DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the

PROGRAM: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology

Syllabus Developed by				
SN	**Name of Expert/**	**Designation**	**Department**	**College/ University**
1	Prof. Rajeeva Gaur	Dean, Faculty of Science	Department of Microbiology	Dr. Rammanohar Lohia Avadh University, Ayodhya
2	Prof. Farrukh Jamal	Professor & Head, Convenor, BoS	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
3	Prof. Ram Naraian	External Expert	Department of Biotechnology	VBS Poorvanchal University, Jaunpur
4	Prof. Neelam Pathak	Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
5	Dr. Pankaj Singh	Assistant Professor	Department of Biotechnology	Dr. Rammanohar Lohia Avadh University, Ayodhya
6	Dr. Manikant Tripathi	Assistant Professor	Department of Biotechnology	Dr. Rammanohar Lohia Avadh University, Ayodhya
7	Dr. Pradeep Kumar Singh	Assistant Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya

Course Code		**Course Title**	**Credits**	**T/P**	**Evaluation**	
					CIE	**ETE**
A	B	C	D	E	F	G
B.Sc. 4th Year (VII Sem) /M.Sc. 1st Year (Sem I)						
B100701T	CORE	Macromolecules: Structure and Functions	4	T	25	75
B100702T		Bioanalytical Tools and Techniques	4	T	25	75
B100703T		Microbial Physiology and Genetics	4	T	25	75
B100704T		Fundamentals of Molecular Biology	4	T	25	75
B100705T	ELECTIVE (Select any one)	Fundamentals of Metabolism	4	T	25	75
B100706T		Enzyme and Food Technology	4	T	25	75
B100707P	CORE	Biotechnology Lab Course-I	4	P	50	50
B100708P		Industrial Training/Survey/	4	P	50	50

Neelam Pathak 13/03/2024

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		Research Project-A				
B.Sc. 4th Year (VIII Sem) /M.Sc. 1st Year (Sem II)						
B100801T	CORE	Cell Biology and Signaling Pathways	4	T	25	75
B100802T		Recombinant DNA Technology	4	T	25	75
B100803T		Clinical Biochemistry and Enzymology	4	T	25	75
B100804T		Essentials of Environmental Biotechnology	4	T	25	75
B100805P		Biotechnology Lab Course-II	4	P	50	50
B100806P		Industrial Training/Survey/ Research Project-B	4	P	50	50
B.Sc. 5th Year (IX Sem) /M.Sc. 2nd Year (Sem III)						
B100901T	CORE	Bioprocess Engineering and Technology	4	T	25	75
B100902T		Animal Biotechnology and Cell Culture	4	T	25	75
B100903T		Fundamentals of Immunology	4	T	25	75
B100904T		Medical Biotechnology	4	T	25	75
B100905P		Biotechnology Lab Course-III	4	P	50	50
B100906P		Industrial Training/Survey/ Research Project-C	4	P	50	50
B.Sc. 5th Year (X Sem) /M.Sc. 2nd Year (Sem IV)						
B101001T	CORE	Plant Biotechnology and Tissue Culture	4	T	25	75
B101002T		Fundamentals of Cancer Biology	4	T	25	75
B101003T		Bioinformatics and Biostatistics	4	T	25	75
B101004T		Research Methodology	4	T	25	75
B101005P		Research Review and Assignment	4	T	25	75
B101006P		Industrial Training/Survey/ Research Project-D	4	T	25	75

Subject Prerequisites:
Program Outcomes (POs)
• The program has been designed in such a way so that the students acquire strong theoretical and practical knowledge in various domains of biotechnology. • The programme includes details of bio-molecules, proteins &enzymes, cell biology, microbial physiology, tools and techniques, metabolism, immunology, molecular biology,

genetic engineering, animal biotechnology, plant biotechnology, bioprocess engineering, followed by computational analysis to make the study of living system more interesting which is the need of hour.

- The practical courses have been designed to equip the students with the laboratory skills in biotechnology. Students will able to design and conduct experiments, as well as to analyze and interpret scientific data.
- The programme will offer students with the knowledge and skill base that would enable them to undertake advanced studies in biotechnology and related areas or in multidisciplinary areas that involve biotechnology and that will develop entrepreneurship skills among students.
- The students will gain domain knowledge and know-how for successful career in academia, industry and research. Promoting lifelong learning to meet the ever-evolving professional demands by developing ethical, inter personal and team skills.
- The students will get exposure of wide range of careers such as teacher, scientists, in pharmaceutical industries that combine biology, plants and medicine.

Semester wise Paper Titles with Details					
Year	**Semester**	**Paper**	**Paper Title**	**Prerequisite for Paper**	**Elective for Major Subjects**
		Bachelor (Research)/Masters in Biotechnology			
B.Sc. 4th Year /M.Sc. 1st Year	**B.Sc. VII Sem/ M.Sc. Sem I**	Core Theory Paper – I	Macromolecules: Structure and Functions	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper –II	Bioanalytical Tools and Techniques	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – III	Microbial Physiology and Genetics	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – IV	Fundamentals of Molecular Biology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		THEORY ELECTIVE (Select any one)	Fundamentals of Metabolism	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology,	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry,

				Microbiology)	Botany, Zoology
			Enzyme and Food Technology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Practical Paper – VI	Biotechnology Lab Course-I	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Practical Paper – VII	Industrial Training/Survey/ Research Project-A	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
B.Sc. 4th Year /M.Sc. 1st Year	**B.Sc. VIII Sem/ M.Sc. Sem II**	Core Theory Paper – I	Cell Biology and Signaling Pathways	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper –II	Recombinant DNA Technology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – III	Clinical Biochemistry and Enzymology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – IV	Essentials of Environmental Biotechnology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – V	Biotechnology Lab Course-II	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

		Core Practical Paper – VI	Industrial Training/Survey/ Research Project-B	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
B.Sc. 5th Year /M.Sc. 2nd Year	**B.Sc. IX Sem/ M.Sc. Sem III**	Core Theory Paper – I	Bioprocess Engineering and Technology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper –II	Animal Biotechnology and Cell Culture	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – III	Fundamentals of Immunology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – IV	Medical Biotechnology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – V	Biotechnology Lab Course-III	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Practical Paper – VI	Industrial Training/Survey/ Research Project-C	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
B.Sc. 5th Year /M.Sc. 2nd Year	**B.Sc. X Sem/ M.Sc. Sem IV**	Core Theory Paper – I	Plant Biotechnology and Tissue Culture	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory	Fundamentals of	B.Sc. (Botany, Zoology,Chemistry,	M.Sc. Microbiology,

		Paper – II	Cancer Biology	Biochemistry,Biotechnology, Microbiology)	Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – III	Bioinformatics and Biostatistics	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – IV	Research Methodology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – V	Research Review and Assignment	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Practical Paper – VI	Industrial Training/Survey/ Research Project-D	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100701T	**Course Title: Macromolecules: Structure and Functions**	

Course Objectives:

The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.

Course outcomes:

- **CO.1** Learn about the Contribution of Indian scientists in biological field and Ayurveda system of disease treatment.
- **CO.2** The students will learn about role of water and buffer in metabolic activity. They will also learn about the classification, structure, function and properties of carbohydrate and glycoconjugates.
- **CO.3** Students will understand classification of lipids and structure, properties, deficiency diseases of vitamins.
- **CO.4** Students will learn about types, structure, properties of nucleic acids, DNA sequencing and various supramolecular assemblies.
- **CO.5** Students will understand the structure, hierarchy of proteins and biophysical and cellular aspects of protein folding.

