COURSES OF STUDY

FOR

Pre Ph.D. Programme in BIOTECHNOLOGY

(Effective from the session 2020 onward)

Department of Botany & Biotechnology
Ravenshaw University, Cuttack-753 003

SUMMARY OF THE COURSES OFFERED IN

Pre Ph. D. PROGRAMME IN BIOTECHNOLOGY

SUMMARY OF THE COURSES OFFERED IN Pre Ph. D. IN BIOTECHNOLOGY

Paper No.	Course Title	Maximum marks
	1st Semester	
Paper 1.1.1	RESERACH METHODOLOGY & COMPUTER APPLICATION	**100**
Paper 1.1.2	ELECTIVE	**100**
	(A) BIOCHEMISTRY	
	(B) ENVIRONMENTAL BIOTECHNOLOGY	
	(C) INDUSTRIAL MICROBIOLOGY	
	(D) PLANT BIOTECHNOLOGY	
Paper 1.1.3	RESEARCH AND PUBLICATION ETHICS (RPE)	**50**
Paper 1.1.4	REVIEW OF LITERATURE	**50**
	2nd Semester	
Paper 1.2.1	PROJECT DISSERTATION	**200**
Paper 1.2.2	PROJECT VIVA VOCE	**100**

FIRST SEMESTER

Paper 1.1.1 RESERACH METHODOLOGY & COMPUTER APPLICATION

Objectives

1. To acquaint the students with modem spectroscopic techniques used in biological research.
2. To study the techniques for separation of biomolecules.
3. To learn about the equipment and methods applied in molecular biology research
4. To learn about various biochemical methods for qualitative and quantitative estimation of biomolecules.
5. To learn the basics and application of statistical methods in processing of data using computers.

Outcomes

On completion of the course the students shall

1. Have clear understanding on the operation of spectrophotometers and spectrofluorimeters and have ability to prepare measuring protocols.
2. be able to select appripriate chromatography, technique for separation of the moleculer of interest.
3. Have sound knowledge for preparation, amplification and integration of the DNA of interest.
4. Know the assay procedure and experimental protocols of key cellular enzymes.
5. Ability to select proper statistical procedure for comparison of data; ability to prepare data sheet for efficient data analysis using software.

Unit-I Laboratory Techniques I

Spectroscopy Techniques- Principles, Instrumentation and Applications: UV visible, fluorescence, Mass spectroscopy, Fluorescence Spectroscopy, Chlorophyll fluorescence analysis, Infra Red gas Analyzer (IRGA), **Separation Techniques**- Principles, Application: Chromatography techniques (TLC, Ion-exchange, Affinity, Gel-filtration, HPLC), NMR, Flow Cytometry

Unit-II Laboratory Techniques II

DNA (Plasmid and genomic DNA) and RNA isolation, Purification and quantification of DNA and RNA. Protein isolation and purification, Polymerase Chain Reaction (PCR) techniques including real time PCR, cDNA preparation. Electrophoresis: Agarose, SDS-PAGE, 2-D Gel electrophoresis.

Unit-III Analytical Biochemistry

Analysis of Biomolecules: Assay and estimation of proteins, proline, Ascorbate, lipids, ELISA. **Analysis of Enzymes:** Assay development, Experimental Design. Assay and estimation of peroxidase, catalase, esterase, phophatase, carbohydrate enzymes (Amylase, Invertase, Cellulase), ATPase.

Unit-IV Biostatistics

Theoretical distribution (normal, binomial and Poisson distribution), Linear and non-linear correlation and regression, Single and multiple correlation, simple and polynomial relationship, Analysis of variance (ANOVA) (One factor and multiple factor), Duncan's multiple range test (DMRT), least significance difference (LSD) test, test of significance: t and Chi-square test.

Unit-V Computer Application

Introduce the students to the algorithmic way of thinking, basic acquaintance with data structures and algorithms, statistical problems requiring significant computation, basics of MS word, excel and PPT, Application and utilisation of in biological data processing, preparation of data on formula sheet for t-test, Chi-square test, ANOVA, LSD and DMRT.

