DEPARTMENT OF BIOTECHNOLOGY

RATHINAM COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

Rathinam Techzone, Pollachi Road, Eachanari,Coimbatore – 641021

Celebrate life

RATHINAM

Syllabus for

M.Sc. BIOTECHNOLOGY

(I - IV Semester)

2024 – 2025 Batch onwards

Vision and Mission of the Institution:

VISION

To emerge as a world-renowned Institution that is integrated with industry to impart Knowledge, Skills, Research Culture and Values in youngsters who can accelerate the overall development of India.

MISSION

To provide quality education at affordable cost, build academic and research excellence, maintain eco-friendly and robust infrastructure, and to create a team of well qualified faculty who can build global competency and employability among the youth of India.

Vision and Mission of the Department:

Vision

To Create a top-tier Biotechnology department by blending academic excellence with industry expertise, aiming for recognition through scholarly achievements and research contributions, attracting top students and faculty to advance national progress.

Mission

To cultivate a premier Biotechnology department by fostering a dynamic environment that integrates rigorous academic pursuits with practical industry knowledge. We are dedicated to achieving scholarly excellence, driving impactful research and nurturing talent to propel national advancement in the field of Biotechnology.

Program Educational Objectives (PEO)

PEO1	**:**	Pursue a career as a globally competent and universally employable professional in core and related fields in diverse sectors who accelerates the overall development of India.
PEO2	**:**	Pursue lifelong learning opportunities including graduate degrees to improve and expand domain specific and professional skills.
PEO3	**:**	Advance personally and professionally by accepting professional and societal responsibilities, and pursuing leadership roles.

Mapping of Institute's Mission to PEO

Institute's Mission	PEO's
To provide quality education at affordable cost, build academic and research excellence maintain eco-friendly and robust infrastructure, and	PEO1, PEO2
To create a team of well qualified faculty who can build global competency and employability among the youth of India.	PEO2, PEO3

Mapping of Department Mission to PEO

Department Mission	PEO's
Imparting critical thinking	PEO 1, PEO 2
Enhancing research skills	PEO 1, PEO 2
Developing professionalism	PEO 2, PEO 3,
Viable technical knowledge and core competency	PEO 1. PEO 3

Program Outcomes (PO):

PO1	**:**	Demonstrate knowledge competency in core discipline
PO2	**:**	Apply the appropriate knowledge and suitable skills in solving the complex problems
PO3	**:**	Conduct investigations of complex problems through various scientific approaches
PO4	**:**	Design solutions for complex and open ended real-life or real-time problems
PO5	**:**	Use appropriate and advanced tools for wide range of practices with an understanding on its associated limitations
PO6	**:**	Work effectively and responsibly as a member or a leader in a team
PO7	**:**	Express complex concepts within the profession and with society at large
PO8	**:**	Understand the professional roles and responsibilities
PO9	**:**	Analyze social and environmental aspects of the professional practices
PO10	**:**	Practice higher moral and ethical standards during the discharge of professional duties
PO11	**:**	Incorporate finer finance and business practices in all professional engagements
PO12	**:**	Identify and address their professional development through lifelong learning

Program Specific Outcomes (PSO):

PSO1	Stay abreast of emerging trends and advancements in biotechnology and provide opportunities for students to engage in cutting edge research and innovation in the field.
PSO2	Encourage innovation and creativity in students by supporting entrepreneurship and the development of novel biotechnological solutions.
PSO3	Foster interdisciplinary collaboration and critical thinking skills to address complex challenges in Biotechnology.
PSO4	Promote ethical and responsible conduct in biotechnological research and practice, emphasizing the importance of sustainability and social impact.

Correlation between the PO/PSO and the PEOs

Program Outcomes		PEO 1	PEO 2	PEO 3
PO 1	:	3	1	3
PO 2	:	3	2	3
PO 3	:	1	2	3
PO 4	:	3	1	3
PO 5	:	3	3	2
PO 6	:	2	3	3
PO 7	:	2	3	1
PO 8	:	3	2	1
PO 9	:	2	2	3
PO 10	:	3	2	1
PO 11	:	2	1	1
PO 12	:	3	2	2
PSO 1	:	2	3	1
PSO 2	:	3	2	2
PSO 3	:	2	3	3
PSO 4	:	3	2	2

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

Components considered for Course Delivery is listed below:

a. Class room Lecture
b. Laboratory class and demo
c. Assignments
d. Mini Project
e. Project
f. Online Course
g. External Participation
h. Seminar
i. Internship

Mapping of POs with Course Delivery:

Program Outcome	Course Delivery								
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**
PO1	3	3	1	1	2	1	3	3	1
PO2	3	3	2	3	3	1	1	2	3
PO3	3	3	1	3	1	1	1	2	3
PO4	2	3	2	3	3	1	1	3	1
PO5	3	2	1	3	1	3	3	3	3
PO6	2	3	1	3	3	1	2	3	3
PO7	2	3	1	3	1	1	2	3	3
PO8	2	2	1	2	3	3	2	3	3
PO9	1	1	2	3	3	3	2	3	3
PO10	2	1	2	3	2	2	2	2	2
PO11	1	1	2	2	2	3	3	3	3
PO12	1	2	3	2	2	2	3	3	3
PSO1	2	3	1	3	2	3	1	3	3
PSO2	3	2	2	3	3	2	2	3	2
PSO3	2	3	3	2	2	3	3	2	3
PSO4	3	2	2	1	3	2	2	1	2

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

Sem	Part	Type	Sub Code	Subject	Credit	Per Week	CIA	ESE	Total	Exam Hours
1.1	3	C1		Core-I Cell and Molecular Biology	4	5	50	50	100	3
1.2	3	C2		Core-II Biochemistry	4	5	50	50	100	3
1.3	3	C3		Core-III Microbial Bioresources	4	5	50	50	100	3
1.4	3	C4		Core-IV Lab in Biochemistry & Microbiology	4	5	50	50	100	3
1.5	3	SEC 1		Skill - I Techniques in Molecular biology	4	5	50	50	100	3
1.6	3	ELE 1		Elective-1	4	5	50	50	100	3
					24	**30**	**350**	**350**	**700**	
2.1	3	C5		Cor -V Immunology & Immune Response	4	5	50	50	100	3
2.2	3	C6		Core-VI Recombinant DNA Technology	4	5	50	50	100	3
2.3	3	C7		Core-VII – Plant and Animal Biotechnology	4	5	50	50	100	3
2.4	3	C8		Core-VIII – Lab in Immunology & rDNA Technology	4	5	50	50	100	3
2.5	3	SEC 2		Skill - II – Cell Culture Techniques	4	5	50	50	100	3
2.6	3	ELE 2		Elective-2	4	5	50	50	100	3
					24	**30**	**250**	**250**	**500**	
3.1	3	C9		Core-IX Enzyme Technology	4	6	50	50	100	3
3.2	3	C10		Core-X Pharmaceutical Research and Development	4	6	50	50	100	3
3.3	3	C11		Core – XI Genomics & Proteomics	4	6	50	50	100	3
3.3	3	C12		Core – XII – Lab in enzymology and Pharmaceutical Biotechnology	4	6	50	50	100	3
3.4	3	SEC 3		Skill - III Omics Tools and Techniques	4	6	50	50	100	3
3.5	3	ELE 3		Elective-3	4	6	50	50	100	3
3.6	3	ITR		Internship / Industrial Training (Summer vacation at the end of II semester activity)	2		50	0	50	3
					26	**30**	**300**	**250**	**550**	
4.1	3	C13		Core-XIII – Industrial and Environmental Biotechnology	4	6	50	50	100	3
4.3	3	ELE 4		Elective-4	4	6	50	50	100	3
4.4	3	PRJ		Project with Viva-Voce	8	12	100	100	200	3
					16	**30**	**250**	**250**	**500**	
TOTAL					**90**	**120**	**1150**	**1100**	**2250**	

Elective	Course Name
1	Ecology and Biodiversity
	Bioethics, Biosafety and IPR
	Bioresource Conservation
2	Embryology and Embryo Technology
	Developmental Biology
	Reproductive Biotechnology
3	Herbal Drug Technology
	Dietary Supplement & Nutraceuticals
	Research Methodology and Scientific Writing
4	Bio-nanotechnology
	Agriculture Biotechnology
	Food Biotechnology

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Core I : Cell and Molecular Biology	**4**	**5**	**0**	**0**	**Theory**

Course Objective: The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

Unit I: Classical Vs modern genetics: History of genetics, Mendelian principles, monohybrid and dyhybrid crosses, dominance, codominance and incomplete dominance, gene interaction and epistasis, concept of gene and cistron, cis-trans complementation experiment, lethal, selfish and pseudogenes, gene concept, structure of genes.

Unit II: Structural and numerical aberrations: Ploidy level, euploidy and aneuploidy, INDELs, inversion and replacement mutations, spontaneous and induced mutation, mutagens, crossing over and linkage.

Unit III: Chromosome organization and replication Organization of eukaryotic chromosome, gene concept, eukaryotic and prokaryotic gene architecture, Replication of DNA in prokaryotes, DNA damage and repair, Comparison of DNA replication between prokaryotes and eukaryotes.

Unit IV: Expression of gene. Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts and translation (initiation, elongation and termination) Operon concept in prokaryotes, Trp attenuation, comparison of gene expression mechanism between eukaryotes and prokaryotes.