Credits: 4	Core Compulsory
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	**Contribution of Indian scientists to biological sciences**: Jagdish Chandra Bose, Har Gobind Khorana, Ananda Mohan Chakrabarty, Birbal Sahni, Lalji Singh; Physical & Chemical properties of Water, pH and buffer system, titration curves, basic biochemical calculations.	**10**
II	**Carbohydrates:** Classification and properties of simple carbohydrates; monosaccharide, oligosaccharide, and polysaccharides; Reducing and Non-Reducing Sugar, Enantiomers, Structural Polysaccharides: Cellulose, Chitin, Storage Polysaccharides: Starch and Glycogen, Glycoproteins and Glycolipids. Biological Importance of carbohydrates	**12**
III	**Proteins:** Amino acids: Chemical structure and general properties; Protein classification – globular, fibrous & membrane proteins, Ramachandran plot, Protein folding & denaturation, sequencing; Biological Importance of amino acids and proteins.**Lipids:** Fatty acids: General formula, nomenclature, and chemical properties; Lipid classification: simple, complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes,	**12**

	steroids, and prostaglandins & free fatty acids; Circulating lipids - chylomicrons. LDL, HDL and VLDL.	
IV	**Nucleic Acids:** Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA: A, B and Z DNA & Triplet DNA, their structure and significance; Chargaff's Rule, DNA denaturation and Tm value, Types of repetitive nucleic acid sequences, Satellite DNA, DNA topology: Supercoiling, Linking number, Twist and Writhe, Classification structure and function of different types of RNA: mRNA, tRNA, rRNA, hnRNA; snRNA, snoRNA, miRNA, gRNA, Primary, secondary, and tertiary structures of RNA.	12
V	**Vitamins and Hormones**: Vitamins – internal & external sources, structure, properties, and functions including biochemical reactions, symptoms of hyper & hypo-vitaminosis. Hormones – Source organs, Structure, classification, properties & functions of animal & plant hormones.	14

Suggested Readings:

- Lehninger, Albert, Cox, Michael M. Nelson, David L. (2017) *Lehninger principles of biochemistry*/New York: W. H. Freeman.
- Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
- Voet, D., &Voet, J. G. (2011). Biochemistry. New York: J. Wiley & Sons
- Biochemistry – Lubertstryer Freeman International Edition.
- Biochemistry – Keshav Trehan Wiley Eastern Publications
- Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
- Fundamentals of Bochemistry-J. L. Jain S. Chand and Company
- Biochemistry and Molecular Biology: Oxford University Press
- Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation: 75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/ in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100702T	**Course Title: Bioanalytical Tools and Techniques**	

Course objectives:

Bioanalytical techniques are used to understand the theoretical principles involved in bioinstrumentation which may be used for the determination of nutrients, major ions and trace elements, biological samples together with the analytical techniques. This will enable the students to implement the use of these techniques in biological research and in discovering new products/compounds.

Course outcomes:

- **CO.1** The course will help students to acquaint with basic principles and applications of various type of chromatography like paper, thin layer, gel filtration, ion exchange, affinity, gas chromatography and HPLC.
- **CO.2** Students will be able to acquire the knowledge of techniques like UV-VIS spectroscopy, NMR, CD, ORD in biological research
- **CO.3** Learn various types of electrophoretic techniques for solving industrial and research problems.
- **CO.4** Students will be able to learn sophisticated instruments like phase contrast, fluorescence, electron microscopy, fluorescent activated cell sorting, and Freeze drying.
- **CO.5** The students will learn about Instrumentation, working and principle of Centrifugation & knowledge of Radioisotopes and its uses in the biological system as well as the principle and practical applications of Geiger-Muller counter, Liquid scintillation counter, autoradiography.

Credits:4	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Chromatography techniques: Paper chromatography, thin layer chromatography, column chromatography, gel filtration, ion exchange chromatography, affinity chromatography, gas chromatography and HPLC.	12
II	Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, NMR, ORD and Circular dichorism.	12
III	Electrophoresis: Agarose gel electrophoresis, SDS polyacrylamide electrophoresis, Isoelectric focusing, pulse field gel electrophoresis, two-dimensional electrophoresis.	12
IV	Microscopic techniques for studying cell structure: Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy, scanning tunneling microscopy, Flow cytometry.	12
V	Centrifugation: Concept of centrifugation, sedimentation coefficient, differential and density gradient centrifugation. Radioisotope Techniques, Autoradiography.	12

Suggested Readings:

- Keith Wilson John Walker John M. Walker "Principles and Techniques of Practical Biochemistry"
- Joseph Sambrook David W. Russell Joe Sambrook "Molecular Cloning: A Laboratory Manual"
- Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012,
- Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 2006.

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biochemistry, Environmental Science, Chemistry, Botany, Zoology

Suggested Continuous Evaluation Methods:
Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.

Suggested equivalent online courses:
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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100703T	Course Title: Microbial Physiology and Genetics	

Course Objective

The objective is to study about the basics of microorganisms, different types of physiological group, microbial metabolic diversity, various types of physiological functions performed by microorganisms and their genetic recombination methods.

Course outcomes

Upon successful completion of the course,

CO1. The students will be able to learn about basics of microbiology. The student will also learn about prokaryotic diversity and microbial taxonomy.

CO2. The students will be acquainted with theory and practice of sterilization, pure culture isolation and preservation techniques. They will also able to understand about microbial nutrition and growth.

CO3. The students will get familiar to the various types of microbial diseases and their characteristic features. They will also learn about different types of toxins, their mechanism of action.

CO4. The students will learn about the metabolic diversity among microorganisms and bacterial photosynthesis. They will also able to understand about nitrogen metabolism and fixation.

CO5. The students will learn and understand about the bacterial recombination methods, viruses and their genetic system. The students will learn about genetics of yeast and Neurospora.

CO6. The students will be acquainted with the diverse physiological groups of bacteria/archaea.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	History, development and scope of microbiology, Structure and function of prokaryotic cells, classification of bacteria: modern approaches of bacterial taxonomy (Numerical Taxonomy, 16S rRNA analysis), prokaryotic diversity, Bacteria: General properties, structure and classification, Viruses: General properties, structure and classification of viruses based on their genomes, viroids and prions.	12
II	Methods in Microbiology: Theory and practice of sterilization, pure culture techniques, principles of microbial nutrition. Microbial growth, preservation and maintenance of cultures, Antibiotics and Chemotherapy: Antimicrobial agents, sulfa drugs, broad-spectrum antibiotics, antibiotics from prokaryotes, mode of action of antibiotics, resistance to antibiotics.	12
III	Microbial diseases: respiratory infections caused by bacteria and viruses, sexually transmitted diseases, diseases transmitted by animals (rabies, plague), food and water borne diseases, pathogenic fungi, Types of toxins: Exotoxins, endotoxins, enterotoxins, their structure and mode of action.	12
IV	Overview of basic metabolism. Metabolic diversity among microorganisms. Photosynthesis in microorganisms: Role of	12

	chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy, methanogenesis and acetogenesis. Fermentation, nitrogen metabolism, nitrogen fixation.	
V	Bacterial genetic system, recombination transformation, conjugation, transduction, plasmids and transposons, bacterial genetic map with reference to *E. coli*. Viruses and their genetic system.	12

Suggested Readings:

1. Moat A.G., Foster J.W. and Spector M.P. 2002. *Microbial Physiology*, 4th edition. A Johan Wiley and sons inc., publication.
2. Kim B.H. and Gadd G.M. 2008. *Bacterial physiology and metabolism*. Cambridge University Press, Cambridge.
3. Gilbert H.F. 2000. *Basic concepts in biochemistry: A student's survival guide*. Second Edition. Mc-Graw-Hill Companies, health professions Division, New York.
4. Madigan M.T., Martinko J.M., Stahl D.A. and Calrk D.P. 2012. *Brock Biology of Microorganisms*. 13th ed. Pearson Education Inc.
5. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer.2015. Biochemistry 8th edition. W. H. Freeman.

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biochemistry, Environmental Science, Chemistry, Botany,Zoology

Suggested Continuous Evaluation Methods:
Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.

Suggested equivalent online courses:
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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100704T	Course Title: Fundamentals of Molecular Biology	
Course Objectives:		
The objective of the course is learning and understanding the fundamentals of molecular biology likenucleic acid as genetic material, replication, gene organization and its regulation etc.		
Course outcomes:		
After completion of this course, a student will be able to: CO1:Learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replication CO2:Understand the detailed mechanism and regulation of Eukaryotic DNA replication, along with Mitochondrial and Chloroplastic DNA Replication CO3:Learn about mechanism and regulation of transcription in prokaryotes along with Reverse transcription. CO4: Understand the fundamentals of translation in prokaryotes and eukaryotes. CO5: Understand regulation of gene expression; Concept of operon, Significance ofrepressor, Attenuation; Inhibitors of transcription and translation.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	**Organization of Genetic materials in prokaryotes and Eukaryotes:** Genetic material, Genome type, Size, Genome Organization - Structural Maintenance of Chromosomes (SMC) Protein, Eukaryotic Nucleosomes, Histones, Chromatin, Concept of Gene, mono-cistronic and poly-cistronic genes, Gene Structure with various functional units - replicon, muton, recon, C-value and C-value paradox; Unique sequences and Cot value, reassociation kinetics, Split genes: Exons and Introns, DNA transposon.	12
II	**Replication:** Modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication: Origin and Initiation, elongation and termination; Roles, properties and mechanism of action of DnaA, Helicase, Primase, DNA gyrase, Topoisomerases, DNA Polymerases, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA primers; Regulation of replication; Fidelity of replication; Viral replication, σ or Rolling circle replication in ϕX174.	12
III	Eukaryotic DNA replication: Initiation, elongation and termination; Multiple replicons/initiation sites; Autonomously replicating sequence; Mechanism and significance of Origin recognition complex, Mini-chromosome maintenance proteins, DNA dependent DNA polymerases α, δ, ε, Nucleases, DNA ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplast DNA replication,	12

