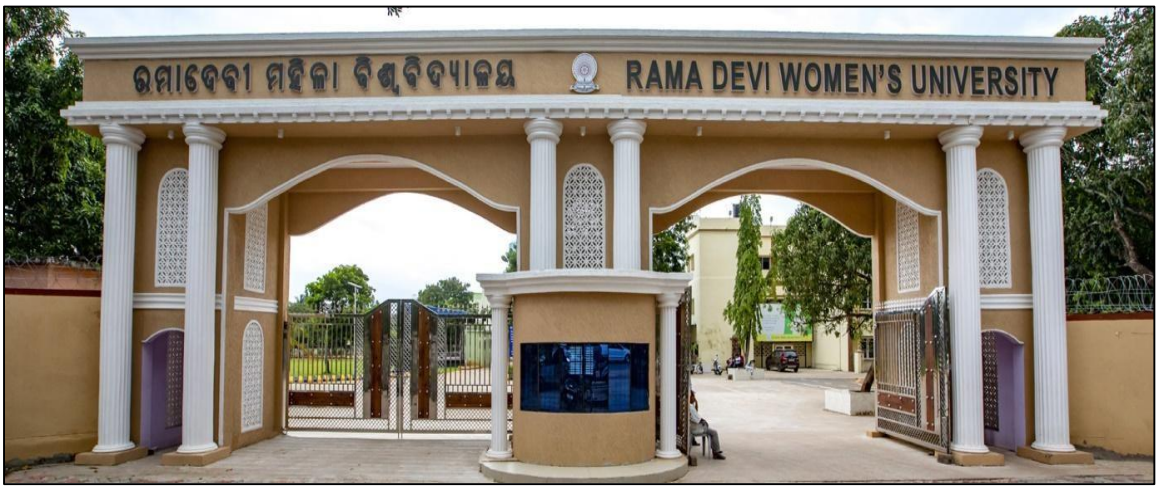
DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS OF PG PROGRAMME (M.Sc.)



RAMA DEVI WOMEN'S UNIVERSITY
Vidya Vihar, Bhubaneswar-751022, Odisha
Website: https://rdwu.ac.in

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS OF PG PRAGRAMME (M.SC)

RAMA DEVI WOMEN'S UNIVERSITY
Vidya Vihar, Bhubaneswar,
ODISHA

Programme outcomes:

PO1: Acquire knowledge for in-depth analytical and critical thinking to identify, formulate andsolve the issues related to various aspects of Biotechnology.

PO2: Inculcate scientific communication skills, scientific writing and data recording required forPharma industry, hospital Regulatory Agencies, & Academia.

PO3: Demonstrate the ability to work on research projects and assignments.

PO4: Enhance the ability of the students to take research initiative, design strategies with socialcohesion between research and social context.

PO5: Aware about ethical issues and challenges related to biotechnology.

PO6: Equipped to take independent decisions for startups or entrepreneurial launches and alsobecome a new knowledge generator in Biotechnology.

PO7: Proficient knowledge in the lead domains of biotechnology including Bioprocess technology, Animal biotechnology, plant Biotechnology, microbiology, genetic engineering, and Bioinformatics.

PO8: Demonstrate the ability to use digital tools and software for mining and analyzing datarelated to biotechnology.

PO9: Enhanced ability for collaborative research work with different scientific community.

PO10: Demonstrate conceptual learning through systematic analysis and critical thinking.

Programme specific outcomes:

PSO1: To gain fundamental knowledge in various aspects of biotechnology and their applications.

PSO2: To demonstrate and apply their knowledge of cell biology, biochemistry, microbiology andmolecular biology to solve the problems related to the field of biotechnology.

PSO3: To understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

PSO4: To familiar with basic laboratory instruments and understand the principle of measurementsusing those instruments with experiments.

PSO5: To understand, analyse and implement the knowledge related to research ethics, intellectualproperty rights and patent formulation.

COURSE STRUCTURE

M.Sc. BIOTECHNOLOGY

Semester-I							
Sl. No.	**Course Code**	**Paper Title**	**Units**	**Credits**	**Marks**		
					Internal	**End-Sem.**	**Total**
1	BT-101	Biochemistry	5	4	20 + 10	40	70
2	BT-102	Cell Biology and Genetics	5	4	20 + 10	40	70
3	BT-103	Microbiology	5	4	20 + 10	40	70
4	BT-104	Molecular Biology	5	4	20 + 10	40	70
5	BT-105	LAB-I (Biochem and Analytical Techniques)	-	4	10 + 10	40	60
6	BT-106	LAB-II (Microbio and Mol BioTechniques	-	4	10 + 10	40	60
7	BT-107	Fundamentals of Physical Sciences/Biological Sciences	-	-	-	-	-
8	AC-101	Fundamentals of Computer application	3	3	10 + 10	30	50
	Total			**27**	**180**	**270**	**450**

Semester-II							
Sl. No.	**Course Code**	**Paper Title**	**Units**	**Credits**	**Marks**		
					Internal	**End-Sem.**	**Total**
1	BT-201	Genetic Engineering	5	4	20 + 10	40	70
2	BT-202	Immunobiology and Immunotechnology	5	4	20 + 10	40	70
3	BT-203	Biostatistics and Bioinformatics	5	4	20 + 10	40	70
4	BT-204	Physiology and DevelopmentalBiology	5	4	20 + 10	40	70

5	BT-205	LABORATORY-III (Genetic Engg. &Bioinformatics)	-	4	10 + 10	40	60
6	BT-206	LABORATORY-IV (Immunologyand Diagnostics)	-	4	10 + 10	40	60
7	BT-207	Summer Internship Report	-	3	-	50	50
	Total			**27**	**160**	**290**	**450**

Semester-III							
Sl. No.	**Course Code**	**Paper Title**	**Units**	**Credits**	**Marks**		
					Internal	**End-Sem.**	**Total**
1	BT-301	Plant and Animal Biotechnology	5	4	20 + 10	40	70
2	BT-302	Bioprocess Engineering and Industrial Biotechnology	5	4	20 + 10	40	70
3	BT-303	Genomics, Proteomics and Molecular Diagnostics	5	4	20 + 10	40	70
4	BT-304	IPR, Biosafety and Bioentrepreneurship	5	4	20 + 10	40	70
5	BT-305	Research Methodology and ScientificCommunications Skill	5	4	20 + 10	40	70
6	BT-306	LAB-V (Plant-Animal Biotech & Genomics)	-	4	10 + 10	40	60
7	BT-307	LABORATORY-VI (Bioprocess Engg, and Technology)	-	4	10 + 10	40	60
8	BT-308	Seminar	-	1	10	-	10
	Total			**29**	**200**	**280**	**480**

Semester-IV							
Sl. No.	**Course Code**	**Paper Title**	**Units**	**Credits**	**Marks**		
					Internal	**End-Sem.**	**Total**
1	BT-401	Elective-I (A) Environmental Biotechnology/Ecology & Evolution / Nano biotechnology	5	4	20 + 10	40	70
2	BT-402	Dissertation	-	10	-	450	450
3	BT-403	Documentation & Presentation	-	3	-	50	50
4	AC-401	Women & Society	3	3	10 + 10	30	50
	Total			**20**	**50**	**570**	**620**

FIRST SEMESTER

BT-101 BIOCHEMISTRY (4 CREDITS) (I= 20+10, F= 40)

Course Outcome:

On successful completion of this course, student will be able to:

- Demonstrate an understanding of fundamental biochemistry principles, including topics specific to chemistry and biochemistry
- Design, carry out, and record the results of chemical and biochemical experiments using classical techniques, modern instruments, and/or computers, then analyze those results to draw reasonable, accurate conclusions.
- Explain that molecular and macromolecular structure as well as supramolecular architecture determine function and regulation.
- Communicate biochemical concepts and understanding to members of a diverse scientific community, as well as to the general public.
- Learn various techniques of enzyme activity analysis.

UNIT- I

Chemical basis of life, Chemical bonding, Forces that stabilize biomolecules: electrostatic andvan der Waal's interaction, hydrogen bonding. Hydrophobic effect. Water – properties of water, essential role of water for life on earth, pH, buffer, maintenance ofblood pH and pH of gastric juice, ionization and hydrophobicity. Bioenergetics-basic principles; equilibria and concept of free energy.

UNIT-II

Amino acids – structure and functional group, properties, peptides and covalent structure ofproteins, elucidation of primary and higher order structures, Ramachandran plot. Protein degradation and introduction to molecular pathways controlling protein degradation. Protein folding: Anfinsen's Dogma, Levinthal paradox, pathways of protein folding, chaperons,diseases associated with protein folding.

UNIT-III

Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose andcellulose.
Glycosylation of other biomolecules - glycoproteins and glycolipids.

Lipids - structure and properties of important members of storage and membrane lipids;lipoproteins.

UNIT-IV

Nucleosides, nucleotides, nucleic acids – structure, Properties, Biological significance. Historical perspective leading up to the proposition of DNA double helical structure; differencein RNA and DNA structure.
Structural characteristics of A, B and Z-DNA. Unusual DNA structure.

UNIT -V

General characteristics and catalytic power of enzymes and their classification.

Different mechanisms of enzyme catalysis- acid base and covalent catalysis, Enzyme Kinematics-Michaelis-Menten Equation.
Enzyme inhibition: Competitive, Uncompetitive and Non-competitive Inhibition.
Regulation ofenzyme action: Allosteric control. Concept of Catalytic strategies.

BOOKS

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.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	2	4	5	5	5	4
CO2	5	4	5	5	5	4	5	4	2	2
CO3	4	5	4	4	2	5	5	5	5	2
CO4	5	5	5	5	5	2	4	4	4	4
CO5	5	5	5	5	5	5	5	4	5	5

BT-102 CELL BIOLOGY AND GENETICS(4 CREDITS) (I= 20+10, F=40)

Course outcomes:

On successful completion of this course, student will be able to:

- Understand three fundamental aspects in biological phenomenon: a) what to seek; b)how to seek; c) why to seek?
- Explain about organization of cell membranes and the transport across it, about cell-cell and cell-ECM communications, cellular signaling process as well as cytoskeletal networks;
- Understand the nuclear architecture and delineate import and export across nuclear pore, chromatin organization, cell cycle process and apoptosis;
- Explain the structural and functional relationships of various organelles such as mitochondria, chloroplast, ER, Golgi complex, lysosome with detailed understanding of protein sorting and vesicular trafficking;
- Describe fundamental molecular principles of genetics.