Unit V: Gene silencing and gene expression analysis Gene silencing approaches: cosuppression, antisense RNA techniques, ribozyme (Hammer head, hairpin ribozymes) mediated methods, dsRNA (microRNA and small interfering RNA).

Reference:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.

2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.

3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.

4. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.

5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings.

6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Core II : Biochemistry		**4**	**5**	**0**	**0**	**Theory**

Course Objective: The objective of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.

Unit I: Macromolecules - structure, classification and properties of Carbohydrates, Proteins and Lipids and Nucleic acids. Carbohydrates- Monosaccharides-classification and structure, Isomerism in monosaccharides, Disaccharides- mclassification and types of disaccharides, its biological significance and finctions, Oligosaccharides-hetero-oligosaccharides and homo-oligosaccharides, Polysaccharides- classification- hetero-polysaccharides, and homo-polysaccharides, storage polysaccharides and structural polysaccharides.

Unit II: Proteins- classification of proteins, building units of proteins- Amino acids- structure, properties and function, classification of Amino acids, peptide bonds, ramachandran plot, oligo peptides polypeptides, Structure of proteins- primary, secondary and tertiary structures, quaternary structures, supra-secondary structures- motifs and domains, Isolation and purification of proteins-different molecular and instrumental methods involved. Characterization of protein- structural and amino acid composition, Functions of proteins.

Unit III: Lipids- structure and classification, various types of lipids – Oils and fats, Triglycerides-structure and function, Phospholipids- structure, classification and functions, Biological significance of various types of Phospholipids, Glycolipids and lipoproteins, serum lipids and its significance, Cholesterol and its derivatives, Nucleic acids- classification of Nucleic acids, Building blocks of Nucleic acids, structure of Nucleotides, classification of nucleotides, Purines, Pyramidines, structure and function of DNA and RNA, Non-genetical function of Nucleic acids and its derivatives.

Unit IV: Metabolism of carbohydrates - Glycolysis, TCA cycle, Gluconeogenesis, Pentose Phosphate pathway, Glycogen metabolism-Glycogenesis, glycogenolysis. Biosynthesis of starch, glycogen and glucose. Photosynthesis. ETS and bioenergetics of cellular respiration. Redox reactions, standard oxidation reduction potential, mitochondrial electron transport chain, Oxidative phosphorylation, structure of ATP synthase, chemiosmotic hypothesis Metabolism of Lipids- Oxidation of lipids. Beta-oxidation, Biosynthesis of lipids, Ketone bodies.

Unit V: Metabolism of proteins and amino acids – Digestion and absorption, Biosynthesis and degradation of amino acid. Urea cycle, regulation. Metabolism of Nucleotides –biosynthesis, degradation and regulation of nucleotides and related molecules. Energy compounds and its biosynthesis- ATP, NAD, NADP, FAD, Creatin phosphates. Secondary metabolism- classification and role of secondary metabolites of plants and microbes - Role of secondary metabolites. Metabolic network - Interrelationship of metabolisms Krebs cycle, amino acid synthesis.

Recommended Textbooks and References:

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.

2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.

3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

4. Dobson, C. M. (2003). Protein Folding and Misfolding. Nature, 426(6968), 884-890. doi:10.1038/nature02261.

5. Richards, F. M. (1991). The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Core III : Microbial Bioresources		**4**	**5**	**0**	**0**	**Theory**

Course Objective: The objective of this course are to introduce students to field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.

Unit I: Microbial characteristics - Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.

Unit II: Microbial diversity - Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.

Unit III: Control of microorganisms - Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms.

Unit IV: Virology - Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.

Unit V: Host- microbe interaction - Host-pathogen interaction, ecological impacts of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

References:

1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (1977). Microbiology (5th ed.). New York: McGraw-Hill.
2. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's Microbiology. New York: McGraw-Hill.
3. Matthai, W., Berg, C. Y., & Black, J. G. (1999). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Skilled: Techniques in Molecular Biology	**4**	**5**	**0**	**0**	**Theory**

Course Objective: To integrate multiple molecular biology techniques to address research questions and solve the biological problems.

CO1: Students will demonstrate a comprehensive understanding of the fundamental principles of Molecular biology.
CO2: Students will acquire practical skills in molecular biology laboratory techniques.
CO3: Students will demonstrate proficiency in following laboratory protocols, safety procedure and good laboratory practices.
CO4: Students will analyse experimental data, interpret results and draw meaningful conclusions using statistical analysis and data visualization techniques.
CO5: Students will apply molecular biology concepts to solve complex biological problems and propose innovative solutions.

1. Isolation and quantification of Nucleic Acids.
    - Isolation & Quantification of DNA from Bacteria.
    - Isolation & Quantification of DNA from Plant
    - Isolation & Quantification of DNA from Blood/tissue
    - Isolation & Quantification of RNA from Plant/Animal tissue.
    - Isolation & Quantification of Plasmid DNA

2. Isolation and quantification of Protein
    - Isolation of protein/ enzyme from Bacteria/Plant/ Animal tissue
    - Quantification of protein by Lowry's method
    - Quantification of protein by Bradford Method
    - Separation of Protein by Colum chromatography.
    - Separation of Protein by SDS PAGE
    - Staining Techniques – coomassie blue staining & Silver Staining

3. Electrophoresis Techniques
    - Agarose Gel Electrophoresis,
    - Polyacrylamide Gel Electrophoresis for DNA
    - Polyacrylamide Gel Electrophoresis for Protein
    - Native PAGE.
    - 2D Gel Electrophoresis

4. Polymerase chain reaction
    - Principles and operation of PCR
    - Amplification of target Gene
    - Random Amplification
    - Colony PCR
    - Nested PCR
    - Reverse Transcriptase PCR
    - Real Time PCR

- Gene Sequencing

5. Cloning & Blotting Techniques
    - Restriction Digestion
    - TA Cloning vector Vs Expression vector
    - Transformation & Blue White Screening
    - cDNA Library & DNA Library
    - Southern Blotting, Western Blotting & Northen Blotting

Reference:

1. Molecular cloning : a laboratory manual / Joseph. Sambrook, David W. Russell. 2000.

2. PCR (Introduction to Biotechniques (BIOS)) by M.J. McPherson, S. Moller, 2000

3. Gel Electrophoresis: Essential Data (Essential Data Series) 1st Edition by D. Patel, 1994.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Practical I : Lab in Biochemistry and Microbiology		**4**	**0**	**0**	**6**	**Theory**

Course Focus on: Skill Development & Research

Course Objective: This practical session students able to know the macromolecules estimation and microbial media preparation, isolation and characterization.

1. Estimation of reducing sugars by Nelson - Somogyi method
2. Estimation of total carbohydrates by Anthrone method
3. Estimation of acid value, saponification value, Iodine number of fat
4. Estimation of total free amino acids
5. Protein estimation by Absorbance at 280nm, Lowry's method and Bradford method.
6. Separation of LDH isozymes from serum by SDS-PAGE.
7. Paper Chromatography - separation of pigments
8. Thin Layer Chromatography - separation of amino acids
9. Ion Exchange Chromatography
10. Extraction and purification of peroxidase from soy bean seeds
11. Estimation of ascorbic acid and riboflavin
12. Microscopy- care and use of microscope
13. Sterilization
14. Sample collection - clinical and Environmental samples
15. Culture media preparation
16. Pure culture techniques
17. Staining of Bacteria: simple, negative, differential, micro chemical staining
18. Staining of fungi - Lacto phenol cotton blue
19. Isolation, purification and biochemical identification of bacteria
20. Antibiotic sensitivity test

REFERENCE

1. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T.A. Nieman, Published by Saunders. 1998. Edition: 5.
2. Laboratory Manual of Biochemistry by J. Jayaraman, Published by Willy Eastern. 1981. Edition: 2. 3. Protein Methods by Daniel M. Bollaget al. Published by Wiley-Liss, Inc. 1996. Edition: 2.
4. Biochemical Methods by S. Sadasivam and A. Manickam, Published by Reprint New age international (P) Ltd. 1996. Edition: 2.
5. An Introduction to practical Biochemistry by David T Plummer, Published by Tata Mcgraw hill Publication. 1971. Reprinted 2004. Edition: 3.
6. Manual of Microbiology Tools and Techniques by Kanika Sharma, Published by Ane Books, 2007. Edition: 4.
7. Laboratory Manual on Biotechnology- Prof. P.M. Swamy, Published by Rastogi Publications.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Elective I : Ecology and Biodiversity	**4**	**5**	**0**	**0**	**Theory**

Course Objectives

The objective of this course is to teach students:

• How organisms interact with each other and their environment;

• How species are distributed throughout the world;

• Key threats and approaches to conserving biodiversity.

Student Learning Outcomes

On completion of this course, students should be able to:

• Understand and appreciate major living and non-living components of regional and global environment, and how they interact; identify threats to them; and know how these threats can be mitigated;

• Understand and appreciate variety of life in India's natural habitats, and become equipped to study, manage and protect the diversity.

Unit I: Ecological principles: Basic ecological concepts and principles, our environment: geological consideration; Atmosphere, hydrosphere, lithosphere; Scope of ecology; Development and evolution of ecosystem; Principles and concepts of ecosystem; Structure of ecosystem; Strata of an ecosystem; Food chain, food web; Energy budget; Production and decomposition in a system; Ecological efficiencies; Trophic structure and energy pyramids; Ecological energetics; Principles pertaining to limiting factors; Biogeochemical cycles (N, C, P cycles).

