COURSES OF STUDY
PH. D. COURSE WORK (Autonomous)
(BIOTECHNOLOGY AND BIOINFORMATICS)

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY, JYOTI VIHAR
BURLA- 768019 (ODISHA)

PEOs

PEO1: Understand the nature and basic concepts of _____ relating to the M.Sc. in Biotechnology

PEO2: Analyse the relationships among different concepts

PEO3: Perform procedures as laid down in the areas of study

PEO4: Apply the Basic Concepts learned to execute them

POs

PO-1: **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions

PO-2: **Effective Communication:** Will be able to speak, read, write and listen clearly in person and through electronic media in English and in one Indian Language

PO-3: **Social Interation (Interpersonal Relation):** Elicit views of others, mediate disagreements and prepared to work in team

PO-4: **Entrepreneurship Capability:** Demonstrate qualities to be prepared to become an enterpreneur

PO-5: **Ethics:** Recognize different value systems including your own, understand the moral dimensions and accept responsibility for them

PO-6: **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development

PO-7: **Life-Long Learning:** Acquire the ability to engage in independent and life-long learning in the context of socio-technological changes

COs

CO-1: Remember and understand the basic concepts/Principles of _____

CO-2: Analyse the Various Concepts to understand them through case studies

CO-3: Apply the knowledge in understanding practical problems

CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

PH. D. COURSE WORK
(BIOTECHNOLOGY AND BIOINFORMATICS)
DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

COURSE AT A GLANCE

First Semester

Course	Course Title	Credit hours	Mark Distribution (ET+MT+HA)	Marks
FIRST SEMESTER				
BT-C-611	Instrumentation and Techniques	4 CH	60+20+20	100
BT-C-612	Research Methodology (Quantitative Analysis and Computer Applications)	4 CH	60+20+20	100
BT-E-613 (A to H)	Elective Papers (Any one):	4 CH	60+20+20	100
	(A) Applied Immunology			
	(B) Bioprocess Engineering & Technology			
	(C) Computational Biology			
	(D) Rational Drug Design & Evaluation			
	(E) Genomics & Proteomics			
	(F) Medical Microbiology			
	(G) Plant Genome Mapping and Genomics			
	(H) Environmental Biotechnology			
BT-C-614	Research And Publication Ethics	2 CH	40+05+05	50
BT-C-615	Practical	4 CH	100	100
BT-C-616	Review of Research papers published in Journals (Review Report- 2 CH and Seminar- 2 CH)	(2+2) CH	50+50	100
Total Credit		**22 CH**		**550**

ET: End Term Examination, MT: Mid Term Examination, HA: Home Assignment

FIRST SEMESTER

BT-C-611	INSTRUMENTATION & TECHNIQUES	4 CH	100

Objective: To educate the students on principle of operation and application of various instruments used for qualitative and quantitative analysis of chemical and biological samples.

Learning outcome: After studying this subject the students can be eligible to become a application specialist or technician in operating an instrument.

Unit-I

Principle, instrumentation and applications of microscopy (light, phase contrast, fluorescence); electron microscope (TEM and SEM); AFM; FACS; principle, instrumentation and application of scintillation counter, Geiger-Muller counter; radiolabeling for the measurement of metabolic activity; autoradiography.

Unit- II

Principle, instrumentation and applications of spectrophotometer (UV-VIS, Fluorescence, IR spectroscopy); mass spectroscopy: tandem MS, MALDI-TOF. characterization of nucleic acid and protein using MALDI-TOF and MS-MS.

Unit-III

Principle, instrumentation and applications of chromatography (size exclusion, ion-exchange, affinity, GLC, HPLC and FPLC); characterization of molecular structure using circular dichorism (CD), Optical Rotary Dichorism (ORD), NMR, ESR, X-ray crystallography.

