SCHOOL OF STUDIES IN BIOTECHNOLOGY

Pt. Ravishankar Shukla University
Raipur 492 010, Chhattisgarh

Syllabus

M.Sc. in Biotechnology
(Semester System)

(Program Code: 0408)

Session
2023-2024
2024-2025

SCHEME OF EXAMINATION FOR SESSION 2023-2025

SCHOOL OF STUDIES IN BIOTECHNOLOGY

PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR

M.Sc. BIOTECHNOLOGY (Semester I to IV) (Program Code: 0408)

First Semester (July 2023 - December 2023)

Paper Code	Paper	Title of Paper	Marks		
			(External)	(Internal)**	Credit
040801	1*	Cell Biology	80	20	4
040802	2*	Genetics	80	20	4
040803	3*	Microbial Physiology	80	20	4
040804	4*	Bio-molecules	80	20	4
040805	LC-1	Lab Course 1 (Based on paper 1 & 2)	80	20	4
040806	LC-2	Lab Course 2 (Based on paper 3 & 4)	80	20	4
		Total	600		24

Second Semester (January 2024 - June 2024)

Paper Code	Paper	Title of Paper	(External)	(Internal)**	Credit
040807	5*	Biostatistics, Bioinformatics & Computers in Biotechnology	80	20	4
040808	6*	Molecular Biology	80	20	4
040809	7*	Plant Biotechnology	80	20	4
040810	8*	Macromolecules & Enzymology	80	20	4
040811	LC-3	Lab Course 3 (Based on paper 5 & 6)	80	20	4
040812	LC-4	Lab Course 4 (Based on paper 7 & 8)	80	20	4
		Total	600		24

Third Semester (July 2024 - December 2024)

Paper Code	Paper	Title of Paper	(External)	(Internal)**	Credit
040813	9*	Genetic Engineering	80	20	4
040814	10*	Biology of Immune System	80	20	4
040815	11*	Bioprocess Engineering & Technology	80	20	4
040816	12*	Environmental Biotechnology	80	20	4
040817	LC-5	Lab Course 5 (Based on paper 9 & 10)	80	20	4
040818	LC-6	Lab Course 6 (Based on paper 11 & 12)	80	20	4
		Total	600		24

Fourth Semester (January 2025 - June 2025)

Paper Code	Paper	Title of Paper	(External)	(Internal)**	Credit
040819	13*	IPR, Biosafety, Bioethics and Nanobiotechnology	80	20	4
040820	14*	Advanced Techniques in Biotechnology	80	20	4
040821	15*	Animal Biotechnology	80	20	4
040822	16*	Genomics & Proteomics	80	20	4
040823	LC-7	Lab Course 7 (Based on paper 13 & 14)	80	20	4
040824	LC-8	Lab Course 8 (Based on paper 15 & 16)	80	20	4
		Total	600		24
		OR			
040825	17	Project Work***	600		24
		Dissertation	240	60	12
		Seminar based on project	160	40	8
		Viva Voce	80	20	4
		Grand Total [Semester I + II + III + IV]	2400		96

18/11/23

*Questions will be asked as per the new policy of question paper, in which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) -type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

**1.Each student will be evaluated continuously throughout the semester.

2. There will be a class test based on each theory paper. The full marks will be 10 for each paper.

3. There will be a poster/oral presentation based on each theory paper. The full marks will be 10 for each presentation.

4. Each student will be required to submit a brief write-up (not more than 20 pages) on his/her poster/oral presentation.

***1. A student of IV semester will have the option to opt for project work in lieu of four theory papers and two lab courses provided he/she secures at-least 65% or more marks in aggregate in semester I and II.

2. The project has to be carried out in recognized national laboratories or UGC recognized universities. No student will be allowed to carry out project in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur.

3. The valuation of all the projects will be carried out by the external examiner and HoD of UTD or its nominee at the UTD Centre.

- M.Sc. Students of Biotechnology have to attend one excursion or visit in one academic year (within or outside Chhattisgarh)

Program Learning Outcomes for M.Sc. Biotechnology

A Master in the Biotechnology program has been assumed to have:

1. An understanding of fundamentals of the life-processes at the molecular level and will be able to design laboratory experiments, manage their execution, and drawing interpretation.
2. Will be able to serve or initiate food-processing industries, sewage treatment plants, brewing industries, biogas plants, bio-fertilizer unit, enzyme production and vaccine development industries.
3. Will have necessary skills for acquisition, organization and processing of data for drawing pinpointed inferences in R&D sectors.
4. Skills for gene sequencing services, primer designing and synthesis, molecular structure prediction, drug discovery and molecular diagnostics.
5. Be able to produce quality-planting materials, at commercial-scale, for horticulture, agriculture, floriculture and forestry applications, following tissue culture technique.
6. Will possess ability to manipulate organisms *via* recombinant DNA technology for bioremediation, gene therapy, diagnostics, disease-models, bio-fuel, crop improvement, protein engineering, and modifying metabolic pathways.
7. Will be assumed to be acquainted with IPR that allows commercialization of the end products of research and provide economic protection to the inventor.

School of Studies in Biotechnology

Scheme of Examination: Semester I

Paper Code	Paper	Title of Theory/Practical Paper	Marks			Credit
			External	Internal**	Total	
040801	1	Cell Biology	80	20	100	4
040802	2	Genetics	80	20	100	4
040803	3	Microbial Physiology	80	20	100	4
040804	4	Bio-molecules	80	20	100	4
040805	LC 1	Based on Theory papers 1, 2	80	20	100	4
040806	LC 2	Based on Theory papers 3, 4	80	20	100	4
		Total Marks			**600**	**24**

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Semester I

Paper 1: Cell Biology (Code: 040801)

M.M.80

Unit-I

1. Cell theory: Discovery and concepts of cell theory.
2. Prokaryotic cells: Structure and function – Cell walls of eubacteria (peptidoglycan) and related molecules: membrane of Gram negative and positive bacteria; Cell wall and cell membrane synthesis; cell inclusion bodies like endospores, gas vesicles.
3. Diversity of cell size and shape; Diversity in prokaryotic and eukaryotic cells.

Unit-II

1. Eukaryotic cells: Cell wall; plasma membrane; endoplasmic reticulum; golgi apparatus; lysosome; peroxisome; ribosome; mitochondria; chloroplast; nucleus; nucleolus; chromosome.
2. Transport of nutrients and macromolecules: Osmosis; ion channels; ion pumps; transport across membranes- active transport; passive transport; Molecules diffusion across membrane, nuclear transport; molecular mechanisms of transport; regulation of intracellular transport in endoplasmic reticulum, golgi bodies, mitochondria, chloroplast; intracellular vesicular trafficking.

Unit-III

1. Mitosis, meiosis and their regulation; steps in cell cycle; Checkpoints and Cell cycle arrest, regulation of cell cycle; cell-cell interactions.
2. Cell signaling: Cellular receptors; Role of G- proteins coupled receptors, Tyrosine kinase receptor in cell signal transduction; signal transduction pathways; second messengers: cAMP; regulation of signaling pathways, ZAK STAT pathway, MAP kinase pathway.
3. Cell motility: Microtubules, cilia and flagella of eukaryotes and prokaryotes, Structure and function of flagella and cilia.

Unit-IV

1. Production of gametes- Spermatogenesis and oogenesis; cell surface molecules in sperm-egg interaction in animals; molecular events during fertilization in animals, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis.
2. Development in *Drosophila melanogaster* and floral development in *Arabidopsis thaliana*; gene expression and its regulation in drosophila development; Spatial and temporal regulation of gene expression.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Gerald Karp (2007) Cell and Molecular Biology.Fifth Edition.
2. Geoffrey M. Cooper; Robert E. Hausman(2009) The Cell: A Molecular Approach.
3. C.B. Powar (2005) Cell Biology. Third Edition.
4. Tortora, Funke and Case (1998) Microbiology: An introduction. Sixth Edition Binjamin/Cummings Publishing Co.
5. Lewis J. Klein smith and Valerie M. Kish (2002) Principlesof cell and molecular biology. Third Edition.
6. P. K. Gupta (2003) Cell and molecular biology. Second Edition, Rastogi publications.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
8. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
9. Cooper, G. M., &Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
10. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.

List of Practicals:

1. To prepare the temporary stained slide of onion bulb peel to study the structure of plant cell.
2. To prepare the temporary stained slide of cheek squamous epithelial cells of mouth of Human Beings.
3. Preparation and Study of slide of mitosis using from onion root tips squash.
4. Schedule for study of mitotic index.
5. To determine the abnormal mitotic index.
6. Preparation and study of slide for meiosis using young anthers of *Allium cepa.*
7. To determine the meiotic index in the flower bud of *Allium cepa.*

Learning Outcomes:

1. This paper focuses upon the understanding of fundamental structure and functions of a cell at the molecular level.
2. It lays a strong foundation in core areas of biology such as cell structure, cell division, gametogenesis, embryo development, central dogma of life, cell signaling,*etc.*
3. Student will be able to conduct studies on cell organization and function, mechanisms of gene expression, cellular bioinformatics, cell signaling, cell differentiation, *etc.*
4. Will be able to design and execute laboratory experiments on molecular and cellular aspects, and interpretation of observations.

Employability/ Skill Development:

1. Can be able to conduct research on cell organization and function, including mechanisms of gene expression, cellular bioinformatics, cell signaling, or cell differentiation in research laboratories.
2. Widespread scope of designing cellular laboratory experiments, oversee their execution, and interpretation of results in universities and academic institutions.

School of Studies in Biotechnology

Semester I

Paper 2: Genetics (Code: 040802)

M.M. 80

Unit I

1. Introduction to genetics; beginning of genetics as a science. Early studies involving genetics.
2. Mendelian inheritance, physical and chemical basis of heredity.
3. Non-Mendelian inheritance, Gene to Phenotype – Interactions between the Alleles of one gene, interfering gene interaction
4. Fine structure of gene, Organization of prokaryotic and eukaryotic genome, DNA supercoiling, Chromatin organization-histone and DNA interactomes.

