DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the

PROGRAM: M.Sc., SUBJECT: Biotechnology

Syllabus Developed by				
SN	**Name of Expert/BoS Member**	**Designation**	**Department**	**College/ University**
1	Prof. R.K. Mishra	External Expert	Department of Biochemistry	University of Lucknow, Lucknow
2	Prof. Farrukh Jamal	Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
3	Dr. Vandana Ranjan	Associate Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
4	Dr. Sangram Singh	Associate Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
5	Dr. Neelam Yadav	Assistant Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
6	Dr. Shivi Srivastava	Assistant Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
7	Dr. Pankaj Singh	Assistant Professor	Department of Biotechnology	Dr. Rammanohar Lohia Avadh University, Ayodhya
8	Dr. Manikant Tripathi	Assistant Professor	Department of Biotechnology	Dr. Rammanohar Lohia Avadh University, Ayodhya
9	Prof. Neelam Pathak	Professor, Head& Convenor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya

Prof C K Mishra Dean, Faculty of Sciences

Dr. Rammanohar Lohia Avadh University Ayodhya

Course Code		**Course Title**	**Credits**	**T/P**	**Evaluation**	
					CIE	**ETE**
A	B	C	D	E	F	G
SEMESTER I (YEAR I)						
B100701T	CORE	Macromolecules: Structure and Functions	5	T	25	75
B100702T	CORE	Microbial Physiology and Genetics	5	T	25	75
B100703T	CORE	Bioanalytical Tools and Techniques	5	T	25	75
B100704T	FIRST	Essentials of Molecular Biology	5	T	25	75

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B100705T	ELECTIVE (Select any one)	Enzyme and Food Technology	5	T	25	75
B100706P	SECOND ELECTIVE (Select any one)	Biotechnology Lab Course-A	5	P	50	50
B100707P		Biotechnology Lab Course-B	5	P	50	50
SEMESTER II (YEAR I)						
B100801T	CORE	Immunology	5	T	25	75
B100802T	CORE	Genetic Engineering	5	T	25	75
B100803T	CORE	Environmental Biotechnology	5	T	25	75
B100804T	THIRD ELECTIVE (Select any one)	Fundamentals of Nutrition Science	5	T	25	75
B100805T		Cell Biology	5	T	25	75
B100806P	FOURTH ELECTIVE (Select any one)	Biotechnology Lab Course-C	5	P	50	50
B100807P		Biotechnology Lab Course-D	5	P	50	50
SEMESTER III (YEAR II)						
B100901T	CORE	Animal Biotechnology and Cell Culture	5	T	25	75
B100902T	CORE	Plant Biotechnology and Tissue culture	5	T	25	75
B100903T	CORE	Bioprocess Engineering and Technology	5	T	25	75
B100904T	FIFTH ELECTIVE (Select any one)	Clinical Biochemistry and IPR & Biosafety	5	T	25	75
B100905T		Medical Biotechnology	5	T	25	75
B100906P	SIXTH ELECTIVE (Select any one)	Biotechnology Lab Course-E	5	P	50	50
B100907P		Biotechnology Lab Course-F	5	P	50	50
SEMESTER IV (YEAR II)						
B101001T	CORE	Applied Biotechnology	5	T	25	75
B101002T	CORE	Research Methodology	5	T	25	75
B101003P	SEVENTH ELECTIVE (Select any one)	Seminar & Interactive Course	5	P	50	50
B101004P		Review and Assignment	5	P	50	50
B101005P	RESEARCH PROJECT/ DISSERTATION	Major Research Project/ Dissertation	10	P	50	50

Neelam Pathak

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**
		Masterin Biotechnology			
First	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	Microbial Physiology and Genetics	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – III	Bioanalytical Tools and Techniques	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		FIRST ELECTIVE (Select any one)	Essentials of Molecular Biology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry,

					Botany, Zoology)
			Enzyme and Food Technology	B.Sc. (Botany, Zoology,Chemistry, Biochemistry,Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		SECOND ELECTIVE (Select any one)	Biotechnology Lab Course-A	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
			Biotechnology Lab Course-B	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
	SEM-II	Core Theory Paper – IV	Immunology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper –V	Genetic Engineering	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Theory Paper – VI	Environmental Biotechnology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc.(Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		THIRD ELECTIVE (Select any one)	Fundamentals of Nutrition Science	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
			Cell Biology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		FOURTH	Biotechnology	B.Sc. (Botany,	M.Sc.