UNIT- I

General organization of Prokaryotic and Eukaryotic cells; Cell Wall and Cell Membranes (Ultrastructure, composition and dynamics), Transport across membrane.

Cell Communications: Cell junctions, cell adhesion and extra-cellular matrix; Cell-ECM and cell-cell interaction, Signaling at the cell surface: Signaling molecules and cell-surface receptors, second messengers, G protein coupled receptor.

Cytoskeleton: Microtubules, intermediate filaments and microfilaments.

UNIT- II

Nucleus: Structure and function of nuclear envelope, nucleolus, Chromatin organization and its packaging, Global structure of chromosome; Macromolecular trafficking into and out of nucleus.

Cell Cycle and Cell Division: Components in cell cycle control, Regulators and check points in cell cycle; Mechanics of Cell Division, Mitosis and cytokinesis, Cellular basis of differentiation and development: Meiosis, stem cells, their differentiation into different cell types and organization into specialized tissues.

Programmed cell death and Mechanism of apoptosis.

UNIT- III

Mitochondria: Structure, function, mitochondrial DNA, origin and evolution of mitochondria; Chloroplast: Structure and function, chloroplast DNA, origin and evolution.

Intracellular compartments-I: Golgi apparatus and endoplasmic reticulum (structure & function). Intracellular compartments-II: Lysosomes-Biogenesis and Pathophysiology,Peroxisomes andGlyoxysomes.

Protein sorting: Transport of proteins into mitochondria, chloroplast and lysosomes. Intracellular Vesicular trafficking: Coated and un-coated vesicles, Transport of secretory materials, Endocytosis and Exocytosis.

UNIT- IV

Mendelian principles-Dominance, segregation, independent assortment,

Concept of gene-Allele, multiple alleles, pseudoallele, complementation tests,

Extensions of Mendelian principles-Co dominance, incomplete dominance, gene interactions, linkage and crossing over, sex linkage

UNIT- V

Extra chromosomal inheritance-Inheritance of Mitochondrial and chloroplast genes, maternalinheritance,

Human genetics- Pedigree analysis, genetic disorders, Polygenic inheritance

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

BOOKS

1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology ofthe Cell. Garland Science.
2. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.Inc.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell.Pearson Benjamin Cummings Publishing, San Francisco.
5. Genetics-Analysis and Principles-Robert Brooker. McGraw Hill Publication
6. Genetics-A conceptual Approach-Benjamin A Pierce. W H Freeman and Company.
7. Principles of Genetics- Sinnot, Dunn, Dobjanasky. McGraw Hill Publication
8. Genetics- Monroe Strickberger. Pearson Publications.
9. Principles of Genetics- Gardner, Simmons. Wiley Publications

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	2	5	5	5	4	5	5	5
CO2	4	2	4	5	4	2	5	4	2	5
CO3	4	4	4	5	4	2	5	4	2	5
CO4	5	5	5	5	5	4	5	5	4	5
CO5	5	5	5	5	5	4	5	5	4	5

BT-103 MICROBIOLOGY 4
CREDITS) (I= 20+10, F= 40)

Course outcomes:

On successful completion of this course, student will be able to:

- **D**escribe microbial diversity, microbial taxonomy and systematics and explain the processes used for replication, adaptations and interaction with the host and environment.
- **D**emonstrate practical skills in the use of tools and techniques for isolation and identification of microorganisms and describe the application of different agents to control microbial growth.
- **E**xplain pathogenesis, morphology, mode of infection, multiplication of medicallyimportant viruses and their treatment.
- **E**xplain principles/concept of Prokaryotic and Eukaryotic genetics, Viral genetics and application in research.
- **E**xplain the different factors regulating microbial interactions and its significance in the natural microbial communities influenced by the specific environmental characteristics of soils,oceans and biofilms.

UNIT- I

Scope and History of Microbiology: Introduction to microbiology and microbes, history &scope of microbiology;

Bacterial characteristics and growth: Morphology, structure, growth and nutrition of bacteria,

bacterial growth curve, bacterial culture methods;

Introduction to bacterial taxonomy: Microbial taxonomy and evolution, classification ofmicroorganisms, criteria for classification; classification of bacteria;

UNIT- II

Bacterial diversity: Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionicacid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma;
Microbial diversity & habitat: Archaea: Halophiles, Methanogens, Hyperthermophilic archaea;Eukarya: algae, fungi, slime molds and protozoa;
Viral diversity: Virus: general properties of viruses, viral structure, viral replication, cultivationand identification of viruses; sub-viral particles – viroids and prions.

UNIT- III

Microbial growth control: Sterilization, disinfection and antisepsis; Physical and chemicalmethods for control of microorganisms;
Antimicrobial agents: Antibiotics, mode of action of different antibiotics, resistance to antibiotics, Multiple Drug Resistance, antiviral and antifungal drugs;

Microbial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation, role in antimicrobial resistance.

UNIT- IV

Methods in microbial ecology: 16S rRNA typing; DGGE; RFLP;

Molecular diagnostic tools: Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markersof microbial resistance to specific antibiotics;
Pharmaceutical quality: Quality oversight; regulations and approved testing.

UNIT- V

Pathogenicity & infection: Host-pathogen interaction: entry of pathogens into the host, Colonization and factors predisposing to infections;
Microbial diseases, detection and their control: Respiratory infections caused by microbes, sexually transmitted diseases, diseases transmitted by animals, insects, ticks. Food and waterborne diseases; Microbial toxins: Exo-, Endo- and Entero-toxins, mode of action of toxins; **Microbial ecology:** symbiosis (Nitrogen fixation and ruminant symbiosis), microbes and nutrient

cycles; microbial communication system: bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

BOOKS

1. Brock Biology of Microorganisms, Maidgan, Martinko and Parker, Prentice Hall Inc.,NewYork.
2. Microbiology, Prescott, Harley and Klein, William C Brown Press.
3. Text book of Microbiology, R.C. Dubey and D.K.Maheswari, S.Cahnd and Company.
4. Modern concepts of Microbiology, H.D.Kumar and S.Kumar, Vikas Publications.
5. Microbiology, Pelczar, Chan and Creig, Tata Mc Graw Hill Publ.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	2	5	5	5	4	5	5	5
CO2	5	2	4	5	2	2	5	4	2	5
CO3	5	4	4	5	2	2	5	4	2	5
CO4	5	5	5	5	5	4	5	4	4	5
CO5	5	5	5	5	5	4	5	5	4	5

- Note related: 1
- From What Related: 2
- Nutral: 3
- Moderately Related: 4
- Highly Related: 5

BT-104 MOLECULAR BIOLOGY(4 CREDITS) (I= 20+10, F= 40)

Course outcomes:

On successful completion of this course, student will be able to:

- Acquire better understanding and comparative knowledge regarding most of theessentialaspects of molecular research
- Learn DNA replication, recombination and repair, transcription and translation.
- Understand the biology and application of antisense technologies and biology ofcancer
- Aware of the modern tools and techniques of genomics and isolation andidentificationof genes
- Understand the regulation of gene expression mechanism in prokaryotes andeukaryotes

UNIT- I

Structure and characteristics of DNA: Chemistry of nucleic acids, Structure and types of nucleic acids. Establishment of DNA as the genetic material. Structure of DNA and flexibility. Genome Variation and stability, DNA supercoiling

Prokaryotic genome organization: Viral genome organization, Bacterial genome organization and compaction

Chromatin structure and dynamics: Chromatin organization - histone and DNA interactome, heterochromatin, euchromatin.

UNIT- II

DNA Replication: Prokaryotic and eukaryotic DNA replication. Mechanism of DNA replication. Enzymes and accessory proteins involved in DNA replication, replication origin and replication fork, Types of DNA polymerases, fidelity of replication

DNA Mutations: Nature of mutations, mutagens-chemical, UV radiations etc., DNA damage **DNA repair:** Repair of replication errors, repair of DNA damage by other external agents, repairmechanisms of DNA DSBs.

UNIT- III

Homologous recombination: Models for Homologous recombination, Prokaryotic and eukaryotic protein machines in homologous recombination, MAT locus and yeast mating type switching, gene conversion

Conservative site-specific recombination: Enzymes for CSSR, Biological roles of CSSR, Intasomes

Transposition: Simple and Complex transposons. Transposable genetic elements in prokaryotes

and eukaryotes, regulation of transposons

UNIT- IV

Transcription: RNA replication, types of RNA polymerase. Transcription cycle: initiation,elongation and termination, Concept of promoters: eukaryotic and prokaryotic promoters.

Post transcriptional processing: RNA splicing, splicing pathways, alternative splicing, RNAediting and exon shuffling

Translation: Genetic code, structure of prokaryotic and eukaryotic ribosomes; initiation, elongation and termination of translation

UNIT- V

Regulation of gene expression in prokaryotes: Concept of operons, positive and negative control, lac, ara and trp operon regulation. Differences in the regulation of gene expression in prokaryotes and eukaryotes.

Regulatory RNAs: Regulation by RNA in bacteria, regulation by miRNA and siRNA, CRISPRs. **Cancer biology:** Oncogenes, tumor suppressor genes, cancer and the cell cycle, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

BOOKS

1. Molecular biology of the gene by J.D. Watson, T.'A. Baker, S.P. Bell, A. Gann, M. Levineand R. Losick. Pearson Publication.
2. Genes XII- By B. Lewin - Oxford Univ. Press
3. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch. Cshl Press.
4. Analysis of Genes and Genome. R J Reese. Wiley Publications.
5. Essential Molecular Biology – TA Brown. Wiley Blackwell Publications.
6. Genes and Genome-A changing Perspective. M. Singer and P. Berg. Wiley Publications.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	2	5	5	5	4	5	5	5
CO2	5	2	4	5	2	2	5	4	2	5
CO3	5	4	4	5	2	2	5	4	2	5
CO4	5	5	5	5	5	4	5	4	4	5
CO5	5	5	5	5	5	4	5	5	4	5

BT-105 LABORATORY-I (BIOCHEMISTRY AND ANALYTICALTECHNIQUES)

(4 CREDITS) (I= 10+10, F=40)

Course outcomes:

On successful completion of this course, student will be able to:

- Elaborate concepts of biochemistry with easy to run experiments.
- Familiarize with basic laboratory instruments and understand the principle ofmeasurements using those instruments with experiments in biochemistry
- Understand the experimental protocol and analyse the data of protein,carbohydrateand enzyme analysis.
- Know the principles and working method of different instruments related tobiotechnology.
- Develop working strategies for handling spectrophotometer, gel electrophoresissystem, chromatography etc.

