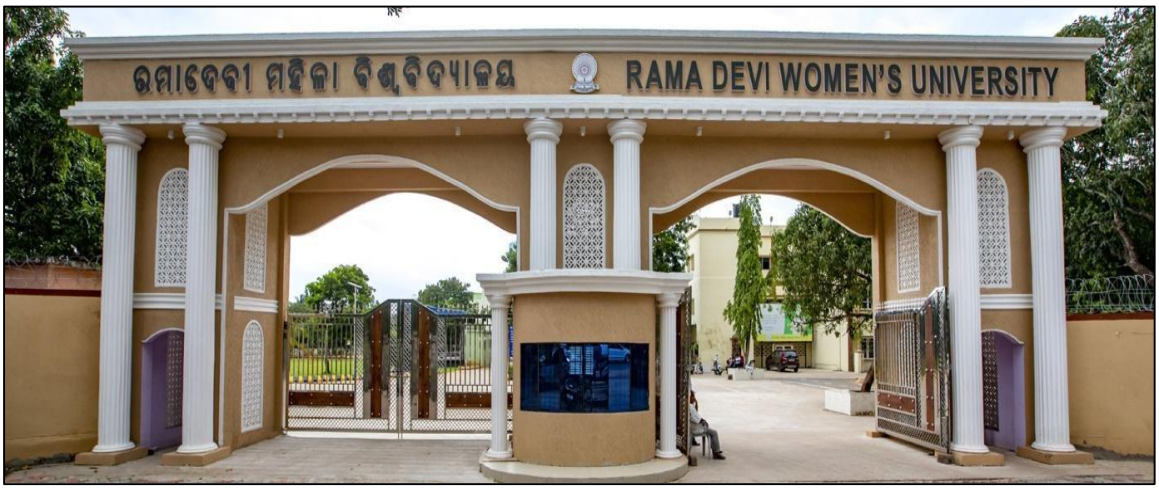
DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS OF UG PROGRAMME (B.Sc.)



RAMA DEVI WOMEN'S UNIVERSITY
Vidya Vihar, Bhubaneswar-751022, Odisha
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DEPARTMENT OF BIOTECHNOLOGY
SYLLABUS OF UG PROGRAMME (B.SC)

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.

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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