IV	Transcription in prokaryotes: Initiation, elongation and termination; Prokaryotic promoter; weak and strong promoters, DNA dependent RNA polymerase: Physical properties, Templet strand, non-template strand, coding strand, Subunits, σ factor, its types and function; Recognition of promoter; Transcription bubble, Direction of Transcription; Abortive initiations; Promoter clearance; Elongation factor Gre and its role, Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase and Reverse transcription. Transcription in eukaryotes: Synthesis of pre-mRNA: Outline of process - Initiation, elongation and termination, RNA Pol II, promoter, Enhancer elements, Subunit structure of RNA Pol II, Roles of RNA polymerase II, Transcription factors, Nucleosome modifiers, Mediator complexes, Chromatin remodelers, Elongation factors in transcription; Synthesis & processing of pre-rRNA and pre-tRNA: Outline of process, RNA Pol I and III, promoters sequences, DNA-binding motifs: Helix-turn-Helix, Zinc Finger, Leucine-Zipper, Homeodomain. **Co-transcriptional processing**: Addition of 5' cap and 3' Poly A tail in mRNA; **Post transcriptional processing**: RNA splicing – Type 1 and Type 2 Intron splicing, Spliceosome mediated splicing and maturation of precursors of rRNA, mRNA, tRNA): Role of different ribonucleases in splicing, Covalent modifications, RNA editing, Alternative splicing, Histone mRNA processing	12
V	Translation in prokaryotes and eukaryotes: Outline of the process - Initiation, elongation and termination; Adapter role of tRNA, Genetic code, Evidences for a triplet codon; Properties of Genetic code; Codon family and Codon pairs; Nonsense and Sense codons; Degeneracy: Significance of Isoacceptor tRNAs and Wobble hypothesis; Codon bias; Amino acyl tRNA synthetase: Classification, Specificity, Reaction catalyzed; A, P and E sites of ribosome; Start and stop codons, Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle; Roles of Initiation factors, Elongation factors, Release factors, Ribosome recycling, Aminoacyl tRNA synthetases, catalytic role of GTP, Peptidyl transferase site and Factor binding site of ribosomes in translation. Proofreading activity of ribosomes and Fidelity of Translation	12

Suggested Readings:

1. Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017)*Lehninger principles of biochemistry*/NewYork:W.H.Freeman.
2. Lewin "Genes"
3. Freifelder, DM "Molecular Biology"
4. Brown, TA "Genomes"
5. Watson, JD "Molecular Biology of the cell"
6. Twyman, R.M.Advanced Molecular Biology"
7. Brown, TA"Gene cloning: An introduction"
8. Old & Primrose "Principles of Gene Manipulation"
9. Primrose, SB "Molecular Biotechnology"
10. Jose B. Cibelli, Robert P. Lanza, Keith Campbell, Michasel D. West "Principles of Cloning"
11. Voet&Voet "Biochemistry"
12. LubertStryer "Biochemistry"

Suggestive digital platforms web links
This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
Suggested Internal Continuous Evaluation Methods:75 Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks
External Evaluation:75 Marks
Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.
Suggested equivalent online courses: .....
Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100705T	Course Title: Essentials of Metabolism	
Course Objectives:		
The objectives of the course are to learn and understand the fundamentals of cellular metabolismof carbohydrates, lipids, aminoacids, and nucleic acids and their association with variousmetabolic diseases.		
Course outcomes:		
After completion of this course, a student will be able to: CO1:Learn Carbohydrate catabolism, and its association with cellular energy production, and carbohydrate anabolism in plants and animal cells. CO2:Understand Lipid biosynthesis, Degradation of fatty acids and cholesterol, ketone bodies, acidosis, ketosis. CO3:Understand about the Biosynthesis of purines and pyrimidine nucleotides, degradation of nucleotides, salvage pathways,biosynthesis and biodegradation of amino acids. Inborn errors of metabolism. CO4: Understand detailed mechanism of nitrogen metabolism and photo synthesis.		
Credits:4	**Elective**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	**Principle of bioenergetics:** Laws of Thermodynamics, Energy cycle and specialized role of ATP as universal currency of energy, **Energy transduction:** energytransducing membranes from organelles in animals, plants and bacteria, Phosphorylation – Oxidative and Photophosphorylation, Chemiosmotic theory of phosphorylation. Photosynthetic light receptors and light harvesting complexes, Hill reaction, its components and products, Redox potential and electron flow through electron transport chain complexes in bacteria, chloroplast & mitochondria, Uphill and downhill flow of electrons, difference between cyclic and non-cyclic phosphorylation, regulation of ETC, Inhibitors of ETC, uncouplers, Bioluminescence,	12
II	**Carbohydrate metabolism:** Catabolic pathways – Glycolysis and Non- glycolytic pathways, Hexose monophosphate shunt and its modes, Tricarboxylic acid cycle. Anaplerotic reactions sequences in metabolism, fate and role of metabolic byproducts -NADH, $FADH_2$, Glycogenolysis, Krebs- Kornberg pathway Glyoxylate pathway. Glucose catabolism in cancerous tissue, aerobic and anaerobic catabolism of glucose in terms of respiration, Biosynthesis/Anabolic pathways with Regulation – Gluconeogenesis, Biosynthesis of disaccharides – sucrose, lactose, Biosynthesis of polysaccharides - glycogen synthesis, Starch synthesis, Cellulose synthesis, Glucosaminoglycans synthesis and their biological roles.	12

III	**Lipid Metabolism: Biosynthesis** – synthesis of saturated and unsaturated fatty acids, biosynthesis of triacylglycerols glycerophospholipids and membrane phospholipids, sphingolipids, cholesterol. Degradation of fatty acids: Carnitine transporters, α, β, ω oxidation; Ketone bodies, acidosis, ketosis, Cholesterol degradation and production bile acids and bile salts.	12
IV	**Metabolism of Nitrogenous compounds:** Biosynthesis of amino acids and Urea cycle, associated metabolic disorders, Kreb-Urea bicycle, Biosynthesis of Nucleotides – salvage and de-novo synthesis of purines and pyrimidines, Catabolism of amino acids and nucleosides, and nucleic acids, Inborn errors of metabolism related to amino acids and nucleosides.	12
V	**Biochemistry of Nitrogen fixation:** Diazotrophy and its components,Nitrogen fixing organism, symbiotic and non-symbiotic modes, Physiology of nodule formation, Nitrogenase complex and its oxygen sensitivity with protection methods, Ammonia assimilation and regulation system, Ammonia and nitrate transport, nif gene, nod gene. **Photosynthesis:** Carbon fixation/reduction pathways - Calvin cycle, C3, C4 and CAM pathway, photorespiration and C2 pathway	12

Suggested readings

1. Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017)*Lehningerprinciplesofbiochemistry*/NewYork:W.H.Freeman.
2. Voet,D.,&Voet,J.G.(2011).Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubertstryer Freeman InternationalEdition.
4. Biochemistry – Keshav Trehan Wiley EasternPublications
5. Fundamentals of Bochemistry-J.L.JainS.ChandandCompany
6. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
8. Biochemistry and Molecular Biology: Oxford University Press
9. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
10. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons,

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Continuous Internal Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation: 75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100706T	Course Title: Enzyme and Food Technology	

Course Objectives: The objective of course to get the basic knowledge about different types of enzyme, their properties, kinetic behavior, factors affecting the enzymatic activities and microorganism involvement in food processing and spoilage.

Course outcomes:

CO1.

The student will be able to learn about enzymes, general properties and kinetics of enzymes. They will also learn about isozymes, catalytic antibodies and enzyme activity.

CO2.

The students will get knowledge about intracellular localization of enzymes, purification and factors affecting the rate of enzyme catalysis.

CO3.

The student will get familiar to activation energy, Michaelis-Menten and Lineweaver Burk graphs for single substrate enzyme catalyzed reaction, Briggs-Haldane steady-state approach, methods for the determination of K_m and V_{max}.

CO4.

The student will learn about the types of enzyme inhibitors, activators, determination of inhibitors/activators constant.

CO5.

The student will get knowledge about the food technology, sources of microorganisms in food, factors affecting on food quality. The students will also learn the basic concept of canning and packing, sterilization and pasteurization of food products.

