Ph.D., BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

Curriculum and Syllabus
(2023-2024)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

DEPARTMENT OF BIOTECHNOLOGY

FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established under section 3 of UGC Act, 1956)
(Accredited with A+ Grade by NAAC in the second cycle)
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DEPARTMENT OF BIOTECHNOLOGY
FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT
RESEARCH PROGRAMME –PhD in Biotechnology
(2023–2024 Batch and onwards)

Code	Course	Objectives and Outcomes		Ins*	Marks	Exam Hrs	Credit
		PEO´s	PO´s & PSO´s	hours / week	Total		
23RBT101	**Paper – I:** Research Methodology and Pedagogy	I, II,III	a, c, e	4	100	3	4
23RBT201	**Paper – II:** Research Publication Ethics	I,II	b, d	4	100	3	4
Paper – III *				4	100	3	4
23RBT301	Paper – III: Plant Biotechnology	II, III	d, f, g				
23RBT302	Paper – III: Animal Biotechnology	II, III	d, f, g				
23RBT303	Paper – III: Microbial Biotechnology	II, III	d, f, g				
23RBT304	Paper – III: Environmental Biotechnology	II, III	d, f, g				
23RBT305	Paper – III: Structural Biology	III, IV	f, g, h, i				
	Grand total			**12**	**300**	**9**	**12**

Blue – Employability; Green – Entrepreneurship; Red- Skill Development

PROGRAMME OUTCOMES (POs)

a) Research Graduates will be able to spread over the basic knowledge of applied theories in practical research.

b) Providing necessary broad analytical knowledge to make the scholar for appearing in competitive examinations

c) Ability to design and conduct experiments as well as to interpret the results.

d) A skilled to work on biotechnological concepts and allied fields (immuno, medical, microbial, Food,agricultural, environmental, plants and animals) with recent tools and techniques towards academic, industrial and research application.

e) Scholars will be able to visualize and work on multidisciplinary laboratory problems with standard operating procedures.

f) With professional, societal and ethical responsibilities, the research scholars with be able to identify,formulate and solve to deliver process/product.

g) Research Graduates will be able to update the current knowledge of interdisciplinary subjects of biotechnology.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

To enable the scholar to emerge as:

a) Professional Biotechnologist with lifelong learning with recognized the societal need.

b) Proficient entrepreneurial and leadership qualities with life-long learning.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO I: The research graduates of Biotechnology will able to acquire in-depth research knowledge in various fields of Biotechnology and become competent in competitive exams

PEO II: The research graduates of Biotechnology are able to design, analyze, conduct and interpret the experimental data for process/product development in all the areas of biotechnology

PEO III: The research graduates of Biotechnology will able to use the concept of theories, research practical skills and recent technological tools in solving any technological and professional issues independently in a global and societal context

PEO IV: The research graduates of Biotechnology will continue learning to update and to become an entrepreneur in a competitive world of technology and contribute to all forms of life

MAPPING OF PEOs AND POs

PEOs	Programme Outcome (s)						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
PEO I	×	×		`			
PEO II			×	×			
PEO III					×	×	
PEO IV							×

Ph.D **2023-2024**

23RBT101 **Paper – I: Research Methodology and Pedagogy** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To impart the knowledge on Identification of research requirements
- To apply the state of art knowledge for dissertation writing
- To become familiarize with Experiment design
- To understand the methods of data collection and analysis
- To grasp knowledge on Objective and roll of higher education
- The students will learn overall the basic concept in Characteristics of instructional design

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Understand principles of formulation of objectives and hypothesis	Understand
CO2	Explain Guidelines for review of literature	Understand
CO3	Get insight to Use of software for graphics	Understand
CO4	Students are able to correlate the results using biostatistics tool	Create
CO5	Explain the Ethical issues in animal biotechnology	Remember
CO6	Explain the methods of teaching and learning	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	S	S	S	M	M	M	M
CO2	S	S	S	M	M	M	M
CO3	S	S	S	M	M	M	M
CO4	S	S	S	M	M	M	M
CO5	S	S	S	M	M	M	M
CO6	S	S	S	M	M	M	M

S-Strong; M-Medium; L-Low

Unit I Analysis and Identification of research requirements: **8 hours**

Prioritization of research area. Review of work done in identified area - time scheduling - laboratory facilities, Research duration –choice of research topic – formulation of objectives- formulation of hypothesis– Methodology – Procedure, experiment design.

