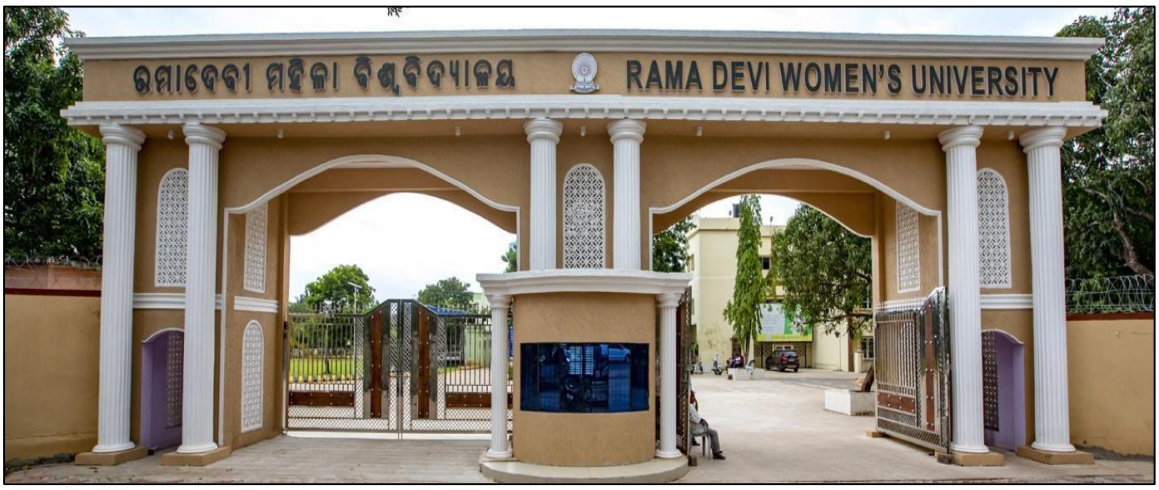
DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS OF UG PROGRAMME (B.Sc.)



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

PROFESSIONAL ETHICS	GENDER	HUMAN VALUES	ENVIORNMENT & SUSTAINABILITY

DEPARTMENT OF BIOTECHNOLOGY
SYLLABUS OF UG PROGRAMME (B.SC)

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

UG Biotechnology

Programme outcomes:

PO1: Grasp of fundamental and advanced knowledge and skill on various domains ofbiotechnology.

PO 2: Students develop pinter-disciplinary learning habit with integrated technologies.

PO3: Enhancing the subject knowledge of students by using traditional and modern aspects of plant of animal biotechnology.

PO3: To train students on different branches of Biotechnology such as genetics, molecular biology, biochemistry, immunology, fermentation technology, environmental biotechnology and tissue culture techniques and their applications for human welfare.

PO4: To groom the students to meet futuristic challenges and national interests.

PO5: To foster students ability in designing and conducting experiments with analysis and interpretation of scientific data.

PO6: To acquaint the students with the surrounding environment and relate the relevant biotechnological aspects.

PO7: Develop social responsibilities towards emerging environment related issues and challenges.PO8: Gain entrepreneurship skills towards establishing innovative start ups.

PO9: Adopt code of ethics in professional and social context and demonstrate professional, ethical and legalbehaviors in decision making.

PO10: Develop written and oral communication skills to communicate effectively in industry,academia and research.

Programme specific outcomes:

PSO1: To confer the students with all the research aptitude and skills required to work independentlyPSO2: To empowerstudents about scientific temperament and social responsibilities.

PSO3: To aware students regarding present environment challenges by imparting knowledge of advancemodern techniques.

PSO4: Empower the students to acquire interdisciplinary knowledge by connecting various aspectsof biotechnology.

PSO5: Acquire knowledge in students of biotechnology enabling their applications in industry andresearch.

BIOTECHNOLOGY

STRUCTURE of CBCS Syllabus for BIOTECHNOLOGY (Honours) from 2019-20Semester – I

No	Name of theCourse	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C1: Microbiology	6	60	100
2	GE-A	GE 1A: Paper 1 from either subjects [Zoology / Botany / Chemistry]	6	60	100
3	CCC-I	C2 : Plant Diversity & Physiology	4	40	100
4	Core	Biomolecules & Cell Science	6	60	100
Total Paper		4	22	220	400

Semester – II

Sl No	Name of theCourse	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C3: Cell Biology and Genetics	6	60	100
2	Core	C4: Animal Diversity & Physiology	6	60	100
3	GE-B	GE 2B: Paper from remaining 02 subjects other than that opted in first semester [Zoology / Botany / Chemistry]	6	60	100
4	AECC - II	MIL Communication (Odia/ AltEnglish)	4	40	100
Total Paper		4	22	220	400

Semester – III

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C5: Molecular Biology	6	60	100
2	Core	C6: Biochemistry and Metabolism	6	60	100
3	Core	C7: Biostatistics and ComputerApplications	6	60	100
4	GE-A	GE 3A: Paper II of the subject opted infirst semester [Zoology / Botany /Chemistry]	6	60	100
5	SEC - 1	SEC–1: Communicative English	4	40	100
Total Paper		5	28	280	500

Semester – IV

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C8: Immunology	6	60	100
2	Core	C9: Plant Biotechnology	6	60	100
3	Core	C10: Animal Biotechnology	6	60	100
4	GE-B	GE 4B, Paper II of the subject opted in second semester Zoology / Botany /Chemistry	6	60	100
5	SEC – 2	SEC–2: Enzymology / Basics of Forensic Science / Mushroom culture/Sericulture	4	40	100
Total Paper		5	28	280	500

Semester – V

Sl No	Name of the Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C 11: Genetic Engineering	6	60	100
2	Core	C 12: Genomics and Proteomics	6	60	100
3	DSE 1	DSE 1: Biotechniques	6	60	100
4	DSE 2	DSE 2: Bioinformatics	6	60	100
Total Paper		4	24	240	400

Semester – VI

Sl No	Name ofthe Course	Paper	CP (Credit Point)	CH (Credit Hour)	Marks
1	Core	C 13: Bioethics and Biosafety	6	60	100
2	Core	C 14: Bioprocess Engineering andTechnology	6	60	100

3	DSE 3	DSE 3: Bioenterpreurship	6	60	100
4	DSE 4	DSE 4: Medical Microbiology (to be opted by students securing below 60%) /Project Report & Seminar* *- for students securing ≥ 60%	6	NA	100
Total Paper		4	24	180	400
Grand Total		26	148	1480	2600

(Project 80 + 20 Viva)

***** *AECC – Ability Enhancement Compulsory Course * SEC – Skill Enhancement Course * DSE – Discipline Specific Elective * GE – Generic Elective*

*Hons students has to opt two Generic Elective Subjects. *SubjectsA& B (containing 2 Papers) from subjects available other than Core (Hons.) Subject. Subject - **A** for Semester 1 & 3 another subject **B** for Semester 2 & 4.

*** GE – Generic Elective [To be opted by +3, Biotechnology (Hons.)]**

Two subjects among three subjects viz., Zoology / Botany / Chemistry to be chosen (02papers/ Subject i.e. Total 04 papers/ 02 subjects) other than Core as **Generic Elective**.

Subject	**Generic Elective Papers**	
	GE Paper-I	**GE Paper-II**
Zoology	Animal Diversity (Non-Chordate),Physiology and Endocrinology	Animal Diversity (Protochordata and Chordata), Developmental Biology andImmunology
Botany	Industrial and Environmental Microbiology	Botany and Plant Biotechnology
Chemistry	Atomic Structure Bonding, General Organic Chemistry & AliphaticHydrocarbons	Chemical Energetic & Equilibria andFunctional Organic Chemistry
Any two subjects among three subjects and each Subject contains two papers (**Subject-A with two papers** at Semester I & III [GE-1A & GE-3A] and another **Subject B with twopapers** for Semester II & IV [GE-2B & GE-4B] is to be opted.		