Unit-IV

Principle, instrumentation and applications of Electrophoresis (Agarose, PAGE, IEF, 2-DE, DGGE); Principle, operation and application of Polymerase chain reaction (PCR), Variants of PCR; Blotting techniques (Southern blotting, Northern blotting, Western blotting); Nucleic acid sequencing.

Suggested readings:

1. Biochemical Techniques Theory and Practice by R. White (2009)

2. A Biologist Guide to Principle and Techniques by K. Willson and K.H. Gounding (2009)

3. An Introduction to Practical Biochemistry by D.T. Plummer (2008)

4. Analytical Chemistry by G.D. Christion (2000)

5. Principle and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Seventh Edition

BT-C-612	RESEARCH METHODOLOGY (Quantitative Analysis & Computer Applications)	4 CH	100

Objective: To impart knowledge to students on meaning, objective, criteria of research. Students also learn how to define research problems, design experiments and way of acquiring, analyzing and representing biological data in statistically valid manner and testing their statistical significance.

Learning outcome: After studying this subject the students can be eligible not only to define research problems but also to design experiment and analyze statistical significance and represent the biological data in statistical manner.

Unit-I

Introduction to research methodology: meaning of research, objectives of research, research and scientific methods, research process, criteria of research, defining research problems, research design, basic principles of experimental design, developing research plan, sample design and its types, characteristics of sampling procedure.

Unit II

Methods of data collection, processing and analysis; frequency distribution, diagrammatic representation, probability distribution, binomial distribution, poisson distribution, distribution of data: normal, skewness and kurtosis; measure of central tendency (arithmetic mean, median, mode, geometrical and harmonic mean), measure of dispersion (range, mean deviation, variance, standard deviation, coefficient of variation), normal distribution: its importance and properties, tabulating areas under standard normal distribution, central limit theorem, skewness and kurtosis.

Unit- III

Tests of hypothesis**:** one-tailed versus two-tailed tests, p-value, type-i and type-ii errors, hypothesis tests, student t-test, paired t-test; categorical data and chi-square test: chi-square distribution and table, 2x2 contingency table, goodness of fit test; correlation and linear regression: relationships between two variables, uses of correlation and regression, scatter diagram, pearson's correlation coefficient, regression analysis, multiple regression; analysis of variance: one-way analysis of variance, two-analysis of variance, F distribution and application, non-parametric methods: advantages and disadvantages, Wilcoxon rank-sum test, Wilcoxon signed-rank test.

Unit- IV

Basics of computer: hardware and software, generation of computers, information storage devices, ROM and RAM, methods of computing (workstation, server, grid computing, parallel computing, cloud computing), application of computer softwares in biostatistics and data management.

Suggested readings:

1. Introductory Biostatistics for the Health Sciences, Michael R. Chernick and Robert H. Frills, Wiley-Interscience Publications
2. Pal Nabendu, Sarkar Sahadeb. Statistics: Concepts and Applications. PHI Learning Pvt. Ltd., 2005. ISBN: 8120326792.
3. Gentle, James E., Härdle, Wolfgang K. Mori, Yuichi (Eds.). Handbook of Computational Statistics Concepts and Methods. Springer 2004. ISBN:354040464.
4. Murray R. Spiegel, Larry J. Stephens Schaum's Outline of Statistics 3rd edition, McGraw-Hill New Delhi 3rd edition 2000. ISBN:0070435103.
5. Schaum's Outline of Introduction to Probability and Statistics. McGraw-Hill, 1999.

BT-613 (A –F) (ELECTIVE PAPER: ANY ONE)

BT-E-613(A)	APPLIED IMMUNOLOGY	4 CH	100

Objective: To educate the students on cells, organs and their mechanism of action in protecting our body from any pathogenic organisms or substances. In addition, the subject educates student regarding the use of immune molecules (like antibodies and cytokines) for therapeutic and diagnostic purposes.