Unit II Dissertation writing: **8 hours**

Guidelines for review of literature - Materials and methods, results and discussion. Interpretation of results, presentation of results, summary, presentation of references and appendix.

Unit III Experiment design: **8 hours**

Regarding observation. Types of observation. Laboratory setting sample; Data collection – Presentation of and analysisof collected data. Preparation of result reports and Publication of research findings in prier reviewed journals, impact factor.

Unit IV Methods of data collection and analysis: **8 hours**

Classification and tabulation. Frequency distribution. Measures of central tendency – Mean, median and mode; Measures of dispersion – Standard deviation, standard error, and variance. Correlation and regression – simple correlation, correlation co-efficient, simple and linear regression analysis. Test of significance (F, t test), chi-square test, ANOVA, DMRT, SPSS. Introduction to computer, MS Office. Data handling – Use of software for graphics, slidemaking, scanning gels, photography X-ray photography and autoradiogram perspective.

Unit V Objective and roll of higher education: **8 hours**

Important characteristics of an effective Lecture - Quality teaching and learning – Lecture Preparation - Characteristicsof instructional design – Methods of teaching and learning: Large group – Technique – Lecture, Seminar, Symposium,Team teaching, Project, Small Group Technique – Simulation, role playing Demonstration, Brain storing, case Discussion, and assignment, Methods of evaluation – Self-evaluation, Student evaluation, Diagnostic testing and remedial teaching – Question banking – Electronic media in education : 'e' learning researches – web based learning.

SUGGESTED READINGS

1. Sandhu,T. (1990). Research Techniques in Biological Sciences. Anmol Publishers, New Delhi.
2. Palanivelu, P. (1999). Analytical Biochemistry and Separation Technique. 3rd Ed, 22st Century Publications,Madurai.
3. Sundar Rao, P.S.S and Richard, J. (2006). Introduction to Biostatistics and Research Methods. PHIPublications, New Delhi.
4. Kothari, C. R. (2004). Research Methodology – Methods and Techniques. 2nd Ed. New Age International Pvt. Ltd, New Delhi.
5. Attwood, T. K. and Parry Smith, D. J. (2002). Introduction to Bioinformatics. Pearson Education Ltd,Singapore.

Ph.D **2023-2024**

23RBT201 **Paper – II: Research Publication Ethics** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To impart the knowledge on philosophy and ethics
- To apply the state of art knowledge for scientific conduct
- To become familiarize with publication ethics
- To understand the methods of publication misconduct
- To grasp knowledge on database and research metrics
- The students will learn overall open access publishing.

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Understand principles of philosophy and ethics	Understand
CO2	Explain research Intellectual honesty	Understand
CO3	Get insight to plagiarism	Understand
CO4	Develop the e-content	Create
CO5	Access the Learning Management System	Remember
CO6	Understand publication misconduct	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	S	S	S	M	M	M	M
CO2	S	S	S	M	M	M	M
CO3	S	S	S	M	M	M	M
CO4	S	S	S	M	M	M	M
CO5	S	S	S	M	M	M	M
CO6	S	S	S	M	M	M	M

S-Strong; M-Medium; L-Low

Unit I Philosophy and Ethics: **6 hours**

Introduction to Philosophy: definition, nature, scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgment and reactions.

Unit II Scientific Conduct: **6 hours**

Ethics with respect to science and research - Intellectual honesty and research integrity, copyright Scientific

misconduct: falsification, fabrication and Plagiarism (FFP) Redundant Publication: duplication and overlapping publication, salami slicing reporting and misrepresentation of data

Unit III Publication Ethics: **6 hours**

Publication Ethics: definition, introduction and importance, Best practice/standard setting initiative and guidelines: COPE, WAME, etc. Conflict and interest - Publication misconduct: definition, concept, problems that leads to unethical behavior and vice versa, type. Violation of publication ethics, authorship and contributorship Identification of publication misconduct, complaint and appeals. Predatory publisher and journals.