Credits:4	Elective
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Classification and nomenclature of enzymes, general properties of enzymes. Isozymes and multiple forms of enzymes, unit of enzyme activity, catalytic antibodies.	12
II	Intracellular localization of enzymes, purification of enzymes and tests for homogeneity factors (pH, temperature etc.) affecting the rate of enzyme catalysis and forces involved in enzyme substrate complex formation.	12
III	Concept of Activation energy, Michaelis-Menten and Lineweaver Burk graphs for single substrate enzyme catalyzed reaction, Briggs-Haldane steady-state approach, methods for the determination of K_m and V_{max}.	12
IV	Types of enzyme inhibitors, derivation of equations for different types of enzyme inhibitions, types of activators, determination of inhibitors/activators constant.	12
V	Introduction to food technology: Sources of microorganisms in food, Intrinsic (pH, moisture, redox potential, nutrients),	12

	antimicrobial constituents of foods and biological structure and extensive factors (temperature of storage, relative humidity of environment, pressure and concentration of gases in environment) affecting growth of microorganisms in food. Elementary idea of canning and packing, sterilization and pasteurization of food products and food preservation	

Suggested Readings:

1. Ananthanarayanan R and Panicker C K. Textbook of Microbiology. Orient Longman.
2. Ken S.Rosenthal, Patrick R.Murray, and Michael A.Pfaller. Medical Microbiology 7th Edition, Elsevier
3. Karen C.Carroll, Geo.Brooks, Stephen Morse, and Janet Butel.Jawetz, Melnick, &Adelberg's Medical Microbiology, Lang

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany,Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/ in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VII/M.Sc. I
Subject: Biotechnology		
Course Code: B100707P	Course Title: Biotechnology Lab Course-I	

Course Objectives:

The lab is designed to train the students in basic and some advanced techniques of Biochemistry like isolation, purification, and estimation of biomolecules. It also deals with microbial techniques of isolation, purification and maintenance of microbial cultures.

Course outcomes:

After completion of the course, a student will be able to achieve theseoutcomes
CO.1: The student will get practical knowledge ofQualitative and Quantitative Analysis of biological molecules.
CO.2: The student will also learn isolation of proteins from milk.
CO.3 The student will perform experiments on blood.
CO.4 The students will acquaint with determination of clinically important enzymes

Credits:4	Core Compulsory
Max. Marks: 50+50	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-10

Unit	Topics	No. of Lectures
I	1. Extraction and estimation of casein protein from milk 2. Experiment on amino acids and proteins i. To perform Xanthoproteic test with amino acids and proteins ii. To perform ninhydrin test with amino acids and proteins 3. Experiment on Carbohydrates i. To perform Benedict's test with various carbohydrates ii. To perform Bial's test with pentoses iii. To perform Selivanoff's test with pentoses iv. To perform Barfoed's test with mono and disaccharides v. To perform iodine test on polysaccharides and to observe the effect of temperature, acid and alkali on the colour produced vi. To perform Molisch's test with different carbohydrates vii. To perform Fehling's test with different carbohydrates 4. To plot a curve for estimation of glucose by anthrone method 5. To estimate and quantify DNA in the given sample by diphenylamine method 6. To plot a curve for estimation of BSA by Biuret method and Folin-Lowry method 8. To prepare suitable solid and liquid media for the routine cultivation of bacterial culture 9. Measurement of bacterial population by serial dilution methods 11. Isolation and enumeration of microorganisms by pour and spread plate methods 13. Isolation of pure cultures by streak plate method and their preservation techniques	60

Suggested Readings:

- Keith Wilson, John Walker, John Walker, John M. Walker "Principles and Techniques of

Practical Biochemistry"

- Chirikjian "Biotechnology Theory & Techniques"
- Joseph Sambrook, David W. Russel, Joe Sambrook "Molecular Cloning: A Laboratory Manual"
- William M, O'Leary Robert, Dony Wu "Practical Handbook of Microbiology"
- Principles of Biochemistry- Albert L. Lehninger CBS Publishers &Distributors
- An Introduction to Practical Biochemistry, David T. Plummer (2006) Tata McGraw Hill Education, 3rd edition
- "Sadasivam "Biochemical Methods"

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 50

House Examination/Test: 20 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 20 Marks

Class performance/Participation: 10 Marks

External Evaluation:50 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	**Year: B.Sc. 4th/M.Sc. 1st**	**Semester: B.Sc. VII/M.Sc. I**
Subject: Biotechnology		
Course Code: B100708P	**Course Title:** Industrial Training/Survey/ Research Project-A	

Course Objectives:

The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.

Credits: 4	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B100801T	Course Title: Cell Biology and Signaling Pathways	

Course Objectives:

The objectives of the course are to learn and understand the fundamentals of cell biology like cell organelles, cytoskeleton, cellular transport, cell-extracellular matrix interaction, cell division, and protein trafficking and signal transduction etc.

Course outcomes:

After completion of this course, a student will be able to:

CO1:Learn about structural organization of prokaryotic and eukaryotic cells, ultra structure and functions of cell organelles.

CO2:Understand about cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in cell cycle regulation,

CO3: Acquire knowledge about Basics of signal transduction

CO4:Understand about protein trafficking in cells, Protein sorting, vesicular Transport and protein targeting.

Credits:4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0	

Unit	Topics	No. of Lectures
I	**Ultrastructure of cell and membrane transport**: Structural organization and function of various subcellular organelles, Cytoskeleton (Microtubules, Microfilaments, actins etc.) **Cell membrane & Transport**: Structure and functions of cell membrane, physiochemical and electrical properties of membrane, Membrane Transport: Diffusion, Facilitated diffusion, Active transport, and its types. Techniques to study biomembranes - FRAP, FRET, Freeze Fracture Technique.	12
II	**Cell cycle and Cell division**: Overview of cell cycle, Check points, role of cyclin and cyclin dependent kinases, Strategies of cell cycle regulation, Positive & Negative regulators, Mitosis and Meiosis; Programmed cell death, aging, and senescence.	12
III	**Cell Communication and Cell Signalling**: GPCR Structure & Functions, Ligand binding & activation, Signal amplification, Heterotrimeric G Proteins, Adenyl cyclase, Receptor tyrosine kinases, Signalling Pathways: AKT Signalling, c-MET, HER2, Nf-kB, Notch, p53, JAK-STAT, Hedgehog and Wnt Signalling pathways (mechanisms & physiological significance), Adenylate cyclase, Phosphodiesterase, Phosphoinositide pathway, Calmodulin, DAG.	12
IV	**Protein traffic in cells**: Secretory and non-secretory proteins, Endocytic and Exocytic pathways, Protein sorting and signal sequences; protein translocation in ER and vesicular transport to Golgi, Lysosomes, and plasma membrane; Protein import into nuclei, mitochondria, chloroplasts, and peroxisomes, Clathrin mediated endocytosis.	12
V	**Applied Cell Biology**: Basic techniques in mammalian cell culture;	12

	Cell &tissue culture media; Serum free media; maintenance of the culture and cell lines; Stem cell and their applications.	

Suggested Readings:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Dennis Bray, Karen Hopkin, Keith Roberts, Peter Walter "Essential Cell Biology"
2. Baltimore "Molecular Cell Biology"
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter "Molecular Biology of the Cell"
4. Lodish H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J. (1995). Molecular cell biology.
5. Cooper ""Molecular Cell Biology"
6. Karp & Karp "Molecular Cell Biology"

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Continuous Evaluation Methods:

Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VIII/M.Sc. II
Subject: Biotechnology		
Course Code: B100802T	Course Title: Recombinant DNA Technology	

Course Objectives:

The course is designed to make the students understand the concept and basic steps in gene cloning, to acquaint them with various vectors and enzymes used in recombinant DNA technology, transformation and screening techniques.

Course outcomes:

- **CO.1** Know the role of the several molecular tool applied in gene cloning for construction of recombinant molecules (DNA and Vectors),several techniques involved in production of C-DNA and Genomic library and primer synthesis, classification and properties of an ideal plasmid, plasmid as cloning vector
- **CO.2** The students will learn about Southern, Northern and Western blotting Nucleic acid hybridization, polymerase chain reaction, techniques of *in vitro* mutagenesis, nucleic acid sequencing. Techniques for studying, gene expression, DNA footprinting.
- **CO.3** The students will learn about codon optimization, *in vitro* transcription and translation, expression in bacteria and yeast and Gene tagging.
- **CO.4** They will learn about genome Sequencing, genomic libraries, c-DNA libraries, YAC, BAC libraries, screening of libraries for selection of desired clones.

Credits:4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Molecular tools and their application: Restriction endonucleases, polymerase nucleases, kinases, topoisomerases, gyrases, methylases, ligases and alkaline phosphatases. Gene cloning, Gene cloning vectors: Plasmids, bacteriophages, cosmids, phagemids, artificial chromosomes. Construction of c- DNA, reverse transcriptase, DNA primers, linkers, adaptors.	12
II	Nucleic acid hybridization: Principles and techniques. Polymerase chain reaction: Principles, variations and applications. Techniques of *in vitro* mutagenesis and protein engineering, nucleic Acid sequencing. Techniques for studying gene expression: DNA transfection, Northern and Western blotting, DNA footprinting.	12
III	Expression strategies for heterologous genes: Vector engineering and codon optimization, *in vitro* transcription and translation, expression in bacteria and yeast. Gene tagging: T-DNA and transposon tagging	12
IV	Genome Sequencing: Genomic libraries and c-DNA libraries, YAC, BAC libraries, screening of libraries for selection of desired clones, strategies for sequencing genome.	12
V	Microarray: Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Genome analysis using	12

	fluorescent-labeled c-DNA. Analysis of single nucleotide polymorphism using DNA chips.	