Learning outcome: After studying this subject the students can be able to answer how immune system of our body functions and what is the effect if they are suppressed or overactive. The students can also be expert in diagnostic techniques used in research and diagnostic labs

Unit-I

Cell and organs of immune system, soluble molecules and membrane associated receptors of innate immune system, toll-like receptors, antigens and antibodies, cytokines, complement system, major histocompatibility complex and antigen presentation, B-cell receptors, T-cell receptors.

Unit-II

Pathophysiology of important diseases of immune system; current approaches to diagnosis and treatment: hypersensitivity reaction, tolerance and autoimmunity, influenza, diphthereia, tuberculosis, malaria, SARS, AIDS, cancer and immunotherapy.

Unit-III

Application of immunological assays: antigen-antibody interaction, radioimmunoassay, ELISA, ELISPOT assay, western blotting, immunoprecepitation, immuno-fluorescence, alternatives to antigen-antibody reaction, immunoelectron microscopy, surface plasmon resonance, biosensor assays for assessing ligand-receptor interaction, CMI techniques (lymphoproliferation assay, mixed lymphocyte reaction).

Unit-IV

Tools and techniques in immunology: experimental animal models, cell culture, two-photon microscopy for *in vivo* imaging, use of bioinformatics tools in immunological research. Application of immunological concepts in drug development, vaccines and diagnostics: development of antibodies, antibodies as drugs, designing vaccines for active and passive immunization.; hybridoma technology and application of Mabs. Biotechnology produced Mabs.

Suggested readings:

1. Immunology (2007) by J. Kuby
2. Kenneth Murphy (Charles A Janeway, Paul Travers, Mark Walport) 8th Edition: Immunobiology
3. Abbas AK, Lichtman AH and Pillai S (2001) Cellular and Molecular Immunology; Elsevier, USA, 7th Ed.
4. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology .W.H. Freeman and Co., New York, 7th Ed.
5. Roit, I. (2012). Essential Immunology. Blackwell Scientific Publications, Oxford, 12th Ed.
6. Primrose SB, Twyman RM and Old RW (2002) Principle of gene manipulation. Wiley-Blackwell, UK, 6th Ed.

BT-E-613(B)	BIOPROCESS ENGINEERING & TECHNOLOGY	4 CH	100

Objective: To educate pupils on tools and techniques used in growing microbes and monitoring their growth for producing useful products in industrial scale through various downstream processes.

Learning outcome: The students become aware about principle and instrumentation of methods and instruments used in the industries for commercial production. They also become eligible to join food and pharmaceutical industries.

Unit-I

Design and operation of conventional fermenter (probes, sterilization, agitation, aeration, heat and mass transfer, control parameters). Submerged vs solid substrate fermentation. Bioreactor design and application: batch, fed-batch, CSTR, tubular flow, plug flow, fluidized bed, membrane reactor), fermentation economics.

Unit-II

Cell kinetics: models of microbial growth; Substrate inhibition kinetics, product inhibition kinetics, ideal and non-ideal reactors; residence time distribution in bioreactor (E-curve, C-curve and F-curve), determination of average conversion in Batch reactor and CSTR. scaling up operation in bioreactor and its advantages.

Unit-III

Enzyme kinetics: michaelis-menten equation, briggs and haldane quasi steady-state approximation, enzyme inhibition (competitive, non-competitive, uncompetitive) and inhibitory kinetics, turnover number and kcat. Bi-substrate reaction kinetics, ordered and random kinetics, ping-pong catalysis (Delziel's form) and mathematical modeling.

Unit-IV

Downstream processing. Enzyme immobilization- types and methods; application of enzyme immobilization in bioreactors. Biosensors: enzyme biosensors, bio-electrodes, optrodes and immunochemical sensors.

Bioreactor design for animal cell culture (integrated suspension culture, immobilized cell cultivation); strategies of maximizing the productivity of amino acid and SCP production (case study).