Unit II : Types of ecosystems - Habitat approach, freshwater ecology; Marine ecology; Estuarine ecosystem, terrestrial ecosystem; Cybernetics and homeostasis; Biological control of chemical environment; Energy transfer in an ecosystem; Natural resources and their conservation.

Unit III: Dynamics of ecosystems - Biotope-Biocenose interactions (Climate and plants, Soil and living things); Interactions among organisms (Types of interactions, Consequences for population dynamics, Man in Biocenoses); Man and Ecosystems (Managing land, resources, waste; Global impact of human activities; Man as a partner in the Ecosystem).

Unit IV: Biodiversity I: Biodiversity definition; Historical and geographical causes for diversity; Types of diversity; Genetic diversity; Species diversity, ecosystem diversity; Quantifying biodiversity; Molecular taxonomy; Maintenance of ecological biodiversity; Biodiversity and centers of origins of animals; Biodiversity hot spots in India; Collection and conservation of biodiversity.

Unit V: Biodiversity II: Conservation of animal genetic resources; Methods of biodiversity conservation; Gene banks; Cryopreservation; Assessing, analyzing and documenting biodiversity; Morphological and molecular characterization of biodiversity; Vulnerability and extinction of biodiversity; Introduction to biodiversity database: endangered animals, endemism and Red data book; Global biodiversity information system.

Recommended Textbooks and References:

1. Odum E.P., 2004, *Fundamentals of Ecology* (5th Edition), Brooks/Cole.
2. Amann, R.I. Stromley, J. Stahl: *Applied and Environmental Microbiology.*
3. M. Dash, S. Dash, (2009), *Concepts of Ecology* (3rd Edition), McGraw Hill Education.
4. Varma P.S.; Agarwal V.K. (2000), *Environmental Biology* (4th Edition), S Chand & Company
5. B. K. Sharma (2014), *Environmental Chemistry*, Krishan Prakashan
6. Peavy H.S. and Rowe D.R. (2013), *Environmental Engineering* (1st Edition), McGraw Hill Education.
7. Asthana D.K.; Asthana M, (2002), *Environment Problems and Solutions* (2nd Edition), S. Chand & Company.
8. Mahahan S.E (2009), *Environmental Chemistry*, (9th Edition); CRC Press
9. Saigo B.W., Canningham W.P., (1995), *Environmental Science: A Global Concern* (3rd Edition); William C Brown.
10. Arceivala, S. J. & Asolekar, S. R. (2012). *Environmental Studies: A Practitioner's Approach*, McGraw Hill Education (India) Pvt. Ltd., New Delhi.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective II :	**Intellectual Property Rights and Bioethics**	**4**	**5**	**0**	**0**	**Theory**

Course Objectives

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- Student Learning Outcomes

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;

Unit I: General overview of Intellectual Property Rights and Patents WIPO, WTO, Trade Related Intellectual Property Rights. Basic requirements of Patentability, Patentable subject matter, Types of patent (process and product), Procedure for obtaining Patent, Provisional and Complete specification.

Unit II: Copyright and trademarks Meaning and objectives of copyright , Rights conferred by registration of copyright , Infringement of copyright Basic Principles of Trademark, Rights conferred by Registration of Trademark, Infringement of Trademark

Unit III: Geographical indicators Geographical Indications-Objectives of Geographical Indications, Rights conferred , Infringement of Geographical Indications, International Position Indian Position, Bioprospecting and Biopiracy.

Unit IV: Bioethics Ethical implications of biotechnological products and techniques: Ethical research, plagiarism, DBT regulations for biosafety and GMOs. . Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labelling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity– biopiracy.

Unit V: National and international regulations: International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labelling –Food Safety and Standards Authority of India (FSSAI).

Recommended Textbooks and References:

1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub.
2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
5. National Biodiversity Authority. http://www.nbaindia.org
6. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/

divisions/csurv/geac/annex-5.pdf
7. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). *Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants*. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective III :	**Conservation of Bioresources**	**4**	**5**	**0**	**0**	**Theory**

Course Objective: Bioresources are being overexploited to meet market demand, threatening their existence. The present course aims at introducing students to approaches for documentation of biodiversity, nature and magnitude of threat to bioresources and imparting knowledge about their conservation.

Student Learning Outcomes

On completion of this course, students should be able to:

- Understand various bioresource assessment methods;
- Understand methods of characterization of bioresources;
- Understand and employ various bioresource conservation techniques.

Unit I: Survey and documentation of biodiversity and bioresources: Biodiversity and bioresources: concept and scope; evolution of biodiversity, factors promoting biodiversity; levels of biodiversity - genetic, species and ecosystem diversity; measuring organismal diversity: species richness index, species evenness index, Shannon-Wiener Index and Simpson Index; measurement of biodiversity at spatial level: alpha, beta and gamma diversity; Remote sensing and Geographical Information System (GIS): introduction, scope, history, components, functions, advantages and limitations; Application of remote sensing for bioresources management: land cover and land use, forestry, agriculture and wildlife.

Unit II: Loss of bioresources: Estimate of biodiversity loss; Means of biodiversity loss: species extinction, genetic erosion; loss of ecosystem diversity; Causes of biodiversity loss: habitat destruction, unsustainable exploitation, biological invasion, environmental pollution and poverty. Species threat status: IUCN threat categories and criteria; concept of rarity; RED Data Book; Biodiversity hotspots; effect of climate change on biodiversity; Biopiracy: factors and reasons, biopiracy- vis – a – vis IPR regime; steps to check biopiracy - vigil, applicability of modern technologies in checking biopiracy

Unit III: Conservation of bioresources: Why conserve bioresources; global measures for conserving bioresources: international conservation organizations (FAO, UNESCO, IUCN, WWF, UNEP, Biodiversity International, WCMC); multilateral treaties (Ramsar Convention, WHC, CITES, CBD). Biological Diversity Act, 2002 and Biological Diversity Rules, 2004, Wild Life (protection) Act,1972 including amendments in 1991, Forest (conservation) Act, 1980, Bioresource Development Board, Indian Bioresource Information Network; National Biodiversity Authority, National Biodiversity Action Plan, 2008, State Biodiversity Boards; IPRs and Biological Resources, Development in Life Sciences Trade Industry and the WTO - TRIPS Agreement, patents and other IPRs, Implication of IPRS to Biological Resources; PVPFRA, Plant Breeder's rights, Farmer's rights, Tribunal rights, Traditional Resource rights, Variety registration.

Unit IV: Conservation strategies: In situ conservation sites: Protected areas - Biosphere Reserves, National Parks, Wildlife Sanctuaries; Reserve Forests; Community conserved areas - Sacred groves and community forests; In situ conservation of aquatic ecosystems: lakes, wetlands, mangroves, coral reefs, and ponds. Ex situ conservation sites: Botanical Gardens and Arboreta, Field gene banks, Seed banks, Zoological parks, zoos and aquaria, role of Animal Breeding Centres in conservation; In vitro conservation and cryopreservation: principles, infrastructure and experimental protocols for in vitro conservation and cryopreservation of cells, tissues and organs;

advantages and disadvantages; in vitro and cryobanks; DNA and genomic resource banks, conservation in permofrost conditions. Gene banks: IBPGR, Indian gene banks for plant, animal, fish, microbial and insect genetic resources; NBPGR, National Genetic Resource Advisory Council.

Unit V: Molecular characterization of bioresources: Molecular markers - definition, properties, classification, importance and scope; Molecular marker techniques: RAPD, SSR, ISSR, SSAP and AFLP, Expressed Sequence Tags, and their utility; merits and demerits of different molecular marker techniques. Proteins, isozymes and allozymes as markers, their significance in characterization; methods of isozyme and allozyme analysis. Biotechnology and its role in biodiversity conservation; software for molecular characterization and diversity analysis; role of taxonomy in assessment, conservation and sustainable use of biodiversity.

References

1. Bhojwani, S. S. (1990). Plant Tissue Culture: Applications and Limitations, Elsevier, Amsterdam.
2. K. V. Krishnamurthy (2003). Textbook of Biodiversity, Illustrated reprint, Science Publishers.
3. Correa, Carlos M. (2000). Intellectual Property Rights, the WTO and Developing Countries: the TRIPS Agreement and Policy Options. Zed Books, New York.
4. Kurt Weising, Hilde Nybom, Markus Pfenninger, Kirsten Wolff, Gunter Kahl. DNA Fingerprinting in Plants, Principles, Methods & Application, 2nd edition, Taylor & Francis.
5. Engelmann F. (2004). Plant Cryopreservation: Progress and Prospects. In vitro Cellular and Developmental Biology 40:427-433.
6. Engels JMM, Visser L, editors. (2003). A Guide to Effective Management of Germplasm Collections. IPGRI Handbooks for Genebanks No. 6. IPGRI, Rome, Italy.
7. FAO/IPGRI. (1994). Genebank Standards. Food and Agriculture Organization of the United Nations, Rome and International Plant Genetic Resources Institute, Rome.
8. Glick, B.R. and Pasternak, J.J. (1998). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, Washington.
9. Groom, M.J., Meffe, G.K. and Carroll, C.R. (2006). Principles of Conservation Biology. Sircuier Associates, Inc.
10. Holdgate MW (1986). Summary and Conclusions: Characteristics and Consequences of Biological Invasions. Philosophical Transactions of the Royal Society, London.
11. Narayan, P.S. (2001). Intellectual Property Law in India, Gogia Law Agency, Hyderabad.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Core IV :	**Immunology Immune Response**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To provide a fundamental understanding of the immune system, its components, and mechanisms, covering both normal and pathological immune responses, and their applications in research and clinical practice.