1. To prepare Buffer and validate the Henderson-Hasselbach equation.
2. Determination of absorption maxima of given chemicals and validating the Beer-Lambert's Law.
3. Paper Chromatography of amino acids.
4. Extraction and Preparation of Protein lysates
5. To determine an unknown protein concentration by plotting a standard graph

of BSAusing UV-Vis Spectrophotometer.

6. Estimation of Nucleic Acids
7. Estimation of Sugars.
8. Enzyme assay (effect of substrate concentration, time and temperature)
9. Introduction to microscopy: Light, confocal, scanning and transmission microscope-demonstration.
10. Histology

    i. Tissue fixation, Paraffin embedding and sectioning.

    ii. Hematoxylin-eosin staining

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	2	5	5	5	4	5	5	5
CO2	5	2	4	5	2	2	5	4	2	5
CO3	5	4	4	5	5	2	4	4	2	5
CO4	4	4	5	4	5	4	2	4	4	5
CO5	5	5	5	5	5	4	5	5	4	2

BT-106 LABORATORY-II (MICROBIOLOGY AND MOLECULAR BIOLOGY TECHNIQUES)
(4 CREDITS) (I= 10+10, F=40)

Course outcomes:

On successful completion of this course, student will be able to:

- Gain hands on experience in isolation, purification and characterization of biomolecules.
- Isolate, characterize and identify common bacterial organisms.
- Determine bacterial load of different samples.
- Perform antimicrobial sensitivity tests;
- Preserve bacterial cultures.

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Preparation of media for cultivation of bacteria.
3. Isolation and identification of bacteria from soil/water samples.
4. Preparation of bacterial smear and Gram's staining.
5. Enumeration of bacteria: standard plate count.
6. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
7. Antimicrobial sensitivity test and demonstration of drug resistance.
8. Isolation & quantification of genomic DNA (Plant & Animal, Bacteria).
9. Agarose & PAGE gel electrophoresis.
10. Demonstration of blotting techniques.
11. Isolation of RNA/mRNA.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	2	5	5	5	4	5	2	5
CO2	5	2	4	5	2	2	5	4	2	5
CO3	4	4	5	4	2	2	4	4	2	5
CO4	4	5	5	5	5	4	5	4	4	5
CO5	4	5	5	5	5	4	5	5	4	5

BT-107 FUNDAMENTALS OF PHYSICAL SCIENCES/ BIOLOGICAL SCIENCES
(NON-CREDIT)

Course Outcome:

- Students should be able to have a firm foundation in fundamentals and application of currentchemical, physical and mathematical scientific theories.

UNIT- I

Basic Mathematics: Logarithms, exponential series, factorials, graphs, Coordinate geometrystraight line and non-linear relationships.

Differentiation & Integration: Rates and limits, Differential coefficients, Differentiation of afunction; Basic concepts of integration, integration by substitution, integration by parts.
Matrix algebra: linear transformation between vector spaces, Representation of linear transformation by matrices,

UNIT- II

Basic Physics: Surface tension, Viscosity, Photoelectric effect,

Basic characteristics of electricity and magnetism: charge, current, voltage, resistance, capacitor, electric field and impedance diodes, Photoresistors, Semiconductors, transistors, Integrated circuits and chips;
Various machines in biology: enzymes, allostery and molecular motors (molecules to cells and organisms).

UNIT- III

Atomic structure: waves and wave functions, quantum numbers, Atomic orbitals, electronic configuration of atoms and periodic properties of elements, ionization potential, electronic configuration of molecules.
Bond & angles: bond order and bond energies, types of chemical bond (weak and strong), intermolecular forces, states of matter - vapor pressure, phase diagrams, surface tension, boiling and melting points, solubility, capillary action, suspensions, colloids and solutions;
Chemical thermodynamics: internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistr

FUNDAMENTAL OF BIOLOGICAL SCIENCES

UNIT- I

Chemistry of Living Organisms: Biomolecules, Origin of Life, Cell- unit of living organisms and multicellular organisms, Structure of animal, plant and bacterial cell, Subcellular organelles (Cytoskeleton, Mitochondria, Golgi complex, Endoplasmic reticulum, Chloroplast, Ribosome, Lysosome, nucleus).

UNIT- II

Classification and nomenclature of living organisms (plant and animal): Survey of microbial world, Diversity in animal and plant kingdom, Phylogeny, Organic evolution,

Evidences in support of evolution (morphological, embryological, taxonomy, genetic, biochemical and molecular), Origin of species and Speciation;

UNIT- III

Genetics- Science of heredity: Chromosome number and structure, Cell division-meiosis and Mitosis, Mendelian principle of heredity; Monohydrid and Dihybrid cross (Examples); Physiological basis of life (Locomotion, Respiration, Digestion, Circulation, Excretion);

Reproduction in plants and animals; Hormonal regulation of physiological processes.

BOOKS

1. Stroud, K. A., & Booth, D. J. (2009). Foundation Mathematics. New York, NY:Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) Mathematics for Biological Scientists. Garland Science.
3. Baaquie, B. E. (2000). Laws of Physics: a Primer. Singapore: National University ofSingapore.
4. Halliday, D., Resnick, R., & Walker, J. (1993). Fundamentals of Physics. New York:Wiley.
5. Ebbing, D. D., & Wrighton, M. S. (1990). General Chemistry. Boston: Houghton Mifin.
6. Averill, B., & Eldredge, P. (2007). Chemistry: Principles, Patterns, and Applications.San Francisco: Benjamin Cummings.
7. Taylor DJ, Green NPO, Stout GW, Biological Science, Cambridge University Press ,ISBN 978-0521684170
8. Scott Freeman, Biological Science, Pearson , ISBN 9780321743671
9. Engner E, ross R, Bailey, D, Concepts in Biology, McGraw Hill Education , ISBN 978-0070607484

AC-101 FUNDAMENTALS OF COMPUTER APPLICATION(3 CREDITS) (I= 10+10, F= 30)

Course Outcomes (COs):

After completion of the course, the students will be able to:

- Learn basis of Basics of MS Windows. (Remembering) Demonstrate basic understanding of computer applications with reference to MS Windows, MS excel and MS PowerPoint. (Applying).

- Generate spreadsheets, charts and presentations. (Creating) Design personal, academicand business documents using MS Office. (Creating).

- Model the modes of development of self-learning materials and prepare different types of instructional material. (Applying) Explain different OERs, MOOCs available for effective learning. (Understanding).

- Develop learners' e-portfolios. (Creating) Classify various e-resources for effective learning. (Analyzing).

- Describe the concept of artificial intelligence and its applications in teaching learning. (Understanding) determine similarity index of the various documents like dissertations,

  thesesetc through plagiarism testing software. (Evaluating).

COURSE CONTENTS

Unit-I: Basics of Computer Applications

- Basics of MS Windows: Desktop, Recycle bin, My Computer, Documents, Pictures, Music, Videos, Task Bar and Control Panel. MS-Word and its features: Creating, Editing, Formatting and Printing of Documents, Inserting, Word Art, Page Numbers, Mail Merge.
- MS-Excel and its features: Creating a new worksheet, selecting cells, Entering and editing Text, Numbers, Inserting Rows/Columns, changing widths and heights of ros and columns, Formulae, referencing cells, changing of font sizes and colors.
- MS-PowerPoint and its features: Creating, Inserting and Deleting Slides of a Presentation. Adding Pictures, Inserting Objects, Audio, Video, Custom Animation and Hyperlinking of documents.

Unit-II: E-learning and its applications

- Concept of e-learning, Approaches to e-learning: Offline, Online, Synchronous, Asynchronous, Blended learning and Mobile Learning. Security concerns related to interactive contents: Viewing, disabling and managing interactive content; securing the computer from viruses and other internet attacks.
- Creating and Sharing: (i) G-Suite: Gmail, Drive, Calendar, Meet, Chat, Doc, Sheet, Slides

  (ii) Surveying: SurveyMonkey, Google Forms, online spreadsheets (iii) Google Classroom: conducting classes, assessment and evaluation.
- Development of Self-Learning Materials (SLM) and e-content: Concept and its purposes, Conventional Teaching versus SLMs & e-content, Types of SLMs and e-content, Process of Developing SLMs and e-content, Content Organization, Integrating video and audio into SLMs.

Unit-III: Trends in Teaching Learning Practices

- Open Education Resources: Creative Common, Massive Open Online Courses; creatinglearners' E-portfolios; Accessing Online Repositories, Online Libraries and E-Resources.
- Artificial Intelligence: Concept and its applications in teaching learning practices.Introduction to SPSS and R, Latex.
- Plagiarism: Regulations, similarity index of the various documents like dissertations, theses etc. through plagiarism testing software (Mendeley, Zotero).

Modes of Course Transaction: Workshop, Learning at ICT-Lab, Seminar, Team Teaching, Tutoring, Peer Group Discussion, Mobile Teaching, Self-learning, Collaborative learning, Cooperative learning, Flipped Learning etc.

Book and Materials Recommended

Creating learning materials for open and distance learning: A Handbook for Authors andInstructional Designers (2005). Commonwealth of Learning. Vancouver: Canada

Excel 2020 in easy steps-Michael Price – TMH publications

Foundations of Self-Learning Materials. http://wikieducator.org/Session_3.

Garrison, D.R. and Anderson, T. (2003). e-learning in the 21st century: a framework for researchand practice. London: Routledge.

Haas, K.B. and Packer, H.Q. (1990): Preparation and use of audio-visual aids, 3rd Edition,Prentice Hall, Inc.