Suggested readings:

1. Bioprocess Engineering Principles-Pauline M. Doran
2. Bioprocess Engineering-Basic Concepts-M.L Shuler & F. Kargi
3. Fermentation Microbiology and Biotechnology-El-Mansi and Bryce
4. Biotechnology- A text book of Industrial Biotechnology- Crueger & Cruger

BT-E-613(C)	COMPUTATIONAL BIOLOGY	4 CH	100

Objective: To provide training to the students on using computational tools for in silico analysis of bioactive compounds

Learning outcome: After studying this subject the students can be eligible to address problems regarding acquiring, storing, retrieving and analysis of bio-information.

Unit-I

Sequence databases and their uses; dynamic programming methods; database searching - Heuristic methods, Markov chain and Hidden Markov model. pairwise alignment using HMM; multiple sequence alignment methods; genome annotation - gene finding algorithms.

Unit-II

Basic concept of molecular evolution and phylogeny; ultrametric trees and distances, data preparation; phylogenetic inference algorithms: distance-based methods, character-based methods; assessment of tree reliability; software packages.

Unit-III

Building molecules: basic chemistry, steric and other constrains, analysis of PDB structure; structure and topology: protein structure, prediction of protein structure, fold, topology (algorithm and implementation). DNA structure and topology; interactions: force fields (classical & quantum), electrostatics, surface area; mapping of binding sites and interaction with small molecules; energy minimization, molecular simulation; molecular dynamics, Monte Carlo simulation (algorithm and implementation).

Unit-IV

Introduction to systems biology; classification of enzymes and metabolic pathways, genetic and biochemical networks: deterministic and stochastic descriptions, pathway databases, pathway inference, visualization tools (DAVID), pathway miner and similar software. Applications in chemical kinetics and metabolic pathway analysis. software packages: SBML, and open source programs eCell, virtual cell, StochSim, BioNets.

Suggested readings:

1. Bioinformatics: D.W. Mount

2. Introduction to Bioinformatics by Arthur Lesk

3. Bioinformatics Methods and applications by Mendiratta and Rastogi

4. BLAST, Ian Korf, Mark & Josaph; O'Reily Pub

5. Bioinformatics and Functional Genomics; J. Pevsner

BT-E-613(D)	RATIONAL DRUG DESIGN AND EVALUATION	4 CH	100

Objective: To impart knowledge to students on drug discovery cycle, use of bioinformatic tools for prediction, structure determination and analysis of new drugs, clinical trials and toxicological evaluation of new drug candidates.
Learning outcome: After studying this subject the students can be eligible to pharmaceutical industries where researches on new drug discovery are carried out.

Unit-I

Drug discovery cycle, rational drug design techniques and types, 2D structures (atom lookup and connection tables; SMILES; SD files), 3D structures (pdb file format), conformational flexibility, structure minimization, 2D and 3D molecular descriptors, QSAR in drug design: QSAR methodology, QSAR applications in drug design, QSAR model selection and validation, pharmacophore and drug discovery, Lupinski rule of five, structure based drug design and virtual screening (CombiChem library development, molecular docking, MM-GBSA, MM-PBSA, LIE-SGB).

Unit-II

High-throughput chemistry: mix and split synthesis, solid-phase synthesis, solution-phase synthesis, combinatorial biosynthesis, library design, high-throughput screening of synthetic library, ADME/Tox of drug, toxicological evaluation of drug (OECD guideline, types of toxicity evaluation), *In vitro* assay and *in vivo* assay (case study).

Unit-III

Clinical trials of drug: pre-clinical vs clinical trials, objectives and principles, phases of clinical trial: Phase I (assess safety), Phase II (test for effectiveness), Phase III (large-scale testing), study design and trial consideration - study population, classifications of epidemiological research, randomization process, blinding, sample size, recruitment, ethics in clinical research, quality control in clinical trials, clinical trial registries, participant adherence, survival analysis, multicentric trials.