Suggested Readings:

- Smita Rastogi and Neelam Pathak (2009), Genetic Engineering, Oxford University Press
- Lewin "Genes".
- Freifelder, DM "Molecular Biology".
- Brown, TA "Genomes". Watson, JD "Molecular Biology of the cell".
- Twyman, R.M. "Advanced Molecular Biology"
- Genetic Engineering Rastogi & Pathak Brown, T.A.
- "Gene cloning: An introduction" Old & Primrose "Principles of Gene Manipulation"
- Primrose, SB "Molecular Biotechnology"
- Jose B. Cibelli Robert P. Lanza Keith Campbell Michasel D. West "Principles of Cloning"

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biochemistry, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had the Botany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B100803T	**Course Title:** Clinical Biochemistry and Enzymology	
Course Objectives:		
The main objective of this course is to learn and understand the fundamentals of physiology and its association with clinical biochemistry. Moreover, they will also learn about IPR and Biosafety.		
Course outcomes:		
After completion of the course, a student will be able to: CO1:Learn the basics composition of body fluids. CO2:Understand the fundamentals of digestive system. CO3:Understand the fundamentals of Respiratory system and Neural & chemical regulation of respiration. CO4:Aid in understanding of the basics aboutclinical and biochemical aspects of atherosclerosis, jaundice, diabetes, hepatitis, glomerular nephritis, gall stones, Addison's disease CO5:Understand about IPR and Biosafety.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Body fluids: Blood-functions, composition, blood groups, Rh factor, Plasma proteins, Blood coagulation, clot formation and coagulation, Urine and its composition, Alterations under pathological conditions, role of kidney in acid-base and electrolyte balance. Biochemistry of respiration, Muscle contraction, cell motility, role of calmodulin	12
II	Nerve impulse transmission: excitation-its conduction and synaptic transmission by neural systems, neurotransmitters, venoms and nerve poisons.	12
III	The living state and role of enzymes in its substance; chemicalcatalysis; general acid-base, covalent and intramolecular catalysis; detection of intermediates in enzymatic reactions; features and mechanism of action of lysozyme, chymotrypsin and carboxypeptidase A.	12
IV	Steady state and equilibrium hypotheses of enzyme kinetics, Michaelis-Menten and Briggs-Haldane equations, significance of Michaelis-Menten parameters i.e., Vmax, Km, Kcat and Kcat/Km; Mechanism and features of different types of enzyme inhibition; Breakdown of the Michaelis-Menten equation; Mechanism and kinetics of multisubstrate reactions.	12
V	Enzyme induction, repression and covalent modification; feed backinhibition; importance of isozymes and zymogen in enzyme regulation; allosteric enzymes and their regulations; Hills coefficient and the determination of enzyme-ligand binding/dissociation constant. Enzyme Immobilization: Immobilization; kinetics of immobilized systems	12

Suggested Readings:

1. Text-book of Biochemistry with clinical correlations by Thomas M. Devlin, 2nd Edition, J. Wiley and Sons (1986).
2. Physiological chemistry by Harper.
3. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
4. Physiological basis of Medical practice, West J.B., Best and Taylor.
5. Introduction to Physiology by Davidson H and Segal M.B. Academic Press

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. I[st]	Semester: B.Sc. VIII/M.Sc. II
Subject: Biotechnology		
Course Code: B100804T	**Course Title: Environmental Biotechnology**	
Course Objective		
The objective is to study about the basics of environment, different types of pollution, different approaches for treatment of wastewater and various types of pollutants alongwith modern biotechnological strategies for abatement of environmental pollution.		
Course outcomes **CO1.** The student will learn about basics environment pollution, types, their monitoring and control. **CO2.** The students will understand about different waste water treatment processes. **CO3.**The student will get familiar to biodegradation of xenobiotics and biodegradation mechanisms for removal various types of pollutants. **CO4.** The student will learn about the bioremediation strategy and its application for remediation of pollutants, and other beneficial processes for sustainable agriculture development like use of biopesticides, biofertilizers, biocomposting, organic forming. **CO5.** The student will learn and understand about the global environmental problems like ozone depletion, green house effect and acid rain as well as impact and management strategies.		
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Environment: Basic concept and issues. Environment pollution: Types of pollution; Air pollution, different pollutants, their monitoring and control. Water pollution and its control: Water as a scarce natural resource, sources of water pollution, need for water management, measurement of water pollution.	12
II	Waste water treatment- physical, chemical and biological treatment processes. Aerobic process: Activated sludge, oxidation ditches, trickling filters, rotating discs, oxidation ponds. Anaerobic processes: Anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors. Treatment schemes for waste waters from distillery and tannery industries.	12
III	Biodegradation of Xenobiotics in environment: Ecological considerations, decay behavior & degradative plasmids. Degradation of chlorinated hydrocarbons, substituted hydrocarbons, petrol, petroleum products, surfactants, Solid waste management.	12
IV	Bioremediation of contaminated soils and wasteland. Bioaccumulation, Biomagnification, Biostimulation, Biopesticides in integrated pest management, Rural Biotechnology with special reference to biofertilizers, biocomposting, organic forming.	12
V	Global environmental problems: Ozone depletion, UV-B, green	12

	house effect and acid rain, their impact and biotechnological approaches for their management.	

Suggested Readings:

1. Alexander M., Introduction to soil microbiology, Wiley Eastern limited, New Delhi.
2. Hurst, C.J., Environmental Microbiology, ASM press, Washington D.C.
3. Pelczar M.J., Chan E.C.S and Kreig N.R., Microbiology, Mcgraw-Hill Book Company, New York.
4. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB Mcgraw-Hill, New York.
5. Steward W.D.P., Nitrogen Fixation in Plants, The Athlone Press, London.

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biochemistry, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/ in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 4th/M.Sc. 1st	Semester: B.Sc. VIII/M.Sc. II
Subject: Biotechnology		
Course Code: B100805P	Course Title: Biotechnology Lab Course-II	

Course Objectives:

The objectives of the course are to learn and understand the basic microbiological and molecular diagnostic techniques and acquaint the students with quantitative and qualitative measurement methods for DNA, RNA and Proteins.

Course outcomes:

The student at the completion of the course will be able to:

CO.1 To understand about biochemical characterization methods of microbes.
CO.2 To learn and understand the water quality measurement through physicochemical and microbial analyses.
CO.3 To understand about enrichment culture technique.
CO.4 To gain knowledge of various molecular methods like isolation of DNA, polymerase chain reaction, SDS-PAGE.
CO. 5 To learn quantitative and qualitative testing of DNA and RNA through spectrophotometric analyses.

Credits:5	Core Compulsory
Max. Marks: 50+50	Min. Passing Marks:40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-10	

Unit	Topics	No. of Lectures
	1. Biochemical characterization of microbes 2. Determination of coliforms for determination of purity of potable water. 3. Determination of total dissolved solids of water. 4. Determination of dissolved oxygen (DO) concentration of water sample. 5. Determination of biological oxygen demand (BOD) of a sewage sample. 6. Determination of chemical oxygen demand (COD) of a sewage sample. 7. Isolation of xenobiont degrading bacteria by selective enrichment technique. 8. To isolate plasmid DNA from bacterial culture by alkaline lyses method 10. To separate and visualize various proteins in cell free homogenate of mouse/rat liver by SDS-PAGE 11. To visualize the precipitation line formed on the agar gel slide by Ouchterlony's double immuno-diffusion technique	60

Suggested Readings:

1. Ananthanarayanan R and Panicker C K. Textbook of Microbiology. Orient Longman.
2. Ken S.Rosenthal, Patrick R.Murray, and Michael A.Pfaller. Medical Microbiology 7th Edition, Elsevier

3. Karen C.Carroll, Geo.Brooks, Stephen Morse, and Janet Butel.Jawetz, Melinck, &Adelberg's Medical Microbiology, Lang
This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany,Zoology
Suggested Internal Continuous Evaluation Methods: **Total Marks: 50** House Examination/Test: 20 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 20 Marks Class performance/Participation: 10 Marks
External Evaluation:50 Marks
Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.
Suggested equivalent online courses: .....
Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	**Year: B.Sc. 4th/M.Sc. 1st**	**Semester: B.Sc. VIII/M.Sc. II**
Subject: Biotechnology		
Course Code: B100806P	**Course Title:** Industrial Training/Survey/ Research Project-B	
Course Objectives: The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.		
Credits: 4		**Core Compulsory**
Max. Marks: 25+75		**Min. Passing Marks:40**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. IX/M.Sc. III
Subject: Biotechnology		
Course Code: B100901T	**Course Title: Bioprocess Engineering and Technology**	

Course Objectives: The objective of course to get the basic knowledge of Bioprocess Engineering and Technology for bio-product development.