UNIT IV Publication Misconduct: **8 hours**

Group Discussions: Subject Specific Ethical Issues FFP, authorship, Complaints and appeals: examples and fraud, from India and abroad. Software tools: Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

UNIT V Database and research metrics: **7 hours**

Database: Indexing database, Citation database: web of science, scopus, etc. Research metrics: Impact factor of Journal as per journal citation report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g-index, i-10 index, altmetrics.

UNIT VI: Development of e-content & IPR: **7 hours**

Integrated Library Management System (ILMS): e-journals, e- books, e-shodhsindu- shodhganga- Database –e content development – Learning Management System (LMS) – e-PG -Pathshala- CEC (UG) SWAYAM- MOOCs-NPTEL-NMEICT. **IPR:** Patent – Copyrights- Trademarks- Geographical Indications.

PRACTICE

Open access publishing

Open access publication and initiatives - SHERPA/RoMEOonline resource to check publisher copyright and self-archiving policies Software tool to identify predatory publication developed by SPPU - Journal finder/journal suggestion tools viz. JANE, Elsevier Journal finder, Springer, Journal Suggester, etc.

23RBT301 **Paper – III: Plant Biotechnology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To give students deep knowledge in plant Biotechnology
- To widen the knowledge acquired in other course by handling of classical and modern plant biotechnology
- To know about breeding of healthy plants, plants with improved characteristics
- To produce biomolecules from plants
- To examine the classification of plant species
- To understand the biotechnological processes have also applicative value in pharmaceutical and food industry, in agriculture and in ecology.

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Recall the basic concepts of Biotechnology and explain fundamental cellular events during the process of plant cell culture development	Understand
CO2	Determine the factors influencing plant cell differentiation	Understand
CO3	Execute proper techniques/ procedures for the maintenance of sterile condition and proper plant growth	Understand
CO4	Apply learned techniques in new or similar situations	Create
CO5	Translate the concepts in future studies and evaluate its significances	Remember
CO6	Express the concerns over modern plant biotechnology and analyze them according to the regulatory frame works	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	M	M	M	S	S	S	S
CO2	M	M	M	S	S	S	S
CO3	M	M	M	S	S	S	S
CO4	M	M	M	S	S	S	S
CO5	M	M	M	S	S	S	S
CO6	M	M	M	S	S	S	S

S-Strong; M-Medium; L-Low

Unit I Plant genetic engineering: **8 hours**

Methodology; Plant transformation with Ti plasmid of *Agrobacterium tumifacians*; Ti plasmid derived vector systems, Ri plasmids; Physical methods of transferring genes to plants - Microprojectile bombardment, Electroporation; Manipulation of gene expression in plants; Production of marker free transgenic plants.

Unit II Biotechnology of medicinal plants: **8 hours**

Production of secondary metabolites from cultured plant cells, elicitation, immobilization, biotransformation, continuous culture and product recovery, DNA bar coding, DNA fingerprinting of medicinal plants- DNA isolation and fingerprinting techniques, Chemical fingerprinting by HPTLC.

Unit III Biotechnological Tools: **8 hours**

UPGMA based analysis – RFLP, RAPD, AFLP, STS, ISSR. Protein and Nucleic acid sequencing and Micro-array. Next generation sequencing approaches. Basic Principles and applications. Bioinstrumentation: Microscopy, Electrophoresis, Centrifugation, ELISA, RIA, FISH. Separation techniques; HPLC, GC, HPTLC, LC-MS and application. Spectrophotometry-UV-VIS, FT-IR, Flame photometry, fluorimetry, Flow cytometry and AAS.

Unit IV Genetic engineering and Biotechnology: **8 hours**

Introduction to plant genetic engineering and biotechnology, gene identification, gene isolation, synthesis of gene and gene cloning, restriction enzymes and vectors, regeneration in crop plants, application of plant genetic engineering and biotechnology, transgenic crops, application of rDNA technology – current status and future prospects, regulation,mechanism for genetically modified crops, biosafety issues of transgenic crops.