Unit-IV

Toxicology of drugs: pharmacokinetic and pharmacodyanamic drug-drug interactions, receptors involved in toxicology of drug **(**dopamine receptor, serotonergic receptor, GABA receptor, opioid receptor); metabolism of toxicants: phase-i reactions, phase-ii reactions, human cytochrome p450 isozymes and selected substrates, hepatotoxicity, nephrotoxicity, neurotoxicity, immunotoxicity, drug dependent and drug abuse.

Suggested readings:

1. Bioinformatics: D.W. Mount
2. Introduction to Bioinformatics by Arthur Lesk
3. Bioinformatics Methods and applications by Mendiratta and Rastogi
4. BLAST, Ian Korf, Mark & Josaph; O'Reily Pub
5. Bioinformatics and Functional Genomics; J. Pevsner
1. Robbins Pathological Basis of disease – 8th Edition
2. General Pathology by J.R.Walter and Israel – 7th edition
3. Andersons Pathology - LINDER – 10th Edition
4. Systemic Pathology . W St C Symmers

BT-E-613(E)	GENOMICS AND PROTEOMICS	4 CH	100

Objective: The course is intended to provide thorough understanding modern technologies of the genomics pertaining to whole genome sequencing, genome mining, comparative genomics, global gene function technologies, protein structure & function technologies at the genome level, etc.

Learning outcome: Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, genome annotation, global gene cloning and gene expression technologies, comparative genomics, Concept of haplotyping, introduction to pharmacogenomics, proteomics, etc. The students will know the vast amount of genome information in publicaly available databases and how to access and best utilize for practical purposes.

Unit-I

Genome sequencing techniques (sanger and pyrosequencing methods), NGS sequencing techniques (Roche/454 FLX, illumina genome analyzer, SOLiD™ sequencing, Ion Torrent™, Nanopore), NGS data quality control methods, NGS data structure, resources and repositories, genome assembly and annotation, gene prediction methods, comparative genomics, trascriptome preparation and annotation, transcriptome abundancy calculation and pathway mapping.

Unit-II

Global gene cloning expression platforms & technologies (microarrays, affymatrix, cDNA-AFLP), image segmentation, normalization techniques and expression analysis, RT-PCR, pharmacogenomics: concepts and applications in healthcare, SNP technologies: platforms and analysis; haplotyping: concepts and applications, gene function technologies (gene targeting, gene silencing (RNAi)).

Unit-III

Proteomics: protein sequencing ; protein-protein interactions; protein arrays, global analysis of protein modifications, protein structure determination (X-ray, NMR), protein structure prediction (homology, threading and *ab initio*), prediction of protein function, protein biomarkers: identification and utilization.

Unit-IV

Molecular phylogeny (phylogenetic tree and terminology, methods of phylogenetic tree prediction: maximum parsimony, distance (UPGMA, NJ), maximum likelihood methods, bootstrapping), EST sequence and mining of simple repeats, types of DNA bands, scoring and distance matrix, population genetic analysis, Analysis of molecular variance, DNA barcoding techniques, Mt DNA & cpDNA and their uses in phylogenetic analysis.

Suggested readings:

1. Introduction to Genomics by Arthur M. Lesk
2. Genomes-3 by T.A. Brown
3. Functional Genomics by
4. Introduction to Proteomics : Daniel C. Liebler and John R. Yates from "Humana Press" (2002)
5. Proteome Research : New Frontiers in Functional Genomics (Principles and Practice) by M. R. Wilkins (Editor) 1997

BT-E-613(F)	MEDICAL MICROBIOLOGY	4 CH	100

Objective: To educate the students on host-pathogen interactions, basics of microbial infection, diagnostic techniques used for detection of microbial infection and preventive measures taken to avoid microbial infections.

Learning outcome: After studying this subject the students can be able to answer how microbes exploit different ways to survive and grow inside the host and how host tries to check microbial growth. Besides students will learn the techniques used in microbiology labs for detection of infections and way to prevent or get cure from microbial infections.

Unit-I

Microbial pathogenesis: pathogrenicity: predisposing factors, PAI (characteristics, origin, virulence factors, evolution, pai prediction, barcoding of PAI, PAI regulation). Pathogenesis of viral infections, pathogenesis of fungal infections.