Unit II

1. Regulation of gene expression in prokaryotes – Operon concept, Lac and Trp operon, positive and negative regulation of Lac operon. Transcriptional attenuation of Trp operon, Regulation of gene expression in eukaryotes by chromatin structure - epigenetic modifications of chromatin. Role of DNA methylation and histone modifications in the regulation of gene expression.
2. Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Mutagens – UV and chemical mutagens.
3. Structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, ploidy and their genetic implications. dosage compensation; mutational assay system
4. Inheritance: autosomal and sex linked inheritance, extra chromosomal inheritance, inheritance of organelle genes.

Unit III

1. Variation; sources of variation; Selection; Heritability of variation, process of speciation; Origin of new genes. Hardyweinberg genetic equilibrium.
2. Genes and Quantitative traits; Genotypes and Phenotypic distribution; heritability of quantitative character; Quantifying Heritability; Polygenic inheritance, locating genes, QTL mapping
3. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Unit IV

1. Bacterial Genetic system: Transformation, Conjugation, Transduction. Bacterial genetic map with reference to *E.coli.*
2. Viruses and their Genetic system: Phage I and its life cycle; RNA viruses; Retroviruses
3. Genetic system of Yeast and Neurospora.
4. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:-

1. Benjamin Pierce (2017). Genetics: A Conceptual Approach. Sixth Edition, W. H. Freeman
2. Griffiths, William M. Gelbart, Jeffrey H. Miller, Richard C. Lewontin and Anthony J.F. Griffiths (2009). Modern Genetic Analysis. W. H. Freeman
3. D. Peter Snustad, Michael J. Simmons (2007). Principles of Genetics. Wiley India Pvt Ltd.
4. Sandy Primrose and Richard Twyman (2016). Principles of Gene Manipulation and Genomics. Wiley-Blackwell

List of Practical's:

1. Demonstration of Mendel's experiments.
2. Studies of prokaryotic & eukaryotic cells.
3. Perform karyotype and determine the genetic abnormality of the given sheet.
4. To Performance and study of Mutation in bacteria.
5. To study polyploidy in onion root tips after treatment with colchicine.
5. To demonstrate Barr body in cheek squamous epithelial cells of mouth of Human.
6. Isolation of genetic material from Bacteria.

Learning Outcomes:

1. Genetics is one of the fastest developing fields of biology. This course will provide an overview of the core concepts and key principles behind inheritance and expression of characters.
2. Advanced topics such as gene interaction, evolutionary genetics and gene regulation will further expand student's knowledge.
3. Study of molecular basis of transmission of genetic diseases will lay ground work for discovery of effective diagnosis, cure and prevention of genetic disorders.
4. It will also introduce modern technologies and methods used in studying prokaryotic and eukaryotic genetics.
5. This paper will generate knowledge on selective breeding, anther culture, population development, genetic and physical mapping, diagnosis of genetic diseases, hybridity testing methods, *etc.*
6. RGA methods will also be taught for an effective business development in this area.
7. Student will possibly be able to suggest a few easier tools that can be followed to sequence the whole genome at organizations such as hospitals, research institutions, universities, pharmaceutical companies, agricultural and horticultural companies, genetic engineering companies,*etc.*

Employability/ Skill Development:

1. Selective breeding, anther culture, breeding population development, genetic and physical mapping can be , genetic disease diagnosis, hybridity testing methods, RGA methods can be taught for an effective business development in this area.
2. On the basis of the knowledge of genetics, easy tools can be developed to sequence the whole genome in organizations such as Hospitals, Research institutions, Universities, Pharmaceutical companies, agricultural and horticultural companies, biotechnology and genetic engineering companies.

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Semester I

Paper 3: Microbial Physiology (Code: 040803)

M.M. 80

Unit I

1. Microbial Evolution, Systematics and Taxonomy –New approaches to bacterial taxonomy classification including ribotyping; Ribosomal RNA sequencing; Characteristics of primary domains; Nomenclature and Bergey's Manual.

2. Microbial Growth – growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, nutrient supplements, water availability and oxygen.

Unit II

1. Methods in Microbiology – Isolation and Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Types of culture media: defined and undefined media, selective and differential media, minimal and enrichment media; Enrichment culture techniques for isolation of chemoautotrophs, chemohetrotrophs and photosynthetic microorganisms.

2. Metabolic Diversity among Microorganisms – Photosynthesis in microorganisms; Calvin cycle; Chemolithotrophy; oxidizing and reducing bacteria; Methanogenesis and acetogenesis, syntrophy, nitrogen metabolism; Nitrogen fixation.

Unit III

1. Bacteria:Purple and green bacteria; Cyanobacteria; Homoacetogenic bacteria; Acetic acid bacteria; Spirilla; Spirochaetes; Pseudomonads; Lactic and propionic acid bacteria; Endospore forming rods and cocci; Mycobacteria; Chlamydia's and Mycoplasmas.

2. Archaea: Archaea as earliest life forms; Halophiles; Methonogens; Hyperthermophilic Archaea; Thermoplasma.

3. Algae, Fungi, Slime moulds and Protozoa. Viruses: Bacterial, Plant and Animal viruses; Discovery, classification and structure of viruses; Lysogeny; DNA viruses; RNA viruses; Examples of Herpes, Pox, Adenoviruses, Retroviruses.

Unit IV

1. Microbial diseases –Infectious disease transmission; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (rabies, plague), insects and ticks (Rickettsias, Lime disease)

2. Host – Parasite Relationships – Normal microflora of Skin, Oral cavity, Gastrointestinal tract; Types of toxins (Exo –, Endo -, Entero -); Virulence and Pathogenesis.

3. Chemotherapy/Antibiotics – Antibiotics and Antimicrobial agents; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Roger Y. Stanier, John L Ingraham, Mark L Wheelis, Rage R Painter (1992) General Microbiology. Fifth edition. The Macmillanb Press Ltd.
2. Michael T. Madigan, John Martinko, Jack Parker Brock Biology of Microorganisms. Tenth edition, Prentice-Hall.
3. Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. (2009) Microbiology. Tata McGraw Hill
4. Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Jones (1994) Microbial Genetics. Second edition, Bartlett Publishers.
5. James G. Cappuccino & Natalie Sherman (1996) Microbiology: A Laboratory Manual. Benjamin-Cummings Pub Co.
6. Lansing Prescott, John Harley, and Donald Klein (2001) Microbiology. Fifth edition. McGraw Hil
7. Tortora, Funke and Case (2016) Microbiology. Tenth Edition, Pearson Education.
8. L Y Kun (2003) Microbial Biotechnology: Principles and applications, Microbiology and Environmental Toxicology, Sharad Saxenda, Published by Manglam Publications.
9. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M. & Willey, J. M. (2011). Prescott's Microbiology. New York: McGraw-Hill.
10. Matthai, W., Berg, C. Y. & Black, J. G. (2005). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.
11. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.

List of Practical's:

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slants and stab cultures. Storage of microorganisms.
3. Isolation of pure culture from soil and water.
4. Growth; Growth curve; Measurement of bacterial population by turbidity and serial dilution methods. Effect of temperature, pH and carbon nitrogen sources on growth.
5. Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain, staining for spores and lactophenol cotton blue mount.
6. Study of mutations by Ames test.
7. Assay of antibiotics and demonstration of antibiotics resistance.
8. Analysis of water for portability and determination of MPN.
9. Biochemical characterization of selected microbes.

Learning Outcomes:

1. This course will emphasize knowledge on diverse areas of microbiology such as bacteriology, virology, microbial evolution and applied microbiology, and will equip the students with basic as well as advanced techniques that are popularly used in these fields.
2. It will promote better understanding of microbial diseases and their prevention by in depth study of host pathogen interaction, microbial evasion of immune system, and mode of action of various antimicrobial agents.
3. As there is a huge demand for new antibiotics in the world, study of microbiology is of utmost importance for human health care and drug development.
4. The students will possibly initiate small-scale food processing industries, sewage treatment plants, brewing industries, biogas plants, bio-fertilizer plant, and vaccine development units as start-ups.

Employability/ Skill Development:

1. Small-scale food processing industries, Sewage treatment plants, brewing industries, biogas plants, bio-fertilizer and vaccine development units can be initiated as start-ups.

School of Studies in Biotechnology

Semester I

Paper 4: Biomolecules (Code: 040804)

M.M. 80

Unit I

1. Chemical foundations of Biology – Weak bonds, Ionization of water, pH scale, p*K*a of weak acids, buffers in biological system, relationship of pH, p*K*a and buffer.
2. Principles of thermodynamics and living system.

Unit II

1. Carbohydrate: Monosaccharides- Aldose and Ketose, Asymmetric centers, Cyclic structures, Hexose derivatives, Reducing agents; Disaccharides, Polysaccharides- Structural feature and roles of Homo polysaccharides and Hetero polysaccharides
2. Glycogen metabolism: Glycogenesis and Glycogenolysis

Unit III

1. Amino acids – Structural features, Classification based on R group, Uncommon amino acids in proteins, Titration curves of amino acids.
2. Proteins – Hierarchy in structure, Ramachandran plot; Primary, Secondary, Super-Secondary, Tertiary and Quaternary Structures; End group analysis.

Unit IV

1. Lipids and Fat: Introduction, Classification, Storage lipids, Structural lipids in Biological Membranes, Lipids as Signals, Vitamins and Pigments,
2. Fatty acid metabolism: Fatty acid Biosynthesis and Catabolism
3. Heterocyclic compounds in living system- Nucleotides, Plant Pigments, Isoprenoids.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Nelson and Cox (2009). Principles of Biochemistry. Fifth Edition.
2. Albert L. Lehninger (2005). Biochemistry. Second Edition.
3. Todd and Howards Mason (2004). Text book of Biochemistry. Fourth Edition.
4. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer (2007). Biochemistry, Sixth Edition
5. Voet D, Voet JG & Pratt CW (2006). Fundamentals of Biochemistry Second Edition. Wiley.
6. Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil (2007). Harper's Illustrated Biochemistry, 28th Edition.
7. Buchanan, Gruissemen& Jones (2015). Biochemistry & Molecular Biology of Plant, 2nd edition.
8. M. Debnath (2011). Tools and Techniques in Biotechnology.