Unit I: Immunology: fundamental concepts and overview of the immune system Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

Unit II: Immune responses generated by Band T lymphocytes Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; B cell maturation activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC.

Unit III: Antigen-antibody interactions Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Unit IV: **Vaccinology** Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, Tcell based vaccine, edible vaccine and therapeutic vaccine.

Unit V: Clinical immunology: Immunity to infection ; bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Reference

1. Kindt, T.J., Goldsby, R. A., Osborne, B. A., & Kuby,J.(2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff,J.,Seaddin, J.K., Male,D.,&Roitt, I. M.(2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: GarlandScience.
4. Paul, W.E.(2012). Fundamental Immunology.NewYork:Raven Press.
5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.
6. Parham, P.(2005). The Immune System.New York:Garland Science.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Core V :	**Recombinant DNA Technology**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To impart a foundational understanding of the principles and techniques used to manipulate DNA for scientific, medical, and industrial applications. Students will learn about gene cloning, DNA sequencing, PCR, gene expression analysis, and the development of genetically modified organisms (GMOs), enabling them to apply these methods in research and biotechnology.

Unit-I: Basics of Genetic Engineering & Cloning Strategies General introduction and concept. Biosafety guidelines and containment strategies DNA modifying enzymes and restriction enzymes, Milestones in genetic engineering, Isolation of enzymes. Molecular tools and their applications: Restriction enzymes, modification enzymes, DNA and RNA markers. Nucleic acid purification and yield analysis. Nucleic acid amplification and its applications. .

Unit-II: Alternative strategies of gene cloning: Cloning interacting genes- two-and-three hybrid systems, cloning differentially expressed genes. Gene regulation-DNA transections, northern blot, primer extension, S1 mapping, RNAase Expression strategies for heterologous genes: Vector engineering and codon optimization, host engineering, invitro transcription and translation. Expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins. Phage display.

Unit-III: T-DNA and Transposon tagging : Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of genes through T-DNA or transposon. Transgenic and gene knockout technologies: Targeted gene replacement, chromosome engineering. Isolation of plasmid. Gene therapy; Vector engineering, Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Unit-IV: Cloning strategies: Genomic libraries, cDNA libraries, single gene cloning. Vectors in gene cloning: Types of vectors and choice of vectors- Plasmids, cosmids, lamda phage vectors, shuttle vectors, BACs and YACs Choice of hosts, Methods for transferring recombinant DNA to host cells (Transformation and Transfection) Hybridizations- Screening, colony, Southern, Northern, Western, Site-directed mutagenesis.

Unit-V: Detection and Characterization of Transformants Gene cloning vectors: Plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes. Restriction mapping of DNA fragments and map construction, nucleic acid sequencing. cDNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening.

REFERENCES

1. Molecular Cloning : A Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000

2. DNA Cloning: A Practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaulman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.

4. Methods in Enzymology, Guide to Molecular Cloning Techniques, vol. 152, S.L. Berger and A.R. Kimmel, Academic Press Inc., San Diego, 1996.

5. Methods in Enzymology, vol. 185, Gene Expression Technology,

6. DNA Science : A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York, 1990.

7. Molecular Biotechnology, 2nd edition, S. B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.

8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, I.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Core VI :	**Plant and Animal Biotechnology**	**4**	**5**	**0**	**0**	**Theory**

Course Objective: The objective of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

Unit I Plant tissue culture and animal cell culture

Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture. Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture.

Unit II: Plant genetic manipulation

Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.

Unit III: Animal reproductive biotechnology and vaccinology

Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species; Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

Unit IV: Plant and animal genomics

Overview of genomics – definition, complexity and classification; need for genomics level analysis; methods of analyzing genome at various levels – DNA, RNA, protein, metabolites and phenotype; genome projects and bioinformatics resources for genome research – databases; overview of forward and reverse genetics for assigning function for genes.

Unit V: Molecular mapping and marker assisted selection

Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.

Text Book & Reference.

1. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.

2. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.

3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.

4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.

5. Umesha, S. (2013). Plant Biotechnology. The Energy And Resources.

6. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.

7. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.

8. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.

9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.

10. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.

11. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker. 12. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Skilled :	**Cell Culture Techniques**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To provide essential knowledge and practical skills in culturing and maintaining various cell types under laboratory conditions. The course covers aseptic techniques, media preparation, cell growth and differentiation, contamination management, and the application of cell culture in research and biotechnology, preparing students for advanced studies and professional work in biomedical and life sciences.

Unit I: CELL CULTURE LABORATORY DESIGN AND EQUIPMENTS:

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubators; CO2 incubator; Culture Racks, Colony Counters, Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer; Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in plants, animals and microbial cell cultures; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Unit II: MEDIA AND REAGENTS:

Types of cell culture media for plants, animals and microbial cells; Ingredients of media; Physiochemical properties; Buffers; Oxygen; Osmolarity; Temperature; Balance salt solutions; Antibiotics, growth supplements; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media and other reagents.

Unit III: ANIMAL CELL CULTURES TECHNIQUES:

History of animal cell culture; Different tissue culture techniques; Cell separation, disaggregation of the explants, mechanical and enzymatic disaggregation; Continuous cell lines; Organ culture, techniques, advantages, disadvantages, applications; Cell cultures, substrate culture and suspension culture; Primary cell culture; Secondary cell culture (cell lines); Development, characterization and maintenance of cell lines, Cryopreservation; Commercial scale production of animal cells; stem cells- fate mapping, application; Application of animal cell culture for in vitro testing of drugs;

Unit IV: PLANT CELL CULTURE TECHNIQUES:

Cellular Totipotency, And its Applications. Organogenesis, factors affecting organogenesis. Cytodifferentiation. Somatic Embryogenesis, Synthetic Seeds, Techniques for production of haploids, diploidization, production of double haploids and their Applications. Triploids production - Endosperm culture and Applications. Secondary metabolite production, selection of high yielding lines, elicitation, immobilization of cultures, hairy root culture and biotransformation. Factors affecting secondary metabolites, industrial application of secondary metabolites. Molecular farming.

Unit V: MICROBIAL CELL CULTURE TECHNIQUES:

Auxotroph isolation - replica plating technique, Screening Preservation of microbial products. Production of antibiotics. Enumeration and screening of novel microbial secondary metabolites, strain improvement, Use of microbes in industrial waste treatment. Microbial leaching.

Textbook/s

1 Plant Cell Culture: A Practical Approach R.A. Dixon & Gonzales IRL Press 1994

2 Culture of animal cells-A manual of basic technique and specialized applications R. Ian Freshney Wiley Blackwell publishers 1983

3 Microbial Biotechnology Alexander N Glazer, Hiroshi Nikaido W H Freeman & Company 1995

Reference Books

1 Living resources for Biotechnology, Animal cells Doyle, R. Hay and B.E. Kirsop Cambridge University Press 1990

2 Plant Tissue Culture Sathyanarayana B N, IK Intl. Publishers 2007

3 Principle of Microbe & Cell Cultivation SJ Prit Blackwell Scientific co 1975

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Practical II : Lab in Immunology and rDNA Technology		**4**	**5**	**0**	**0**	**Theory**

Course Focus on: Employability & Research

Course Objective: This practical session students able to know the phytochemical analysis and genetic transformation

1. Isolation of genomic DNA from bacteria and animal tissue. Purification and Quantification.

2. Agarose gel electrophoresis

3. Isolation of plasmid DNA from bacteria

4. Restriction digestion and ligation of Lambda phage DNA and gel analysis

5. Transformation of plasmid DNA in E.coli, expression and selection 6. Polymerase chain reaction.

6. Separation of IgG using affinity chromatography

7. Blood grouping and counting of blood cells

8. Antigen-Antibody Interactions: Radial Immunodiffusion, Ouchterlony double diffusion Precipitin ring test

9. Immunoelectrophoresis and rocket immunoelectrophoresis.

10. Antibody titre by ELISA 8. SDS-PAGE and Immunoblotting 9. Separation of mononuclear cells from Human peripheral blood

Reference:

1. An Introduction to Practical Biotechnology - S. Harisha, Published by Firewall Media, 2006.

2. Novo's Handbook of Practical Biotechnology - C. O. L. Boyce, Boyce, Published by Novo Industri A/S, 1986.

3. Genetic Engineering Principles and Practice, Sandhya Mitra, Published by Macmillan India, 1996.

4. Molecular Cloning: A Laboratory Manual - Joseph Sambrook, E. F. Fritsch, Tom Maniatis, Chris Nolan Published by Cold Spring Harbor Laboratory, 1989 Edition: 2.

5. Molecular Cloning: A Laboratory Manual - Joseph Sambrook, David William Russell, Published by CSHL Press, 2001, Edition: 3.