Jayaram, K and Dorababu, K.K. (2015). Self learning materials in distance education system. International Journal of Current Research. Vol. 7, Issue, 10, pp.21929-2193Minnick, D.R. (1989). Aguide to creating Self Learning Materials. International Rice ResearchInstitute Los Baños, Laguna, Philippines.

MS Office 2007 in a Nutshell –Sanjay Saxena – Vikas Publishing House.

Murthy, CRK and Santosh Panda (2002). Report of the workshop on strategies for revision ofself-learning materials, IGNOU, New Delhi. (Unpublished).

Oreyet.al. (2009). Educational media and technology. New York: Springer Science BusinessMedia.Rana, S. (1994): Open Learning in India, Commonwealth Publishers, New Delhi.

Roblyer, M.D. (2008). Integrating educational technology into teaching. New Delhi: Pearson. Rowntree, Derek (1986). Teaching through self-instruction, Kogan Page, London/Nichola Pub.

Comp. New York.

Senapaty, H.K. (2009). ICT integrated learning materials on basic school subjects from constructivist perspectives. Bhubaneswar: Regional Institute of Education, NCERT.

UNESCO (2005). How ICT can create new, open learning environments: Information and communication technologies in schools: A handbook for teachers. Paris: UNESCO.

UNESCO (2008). Capacity building for ICT integration in education. Retrieved from http://portal.unesco.
UNESCO (2008). ICT Competency standards for teachers: Policy Framework. Retrieved from http://portal.unesco.
Working in Microsoft Office – Ron Mansfield - TMH.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	2	5	5	5	4	5	2	5
CO2	5	2	4	5	2	2	5	4	2	5
CO3	4	4	2	4	2	2	4	4	2	5
CO4	4	5	5	5	5	4	2	4	4	5
CO5	4	5	2	5	2	4	5	5	4	5

SECOND SEMESTER

BT-201 GENETIC ENGINEERING(4 CREDITS) (I= 20+10, F= 40)

Course Outcome:

After completion of this course successfully, the students will be able to

- explain the basic principles behind gene cloning and the usage of tools thereof.
- apply the knowledge of molecular cloning and design cloning strategy
- apply most appropriate recombinant-DNA techniques to under the function of geneand itsinteraction.
- explain various contemporary techniques towards tagging and knockout of genes.
- explain various r-DNA techniques towards silencing and editing of genes & analyzepublishedresults in the field of rDNA technology.

UNIT- I

Enzymatic & sequence tools for genetic engineering: restriction endonucleases, DNA

ligase,polymerases, polynucleotide kinase, alkaline phosphatase; linkers; adaptors;
Labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes.

Hybridization techniques: northern, southern, Western and colony hybridization

UNIT- II

Cloning vectors: Plasmids, Bacteriophages, phagemids, cosmids, artificial chromosome vectors

Expression vectors: pMal, pET-based vectors, His-tag**;** GST-tag; MBP-tag vectors,

Plant based vectors: Ti and Ri as vectors, yeast vectors, shuttle vectors.

UNIT- III

Insertion of foreign DNA into host cells: Physical, chemical and biological methods of DNAdelivery.
cDNA and genomic libraries: reverse transcriptase and cDNA synthesis

protein-DNA interactions: electrophoretic mobility shift assay**;** DNase footprinting; methylinterference assay, chromatin immunoprecipitation; yeast two-hybrid system
UNIT- IV

T-DNA tagging: t-DNA tagging strategies, isolation and cloning sequences flanking t-DNA;

Transposon tagging: Types of transposons, transposon tagging strategies, case studies of transposon tagging in plants and animals

Gene knockout technologies and Gene therapy: Targeted gene transfer, homologous recombination; site-specific mutagenesis

UNIT- V

Gene silencing techniques: siRNA & miRNA technology

G**ene editing**: Zinc Finger Nucleases, TALENs, CRISPR-Cas9 system

Case studies of gene editing: editing towards improvement of plants and animals

BOOKS

1. Analysis of Genes and Genome. R J Reese. Wiley Publications.

2. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch. Cshl Press.
3. Molecular biology of the gene by J.D. Watson, T.'A. Baker, S.P. Bell, A. Gann, M. Levineand R. Losick. Pearson Publication.
4. Gene Cloning and DNA analysis. T A Brown. Wiley Blackwell Publications.
5. Genes and Genome-A changing Perspective. M. Singer and P. Berg. Wiley Publications.
6. Essential Molecular Biology – TA Brown. Wiley Blawell Publications.
7. Genes IX- Benjamin Lewin. Pearson Publications.
8. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of GeneManipulation. 6th Edition, S.B.University Press, 2001.\
9. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3,CSHL, 2001. 3.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	5	5	5	5	5	4	5	2	5
CO2	5	2	4	5	2	4	2	4	5	5
CO3	5	4	2	4	2	2	4	2	2	4
CO4	4	5	5	5	5	4	5	4	4	5
CO5	4	5	5	5	5	4	5	5	4	5

BT-202 IMMUNOBIOLOGY AND IMMUNOTECHNOLOGY(4 CREDITS) (I= 20+10, F= 40)

Course outcomes:

After completion of this course successfully, the students will be able to

- To access knowledge in Immunology and to understand their practical applications.
- To understand the mechanism of immune system.
- This course will help students to understand the immunity, diseases, disorders andotherrelated infections.
- students will be able to apply their immunology knowledge in health and diagnosticareasfor designing novel therapeutics.
- To impart concepts of Tumor immunology and cancer immunotherapy

UNIT- I

Immunology- fundamental concepts and anatomy of the immune system:

Innate and acquired immunity; Phagocytosis; Organs of immune system: primary andsecondary lymphoid organs; innate immune response; mucosal immunity;
Antigens: immunogens, haptens; pathogen recognition receptors (PRR) and pathogenassociated molecular pattern (PAMP)
Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness anddisease susceptibility.

UNIT- II

Immune responses generated by B and T lymphocytes

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunological basis of self & non-self-discrimination; B cell maturation, activation and differentiation; generation of antibody diversity; Generation of humoral immune response;

T-cell Response: T-cell maturation, activation and differentiation and T-cell receptors; functional T Cellsubsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses;

Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.

UNIT- III

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions;

Advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy and immunoelectron microscopy;

cell cytotoxicity assays, apoptosis, flow cytometry

UNIT- IV

Clinical Immunology

Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group);

Hypersensitivity and immune disorders: Type I-IV; Autoimmunity; Rheumatoid arthritis, Type 1 diabetes mellitus, Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Immunodeficiency: Severe combined Immunodeficiency, AIDS;

immune exhaustion in chronic viral infection, immune tolerance.

Transplantation and Tumor immunology: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor antigens, immune response to tumors and tumor evasion of the immune system, cancer immunotherapy;

UNIT- V

Vaccinology

Immunization: Active and passive immunization; live, killed, attenuated, subunit vaccines; roleand properties of adjuvants.

Vaccine technology: recombinant DNA and protein-based vaccines, plant-based vaccines,peptide vaccines, conjugate vaccines; edible vaccine and therapeutic vaccine

Antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonalantibodies.

BOOKS

1. Kuby Immunology, 5th edition, By R. A. Goldsby et al.

2. Immunology By Roitt

3. Immunology by Khan

4. Fundamentals of immunology By William Paul.

5. Principles of Immunology by N.V. Shastri, Himalaya Publishing House.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	5	4	4	5	2	5
CO2	5	2	2	5	2	5	2	4	5	5
CO3	2	4	5	4	2	2	4	2	2	4
CO4	4	4	5	4	4	4	5	4	5	4
CO5	4	5	5	5	5	4	5	5	4	5

BT-203 BIOSTATISTICS AND BIOINFORMATICS(4 CREDITS)(I= 20+10, F= 40)

Course Outcomes

After completion of this course successfully, the students will be able to

- Define the principal concepts of biostatistics
- Collect data relating to variable/variables which will be examined, calculate, and interpretparametric and nonparametric statistics from these data.
- Identify different distribution forms (Normal, Binomial and Poisson) relating to thevariable/variables.
- Develop an understanding of basic theory of these computational tools;
- Gain working knowledge of these computational tools and methods.

UNIT- I

Bio Statistical Methods: Sampling methods, the concept of Parametric and non-parametricstatistics

Measures of central tendency and measures of dispersion: Mean, Mode & Median, Meandeviations, coefficient of variance (CV), Standard deviations, skewness and kurtosis.

UNIT- II

Test of hypothesis: Student t-test; chi square test;

Probability distribution (normal, binominal and poison distributions), Simple Correlation andRegression

Analysis of variance: one way and two-way classification

UNIT- III

Biological databases: nucleic acid & protein databases, primary, secondary, functional andcomposite databases,

Data analysis: Data access, retrieval and submission, limitations of existing databases

Global webservers for databases: NCBI, EMBL and DDBJ

UNIT- IV

Sequence alignment: Local alignment, Global alignment, tools for sequence alignments

Scoring matrices: PAM, BLOSUM, Gaps and penalties, Dot plots.

Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and WatermanAlgorithm, Hidden Markov Model

UNIT- V

Genome sequencing and Assembly: Sequencing and analysis of large genomes, gene predictionand functional annotation.

Visualization tools genome comparison, Artemis, VISTA, visualization tools such as PyMol andVMD.