List of Practical's:

1. Qualitative test for Carbohydrate. (Molisch's test)
2. Qualitative test for Carbohydrate.(Anthrone test)
3. Qualitative test for Carbohydrate.(Benedict's test)
4. Qualitative analysis of Carbohydrate by Barfoed's test.
5. Qualitative test for amino acid by Ninhydrin reaction.
6. Qualitative test for amino acid by Xanthoprotic reaction.
7. Qualitative test for Proteins using Biuret test.
8. Qualitative test for amino acid by Millon's test.

Learning Outcomes:

1. Biochemistry is the foundation of all the metabolic processes that occurs within a cell.
2. This course will develop a deep understanding of basic properties and interactions of biomolecules as life processes are studied closely at atomic and molecular levels.
3. The study of basic building blocks of life and energy metabolism will clarify underlying principles of life.
4. As biochemistry links all the other fields of biology, its application is boundless.
5. Widespread scope in biomedical research like discovery of new drugs for treating various diseases, *etc.*
6. Will be able to apply gathered knowledge in various industries engaged in enzyme production, purification, characterization, *etc.*
7. Will be capable to initiate start-ups for developing biochemical test based kits for detection of various diseases and other contaminants.

Employability/ Skill Development:

1. Widespread scope in biomedical research like discovery of new drugs for treating various diseases, *etc.*
2. Can be employed in various industries engaged in enzyme production, purification, characterization, etc.
3. Can initiate start-ups for developing biochemical test based kits for detection of various diseases and other contaminants.

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Lab Course 1(Code: 040805)

Based on Theory Papers 1 and 2

Time: 6 hrs.	**Total Marks – 100**
Q.1 Experiment based on Theory paper 1 (one major & one minor)	30
Q.2 Experiment based on Theory paper 2. (One major & one minor)	30
Q.3 Spotting based on Theory paper 1 and 2	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
Students will gain expertise in cell biology and genetics. They flurish with knowledge of cell and genetics of life. Students can participate in various laboratories to study cellular reponses and genetic analysis. Student will possibly be able to suggest a few easier tools that can be followed to sequence the whole genome at organizations such as hospitals, research institutions, universities, pharmaceutical companies, agricultural and horticultural companies, genetic engineering companies, *etc.*

Lab. Course 2(Code: 040806)

Based on Theory Papers 3 and 4

Time: 6 hrs.	**Total Marks – 100**
Q.1 Experiment based on Theory paper 3 (one major & one minor)	30
Q.2 Experiment based on Theory paper 4 (one major & one minor)	30
Q.3 Spotting based on Theory paper 3 and 4	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
It will help in gaining knowledge and idea about microbial diversity, their importance and their handling. It will also give knowledge of different biomolecules of life. Students will be capable to initiate start-ups for developing biochemical test based kits for detection of various diseases and other contaminants.

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Semester II

Scheme of Examination

Paper Code	Paper	Title of Theory/Practical Paper	Marks			Credit
			External	Internal**	Total	
040807	5	Biostatistics, Bioinformatics & Computers in Biotechnology	80	20	100	4
040808	6	Molecular Biology	80	20	100	4
040809	7	Plant Biotechnology	80	20	100	4
040810	8	Macromolecules & Enzymology	80	20	100	4
040811	LC 3	Based on Theory papers 5, 6	80	20	100	4
040812	LC 4	Based on Theory papers 7, 8	80	20	100	4
		Total Marks			**600**	**24**

School of Studies in Biotechnology

Semester II

Paper 5: Biostatistics, Bioinformatics & Computers in Biotechnology (Code: 040807)

M.M. 80

Unit I

1. Brief description of data and its types; sampling; tabulation of data and its graphical representation.
2. Measures of central tendency and dispersion: mean, median, mode, range, standard deviation, Standard error and variance. Idea of two types of errors- Type I & Type II error and level of significance; hypothesis testing.

Unit II

1. Simple linear regression: negative and positive; correlation: negative and positive.
2. Test of significance: F test, t test: one sample t-test, matched pair and two sample t-test; chi – square test: goodness of fit, test of independence, test of homogeneity; analysis of variance.

Unit III

1. Introduction to Word processing, Spreadsheets and Presentation software.
2. Computer oriented statistical techniques in MS Excel: Frequency table of single discrete variable, Computation of mean, variance and standard deviation.

Unit IV

1. Bioinformatics: introduction and its applications.
2. Data Base: Types of database, Protein and nucleic acid databases; Sequence alignment- Global and local alignment, pair wise alignment techniques, multiple sequence alignment.
3. Identification of protein sequence from DNA sequence; NCBI; DDBJ; EMBL; different tools of bioinformatics; database mining tools.
4. BTIS network in India.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Animesh K. Dutta (2007). Basic Biostatistics and Its Application. New Central Book Agency (P) Ltd. Kolkata.
2. P.K. Banerjee (2006). Introduction to Biostatistics. 3rd edition. S. Chand & Company Ltd.
3. C.S.V. Murthy (2003). Bioinformatics. First Edition, Himalaya Publishing House.
4. S.C. Rastogi, Namita Mendiratta, Parag Rastogi (2003) Bioinformatics: Concepts, Skills and Applications, CBS Publishers and Distributors, New Delhi.
5. C. Subramanian (2004) . A Text Book of Bioinformatics. Dominant Publishers and Distributors, New Delhi.
6. David W. Mount (2005). Bioinformatics: sequence and genome analysis. Second edition. CBS Publishers and Distributors, New Delhi, Bangalore (India).
7. David W. Mount (2004). Bioinformatics: sequence and genome analysis; CSHL press
8. C.S.V. Murthy (2003). Bioinformatics. First Edition, Himalaya Publishing House.
9. Johnathan Pevsner (2015). Bioinformatics and Functional, 3nd edition.
10. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
11. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
12. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
13. Baxevanis, A. D. & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
14. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
15. Bourne, P. E., &Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

List of Practical's:

Biostatistics

1. Calculate the mean value of given leaves samples.
2. Calculate the median of the given sample of leaves samples.
3. Find out the mode value of given leaves samples.
4. To determine correlation between given samples.
5. To perform the t-test of the given data/ sample.
6. To perform the Chi- Square test of given data.
7. To calculate standard deviation, and variance of the data set.

Computer Application

1. Draw Histogram, Pie, Graph, Line graph.
2. Prepare presentation using MS Power point software.
3. Use of Internet in biotechnological Research.
4. Perform various applications of spreadsheet.
5. Calculate various statistical parameters using MS Excel

Bioinformatics

1. Search nucleotide sequence of a target gene on NCBI website, align, and compare with other database using BLAST tool.
2. Find out amino acid sequence of a particular protein from protein database available on public domain and compare it with other proteins.

Learning Outcomes:

1. This course will impart knowledge on skills and techniques to be followed for meaningful data acquisition, handling, tabulation, organization and processing for fruitful results.
2. This course is sincerely designed to promote computer literacy and understanding of computer-based applications involved in simulation, visualization, and analyzing biological information.
3. There is a widespread scope for biostatistician in medical research, clinical decision-making, and health management.
4. Knowledge imparted on bio-statistical tools and techniques could be helpful to improve research outcomes through accurate, precise and truthful interpretations.
5. Computational biology will probably boost the R&D *via in silico* experiments, and administrating the large databases of biological experiments.

Employability/ Skill Development:

1. There is a widespread scope of biostatistician in medical research, clinical decision-making, and health management.
2. Bio-statistical knowledge could be helpful to frequently improve research outcomes through accurate, precise and truthful interpretations.
3. Computational biology boosts the R&D via *in silico* experiments, administrating the large databases of experimental biological data.
4. Can be employed in various sectors as Bio-analytics, Clinical pharmacologists, Computational chemists, Database designer and maintainer, Proteomics analyzer, Pharmacogenomics analyzer, Pharmacologists, Sequence assembly analyzer, Informatics developers.

School of Studies in Biotechnology

Semester II

Paper 6: Molecular Biology (Code: 040808)

M.M.80

Unit I

1. Introduction to Molecular Biology
2. DNA Replication – Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication in prokaryotes and eukaryotes. Enzymes and accessory proteins involved in DNA replication.
3. DNA Repair- DNA repair pathways – Mismatch repair, Base excision repair, Nucleotide excision repair, Non-homologous end joining pathway and Recombinational repair.
4. Recombination- Homologous and recombination, gene targeting i.e. FLP/FRT and Cre/Lox recombination, RecA and other recombinases.

Unit II

1. Transcription – Prokaryotic transcription: RNA polymerase, Regulatory elements and mechanisms of transcription regulation, Transcription termination.
2. Transcription – Eukaryotic transcription: RNA polymerase, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation.
3. Post-transcriptional processing events-capping, splicing of introns and polyadenylation, Processing of Pre-ribosomal RNA and the assembly of ribosomes, Structure and the maturation of tRNAs and mRNA stability.

Unit III

1. Genetic code, degeneracy of codons, Wobble hypothesis, codon bias, Mechanism and fidelity of amino acyl tRNAsynthetases.
2. Translation – Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation.
3. Co – and post – translational modifications of proteins. Protein Localization – Synthesis of secretary and membrane proteins and receptor mediated endocytosis.