*** GE – Generic Elective [To be opted by +3, Science (Hons.) other than Biotechnology]**

Subject	**Generic Elective Papers**	
	Paper-I	**Paper-II**
Biotechnology	Biochemistry and Molecular Biology	Recombinant DNA Technology
	Paper-III	**Paper-IV**
	Environmental Biotechnology andBioethics	Bioprocess Technology &Enterpreneurship

BIOTECHNOLOGY Papers for HONOURS Students

Core course – 14 papers, Discipline Specific Elective – 4 papers

Generic Elective for Non Biotechnology students – 4 papers. Incase University offers 2subjects as GE, then papers 1 and 2 will be the GE paper.

Marks per paper - Midterm: 15 marks, Practical: 25 marks, End term: 60 marks, Total: 100marks, Credit per paper – 6: Theory-4, Practical-2, Teaching hours per paper – 40 hours theory classes+ 20 hours practical classes

C 1: MICROBIOLOGY

Course outcome:

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

- Apply fundamental principles governing classification schemes to categorize microorganisms.
- Explain the concepts of microbial diversity, taxonomy, and systematics and methods employed forreplication, adaptations, and interaction with the host and environment.
- Describe the morphology, mechanism of infection and multiplication, and therapy of viruses that aresignificant to medicine.

- Describe the use of various substances to control microbial growth and show practical competency inthe use of tools and techniques for the isolation and identification of microorganisms.
- Apply the knowledge of environmental bacteria in sewage treatment and water quality control.

Unit-I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms:Microbial taxonomy, criteria used, including molecular approaches, Microbial phylogeny, Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells,Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi,Protozoa, Archea (Halophyles, Methanogens, Thermophyles), Virus (structure of viruses,Bacterial, plant, animal and tumor viruses, DNA- and RNA- viruses.

Unit-II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Unit-III

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Nutritional Classification of Microorganisms.

Unit-IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents, Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: molds, Yeasts, bacteria.

Practical:

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining,hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria fromdifferent sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Text Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw HillBookCompany.
2. Prescott/Harley/Klein's Microbiology, by Joanne Willey (Author), Linda Sherwood(Author), Chris Woolverton (Author), McGraw Hill Education; 7 edition

Suggested Readings

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4thedition.John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition,CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms.12thedition. Pearson/Benjamin Cummings.
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology.5thedition. McMillan.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

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

C 2: PLANT DIVERSITY AND PLANT PHYSIOLOGY

Course outcome:

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

- To develop an understanding of classification, diversity and identification, and classification andexplore the economic importance of lower groups of plants
- To explain fossils and fossilization and geological time scale for evolution of life forms in the earth.
- Comprehend various physiological processes and their underlying mechanism in plants
- To relate photosynthesis with the formation of primary and secondary metabolites,
- To understand the phenomenon of mechanism and breaking of dormancy, role of plant growth hormones, micro and macronutrients water relations, nitrogen fixation and flowering mechanism in plants.

Unit-I

Algae: General character, classification& economic importance. Fungi: General characters, classification& economic importance.
Lichens: Classification, general structure, reproduction and economic importance.

Bryophytes: General characters, classification& economic importance.

Unit-II

General characters of pteridophytes, affinities with bryophytes & gymnosperms,classification, economic importance.
Gymnosperms:General characters, classification, geological time scale, theories of fossilformation, types of fossils
Life histories of Cycas & Pinus, economic importance of gymnosperms.

Unit-III

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis,imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of foodtransport
Growth and development: Definitions, phases of growth, growth curve, growth hormones(auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Unit-IV

Physiological role and mode of action, seed dormancy and seed germination, concept ofphotoperiodism and vernalization.
Photosynthesis- Photosynthesis pigments, concept of two photo systems,

photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Practical:

Comparative study of thallus and reproductive organs of various algae mentioned intheory.

1. Separation of photosynthetic pigments by paper chromatography.
2. Study of various types of lichens.
3. Demonstration of aerobic respiration.
4. Preparation of root nodules from a leguminous plant.
5. Demonstration of plasmolysis by *Tradescantia* leaf peel.

Text Books:

1. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA,USA
2. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms andPaleobotany. IK, International Publishers.

Suggested Reading:

1. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
2. Van den Hoek, C.; Mann, D.J. &Jahns, H.M. 1995. Algae: An introduction to Phycology.Cambridge Univ. Press.
3. A Test Book of Plant Physiology, Biochemistry & Biotechnology, Author: Verma &Verma, Pub: S. Chand
4. Plant Physiology, Author: Salisbury & Ross, Pub: WADSWORTH C engage learning
5. Unified Botany, Author: Agrawal S.B, Pub: Shivlal Agrawal A Textbook of Botany bySingh, Pande, Jain.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C-3: CELL BIOLOGY & GENETICS

Course outcome:

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

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles gain a thorough understanding of the chemistry behind heredity genetic transmission and the interactions between genes and environment, the work contributes to showing the importance of genetics.
- Evaluate and apply knowledge of modern techniques in cellular biology.
- Learn about the molecular causes of genetic abnormalities and diseases.
- To educate society about diverse genetic problems, their inheritance patterns, and the development of strategies and procedures for battling diseases.
- Understanding the mechanism of sex determination and the role of environmental conditions in different organisms.

Unit-I:

Cell: Introduction and structural organization of prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells, cell fractionation. Cell membrane and Permeability:Chemical components of biological membranes and its organization, Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure & function, Golgi complex: Structure, biogenesis and function

Unit-II:

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membranes receptors for extra cellular matrix, macromolecules, regulation of receptors expression and function. Signal transduction

Structure and functions; Lysosomes, Vacuoles and micro bodies, Ribosomes, Mitochondria, Chloroplasts, Nucleus: Chromosomes and their structure.

Unit-III:

Historical developments in the field of genetics. Organisms suitable for geneticexperimentationand their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast.Role ofmeiosis in life cycles of organisms.

Mendelian genetics : Mendel's experimental design, mono, di- and tri hybrid crosses, Law ofsegregation & Principle of independent assortment. Chromosomal theory of inheritance.

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Unit-IV

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, concept of cistron, exons, introns, genetic code, gene function.

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

Practical:

1. Study of plasmolysis and de-plasmolysis.
2. Study of structure of any prokaryotic Eukaryotic cell.
3. Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissueslike liver, Oesphagus, Stomach, pancreas, Intestine, Kidney, Ovary, testes.
4. Cell division in onion root tip/insect gonads.
5. Preparation of Nuclear, mitochondria & cytoplasmic fractions.
6. Study of polyploidy in onion root tip by colchicine treatment.
7. Karyotyping with the help of photographs

Text Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley & Sons. Inc.
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII EditionJohn Wiley & Sons.

Suggested Readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology.8thedition.Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th

edition.ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of theCell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introductionto Genetic Analysis, W. H. Freeman & Co.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C 4: ANIMAL DIVERSITY AND PHYSIOLOGY

Course outcome:

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

- To comprehend various degrees of biological diversity through systematic classification and get familiarwith taxonomic level animal identification.
- The student will demonstrate knowledge of the distinctive features and characteristics of the major invertebrate groups by differentiating between different types of body symmetry and outlining the key similarities and differences between the Radiata and Bilateria, protostomes and deuterostomes, acoelomates,pseudocoelomates, and acoelomates.
- The student will exhibit understanding of the varied traits of the main vertebrate animal groupings by comparing and contrasting the members of the chordate subphyla Urochordata, Cephalochordata, and Vertebrata.
- Develop critical thinking skills and apply physiological concepts and principles at the basic and applied levels.