Unit-II

Basics of microbial infections: nosocomial infections (types of HAI, sources and reservoirs of HAI, microorganisms causing nosocomial infections), bacterial infections (MRSA, VRE, ESBL producing bacilli, carbapenem resistant enterobacteriaceae, CPE), viral infectious diseases (SARS, Avian influenza, H1N1 influenza), fungal infections (dermatomycoses: *Trichophyton* sp. *Epidermophyton* sp.), systemic infections (Coccidiodomycetes, Candidiasis, Cryptococcosis), opportunistic fungal infections.

Unit-III

Microbial diagnostics: bacteriology: staining procedures in clinical microbiology, typing methods: biotyping, antibiogram typing, bacteriocin typing, biofilm typing, bacteriophage typing, phage typing. nucleic acid based typing: PCR typings, ribotyping, plasmid profile based typing, optical map typing, WGS typing.
Mycology: signs and symptoms of fungal infection, culture methods: specimen collection, direct microscopy, culture of filamentous and yeast like fungi, laboratory diagnostic tools, non culture methods: PCR based identification of DNA from body fluids, detection of glucan in blood, galactomannan Ag testing.
Virology: sampling, cell culture, seropyting, diagnostics, assays, cytopathic effect test, genome sequencing, isolation and identification of structural and non-structural proteins.

Unit-IV

Prevention and control of diseases: principles and measures taken for infectious diseases, Biotechnologically produced vaccines, Mabs, antibiotics, anti-metabolites, genome knock out programmes using CRISPER/Cas 9.

Suggested readings:

1. Microbiology (2nd Edn) by Talaro (2005)
2. Biology of Microorganism (9th Edn) by Broak (2005)
3. Principal of Microbiology by Atlas (2009)
4. Microbiology (6th Edn) by Fred Alcamo (2006)
5. General Microbiology by Stanier (2006)
6. Microbiology by Pelczar & Krieg (2009)
7. Microbial Genetics by David Fridflelder (2007)

BT-E-613(G)	PLANT GENOME MAPPING AND GENOMICS	4 CH	100

Objective: The objective of the course is to familiarize the students with the basic concepts in Genetic Engineering. The detailed biology of different Cloning Vehicles, methodologies in construction of genomic libraries; strategies used in gene cloning; DNA transfer in bacteria, plant, mammalian cell, fungal cell, etc. Analysis and expression of the cloned genes in host cell. Practical applications of rDNA and to familiarize with the Ethical issues and Biosafety regulations related to genetic engineering.

Learning outcome: At the end of the course the student will have thorough understanding of the techniques and applications of recombinant DNA technology from a academic and industrial perspective. The students should be capable of pursuing a career in an industry such as in a pharmaceutical industry, diagnostics company, Agricultural Biotechnology, etc.

Unit-I

Molecular markers: concept of molecular markers; molecular markers (RFLP, RAPD, AFLP, SSR, SCAR, STS, EST, SNP) and their development for molecular dissection of plant genome. concept of minimal cell genome, molecular marker based inference.

Unit-II

Genome mapping: molecular mapping of plant genome- mapping population, constructing molecular maps; molecular tagging and mapping of oligogenes and QTL; marker assisted selection of qualitative and quantitative traits; physical mapping of gene; map based cloning of gene and QTL; association mapping; comparative mapping and synteny map.

Unit-III

Plant genome sequencing and structural genomics: rationale of genome sequencing, genome sequencing: principles, methodology and strategies; genome sequencing projects in plants; curation draft sequence of genome; Recognition of coding and non-coding sequences and gene annotation; Tools of gene cataloguing and gene structure prediction; High throughput cloning of ORFs.

Unit-IV

Functional genomics: identification of candidate genes using positional cloning, microarray analysis, transcriptome analysis (EST, SAGE), proteome comparison and metabolome profiling; characterization and functional analysis of genes: TILLING, reverse genetics, gene knockout system and heterologous expression system.