Molecular modelling: different types of protein chain modelling: ab initio, homology, hybrid,loop; Modelling parameters and considerations, Model analysis and validation

BOOKS

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold SpringHarbor, NY: Cold Spring Harbor Laboratory Press.
2. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press
3. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
4. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
5. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the
6. Analysis of Genes and Proteins. New York: Wiley-Interscience.
7. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, andGenomics. Oxford: Oxford University Press.
8. Campbell, M & Heyer, L. J. (2006), Discovering Genomics, Proteomics andBioinformatics, Pearson Education.
9. Oprea, T. (2005). Chemoinformatics in Drug Discovery, Volume 23. Wiley OnlineLibrary.
10. Gasteiger, J. & Engel,T. (2003), Chemoinformatics: a Textbook, Wiley Online Library
11. Biostatistics by Malhan and Arora
12. Introductory Practical Biostatistics by B. N. Misra, and, M. K. Misra
13. Elementary Biostatistics: Satguru Prasad
14. Biostatistics: GBN Chainy
15. Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	5	4	4	5	2	5
CO2	5	2	2	5	2	5	2	4	5	5
CO3	2	4	5	4	2	2	4	2	2	4
CO4	4	4	5	4	4	4	5	4	5	4
CO5	4	5	5	5	5	4	5	5	4	5

BT-204 PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY(4 CREDITS) (I= 20 +10, F= 40)

Course Outcomes

After completion of this course successfully, the students will be able to

- explain the anatomical and physiological understandings of various organs, understand functioning of important physiological systems including cardiovascular, renal, respiratory, nervous and endocrine systems.
- understand the cellular and molecular basis of development, differentiation and embryogenesis in model organisms like Dictyostelium, Drosophila, C. elegans and vertebrates
- explain the sugar transport, translocation processes, light and dark reactions of photosynthesis, nitrate assimilation, and biological nitrogen fixation photorespiration mechanism in plants.
- they will explain the relations between secondary metabolites and plant defense. explain the plant hormones and their roles in plant development and explain the physiological changes that occurred during different stress conditions such as water deficit, salinity, heat, and chilling stresses.
- the students will achieve proper understanding of the molecular, cellular, and morphogenesis-related processes which underlie plant development.

UNIT- I

Cardiovascular System: Heart structure, Pacemaker System, cardiac cycle.

Respiratory system: Transport of gases and Gaseous exchange; Excretory system- Structure and functions of the kidney, Mechanism of Urine Formation.
Nervous System- Action Potentials generation and propagation; Endocrinology and Reproduction- Endocrine glands, basic mechanism of hormone action, hormones and diseases

UNIT- II

Stem cells and potency, Commitment, Specification, Induction, Competence, Determination, Differentiation, Morphogenetic gradients, Cell fate and cell lineages.
Genomic equivalence and the cytoplasmic determinants, Imprinting, Mutants, Transgenics in analysis of development. Production of gametes, Cell surface molecules in sperm-egg recognition in animals, Embryo sac development, Zygote formation, Cleavage, Blastula formation, Gastrulation, Formation of germ layers in animals, Embryogenesis.

UNIT- III

Cell aggregation and differentiation in Dictyostelium, Axes and pattern formation

inDrosophila.
Organogenesis: Vulva formation in Caenorhabditis elegans, Regeneration in vertebrates, Differentiation of neurons.
Post embryonic development: Larval formation, Metamorphosis, Environmental regulation ofnormal development; Sex determination

UNIT- IV

Photosynthesis (Concepts of photosystem, light reaction, dark reaction), Solute transport and photoassimilate translocation, Respiration and photorespiration,
Nitrogen metabolism, Plant hormones, Sensory photobiology
Secondary metabolites and Stress physiology.

UNIT- V

Double fertilization in plants, Establishment of symmetry in plants, Seed formation, Germination, Organization of shoot and root apical meristem, Shoot and root development, Leaf development and phyllotaxy,
Transition to flowering, Floral meristems, Floral development in Arabidopsis, Programmed cell death, aging and senescence in plants

BOOKS

1. Schmidt-Nielsen, Animal Physiology, Cambridge University Press.
2. Christopher D. Moyes and Patricia M. Schulte, Principles of Animal Physiology, PearsonPress.
3. William S. Hoar, General and Comparative Animal Physiology, Prentice Hall, India
4. Animal Physiology, Richard W, Gordon A and Margaret A. Sinauer Associates, USA
5. Gilbert S.F. Developmental Biology, 10th Edition, Sinauer Associates, Inc., PublishersSunderland, Massachusetts, USA.
6. Slack J.M.W. Essential Developmental Biology, Wiley-Blackwell.
7. T. Subramonium (2013) Molecular Developmental Biology.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	5	4	4	5	5	5
CO2	5	2	5	5	4	5	2	5	5	5
CO3	5	4	5	4	2	2	4	4	2	4
CO4	4	2	5	4	4	2	4	4	5	5
CO5	5	5	5	5	5	4	5	4	4	5

BT-205 LABORATORY-III
(GENETIC ENGINEERING ANDBIOINFORMATICS)(4 CREDITS) (I= 10+10, F= 40)

Course outcomes:

After completion of this course successfully, the students will be able to

- to gain hands-on experience in gene cloning, protein expression and purification.describe contents and properties of most important bioinformatics databases;
- perform text- and sequence-based searches and analyze and discuss results in lightofmolecular biological knowledge;
- explain major steps in pairwise and multiple sequence alignment.
- explain principle and execute pairwise sequence alignment by dynamic programming;
- predict secondary and tertiary structures of protein sequences.

1. Plasmid DNA isolation and DNA quantitation.
2. Restriction Enzyme digestion of DNA
3. Vector construction, cloning and transformation of *E.coli.*
4. Confirmation of the insert by Colony PCR.
5. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
6. Similarity searches using tools like BLAST and interpretation of results.
7. Multiple sequence alignment using ClustalW.
8. Phylogenetic analysis of protein and nucleotide sequences using MEGA.
9. Construction and study of protein structures using Deepview/PyMol.
10. Homology modelling of proteins.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	5	4	4	5	5	5
CO2	5	4	5	5	4	5	2	4	5	5
CO3	5	4	2	5	2	4	5	4	2	4
CO4	4	2	5	4	4	2	4	5	5	5
CO5	5	4	5	4	5	4	5	4	5	5

BT-206 LABORATORY-IV (IMMUNOLOGY AND DIAGNOSTICS)(4 CREDITS) (I= 10+10, F= 40)

Course outcomes:

After completion of this course successfully, the students will be able to

- To access knowledge in Immunology and to understand their practical applications.
- To understand the mechanism of immune system.
- This course will help students to understand the immunity, diseases, disorders andother related infections.
- students will be able to apply their immunology knowledge in health and diagnosticareasfor designing novel therapeutics.
- To impart concepts of Tumor immunology and cancer immunotherapy

1. Blood smear identification of leucocytes by Giemsa stain.
2. Separation of leucocytes by dextran method.
3. Demonstration and preparation of antigens, immunization and methods ofbloodcollection, serum separation and storage.
4. Immunoprecipitation
5. Radial Immunodiffusion and double Immunodiffusion
6. Antibody titre by ELISA method
7. Isolation and purification of IgG from serum or IgY from chicken egg.
8. Detection of Rheumatoid arthritis
9. Haemagglutination inhibition assay
10. Detection of human chorionic gonadotrophin (hcg) in urine sample

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	5	4	4	5	5	5
CO2	5	4	4	5	4	5	2	4	5	5
CO3	4	5	2	4	2	4	5	4	2	4
CO4	4	2	5	4	4	4	4	5	5	4
CO5	5	4	5	4	5	4	5	5	5	5

BT-207 SUMMER TRAINING REPORT(3-CREDIT) (F= 50)

Students will undertake summer training or collect material on a special topic and deliver aseminar as part of the course.

THIRD SEMESTER

BT-301 PLANT AND ANIMAL BIOTECHNOLOGY(4 CREDITS)(I= 20+10, F= 40)

Course Outcome:

After completion of this course successfully, the students will be able to

- understand about basic design of a cell culture laboratory and minimum essential requirements, maintenance of cells, tissues and organs along with the scale up process
- explain about various applications of cell culture technology for virus production, therapeutic protein and vaccine production, toxicity testing and disease modelling along withadvanced tools such as stem cells and tissue engineering, lab-on-chip technology, 3D printingand nanobiotechnology
- understand basics and applications of various assisted reproductive technology such as artificial insemination, embryo transfer, in vitro fertilization and transgenic animal technology.
- techniques of establishing cell suspension culture, synthetic seeds and applications. culturing of reproductive structures - anther, microspores, embryos, endosperm, Ovuleand ovary
- cultures and methods to produce haploids.

UNIT-I

Equipment and materials for animal cell culture: Design and layout of culture room, Sterilizationand aseptic techniques; cell culture media and reagents.
Culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuouscell lines, suspension cultures, three-dimensional (3D) Culture.
Characterization of cultured cell, Transformation of cells- Process of Immortalization, Scaling upof cultured cells- Substrate for cell growth.

UNIT- II

Application of animal cell culture for virus isolation and in vitro testing of drugs;

testing of toxicity of environmental pollutants in cell culture.Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins; Hybridoma

technology and production of monoclonal antibodies.

Stem cell culture and its application in regenerative medicine; Tissue engineering for developments of bioartificial organs; Lab-on-achip and 3D Bioprinting Technology for disease modelling and toxicity screening; Nanobiotechnology approaches for disease screening, diagnosis and therapy.

UNIT- III

Animal reproductive biotechnology: cryopreservation of sperms, ova and embryo of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; embryo transfer technology.

Transgenic manipulation of animal embryos; applications of transgenic animal technology. Animal cloning - basic concept, cloning for conservation of endangered species

UNIT- IV

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 - micropropagation; somaclonal variation; androgenesis and its applications; germplasm conservation and Cryopreservation, slow growth and DNA banking for germplasm conservation; synthetic seed production.

UNIT- V

Protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids.

Plant cell cultures for secondary metabolite production. Metabolic Engineering and industrial products.

Plant secondary metabolites, Biosynthesis of Alkaloids, terpenes, phenols and nitrogenous compounds, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway.

BOOKS

1. Culture of animal cells by R. Ian Freshney. (7th Edition)
2. Butler, M. Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Robert Lanza, Robert Langer, Joseph Vacanti, Principles of Tissue Engineering 4th Edition, Academic Press.
4. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
5. Cell and Tissue culture: Laboratory procedures by Doyle and Griffiths.
6. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
7. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols.