Unit IV

1. Oncogenes and Tumor Suppressor Genes – Viral and cellular Oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins.
2. Antisense and Ribozyme technology – Molecular mechanism of Antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping. Biochemistry of ribozyme; hammer – head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of Antisense and ribozyme technologies.
3. Molecular Mapping of genome – Genetic and physical maps, physical mapping and map – based cloning, Southern and fluorescence *in situ* hybridization for genome analysis, Chromosome micro dissection and micro cloning.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Gerald Karp (2007). Cell and molecular biology, 5th Edition.
2. Lewis J. Klein smith and Valerie M. Kish (2002). Principles of cell and molecular biology, Third Edition.
3. Richard M. Twyman (1998). Advanced Molecular Biology, First South Asian Edition,Viva Books Pvt. Ltd.
4. Benjamin Lewin (2007). Gene IX, 9th Edition, Jones and Barlett Publishers.
5. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner (2007) Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc.
6. TA Brown (2002). Genomes 2nd Edition; Bios Scientific Publishers.
7. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh and Paul Matsudaira(2008). Molecular Cell Biology, 6th Edition; WH Freeman.
8. Buchanan, Gruissemen& Jones (2015). Biochemistry & Molecular Biology of Plant, 2nd edition.
9. M. Debnath (2011). Tools and Techniques in Biotechnology.
10. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
11. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
12. Cooper, G. M., &Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM; Sunderland.

List of Practicals:

1. Extraction of DNA from plant leaves by CTAB methods.
2. Estimation of plant genomic DNA by Spectrophotometer methods.
3. Separation of plant genomic DNA by Agarose gel electrophoresis.
4. Extraction of DNA from animal cells.
5. Estimation of animal genomic DNA by Spectrophotometer methods.
6. Separation of animal genomic DNA by Agarose gel electrophoresis.
7. Separation of Bacterial proteins by vertical SDS-PAGE electrophoresis.
8. Extraction of RNA from Yeast cells.
9. Estimation of Yeast cellular RNA by Spectrophotometer methods.

Learning Outcomes:

1. This course focuses molecular mechanisms underlying DNA replication, transcription, translation, protein synthesis, *etc.*
2. Furthermore, oncogenesis, antisense technology and molecular mapping have been included to establish a coherent connection with the core topics.

3. Entrepreneurship and technical skills for important services like gene sequencing, whole genome sequencing, primer designing and synthesis, molecular structure prediction, DNA sequence assembly analysis, will be imparted.
4. Will be able to diagnose cancerous/diseased cells following standard procedures.
5. Will possibly be employed in any of the molecular biology based industries or be able to develop diagnostic kits based on molecular/ biochemical reactions.

Employability/ Skill Development:

1. Skills for Molecular Biology services like gene sequencing services, whole genome services, primer designing and synthesis, molecular structure prediction, DNA sequence assembly, Cancerous/diseased cell diagnosis can be imparted for entrepreneurship development.
2. Can be employed in any of the molecular biology based industries or be able to develop certain diagnostic kits based on molecular reaction.

School of Studies in Biotechnology

Semester II

Paper 7: Plant Biotechnology (Code: 040809)

M.M. 80

Unit I

1. Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids.
2. Tissue culture media (composition and preparation)
3. Initiation and maintenance of callus and suspension culture; single cell clones.
4. Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil
5. Shoot – tip culture: Rapid clonal propagation and production of virus free plant

Unit II

1. Embryo culture and embryo rescue
2. Anther, pollen and ovary culture for production of haploid plants and homozygous lines
3. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
4. Germplasm conservation – Cryopreservation and slow growth cultures

Unit III

1. Plant transformation technology: Basis of tumor formation, Mechanism of DNA transfer, Features of TI and RI plasmids, role of virulence genes, use of Ti and Ri as vectors, binary vectors, markers, use of reporter genes, 35S and other promoters, multiple gene transfers, particle bombardment, electroporation, microinjection.
2. Chloroplast Transformation: Advantages, vectors
3. Application of plant transformation for productivity and performance: herbicide resistance, insect resistance, Bt genes, Non – Bt like protease inhibitors & amylase inhibitors, virus resistance, nucleocapsid gene, disease resistance, PR proteins, nematode resistance, abiotic stress, long shelf-life of fruits and flowers, male sterile lines, bar and barnase systems.

Unit IV

1. Metabolic Engineering and Industrial Products: *In vitro* production of plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines.
2. Molecular Marker –RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence characterized amplified regions), SSCP (Single strand conformational polymorphism), AFLP, map based cloning, molecular marker assisted selection.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:-

1. Razdan MK (2010). Introduction to Plant Tissue Culture 2nd Edition; Oxford &Ibh Publishing Co. PvtLtd.
2. Vasil IK (1994). Plant Cell and Tissue Culture; Springer.
3. Bhojwani SS and Razdan MK(1996). Plant Tissue Culture; Elsevier.
4. TJ Fu, G Singh and WR Curtis (Eds) (1999). Plant Cell and Tissue Culture for the production of Food Ingredient. Kluwer Academic/Plenum Press.
5. J Hammond, P McGarvey& V Yusibov (Eds)(2000). Plant Biotechnology, Springer Verlag.
6. H.S. Chawla (1998). Biotechnology in Crop Improvement, International Book Distributing Company.
7. H.S. Chawla (2000). Introduction to plant biotechnology. Oxford & IBH Publishing Co. (P) Ltd.
8. Buchanan, Gruissemen& Jones (2015). Biochemistry & Molecular Biology of Plant, 2nd edition.
9. M. Debnath (2011). Tools and Techniques in Biotechnology
10. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
11. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
12. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.
13. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.

List of Practical's:

1. Media preparation
2. Meristem / bud culture, shoot multiplication & rooting
3. Callus culture
4. Organogenesis
5. Somatic embryogenesis
6. Plantlet acclimatization
7. Embryo culture
8. Extraction of DNA from plant tissue
9. Estimation of DNA by spectrophotometer and its separation following agarose gel electrophoresis
10. Study of molecular markers

Learning Outcomes:

1. This course will introduce knowledge on basic principles and techniques of plant tissue culture.
2. It will impart through knowledge on both basic and applied aspects of this technique in large-scale production of agronomically and commercially important plants, production of disease free plantlets, and genetic engineering to develop plants with desirable characters.
3. Will be capable to go for genetic modification of existing plant species to lower the cost of food production, to increase yield, produce food materials of higher nutritional values, disease-free crop production, and restoration of endangered species.
4. Will possibly be able to initiate tissues culture based industries such as floriculture, horticulture,*etc.*

Employability/ Skill Development:

1. Scope in agriculture field, which concentrate on the genetic modification of existing plant species to lower the cost of food production, to increase yield, to produce food of higher nutritional value, disease-free crop production, and restoration of endangered species.
2. Can be able to initiate plant tissues culture industries, floriculture industries, orchid production, etc.

School of Studies in Biotechnology

Semester II

Paper 8: Macromolecules and Enzymology (Code: 040810)

M.M. 80

Unit I

1. Macromolecules and supra molecules assemblies – Types of macromolecules in biological systems,
2. Molecular assemblies like membranes, ribosomes, extracellular matrix, chromatin
3. Sequencing of proteins and nucleic acids.

Unit II

1. Protein – protein and protein – ligand interactions, physical and chemical methods of study.
2. Conformational properties of polynucleotide's and polysaccharides – secondary and tertiary structural features and their analysis – theoretical and experimental; protein folding – biophysical and cellular aspects

Unit III

1. Enzyme catalysis in solution – kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences.
2. Physical and chemical methods for immobilization of enzyme.
3. Glyco and lipoproteins – structure and function

Unit IV

1. Protein denaturation
2. Ribozymes and Catalytic antibodies – Functional proteins – structure and drug targets (enzymes and receptors)
3. Nucleic acid hybridization – structural analysis and biological study.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Nelson and Cox (2009). Principles of Biochemistry, 5th Edition.
2. Albert L. Lehninger(2005). Biochemistry, Second Edition.
3. Todd and Howards Mason (2004). Text book of Biochemistry, Fourth Edition.
4. Jeremy M. Berg, John L. Tymoczko and LubertStryer(2007). Biochemistry, 6th Edition.
5. Voet D, Voet JG & Pratt CW (2006). Fundamentals of Biochemistry, 2nd Edition. Wiley
6. Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil (2007). Harper's Illustrated Biochemistry, 28th Edition
7. M. Debnath (2011). Tools and Techniques in Biotechnology.

List of Practicals:

1. Qualitative assay of protein by the Biuret method.
2. Quantitative estimation of protein by following Folin Lowry Method.
3. Estimation of cholesterol by the method of Crawford
4. Determine activity of alkalieprotease.
5. Determine activity of neutral protease.
6. Effect of temperature on activity of α-amylase.
7. Determine activity of catalase.
8. Determine activity of urease.
9. Separation of protein by SDSPAGE.
10. Determination of enzyme kinetics.

Learning Outcomes:

1. It will provide basic understanding of structure and conformation of various biomolecules, more especially proteins.
2. This paper will impart knowledge on core principles behind enzyme structure, function and mechanism of action.
3. Imparted knowledge can be used for setting up of industries for enzyme purification, characterization, possible applications, *etc.*
4. Produced enzymes could be used as a tool in the areas such as industries of consumable products and medicine, and in agriculture sector for enhanced production and improvement of crops.

Employability/ Skill Development:

1. Above knowledge can be used for setting up industries such as for enzyme purification, characterization, etc. Produced enzymes could be used as a tool in the areas such as industries for production of consumable products, in medicine, agriculture field for enhanced crop production and improvement.

School of Studies in Biotechnology

Lab Course 3 (Code: 040811)

Based on Theory Papers 5 and6

Time: 6 hrs. **Total Marks – 100**

Q.1 Experiment based on Theory paper 5 (one major & one minor)	30
Q.2 Experiment based on Theory paper 6 (one major & one minor)	30
Q.3 Spotting based on Theory papers	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
Knowledge imparted on bio-statistical tools and techniques could be helpful to improve research outcomes through accurate, precise and truthful interpretations. Computational biology will probably boost the R&D *via in-silico* experiments, and administrating the large databases of biological experiments. Will be able to diagnose cancerous/ diseased cells following standard procedures. Will possibly be employed in any of the molecular biology based industries or be able to develop diagnostic kits based on molecular/ biochemical reactions.