6. Analytical Microbiology by Frederick Kavanagh Volume I & II. Published by Academic Press New York.

7. Manual of Clinical Laboratory and Immunology by Noel R. Rose, Published by ASM Publications, 2002, Edition: 6.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective IV :	**Embryology & Embryo technology**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To equip with a comprehensive understanding of embryonic development and the advanced technologies used in reproductive biology. Students will explore the stages of embryogenesis, genetic and environmental factors influencing development, and techniques such as in vitro fertilization (IVF), embryo culture, and genetic screening, preparing them for careers in reproductive medicine, research, and biotechnology.

Unit I: INTRODUCTION TO EMBRYOLOGY – • Basic Human Embryology • Gametogenesis • Meiosis • Implantation and placentation • Preimplantation embryo development • Development of various organs • Anatomy of Male Reproductive System • Anatomy of Female Reproductive System • Anatomy of Brain • Anatomy of Sperms.

Unit II: INFERTILITY AND ITS CLINICAL MANAGEMENT I: Physiology of Ovulation • Folliculogenesis • Physiology of Menses • Hormonal control of human • Natural Cycle • Various stimulation protocols • Ovarian Hyperstimulation syndrome (OHSS) • Complication of stimulation • Monitoring of patients •

Unit III: INFERTILITY AND ITS CLINICAL MANAGEMENT II: Reproductive function and causes of subfertility • Investigating male and female patients • Infertility and its management • Ultrasound • Elderly Patients reproduction • Miscarriage • Ectopic Pregnancies • Multiple Gestation • Heterotrophic Pregnancies • Oocyte Donation Programme • Surrogacy.

Unit IV: ANDROLOGY I: • Physiology of Sperm • Spermatogenesis • Male Factor • Lab Set-up for andrology • Sperm separation • Semen analysis • Semen analysis as per WHO criteria. Sperm morphology assessment according to Strict (Kruger) criteria. • Sperm survival test.

Unit V: ANDROLOGY II: Grading of Sperms • Sperm preparation for IUI • Sperm preparation for IVF • Semen preparation for IUI-Classical method, Standard method and Density gradient method. • Semen cryopreservation-both neat and processed sample. • Sperm freezing • Donor Sperm Programme

Reference:

1. A Practical Guide to Setting Up an IVF Lab, Embryo Culture Systems and Running the Unit Alex C Varghese, Peter Sjoblom, K. Jayaprakasan, April 2013.
2. Oogenesis Giovanni Coticchio, David Albertini, Lucia De Santis December 2012.
3. Sperm Chromatin Biological & Clinical Applications in Male Infertility & Assisted Reproduction Nini, Armand; Agarwal, Ashok (Eds.) September2011.
4. Practical Manual of In Vitro Fertilization: Advanced Methods and Novel Devices Nagy, Zsolt Peter; Varghese, Alex C; Agarwal, Ashok (Eds) September2011.
5. Preservation of Human Oocytes Dr. Andrea Borini & Dr. Giovanni Coticchio December 2009.
6. Human Preimplantation Embryo Selection Kay Elder, Jacques Cohen February2008.
7. In Vitro Fertilization: A Practical Approach David K. Gardner February2008.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective V:	**Developmental Biology**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To understanding of the processes and mechanisms underlying the development of organisms from fertilization to maturity. Students will study cellular differentiation, morphogenesis, gene regulation, and the genetic and environmental influences on development, preparing them for advanced research and careers in developmental biology, genetics, and related fields.

Unit I: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Unit II: Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Unit III: Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans;* eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Unit IV: Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.*

Unit V: Cleavage: Patterns and Types of cleavage Blastulation Brief account on Holoblastic and Meroblastic cleavages Gastrulation (Epiboly and Emboly) Growth and Differentiation. Genetic errors of Human development, Infertility, Teratogenesis.

References:

1. Essential developmental biology – Jonathan Michael Wyndham slack, Wiley-Blackwell, 2006.

2. Current topics in developmental biology – Geral P. Schatten, Academic press, 2006.

3. The origin of animal body plans: a study in evolutionary developmental biology – Wallace Arthur, Cambridge university press, 2000.

4.Developmental biology – Werner A. Muller, Springer, 1997.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective VI :	**Reproductive Biotechnology**	**4**	**5**	**0**	**0**	**Theory**

Course Objectives: Reproductive Biology covers principles and techniques in reproduction. It also enlightens the areas including Physiology of human reproductive system and its hormonal regulation, Applications of Reproductive Biology like Artificial Reproductive Techniques (ARTs) etc**.** that will help to develop further practical skills or research ability of the students.

Unit I: Principles of Reproductive Biology - Potency, commitment, specification, induction, competence. Determination and differentiation; morphogenetic gradient, cell fate and cell lineages. Cell to cell communication during early development. Environmental control of gene regulation, Epigenetic regulation of developmentally relevant genes.

Unit II: Physiology of Reproduction - Primary and accessory sex organs and secondary sex characters. Testis: histology, testicular hormones and their functions. Ovary: histology, ovarian hormones and their functions. Oestrous cycle and its hormonal control. Maintenance of pregnancy – role of hormones. Development of mammary gland and lactation - role of hormones.

Unit III: Reproductive system and hormonal regulation - Female reproductive system: Hormonal regulation of ovulation, gestation, parturition and lactation; Menstrual cycle and its hormonal control, Male reproductive system: Hormonal regulation of spermatogenesis, Molecular basis of male and female reproductive disorders, therapeutics, male and female infertility. Steroid receptors: Defects, modulators, clinical significance.

Unit IV: Serogenetics – Genetic Compatibility, Carrier Status, Reproductive Counselling. Preconception Genetic Testing, Invitro Fertilization (IVF) and Genetic Screening, Genetic Counselling.

Unit V: Applications of Reproductive Biology - Artificial Reproductive Techniques (ARTs), Types and application of contraception; Male and female contraceptives, Menopause, andropause and their management.

Reference:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Eckert Animal Physiology: Mechanisms and adaptations Randall, Burggren and FrenchVander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
4. Victor P. Eroschenko. (2008). diFiore’s Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
5. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
6. Histology: A Text and Atlas. Sixth Edition. Ross &Pawlina. Lippincott Williams & Wilkins.
7. Eckert Animal Physiology by David Randall and Warren Burggren. 4th edition.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Core VII : Enzyme Technology	**4**	**5**	**0**	**0**	**Theory**

Course objective: To understand of the principles and applications of enzymes in industrial and biomedical contexts. Students will learn about enzyme structure, function, kinetics, production, and immobilization techniques, as well as their uses in processes such as biocatalysis, drug development, and diagnostics, preparing them for careers in biotechnology and related industries.

UNIT-I Enzyme classification & nomenclature of enzymes (IUB); extraction, isolation and purification of enzyme by various methods.

UNIT-II Mechanism of enzyme action - concept of active site and energetic of enzyme substrate complex formation - specificity of enzyme action; kinetics of single substrate reactions - turnover number - estimation of Michaelis - Menten's parameters; multi-substrate reactions - mechanisms & kinetics; allosteric regulation of enzymes.

UNIT-III Enzyme inhibitions - kinetics of competitive, non-competitive & uncompetitive inhibitions; nucleophilic & electrophilic attack; role of metal ions in enzyme catalysis.

UNIT-IV Immobilized enzymes - principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulose, artificial enzymes, industrial applications, fermentation, enzymes modification, site directed mutagenesis; immobilized enzyme in industrial processes.

UNIT-V Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin. Industrial utilization of enzymes, food, detergents, energy, waste treatment, pharmaceuticals and medicine.

Books for Reference

1. Biological chemistry, H.R Mahier & E. Cordes 1986.

2. Enzymes, Dizon & Webb

3.Genes VII, Benjemin Lewin, 1994. Oxford University Press. Oxford

4. Principles of Biochemistry, AL. Lehninger, D.L. Nelson and M. M. Cox. 1993. Worth Publishers, New York

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Core VII : Pharmaceutical Research and Development	**4**	**5**	**0**	**0**	**Theory**

Course objective: To comprehensive understanding of the drug development process, from initial discovery through preclinical and clinical trials to regulatory approval and market introduction. Students will learn about pharmacology, medicinal chemistry, formulation, and the principles of clinical research, equipping them with the knowledge and skills needed for careers in pharmaceutical research and development.

Unit I: Introduction to Pharmaceutical R&D, Overview of Drug development Lifecycle – Role and importance of R&D in Pharmaceuticals – Current Trends and emerging technologies. Biopharmaceuticals and their development – Biosimilars and Biobetters.

Unit II: Drug Discovery and Development – Target identification and validation – High Throughput Screening – Medicinal chemistry fundamentals – Preclinical Testing and optimization.

Unit III: Clinical Trial Design and Management – Phases of Clinical Trials – Protocol Development and Ethical considerations – Patient Requirement and Monitoring – Data collection and analysis.

Unit IV: Regulatory Affairs and Compliance: Regulatory framework in Pharmaceutical R&D – Good Clinical Practice (GCP) Guidelines – Compliance with International standards – FDA and EMA regulations.

Unit V: Pharmacovigilance and post market surveillance: Safety monitoring of drugs – Adverse event reporting – Risk Management plans – Post market surveillance strategies. Artificial intelligence and machine learning Applications – Personalized medicine and Biomarker Development – Advanced drug delivery systems.