- Develop a working knowledge of major physiological systems and be able to associate anatomical areas with their specific function.

Unit-I

Proto-chordates: Outline of classification, General features

Outline of classification of Non-Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.

General characters, outline of Classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata.

Unit-II

Proto-chordates: Outline of classification, General features and important characters of Herdmania, Branchiostoma
Origin of Chordates Pisces: Migration in Pisces, Outline of classification Amphibia: Classification, Origin, Parental care, Paedogenesis
Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration Mammalia: Classification, Origin,dentition

Unit-III

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids andnucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice
Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve,Chloride shift.Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. **Unit-III**
Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat,
Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Unit-IV

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions, Mechanism of action of hormones (insulin and steroids)

Practical:

1. Identification of slides with two points of identification. Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules ofsponges, L.S. Hydra, Obelia, Bougainvillia, Larvae of Fasciola, Seta of Earthworm, Radul
2. Identification & Classification upto order of the following: Proto-chordata: Salpa, Doliolum, Herdmania, Branchiostoma
3. Finding the coagulation time of blood
4. Determination of blood groups
5. Determination of Haemoglobin
6. Counting of mammalian RBCs
7. Determination of TLC and DLC

Text Books:

1. Modern text book of zoology: invertebrates, R.L. Kotpal, Rastogi Publications,Meerut
2. Modern text book of zoology: vertebrates, R.L Kotpal, Rastogi Publications, Meerut
3. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition.John Wiley & Sons,Inc

Suggested Reading:

1. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. andNelson.
2. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students.Asia Publishing Home.
3. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition.

   HercourtAsia PTE Ltd. /W.B. Saunders Company.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOME

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	5	5	4	2	2	2	2	2	2	2
CO2	5	5	4	2	2	2	2	2	2	2
CO3	5	2	5	2	2	4	2	2	2	2
CO4	5	2	4	2	2	4	2	2	2	2
CO5	5	2	4	4	2	5	4	2	2	2

C5: MOLECULAR BIOLOGY

Course outcome:

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

- Understand the interactions among various systems of the cell, including thosebetween DNA, RNA and proteins
- Learn the regulatory mechanism of DNA, RNA and proteins.
- Understand the chemical and molecular processes that occurs in and betweencells.
- Get insight into the most significant molecular and cell-based methods usedtoday to expand their understanding of biology.
- Design and implement experimental procedures using relevant moleculartechniques.

Unit-I

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Packaging of DNA molecule into chromosomes, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primo some, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication,Fidelity of replication.

Unit-II

DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Homologous recombination: modelsand mechanism.

Unit-III

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5 cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit-IV

Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoa acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins

Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics.

Practical:

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from animal/bacterial cells.
3. Agarose gel electrophoresis of genomic DNA.
4. Quantitation of DNA by Spectrophotometry.
5. Extraction of protein
6. SDS PAGE and Native PAGE

Text Book:

1. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner(Pearson Education)

Suggested Readings

1. Cell and Molecular Biology - By Robertis & Robertis, Publ: Waverly
2. Genes - By B. Lewin - Oxford Univ. Press
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition.John Wiley & Sons. Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIIIEdition. Lippincott Williams and Wilkins, Philadelphia.
5. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford UniversityPress.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C6: BIO-CHEMISTRY AND METABOLISM

Course outcomes:

On successful completion of the course, the 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

PH and buffers, Preparation and significance of buffers in biological system.

.Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero polysaccharides, Muco-polysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their

biological functions.

Carbohydrates Metabolism: Reactions, energetic and regulation. Glycolysis: Fate of pyruvate under aerobic and anerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis,Glycogenolysis and glycogen synthesis. TCA cycle, Electron transport chain, Oxidative phosphorylation,

Unit-II

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Different levels of structural organization of proteins, Fibrous and globular proteins.

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenezyme, prosthetic groups, Enzyme activity, Specific activity,

Unit-III

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Prostaglandins, Cholesterol**.** Beta-oxidation of fatty acids.

Unit-IV

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z DNA.

Practical:

1. To study activities of any enzyme under optimum conditions.
2. Preparation of buffers.
3. Separation of Amino acids by paper chromatography.
4. Qualitative and quantitative tests for Carbohydrates and lipids.
5. Qualitative and quantitative estimation of proteins.

Text Book:

1. Nelson, D.L., Cox, M.M. (2004), Lehninger Principles of Biochemistry, 7th Edition, WHFreeman and Company, New York, USA.

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.HFreeman and Co.

2. Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.
3. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by DonaldVoet, Judith G. Voet and Charlotte. W. Pratt. Willey 2010.
4. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay&Nath –Himalaya Publ.
5. Biochemistry, 4th edition by U Satyanarayana and U Chakrapani, Elsevier India
6. Biochemistry Concepts and Connections, DR Appling, SpEncer J. Anthony-Cahill,&Christopher K.Mathews, Pearson.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C7: BIOSTATISTICS AND COMPUTER APPLICATIONS

Course outcome: On successful completion of the course, the student will be able to

- Describe the roles biostatistics serves in the various other discipline and demonstrate basic analyticaltechniques to generate results
- Interpret results of commonly used statistical analyses in written summaries and demonstrate statisticalreasoning skills accurately and contextually
- Apply statistical knowledge to design and conduct research studies and operate statistical softwarepackages to conduct research studies.
- Apply the MS office of computer application for interpretation of data.
- Apply computer skills for statistical methods and techniques.

Unit-I

Statistical methods and Developmental models: Graphical representation of statistical data, Mean, Poisson and Binomial, Distribution, Arithmetic, Geometric and Harmonic means, Median, Mode; Design of experiments,

Unit II

Analysis of Variance, Standard Deviation, Standard error of mean, Correlation and

regression of two variables, Test of significance, Probability, sampling, measurement and distribution of attributes, t-test, chi-square test, F-test. Collection, Classification and Tabulation of data,

Unit III

Basic concept of computer: - Introduction, different components of computer, basic design of computer. Introduction to operating system, different management (processor, memory, device ,file), Processor management-Process concept ,Threads ,CPU Scheduling Process scheduling, Deadlocks ,Process synchronization. Memory management – Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory. Device management, File management.

Unit IV

Computer application, DOS command, MS-Office, MS-Access, MS-Excel, MS-Power point, Assessing Internet. Services: Browsing, Downloading, e-correspondence.

Introduction C programming: Structure of C Program, Execution of C Program, Constants, Variable, Datatypes, Operator and Expression, Decision making Branching and Decision making looping, Array.

Practical:

1. Calculation of mean, median & mode taking biological samples
2. Calculation of standard error of mean
3. Chi-square test using biological samples
4. DOS commands (Internal & External)
5. Some basic programs in C
6. Programs on Decision making branching
7. Programs Decision making Looping
8. Programs on operators

Text Books:

1. C in Depth by Shrivastava SK, Shrivastava D, BPB Publication, 2nd revised edition.
2. Biostatistics Theory and Applications by G. Mishra & P.K. Mohanty G.B.N. Chainy.

Suggested Readings:

1. Taxmann's Information Technology by Dr.Sushila Madan.
2. Let Us C by YashwantKanetkar 11th Edition
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford UniversityPress.