		ELECTIVE (Select any one)	Lab Course-C	Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	(Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
			Biotechnology Lab Course-D	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
Seco nd	SEM-III	Core Theory Paper - VII	Animal Biotechnology and Cell Science	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper - VIII	Plant Biotechnology and Tissue culture	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		Core Theory Paper – IX	Bioprocess Engineering and Technology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		FIFTH ELECTIVE (Select any one)	Clinical Biochemistry and IPR & Biosafety	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
			Medical Biotechnology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology
		SIXTH ELECTIVE (Select any one)	Biotechnology Lab Course-E	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
			Biotechnology Lab Course-F	B.Sc. (Botany, Zoology, Chemistry, Biochemistry,	M.Sc. (Microbiology, Biotechnology,

				Biotechnology, Microbiology)	Environmental Science, Chemistry, Botany, Zoology)
	SEM-IV	Core Theory Paper- X	Applied Biotechnology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M. Sc (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper- XI	Research Methodology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M. Sc (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		SEVENTH ELECTIVE (Select any one)	Seminar & Interactive Course		
			Review and Assignment		
		RESEARCH PROJECT/ DISSERTATION	Major Research Project/ Dissertation		

Program/Class: Master in Biotechnology	Year: First	Semester: 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** 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.2** Students will understand classification of lipids and structure, properties, deficiency diseases of vitamins.
- **CO.3** Students will learn about types, structure, properties of nucleic acids, DNA sequencing and various supramolecular assemblies.
- **CO.4** Students will understand the structure, hierarchy of proteins and biophysical and cellular aspects of protein folding.
- **CO.5** The students will understand about the classification, mode of action, deficiency disease of animal hormone and structure and types of porphyrins.

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	Properties of water, pH, Henderson Hasselbalch equation, buffer, physiological buffer & its significance; Carbohydrates: Classification, structure, function and properties, Glycoconjugates: glycolipids, glycoproteins, proteoglycans, Glycosaminoglycans.	12
II	Lipids: Classification, structure, function and properties, Sterols, Lipoproteins, Vitamins (fat soluble and water soluble), structure, properties, deficiency diseases.	12
III	Nucleic Acids: types, structure, properties, DNA sequencing, DNA polymorphism, Supramolecular assemblies: molecular assemblies like membranes, ribosomes, extracellular matrix and chromatin.	12
IV	Proteins: structure of amino acids and its classification, hierarchy in structure: Primary, secondary, tertiary and quaternary structure, Ramachandran map, Protein folding: Biophysical and cellular aspects.	12
V	Protein-protein and protein-ligand interactions, Harmones: classification, mode of action, deficiency disease. Sequencing of proteins, Protein denaturation, Porphyrins: structure and its types.	12

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

Neelam Pathak

Program/Class: Master in Biotechnology	Year: First	Semester: I
Subject: Biotechnology		
Course Code: B100702T	**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: 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	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), Bacteria and Viruses: General properties, structure and classification,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: Mode of action of antibiotics, drug resistance in bacteria.	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 chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy, methanogenesis and acetogenesis. Fermentation, nitrogen metabolism, nitrogen fixation.	12

V	Bacterial genetic system, recombination transformation, conjugation, transduction, plasmids and transposons, bacterial genetic map with reference to *E. coli.*	**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 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: Master in Biotechnology	Year: First	Semester: I
Subject: Biotechnology		
Course Code: B100703T	**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: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	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, 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 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: Master in Biotechnology	Year: First	Semester: I
Subject: Biotechnology		
Course Code: B100704T	**Course Title: Essentials 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: DevelopUnderstanding about the classes of DNA sequences, Genome-wide and Tandem repeats, Retroelements, Transposable elements, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA and Split genes		
Credits:5	**Elective**	
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	**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.	12
V	**DNA damage and DNA Repair:** Types of DNA damages,TypesofDNARepair systems, Photoreactivation, BER,NER, Mismatch Correction, Homologous recombination and NHEJ method, SOS Repair,	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:

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Further Suggestions: None

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

Neelam Pathak

Program/Class: Masters in Biotechnology	Year: First	Semester: I
Subject: Biotechnology		
Course Code: B100705T	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:5	Elective
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	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, 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: Master in Biotechnology	Year: First	Semester: I
Subject: Biotechnology		
Course Code: B100706P	Course Title: Biotechnology Lab Course-A	