References

1. Pharmaceutical Medicine and Translational Clinical Research by Prof. Y. K. Gupta, 2017
2. Pharmaceutical Biotechnology by Prof. Vyas S.P. and Dixit V.K, 2007
3. Pharmaceutical Regulatory Affairs in India" by Dr. Ramakrishna Yelamarthi, 2007
4. Goodman & Gilman's: The Pharmacological Basis of Therapeutics" by Laurence L. Brunton, Randa Hilal-Dandan, and Bjorn Knollmann, 2022
5. Drug Discovery and Development: Technology in Transition" by Raymond G. Hill and Duncan Richards, 2021

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Core VIII : Genomics and Proteomics	**4**	**5**	**0**	**0**	**Theory**

Course objective: On successful completion of the course the students should have understood the basics of fermentation technology and learnt the concept of screening, optimization and maintenance of cultures.

CO 1: Develop basic skills and techniques involved in Genome Mapping and Sequencing

CO 2: Understand and build skills for separation and amplification of DNA

CO 3: Analyse the data available in databases

CO 4: Familiarize the techniques involved in protein-protein interaction

CO 5: Understand the repositories of Biological Data Knowledge.

Unit-I: Genome mapping, assembly and comparison. Genome mapping, Genome sequencing, Genome sequence assembly: Base calling and assembly programs, Genome annotation: Gene ontology, Automated genome annotation. Comparative genomics: Whole genome alignment, Finding a minimal genome, Lateral gene transfer.

Unit-II: Functional Genomics. Sequence based approaches: EST, EST index construction and SAGE. Microarray based approaches: Oligonucleotide design, Data collection, Data transformation and normalization, Statistical analysis to identify differentially expressed genes and Microarray data classification. Comparison of SAGE and DNA Microarrays.

Unit-III: Proteomics Technology of protein expression analysis: 2D-PAGE, Mass spectrometry protein identification, protein identification through database searching, Differential in-gel electrophoresis and Protein Microarrays. Post translational modification: Prediction of disulphide bridges and Identification of posttranslational modifications in proteomics analysis. Protein sorting.

Unit-IV: Protein-protein interactions. Experimental determination of protein-protein interaction, Prediction of protein-protein interactions: predicting interactions based on phylogenetic information and prediction interactions using hybrid methods.

Unit-V: Applications of proteomics. Medical proteomics-disease diagnosis: Biomarkers, Biomarker discovery using 2DGE and mass spectrometry and Biomarker discovery and pattern profiling using protein chips. Pharmaceutical proteomics-drug development: Proteomics and target validation, Proteomics in the development of lead compounds and Proteomics and clinical development.

Text Book(s)

1. Xiong J. (2006). Essential bioinformatics. Cambridge, UK: Cambridge University Press.

2. Goodman N. (2002). Biological data becomes computer literature: New Advances in Bioinformatics. Curr. Opin. Biotechnol. 13:68-71.

3. Hagen J.B. (2000).The origin of bioinformatics. Nat. Rev. Genetics. 1:231-236.

4. Apweiler R. (2000). Protein sequence databases. Adv. Protein Chem. 54:31-71.

5. Hughes A.E. (2001). Sequence databases and the internet. Methods Mol. Biol. 167: 215- 223.

6. Stein L.D. (2003). Integrating biological databases. Nat. Rev. Genet. 4:337-45.

7. Batzoglou S. (2005). The many faces of sequence alignment. Brief. Bioinformatics. 6: 6- 22.

8. XuangX.(1994). On global sequence alignment. Comput. Appl. Biosci. 10:227-235.

9. Pearson, W.R. (1996). Effective protein sequence comparison. Methods Enzymol.266: 227-258.

10. Spang R. and Vingron M. (1998). Statistics of large scale sequence searching. Bioinformatics. 14:279-284.

REFERENCES:

1. Mullan L.J. (2002). Multiple sequence alignment- The gateway to further analysis. Brief. Bioinform. 3: 303-305.

2. Brenden C, and ToozeJ.(1999). Introduction to protein structure, 2nd ed. NewYork: Garl

And publishing.

3. Baker D. and Sali A. (2001). Protein structure prediction and structural genomics. Science 294:93-96.

4. Stekel D. (2003). Microarray bioinformatics. Cambridge, UK: Cambridge university press.

5. Huynen M.A., Snel B., Mering C. and Bork P.(2003). Function prediction and protein networks. Curr. Opin. Cell Biol. 15:191-198.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Skilled III : Omics Tools and Techniques	**4**	**5**	**0**	**0**	**Theory**

Course objective: To familiarize with advanced molecular biology technologies used in genomics, proteomics, metabolomics, and other omics disciplines. Students will learn about high-throughput sequencing, bioinformatics analysis, mass spectrometry, and data integration methods essential for studying biological systems comprehensively. The course emphasizes practical applications in biomedical research, personalized medicine, and agriculture, preparing students for careers at the forefront of omics-driven scientific discovery and innovation.

Unit I: Fundamentals and analytical methodologies in metabolomics (a) Metabolomics: Significance in clinical research (b) Collection and preparation of clinical samples for metabolomics (c) Preparation of external and internal standards for quality control (d) Targeted and untargeted Metabolomic profiling by gas chromatography/liquid chromatography-mass spectrometry (e) Data interpretation and statistical analysis (f) Application of metabolomics in clinical cases.

Unit II: Lipidomics (a) Basic fundamentals and importance of lipidomics (b) Sample preparation and internal standards for lipidomics (c) Lipids classification and characterization using mass spectrometry. (d) Shotgun lipidomics and LC-MS/MS based lipidomics (e) Targeted and global lipidomics. (f) Application of Lipidomics in Biomedical Research (g) Data interpretation and statistical analysis.

Unit III: Proteomics (a) Basics and importance of proteomics. (b) Strategies in proteomics: Gel based and gel-free proteomics (c) Database and search engines in proteomics. (d) Applications of proteomics: Understanding mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification, and characterization of novel proteins (e) Quantitative proteomics: Labeled and label-free proteomics (f) PTM (post translational modifications) sample prep, enrichment and separation (g) Interactomics and its applications in biological sciences. (h) Advanced topics – Proteogenomics, Top-down proteomics (i) Data interpretation and statistical analysis

Unit IV: Phyto Metabolomics - Collection of Plant Material: Planning, Pressing, Drying, Poisoning, Mounting, Labeling, Storing; Extraction Techniques: Maceration, Infusion, Digestion, Decoction, Percolation, Soxhlet extraction, Microwave-assisted extraction, Ultrasound-assisted extraction, Supercritical fluid extraction, Pressurized hot water extraction, Pressurized fluid extraction, Membraneassisted solvent extraction, Stir-Bar sorptive Extraction.

Unit V: Derivatization Techniques: (1) Silylation, Alkylation/Methylation, Acylation, Esterification for GCMS analysis (2) Derivatization method of amine, carboxyl, phenols, hydroxyl, carbonyl, thiols functional group for LC-MS/MS analysis. Analytical Techniques: Phyto metabolomics analysis by NMR, GC-MS, GC-QTOF, LCMS, LC-QTOF, CE-MS, FTICR-MS, Data interpretation and statistical analysis.

Reference Book

1. Metabolomics: From Fundamentals to Clinical Applications edited by Alessandra Sussulini. Cham : Springer International Publishing ISBN: 9783319476568
2. Metabolomics in Practice: Successful Strategies to Generate and Analyze Metabolic Data Editors: Wolfram Weckwerth, Michael Lämmerhofer, Wiley-VCH, ISBN: 9783527330898
3. Metabolomics, Editors Paul L. Wood, ISBN: 978-1-0716-0864-7 4
4. Lipidomics: Current and Emerging Techniques (ISSN) 1st Edition, by William Griffiths (Editor, Contributor), Yuqin Wang (Editor, Contributor), Jonathan M Curtis (Contributor), Yu Xia (Contributor), Ruth Andrew (Contributor), Giuseppe Astarita (Contributor), Steven Wilson (Contributor), Jonas Abdel-Khalik (Contributor), J Griffin (Contributor), Royal Society of Chemistry, ISBN 978-1788011600
5. Mass Spectrometry-Based Lipidomics Methods and Protocols, Editors, Fong-Fu Hsu, ISBN: 978-1-0716-1410-5
6. Lipidomics in Health & Disease: Methods & Application (Translational Bioinformatics Book 14) 1st ed. 2018 Edition by Xiangdong Wang (Editor), Duojiao Wu (Editor), Huali Shen (Editor), ISBN 978-9811306198
7. 7. LC-MS/MS in Proteomics: Methods and Applications Book in Methods in molecular biology (Clifton, N.J.) · January 2010 DOI: 10.1007/978-1-60761-780-8

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Practical III : Lab in Enzymology and Pharmaceutical Biotechnology	**4**	**5**	**0**	**0**	**Practical**

Course objective: To equip comprehensive understanding of enzyme structure, function, and kinetics, along with practical skills in enzyme purification and assay techniques. The course aims to explore enzyme inhibition, regulation, and their biotechnological applications while emphasizing critical thinking, problem-solving, and collaborative laboratory work.