4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wileyand Sons Inc.
5. S.C. Gupta, V.K. Kapoor Fundamentals of Mathematical Statistics, A Modern Approach,10th edition, S Chand & Sons.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C8: IMMUNOLOGY

Course outcome:

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

- Describe key immunological principles and ideas and have fundamental understanding ofimmunological processes at the cellular and molecular level.
- To provide students with knowledge on how the immune system works building on their previousknowledge from biochemistry, genetics, cell biology and microbiology
- To promote critical thinking among students;
- Understand the fundamentals and identify the characteristics of autoimmunity, immune tolerance andimmunodeficiency and the related diseases.
- Understand the principles of immunization and the mechanisms behind immunity to infectious diseases.

Unit-I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-

lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T- cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell

receptor genes by somatic recombination.

Unit-II

Regulation of immunoglobulin gene expression clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory.

Unit-III

Major Histocompatibility complexes class I & class II MHC antigens, antigen processing and presentation.

Immunity to infection- immunity to different organisms, pathogen defence strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency diseases, AIDS.

Unit-IV

Vaccines & Vaccination adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics RIA, ELISA.

Practical:

1. Differential leucocytes count.
2. Total leucocytes count.
3. Total RBC count.
4. Haemagglutination assay.
5. Haemagglutination inhibition assay.
6. Separation of serum from blood.

Text Book:

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W. H.Freeman and Company, New York.

Suggested Readings

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6thedition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11thedition Wiley-Blackwell Scientific Publication, Oxford.
3. Essentials of immunology by Roitt(Blackwell scientific publication)
4. Immunology and immunotechnology by Ashim k. Chakravarty (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	5	4	2	2	2	2	2	2	2
CO2	5	5	5	2	5	4	4	2	2	2
CO3	5	5	4	2	5	4	4	2	2	2
CO4	5	5	4	2	2	2	2	2	2	2
CO5	5	5	4	2	2	2	2	2	2	2

C 9: PLANT BIOTECHNOLOGY

Course outcome:

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

- Learn the techniques of sterilization and monitoring method of sterilization.
- Learn different pathways of plant regeneration under in vitro conditions - organogenesis andsomatic embryogenesis.
- Techniques of establishing cell suspension culture. Synthetic seeds and applications.
- Culturing of reproductive structures - anther, microspores, embryos, endosperm, Ovule and ovarycultures and methods to produce haploids.
- Protoplast isolation, culture and protoplast fusion - applications -. Somaclonal variation -applications.

Unit I

Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis,

Unit- II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Significance and use of haploids, Ploidy level and chromosome doubling,diplodization, Gynogenic haploids, factors effecting gynogenesis,

chromosomeelimination techniques for production of haploids in cereals.

Unit - III

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

Unit - IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation,Biocontrol of pathogens, Growth promotion by free-living bacteria.

Practical:

1. Preparation of complex nutrient medium (Murashige& Skoog's medium)
2. To selection, Prune, sterilize and prepare an explant for culture.
3. Significance of growth hormones in culture medium.
4. To demonstrate various steps of Micropropagation

Text Book:

1. Introduction to Plant Biotechnology, H.S. Chawla,Science Publishers, 2002

Suggested Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd.,New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory andPractice.Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applicationsof recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
5. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication
6. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The GeneticManipulation of Plants, 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	5	4	2	2	4	4	2	2	2
CO2	5	5	4	2	2	2	2	2	2	2
CO3	5	5	4	2	5	4	2	2	2	4
CO4	5	5	4	2	5	4	2	4	2	4
CO5	5	5	4	2	5	4	4	4	2	2

C 10: ANIMAL BIOTECHNOLOGY

Course outcome:

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

- Learn the basic techniques of for media preparation, cell culture and its maintenance.
- Understand the methods of cell separation, cloning and transformation of cells.
- Acquire the skills for gene transfer methods and stem cell technology.
- Understand the techniques of gene therapy, molecular and human genetic engineering.
- Perform various experiments related to animal cell culture.

Unit I

Equipments and materials for animal cell culture: Design and layout of culture room, Basicequipments used in cell culture, Sterilization and aseptic techniques. Culture media: General considerations in media design, Natural media, synthetic media.Primary culture and its maintenance.

Unit II

Various methods of cell separation, Cell cloning: Dilution cloning and isolation cloning, Transformation of cells, Organ culture, In vitro Fertilization, Embryo culture. Three dimensional culture.

Unit III

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer,Retrovirus & Gene transfer.

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology –

Embryo

transfer techniques. Introduction to Stem Cell Technology and its applications.

Unit IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in genetherapy,molecular engineering, human genetic engineering, problems & ethics.

Practical:

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Mediasterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Cell counting and cell viability
4. Preparation of Hanks Balanced salt solution
5. Preparation of Minimal Essential Growth medium

Text Book:

1. Animal cell culture techniques, Ian Freshney, Wiley-Leiss

Suggested Readings:

1. Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.
2. Cell Culture LabFAx, M. Butler and M. Dawson, Bios scientific Publications Ltd
3. Cell and Tissue Culture: Laboratory Procedures in Biotechnology, A. Doyle andB.Griffith, Wiley publications.
4. Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh andCurtis
5. Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.
6. Animal Cell Culture - John R. W. Masters - Oxford University Press.
7. Introduction to Plant Biotechnology 2017 by H S Chawla - CRC Press.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

CO2	5	5	4	2	5	4	2	2	2	2
CO3	5	5	4	2	5	4	4	4	4	2
CO4	5	5	4	2	2	4	4	4	2	4
CO5	5	5	4	2	5	4	2	2	4	2

C 11: GENETIC ENGINEERING

Course outcome:

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

- Understand the learning tools and techniques in rDNA technology including enzymes, vectors andPCR.
- Acquire skills for the construction of recombinant DNA through molecular cloning approaches
- Perform the experiments for selection of recombinants and analysis of cloned genes
- Understand the concepts of site-directed mutagenesis and its application in protein engineering.
- Acquire skill sets for developing transgenic plants and animals and their applications

Unit- I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, lectroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

Unit-II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Unit-III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Unit-IV

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Useof plant viruses as episomal expression vectors.

Practical:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Demonstration of PCR

Text Book:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applicationsof recombinant DNA. ASM Press, Washington

Suggested Readings:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. BlackwellPublishing,Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic
3. Revolution.Elsevier Academic Press, USA.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics,7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A LaboratoryManual. 3rd edition. Cold Spring Harbor Laboratory Press.
6. Biotechnology by B.D.Singh (Kalyani Publishers).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C 12: GENOMICS & PROTEOMICS

Course outcome:

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

- Understand various strategies and methods for genome sequencing
- Browse and analyse data from various genome databases.
- Analyze the physico-chemical nature of proteins and their separation through sizes.
- Aquire skills for analysis of proteomes using 2D PAGE and mass spectrometry
- Perform purification and sequencing of proteins

Unit-I

Introduction to Genomics, DNA sequencing methods manual& automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit-II

Managing and Distributing Genome Data: Web based servers and software for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

Unit-III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.

Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures Edman degradation.

Unit-IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilisation, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

Practical:

1. Use of SNP databases at NCBI and other sites
2. Detection of Open Reading Frames using ORF Finder
3. Proteomics 2D PAGE database
4. Software for Protein localization.
5. Native PAGE
6. SDS-PAGE

Text Books:

1. Charles Malkoff, 2016. Exploring Genomics, Proteomics and Bioinformatics,Syrawood Publishing House.
2. A. Malcolm Campbell Discovering Genomics, Proteomics andBioinformatics,Pearson Education India; 2 edition

Suggested Readings:

1. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific.
2. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
3. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G.Veres.2004. Genetics from Genes to Genomes. McGraw Hill.
4. The Human Genome 2001, Nature Vol. 409.