Lab Course 4 (Code: 040812)

Based on Theory Papers 7 and 8

Time: 6 hrs. **Total Marks – 100**

Q.1 Experiment based on Theory paper 7(one major & one minor)	30
Q.2 Experiment based on Theory paper 8 (one major & one minor)	30
Q.3 Spotting based on Theory papers	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill development:
Students will be capable to go for genetic modification of existing plant species to lower the cost of food production, to increase yield, produce food materials of higher nutritional values, disease-free crop production, and restoration of endangered species. Will possibly be able to initiate tissues culture based industries such as floriculture, horticulture, etc. Imparted knowledge can be used for setting up of industries for enzyme purification, characterization, possible applications, etc. Produced enzymes could be used as a tool in the areas such as industries of consumable products and medicine, and in agriculture sector for enhanced production and improvement of crops.

School of Studies in Biotechnology

Semester III

Scheme of Examination

Paper Code	Paper	Title of Theory/Practical Paper	Marks			Credit
			External	Internal**	**Total**	
040813	9	Genetic Engineering	80	20	100	4
040814	10	Biology of Immune System	80	20	100	4
040815	11	Bioprocess Engineering & Technology	80	20	100	4
040816	12	Environmental Biotechnology	80	20	100	4
040817	LC 5	Based on Theory papers 9, 10	80	20	100	4
040818	LC 6	Based on Theory papers 11, 12	80	20	100	4
		Total Marks			**600**	**24**

School of Studies in Biotechnology

Semester III

Paper 9: Genetic Engineering (Code: 040813)

M.M. 80

Unit I

1. Scope of Genetic Engineering.
2. Cloning and patenting of life forms. Genetic engineering guidelines.
3. Molecular tools and their application: Restriction enzymes, modification enzymes, molecular markers.
4. Nucleic acid purification, yield analysis
5. Nucleic acid amplification and its applications: Polymerase Chain Reaction (PCR), Reverse transcriptase PCR, Multiplex PCR, Quantitative PCR

Unit II

1. Cloning vectors: Plasmids, bacteriphages, phagemids, cosmids, Artificial chromosomes
2. Restriction Mapping of DNA Fragments and Map Construction, Nucleic acid sequencing.
3. cDNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening.
4. Cloning interacting genes – Two and three hybrid systems. Nucleic acid micro array assay.

Unit III

1. Site – directed mutagenesis and protein engineering.
2. DNA Transfection, Southern blot, Northern blot, Western blot, Primer extension, S1 mapping, RNase protection assay, and reporter assays.
3. Expression Strategies for hetrologous genes: Vector engineering and codon optimization, host engineering; expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants
4. Phage display: Technique and applications

Unit IV

1. Processing of recombinant Proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
2. T – DNA and transposon tagging: Role of gene tagging in gene analysis, t – DNA and transposon tagging, Identification and isolation of genes through T – DNA or transposon; Targeted gene replacement, Chromosome engineering. Cisgenesis, intragenesis and genome editing by CRISPR-CAS.
3. Gene therapy: Vector engineering. Strategies of gene delivery – Viral & non-viral, gene knockout, gene augmentation, gene correction / gene editing, gene regulation and silencing.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Philip M. Gilmaritin(2005). Molecular Plant Biology. Edition Oxford University Press.
2. TA Brown (2005). Gene Cloning and DNA Analysis. 4th Edition.
3. Rusell and Peter (2002). Genetics Edition. Pearson Education, Inc, San Francisco.
4. Old and Primrose (2001). Principles of Gene Manipulation. 6th Edition.
5. B.D. Singh (2004) Biotechnology: An Expanding Horizons, 1st Edition.
6. W.H. Elliott and D. C. Elliott (2001). Biochemical and Molecular Biology. 2nd Edition.
7. Eldon John Gardner, Michael J. Simmons and Peter Snustad (1991) Principles of Genetics.Eigth Edition, John Wiley and Sons, INC.
8. Benjamin Lewin (2007). Genes IX. 9th Edition Pearson Education International.
9. HD Kumar (2003). Modern Concepts of Biotechnology. Third reprint Edition, Vikas Publishing House. Pvt. Ltd.
10. Brown TA (2006). Genomes, 3rd ed. Garland Science.
11. James D Watson, Richard M. Myers, Amy A. Caudy and Jan A. Witkowski (2007). Recombinant DNA: Genes and Genomes 3rd Edition; WH Freeman.
12. Sandy Primrose and Richard Twyman (2006). Principles of Gene Manipulation and Genomics 7th Edition; Wiley-Blackwell.
13. Buchanan, Gruissemen & Jones (2015). Biochemistry & Molecular Biology of Plant, 2nd edition.
14. Choudhuri, S and DB Carlson (2008). Genomics: Fundamentals and applications, 1st edition.
15. M. Debnath (2011). Tools and Techniques in Biotechnology.
16. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

List of Practical's:

1. Extraction of DNA from *E.coli.* Bacteria.
2. Estimation of bacterial DNA by Spectrophotometer methods.
3. Separation of bacterial genomic DNA by Agarose gel electrophoresis.
4. Hot phenol method for preparation of total cellular RNA from *E.coli.*
5. Estimation of cellular RNA by Spectrophotometer methods.
6. Restriction digestion of DNA with restriction enzymes.
7. Ligation of DNA.
8. Isolation of plasmid DNA from *E.coli.*
9. DNA amplification by PCR.

Learning Outcomes:

1. This course will impart knowledge on manipulation of organisms for betterment of human society following genetic information.
2. It will delineate the principles and procedures involved in developing genetically modified organisms with desired characteristics.
3. Will be able to apply his knowledge for production of insulin, human growth hormones, human albumin, monoclonal antibodies, vaccines, and drugs.
4. Genetic engineers who can use a variety of molecular tools and technologies to rearrange fragments of human genome or an organisms genome in various sectors like pharmaceutical companies, agriculture sector, research organization, and even some hospitals or universities so as to add or remove an organisms genetic makeup for their better survival in adverse environments or for producing GMOs.

Employability/ Skill Development:

1. Genetic engineers who can use a variety of molecular tools and technologies to rearrange fragments of human genome or an organism's genome in various sectors like pharmaceutical companies, agriculture sector research organizations, and even some hospitals or universities so as to add or remove an organism's genetic makeup for the better survival in adverse environments or for producing GMOs.

School of Studies in Biotechnology

Semester III

Paper 10: Biology of Immune System (Code: 040814)

M.M. 80

Unit I

1. Introduction – Phylogeny of immune system, innate and acquired immunity, Clonal nature of immune response.
2. Organization and structure of lymphoid organs.
3. Cells of immune system – Hematopoiesis and differentiation, B – lymphocyte, T – lymphocyte, Macrophages, Dendritic cells, Natural Killer and lymphokine-activated killer cells, Eosinophils, Neutrophils and Mast cells. Lymphocyte trafficking.
4. Nature and biology of antigens and super antigens.
5. Antibody structure and function.

Unit II

1. Major histocompatibility complex (MHC); MHC genes, and immune responsiveness & MHC restriction.
2. BCR &TCR, generation of diversity.
3. Complement system.
4. Regulation of immune response – Antigen processing and presentation, generation of humoral and cell mediated immune responses; Activation of B – and T – lymphocytes; cytokines and their role in immune regulation; T – cell regulation.

Unit III

1. Antigen – antibody interactions.
2. Cell – mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity.
3. Immunological tolerance & Autoimmunity; types of autoimmune diseases.
4. Hypersensitivity.

Unit IV

1. Transplantation: General concept of immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy.
2. Immunity to infectious agents (intracellular parasites (malaria), helminthes, bacterial (tuberculosis), viruses, (AIDS) infections and other congenital and acquired immunodeficiency' vaccines.
3. Antibody engineering: Chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies.
4. Tumor immunology and Cancer immunotherapy.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby (2007). Immunology, 6th Edition; WH Freeman.
2. Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt (2006). Roitt's Essential Immunology, 11th Edition; Wiley-Blackwell.
3. H.D. Kumar (2003). Modern Concepts of Biotechnology 3rd Edition, Vikas Publishing House. Pvt. Ltd.
4. K. Banerjee and N. Banerjee (2006). Fundamental of Microbiology and Immunology, First Edition. New Central Book Agency (P) Ltd. Kolkata.
5. Brostoff J, Seaddin JK, Male D, Roitt IM.(2002). Clinical Immunology, 6th Edition, Gower Medical publishing.
6. Abul K. Abbas, Andrew H. Lichtman, & Shiv Pillai (2007). Cellular and Molecular immunology; Elsevier Inc
7. M. Debnath (2011). Tools and Techniques in Biotechnology.
8. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
9. Murphy, K., Travers, P., Walport, M. & Janeway, C. (2012). Janeway'sImmunobiology. New York: Garland Science.
10. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.

List of Practicals:

1. Blood group determination by slide agglutination reaction.
2. Enumeration of WBC in blood sample.
3. Preparation of a blood smear and differential blood count.
4. To separate serum from the given blood sample.
5. To determine Albumin Globulin ratio in given serum sample.
6. Estimation of serum protein by Folin Lowry test.
7. Isolation of Immunoglobulin.
8. Separation of serum protein by SDSPAGE.
9. Detection of class specific Antibody by Double Diffusion method.
10. Observe Ag-Ab interaction by Immunoelectrophoresis.
11. Observe Ag-Ab interaction by counter current Immunoelectrophoresis.
12. Study of Agglutination reaction
13. Study of ELISA technique.
14. Immuno diffusion test.