Course outcomes:

CO1.

The student will get theoretical understanding about bioprocess engineering, bioreactors, isolation, preservation and maintenance of industrial microorganisms and microbial kinetics during industrial fermentation.

CO2.

The students will learn the strain development techniques including recombinant DNA technique. They will also learn about fermentation processes and different types of bioreactor.

CO3.

The student will get knowledge about different steps in downstream processing like removal of microbial cells and solid matters, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization.

CO4.

The student will learn about the enzyme and whole cell immobilization and its industrial application. They will also learn the industrial production of alcohols, acids, solvents, antibiotics and amino acids.

CO5.

The student will learn and understand about the single cell protein, microbial leaching of metals and oil recovery. They will also understand about online monitoring and control of bioprocess parameters and sterilization procedures for media, air and fermenter.

Credits:4	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Introduction to bioprocess engineering, bioreactors, isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth various substrates for industrial fermentation.	12
II	Strain development: screening, mutation, protoplast fusion, hybridization and recombinant DNA technique. Types of fermentation process: Batch, fed-batch and continuous bioreactors, stability of microbial reactors with mixed microbial populations, specialized bioreactors (pulse, fluidized, photo bioreactors, etc.).	12
III	Downstream processing: Introduction, removal of microbial cells and solid matters, foam separation, precipitation, filtration, distillation, centrifugation, cell disruptions, liquid-liquid	12

	extraction, chromatography, membrane process, drying and crystallization.	
IV	Enzyme and whole cell immobilization and its industrial application. Industrial production of chemicals: Ethanol, citric acid, acetic acid, glycerol, acetone, antibiotics (penicillin, tetracycline), amino acids (lysine, glutamic acid).	12
V	Single cell protein, Microbial leaching of metals and oil recovery, Online monitoring and control of bioprocess parameters and sterilization of media, air and fermenter.	12

Suggested Readings:

1. Ananthanarayanan R and Panicker C K. Textbook of Microbiology. Orient Longman.
2. Ken S.Rosenthal, Patrick R.Murray, and Michael A.Pfaller. Medical Microbiology 7th Edition, Elsevier
3. Karen C.Carroll, Geo.Brooks, Stephen Morse, and Janet Butel.Jawetz, Melinck, &Adelberg's Medical Microbiology, Lang

This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany,Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/ in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. IX/M.Sc. III
Subject: Biotechnology		
Course Code: B100902T	**Course Title: Animal Biotechnology and Cell Science**	

Course Objectives:

The objective is to study about the basic technique involve in animal tissue culture for producing in vitro model systems and also provide understanding that how transgenic animals are produced for improved quality and yields.

Course outcomes:

CO.1 Students will learn about Totipotency, SCNT, mechanism of fertilization, role of maternal contribution in development, culture medium , viability and cytotoxicity.

CO.2 Students will learn basic techniques in mammalian cell culture; Cell culture media; Serum free media; maintenance of the culture and cell lines; Stem cell and their applications.

CO.3 Students will learn about micromanipulation, synchronization and transformation, stem cell culture, organ culture, embryonic stem cells and their applications.

CO. 4 Students will learn about strategies for producing transgenic animals and treatment of diseases with gene replacement methods.

CO.5 Students will learn about assisted reproduction technology, ethical and biosafety considerations, Preservation of animal cell lines.

Credits:4	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Totipotency, nuclear transfer experiments, role of maternal contribution in early embryonic development, culture medium and role of serum, measurement of viability and cytotoxicity.	12
II	Biology and characterization of the cultured cells, measurement of growth, basic techniques of mammalian cell culture, primary and established cell line cultures, disaggregation of tissue and primary culture, monolayer, suspensions and immobilized culture.	12
III	Cell cloning, micromanipulation, synchronization and transformation, stem cell culture, organ culture, embryonic stem cells and their applications, nuclear transplantation.	12
IV	Gene Therapy and Transgenic animals: Genetic disorders, somatic and germline manipulations, strategies of gene delivery, targeted gene replacement/augmentation, construction and application of transgenic animals.	12
V	Assisted reproduction technology: artificial insemination, *in vitro* fertilization and embryo transfer, ethical and biosafety considerations, Preservation and maintenance of animal cell lines.	12

Suggested Readings:

- Animal Cell Culture Technique, Ed. Martin, Clynes. Springer, 1998

- Animal Cell Culture-Practical Approach, 3rd Edition, Ed. John R.W. Masters, Oxford University Press, 2000
- Stem Cells, C.S.Potten, Elsevier, 2006
- Stem Cell Biology and Gene Therapy, Peter J. Quesenberry, 1st Edition, Willy – Less, 1998

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biochemistry, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. IX/M.Sc. III
Subject: Biotechnology		
Course Code: B100903T	Course Title: Fundamentals of Immunology	

Course Objectives:

The objective is to study about the immunity, structure and function of immune cells and organs, hypersensitivity, complement system, autoimmune disorders, vaccination and cell mediated cytotoxicity laying the foundation for other advanced courses like medical biotechnology, medical microbiology and medical biochemistry.

Course outcomes:

- **CO.1** The students will understand the concept of immunity, primary and secondary immune response and antigens and super antigens.
- **CO.2** The student will learn and understand about the immune cells and organs, structure and function of various immunoglobulins.
- **CO.3** The student will learn and understand the principle of antigen antibody interaction and mechanism of immune cell cytotoxicity.
- **CO.4** The Students will understand type, structure and function of major histocompatibility complex, complement system, hypersensitivity and cytokines.
- **CO.5** They will be able to understand the basic concepts of vaccination and different types of vaccines, autoimmune disorders, Immunotechnology and hybridoma technology.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Immunology: Introduction, active and passive immunity, primary and secondary immune response and clonal nature of immune response, Antigens and super antigens.	12
II	Structure of immune cells and organs, structure and function of immunoglobulins, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells.	12
III	Antigen-antibody interactions, BCR & TCR, Cell-mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity.	12
IV	Major Histocompatibility Complex: Antigen processing and presentation, complement system. cytokines and their role in immune regulation, Hypersensitivity, immunological tolerance.	12
V	Immunoprophylaticintervetion: Basic concepts of vaccination and different types of vaccines. autoimmune disorders. Immunotechnology: Immuodiffusion, immunoelectrophoresis, RIA, ELISA, Hybridoma technology and monoclonal antibodies, along with their applications.	12

Suggested Readings:

- Richard A. Goldsby Thomas J. Kindt Janis Kuby Barbara A. Osborne "Immunology".

- Peter Parkham Peter Parham "The Immune System".
- Coleman, R.M, "Fundamental Immunology"
- Abul K Abbas, Andrew H. Lichtman, Abdul K. Abbas, Jordan S. Pober "Cellular & Molecular Immunology"
- Janeway Charles A., Travers Paul, Walport Mark, Shlomchik Mark, Immunobiology Lehninger AL "Principles of Biochemistry".
- Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell)

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had thcBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. IX/M.Sc. III
Subject: Biotechnology		
Course Code: B100904T	**Course Title: Medical Biotechnology**	

Course Objectives: The objective of this course is to learn and understand the basic concepts of different types of microbial diseases and their treatment strategies, pathology and medico-legal aspects.

Course outcomes:

CO1.

The student will be able to understand about various types of disease causing microorganisms, morphology and their important characteristics.

CO2.

The students will acquaint with medical virology including adenoviruses, pox viruses, Retroviruses and other. They will also get knowledge of pathogenic fungi and various types of mycoses.

CO3.

The student will learn about blood formation, different types of anemia, leukemia, brain tumors, and stem cells. The student will also understand about pathology of several diseases like tuberculosis, yellow fever, Japanese encephalitis and AIDS.

CO4.

The student will learn about different types of therapeutic measures like chemotherapy, radiotherapy, gene therapy. They will also learn about antibiotics and basic principles for the use of antibiotics.

CO5.

The student will learn and understand about medico-legal aspects as well as ethical issues to clinical trials, the right to information and role of ethical committee.