Unit V Molecular breeding: **8 hours**

Molecular mapping and tagging of agronomically important traits, QTL analysis in crop plants, marker assisted selection for qualitative and quantitative traits, gene pyramiding, genetic engineering, Application in crop improvement.

SUGGESTED READINGS:

1. Bernald R Glick, and Jack J Paternack (1996), Molecular Biotechnology, Panima Publication, New Delhi.
2. Brown T A (2000) 'Gene Cloning – An Introduction, 3rd Edition, Stanley thrones Publishers Ltd, New York.
3. Chawla, H.S (2018). Introduction to Plant Biotechnology (3rd ed.) . CRC Press, Florida, United States.
4. Halford, N. (2006). Plant Biotechnology: Current and Future Application of Genetically Modified Crops.Wiley-Blackwell, New Jersey, United states.

Ph.D **2023-2024**

23RBT302 **Paper – III: Animal Biotechnology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To impart the knowledge on basic animal tissue culture techniques
- To apply the state of art knowledge of subject for the production of tissues, introducing modern drug delivery or vaccination methods
- To become familiarize with the ethical practices in animal biotechnology
- To understand the laboratory design and requirements for animal tissue culture
- To grasp knowledge on molecular techniques in animal cell culture
- The students will learn overall the basic concept in embryology

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Understand principles of animal culture, media preparation	Understand
CO2	Explain *in-vitro* fertilization and embryo transfer technology	Understand
CO3	Get insight in applications of recombinant DNA technology in improvement of livestock and animal breeding	Understand
CO4	Production of therapeutic proteins in transgenic animals	Create
CO5	Explain the Ethical issues in animal biotechnology	Remember
CO6	Handle and maintain the animal models in animal houses	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	M	M	M	S	S	S	S
CO2	M	M	M	S	S	S	S
CO3	M	M	M	S	S	S	S
CO4	M	M	M	S	S	S	S
CO5	M	M	M	S	S	S	S
CO6	M	M	M	S	S	S	S

S-Strong; M-Medium; L-Low

Unit I Laboratory design and requirements for animal tissue culture: 8 hours

Animal tissue culture media, Physical, chemical and metabolic functions of different constituents of serum free culture medium and their

applications. Types of tissue culture; disaggregation of tissue and primary cellculture, established culture, suspension culture, organ culture, three-dimensional culture.

Unit II Cell separation: **8 hours**

Cell counting Cell synchronization. cryopreservation. Cell lines - cell banks. Tissue engineering. Biology and characterization of cultured cells, tissue typing; cell – cell interaction; measuring parameters of growth; measurement of cell death – apoptosis and its determination; cytotoxicity assays.

Unit III Characterization: **8 hours**

Need for characterization, Morphology, Chromosome analysis, DNA, RNA, Protein, Enzyme and Antigenic Markers. Lymphocyte preparation, Somatic cell fusion.

Unit IV Molecular cell techniques in cell culture: **8 hours**

Cell transformation- physical, chemical and biological methods; manipulation of genes; cell cloning and micro manipulation; hybridoma technology and its applications; gene targeting. Gene Therapy. Green fluorescent protein and its applications, Oncogenes and tumor suppressor genes and their regulation.

Unit V Embryology: **8 hours**

Collection and preservation of embryos; culturing of embryos; gametogenesis and fertilization in animals; types ofcleavage pattern. *In vitro* fertilization and stem cell research. Transgenesis: Transgenic animals; production and application; transgenic animals as models for human diseases, transgenic in industry; Vaccine production. Ethical issues in animal biotechnology.

SUGGESTED READINGS:

1. Freshney, R.I. (2000). Culture of Animal cell: A practical approach, 4th Edition, John Wiley Publications,New York.
2. Jennie, P. Mather and David Barnes. (2001). Methods in Cell Biology. Academic Press, New York.
3. Primrose, S. B., Twyman, R. M. and Old, R. W. (2001). 6th Ed, Principles of Gene Manipulation. BlackwellScience Publishing Company, Germany.
4. Ranga, M. M. (2003). Animal Biotechnology. 2nd Edition, Agrobios (India), Jodhpur.