Suggested readings:

1. Principles of Gene Manipulation by S.B. Primrose, RM Twyman and RW Old (6^{th} Edition)
2. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz
3. Biotechnology by BD Singh
4. Biotechnology by PK Gupta
5. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz
6. Plant Biotechnology- Adrian Slater, Nigel W. Scott and Mark R. Fowler (Text Book)
7. Biotechnology- Expanding Horizons by B.D. Singh
8. Introduction to Plant Biotechnology by H S Chawla
9. Elements of Biotechnology by P K Gupta

BT-613 (H)	ENVIRONMENTAL BIOTECHNOLOGY	4 CH	100 marks

Unit-I

Water pollution: Causes and prevention; Biological treatment of waste water: Microbial processes in water treatment, Microbial bioflim and waste water treatment, Microbial removal of nitrogen and phosphorous, Waste water treatment through nutrient removal biomass production. Primary, Secondary, Tertiary treatment of waste water, Removal of pathogens by sewage treatment process, Sludge processing, Oxidation pond, Septic tank, Wet land and aquaculture system, Phytoremidiation.

Unit-II

Biodegradation: Biodegradation of Xenobiotic, Pesticides and Pollutants, Biodegradation in context of functional genomics, Zero order kinetics, First order kinetics, Monod kinetics, Types of fermentation: Batch, Continuous and Fed-batch system; Continuous culture – types, multistage systems, feedback systems; Biosorption: Use of bacteria, fungi and algae in biosorption, Biomineralization and Bioleaching. Bioremediation: types of bioremediation, Bioremidiation of agrochemicals and heavy metals in soils, Bioreactors for bioremediation, Application of bioremediation.

Unit-III

Air pollution: Causes and prevention; Biotechnology for air pollution: Air pollution abatement (bioscrubber and biofilter), Water pollution abatement: Aerobic (Activated sludge process, Biological filters, Rotating biological contractors, Fluidized bed reactors, Inverse fluidized bed bioflim reactor, expanded bed reactor); Anaerobic biological treatment (Contact digester, Packed bed or Packed volume reactor, Anaerobic baffled digester, Upflow anaerobic sludge blanket reactors); Membrane bioreactor and Biocatalyst.

Monitoring pollution; Bioindicators; Biomarkers – biochemical indicators, immunochemistry, genetic indicators; Toxicity testing using biological material Biosensors – mechanism, principle and working, Environment Impact Assessment: EIA complete process, Importance of EIA

Unit-IV

Biotechnology for solid waste management (Composting of crop residue, Principles and Advantages of composting, Factors influencing composting, techniques of compost enrichment), Vermicomposting and Crop productivity. Biofertilizers: Concept and utility.

Environmental sample collection and processing: soils and sediments, Sampling strategies and methods for soils, Sample processing and storage, water Sampling strategies and methods for water, Processing of water sample for virus analysis, bacteria and protozoan parasites detection. Measuring microbial activity in pure culture: Substrate disappearance, Terminal Electron acceptors, cell mass, carbon dioxide evolution; Dehydrogenase assay, Esterase essay; Biosafety in the laboratory.

Suggested readings:

1. Environmental Biotechnology, A.K. Chatterjee, Prentice-Hall Of India Pvt Ltd (2011). ISBN-13: 9788120342989.
2. Environmental Biotechnology, Mh Fulekar, Oxford & Ibh Publishing Co Pvt Ltd (2006). ISBN-13: 9788120416918.
3. Environmental Biology by Varma and Agarwal (2012)
4. Environment Problems and Solution, DK Asthana, Meera Asthana,S Chand & Company Pvt Ltd (2010). ISBN-13: 9788121916547.
5. Environmental Biotechnology, Monika Jain, Narosa Publishing House (2014). ISBN-13: 9788184872705.