Totowa, NJ:Humana Press
8. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
10. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biologyof Plants. Chichester, West Sussex: John Wiley & Sons.
11. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applicationsof Recombinant DNA. Washington, D.C.: ASM Press.
12. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics.Malden, MA: Blackwell Pub.
13. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The GeneticManipulation of Plants. Oxford: Oxford University Press.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	5	5	5	4	4	5	5	5
CO2	5	5	2	4	4	5	2	4	5	5
CO3	4	5	2	4	2	4	5	4	4	4
CO4	4	4	5	4	5	5	2	5	5	4
CO5	5	4	5	4	5	4	5	5	5	4

BT-302 BIOPROCESS ENGINEERING AND INDUSTRIALBIOTECHNOLOGY (4 CREDITS) (I= 20+10, F= 40)

Course Outcomes:

After completion of this course successfully, the students will be able to

- study the design of the bioreactors and the kinetics and dynamics behind the bioprocesstechnology.
- design medium for microbial growth
- state the significance of aeration and agitation for synthesis of bioproducts and modes ofoperation of Fermenter.
- collect the proficient knowledge of translation of lab data to pilot level, they will be able tosolve features involved in the scale up process, process monitoring and control.
- develop the capacity of production processes and control of aerobic and anaerobicsystems

UNIT- I: Microbial Kinetics, Media formulation and Strain improvement

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics;

Media for industrial fermentation, air and media sterilization;

Sources of microbes for industrial use; strain improvement for increased yield and other desirable characteristics.

UNIT- II: Bioreactor Instrumentation, Fermentation and types, Scale Up

Bioreactor design: batch, fed-batch and continuous fermenters; conventional, solid substrate, surface and submerged fermentation;

Specialized bioreactors: pulsed, fluidized and photo- bioreactors, bioreactors using immobilized enzymes; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics;

Upstream processing: media formulation and optimization; aeration,agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.

UNIT- III: Downstream Processing

Separation of insoluble products: filtration, centrifugation, sedimentation, flocculation; Cell disruption;

Separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis;

Final purification: drying, crystallization, storage and packaging.

UNIT- IV: Enzyme in food processing

Mechanism of enzyme function and reactions in food process techniques; enzymatic bioconversions, e.g. starch and sugar conversion processes; high-fructose corn syrup; esterified fat; hydrolyzed protein *etc.*, and their downstream processing;

baking by amylases, deoxygenation and desugaring by glucose oxidase,

beer mashing and chill proofing;cheese making by proteases and various other enzyme catalytic actions in food processing.

UNIT- V: Microbiological fermentation & Fermented products

Fermented foods; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their usage in pickling, producing colours and flavours,

Fermented beverages; alcoholic beverages and other products;Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products;

Bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery.

BOOKS

1. M. L. Shuler and F. Kargi, *Bioprocess Engineering: Basic Concepts*. Prentice Hall,2002.
2. P. F. Stanbury, A. Whitaker, and S. J. Hall, *Principles of Fermentation Technology*.Elsevier, 2013.
3. D. S. Clark and H. W. Blanch, *Biochemical Engineering, Second Edition*. CRC Press,1997.
4. J. Bailey, J. E. Bailey, D. F. Ollis, R. J. Simpson, and D. F. Ollis, *BiochemicalEngineering Fundamentals*. McGraw-Hill, 1986.
5. W. Gerhartz, *Enzymes in Industry: Production and Applications*. VCH, 1990.
6. T. Palmer, *Principles of Enzymology for Technological Applications*. Open universiteit and University of Greenwich [by] Butterworth-Heinemann, 1993.
7. D. Balasubramanian, *Concepts in Biotechnology: Revised Edition*. Universities Press, 2018.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	5	5	5	4	4	5	5	5
CO2	5	5	4	4	4	5	2	4	5	5
CO3	4	5	2	4	2	4	5	4	4	4
CO4	4	4	5	4	5	5	2	5	5	4
CO5	5	5	5	4	5	4	5	5	5	4

BT-303 GENOMICS, PROTEOMICS AND MOLECULAR DIAGNOSTICS

(4 CREDITS) (I= 20+10, F= 40)

Course outcomes:

After completion of this course successfully, the students will be able to:

- define and describe structural, functional and comparative genomics.
- learn detail structure and organization of genes and other DNA elements in agenome.
- describe advanced techniques and methods used for genome analysis, such as DNAmarkers, PCR,microarrays and NGS platforms.
- describe significance of studying global gene expression profile.
- describe advanced techniques and methods used for proteome analysis, such as 2DPAGE, MassSpectrometry and polypeptide sequencing.

UNIT- I

Genetic mapping: **linkage analysis,** Choice of mapping populations, methods and techniquesused for genetic mapping
Physical mapping: cytogenetic maps, FISH, radiation hybrid maps, high resolution physicalmapping;
Genome sequencing: First, Second and third generation DNA sequencing strategies, GenomeSequencing strategies

UNIT- II

Molecular markers – hybridization, PCR and sequence based markers

DNA fingerprinting-principles and applications

Marker-assisted selection: Principles and applications, case studies for introducing genes ofbiotic and abiotic stress resistance using molecular markers in plants

UNIT- III

Polymerase chain reaction: touchdown, hot start, nested, reverse-transcription PCR, colonyPCR, Real-time; Multiplex; DGGE; SSCP;
Global gene expression strategies-1: Northern blotting, Serial Analysis of Gene Expression(SAGE), Massively Parallel Signature Sequencing (MPSS), Microarray
Global gene expression strategies-2: Transcriptome profiling; 16S rRNA typing and metagenome sequencing

UNIT- IV

Proteomics technologies: 2D-PAGE, mass spectrometry, MALDI-TOF, LC-MS

Protein sequencing: N-terminal sequencing- Sanger's method, Edman degradation; C-terminalsequencing, types of carboxy peptidases
Peptide mapping: cleavage points of different proteolytic enzymes.

UNIT- V

Metabolomics: Metabolome, Metabolite profiling, Metabolome fingerprinting, Role of

Biomarker in metabolomics, metabonomics

Tools of metabolome studies: NMR, MS, GC, LC, IR and its application, Metabolic engineeringof industrially important products;

Control mechanisms and manipulation of pathways: shikimate pathway, phenyl alaninepathway, alkaloids, and industrial enzymes

BOOKS

1. Analysis of Genes and Genome. R J Reese. Wiley Publications.
2. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch. Cshl Press.
3. Molecular biology of the gene by J.D. Watson, T.'A. Baker, S.P. Bell, A. Gann, M. Levineand R. Losick. Pearson Publication.
4. Bioinformatics and Functional Genomics- J Pevsner. Wiley Blackwell Publications.
5. Principles of Gene Manipulation and Genomics, Primerose SB. Malden, MA: BlackwellPub.
6. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa,NJ: Humana Press.
7. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, andBioinformatics. San Francisco: Benjamin Cummings.
8. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw-Hill.
9. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principlesand Applications of Recombinant DNA. Washington, DC: ASM Press.
10. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the ClinicalLaboratorian. Totowa, NJ: Humana Pres

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	5	5	5	4	4	5	5	4
CO2	5	4	2	4	4	5	5	4	5	5
CO3	5	5	2	4	2	4	5	4	4	4
CO4	4	2	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	5	5	4

BT-304 IPR, BIOSAFETY AND BIOENTREPRENEURSHIP(4 CREDITS) (I= 20+10, F= 40)

Course Outcomes

After completion of this course successfully, the students will be able to

- learn about different intellectual property rights (IPRs) and their different kinds
- understand the process of patent filing
- aware about the patenting of materials of biological origin
- acquire knowledge of ethical practices appropriate to biotechnology research
- know about different international regulations associated with risk assessment andbiosafety.

UNIT-I

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications

Basics of patents: types of patents; Indian Patent Act 1970; Patent Cooperation Treaty (PCT); filing of a patent application; role of a Country Patent Office; precautions before patenting- disclosure/non-disclosure, types of patent applications: provisional and complete specifications. **Protection of new GMOs**; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; plant variety protection and farmers rights;

UNIT- II

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms; definition of GMOs & LMOs

Risk – Environmental risk assessment, risk assessment of transgenic crops.

International regulations – Cartagena protocol, Indian regulations – EPA act and rules, regulatory framework – RCGM, GEAC; Draft bill of Biotechnology Regulatory authority of India.

UNIT- III

Bio-entrepreneurship: Types of bio-industries and competitive dynamics between the sub- industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech).

Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation andentrepreneurship in bio-sectors

Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India),

UNIT- IV

Biomarketing strategies: Negotiating the road from lab to the market, Pricing strategy,
Challenges in marketing in bio business (market conditions & segments; developingdistribution channels, the nature, analysis and management of customer needs).
Basic contract principles: different types of agreement and contract terms typically found injoint venture and development agreements.

UNIT- V

Finance & Accounting: Business plan preparation including statutory and legal requirements,financial management issues of procurement of capital and management of costs.
Technology Management: Technology – assessment, development & upgradation, Managingtechnology transfer, Quality control & transfer of foreign technologies,
Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA,GMP).

BOOKS

1. M. L. Shuler and F. Kargi, *Bioprocess Engineering: Basic Concepts*. Prentice Hall, 2002.
2. P. F. Stanbury, A. Whitaker, and S. J. Hall, *Principles of Fermentation Technology*.Elsevier, 2013.
3. D. S. Clark and H. W. Blanch, *Biochemical Engineering, Second Edition.* CRC Press,1997.
4. J. Bailey, J. E. Bailey, D. F. Ollis, R. J. Simpson, and D. F. Ollis, *BiochemicalEngineering Fundamentals*. McGraw-Hill, 1986.
5. W. Gerhartz, *Enzymes in Industry: Production and Applications*. VCH, 1990.
6. T. Palmer, *Principles of Enzymology for Technological Applications*. Openuniversiteit and University of Greenwich [by] Butterworth-Heinemann, 1993.
7. D. Balasubramanian, *Concepts in Biotechnology: Revised Edition*. Universities Press,2018.
8. S. and Nancy F. Millis Aiba, *Biochemical Engineering [By] Shuichi Aiba, Arthur E.Humphrey [and] Nancy F. Millos*. Academic Press, 1965.
9. A. T. Jackson, *Process Engineering in Biotechnology*. Open University Press, 1990.
10. E. M. T. El-Mansi, J. Nielsen, D. Mousdale, and R. P. Carlson, *FermentationMicrobiology and Biotechnology, Fourth Edition*. CRC Press, 2018.
11. G. Reed, *Prescott and Dunn's Industrial Microbiology*. CBS Publisher, 1987.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	5	4	4	5	5	4
CO2	5	4	2	5	4	5	4	4	5	5
CO3	4	4	2	4	2	2	5	4	5	4
CO4	4	2	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	5	5	2

BT-305 RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATIONS SKILL
(4 CREDITS) (I= 20+10, F= 40)

Course Outcome:

After completion of this course successfully, the students will be able to

- understand about selection of biotechnological research problem and the stages involved inexecuting research.
- students should be able to understand various presentation skills and scientific communication skills.
- understand various technical writing skills, drafting of report and publication skills.learn toperform database search and computing skills for fine tuning the research outputs.
- learn about plagiarism and ethics involved in scientific publications, peer-review process.