Ph.D **2023-2024**

23RBT303 **Paper – III: Microbial Biotechnology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To provide an in-depth look at how microbes and their metabolic pathways and products can be used in biotechnology
- To develop their own interests in other aspects of biotechnology
- To acquire knowledge on the use of genetically manipulated organisms, biotechnologically important enzymes and specific biochemical pathway
- To understand the microbial bio-conservation rate in yield of agriculture
- To describe the waste utilization of sewage
- To know the industrial applications of algal biomass

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Critically evaluate the role of micro-organisms in specific biotechnological processes.	Understand
CO2	Explain the complex processes behind the development of genetically manipulated organisms.	Understand
CO3	Demonstrate a clear understanding of how biochemical pathways relate to biotechnological applications.	Understand
CO4	Discuss state-of-the-art technologies of genetics of antimicrobial metabolite production in biocontrol bacteria.	Create
CO5	Identify microbiological techniques, the defining characteristics of the major groups of microorganisms andapply to study microbial phylogeny	Remember
CO6	Collect the proficient knowledge of living systems in the energy production, utilization of waste to commercially important compounds and bioremediation process	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	M	M	M	S	S	S	S
CO2	M	M	M	S	S	S	S
CO3	M	M	M	S	S	S	S
CO4	M	M	M	S	S	S	S
CO5	M	M	M	S	S	S	S
CO6	M	M	M	S	S	S	S

S-Strong; M-Medium; L-Low

UNIT I Introduction: **8 hours**

General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds.Genetic engineering of microbes to improve production of antibiotics and secondary metabolites. Biopolymers andbioplastics. Preservation and improvement of Industrially important microorganisms, Strain development by Mutagenesis, Protoplast fusion and Genetic engineering.

UNIT II Microalgae and Fungai: **8 hours**

History and biotechnological potentials of microalgae, food, feed. Colorant, fuel and pharmaceutically valuable compounds. Cultivation methods of algae with reference to *Dunaliella sp.* and *Phormidium valderianum,* Characteristics of Single-cell Biomass composition; Nutritional Value and Toxicological Status; Types of fermentationsystem for biomass production. Baker's yeast; Production of probiotic biomass; and mold cultures. Application ofmicroalgae in industries.

UNIT III Agricultural Microbiology: **8 hours**

Plant Microbes Interaction; Microbial herbicides, Agricultural antibiotics, Microbial Bio-fertilizers and Bio- insecticides; Biological pest control. Mode of action of biological control involved in different biocontrol agents. Genetics of antimicrobial metabolite production in biocontrol bacteria. Potential impacts on the environment and human health.

UNIT IV Microbial Bioconversion: **8 hours**

Bioconversion of cellulosic and non-cellulosic wastes. Mechanism of novel carboxylase genes involved in bioconversion. Agro byproducts. Bioremediation of wood, fuels lubricants, rubber and plastics. Bioremediation in paper and pulp industries; Aerobic and anaerobic digester: Design; various types of digester for bioremediation in Industrial effluents. Production of citric acid using sucrose and molasses; Production of extracellular enzymes; Ethanol production using immobilized yeast culture.

UNIT V Waste utilization: **8 hours**

Biogas production, Waste water treatment - Aerobic and Anaerobic processes, Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Sewage disposal, compost making, green manuring, Microbialproducts and plant health, methane generation. Microbiology of degradation of xenobiotics in environment.

SUGGESTED READINGS:

1. Bernad. R. Glick and Jack J. Pasternak. (2002). Molecular Biotechnology Principles and Applications ofRecombinant DNA. WCB.
2. Glazer, A.N. and Nikaido, H. (2007) Microbial Biotechnology. Cambridge, New York.
3. Harzevili, D.F. and Chen, H. (2015). Microbial Biotechonology: Progress and trends. Taylor and Francisgroup.
4. Kun, Y.L (2013). Microbial Biotechnology: Principles and applications. World Scientific PublishingCompany; 3rd revised ed. Edition.