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:5	Elective
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: Master in Biotechnology	Year: First	Semester: I
Subject: Biotechnology		
Course Code: B100707P	**Course Title: Biotechnology Lab Course-B**	
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:5	**Elective**	
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. To prepare suitable liquid media for the routine cultivation of bacterial culture 2. Isolation and maintenance of microorganisms from soil by the serial dilution-agar plating method 3. Isolation of algae from soil 4. To prepare suitable media for fungal culture 5. To prepare pure culture of microorganisms by streak plate method, pour plate method, spread plate method 6. Preparation of agar slants for culture of microorganisms 7. . Measurement of bacterial growth by turbidity measurements (Spectrophotometric method) & preparation of growth curve 8. To plot a curve for estimation of glucose by phenol sulphuric acid and Nelson and Somogyi method 9. To determine blood group and Rh factor in a given sample of blood 10. To determine RBC and WBC count in a double oxalated blood sample 11. To extract nucleic acids from the given plant tissues	**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: .....
Further Suggestions: None

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

Program/Class: Master in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code:B100801T	Course Title: 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: 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	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 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: Masters in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code: B100802T	**Course Title: Genetic Engineering**	

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 DNAtechnology, 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: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	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, Oxfoed 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 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: Masters in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code: B100803T	**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: 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	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 house effect and acid rain, their impact and biotechnological approaches for their management.	**12**

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: Master in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code: B100804T	Course Title: Fundamentals of Nutrition Science	

Course Objectives:

The objective of this course is to learn and understand the basic concepts of nutritional biochemistry which comprises nutritional values of foods, dietary requirements of carbohydrates, lipids and proteins, nutritional significance of minerals. Moreover, this course is also designed to understand the factors responsible for malnutrition and measures to overcome malnutrition in infants and adults.

Course outcomes:

After completion of this course, a student will be able to:
CO1:Learn and understand the basic concepts of nutrition, andnutritional values of foods, and BMR and measurement ofenergy requirements.
CO2:Learn and understand the dietary requirement ofcarbohydrates, lipids and proteins and their biological significance.
CO3:Understand the nutritional requirement andsignificance of dietary minerals and Vitamins.
CO4: Understand the condition of malnutrition, its prevention, andrecommended dietary allowances.

Credits:5	Elective
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	Basic concepts – Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements.	12
II	Elements of nutrition – Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions.	12
III	Minerals – Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.	12
IV	Malnutrition – Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.	12
V	Obesity: Definition, Genetic and environmental factors leading to obesity. Starvation: Techniques for the study of starvation. Protein metabolism in prolonged fasting.	12

Suggested Readings:

- Tom Brody: Nutritional Biochemistry (Second Edition), Academic Press.
- DAVID A. BENDER: Nutritional Biochemistry of the Vitamins, SECOND EDITION, University College London, Cambridge University Press.

- Harper's Illustrated Biochemistry, 29th edition, Mc Graw Hill Education, Lange.
- Denise R. Ferrier, Richard A. Harvey, Biochemistry (Lippincott Illustrated Reviews Series), 6th edition. Wolters Kluwer/ Lipincott, Williams and Wilkins.

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 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: Master in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code: B100805T	**Course Title: Cell Biology**	

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:

- **CO.1** Students will understand the structures and functions organelles of prokaryotic and eukaryotic cells, as well as transport of molecules and ions across the plasma membrane.
- **CO.2** Students will understand about processes and mechanism of underlying cell division and cell cycle.
- **CO.3** Students will learn about cell signaling through distinct signaling pathways that will help them to understand about the mechanism action of therapeutic targets/agents.
- **CO.4** Students will understand pathways and mechanisms of intracellular protein trafficking targeting.
- **CO.5** They will be able to understand about differentiation. Cell division, differential gene activity and cell differentiation, morphogenetic determinants in egg cytoplasm and apoptosis.

