
4	1	3	4

Preamble

This paper contains the management process in biotechnology based companies. It clearly explains the functions of organization, leadership and management control. Moreover, it includes the process techniques, product recovery, product cost estimation, patents and recent trends in biotechnology industries. This paper offers an idea to start and manage a biotechnology industry.

Unit I

Theory Principles of Management, Management Process, Functions of Organization. Functions of Managers - Delegation, Decentralization and Leadership – 12 hrs

Unit II

Motivation - Management Control, MIS process of Design and Management. Use of flow sheets in the design of a process – 12 hrs

Unit III

Process Techniques, Raw Material Preparation, Product recovery and purification, Formulation packaging and quality control. Economic considerations - Cost estimation, Total product cost, Capital investment and Profitability – 12 hrs

Unit – IV

Manufacturing cost estimates, Capital investment and resources, Cost benefit analysis. Patents and exploitation of inventions. Bio industry and Prospects - Recent trends in the development of bio industry, Selection, Transfer and Adaptation of Technologies – 12 hrs

Unit V

Training of Qualified Personnel, New relationship between industries and universities. International Cooperation. Scope and Status of biotechnology industry in India – 12 hrs

References

1. Craig Shimasaki, Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press, Elsevier, 2014.
2. Pete Harpum, Portfolio, Program, and Project Management in the Pharmaceutical and Biotechnology Industries, Wiley Interscience, 2011.

Stem Cells and Regenerative Biology (Elective)

L	P	T	C
4	1	3	4

Preamble

This paper deals about the stem cells and its importance in regeneration biology. It includes the techniques to characterize the stem cells and growth factors to maintain the stem cell culture. In addition, it explains the interaction between the stem cells and cancer. Obviously, this paper provides an idea for students to do innovative research in the field of stem cell biology and it offers job opportunity in cell culture institutes and companies.

Unit I

Stem cell, Embryonic stem cells, Embryonic germ cell, Bone marrow stem cells, Adult stem cell, Differentiation. Introduction to concepts in Stem cell biology (renewal, potency, etc.). Stem cell characterizations: Isolation & Characterizations, Markers & their identification, Growth factor requirements and their Maintenance in culture. Pluripotency and Reprogramming – 12 hrs

Unit II

Hematopoietic Stem Cell. Induced Pluripotent Stem (Ips) Cell Technology. Epigenetic memory in iPS cells. Epigenetic controls of stem cells. Early embryonic development. Lymphoid cell differentiation and maturation. Cell cycle regulators in stem cells. Molecular mechanisms of self-renewal, pluri/multipotency and lineage differentiation. Molecular basis of pleuripotency and stem cell niche – 12 hrs

Unit III

The human umbilical cord: A source of stem cells. Isolation of mesenchymal stem cell (MSCs) from the umbilical cord. *In vitro* Differentiation potential of Umbilical cord mesenchymal stem cell. In vivo applications of UCSC. Cord blood stem cells transplantation: Advantages and Disadvantages. Cord blood banking – 12 hrs

Unit IV

Generation and Manipulation of Mouse Embryonic Stem Cells. Generation and Manipulation of Human Embryonic Stem Cells. Animal Models of Regeneration (Hydra, Planaria, Earthworm, Zebra fish, etc.) – 12 hrs

Unit V

Cancer Stem Cell- The origin of cancer stem cells, the impact of cancer stem cell concept on cancer therapy. Epigenetics and Reprogramming in Stem Cell Biology. Stem Cell Gene Therapy. Stem

cell therapy for neurodegenerative diseases. Stem cell therapy for cardiac regeneration. Clinical cell transplantation for leukemia. Ethical issues associated with stem cell biology – 12 hrs

References

1.Regenerative Medicine and Cell Therapy (Hossein Baharvand, Nasser Aghdami. 2012)
2. Principles of Regenerative Medicine 2nd Edition (Anthony Atala, Robert Lanza, James A. Thomson &Robert Nerem. 2010)
3. Stem Cells (Anna Wobus & Kenneth Boheler. 2008)
4. Essentials of Stem Cell Biology 2nd Edition (Robert Lanza. 2009)
5. Kursad Turksen, Adult and Embryonic Stem Cells, Humana press.
6. Carlson, B. M. (2007). Principles of Regenerative Biology. Elsevier Inc.. pp. 400. ISBN 978-0-12-369439-3.
7. Reddien, P. W.; Alvarado, A. S. (2004). "Fundamentals of planarian regenerations". Annual Review of Cell and Developmental Biology 20: 725-757.
8. Reya, T; Morrison, SJ; Clarke, MF; Weissman, IL (2001 Nov 1). "Stem cells, cancer, and cancer stem cells.". Nature 414 (6859): 105–11.
9. Heppner, GH; Miller, BE (1983). "Tumor heterogeneity: biological implications and therapeutic consequences". Cancer metastasis reviews 2 (1): 5-23.

SEMESTER X

Research Methodology (Core)

L	P	T	C
4	1	3	4

Preamble

This paper includes the methods to do an innovative research. Also, it covers types of research, sources for literature survey, how to write a research project proposal and scientific papers. This paper is very helpful for students who are willing to do an innovative research.