Learning Outcomes:

1. This course will lay the foundations of immune system and its applications in understanding disease pathogenesis and immunity.
2. This will cover the basic principle behind the rising epidemic of allergies and the challenges of current organ transplantation technology.
3. It will provide insight into pathogenesis and host pathogen interaction in some of the deadliest diseases.
4. In depth knowledge in this area will allow to use immuno molecules in diagnostic and clinical intervention strategies, including therapeutic manipulation of the immune system for cancer treatment, vaccine development and transplant tolerance.
5. Clinicians work related to patient-facing or laboratory work like undertaking original medical research designing, planning and carrying out controlled experiments and trials,
6. Devising and testing hypotheses using appropriate analytical techniques, analyzing and interpreting data, *etc.*, will be imparted.

Employability/ Skill Development:

1. In depth knowledge in this area will allow to use immuno molecules in diagnostic and clinical intervention strategies, including therapeutic manipulation of the immune system for cancer treatment, vaccine development and transplant tolerance
2. Clinicians work related to patient-facing or laboratory work like undertaking original medical research designing, planning and carrying out controlled experiments and trials, devising and testing hypotheses using appropriate analytical techniques, Analyzing and interpreting data, etc.

School of Studies in Biotechnology

Semester III

Paper 11: Bioprocess Engineering & Technology (Code: 040815)

M.M. 80

Unit I

1. Introduction to Bioprocess Engineering & its applications.
2. Kinetic of microbial growth and death
3. Isolation, Screening, Preservation and Maintenance of industrial Microorganisms.
4. Nutrients and Media for industrial fermentation
5. Air and Media Sterilization- physical & chemical sterilization.

Unit II

1. Types of fermentation processes: Bioreactors- Types; Design and components; Analysis of batch, Fed – batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized reactors (pulsed, fluidized, photo bioreactors).
2. Measurement and control of bioprocess parameters- inoculum, pH, temperature, foaming, agitation, aeration, etc.

Unit III

1. Downstream processing: Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruption- physical and chemical methods, liquid – liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment: TDS, BOD, C.O.D. treatment and disposal of effluents.
2. Immobilization technique; types of immobilization; Materials used for immobilization, whole cell Immobilization and their industrial applications.

Unit IV

1. Industrial production of chemicals: Alcohol (ethanol), Acids (citric acetic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid), Single cell protein. Use of microbes in mineral beneficiation and oil recovery.
2. Introduction to food technology: Elementary idea of canning and packing, Sterilization and pasteurization of food products, technology of typical food/food products (bread, cheese, idli), Food preservation.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Shuler ML and Kargi F (2002). Bioprocess Engineering: Basic concepts. 2nd Edition, Prentice Hall, Engelwood Cliffs.
2. Stanbury and Whittaker (1997). Principles of Sterilization techniques, First Indian reprint Edition. Aditya Book (P) Ltd. New Delhi.
3. Michael J. Waites(2008). Industrial microbiology: an introduction 7th Edition; Wiley-Blackwell.
4. Damien and Devies(1994). Microbial Technology.
5. LE Casida(1994). Industrial Microbiology
6. H Patel (2003). Industrial Microbiology. 4th Edition.
7. KS Bilgrami and AK Pandey (1998). Introduction to Biotechnology. Edition 2nd.
8. U Satayanarayan(2005). Biotechnology. First Edition Books and Allied (P) Ltd. Kolkata.
9. Baily JE and Ollis DF. (1986). Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York.
10. Mansi EMTEL, Bryle CFA (2007). Fermentation Microbiology and Biotechnology. 2nd Edition, Taylor & Francis Ltd, UK,
11. Shara L. Aranoff, Daniel R. Pearson, Deanna Tanner Okun, Irving A. Williamson, Dean A. Pinkert (2009). Industrial Biotechnology; Nova Science.
12. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
13. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
14. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.

List of Practical's:

1. Isolation and identification of microorganisms from industrial wastewater.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism (Bacteria and Fungi).
3. To study the production of citric acid by *Aspergillus niger* and also qualitative and quantitative test.
4. To study the bacterial growth curve.
5. To study the fungal growth curve.
6. Determine enzyme kinetics in respect to substrate concentration.
7. Production of Bio-ethanol from different wastes and its qualitative analysis.

Learning Outcomes:

1. This course focuses on principles behind designing and development of equipments, and procedures involved in manufacturing of industrially important products such as pharmaceuticals, nutraceuticals, alcohol, enzymes, antibiotics, acids, polymers, *etc.*, from biological materials.
2. It also deals with studying various biotechnological processes involved in isolation and identification of industrially important microorganisms.
3. This course will also enable the students to understand the basic principles and processes behind food packaging and preservation processes.
4. As bioprocess covers all the physical and biological sciences, it will enable various bioprocess researches, developments, and manufacturing functions for biotherapeutics and other bioproducts, including by-products, which are obtained from renewable resources like bioprocessing, agricultural materials, and waste processing.

Employability/ Skill Development:

1. As bioprocess covers all the physical sciences and biological sciences, it will enable various bioprocess researches, developments, and manufacturing functions for biotherapeutics and other bioproducts, including by-products, which are obtained from renewable resources like bioprocessing, agricultural materials, and waste processing.

School of Studies in Biotechnology

Semester III

Paper 12 : Environmental Biotechnology (Code : 040816)

M.M. 80

Unit I

1. Environment: Basic concepts and issues.
2. Environmental Pollution: Types of pollution, Methods for the measurement of pollution; Methodology of environmental management – the problem solving approach, its limitations.
3. Air pollution and its control through Biotechnology

Unit II

1. Water pollution and its control: Water as a scarce natural resource, sources of water pollution, Need for water management, Measurement of water pollution, waste water collection, waste water treatment – physical, chemical and biological treatment processes
2. Microbiology of waste water treatments, aerobic process: Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds.
3. Anaerobic process: Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors.

Unit III

1. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries; Bioremediation
2. Xenobiotics in Environment – Ecological considerations, oil pollution, surfactants, pesticides.
3. Biopesticides in integrated pest management.

Unit IV

1. Solid wastes: Sources and management (composting, vermiculture and methane production).
2. Global Environmental Problems: Ozone depletion, UV – B, green house – effect and acid rain, their impact and biotechnological approaches for management.
3. Role of National organization in Biotechnology.
4. Acts and rules for environment managements and pollution control in India.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Gareth G. Evans, Judy Furlong (2011). Environmental Biotechnology: Theory and Application. 2nd Edition; John Wiley and Sons
2. Hans-Joachim Jördening, Josef Winter (2005). Environmental biotechnology: concepts and applications; Wiley-VCH.
3. InduShekhar Thakur (2006). Environmental Biotechnology: Basic concepts and Applications. First Edition. I. K. International Pvt. Ltd.
4. A.K. Chatterji (2002). Introduction to Environmental Biotechnology. First Edition. Prentice Hall of India Pvt. Ltd. New Delhi.
5. Manoj Tiwari, KapilKhulbe and Archana Tiwari (2007). Environmental Studies. First Edition, I. K. International Publishing House Pvt. Ltd.
6. H.D. Kumar (2003). Modern Concepts of Biotechnology. Third reprint Edition, Vikas Publishing House. Pvt. Ltd.
7. B.D. Singh (2004) Biotechnology: Expanding Horizons, 1st Edition. Kalyani Publishers.
8. Alan Scragg (2005). Environmental Biotechnology First Edition, reprinted. OxfordUniversity Press.
9. M. Debnath (2011).Tools and Techniques in Biotechnology.
10. B. Ritmann and P. L. McCarty (2000). Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.

List of Practical's:

1. To determine the total suspended solids of water.(TSS)
2. To determine the total dissolved solids of water.(TDS)
3. Determination of Dissolved oxygen (DO) of water.
4. Determination of chemical oxygen demand (COD) of water.
5. Determination of biochemical oxygen demand (BOD) of water.
6. To screen the antagonism between *Trichoderma* sp. and *Aspergillus* sp.
7. Determination of effect of fungicide on the growth of fungi.
8. To determine the Most Probable number (MPN) of a given water sample.

Learning Outcomes:

1. This course unifies environmental sciences and biotechnology by the inception of applications of biotechnology in environmental conservation and mitigation of pollution. It emphasizes on the utilization of various biological processes in solid waste management and, bioremediation of industrial wastes and xenobiotics.
2. It elucidates the global environmental problems, their impacts and mitigation strategies.
3. Facilitate opportunities in private as well as Govt. organizations providing bioremediation services, environmental consulting companies with clients in the manufacturing sector.
4. Imported knowledge will allow developing appropriate techniques utilizing microbes for remediating a particular area, and the pollutants unique to it.
5. Various firms like bio-plastic production unit, biofuel plant, sewage treatment plants, enzyme manufacturing units, *etc.*, will be able to establish.
6. Plant, and microbe based bioremediation process can be exploited for societal benefit.

Employability/ Skill Development:

1. Opportunities in private as well as Govt. agencies providing bioremediation services, or for environmental consulting companies with clients in the manufacturing sector
2. Knowledge will allow developing appropriate techniques utilizing microbes for remediating a particular area, and the pollutants unique to it.
3. Various firms can be established like bio-plastic, biofuel, Sewage treatment plants, enzyme manufacturing, etc. Plants and microbe based Bioremediation.

School of Studies in Biotechnology

Lab Course 5 (Code: 040817)

Based on Theory Papers 9 and 10

Time: 6 hrs. **Total Marks – 100**

Q.1 Experiment based on Theory paper 9 (one major & one minor)	30
Q.2 Experiment based on Theory paper 10 (one major & one minor)	30
Q.3 Spotting based on Theory papers	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
Knowledgement imparted can be used for betterment of human society following genetic information. It will delineate the principles and procedures involved in developing genetically modified organisms with desired characteristics. Will be able to apply his knowledge for production of insulin, human growth hormones, human albumin, monoclonal antibodies, vaccines, and drugs. It will allow to use immuno molecules in diagnostic and clinical intervention strategies, including therapeutic manipulation of the immune system for cancer treatment, vaccine development and transplant tolerance.