Credits: 5	Elective
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	General structure of Cell, Historical origins of cell biology: The discovery of cell, development of the cell theory, the molecular evolution, Intercellular communication- Gap junctions, tight junction and Desmosomes. Isolation and growth of cells.	12
II	Structure of prokaryotic and eukaryotic cells: Cellular organelles: Plasma membrane, cell wall, cytoskeleton, their structural organization, mitochondria, chloroplast, nucleus and other organelles and their organization, lysosome, membrane models.	12
III	Membrane transport: passive and facilitated diffusion, active transport, symport, antiport, transport of nutrients, ion and macromolecules across membranes, lipsomes, intracellular protein trafficing.	12
IV	Cell cycle: Molecular events and regulation in model systems, Mechanism of signal transduction, Exocrine, Endocrine, Paracrine and Synaptic strategies of chemical signaling, surface receptor mediated transduction (DAG, Ca+2, c-40AMP, G-Proteins).	12
V	Cellular basis of differentiation and development: Cell division, gametogenesis and fertilization, differential gene activity and cell differentiation, morphogenetic determinants in egg cytoplasm and programmed cell death- apoptosis.	12

Suggested Readings:

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

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: Masters in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code: B100806P	**Course Title: Biotechnology Lab Course-C**	

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	Elective
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: Masters in Biotechnology	Year: First	Semester: II
Subject: Biotechnology		
Course Code: B100807P	**Course Title: Biotechnology Lab Course-D**	

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	Elective
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. To perform qualitative tests on urine for protein, sugar, creatine, urobilinigen, urea 2. To perform immunoelectrophoresis for BSA and egg albumin separately and their mixture 3. Radial immunodiffusion 4. Western blotting and ELISA 5. To visualize the precipitation line formed on the agar gel slide by Ouchterlony's double immuno-diffusion technique 6. Bacterial transformation 7. To transform the competent cells 8. Test of the degradation of a aromatic hydrocarbon by bacteria. 9. Estimation of nitrate in drinking water. 10. Study of biogenic methane production in different habitats	**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: Masters in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100901T	**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: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	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: Masters in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100902T	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: 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	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: Masters in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100903T	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: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	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: Master in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100904T	**Course Title: Clinical Biochemistry, IPR& Biosafety**	
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:5	**Elective**	
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	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	Clinical and biochemical aspects of atherosclerosis, jaundice, diabetes, hepatitis, glomerular nephritis, gall stones, Addison's disease, Conn's syndrome, Cushing's syndrome, hypo & hyperthyroidism, Parkinson's disease and Alzheimer's disease.	12
IV	IPR: Introduction to intellectual property rights; Intellectual property laws; significance of IPR. Forms of IPR like patent, design copyright and trademark. Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms. Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity. trade related aspects of Intellectual Property Rights and Budapest treaty	12
V	Biosafety: Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines - Government of India; Definition of GMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and	12

	communication. Bioethics: Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics.	

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 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: Master in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100905T	**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	**Elective**
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, Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function.	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

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: Master in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100906P	**Course Title: Biochemistry Lab Course-E**	

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	Elective
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: .....
Further Suggestions: None

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

Program/Class: Master in Biotechnology	Year: Second	Semester: III
Subject: Biotechnology		
Course Code: B100907P	Course Title: Biochemistry Lab Course-F	

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	Elective
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. Comparative studies of ethanol production using different substrates. 4. Isolation of amylase producing bacteria form soil sample 5. Isolation of proteolytic bacteria. 6. To determine the quality of milk through methylene blue reductase test. 7. Production and estimation of alkaline protease. 8. Microbial production of citric acid using *Aspergillus niger* 9. To prepare stock solutions of nutrients for plant tissue culture medium 10. To prepare plant tissue culture medium 11. To surface sterilize the given explant and inoculate the MS medium 12. To see the effect of BAP on shoot multiplication 13. To isolate plant genomic DNA	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: .....
Further Suggestions: None