23RBT304 **Paper – III: Environmental Biotechnology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To obtain basic concepts of biotechnology to solve the environmental pollution problems
- To ascertain the knowledge about solid waste management and wastewater treatment.
- To gain information about Environmental nanotechnology.
- To gain knowledge about the biological and biotechnological measures for restoringenvironment.
- To involve in the present scenarios and find valuable solutions for remedy
- To update about the management strategies followed up by the industries and government

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Water Pollution Monitoring	Understand
CO2	Pollution and pollution control	Understand
CO3	Environmental significance of genetically modified microbes, plants and animals	Understand
CO4	Solid waste management systems	Create
CO5	Treatment of municipal waste and Industrial effluents	Remember
CO6	Biotechnologically important intracellular products	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	M	M	M	S	S	S	S
CO2	M	M	M	S	S	S	S
CO3	M	M	M	S	S	S	S
CO4	M	M	M	S	S	S	S
CO5	M	M	M	S	S	S	S
CO6	M	M	M	S	S	S	S

S-Strong; M-Medium; L-Low

Unit I Environmental pollution: **8 hours**

Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Majorsources; Environmental Pollution at local regional and global level. Environmental Quality Assessment and Monitoring, Deterioration of environmental quality with reference to anthropogenic impact; Environmental ImpactAssessment (EIA).

Unit II Water pollution monitoring: **8 hours**

Pollutant analysis in water – Physiochemical parameters, Microbiological examination, APDC and MIBK analyses.Methods of monitoring; Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; Strategies for controlling pathogen transfer; Chemicalmethods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.; Biosensors to monitor pollution.

Unit III Effluent treatment and solid waste management systems: **8 hours**

Sewage and waste water treatments systems; Primary, secondary and tertiary treatments- Phytoremediation; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Environmentalpollution control- Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Bioreactors for waste water treatments; Reactors types and design; Solid waste management – types of solid waste; Disposal methods – Sanitary, incineration, land-fill, composting, vermicomposting; recovery of energy from solid waste.

Unit IV Environmental Nanotechnology: **8 hours**

Techniques for synthesis of nanomaterials and nanocomposite; mobility of nanomaterials in aqueous environments, surface chemistry of mineral oxide and carbon nanoparticles, development of nanostructured membranes, mechanisms of nanoparticle bio- degradation, development of nanostructured ceramic bodies for environmental separations and catalysis, nanomaterial-based adsorbents for water treatment, possible mutagenic properties of nanoparticles, nanoparticle bioaccumulation.

Unit V Environmental Microbiology: **8 hours**

Microbes in the environment, measurement of bacterial growth, collection and processing of environmental samples. Media Formulation; Sterilization; Thermal death kinetics Primary and secondary metabolites; Extracellular enzymes; biotechnologically important intracellular products; exopolymers; biopolymer production.

SUGGESTED READINGS:

1. Agarval, S. K (2002). Environmental Biotechnology. APH Publishing Corporation, New Delhi.
2. Alans Scragg (2005). *Environmental Biotechnology*. Oxford University Press. Inc. New York.
3. Bailey J E and D F Ollis (1986). Biochemical Engineering fundamentals. 2nd Ed. Chapters 13 & 14,McGraw – Hill.
4. Charles P Poole Jr., Frank J Owens. (2007). Introduction to Nanotechnology. John Wiley & sons Asia Pvt.Ltd. New Delhi.
5. Mark J Hammer (2000). Water and Waste Water Technology. 4th Edition, Prentice Hall of India Pvt Ltd, NewDelhi.
6. Singh, M. P., Soma Dey and Bijay S Singh. (2004). Conservation of Biodiversity and Natural Resources.Daya Publishing House, New Delhi.
7. Yadav, P. R and Shubhrata R Mishra. (2004). Environmental Biodiversity. Discovery Publishing House, NewDelhi.