Paper 1.1.2 ELECTIVE (A) BIOCHEMISTRY

Objectives

1. To learn the basic nutritional biochemistry and the laws and standards for protection of food and food processes.
2. To learn about the structure, replication and control of SARS viruses.
3. To learn about the function and regulation of key cellular organelle.
4. Study the hormonal regulation of plant growth.
5. To learn the cell signaling processes and their application for plant growth development.
6. To learn the basics and Procedure for structural analysis of proteins.

Outcomes

On completion of the course the students shall

1. Have ability to understand the processes to mountain nutritional standard of food and select appropriate method for food protection.
2. Have a clear understanding of the nature and pathogenicity of SARS viruses and methods of their control with special reference to SARS-COVID vorus.
3. Properly understand the functional aspects of chloroplast and mitochondria.
4. Be able to select proper plant hormones and their combinations for manipulating plant growth and productivity.
5. Be able to determine the signaling pathway to apply for appropriate plant growth and development.
6. Have ability to determine the protein structure by understanding simulation and use of bioinformatic tools.

Unit-I Nutritional Biochemistry

Nutrition: Definition and importance, role of water in food, water activity and shelf life of food. Food processing: Losses of vitamins and minerals due to processing. Pigments in food, food flavours, browning reaction in foods.

Food safety laws and standards: Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP) Bureau of Indian Standards (BIS), AGMARK, Food Safety and Standards Act, 2006 (FSSA): Prevention of Food Adulteration Act (PFA)

Unit-II SARS Biochemistry

Structure, replication and pathological specificity of SARS viruses, structural basis of RNA-dependent RNA polymerase catalysis and translocation, Inhibition of SARS RNase. Binding mechanisms of Remedisivir, fabipiravir and Zn^{2+}.

Unit-III Metabolic Biochemistry

Mitochondrial and Chloroplast protein synthesis. Regulation of Protein synthesis.
Plant hormones: Auxins and Cytokines, Biosynthesis and breakdown of Auxin and Ethylene. Functional role of plant hormones in agriculture and horticulture.

Unit-IV Signaling Biochemistry

Molecular mechanisms of signaling: Light signal transduction in higher plants, chemical signaling between plant and pathogen.
Developmental signaling pathway (Sonic-Hedgehog pathway), Proliferative signaling pathway (MAPK/ERK pathway), inflammatory pathway (Rel/NFkB pathway).
Experimental methods in signaling studies: Western Blotting, Kinases assay,immunoprecipitation, Chromatin-immunoprecipitation.

Unit-V Structural Biochemistry

Structure of proteins (model proteins: ATPase, Rubisco, Albumin)
Structural determination through x-ray crystallography, NMR and mass spectrometry
Structural aspects in protein interactions, molecular visualisations tools in Structural bioinformatics

Paper 1.1.2 ELECTIVE (B) ENVIRONMENTAL BIOTECHNOLOGY

Objectives

1. To learn the test procedures for toxicity assessment of aquatic habitats.
2. To study the microbial processes for degradation of xenobiotics and natural toxicants.
3. To understand the enzymatic basis of degradation of pesticides and toxic hydrocarbons.
4. To learn the methods for remediation of problem soils
5. To learn the physico-chemical and biological methods for treatment and reuse of wastewater.
6. To learn the modeling procedures for management of ecosystem and their functions.

Outcomes:

On completion of the course the students shall

1. Halve ability to perform aquatic toxicity testing by selecting the proper test system.
2. Understand the microbial degradation and biotransformation processes and able to apply microbes for environmental remediation.
3. Be able to acquire knowledge to apply call bound and immobilized enzymes to remove environmental toxicants.
4. Be able to select proper remediation processes for reclaiming problem soils and polluted water bodies.
5. Know the operational details of water treatment for nutrients and pollutants removal.
6. Have basic mathematical knowledge for preparing models of ecosystem functions.

Unit I

Aquatic Toxicology: Media and test batteries, levels of toxicity testing. Algal toxicity test, Microtox, Solid-phase test with luminescent bacteria, macrophytes in phytotoxicity test, Spirotox test, Micro-invertebrates in toxicity analysis, Fish cells as toxicity test battery, Flow cytometry based phytotoxicity analysis.

Unit II

Biodegradation of environmental toxicants: Fate of pesticides and metals in the environment, measurement of biodegradability, bacterial, fungal and algal degradation of pesticides and industrial pollutants; enzymatic basis of toxicant degradation: activity of esterases, phosphatases, Cyt. P450 monooxygenases, LIP and PTE

Microbial immobilization of metals and detoxification of bioactive metal species

Unit III

Management and remediation of contaminated habitats: removal of pollutants from soil.