5. The Drosophila Genome. 2000, Science Vol. 267.
6. The Caenorhabditis elegans genome 1998. Science Vol. 282.
7. The Arabidopsis Genome 2000 Nature vol. 408.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C 13: ENVIRONMENTAL BIOTECHNOLOGY & BIOETHICS

Course outcome:

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

- Explain the importance of microbial diversity and of molecular approaches in environmentalmicrobiology and biotechnology
- Describe existing and emerging technologies that are important in the area of environmentalbiotechnology
- Describe biotechnological solutions to address environmental issues including pollution, mineralresource winning, renewable energy.
- Understand about national and international laws concerning biotechnology and bioethical issues.
- To comprehend various IPRs for protection of intellectual property

Unit-I

Environment: Basic concepts and issues, Environmental modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozone depletion, Influence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.

Unit-II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation,
Degradation of

pesticides and other toxic chemicals by micro-organisms- degradation aromatic andchlorinates hydrocarbons and petroleum products.

Unit-III

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium).Environmental significance of genetically modified microbes, plants and animals.

Unit-IV

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.
Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights,Industrial design, Traditional knowledge, Geographical indications, Protectionof GMOs).

Basics of patents (Types of patent application and Specifications), concept of PriorArt and patent filing procedures

Practical:

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence

Text Book:

1. P. K. Mohapatra, Textbook of Environmental Biotechnology, I.K. InternationalPublishing House; 1st Ed. edition.

2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age internationalpublishers

Suggested Readings:

1. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening andJesef Winter
2. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
3. Agricultural Biotechnology, S.S. Purohit
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer,John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

C 14: BIOPROCESS ENGINEERING & TECHNOLOGY

Course outcome:

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

- Understand the production of industrially important chemicals and chemotherapeutic products.
- Acquire skills for enzyme and cell immobilization, food technology and microbial metabolicengineering.
- Purify and characterize proteins, upstream and downstream processing.
- Understand the method of microbial cell centrifugation, ion exchange and recovery of biologicalproducts

- Analyse the rate equation for enzyme kinetics, growth kinetics and metabolic engineering of antibioticbiosynthetic pathways.

Unit-I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid,butyric acid, 2 - 3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol,hydrogen, biodiesel, Microbial electricity, starch conversion processes.

Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newerantibiotics, anti-cancer agents, amino acids.

Unit-II

Production of microbial metabolite, Secondary metabolism its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

Unit-III

Purification & characterization of proteins, Upstream and downstream processing. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit-IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosyntheticpathways

Practical:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity(protease/peptidase/glucosidase etc.)
5. Production and analysis of Amylase.

Text Book:

1. Prescott & Dunn's Industrial Microbiology Paperback, 2004 by G. Reed (Author), CBSPublication

Suggested Readings

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology.2nd edition, Elsevier Science Ltd.
2. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
3. Crueger W and Crueger A. (2000). Biotechnology: A textbook of IndustrialMicrobiology.2nd edition. Panima Publishing Co. New Delhi.
4. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Discipline Specific
Elective 1
BIOTECHINIQUES

Course outcome:
On successful completion of the course, the student will be able to

- Learn the various instrumentations that are used in the analytical laboratories.
- Know the fundamental and applications of the instruments that are routinely used for thecharacterization of biomolecules.
- Acquire basic knowledge on the theory, operation and function of analytical instruments.
- Learn the methodology involved in biotechniques and knowledge and practical skills of usinginstruments in biology and medical field.

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Unit-I

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

Unit-II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared),centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

Unit-III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography,column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

Unit-IV

Introduction to electrophoresis, polyacrylamide gel (native and SDS-PAGE), agarose-gelelectrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.

Introduction to Biosensors and Nanotechnology and their applications.

Practical:

1. Native gel electrophoresis of proteins
2. Determination of absorption maxima of given chemicals.
3. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.
6. To verify the validity of Beers law and determine the molar extinction coefficient of NADH.

Text Books:

1. Principle and Techniques of Biochemistry and Molecular biology, 7th ed By KeithWilson and Jhon Walker, Cambridge Press
2. Rodney Boyer, Modern Experimental Biochemistry, Pearson Education; 3 Edition.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I toIII,
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of theCell.7thedition. Pearson Benjamin Cummings Publishing, San Francisco.
3. An introduction to Practical Biochemistry - T. Plummer
4. Experimental Biochemistry- V. Deshpande and B. Sasidhar Rao (A Student Companion)

5. Biophysics – Vastala Piramal (Dominent Publishers)
6. Introductory Practical Biochemistry - S.K. Sawhney, Randhir Singh, Narosa Publishing.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Discipline Specific
Elective 2
BIOINFORMATICS

Course outcome:

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

- Understand the concepts and applications of bioinformatics.
- Apply basic principles of biology, computer science and mathematics to address complex biologicalproblems.
- Learn methodologies and softwares used in bioinformatics that will give them a comprehensive frame indata analysis.
- Learn basic novel strategies implemented through machine learning and artificial intelligence andunderstanding how their applications in bioinformatics and allied domains.

Unit I

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

Unit II

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structureof each source and using it on the web.

Introduction of Data Generating Techniques and Bioinformatics problem posed by them-Restriction Digestion, Chromatograms, Blots, PCR,Mass Spectrometry.

Unit-III

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Introduction to BLAST, using it on the web,Outline of sequence Assembly, Pairwise Alignments, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

Unit-IV

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Practical:

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Text Book:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. OxfordUniversity Press.

Suggested Readings:

1. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
2. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics andBioinformatics. II Edition. Benjamin Cummings.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Discipline Specific
Elective 3
BIOENTERPRENEURSH
IP

Course outcome:

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

- Gain numerous entrepreneurial skills.
- Understand various operations involved in the venture creation.
- Identify scope for entrepreneurship in biosciences and utilize the schemes promoted throughknowledge centers and various agencies..
- Build up a strong network within the industry.

Unit I: Introduction

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship,Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

Unit II: Establishing an Enterprise

Forms of Business Organization, Project Identification, Selection of the product,

Projectformulation, Assessment of project feasibility.

Unit III: Financing the Enterprise

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to movefor loans, Inventory direct and indirect raw materials and its management.

Unit IV: Marketing Management

Meaning and Importance, Marketing-mix, product management – Product line, Productmix, stages of product like cycle, marketing Research and Importance of survey, PhysicalDistribution and Stock Management.

Meaning of International business, Selection of a product, Selection of a market forinternational business, Export financing, Institutional support for exports.

Text Book:

1. Gupta CB, Khanka SS. Entrepreneurship and small Business Management, Sultan Chandand Sons

Suggested Readings:

1. Holt DH Entrepreneurship: New Venture Creation.
2. Kalpan JM Patterns of Entrepreneurship

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Discipline Specific Elective
4 MEDICAL
MICROBIOLOGY

Course outcome:

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

- Learn about culture, collection, handling and transport of clinical samples.
- Know the interactions between human and microbes, diseases caused by microbes.
- Learn about diagnosis of various microbial diseases.
- Identify the diseases and understand their treatment plan.

Unit I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S. aureus, B. anthracis, C. tetani C. diphtheriae M. tuberculosis, M. leprae*

Unit II

Pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapycaused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, S. typhi, S.dysenteriae, H. influenzae, V. cholerae, M. pneumoniae, Rickettsiaceae, Chlamydiae.*

Unit III

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses

Unit IV

Fungal and Protozoan infections. Dermatophytoses (Trichophyton and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Practical:

1. Identification of pathogenic bacteria (any two) based on cultural, morphological andbiochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of Aspergillus and Candida by apprpriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsulestaining and spore staining.