23RBT305 **Paper – III: Structural Biology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks**: **Internal: 0 External: 100 Total: 100**

End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- Understand fundamental principles of Stereochemical analysis of proteins
- Comprehend the optical activities of biological macromolecules.
- Recognize the concepts on Structural characterizations of proteins
- Obtain key knowledge on Molecular Modeling methods
- Understand key concepts on NMR structures of proteins – Calculations and validations.
- Attain strong knowledge on Computational Methods in Structural Biology

Course Outcomes

On successful completion of the course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Demonstrate an understanding the detection methods for enzyme kinetics	Understand
CO2	Identify, explain and judge safety issues related to biomedical instrumentation	Understand
CO3	Apply the principles in analyzing structural interactions and structural transitions	Understand
CO4	Define the principal concepts about Proteins in solution state	Create
CO5	Recognize the definition of protein crystallography and related concepts	Remember
CO6	Apply the Phylogenetics in Structural Biology	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	M	M	M	S	S	S	S
CO2	M	M	M	S	S	S	S
CO3	M	M	M	S	S	S	S
CO4	M	M	M	S	S	S	S
CO5	M	M	M	S	S	S	S
CO6	M	M	M	S	S	S	S

S-Strong; M-Medium; L-Low

Unit I Biomolecular Chemistry: **8 hours**

Electronic configurations – Quantum numbers – Chemical bondings – Isomerisms – Buffers in biological systems –Stereochemical analysis of proteins – Protein folding and biological significance – Thermodynamic estimation of protein stability – Biological functions – Allosteric effect - Detection methods for enzyme kinetics – DNA structures –Types – Helical transitions – *Syn/Anti* conformations - Sugar puckering –Optical activities of biological macromolecules.

Unit II Structural Characterizations of Biomolecules: **8 hours**

Analyzing structural interactions and structural transitions of biological macromolecules under thermodynamic and as well kinetic environments through advanced techniques – SF-Ultraviolet spectroscopy - SF-Fluorescence spectroscopy- SF-Circular Dichroism spectroscopy - QF-Nuclear Magnetic Resonance techniques in conjunction with Hydrogen- Deuterium exchange (EX1/EX2) methods.

Unit III NMR of Proteins: **8 hours**

Proteins in solution state - Basic principles of NMR - Chemical shift - Inductive effects - Anisotropic effects - Spin-spin splitting - Double resonance method - Structural characterizations of proteins by 1D NMR methods - 2D NMR experiments: COSY, TOCSY, NOESY - Assignment strategies - 3D NMR experiments (HNCA, HNCOCA, HNCACB, CBCACONH, CCH-TOCSY, HCCH-TOCSY) – NMR structures of proteins – Calculations and validations.

Unit IV Structures of Proteins in Solid and Gaseous states: **8 hours**

Mass spectrometry – Basic principles – EI-MS of small molecules - Structural characterizations and folding pathways of proteins by ESI-MS and MALDI-MS - Structures of proteins in gaseous state by IM-MS - Protein crystallography -Bragg's law - Space groups - Miller indices - Collecting X-ray data - Unit cell determination - Matthew's coefficient -Phase problem - Obtaining Model Structures.

Unit V Computational Methods in Structural Biology: **8 hours**

Local and global sequence alignment algorithms - Multiple-sequence alignment strategies – Phylogenetics – MolecularModelling methods - Classification of proteins using CATH & SCOP - Process of drug discovery - Structure-based lead design – Ligand-based lead design – Molecular docking – HTVS - Small molecular libraries – Pharmacophores -QSAR methods - Lead optimization – ADMET.

SUGGESTED READINGS

1. David W.M. (2005). Bioinformatics – Sequence and Genome Analysis. (CSHL Press).
2. Freeman WH (1999). Structure and mechanism in protein science.
3. Keith W and John MW. (2010). Principles and Techniques of Biochemistry and Molecular Biology(Cambridge University Press).
4. Kurt W (1986). NMR of proteins and nucleic acids (Wiley, New York).
5. Morrison RT, Boyd RN and Bhattacharjee SK. (2011). Organic Chemistry (Pearson India).
6. Rodwell VW, Bender D, Botham KM, Kennelly PJ and Weil PA. (2015). Harper's Illustrated Biochemistry(McGraw-Hill Medical).
7. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. (2013). Molecular Biology of the Gene(Benjamin Cummings).