Biological decontamination of soil and aquatic ecosystems, reclamation of saline, acidic, alkaline and waterlogged soil, In situ remediation of chemically contaminated soil. Reclamation of eutrophicated water bodies.

Unit IV

Emerging technologies for wastewater treatment: Development in physical treatment processes – wet oxidation process, lamellar plate separator, membrane filtration.

Development in chemical treatment processes – nitrogen, phosphorus and iron removal

Development of biological treatment processes – bio-bead cells, reed beds, rhizofiltration, bio-wave system, water Hyacinth ponds, algae-fish pond, upward flow sludge blanket reactors, tower aerated filters.

Unit V

Modelling of ecosystems: model components-system variables and forcing functions; ecological basis of predictive modelling; ecosystem approach to ecological models; construction, analysis and validation of dynamic models; sensitivity analysis.

Construction of sub-models: sediment sub-models, primary production sub-models, trophic sub-models.

Predictive models for nitrogen, phosphorus and metals in an ecosystem.

Paper 1.1.2 ELECTIVE (C) INDUSTRIAL MICROBIOLOGY

Objectives

7. To learn about the industrially important microbes and their application.
8. To understand the procedures for downstream processing of industrial broth.
9. To learn the microbial production of antibiotics and metabolites.
10. To know the details of industrial production of enzymes and product application.
11. To learn the method of patent development and submission and IPR.

Outcomes

On completion of the course the students shall

1. Have ability to isolate, maintain and apply industrial microbes for synthesis of value added products.
2. Have a clear understanding of downstream processing and optimized product recovery.
3. Know the industrial production processes for antibiotics, vitamins, proteins and other secondary metabolites.
4. Have ability to understand the mechanisms for microbial production of enzymes and other primary metabolites.
5. Be able to prepare and submit patents; know details of IPR.

Unit-I Industrial Microorganisms & Fermentation Process

Isolation and preservation of industrial microorganism, screening of industrially important microorganisms, strain improvement strategies. Fermentation: media composition, media sterilization, media economics, types of fermentors, design and analysis of CSTR, Scale up fermentation, optimization and control of process parameters.

UNIT-II DOWN STREAM PROCESSING

Strategies to recover and purify products, cell disruption, separation of insoluble products, separation of soluble products, purification of products, final processing.

UNIT-III INDUSTRIAL FERMENTATION-I

Microbes and industrial products, Production of primary and secondary metabolites; Antibiotic fermentation: Penicillin, Streptomycin; Anaerobic fermentation of solvents: Acetone, Butanol; Vitamins and growth stimulants: Vitamin B12, Riboflavin, Vitamin A.

UNIT-IV INDUSTRIAL FERMENTATION-II

Enzymes as fermentation products: Amylase, Proteolytic enzymes, Pectinases. Enzyme

engineering: isolation, purification and immobilization of enzymes and application of such procedures, Commercial production of biopesticides; Methods and application of Single cell proteins with special reference to *Spirulina;*

UNIT –V PROBLEMS AND PROSPECTS

Patent concept, Composition of a patent, subject matter and characterization of a patent, protection of the rights of the inventor. Fermentation economics: Market potential, Fermentation and product recovery acts; Future of industrial microbiology

Paper 1.1.2 ELECTIVE (D) PLANT BIOTECHNOLOGY

Objectives:

1. To know the detailed techniques of plant tissue culture pathways and problems associated with it.
2. To understand the application and low-cost options of plant tissue culture.
3. To gain knowledge on various types of plant transformation including nuclear, chloroplast and *in planta*.
4. To have knowledge on production of transgenic plants with different traits and molecular farming.
5. To have in depth knowledge on techniques and applications of recombinant DNA technology and CRISPR-Cas mediated genome editing.
6. To understand the concept and applications of intellectual property rights (IPR).
7. To understand the detail concept and applications of bioinformatics.