Text Book:

1. Ananthnarayan ,Paniker, Arti Kapil Ananthanarayan and Paniker's Textbook ofMicrobiology, Universities Press (India) Private Limited

Suggested readings

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg'sMedical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' MedicalMicrobiology. 4th edition. Elsevier.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein'sMicrobiology. 7th edition. McGraw Hill Higher Education.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

DISCIPLINE SPECIFIC ELECTIVE
4: Project Reports& Seminar

Credits-6, Project Report: 60 marks, Seminar: 20 marks, Viva: 20 marks&Total: 100 Marks

- A selected Biotechnology based product
- Review articles
- Latest techniques and products of societal impact
- Contribution/discovery of Scientists in the field of Biotechnology
- Instrumentation and applications
- Scale up/ Down stream processing
- Models
- Bioinformatics tools

Generic Elective Paper-I
BIOCHEMISTRY AND MOLECULAR BIOLOGY

Course outcome:

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

- Acquire knowledge in the quantitative and qualitative estimation of biomolecules.
- Thoroughly understand the importance of biomolecules and their functions.
- Understand the concepts of cellular function and molecular aspects of the biology.
- Learn the concepts of central dogma of molecular biology spanning from DNA Replication tillProtein Synthesis and Reverse transcription.

Unit-I

pH and buffers, Preparation and significance of buffers in biological system. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides andPolysaccharides. Homo & Hetero polysaccharides, Glycoproteins and their biologicalfunctions.

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Different levels of structural organization of proteins.

Unit-II

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Cholesterol**.**

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z DNA.

Unit-III

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Replication of DNA in prokaryotes and eukaryotes: semiconservative nature of DNA replication.

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes and Eukaryotes, RNA splicing and processing: processing of pre-mRNA:5 capformation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit-IV

Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoa acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins.

Practical:

1. Preparation of buffers.
2. Separation of Amino acids by paper chromatography
3. Qualitative and quantitative estimation of proteins.
4. Isolation of chromosomal DNA from bacterial cells.
5. Agarose gel electrophoresis of genomic DNA.
6. Quantification of DNA by Spectrophotometry.

Text Books:

1. Nelson, D.L., Cox, M.M. (2004), Lehninger Principles of Biochemistry, 7th

Edition, WHFreeman and Company, New York, USA.
2. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner(Pearson Education)

Suggested Readings

1. Biochemistry, 4th edition by U Satyanarayana and U Chakrapani, Elsevier India
2. Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.
3. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by DonaldVoet, Judith G. Voet and Charlotte. W. Pratt. Willey 2010.
4. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay&Nath –Himalaya Publ.
5. Genes - By B. Lewin - Oxford Univ. Press
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition.John Wiley & Sons. Inc.
7. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford UniversityPress.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Generic Elective Paper-II
RECOMBINANT DNA
TECHNOLOGY

Course outcome:

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

- Gain knowledge on the manipulation of gene, gene expression which will help them for furtherstudies in the area of genetic engineering.
- Learn rDNA technology techniques and their application in the field of genetic engineering.
- Gain knowledge about plasmids, vectors and gain knowledge on the construction of cDNA libraries.
- Apply most appropriate recombinant-DNA techniques and other contemporary molecular techniquesto understand the function of gene.

.

Unit I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes),
Principle and applications of Polymerase chain reaction (PCR), primer-design, and Types of PCR.

Unit II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Unit III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Unit IV

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Practical:

1. Isolation of chromosomal DNA from *E.coli*
2. Qualitative and quantitative analysis of DNA using spectrophotometer
3. Plasmid DNA isolation
4. Restriction digestion of DNA
5. Demonstration of PCR

Text Book:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applicationsof recombinant DNA. ASM Press, Washington

Suggested Readings:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. BlackwellPublishing,Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the GeneticRevolution.Elsevier Academic Press, USA.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics,7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A LaboratoryManual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Biotechnology by B.D.Singh (Kalyani Publishers).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Generic Elective Paper-III

ENVIRONMENTAL BIOTECHNOLOGY AND BIOETHICS

Course outcome:

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

- Exposed to the diversity, function, ecological adaptation of microorganisms within the environment.
- Know the importance of microbial life to key ecosystem process and teaches the role of biotechnologyto address environmental issues.
- Learn the ethical aspects of conducting research and safety aspects to be adhered in a research setting.
- Gained sufficient knowledge to act as a responsible scientist and environmentally conscious

Unit-I

Environment: Basic concepts and issues, Environmental modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozone depletion, Influence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.

Acid rain, Arid and semi-arid plant biotechnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

Unit-II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation,

Degradation of pesticides and other toxic chemicals by micro-organisms-degradation aromatic and chlorinates hydrocarbons and petroleum products.

Unit-III

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Unit-IV

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights,Industrial design, Traditional knowledge, Geographical indications, Protection ofGMOs).

Basics of patents (Types of patent application and Specifications), concept of PriorArt andpatent filing procedures

Practical:

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence

Text Book:

1. P. K. Mohapatra, Textbook of Environmental Biotechnology, I.K. InternationalPublishing House; 1st Ed. edition.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age internationalpublishers

Suggested Reading:

1. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordeningand JesefWinter
2. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
3. Agricultural Biotechnology, S.S. Purohit
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer,John F.T.Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

Generic Elective Paper-IV

BIOPROCESS ENGINEERING & TECHNOLOGY

- Get fundamental insights to exploit microbes for manufacturing of products which have hugeindustrial significance.
- Gain idea on various biochemical processes to obtain products such as food, chemicals, vaccines, medicines.
- Know various industrially important microorganisms and their growth conditions as well asapplications.
- Have a better appreciation for the role of biotechnology in industry using microbes

Unit-I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid,butyric acid, 2 - 3 butanediol, gluconic acid, Biofuels: Biogas, Ethanol, butanol, biodiesel, Microbial electricity,

Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.

Unit-II

Production of microbial metabolite, Secondary metabolism its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, enzymes in food technology/organic synthesis.

Unit-III

Purification & characterization of proteins, Upstream and downstream processing. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit-IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effectof pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall

mass transfer co-efficient (Ka) determination, factors depending on scale up principleand different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Practical:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity(protease/peptidase/glucosidase etc.)
5. Production and analysis of Amylase.

Text Book:

1. Prescott & Dunn's Industrial Microbiology Paperback, 2004 by G. Reed (Author), CBSPublication

Suggested Readings:

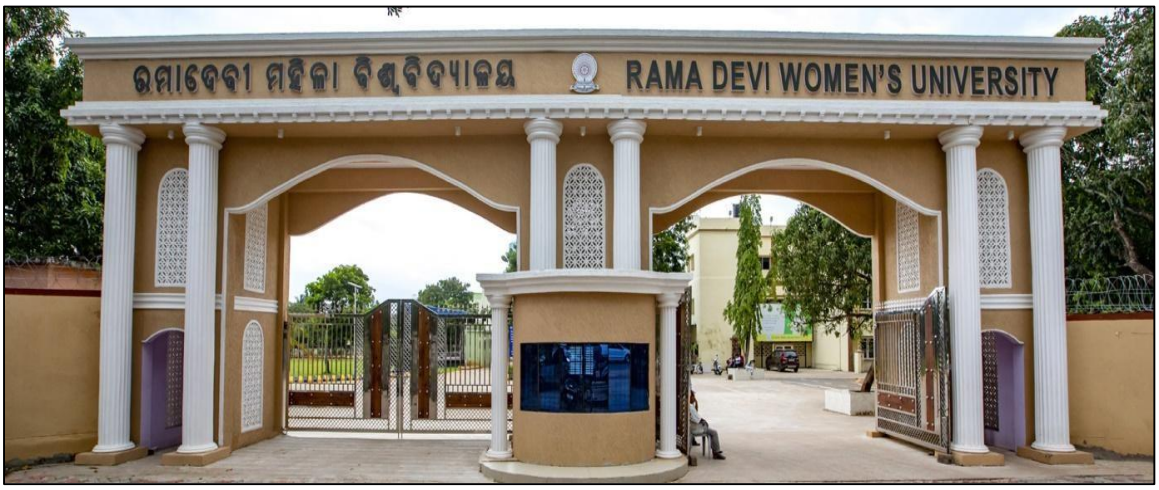
1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology.2nd edition, Elsevier Science Ltd.
2. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
3. Crueger W and Crueger A. (2000). Biotechnology: A textbook of IndustrialMicrobiology.2nd edition. Panima Publishing Co. New Delhi.
4. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

MAPPING OF COURSE OUTCOMES WITH THE PROGRAM OUTCOMES

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

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)

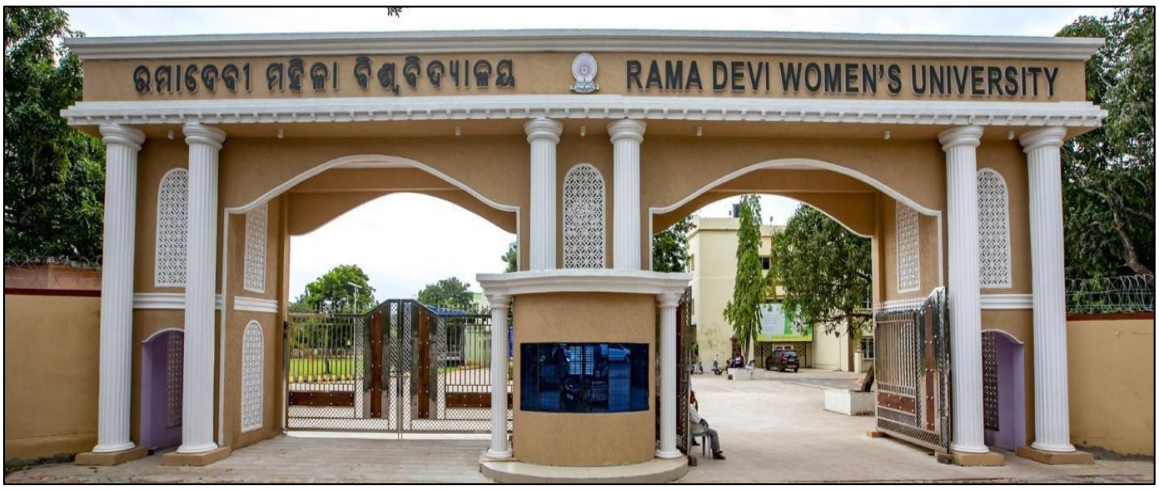
MODULE 3:

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)

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS OF Ph.D. PROGRAMME



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

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS OF
Ph.D IN BIOTECHNOLOGY

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

20/12/23
Controller of Examinations
R.D. Women's University
Bhubaneswar

OUTLINE OF THE COURSE STRUCTURE

Sl. No	Paper code	Course Title	Credit	Marks	Pass Mark
1	BT01	Research Methodology & Computer Application	4	100	50%
2	BT02	Advances in Biotechnology	4	100	50%
3	BT03	Presentation of Review Literature	4	100	50%
4	BT04	Research & Publication Ethics	4	100	50%
TOTAL			**16**	**400**	

Ph.D. Biotechnology Programme
outcomes:

PO1: This degree programme provides opportunity to students to study the application of biotechnology in depth which someone may wish to apply for building blocks in area of research.

PO2: Inculcate scientific communication skills, scientific writing and data recording required for Pharma 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 social cohesion between research and social context.

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

PO6: Acquire knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to various aspects of 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 softwares for mining and analyzing data related to biotechnology.

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

PO10: An ability to demonstrate a critical awareness of current gaps in research and practice inthe field.

Program specific outcomes:

PSO 1: Doctoral research helps in shaping the future of specialist by individual cognitive activities aimed at obtaining new, knowledge, solving theoretical and practical problems, self-education and self-realization.

PSO2: To demonstrate and apply their knowledge of cell biology, biochemistry, microbiology and molecular 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 measurements using those instruments with experiments.

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

PAPER 1: RESEARCH METHODOLOGY & COMPUTER APPLICATION
(4 CREDITS) (100 Marks)

Course Outcome:

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

- Gain knowledge of ethical issues related to Research and Publication, patents andrights and intellectual property rights.
- Able to review of existing work in the field of choice.
- Use of open courseware like INFLIBNET, ShodhGanga etc.
- Use computing skills and computer applications in research to draw reasonable,accurate conclusions
- Utilize the tools/software like LaTex, MS-Office, Active Scholar and alike.

Unit-I: Introduction to Research Methodology

Importance and Meaning of Research; Characteristics, Objectives and Motivations in Research; Types of Research; Significance of Research; Research Process and steps; Criteria for good research; Identification, selection and formulation of research problems; Research Design- meaning, need, features of a good design, basic principles of experimental designs, important concepts and different research designs, Developing a research plan, Sample design and its types, Characteristics of sampling procedure.

Unit-II: Data Collection, hypothesis testing and analysis in Biotechnology

Frequency distribution, Diagrammatic representation, Probability Distribution, Binomialdistribution, Measure of dispersion (range, mean deviation, variance, standard

deviation, variance, coefficient of variation), Normal distribution: its importance and properties. One- tailed versus two-tailed tests, p-value, hypothesis testing, student t-test, paired t-test and Chi- square test; Correlation and Regression; Analysis of Variance: One-way and Two-way ANOVA, F-Distribution and application.

Unit-III: Scientific Writing, Research ethics and Intellectual Property Rights (IPR) in Biotechnology

Interpretation of data and scientific report writing: Significance of report writing, Different steps, Layout of the research report, Types of Reports; Laboratory Biosafety, Good Laboratory practices (GLP) and Good Manufacturing Practice (GMP), Ethics in manipulation of cells, tissues and animals; Introduction to IPR, Types of IP - Patents, Trademarks, Copyright and Related Rights, patentable and non-patentables, legal protection of Biotechnological inventions.