Credits:5	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-1-0

Unit	Topics	No. of Lectures
I	Definition of Zoonoses: Classifications of pathogenic microbes, Leptospira, Brucella, Bacillus anthracis, Medical Parasitology: Amebiasis, Malaria, Trichomoniasis, Medical Bacteriology: Staphylococcus, Enterococcus, Peneumococcus, Mycobacterium, and Vibrio.	12
II	Medical Virology: Adenoviruses, Pox viruses, Hepadnaviruses, Retroviruses, Coronavirus Medical Mycology: Fungi, Yeast, Pathogenic fungi, Mycoses.	12
III	Pathology of diseases: Blood formation, Anemia; Blood loss anemia, Megaloblastic anemia, Leukemia, Stem cells: stem cell or Bone marrow transplant, Japanese Encephalitis, Dengue, Acquired Immune Deficiency Syndrome (AIDS).	12
IV	Therapies:Introduction to chemotherapy and radiotherapy, Human Gene Therapy. Antibiotics: Classification of Antibiotics, Combinations of Antibiotics, Doses of Antibiotics, Side Effects of Antibiotics, General Principles for use of Antibiotics.	12
V	Medico-legal aspects:Social: genetic discrimination: insurance and employment, human cloning, foeticide, sex determination,	12

	Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function.	

Suggested Readings:

1. Ananthanarayanan R and Panicker C K. Textbook of Microbiology. Orient Longman.
2. Ken S.Rosenthal, Patrick R.Murray, and Michael A.Pfaller. Medical Microbiology 7th Edition, Elsevier
3. Karen C.Carroll, Geo.Brooks, Stephen Morse, and Janet Butel.Jawetz, Melinck, &Adelberg's Medical Microbiology, Lang

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. IX/M.Sc. III
Subject: Biotechnology		
Course Code: B100905P	**Course Title: Biochemistry Lab Course-III**	

Course Objectives:

The lab is designed to train the students in basic and some advanced techniques of Biotechnology like isolation and purification of industrially important microorganism.

Course outcomes:

After completion of the course, a student will be able to achieve theseoutcomes

CO1: The students will learn about ethanol, amylase, proteases, citric acid producing bacteria, yeast and fungi.

CO2. The students will learn about plant tissue culture methods and different types of media used in plant cell cultue.

CO.3 The students will learn about to isolate plant genomic DNA and quantify the genomic DNA by spectrophotometer and agarose gel electrophoresis.

CO.4 Students will learn also about measurement of doubling time of bacteria, effect of carbon source, pH and temperature on bacterial growth and antibiotic sensitivity assay.

Credits:5	Core Compulsory
Max. Marks: 50+50	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-10

Unit	Topics	No. of Lectures
I	1. Isolation of industrially important microorganisms for microbial processes. 2. Isolation of ethanol producing yeast from a spoilt fruit sample. 3. Isolation of amylase producing bacteria form soil sample 4. Isolation of proteolytic bacteria. 5. To determine the quality of milk through methylene blue reductase test. 6 To prepare stock solutions of nutrients for plant tissue culture medium 7. To quantitate the plant genomic DNA by spectrophotometer 8. To quantitate the plant genomic DNA by agarose gel electrophoresis 9. Measurement of doubling time of bacteria 10. Effect of carbon source, pH and temperature on bacteria 11. To perform the Antibiotic sensitivity assay	60

Suggested Readings:

Keith Wilson, John Walker, John Walker, John M. Walker "Principles and Techniques of Practical Biochemistry"
Chirikjian "Biotechnology Theory & Techniques"
Joseph Sambrook, David W. Russel, Joe Sambrook "Molecular Cloning: A Laboratory Manual"
William M, O'Leary Robert, Dony Wu "Practical Handbook of Microbiology"
Principles of Biochemistry- Albert L. Lehninger CBS Publishers &Distributors
Texbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley &

Sons, Inc. (New York), ISBN:978-0-470-28173-4.
An Introduction to Practical Biochemistry, David T. Plummer (2006) Tata McGraw Hill Education, 3rd edition
"
Sadasivam "Biochemical Methods"

This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 50

House Examination/Test: 20 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 20 Marks

Class performance/Participation: 10 Marks

External Evaluation:75

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	**Year: B.Sc. 5th/M.Sc. 2nd**	**Semester: B.Sc. IX/M.Sc. III**
Subject: Biotechnology		
Course Code: B100906P	**Course Title:** Industrial Training/Survey/ Research Project-C	

Course Objectives:

The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.

Credits: 4	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. X/M.Sc. IV
Subject: Biotechnology		
Course Code: B101001T	Course Title: **Plant Biotechnology and Tissue Culture**	

Course Objectives:

The objective is to study about the basic technique involve in plant tissue culture for producing novel hybrids, cybrids, virus free plants and haploids and also provide understanding that how transgenic plants are produced for improved crop quality and yields laying the foundation for other advanced courses like plant breeding, crop protection and sustainable harvesting.

Course outcomes:

CO.1 The students will learn about the basic techniques of plant tissue culture to produce novel plants and hybrids, virus-free plants, cybrids and haploid plants and homozygous lines.

CO.2 The student will learn and understand the basic principle of cryopreservation, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines and purification strategies.

CO.3 The student will learn about plant transformation technology, chloroplast transformation and viral vectors and their applications.

CO.4 Student will learn about basics of application of plant transformation for productivity and performance.

CO.5 They will be able to understand the Molecular marker, linkage analysis, QTL, marker assisted selection, arid and semi-arid plant biotechnology, green house technology.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids, tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture. Organogenesis: somatic embryogenesis, artificial seeds, Shoot-tip cultureand production of virus-free plants, Embryo culture and embryo rescue. Protoplast isolation, culture and fusion, symmetric and asymmetric hybrids, cybrids, anther, pollen and ovary culture for production of haploid plants.	12
II	Cryopreservation, slow growth and DNA banking for germplasm conservation, Plant secondary metabolites, phenylpropanoid pathway, shikimate pathway, alkaloids, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines, purification strategies.	12
III	Plant transformation technology: Basis of tumor formation, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as Vectors, binary vectors, Methods of nuclear transformation: Particle bombardment, electroporation, microinjection, transformation of monocots. Viral vectors and their applications, Chloroplast transformation.	12

IV	Application of plant transformation for productivity and performance: With reference to engineered resistance to herbicides (phosphinotricin, glyphosphate, sulphonylurea, atrazine), insect (Bt genes), virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinases, 1-3 β-glucanase, RIP, antifungal proteins, thionins, PR proteins, abiotic stress (salinity, drought), post-harvest losses, long shelf life of fruits and flowers.	12
V	Molecular marker-aided breeding: RFLP RAPD, AFLP, STS, SSR, SCAR, SSCP markers, linkage analysis, marker assisted selection, plant biotechnology, green house technology.	12

Suggested Readings:

- H. S. Chawla "Plant Biotechnology: A Practical Approach"
- Bhojwani and Razdan "Plant Tissue Culture"
- Richard A. Dixon Robert A. Gonzales "Plant Cell Culture: A Practical Approach"
- Adrian Slater, Nigel W. Scott, Mark R. Fowler "Plant Biotechnology: The Genetic Manipulation of Plants"
- S.H. Mantell, J.A. Matthews, R.A. McKee "Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants"
- Angela Stafford Graham Warren "Plant Cell and Tissue Culture (Biotechnology Series)"
- Old & Primrose "Principles of Gene Manipulation"
- Brown TA "Gene cloning: An Introduction"

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had the Botany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. X/M.Sc. IV
Subject: Biotechnology		
Course Code: B101002T	Course Title: Fundamentals of Cancer Biology	

Course Objectives:

To enable the students to understand • Basic biology of cancer • Impact of antibodies against cancer in the human body leading to more effective treatments • Enhanced immunology based detection methods and imaging techniques • Development of cell based and cytokine based immunotherapy against cancer.

Course outcomes: The course would facilitate the students

CO.1 To appreciate the role of immune system in cancer.

CO.2 To describe self – tolerance machinery and immune surveillance.

CO.3 To understand the cancer microenvironment and its influence on immune cells.

CO.4 To have awareness on medical applications of cytokines and immune cells against cancer.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Fundamentals of cancer biology: Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.	12
II	Principles of carcinogenesis: Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.	12
III	Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases.	12
IV	Principles of cancer metastasis: Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.	12
V	New molecules for cancer therapy: Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.	12

Suggested Readings:

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007

2. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004
3.King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996. 2. Ruddon, Raymond W. " Cancer Biology" IIIrd Edition . Oxford University Press, 1995.
4. Lauren Pecorino, "Molecular Biology of cancer: Mechanisms, Targets, and Terapeutics," Oxford University Press. 3rd edition, 2012.
5. Owen, J. A., Punt, J., & Stranford, S. A. (2013). Kuby immunology . seventh Edition, New York: WH Freeman.
6.Robert A. Weinberg, "The Biology of Cancer," Garland Science; 1 Cdr Edition, 2010

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had the Botany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. X/M.Sc. IV
Subject: Biotechnology		
Course Code: B101003T	Course Title: **Bio-informatics and Biostatistics**	

Course Objectives:

The objective is to study about the immunity, structure and function of immune cells and organs, hypersensitivity, complement system, autoimmune disorders, vaccination and cell mediated cytotoxicity laying the foundation for other advanced courses like medical biotechnology, medical microbiology and medical biochemistry.