Outcomes:

On completion of the course the students shall

1. Understand the diverse pathways of plant tissue culture and methods used to overcome the problems associated with culture establishment.
2. Gain knowledge about the low-cost options for tissue culture and its advantages.
3. Learn different transformation techniques along with its advantages and limitations.
4. Get acquainted with improved plant production using techniques of transgenics and molecular farming.
5. Be able to understand the potential of various techniques of Recombinant DNA and CRISPR-Cas technology for human welfare.
6. Learn about the IPR rules, regulations and applications.
7. The students shall have an in-depth knowledge about techniques of bioinformatics and its applications.

Unit-I Plant Tissue Culture

Techniques of *in vitro* plant regeneration: axillary shoot proliferation, adventitious shoot proliferation, callus mediated organogenesis and somatic embryogenesis. Problems (oxidative browning, recalcitrance of some plants) associated with tissue culture

Production and utilization of synthetic seeds. Role of plant tissue culture in plant improvement and biodiversity conservation. Low-cost options for in vitro propagation.

Unit-II Transgenics

Vector mediated gene transfer: *Agrobacteriumm* and virus mediated gene transfer. Vector less gene transfer methods: particle bombardment, electroporation, microinjection, liposome, silicon carbide-mediated, chemical methods of gene transfer. Chloroplast transformation, *In planta* transformation, Production and utilization of transgenic plants: insect resistance, virus resistance, heribicide resistance, nutritive food quality improvement. Gene pyramiding. Molecular farming.

Unit-III Recombinant DNA Technology

Restriction enzymes: types and their role in genetic engineering and cloning, vectors: plasmid, phages, cosmid, YAC and BAC vectors and their role in gene cloning, molecular probes: types and uses, isolation of genes, construction of genomic library, c-DNA library, cloning in bacteria and eukaryotic system, identification and expression of transgene by PCR, Northern, Southern and Western blotting. Mechanism and applications of CRISPR-Cas9 mediated plant genome editing.

Unit-IV IPR

Introduction, History of IPR in India, Protection of IPRs: Trade secret, Patent, Copyright, Plant variety protection (PVP); Trips, India and Trips, Protection of Biotechnological inventions: Patenting of genes and DNA sequences, Patenting of Life forms; Plant Breeder's Right (PBR) and Farmers Right; Benefits and problems from IPR. Institutional Biosafety Committee (IBSC).

Unit-V Bioinformatics

Overview of bioinformatics, data acquisition, databases-content, structure and annotation, Nucleic acid sequence databases: GenBank, EMBL, DDBJ, Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB, Genome Databases at NCBI, EBI, TIGR, SANGER.

Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues. Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series. BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.

Paper 1.1.3 RESEARCH AND PUBLICATION ETHICS (RPE)

THEORY

RPE 01: PHILOSOPHY AND ETHICS (10 hrs.)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions
3. Intellectual honesty and research integrity
4. Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)
5. Redundant publications: duplicate and overlapping publications, salami slicing
6. Selective reporting and misrepresentation of data

RPE 02: PUBLICATION ETHICS (10HRS)

1. Publication ethics: definition, introduction and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME etc.
3. Publication misconduct: definition, concept, problems that lead to unethicalbehavior and vice versa types.
4. Violation of publication ethics, authorship and contributorship
5. Identification of publication misconduct, complaints and appeals
6. Predatory publishers and journals

PRACTICE

RPE 03: OPEN ACCESS PUBLISHING (10 HRS)

1. Open access publications and initiatives
2. Journal finder/journal suggestion tools viz. JANE. Elsevier Journal Finder,Springer Journal Suggester, etc.
3. Complaints and appeals: examples and fraud from India and abroad
4. Use of plagiarism software like Turnitin, Urkund and other open source softwaretools
5. Conflicts of interest

Paper 1.1.3 REVIEW OF LITERATURE

References

Bird, A. (2006). Philosophy of Science, Routledge

Maclntyre, Alasdair (1967) *A Short History of Ethics*, London

P. Chaddah (2018) Ethics in Competitive Research: Do not get sooped: do not get plagiarized, ISBN: 978-9387480865

National Academy of Sciences, National Academy of Engineering and Institute of Medicine.(2009). *On Being a Scientist*: *A Guide to Responsible Conduct in Research*: *Third Edition*.

National Academies Press.
Resnik, D.B. (2011). What is ethics in research & why is it important. *National Institute of Environmental Health Sciences,* 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179.
https://doi.org/10.1038/489179a
Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019)
ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics Book.pdf