Lab Course 6 (Code: 040818)

Based on Theory Papers 11 and 12

Time: 6 hrs. **Total Marks – 100**

Q.1 Experiment based on Theory paper 11 (one major & one minor)	30
Q.2 Experiment based on Theory paper 12 (one major & one minor)	30
Q.3 Spotting based on Theory papers	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
It will enable various bioprocess researches, development and manufacturing of therapeutics and other bio products, including by-products, which are obtained from renewable resources like agricultural materials, and waste products. Facilitate opportunities in private as well as Govt. organizations providing bioremediation services, environmental consulting companies with clients of manufacturing sector. Imparted knowledge will allow developing appropriate techniques utilizing microbes for remediating a particular area, and the pollutants.

School of Studies in Biotechnology

Semester IV

Scheme of Examination

Paper Code	Paper	Title of Theory/Practical Paper	Marks			Credit
			External	Internal**	Total	
040819	13	IPR, Biosafety, Bioethics and Nanobiotechnology	80	20	100	4
040820	14	Advanced Techniques in Biotechnology	80	20	100	4
040821	15	Animal Biotechnology	80	20	100	4
040822	16	Genomics & Proteomics	80	20	100	4
040823	LC 7	Based on Theory papers 13, 14	80	20	100	4
040824	LC 8	Based on Theory papers 15, 16	80	20	100	4
		Total Marks			**600**	**24**

or

Paper Code	Paper	Project Work	External	Internal	Total	Credit
040825	17	Dissertation	240	60	300	12
		Seminar based on project	160	40	200	8
		Viva Voce	80	20	100	4
		Total			**600**	**24**

School of Studies in Biotechnology

Semester IV

Paper 13: IPR, Biosafety, Bioethics and Nanobiotechnology (Code: 040819)

M.M. 80

Unit – I

1. IPR:Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, plagiarism, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D. Intellectual property laws of India.

2. Entrepreneurship in bio-business: Introduction and scope in Bio-entrepreneurship, Types of bio-industries Strategy and operations of bio-sector firms; Entrepreneurship development program of public and private agencies (MSME, DBT, BIRAC, Make in India).

Unit II

1. Biosafety - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of pathogenic microorganisms; definition of GMOs; principles of environmental risk assessment and food and feed safety assessment

2. Bioethics – cloning and stem cell research, Human, plants, microbes and animal experimentation, animal rights/welfare, Agricultural biotechnology – Genetically engineered food, Protection of environment and biodiversity – biopiracy.

Unit – III

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

2. Cellular Nanostructures; Nanopores; Bimolecular motors; Synthesis and characterization of different nanomaterials.

Unit – IV

1. Nanoparticles for diagnostics and treatments; concepts of smart stimuli responsive nanoparticles, implications in cancer therapy,

2. Nanodevices for biosensor development, nanomaterials in pollution control.

3. Thin films: synthesis and applications.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Onetti, A., & Zucchella, A. (2014). Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
2. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
3. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
4. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
5. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI.
6. National Portal of India. http://www.archive.india.gov.in
7. National Biodiversity Authority. http://www.nbaindia.org
8. Recombinant DNA Safety Guidelines (1990) Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from-http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf.
9. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009) Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9.
10. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008) An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8.
11. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. (2008).
12. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. (2008). Retrieved from http://www.igmoris.nic.in/guidelines1.asp
13. Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments. Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.
14. Sandra J. Rosenthal, David W. Wright (2005). Nanobiotechnology Protocols. Humana Press Inc. 999 Riverview Drive, Suite, 208, Totowa, New Jersery.
15. PC Trivedi (2008). Nanobiotechnology. Pointer Publishers.
16. GL Hornyak, HF Tibbals, and J Dutta (2008) Fundamentals of Nanotechnology.
17. Rita Khare (2013). Concepts in Nano Biotechnology.
18. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
19. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
20. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
21. World Intellectual Property Organisation. http://www.wipo.int
22. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss.

List of Practical's:

1. Synthesize different types of Nanoparticles.
2. Biophysical characterization of synthesized nanoparticle through UV-Vis Spectrophotometer.
3. Determine antimicrobial activity of nanoparticle.
4. Detection of plagiarism following different online plagiarism-tools.
5. Write-down guidelines for GMO.
6. Find and list-out bio-safety rules for food & beverage.
7. Write down IPRs of a researcher.
8. Find and list-out different bio-safety rules to be followed in the laboratories.
9. Find and list-out different bio-safety rules to be considered during management of biohazard materials.

Learning Outcomes:

1. The study of IPR will impart basic understanding and awareness towards the values of intellectual property and various ways ofits protection. It will instill a desire among the students for innovation and entrepreneurship.
2. Biosafety is an integral part of any scientific research and, the knowledge of safety procedures and precautions is a priority in any experiment. This course will guide the students to not only assess the risk, which may be appearing during any experimentation, but also to derive its management strategies.
3. Bioethics is an emerging field, which deals with various ethical issues arising as a result of advances in medicine and biotechnology. It will educate the students to recognize boundaries of research in stem cells, cloning and animal experimentation. The course introduces the students with global issues of genetically modified crops, biodiversity conservation and biopiracy.
4. Knowledge of IPR will allow protection of researcher's piece of work like literary or artistic work, images, symbols, *etc.*
5. IPR will aim to reward the innovator; so as to improve socio-economic progress by allowing commercialization of the end-products of any research.
6. Knowledge of IPR could be applied to various ethical issues pertaining to biotechnical researches.
7. Knowledge of biosafety regulations will allow safer handling as well as disposal of biohazards.

Employability/ Skill Development:

1. Knowledge of IPR will allow protecting researcher piece of work like literary or artistic work, images, symbols, etc.
2. IPR will aim to reward the innovator, so as to improve socio-economic progress.
3. Allow commercialization of the end products of research.
4. IPR Knowledge could be applied to various ethical issues pertaining to biotechnical research.
5. Biosafety regulations knowledge will allow safer handling as well as disposal of biohazards.
6. On successful completion of this course, students should be able to describe basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

School of Studies in Biotechnology

Semester IV

Paper 14: Advanced Techniques in Biotechnology (Code: 040820)

M.M. 80

Unit I

1. Principles and application of: Centrifugation, Chromatography (Paper, Thin layer, column, gas and liquid chromatography, LCMS), Electrophoresis- principle and types, Agarose gel electrophoresis, SDS PAGE, etc.
2. RIA and autoradiography in biology, ELISA: its types and application.

Unit II

1. Principle and application of PCR, Thermocycler- types and application.
2. Microscopy: Light and compound microscopes, Confocal microscopy, Scanning & Transmission Electron microscopy, Inverted microscopy, Phase Contrast and fluorescence microscopy.

Unit III

1. Principles and application of DNA micro array
2. Principles and application: Colorimetry, Spectrophotometry, Fluorescence spectrophotometry.
3. Molecular structure determination using NMR and X- ray diffraction.

Unit IV

1. Principles and application of Cytophotometry
2. Flow cytometry: Cell sorting and separation, Determination of cell cycle stages.
3. Blotting techniques: Southern, Northern, and Western Blotting.
4. DNA sequencer

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. K. Wilson and J. Walker (2018). Principle and Techniques of Biotechnology and Molecular Biotechnology.Cambridge University Press.
2. Upadhya and Upadhya(2009). Biophysical Chemistry.Mumbai : Himalaya Pub. House.
3. David, L. Nelson and Michael, M. Cox Lehniger (2008). Principal of Biochemistry. 5th Edition. W.H. Freeman and Company, New York.
4. Anthony J.F. Griffiths, William M. Gelbart, Richard C. Lewontin and Jeffrey H. Miller; (1999). Modern Genetic Analysis. PublisherW. H. Freeman.
5. Ralf Pörtner (2013). Animal cell biotechnology: methods and protocols. Humana Press.
6. M. Debnath (2011). Tools and Techniques in Biotechnology.
7. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
8. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics:Structure, Dynamics, Function. Cambridge: Cambridge University Press.
9. RajagopalVadivambal, Digvir S. Jayas. (2015). Bio-Imaging: Principles, Techniques, and Applications. ISBN 9781466593671 - CAT# K20618.
10. Alberto Diaspro & Marc A. M. J. van Zandvoort. (2016). Super-Resolution Imaging in Biomedicine. ISBN 9781482244342 - CAT# K23483.

List of Practical's:

Perform various advance laboratory techniques, like –

1. Separate molecules following centrifugation.
2. Separate amino acids using paper chromatography.
3. Separate plant pigments through thin layer chromatography.
4. Determine concentration of different macromolecules using spectrophotometer.
5. Separate different macromolecules through electrophoresis.
6. Perform ELISA, PCR, Southern blotting, etc.

Learning Outcomes:

1. This course will equip the students with basic principles behind the working of various sophisticated instruments and techniques used popularly in biotechnology.
2. The course is designed to bridge the gap between theory and practical applications of various techniques, which will play a pivotal role in discovery of new drugs, biopharmaceuticals and bioactive compounds.
3. Knowledge of instrumentation is quite essential for discovery of novel molecules, their extraction, purification, quantification and quality assessment.
4. Will possibly be able to suggest necessary improvements in the instruments, which may enhance their sensitivity and accuracy.

Employability/ Skill Development:

1. Knowledge of instrumentation is quite essential for discovery of novel molecules, their extraction, purification, quantification and quality assessment.
2. Can be able to suggest necessary improvements in the instruments for enhancing its sensitivity and accuracy.