1. Isolation of extra cellular enzymes.

2. Isolation of intra cellular enzymes.

3. Isolation of membrane bound enzymes.

4. Purification of enzymes.

5. Assay of enzyme (protease) activity

6. Enzyme kinetics (Vmax and km values)

7. Immobilization of enzyme.

8. Various modes of administration of drugs: Intravenous, Intramuscular, Intraperitoneal, Intradermal.

9. Acute toxicity testing of drugs

10. Determination of analgesic and anti-inflammatory activity of a compound

11. Spectrophotometric determination of Allantoin and Griseofulvin

12. Microbial analysis of pharamaceuticals (syrups)

13. Chemical assays for antimicrobial drugs.

14. Testing for antibiotic/drug sensitivity/resistance.

15. Determination of MIC value for antimicrobial chemicals.

16. Microbiological assays for antibiotics (Liquid tube assay, agar tube, agar plate assays)

17. Toxicity tests in lab animals; Pyrogenicity tests in lab animals

References

1. Practical Enzymology by H Bisswanger, 2019
2. Biochemical Methods by S. Sadasivam and A. Manickam, 2018
3. Enzymes: Catalysis, Kinetics and Mechanisms by N. S. Punekar, 2018
4. ENZYMES: Catalysis, Kinetics and Mechanisms by N.S. Punekar, 2018
5. Experiments in the Purification and Characterization of Enzymes A Laboratory Manual by Thomas E. Crowley, Jack Kyte, 2014.
6. Pharmaceutical Microbiology by W. B. Hugo & A. D. Russell Published by Blackwell

scientific Publications.2009,Edition: 6.

7. Analytical Microbiology by Frederick Kavanagh Volume I & II. Published by Academic Press New York.
8. Quality control in the Pharmaceutical Industry by Murray S. Cooper Volume.II. Published by Academic Press New York.
9. Manual of Clinical Laboratory and Immunology by Noel R. Rose, Published by ASM Publications, 2002, Edition: 6.
10. Pharmaceutical Biotechnology- K Sambamurthy and Ashutosh Kar, New age International Publishers-New Delhi 2006.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
	Elective VII : Herbal Drug Technology	**4**	**5**	**0**	**0**	**Theory**

Course objective: This subject gives the student the knowledge of basic understanding of herbal drug industry, the quality of raw material, guidelines for quality of herbal drugs, herbal cosmetics, natural sweeteners, nutraceutical etc. The subject also emphasizes on Good Manufacturing Practices (GMP), patenting and regulatory issues of herbal drugs

UNIT-I: Hours Herbs as raw materials Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation Source of Herbs Selection, identification and authentication of herbal materials Processing of herbal raw material Biodynamic Agriculture Good agricultural practices in cultivation of medicinal plants including Organic farming. Pest and Pest management in medicinal plants: Biopesticides/Bioinsecticides. Indian Systems of Medicine a) Basic principles involved in Ayurveda, Siddha, Unani and Homeopathy b) Preparation and standardization of Ayurvedic formulations viz Aristas and Asawas, Ghutika,Churna, Lehya and Bhasma.

Unit II: Nutraceuticals General aspects, Market, growth, scope and types of products available in the market. Health benefits and role of Nutraceuticals in ailments like Diabetes, CVS diseases, Cancer, Irritable bowel syndrome and various Gastro intestinal diseases. Study of following herbs as health food: Alfaalfa, Chicory, Ginger, Fenugreek, Garlic, Honey, Amla, Ginseng, Ashwagandha, Spirulina Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification. Study of following drugs and their possible side effects and interactions: Hypercium, kava-kava, Ginkobiloba, Ginseng, Garlic, Pepper & Ephedr.

Unit III: Herbal Cosmetics: Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products. Herbal excipients: Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors & perfumes. Herbal formulations : Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes.

Unit IV: Evaluation of Drugs WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs. Patenting and Regulatory requirements of natural products: a) Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy b) Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem. Regulatory Issues - Regulations in India (ASU DTAB, ASU DCC), Regulation of manufacture of ASU drugs - Schedule Z of Drugs & Cosmetics Act for ASU drugs.

Unit V: General Introduction to Herbal Industry Herbal drugs industry: Present scope and future prospects. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India. Schedule T – Good Manufacturing Practice of Indian systems of medicine Components of GMP (Schedule – T) and its objectives Infrastructural requirements, working space, storage area, machinery and equipments, standard operating procedures, health and hygiene, documentation and records.

Reference Books:

1. Textbook of Pharmacognosy by Trease & Evans.

2. Textbook of Pharmacognosy by Tyler, Brady & Robber.

3. Pharmacognosy by Kokate, Purohit and Gokhale

4. Essential of Pharmacognosy by Dr.S.H.Ansari

5. Pharmacognosy & Phytochemistry by V.D.Rangari

6. Pharmacopoeal standards for Ayurvedic Formulation (Council of Research in Indian Medicine & Homeopathy)

7. Mukherjee, P.W. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. Business Horizons Publishers, New Delhi, India, 2002

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective VIII :	**Dietary Supplement & Nutraceuticals**	**4**	**5**	**0**	**0**	**Theory**

Course objective: This module aims to provide an understanding of the concepts behind the theoretical applications of dietary supplements. By the end of the course, students shall be able to :

CO1: Understand the need of supplements by the different group of people to maintain healthy life.
CO2: Understand the outcome of deficiencies in dietary supplements.
CO3: Appreciate the components in dietary supplements and the application.
CO4: Appreciate the regulatory and commercial aspects of dietary supplements including health claims.

Unit I: Definitions of Functional foods, Nutraceuticals and Dietary supplements. Classification of Nutraceuticals, Health problems and diseases that can be prevented or cured by Nutraceuticals i.e. weight control, diabetes, cancer, heart disease, stress, osteoarthritis, hypertension etc. Public health nutrition, maternal and child nutrition, nutrition and ageing, nutrition education in community. Source, Name of marker compounds and their chemical nature, Medicinal uses and health ben- efits of following used as nutraceuticals/functional foods: Spirulina, Soyabean, Ginseng, Garlic, Broccoli, Gingko, Flaxseeds.

Unit II: Phytochemicals as nutraceuticals: Carotenoids- α and β-Carotene, Lycopene, Xanthophylls, leutin, Sulfides: Diallyl sulfides, Allyl trisulfide. Polyphenolics: Reservetrol. Flavonoids- Rutin , Naringin, Quercitin, Anthocyanidins, catechins, Flavones. Prebiotics / Probiotics.: Fructo oligosaccharides, Lacto bacillum. Phyto estrogens : Isoflavones, daidzein, Geebustin, lignans.Tocopherols. Proteins, vitamins, minerals, cereal, vegetables and beverages as functional foods: oats, wheat bran, rice bran, sea foods, coffee, tea and the like.

Unit III: **Introduction to free radicals:** Free radicals, reactive oxygen species, production of free radicals in cells, damaging reactions of free radicals on lipids, proteins, Carbohydrates, nucleic acids. Dietary fibres and complex carbohydrates as functional food ingredients.

Unit IV: Free radicals in Diabetes mellitus, Inflammation, Ischemic reperfusion injury, Cancer, Athero- sclerosis, Free radicals in brain metabolism and pathology, kidney damage, muscle damage. Free radicals involvement in other disorders. Free radicals theory of ageing. Antioxidants: Endogenous antioxidants – enzymatic and nonenzymatic antioxidant defence, Superoxide dismutase, catalase, Glutathione peroxidase, Glutathione Vitamin C, Vitamin E, α- Lipoic acid, melatonin Synthetic antioxidants: Butylated hydroxy Toluene, Butylated hydroxy Anisole.

Unit V: Effect of processing, storage and interactions of various environmental factors on the potential of nutraceuticals. Regulatory Aspects; FSSAI, FDA, FPO, MPO, AGMARK. HACCP and GMPs on Food Safety. Adulteration of foods. Pharmacopoeial Specifications for dietary supplements and nutraceuticals.

Recommended Books (Latest Editions)

1. Dietetics by Sri Lakshmi
2. Role of dietary fibres and neutraceuticals in preventing diseases by K.T Agusti and P.Faizal: BSPunblication.
3. Advanced Nutritional Therapies by Cooper. K.A., (1996).
4. The Food Pharmacy by Jean Carper, Simon & Schuster, UK Ltd., (1988).
5. Prescription for Nutritional Healing by James F.Balch and Phyllis A.Balch 2nd Edn., Avery Pub- lishing Group, NY (1997).
6. G. Gibson and C.williams Editors 2000 Functional foods Woodhead Publ.Co.London.
7. Goldberg, I. Functional Foods. 1994. Chapman and Hall, New York.
8. Labuza, T.P. 2000 Functional Foods and Dietary Supplements: Safety, Good Manufacturing Practice (GMPs) and Shelf Life Testing in Essentials of Functional Foods M.K. Sachmidl and T.P. Labuza eds. Aspen Press.
9. Handbook of Nutraceuticals and Functional Foods, Third Edition (Modern Nutrition)
10. Shils, ME, Olson, JA, Shike, M. 1994 Modern Nutrition in Health and Disease. Eighth edition. Lea and Febiger

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective IX:	**Research Methodology Scientific Writing**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To equip essential skills in designing, conducting, and reporting scientific research. Students will learn about research ethics, study design, data analysis techniques, and the principles of effective scientific writing and communication. The course emphasizes critical thinking, literature review, and manuscript preparation, enabling students to produce high-quality research papers and presentations suitable for publication in scientific journals or presentation at conferences.