Course outcomes:

- **CO.1** The students will understand the concept of immunity, primary and secondary immune response and antigens and super antigens.
- **CO.2** The student will learn and understand about the immune cells and organs, structure and function of various immunoglobulins.
- **CO.3** The student will learn and understand the principle of antigen antibody interaction and mechanism of immune cell cytotoxicity.
- **CO.4** The Students will understand type, structure and function of major histocompatibility complex, complement system, hypersensitivity and cytokines.
- **CO.5** They will be able to understand the basic concepts of vaccination and different types of vaccines, autoimmune disorders, Immunotechnology and hybridoma technology.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0

Unit	Topics	No. of Lectures
I	Basic Bioinformatics: Basics of networking, Introduction to Internet, Introduction of Genomics: Information flow in biology, Experimental approach to genome sequence data, Genome information resources.	12
II	Computational Genomics: Biological data analysis and application, Nucleic acid Protein Data Banks- Genbank, EMBL, SWISSPROT, NCBI model Information retrieval system- Entrez and Pubmed etc, File format, Annotation, ESTs Databases, Clustering, Gene discovery, identification and functional classification.	12
III	Structural and Functional Protcomics: Small molecules databases, Protein information resources and secondary databases, Computational techniques in structural analysis, Structural comparison at secondary and tertiary levels, Computer aided drug designing.	12
IV	Sequence alignment and Database Search: Introductory basis of sequence alignment, DNA primary sequence analysis, Pair wise sequence alignment- NEEDLEMAN and Wunsch, Smith Waterman algorithm, BLAST and FASTA algorithm, Multiple sequence alignment, Database similarity search tools- BLAST, FASTA, CLUSTAL, TCOFFEE.	12

V		12

Suggested Readings:

- Richard A. Goldsby Thomas J. Kindt Janis Kuby Barbara A. Osborne "Immunology".
- Peter Parkham Peter Parham "The Immune System".
- Coleman, R.M, "Fundamental Immunology"
- Abul K Abbas, Andrew H. Lichtman, Abdul K. Abbas, Jordan S. Pober "Cellular & Molecular Immunology"
- Janeway Charles A., Travers Paul, Walport Mark, Shlomchik Mark, Immunobiology Lehninger AL "Principles of Biochemistry".
- Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell)

This course can be opted as an elective by the students of following subjects: M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. X/M.Sc. IV
Subject: Biotechnology		
Course Code: B101004T	**Course Title: Research Methodology**	
Course Objectives:		
To equip the students with knowledge of framing and analyzing research related issues.		
Course outcomes:		
After completion of this course, a student will be able to: CO1: Learn about various aspects of research design. CO2: Learn about analysis of research findings through statistical means. CO3: Train students about presenting research findings and publishing them. CO4: Learn about computer applications in research.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Research Methodology: definition, purpose, Process of Research; Objectives and Dimensions of Research, Design Tools of Research: Library, Field, Laboratory; Methods of research: Qualitative and Quantitative. Systematic review of literature, Features of good research study. Research Ethics (Issues relating to referencing and documentation, copyrights, plagiarism etc), Impact Factor, H-Index, Citation Index, references/ bibliography	12
II	Biostatistics: Data Collection, presentation, data processing, classification and tabulation. Measures of Central tendency and Dispersion. Quantitative Techniques: Levels of significance	12
III	Scientific proposal and paper writing: An Insight into Research proposal: Definition and basic concepts, defining the problem, creating a hypothesis, objectives, work plan, significance and techniques of research, expected outcome, finding research materials – literature survey, compiling records. Definition and kinds of scientific documents – research paper, review paper, book reviewsThesis: chapter format, pagination, identification, using quotations, footnotes, abbreviations, presentation of tables and figures, referencing, documentation, use and format of appendices, indexing.	12
IV	Basics of Computers- classification, computer system components (CPU, Input/output devices, internal memory i.e. RAM, ROM & Cache and external memory i.e. secondary storage devices). Computers networks and introduction of internet. MS-Office .	12
V	Computer applications in Biology -tools: Introduction to spreadsheet applications, features, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts / graph and other features, Presentation of Power Point Presentation, Customizing presentation, Use of Computers in	12

	Quantitative analysis. Tools for digital image processing.

Suggested Readings:

1. **Marder M P (2011) Research Methods for Science, Cambridge University Press**
2. Research Methodology: Methods And Techniques By Dr C R Kothari
3. **Rosner B (2010) Fundamentals of Biostatistics, 7th Edition, Brooks/Cole Cengage Learning Publication**
4. **Dunleavy P (2003) Authoring a PhD: How to Plan, Draft, Write and Finish a Doctoral Thesis or Dissertation. Palgrave Macmillan**
5. Computer Fundamentals: Concepts, Systems and Applications By PK Sinha. BPB Publications.
6. Computer Fundamentals and Programming in C By JB Dixit. University Science Press. 7. Computer fundamentals and programming in C By Amiya Kumar Rath, Alok Kumar

Suggestive digital platforms web links

This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

External Evaluation:75

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/ in B.Sc.

Suggested equivalent online courses:

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Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	Year: B.Sc. 5th/M.Sc. 2nd	Semester: B.Sc. X/M.Sc. IV
Subject: Biotechnology		
Course Code: B101005P	**Course Title: Research Review and assignment**	
Course Objectives: The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.		
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Program/Class: Bachelor (Research) in Biotechnology/M.Sc. Biotechnology	**Year: B.Sc. 5th/M.Sc. 2nd**	**Semester: B.Sc. X/M.Sc. IV**
Subject: Biotechnology		
Course Code: B101006P	**Course Title:** Industrial Training/Survey/ Research Project-D	
Course Objectives: The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.		
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Department of Biochemistry
Dr. Rammanohar Lohia Avadh University, Ayodhya-224001

Regulation/ Ordinance of the Certificate Course

1- The title of the course is: **Certificate Course in 'Advanced Genetic Engineering'**

2- This course has structure of four units that requires a class duration of 30 hrs.

3- This course is open for any students / faculty members with elementary background information about biological sciences.

4- It is mandatory for the students who are enrolled in the undergraduate, postgraduate or Ph.D. program of this university to complete this certificate course.

5- The fee for this certificate course is Rs. 1000=00. However, all students enrolled in any undergraduate, post graduate or Ph.D. program will have to pay Rs. 500/= along with their structured fees.

6- The course will be delivered in hybrid mode (both online and off line)

7- This course is equivalent to 02 Credit on credit-based scale.

8- The course will be completed by the faculty members of Biotechnology and Biochemistry.

Prof. Farrukh Jamal
Head, Biochemistry
Dr. RMLAU, Ayodhya

13.03.2024

Pk Singh
13.03.24

13.03.24

Course Title: Certificate Course in 'Advance Genetic Engineering'

Unit	Topics	No. of Lectures
I	Fundamentals of Genetic Engineering: Introduction to Genetic Engineering, Tools of Genetic Engineering, Restriction modification system and Applications of Genetic Engineering: Restriction Endonucleases and its Types, Steps involved in Genetic Engineering, Principles of cloning, Applications of cloning, Different types of libraries, Library Screening	8
II	Plasmids and Vectors, Cloning and Expression Vectors, Yeast Artificial Chromosome, Types of Transfections, Genetic manipulation in plants, Transgenic Plants, Transgenic Animals, Gene silencing- m-RNA, si-RNA, RNAi Knock out technology, Regulation of Gene Expression in prokaryotes, Transcription and its regulation in prokaryotes Translation and its regulation in prokaryotes	7
III	Restriction modification system, Reporter genes, Microarrays, DNA foot printing, Gene Therapy, Future trends in transgenic plants, Future trends in transgenic animals, Pharm animals	8
IV	Genome Editing: Genome editing, CRISPR-Cas Technology, Mechanism of CRISPR-Cas, Case studies of CRISPR-Cas, Basic instrumentations in Genetic Engineering, Sequence analysis	7

Suggested Readings:

1. Genes VIII by Benjamin Lewis

2. An Introduction to Genetic Engineering, 3rd Edition (South Asian Edition) by Desmond S. T. Nicholl

3. Brown TA. Gene cloning and DNA analysis: An introduction. (2016) 7th Edition. Wiley-Blackwell

4. Principles of Gene Manipulation and Genomics, Old, R. W., Primrose, S. B., & Twyman, R. M. (2006). 7th Edition: Blackwell Publishing.

13.03.2024

Prof. Farrukh Jamal
Head, Biochemistry
Dr. RMLAU, Ayodhya

P.K. Singh
13.03.24

13.03.24