School of Studies in Biotechnology

Semester IV

Paper 15: Animal Biotechnology (Code: 040821)

M.M. 80

Unit I

1. Animal cell: Structure and organization
2. Equipment's and materials for animal cell culture
3. Animal Cell culture: Primary and established cell line cultures.
4. Constituents of culture media and their application
5. Basic techniques of mammalian cell culture *in vitro*; disaggregating of tissue and primary culture; maintenance of cell culture; cell separation

Unit II

1. Biology and characterization of the cultured cells, measuring parameters of growth
2. Scaling - up of animal cell culture.
3. Cell synchronization: Cell growth stages
4. Cell cloning: Basic techniques for cell cloning
5. Cell transformation: Characteristics of transformed cells

Unit III

1. Stem cell cultures, embryonic stem cells and their applications.
2. Cell culture based vaccines: General introduction, Vaccines for Malaria and AIDS
3. Ethical issues in animal biotechnology: animal usage, CPCSEA and IAEC guidelines, Management aspects of biotechnology and genetic engineering
4. Somatic cell genetics

Unit IV

1. Transgenic animals: Mice, Sheep, Birds and Fish
2. Apoptosis.
3. Tissue engineering: Elementary idea of tissue engineering, Artificial skin, artificial cartilage
4. Application of animal cell culture in viral based vaccine development and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture and pharmaceutical proteins.

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. RW Masters (2000). Animal Cell Culture Practical Approach: Oxford University Press.
2. Ralf Pörtner (2007). Animal cell biotechnology. Humana Press.
3. M Clynes (2012). Animal Cell Culture Techniques.
4. Nigel Jenkins (1999). Animal Cell Biotechnology methods and Protocols. Humana Press, Totowa, New Jersey.
5. B.D. Singh Biotechnology (2004). Expending Horizons. First Edition. Kalyani Publishers, Ludhiana.
6. U Satyanarayana (2005). Biotechnology. Books and Allied (P) Ltd., Kolkata.

List of Practicals:

1. Extraction, estimation and separation of DNA from blood
2. Extraction, estimation and separation of DNA from spleen
3. Extraction, estimation and separation of DNA from muscle tissue
4. To perform mechanical disaggregation of soft tissues of chick, for recovery of cells.
5. To perform enzymatic disaggregation of tissue, for recovery of cells.
6. To perform primary animal cell culture and subculture.
7. Determine viability of cultured cells.

Learning Outcomes:

1. This course involves the study of basic principles and techniques of animal tissue culture and is one of the most important fields of biology that has played a pivotal role in advancement of medicine and disease biology.
2. This course will advance the students in the field of biomedical research.
3. Will be able to go for animal cell and tissue culture for product development.

Employability/ Skill Development:

1. Aid in IVF, vaccine production, animal cell line production, maintenance.
2. Animal cell and tissue culture for product development

School of Studies in Biotechnology

Semester IV

Paper 16: Genomics & Proteomics (Code: 040822)

M.M. 80

UNIT – I

1. Genomics – General introduction, Types of genomics, Structural genomics, Functional genomics, Comparative genomics, Genome sequencing, Genome mapping, Future of genomics
2. Plant Genomics
3. Genomics in medicine: Gene medicine, Disease models, The impact of genomics on medicine

UNIT – II

1. Human genome project, Methods of gene sequencing: - Random shotgun sequencing, EST. Whole genome shotgun sequencing, Genome prediction and gene counting, Single nucleotide polymorphisms (SNPs)
2. Comparative Genomics: Sequence comparison, Comparative genomics in bacteria, Comparative genomics in Eukaryotes & organelles

UNIT – III

1. Proteomics – General concept, Gene and Protein, Types of proteomics, Structural proteomics and Functional proteomics
2. Methods of study the protein, Protein arrays, protein chips, System biology, Practical application of proteomics

UNIT – IV

1. Future of proteomics, Analysis of protein structure,
2. Protein-Protein interactions, Protein database, Global analysis of protein, Expression analysis and characterization of protein

NOTE: Questions will be asked as per the new policy of question paper. In which, 20 multiple choice questions (covering entire syllabus of the paper), 8 very short answer (2-3 sentences) type questions (two from each unit), 8 short answer (about 75 words) type questions (two from each unit), and 5 long answer (about 150 words) type questions (at least one from each unit) will be asked. Each question will cover entire (4) units of the paper.

Books:

1. Primrose &Twyman (2013). Principles of Gene Manipulation and Genomics.
2. TA Brown (2015). Gene cloning and DNA analysis: An introduction.
3. Guido Grandi (2004). Genomics, Proteomics & Vaccines.
4. Primrose &Twyman (2008). Genomics: Application in Human biology.
5. Introduction to molecular Genetics and Genomics; JBH Publication
6. Timothy Palzkill (2002). Proteomics.
7. U Satyanarayana (2005) Biotechnology. Books and Allied (P) Ltd., Kolkata.
8. P.K. Gupta (2004). Biotechnology and Genomics. Rastogi Publication.
9. S Choudhuri and DB Carlson (2008). Genomics: Fundamentals and applications, 1st edition
10. JohathanPevsnev (2015). Bioinformatics and Functional. 3nd edition.

List of Practical's:

1. Find out and study the sequence similarity by BLAST & FASTA.
2. To study the genome map from NCBI resource.
3. To study the basic functionality of genome by genome browser.
4. Study the whole genome of Hepatitis B virus and Human Mitochondrial Genome using genome databases of Gene Bank.
5. Study the single nucleotide polymorphism (SNP) of human genome using SNP databases of NCBI (Example: MTHFR gene)
6. Study the Sequence comparison in bacterial genome using Gene Bank (16S Ribosomal DNA sequence of *Rickettsia* sp.)
7. To study the Multiple Alignment Sequence by using CLUSTAL OMEGA tools.
8. To determine the sequence of database of RNA families by using Rfam.
9. To retrieve the protein sequence by Swiss Prot database
10. Study the Protein protein and Protein nucleotide interaction using Gene Bank databases (Example : Human 40S ribosome)

Practical References:-

1. Shui Qing Ye (2007) Bioinformatics: A Practical Approach. Chapman & Hall Taylor & Francis Gen.
2. Mount D. W (2005) Bioinformatics – Sequence & Genome Analysis. CBS Publishers & Distributors (Pvt) Ltd.
3. Bela Tiwari (2007) Introductory Bioinformatics For Users: The Practicals.
4. Griffiths-Jones S, Bateman A, Marshall M, Khanna A, Eddy SR (2003). "Rfam: an RNA family database". Nucleic Acids Res. 31 (1): 439–41.

Learning Outcomes:

1. This will enable the students to acquire knowledge about the basic structural and functional aspects of genes and proteins.
2. It focuses on the unified applications of genomics and proteomics in the fields of medicine such as drug discovery, identification of potential vaccine candidates, *etc.*
3. This paper has wide scope in the field of drug discovery, cancer therapy, *etc.*

Employability/ Skill Development:

1. A novel and fruitful research area called as 'genoeconomics' can be established in which sequencing of the complete genome of organisms will reveal similarities and dissimilarities among individual at various taxonomical levels
2. Wide scope in the field of drug discovery like in cancer therapy.

School of Studies in Biotechnology

Lab Course 7 (Code: 040823)

Based on Theory Papers 13 and 14

Time: 6 hrs. **Total Marks – 100**

Q.1 Experiment based on Theory paper 13 (one major & one minor)	30
Q.2 Experiment based on Theory paper 14 (one major & one minor)	30
Q.3 Spotting based on Theory papers	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
The course introduces the students with global issues of genetically modified crops, biodiversity conservation and biopiracy. Knowledge of IPR will allow protection of researcher's piece of work like literary or artistic work, images, symbols, etc. IPR will aim to reward the innovator; so as to improve socio-economic progress by allowing commercialization of the end-products of any research. Knowledge of IPR could be applied to various ethical issues pertaining to biotechnical researches. Knowledge of biosafety regulations will allow safer handling as well as disposal of biohazards. Knowledge of instrumentation is quite essential for discovery of novel molecules, their extraction, purification, quantification and quality assessment. Will possibly be able to suggest necessary improvements in the instruments which may enhance their sensitivity and accuracy.

Lab Course 8 (Code: 040824)

Based on Theory Papers 15 and 16

Time: 6 hrs. **Total Marks – 100**

Q.1 Experiment based on Theory paper 15 (one major & one minor)	30
Q.2 Experiment based on Theory paper 16 (one major & one minor)	30
Q.3 Spotting based on Theory papers	10
Q.4 *Viva Voce*	10
Q.5 Sessional	20

Employability/ Skill Development:
This course will advance the students in the field of biomedical research. Aid in IVF, vaccine production, animal cell line production, and maintenance. Will be able to go for animal cell and tissue culture for product development. A novel and fruitful research area called as 'genoeconomics' can be established in which sequencing of the complete genome of organisms will reveal similarities and dissimilarities among individual at various taxonomical levels. This paper has wide scope in the field of drug discovery, cancer therapy, etc.

School of Studies in Biotechnology
Project (Code: 040825)

Code	Paper	Project Work	External	Internal	Total	Credit
040825	17	Dissertation	240	60	300	12
		Seminar based on project	160	40	200	8
		Viva Voce	80	20	100	4
		Total			**600**	**24**

1. A student of IV semester will have the option to opt for project work in lieu of four theory papers and two lab courses provided he/she secures at-least **65%** or more marks in aggregate in semester I and II.

2. The project has to be carried out in recognized national laboratories or UGC recognized universities. No student will be allowed to carry out project in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur.

3. The valuation of all the projects will be carried out by the external examiner and HoD of UTD or its nominee at the UTD Centre.

The project work should be related to the field of Biotechnology. The project report should include declaration by the candidate, certificate by the supervisor, acknowledgement, title and introduction along with the following points:

1. Introduction
2. Review of Literature
3. Materials and Methods
4. Results & Discussion
5. Summary
6. Bibliography

Learning Outcomes:

1. Will develop skills to plan and conduct investigational work; gain practical knowledge, think scientifically, writing research report.
2. Will be helpful to further carry-out small piece of research work, using knowledge and expertise acquired.

Employability/ Skill Development:

1. Discovering new facts and ideas for translating complex science into language and concepts that are understandable by non-scientific audiences.
2. Expertise in analytical, technical and problem solving skills along with subject specific knowledge.
3. Stronger communication skill will lead to higher chances of success of the entrepreneurs.