UNIT-I

Empirical science; scientific method; manipulative experiments and controls; deductive andinductive reasoning.
Choosing a mentor, lab and research question; maintaining a lab notebook.Selection of problems - stages in the execution of research.

UNIT- II

Concept of effective communication- setting clear goals for communication; determiningoutcomes and results
Barriers to effective communication.

Non-verbal communication-importance of body language, power of effective listening.

UNIT- III

Presentation skills – formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation. scientific poster preparation & presentation.Computing skills for scientific research - web browsing for information search

Search engines and their mechanism of searching; effective email strategy using the right toneand conciseness

UNIT-IV

Technical writing skills - types of reports; layout of a formal report; standard of Journal (ImpactFactor, Citation Index).
Scientific writing skills - importance of communicating science; problems while writing ascientific document; plagiarism, software for plagiarism.

UNIT- V

Scientific publication writing: elements of a scientific paper including abstract, introduction,materials & methods, results, discussion, references.
Publishing scientific papers - peer review process and problems, recent developments such asopen access and non-blind review.
Ethical issues in scientific presentations and scientific misconduct.

BOOKS

1. Research Methodology- Methods and Techniques, C R Kothari, New Age InternationalPublishers
2. Designing and conducting health system research projects-Data analysis and Reportwriting,C M Varkevisser, I Pathmanathan, A Brownlee, KIT Publishers
3. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of ScientificResearch. Oxford: Oxford University Press.
4. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington,D.C.: National Academies Press.
5. Gopen, G. D., & Smith, J. A. The Science of Scientifc Writing. American Scientist, 78(Nov-Dec 1990), 550-558.
6. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
7. Movie: Naturally Obsessed, The Making of a Scientist.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	5	4	4	5	5	4
CO2	5	4	2	5	4	5	4	4	5	5
CO3	4	4	2	4	2	2	5	4	5	4
CO4	4	2	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	5	5	2

BT-306 LABORATORY-V (ANIMAL & PLANT BIOTECH. AND GENOMICS)

(4 CREDITS) (I= 10+10, F= 40)

Course outcomes:

After completion of this course successfully, the students will be able to

- gain basic skills in plant and animal biotechnology.
- acquire knowledge and understanding of fundamentals of genomics and proteomics.
- aware of recent technologies related to animal cell culture, media preparation andmaintenance.
- learn the techniques of micropropagation, subculturing and artificial seed formation.
- gain basic information related to DNA isolation, gel electrophoresis and sequencing.

List of practicals:

1. Prepare culture media with various supplements for plant tissue culture.
2. Prepare explants for inoculation under aseptic conditions.
3. Prepare artificial seeds.
4. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion byPEG
5. Extraction of plant secondary metabolites.
6. Prepare culture media with various supplements for animal tissue culture.
7. Primary culture of animal cell**:** Aseptic techniques, single cell suspension preparationfrom spleen/thymus (Mechanical/enzymatic method)
8. Count cells of an animal tissue and check their viability
9. Chromosome preparations from cultured animal cells
10. Polymerase chain reaction & its applications in DNA amplification

11. Study genetic fingerprinting profiles of plants and calculate polymorphic information content.
12. Create genetic maps for determining the location of gene(s)
13. Molecular characterization of predicted genes- *in silico* translation, calculation of Mw/pI; hydropathy analysis; characterization of intron-exons; functional annotation of genes.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	5	4	4	5	5	4
CO2	5	5	2	5	4	4	4	4	5	5
CO3	4	4	2	4	2	2	5	4	5	4
CO4	5	4	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	5	4	2

BT-307 LABORATORY-VI (BIOPROCESS ENGG, AND TECHNOLOGY)
(4 CREDITS) (I= 10+10, F= 40)

Course Outcomes:

After completion of this course successfully, the students will be able to

- To study the design of the bioreactors and the kinetics and dynamics behind thebioprocess technology.
- Design medium for microbial growth
- State the significance of aeration and agitation for synthesis of bioproducts andmodes ofoperation of Fermenter.
- Collect the proficient knowledge of translation of lab data to pilot level, they will
- be able to solve features involved in the scale up process, process monitoring and control.
- Develop the capacity of production processes and control of aerobic and anaerobicsystems

1. Basic Microbiology techniques

a) Scale up from frozen vial to agar plate to shake flask culture.

b) Instrumentation: Microplate reader, spectrophotometer, microscopy.

c) Isolation of microorganisms from soil samples.

2. Experimental set-up

a) Assembly of bioreactor and sterilization.

b) Growth kinetics.

c) Substrate and product inhibitions.

d) Measurement of residual substrates.

3. Data Analysis

a) Introduction to Metabolic Flux Analysis (MFA).

4. Fermentation

a) Batch.

b) Fed-batch.

c) Continuous.

5. Unit operations

a) Microfiltrations: Separation of cells from broth.

b) Bio-separations: Various chromatographic techniques and extractions.

6. Bio-analytics

a) Demonstration of HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	5	4	4	5	5	4
CO2	5	4	4	5	4	5	4	4	5	5
CO3	5	2	2	4	2	4	5	4	5	4
CO4	4	2	5	4	4	5	4	5	2	4
CO5	5	4	5	4	5	4	2	5	5	4

BT-308 SEMINAR-I

(1 CREDIT) (I= 10 marks)

Students will deliver a seminar on a topic of choice preferably but not necessarily in the area where they wish to pursue their final dissertations and the same will be evaluated by a panel of teachers

FOURTH SEMESTER

BT-401 ELECTIVE-I [ENVIRONMENTAL BIOTECHNOLOGY/ NANOBIOTECHNOLOGY]

(4 CREDITS) (I= 20+10, F=40)

ENVIRONMENTAL BIOTECHNOLOGY

Course Outcomes:

After completion of this course successfully, the students will be able to

- explain technologies, tools and techniques in the field of environmental biotechnology by recognizing the various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity and
- investigate some examples of different types of environmental pollution and their impacts
- aware on emerging concerns such as climate change, waste management or reductions infossil fuels, and new technologies for addressing these.
- understand the role of microorganisms as biotechnological agents for combating variousenvironmental pollution and management of biotic and abiotic stress.
- exploring environmental resources for new technologies

UNIT-I

Introduction to the environment; pollution and its control; Bioindicators of pollutionWaste management: solid and hazardous waste management.
Concept of biodiversity and its conservation

UNIT-II

Microbial biodegradation of lignin and cellulose.

Bioremediation- Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) technological aspects of bioremediation (in situ, ex situ).
Bioremediation of metal (Cr), organic pollutants (PAHs, PCBs,

UNIT-III

Phytoremediation: Fundamentals and description of major methods of application(phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization).
Phyto-mining -concept and mechanismSWOT Analysis of Phytoremediation **UNIT-IV**

Biopesticides: Bioinsecticides-Bacillus thuringiensis, Baculoviruses, uses, aspects of safety intheir use
Biofertilizers: Symbiotic systems between plants–microorganisms (nitrogen fixing symbiosis,mycorrhiza fungi symbiosis)
Plant growth promoting rhizobacteria (PGPR) – uses and practical aspects.

UNIT-V

Biofuels- biogas; bioethanol; biodiesel; biohydrogen

Bioleaching of metals- concept, mechanismProduction of bioplastics; biosurfactants.

BOOKS

1. Environmental biology and toxicology- P.D. Sharma – Rastogi Publisher

2. Environmental Biotechnology- P.K. Mohapatra -IK. International publishers-2nd edition

3. Environmental Biotechnology- Alan Scragg- 2nd Edition-Oxford University Press.

4. Environmental biotechnology- concept and applications. Hans Joachim Jordening, JosefWinter. Wiley VCH publishers.

5. Environmental Biotechnology: Theory and Application. Gareth M. Evans, Judith C. Furlong.Wiley publishers.

6. Environmental Biotechnology: Principles and Application. Bruce E. Rittmann, Perry L.McCarty

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	5	4	4	5	5	4
CO2	5	4	2	5	4	5	4	4	5	5
CO3	4	4	5	4	2	2	5	4	5	5
CO4	4	2	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	5	5	2

NANOBIOTECHNOLOGY

Course Outcomes:

At the end of the course, the students should be able to

- Understand about basics of nanobiotechnology with specific nanostructures
- Explain about nanoparticles structures, types and various applications in drug delivery,diagnostics, imaging (theranostics) and as biosensors
- Understand basics and applications of nanofibers and their process of synthesis throughelectrospinning, carbon nanotubes and various nanomaterials characterization techniques
- Explain the safety of nanomaterials, nanotoxicity and various assays for assessment,ecotoxicity and various biomedical applications

- Understand nanostructures in biological materials and their application in tissue engineering and regenerative medicine

UNIT I

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications.

Cellular Nanostructures, Nanopores, Biomolecular motors, Bio-inspired Nanostructures-Synthesis and characterization of different nanomaterials.

Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles, Nanospheres, Nanocapsulesand their characterization.

UNIT II

Nanoparticles - quantum dots, metal nanoparticles, magnetic nanoparticles, conjugation, fabrication, advantages and issues.

Nanoparticles for drug delivery, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

UNIT III

Nanofibers – electrospun fibers, self-assemble fibers, conjugation, fabrication, advantages and issues.

Nano materials fabrication – top down and bottom up approaches. Carbon nanotubes, Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in synthesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Nanomaterial characterization for biological applications – ATR FTIR, XPS, Time of flight SIMS, Colorimetric methods, CD spectroscopy, AFM

UNIT IV

Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for

Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment, Ecotoxicity-models and assays.

Nanoporous materials – phase separation, hydrogels.

Biomedical Applications – drug delivery, tissue regeneration, cancer detection, imaging and diagnostics, outlook for future.

UNIT V

Nanostructures in biological materials – Introduction, Mechanics of bulk nanostructures ofbone like materials.
Rationale for nanomaterial – tissue interactions.