Unit I: Research Methodology. Introduction, meaning of research, definition, characteristics and function, objectives, classification and kinds of research. Research Problem Introduction, selecting the problem, defining the problem, sources of problem, Criteria for selection of the problem, delimiting a problem, assumptions about a problem, evaluating the problem.

Unit II: Foundation of Hypothesis Meaning, definitions; assumption, postulate and hypothesis; nature of hypothesis Functions, importance, kinds, characteristics of a good hypothesis, variables in a hypothesis, sources of hypothesis, testing of hypothesis Research Plan/Design & Sampling. Meaning and definition of plan/design, design format Meaning and definition of sampling, functions of population and sampling, types of Sampling designs, characteristics of a good sample, application of sampling technique in various types of researches.

Unit III: Types of Researches Survey, historical, philosophical, experimental, case study, genetic Design of Experiments. Need and purpose, importance, characteristics of good experimental design, basic principles, types of basic experimental design.

Unit IV: Tools of Research Questionnaire, schedule, rating scale, tests Collection of Data Need, meaning, nature; constants, variables, variate; characteristics of quantitative data, types of data, data collection, organization of data.

Unit V: Research Report & Proposal Writing Need of research report, format of research report (preliminary section, main section & reference section), mechanics of report writing Writing Research Abstract Writing research Paper Need of research proposal for dissertation to get funds from various sources.

Reference:

Kothari R.C. (2005): Reseach Methodology, 2nd Edition, New Age International Publisher Ltd. , New Delhi.

Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.

On Being a Scientist: A Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press.

Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78(Nov-Dec 1990), 550-558.

Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.

Movie: Naturally Obsessed, The Making of a Scientist.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Core: Industrial and Environmental Biotechnology		**4**	**5**	**0**	**0**	**Theory**

Course objective: To provide students with a comprehensive understanding of biotechnological applications in industrial processes and environmental management.

Unit I: Industrial Biotechnology, Introduction and history, Isolation and screening, Primary and Secondary screening, Production strains, Production media, Inoculum preparation and inoculum Development,

Unit II: Introduction to Fermenter, Industrial sterilization, Scale up fermentations, Types of fermenters, Acetator and cavitator, product recovery, Industrial production of penicillin, production of streptomycin, Industrial production of organic acids- introduction, production of citric acid, production of lactic acid,

Unit III: Industrial production of enzymes, introduction; general aspects, production of amylases& proteases, production of nucleotides & nucleotides, production of alcohols-acetone-butanol, production of ethanol, production of amino acids.

Unit IV: Production of single cell proteins, production of fermented foods, production of microbial insecticides, production of Biopolymers, Biofuels, biogas, production of Bioplastics, Biosurfactants, and Biofertilizers.

Unit V: Environmental Biotechnology – Waste water treatment, Bioremediation, Genetically Engineered Microorganisms in Biotreatment of wastes, Biotechnological methods for pollution detection, Biosensors.

Reference:

1. Biotechnology-A textbook of Industrial Microbiology. II edition.Wulf Crueger and Anneliese Crueger.
2. Industrial Microbiology by L.E Casida, John Wiley and sons INC.
3. Industrial microbiology by A.H.Patel, Macillan India Ltd.
4. Principles of fermentation technology by P.Stanbury & Allan Whitekar, Pergamon.
5. Manual of Industrial Microbiology and Biotechnology,II edition. Arnold L.Demain and Juilan E.Davies.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective X:	**Bionanotechnology**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To introduce students to the interdisciplinary field at the intersection of biology, nanotechnology, and engineering. Students will learn about the principles and applications of nanomaterials in biological systems, including drug delivery, imaging, sensing, and tissue engineering. The course emphasizes nanoscale characterization techniques, ethical considerations, and the integration of nanotechnology with biological sciences, preparing students for careers in biomedical research, pharmaceuticals, and advanced materials science.

Unit -I Overview of Nanobiotechnology - Historical perspective of Integration of biology, chemistry, and material science. Opportunities and Promises of nanobiotechnology. Functional Principles of Nanobiotechnology- Structure and functional properties of Biomaterials, Bimolecular sensing, Molecular recognition and Flexibility of biomaterials.

Unit -II Protein and DNA based Nanostructures - Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers.

Unit III: Microbial production of inorganic nanoparticles – Magnetosomes. DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers Nanomaterials used in Biotechnology.

Unit -IV: Nanoparticles, carbon nanotubes, quantum dots and buckyballs interface with biological macromolecules. Biological perspectives of nanomaterials – impact of nanomaterials in biological processes – tolerance by immune systems and toxicity. Nucleic acid Engineering- Modifications of DNA for nano-technological applications. Nanostruture assembly using DNA.

Unit -V: Nanotechnology in Agriculture and Food technology - Insecticides development using nanotechnology and Nanofertilizers. Nanotechnology in food processing, food safety and biosecurity, toxin and contaminant detection, Smart packaging.

References:

ChaChalla, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact‖, Wiley – VCH. 2005

D.S. Goodsell, Bionanotechnology: Lessons from Nature, Wiley Press, 2004.

C. M. Niemeyer and C. A. Mirkin- (Editor), Nanobiotechnology: Concepts, Applications and Perspectives, Wiley Press, 2004.

Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, 2006.

Neelina H. Malsch (Ed.),Biomedical Nanotechnology, CRC Press, 2005.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective XI:	**Food Biotechnology**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To educate students about the application of biotechnological principles and techniques in the production, processing, and enhancement of food products.

Unit I: Biotechnology and food ingredients – biogums, fats, oils, fatty acids and oilseed crops, fat substitutes, citric, fumaric and malic acids, bioflavours and biocolors. Biosensorsprinciple, types and applications in food processing.

Unit II: Protein engineering in food technology– methods, objectives, limitations and applications of protein engineering (glucoseisomerase, lactobacillus β-galactosidase and peptide antibiotic nisin).

Unit III: Nutraceutical: Historical perspective; Definition, nature, nutraceutical compounds and their classification based on chemical/biochemical nature with suitable and relevant descriptions; scope and future prospects.

Unit IV: Functional food overview; Definition, classification; functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods.

Unit V: Introduction to gene-diet interactions Nutrigenomics: Scope and Importance to Human Health and Industry. Transporter gene polymorphisms -interaction with effects of micronutrients in humans. Nutrigenomics approaches to unraveling physiological effects of complex foods.

References:

Gutierrez, G. F. & Barbosa-Canovas, G. V. Food Science and Food Biotechnology: CRC Press, Boca raton.2003.

Robert E.C. Wildman; Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press, 2009.

Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition, 2012.

Subject Code	Subject title	Credit	Lecture	Tutorial	Practical	Type
Elective XII:	**Agriculture Biotechnology**	**4**	**5**	**0**	**0**	**Theory**

Course objective: To provide students with a comprehensive understanding of the application of biotechnological tools and techniques in agriculture.

Unit I: Introduction to agricultural Biotechnology • Importance of Agriculture at national economy • Advantages of biotechnological methods over conventional methods of crop improvement. • In-Vitro Plant propagation- a) Virus indexing, virus free plants, b) fruit crop c) flower crops d) Cereals and e) oil seeds plants • Endosperm culture & production of triploids for production of seedless plant varieties with examples.

Unit II: Use of bioreactors in plant production & Scale-up for Commercialization • Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial Bio insecticides • Major pest and diseases of horticultural crops and their control by Biotechnological methods.

Unit III: Crop improvement – • Improvement of crop quality (FlavrSavr tomato, Golden rice) • Chloroplast manipulations for production of therapeutic proteins, vaccines, antibodies and increased production.

Unit IV: Recent advances – • Plant genotyping by different methods PCR, Plant fingerprinting, Microsatellite, Nanotechnology. • Homogenous assays – Qualitative Real Time PCR assays, applications • CRISPR based technology: Introduction, techniques, and its application in plants,

Unit V: Development and formulation of bioinoculants, for better Agricultural productivity, using: i. Growth promoting , ii. Nitrogen fixing, iii. Phosphate solubilizing, iv. Metal chelating, v. Growth hormone producing microorganisms • Agricultural biotechnology and agribusiness • Opportunities in the Agriculture Biotechnology.

References:

1. Plant molecular breeding, (2009), Newbury HJ, John Wiley and Sons.,USA.

2. Ashwani Kumar, Shekhawat NS (2009) – Plant tissue culture and molecular a. Markers :their role in improving crop productivity (IK International)

3. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India

4. Chawla HC (2004) – Introduction to plant biotechnology (SciencePubl)

5. Plant Biotechnology: the genetic manipulation of plants (Oxford Press) (2008) – Slater A,Scott NW,

6. Fowler MR Green MR &Sambrook J. (2014) Molecular Cloning: A Laboratory Manual. 4th Ed. Vol. I, II & III. Cold Spring Harbor Laboratory Press.

7. Plant Genetic Engineering (2012) Grierson D Springer Netherlands.

8. Principles of Gene Manipulation and Genomics (2006) Primose SB &Twyman RM. 7 th Ed. Blackwell Publishing.

9. Molecular Cloning: A Laboratory Manual (2001) Sambrook J. and Russel D, 3rd Ed Cold Spring Harbor Laboratory Press.

10. Plant cell tissue and organ culture: fundamental methods by C. L. G. C. Philips and L.R.Wetter 1995. National Research council, Canada, PRL, Saskatoon.