Unit-IV: Practicals on Computer Applications

Approaches to Computer Application: MS Word: Working with Text, Working with Tables, Graphics and Pages, Document Views and Formatting, and Mail-merge, and Referencing Style; MS-Office and its application, File handing in window, various versions of MSOffice, Research publishing tool- MS-Word, Adobe acrobat, Graphics tool- MS Excel, MS-Power Point: Creating presentations and adding effects, Subject/field specific tools on www.freeware.com; Use of Internet: Fundamentals and Services – E-mail, FTP, Telnet, WWW

Suggested Readings:

1. D. R. Cooper and P. S. Schindler, Business Research Methods, 9/e, TMH, 2009.
2. C. R. Kothari, Research Methodology, 2/e, New Age International (P) Ltd. Publishers,2006.
3. Jerrold H. Zar, Biostatistical Analysis (4th edition), Prentice Hall publishers. 1998
4. Fundamentals of Biostatistics, Veer Bala Rastogi, Ane Books India, New Delhi, 2006
5. Anderson, J; Durston, D and Poole, M. Thesis and Assignment writing. New AgeInternational Pvt. Ltd, New Delhi, 1991
6. Conference of Biological Editors, Style manual for Biological Journals, AmericanInstitute of Biological Science, Washington, D.C, 2000
7. Padma Nambisan, An Introduction to Ethical, Safety and Intellectual Property RightsIssues in Biotechnology, 1st Edition, Academic Press, 20

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

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

PAPER 2: ADVANCES IN BIOTECHNOLOGY

(4 CREDITS) **(100 Marks)**

Course outcomes:

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

- Describe microbial diversity, microbial taxonomy and systematics and explain the processes used for replication, adaptations and interaction with the host andenvironment.
- To learn and get introduced to some rapidly evolving fields, including genome editing techniques and regulation of gene expression by different types of RNAs
- Understand basics and applications of various assisted reproductive technology such as artificial insemination, embryo transfer, in vitro fertilization and transgenic animal technology
- 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: Tools & Techniques in Biotechnology & Microbiology

Basics of Microscopy (Light, Phase-Contrast, Fluorescence), Electron Microscope (SEM and TEM), FACS, Spectrophotometry (UV-VIS, Fluorescence, IR Spectroscopy), Mass spectrometry and MALDI-TOF, Chromatographic Techniques (Gel exclusion, Ion Exchange, Affinity, HPLC, FPLC), NMR, Circular Dichorism, Electrophoresis (Agarose, PAGE, IEF, 2DE-DIGE), PCR and Blotting Techniques.

Sterilization and Aseptic Techniques, Media Preparation for microbial cultures, Culture and Identification of Microbes; Microbial diagnostics: Bacteriology: Staining procedures in clinical Microbiology, Typing methods: Biotyping, Antibiogram typing, Phage typing. Nucleic acid based typing: PCR typings, Robotizing, WGS typing. Virology: Sampling, Cell culture, Serotyping, Diagnostic assay: Cytopathic effect test.

Unit-II: Plant and Animal Tissue Culture Technology

Biotechnology in crop improvement: micro propagation, callus culture, cell suspension culture, soma clonal variation, Biotechnology of secondary metabolites. Equipments and materials for animal cell culture, Animal cell culture techniques- Role of serum and specific media formulations, Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer, suspension and 3D culture, establishment of cell lines, Characterization of cells, Transformation and Cryopreservation.

Unit-III: Functional Genomics & Genetic Engineering

Molecular Mapping of Genome- Genetic and physical mapping; Molecular markers in genome analysis; Global gene expression strategies; Next-generation sequencing strategies. Genetic engineering of plants & animals; modern methods of foreign DNA delivery; marker genes and marker free transgenic systems; cDNA library, cloning interactions and hybrid systems; Gene silencing & its applications

Unit-IV: Basics of Environmental Biotechnology

Biofertilizers: Symbiotic free nitrogen fixers, asymbiotic free nitrogen fixers, algal, phosphate solubilizing, mycorrhizae and green manure. Microbial sources of pharmaceutically important compounds. Bioremediation: in situ and ex situ bioremediation, constrains and priorities of bioremediation, Evaluating Bioremediation, Bioremediation of VOCs; Biodegradation: Factors affecting on process of biodegradation. Methods in determining biodegradability. Contaminant availability for biodegradation; Phytoremediation technology: methods, advantages and disadvantages, Bioleaching, Biosorption phytomining; Sources of heavy metal pollution.

Suggested Readings:

1. Textbook of environmental biotechnology: Pradipta Kumar Mohapatra. 2nd edition. IKinternational publishers.
2. Introduction to Environmental Biotechnology: A.K. Chatterji. PHI publishers.
3. Environmental Biotechnology: A Text Book for University Student- SVS Rana.Rastogi Publications, 2009
4. Biotechnology in crop improvement. H. S. Chawla.
5. Biotechnology and Genomics, P. K. Gupta, Rastogi publications.
6. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch.
7. Genomes by T.A. Brown
8. Molecular biology of the gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M.Levine and R. Losick.
9. Brock Biology of microorganisms: Madigan, Martinko, Dunlap, Clark. 12th editionPearson International edition.
10. Willey JM, Sherwood LM, and Woolverton CJ (2008) Prescott, Harley and Klein'sMicrobiology. 7th edition. McGraw Hill Higher Education.
11. Ian Feshney, Basics of Animal Cell Culture.

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

PAPER 3: REVIEW OF RELATED LITERATURE

(2 CREDITS) **(50 Marks)**

Each student is required to select a problem on which she has to do intensive review of related studies under the supervision of a faculty member or the supervisor. She has to review adequate research studies related to the problem and prepare a report.

Each student is required to present the review of related studies through Power-Point. All the Ph.D. and P.G. students of the Department shall remain present and participate in the discussion. There will be an open viva-voce test after the presentation. Assessment shall be made on the basis the following criteria:

1) Relevance of the reviews.
2) Finding the research gap.
3) Standard and quality of writing the review.
4) Style of presentation.
5) Answering the question by Examiners
6) Clarification of queries raised by the participants.

DISTRIBUTION OF MARKS (Total: 50 Marks)

1) Report submission : 20 Marks
2) Presentation : 20 Marks
3) Viva-voce Test : 10 Marks

PAPER 4: RESEARCH & PUBLICATION ETHICS

(2 CREDITS) **(50 Marks)**

Course outcome

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

- Gain knowledge on different ethical philosophies
- Able to apply the ethics and scientific conduct in relation to research andpublication.
- Adapt best standard practices in research
- Get information on consequences of violating publication ethics
- **A**ble to identify predatory journals and publishers

THEORY

Unit-IA: Philosophy and Ethics (3 hrs)

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

Unit-IB: Scientific Conduct (5 hrs)

Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP); Redundant Publications: duplicate and overlapping publications; Selective reporting and misrepresentation of data.

Unit-IC: Publication Ethics (7 hrs)

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 behaviour, types; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals

PRACTICE

Unit-IIA: Open Access Publishing (4 hrs)

Open Access Publications and initiatives; Online resource to check publisher copyright and self-achieving policies (SHERPA/RoMEO); Software tool to identify

predatory publications developed by SPPU; Journal finder/journal suggestion tools viz. Elsevier finder, Springer, Journal suggester etc.

Unit-IIB: Publication Misconduct (4 hrs)

A. Group Discussion

Subject Specific ethical issues, FFP, authorship; Conflict of interest; Complaints and appeals: examples and fraud from India and abroad

B. Software tools

Use of plagiarism software like Turnitin, Urkund and other open source software tools

Unit-IIC: Database and Research Metrics (7 hrs)

A. Databases

Indexing databases; Citation databases: Web of Science, Scopus. etc.

B. Research Metrics

Impact Factor of journal as per Journal Citation Report; Metrics: h-index, g-index, i10index, altmetrics.

REFERENCES

1. Bird, A. (2006). Philosophy of science. Rutledge.
   MacIntyre, A. (1967). A short history of ethics.
   London.
2. P.Chaddah (2018). Ethics in competitive Research: Do not get scooped; do not get plagiarised.National Academy of Sciences (2009). On being a scientist: A guide to responsible conduct in Research (3rd Ed.), National Academics Press.
3. Resnik, D.B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10.
4. Beall, J. (2102). Predatory publishers are corrupting open access. Nature, 489 (7415), 179-179.
5. Indian National Science Academy (INSA). Ethics in science education, research and governance (2019)

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	5	5
CO2	4	2	4	5	4	2	4	4	2	5
CO3	2	4	4	5	4	2	5	4	2	5
CO4	5	5	4	4	5	4	4	5	4	5
CO5	4	5	5	5	5	4	5	5	4	5