Nanomaterials for Tissue Engineering and Regenerative Medicine-Bone, Cartilage, liver,vascular, bladder and neural applications.

BOOKS

1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Tin Films: Sequential Assembly ofNanocomposite Materials, Wiley-VCH Verlag GmbH & Co.
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley
3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
5. R. H. J. Hannink and A. J. Hill "Nanostructure control of materials", Woodhead
6. Publicating Limited, CRC Press 2006.
7. C.N.R. Rao, A.Muller, A.K. Chutham. Vol 1 & Vol 2: The Chemistry of Nanoparticles(Synthesis, Properties and Applications) –WILEY-VCH
8. Challa Kumar Nanomaterials for Medical Diagnosis and Therapy – Vol 10,WILEY-VCH, 2007
9. William A. Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J. Iafrate: Handbook of Nanoscience, Engineering, and Technology, CRC Press Taylor and Francis Group, 2007
10. Bhushan:Springer Handbook of Nanotechnology –Springer,2007

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	5	4	4	5	5	4
CO2	4	4	2	5	4	5	2	4	4	5
CO3	4	4	5	4	2	2	5	4	4	5
CO4	2	2	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	5	5	2

BT-402 DISSERTATION
(10 CREDITS) (F- 450)

Students will undergo dissertation in a topic of choice under the supervision of the faculty members of the dept. and/or in co-supervision of Professors/scientists from other research academic/research institutes towards partial fulfillment of the award of the M.Sc degree.

BT-403 PROJECT PROPOSAL PREPARATION AND PRESENTATION
(3 CREDITS) (F- 50)

Students will undergo dissertation in a topic of choice and will submit a project report and makea presentation as part of the project undertaken towards partial fulfilment of the award ofthe M. Sc degree.

AC-401: Women and Society (3 CREDITS) (I=10+10, F- 30)

Course Outcomes

After completion of Course students will be able to:

- Familiarize with the women lead environmental movements and women'sparticipation in theclimate resilience natural resources management.
- Acquire knowledge on the differential impact of climate change disasters.
- Be familiar with the role of technology and how has ICT brought about a changein onwomen's everyday lives and livelihoods.
- It will enhance students' critical thinking in the use and management of technologyindifferent productive sectors across different category of women.
- Gain an insight into the women and law from rights and equality of opportunity intheaccess to justice as well as the nuances involved in it.

Unit - I: Women and Environment

Concept of carbon footprint, GHE & Climate Change: Eco-feminism perspective
Reclaiming women's environmental rights – Neem patent victory, living democracy andCHIPKO Movement; Narmada *Bachao Aandolan*
India's Environmental Policies and International Conferences on Environment: Focus onAgenda 21 of Rio Conference, COP 21 and 23; Joint Forest Management Act.
Case studies on the gendered differential impact of disaster risks and vulnerability: 1999

Super Cyclone in Odisha, Tsunami in Tamil Nadu and Bhopal gas Tragedy

Women responsive initiatives by the National disaster management plan (NDMP), ODM, pollution control board, waste managements and recycling technology

Unit II: Women and Technology

The Changing Face of Technology: Status of women

Concept of Alternative Technology Strategies for positive social changes

Impact, Programs and policy measures at International, National and State Levels on thetechnology transformation in India
Women in the production and service technologies: Case study of agricultural mechanization, health, education, media, ICT, bio-technology and digital innovation Women professionals and entrepreneurs in Technology: Job opportunities, constraints andchallenges

Unit -III: Women and Law

Human rights as women's rights: International Conventions and Legislations; Constitutional Guarantee of Equality and Uniform Civil Code

Civil Laws: Personal Laws; Family Court Act 1984, NCW; the Protection of Womenfrom Domestic Violence Act 2005; Sexual Harassment of Women at Workplace Act2013; Dowry Prohibition Act 1961; the Prohibition of Child Marriage Act 2006 **Criminal Laws:** Indian Penal Code (IPC) & Code of Criminal Procedure (CRPC);Protection of Children from Sexual Offences Act (POCSO) and JJ Act; Witch Huntingand SC and ST Prevention of Atrocities Act 1989; Trafficking (ITPA)
Labour Laws: Minimum Wages Act, 1948; Equal remuneration Act, 1976; Maternitybenefit act, 2017; The Factories act, 1948; Laws for women with disabilities
Media Laws: Law of Obscenity, Section 292-293, IPC; Indecent Representation ofWomen (Prohibition) Act, 1986; Law of Defamation, Section 499-502 of IPC

Reference

Women and Environment

1. Agarwal, B. (1992). The gender and environment debate: lessons from India. Feministstudies, 18(1), 119-158.
2. Elaine Enarson and PG Dhar Chakrabarti, 2009, Women, Gender and Disaster edited bySage Publications, India.
3. Guha, Ramachandra., How Much Should a Person Consume? Thinking through theEnvironment, Permanent Black, New Delhi, 2006.

4. Krishna, Sumi., Genderscapes, Revisioning Natural Resource Management, Zubaan, NewDelhi, 2009.
5. Parveen, Uzma., Women and Environmental Management, Women Press, New Delhi,2009.
6. Vandana Shiva**.** (2005). Globalization's New Wars: Seed, Water and Lifeforms. WomenUnlimited, New Delhi.

Women and Technology

1. Vivek Wadhwa and Farai Chideya. 2014. Innovating Women: The Changing Face ofTechnology "Where are all the women?". Diversion Books, ISBN-10 : 1626814228
2. Cara Alwill Leyba. 2015. Girl Code: Unlocking the Secrets to Success, Sanity, andHappiness for the Female Entrepreneur. Penguin Group
3. Dava Sobel, 2017. The Glass Universe: How the Ladies of the Harvard ObservatoryTook Measure of the Stars. A New York Times Book Review
4. Sara Wachter. 2017. Technically Wrong – Sexist Apps, Biased Algorithms, and Other Threats of Toxic Tech: Why Digital Products Are Designed to Fail You. ISBN. 978- 0393634631
5. Chakravarti, Uma (2000) State, Market and Freedom of Expression: Women and Electronic Media. Economic and Political Weekly Vol. 35, No. 18, Apr. 29 - May 5, pp. WS12-WS17

Women and Law

1. Rao, Mamta. 2018. Law relating to Women & Children. EBS Explorer. Edition: 4thEdition 2018, Reprinted 2022
2. Flavia Agnes, Sudhir Chandra & Monmayee Basu (Eds.) 2016). Women and Law in India.Oxford University Press. ISBN:9780199467211; 780 pages
3. Bindra Anju. 2009. Women and Human Rights. New Delhi: Manglam Publishers.
4. Karna, G.N. (2000), Disability Rights Movement: Conceptual Framework and itsImplications for India, Disabilities and Impairments, Vol. 14, NO.1.
5. Mapp Susan C. 2008. *Human Rights and social Justice in a Global Perspective*. NewYork: Oxford University Press.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	5	4	5	5	4	4	5	5	4
CO2	4	4	2	4	4	5	2	4	4	5
CO3	4	4	5	4	2	2	5	4	4	5
CO4	2	2	5	4	4	5	2	5	2	4
CO5	5	4	5	4	5	4	5	4	5	2

Skill based certificate course on

MOLECULAR TECHNIQUES FOR INTEGRATIVE RESEARCH

1. Name of Department offering SBCC: Dept. of Biotechnology, RDWU
2. Title of SBCC : Molecular Techniques For Integrative Research
3. SBCC Code : BT/SBC/MTIR
4. Semester for offering : 2nd or 3rd.
5. Applicable to Class : PG Only
6. Duration : 42 Hours (Theory-20 hours; Practice-20 hours)
7. Time : 09:00 AM- 10:00 AM/ 4:00 PM-5:00 PM
8. Weekdays : variable

SYLLABUS STRUCTURE

Course code: BT/SBC/MTIR

Course title: MOLECULAR TECHNIQUES FOR INTEGRATIVE RESEARCH

Credits: 03	Full marks: 50	Total hours: 42

Course description:

The course is designed to help master level students from different domains (botany/zoology/biotechnology/genomics/physics/chemistry) to learn about different types of molecular techniques as required for Trans-disciplinary research. This course will make the students familiar with the techniques employed in molecular biology, experiments involved using different techniques and the use of instruments in these techniques.

Course Outcomes

- The objective of the course is to provide a theoretical and practical introductionintovariousmolecular techniques.
- Students will be trained in working with molecular laboratory equipment andbiologicalsolutions formolecular research.
- Students will be emphasized on planning, presentation and critical evaluation oflaboratoryresults.
- Students can independently handle basic molecular equipment.
- They can used web-based data resources for bio molecular analyses

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	4	5	2	4	4	5	5	4
CO2	4	4	5	5	5	4	5	4	2	2
CO3	4	5	4	4	2	5	5	5	5	2
CO4	5	5	4	5	5	2	4	4	4	4
CO5	2	5	5	5	4	5	5	4	5	5

MODULE 1:

Bioanalytics- Chromatographic & Spectroscopic techniques (3 hours)
Practical demonstration on chromatography and UV-Vis spectroscopy (3 hours)

Microscopic techniques- SEM, TEM, AFM & Confocal microscopy (3 hours)Practical demonstration on phase-contrast & inverted microscopy (3 hours)

MODULE 2:

Biochemical techniques: Biomolecules estimation methods, protein purification assays,protein sequencing (3 hours)
Practical demonstration on protein estimation & purification (3 hours)

Immunological Techniques: Immunoelectrophoresis, Immunodiffusion, Double Diffusion,Western blotting (3 Hours)
Practical demonstration on Elisa & Immuno-blotting system (3 Hours)

Nano Techniques: Nanoparticles as biosensors, nanomedicine in therapeutics,

nanomaterialsfor tissue engineering (3 Hours)
Practical demonstration on preparation of nanoparticles (3 hours)

MODULE 3:

Recombinant-DNA Techniques: Isolation of DNA & RNA, Electrophoresis & PCR, genecloning, bacterial transformation (3 hours)
Practical demonstration on isolation of DNA/RNA, PCR and gene cloning (3 Hours)

Bioinformatics: DNA Sequencing, tools for DNA sequence assembly, gene prediction and functional annotation (3 Hours)
Practical demonstration on application of tools for identification, characterization andfunctional annotation of gene(s) & proteins (3 Hours)