Unit I

Research: Meaning-Purpose-Types of research-Steps in Research: Identification, selection and formulation of research problem. Formulation of hypothesis- types of hypothesis and testing of the hypothesis – 14 hrs

Unit II

Literature Survey: sources of information- Primary, Secondary, Tertiary sources – journals, reviews, books, monographs etc. bibliography. Web resources-E-Journal, Journal access, TOC alerts, Citation index, Impact factor, H-Index, E-Consortium, UGC infonet, E-Books, Internet discussion groups and communities, Scirus, Pubmed, Google Scholar, ChemIndustry, Wiki Databases, Science Direct, SciFinder, Scopus – 15 hrs

Unit III

Research Proposal: Purpose and scope, Sponsor identification, format, Proposal development, structure of research proposal-style of write up. Research Report: Types of reports, Technical report, Popular report, Contents-Styles of reporting- Steps in drafting reports, Editing the final draft, Evaluating the final draft – 15 hrs

Unit IV

Scientific Papers, Short Communication, Research Articles, Review Articles, Book Reviews; Justification for scientific contributions, Bibliography, Description of methods, conclusions, the need for illustration, style, Synopsis, Thesis writing. Presentations: Oral and Poster, Publications of scientific works in Journals, Proceedings and Chapters in Book, Plagiarism – 15 hrs

Unit V

Categories of Research - Fundamental, basic, applied adaptive, operational, action research. Level of research, Collaborative research, Participatory research. Identification of research problems. Formulation of research project proposals. Monitoring and Evaluation – 15 hrs

References

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers'Distributors.
2. Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners,(2nd.ed.),Singapore, Pearson Education.
4. Thesis and Assignment writing - Anderso J.berry H.D. & Poole M. Wiley Eastern Limited, New Delhi.
5. Davis, G.B. and C.A. Parkar 1997. Writing the doctoral dissertation. Barrons Educational series, 2nd edition, Pp 160. ISBN : 0812098005.
6. Duncary, P.2003. Authoring a Ph.D. thesis: how to plan, draft, wirite and finish a doctoral dissertation. Plagrave Macmillan, Pp256. ISBN 1403905843.
7. Krathwohl, D. R. (1993). How to prepare a research proposal. (3rd edition). Syracuse, NY: Syracuse University Press.
8. Fundamentals of Computers by Rajaraman, Prentice Hall India Pvt. Limited.
9. Microsoft Office Word 2007: Complete Concepts and Techniques by Gary B. Shelly, Thomas J. Cashman, Misty E. Vermaat, Cengage Learning Inc.

Bioethics, IPR and Entrepreneurship (Core)

L	P	T	C
4	1	3	4

Preamble

The paper covers the risks, ethics and safety of biotechnology based research and products related to human health care, agriculture, animals, etc. In addition, it also includes the application of patent, entrepreneurship and IPR. This paper offers opportunity to start biotechnology based companies.

Unit I

Biotechnology, Society, Risks, Ethics and Patenting. Benefits of Biotechnology, ELSI of Biotechnology, Recombinant therapeutic products for human health care. Genetic Modifications Recombinant foods, Safety of GM foods. Release of genetically engineered organisms-Human embryonic stem cell research-cloning – 15 hrs

Unit II

Patents, Introduction, Basis of Patentability, Non Patentable Inventions, Patent Application Procedure in India, Treaties and Conventions of Patents, Patent Cooperation Treaty, TRIPS and Pharmaceutical Industry, issues and prospects. Other Forms of IPR, Definition, Different forms of IPR, Benefits of IPR system. WTO, GATT, Objectives, Structural format of WTO - Economic Impact of WTO, WTO Agreements, Benefits of WTO in relation to biotechnology – 15 hrs

Unit III

Biosafety, definitions, Biosafety levels, Framework of biosafety regulation in India; Structure and functions of Committees; DBT Guidelines on biosafety in conducting research in biotechnology. Regulations of Genetically modified Organisms in India, Biosafety regulation for transgenic plants and animals, labeling of GM foods – 15 hrs

Unit IV

Bioethics, Definition, Bioethics of IPR, Ethical criteria in Biotechnology, Animal ethics; Guidelines for use of lab animals in medical Colleges, Licensing of animal house, Human cloning, Ethical issues, Ethical clearance norms for conducting studies on human subjects – 14 hrs

Unit V

Structure of a Company, Start-up of a Company, New Product Development. Market Research. Sales & Marketing Principles. Intellectual Property Principles in Biotechnology. Health Care, Overview and Role of Government in Biotechnology. Ethical and Other Legal Issues in Biotechnology – 15 hrs

References

1. Biosafety, Traylor, Fredric & Koch, 2002. Michigan sate University pub., USA
2. Contemporary issues in Bioethics, Beauchamp & Leroy, 1999. Wards worth Pub. Co. Belmont, California.
3. www.ipr-helpdesk.org/

4. www.patentoffice.nic.in/ipr/patent/patents.htm
5. www.bangalorebio.com/GovtInfo/ipr.htm
6. Manual of patent practice and procedure. IPR India, 2005. Ministry of commerce and industry, New Delhi, pp.163.
7. Biotechnology and safety assessment, John.A.Thomas, 2004. pp.333.

PROJECT (Related to Biotechnology)