BT-C-614	RESEARCH AND PUBLICATION ETHICS	2 CH	50

Objective: Theoretical knowledge is handicapped without practical and research based knowledge acquisition and knowledge dissemination. Hence, research and publications are inseparable form teaching. The objective of this course is to orient the students towards ethical practices in research and publications of research outcomes.

Learning outcome: At the end of the course the student will have thorough understanding of what is allowed to do and what should be done during their dissertation work and how they should publish their findings in reputed peer-reviewed journals safeguarding themselves from predatory journals and without plagiarism.

Unit-I

Philosophy and Ethics: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and reactions. *Scientific Conduct:* Ethics with respect to science and research; Intellectual honesty and research integrity;

Unit-II

Scientific Misconducts: Falsification, Fabrication, and Plagiarism (FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data. *Group Discussions:* Subject specific ethical issues, FFP, authorship, conflict of interest, 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-III

Publication Ethics: Definition, introduction and importance; Best practices/ standards setting initiatives and guidelines: COPE, WAME etc.; Conflict of Interest; Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals

Unit-IV

Open access publications and initiatives: SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies; Software tool to indentify predatory publications developed by SPPU; Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Databases and Research Metrics: Databases, Indexing databases, Citation databases: 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, altmetrics

Suggested readings:

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967). A Short History of Ethics. London.
3. P. Chaddah, (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN: 9789387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine, (2009).On Being a Scienctist: A Guide to Responsible Conduct in Research: Third Edition. National Academics Press.
5. 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, https://doi.org/10.1038/489179a
6. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN: 9788193948217. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

BT-C-614	**PRACTICAL**	**4 CH**	**100**

BT-C-615	**REVIEW OF RESEARCH PAPERS IN REFERRED JOURNALS (Review Report: 2 CH & Seminar: 2 CH)**	**2+2 CH**	**100**

***** $$ *****

Sem.I-2024:BT- 611

DEPT. OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

Ph. D. Course work, Biotechnology/Bioinformatics, Semester-I
End Term Examination, April 2024

Full Marks – 60 **BT-C-611: Instrumentation and Techniques** **Time – 3 hours**

Q.1 **Answer the following questions. (15) From Unit-I**
(a).

OR

(a) **Answer the following questions. (15)**
(b)

Q.2 **Answer the following questions. (15) From Unit-II**
(a)

OR

Answer the following questions. (15)
(a)
(b)

Q.3 **Answer the following questions. (15) From Unit-III**
(a)

OR

Answer the following questions. (15)
(a)
(b)

Q.4 **Answer the following questions. (15) From Unit-IV**
(a)

OR

Answer the following questions. (15)
(a)
(b)

*** $$ ***

DEPT. OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

M.Sc. Biotechnology/Bioinformatics, Semester-I
End Term Examination, December 2023

Full Marks – 40 **BT-C-614: Research And Publication Ethics** **Time – 2 hours**

Q.1 **Answer the following questions. (10) From Unit-I**
(a).

OR

(a) **Answer the following questions. (10)**
(b)

Q.2 **Answer the following questions. (10) From Unit-II**
(a)

OR

Answer the following questions. (10)
(a)
(b)

Q.3 **Answer the following questions. (10) From Unit-III**
(a)

OR

Answer the following questions. (10)
(a)
(b)

Q.4 **Answer the following questions. (10) From Unit-IV**
(a)

OR

Answer the following questions. (10)
(a)
(b)

*** $$ ***

DEPT. OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

M.Phil. Biotechnology & Ph.D. Course Work, Semester-I
End Term Examination, May 2024

BT-C-615: Practical

Full Marks – 100 Time – 4 hours

Figures in right hand margin indicate marks.

1. Solve any one of the following problem chosen by lot. Based on BT-C-612 **[35]**

(a)
(b)
(c)
(d)

2. Perform any one of the following experiments chosen by lot and draw your conclusion. **[50]**

(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)

3. Practical Record **[07]**
4. Viva Voce **[08]**

---xxx---