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

Program/Class: Master in Biotechnology	Year: Second	Semester: IV
Subject: Biotechnology		
Course Code: B101001T	**Course Title: Applied Biotechnology**	
Course Objectives:		
The course is designed to make the students understand the modern techniques such as PCR technology, Real-Time PCR, Sequencing, DNA fingerprinting etc.		
Course outcomes:		
After completion of the course, a student will be able to: CO1:Understand principle and application of PCR, Rapid DNA and RNA sequencing techniques, High throughput Sequencing, and Microarray. CO2:Learn about the principle& applications of Blotting and hybridization. CO3:Introducedwith DNA fingerprinting and Molecular Markers CO4: Learn about application of recombinant microorganism, plant biotechnology & animal biotechnology. CO5: Develop understanding of basics in protein engineering and bionanotechnology.		
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	**Principle & applications of PCR**; RACE, DD-RTPCR, Degenerate PCR TA cloning, Realtime PCR, Scorpion PCR, Site Directed Mutagenesis: oligonucleotide directed, PCR based Mutagenesis, Error prone PCR. Antisense RNA technique, Sense co-suppression in plants and animals, RNAi, in gene silencing, ribozymes, Microarray techniques for DNA, Proteins and Antibodies	12
II	Rapid DNA and RNA sequencing techniques: Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; High throughput Sequencing Genomics::shot gun cloning, Clone contig cloning, Fundamentals of Whole-Genome Sequencing., Sequencing of Phage, Viral and Bacterial Genomes, Human Genome sequencing, and comparative genomics. Molecular Markers: RFLP, RAPD, AFLP, SCAR, STS, Yeast two-hybrid system, DNase I foot printing, Genome editing, CRISPER/cas 9.	12
III	**Application of recombinant microorganism:** Production of recombinant pharmaceuticals, therapeutic proteins, Production of Restriction Enzyme,Production of Antibiotics,MetabolicEngineering,Production of Biopolymer,Combating Human Diseases,Biopesticides, Bioremediation.	12
IV	**Plant Biotechnology**:Ti plasmid, Binary and Cointegrate vectors derived from Ti plasmid of Agrobacterium, plant virus vectors, Transgenic plants and their applications, Improving agronomic traits, Herbicide tolerant, Insect resistance, disease resistance, viral resistance, abiotic stress resistance,Genetic Manipulation of	12

	FlowerPigmentation,Delaying of Postharvest Softening and Discoloration of Fruits,Plants as Bioreactors,Production of Biopolymers,Production of Edible Vaccines. **Animal transgenesis and its application:** Expression of transgenes, Reproductive and Therapeutic cloning, gene knock outs, Applications of transgenic animals,Transgenic Animals as Basic Research Models,Gain-of-function, Loss-of-function, Gene Knock-out, Modeling Human Diseasetransgenic Animals as Bioreactors,Xenotransplantation.	
V	Protein Engineering: Concept of designing of new protein molecule, Application of protein engineering.Basics of nanobiotechnology.	**12**

Suggested Readings:

1. Brown TA "Gene cloning: An introduction"
2. Old & Primrose "Principles of Gene Manipulation"
3. Jose B. Cibelli Robert P. Lanza Keith Cambell, Michasel D. West "Principles of Cloning"
4. H. S. Chawla "Plant Biotechnology: A Practical Approach"
5. Adrian Slater, Nigel W. Scott, Mark R. Fowler "Plant Biotechnology: The Genetic Manipulation of Plants"
6. Molecular Cloning
7. Brown TA "Gene cloning: An Introduction"
8. Old & Primrose "Principles of Gene Manipulation"
9. Genetic Engineering Rastogi and Pathak

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/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

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Program/Class: Master in Biotechnology	Year: Second	Semester: IV
Subject: Biotechnology		
Course Code: B101002T	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: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	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	12

	charts / graph and other features, Presentation of Power Point Presentation, Customizing presentation, Use of Computers in 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: Master in Biotechnology	Year: Second	Semester: IV
Subject: Biotechnology		
Course Code: B101003P	**Course Title:** Seminar & Interactive Course	
Course Objectives:		
The students will be able to summarise the existing data related to a specific topic in the form of a presentation.		
Course outcomes:		
After completion of the course, a student will be able to: CO 1 Summarize the literatureavailable on any specific topic. CO 2 Deliver power point presentations on an assigned topic.		
Credits:5	**Elective**	
Max. Marks: 50+50	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-5		
Internal Evaluation:50		
External Evaluation:50		

Program/Class: Master in Biotechnology	Year: Second	Semester: IV
Subject: Biotechnology		
Course Code: B101004P	**Course Title:** Review & Assignment	
Course Objectives:		
The students will be able to compile the existing data related to a specific topic in the form of a review.		
Course outcomes:		
After completion of the course, a student will be able to: CO 1 Summarize the recent research work. CO 2 Acquaint with writing of bibliography.		
Credits:5	**Elective**	
Max. Marks: 50+50	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-5		
Internal Evaluation:50		
External Evaluation:50		

Program/Class: Master in Biotechnology	Year: Second	Semester: IV
Subject: Biotechnology		
Course Code: B101005P	**Course Title:** Project Work/Dissertation	
Course Objectives:		
The objective of this course is to apprise the student with various techniques used in modern-day		

research in life sciences specifically in biochemistry.	
Course outcomes:	
After completion of the course, a student will be able to: CO 1:Prepare synopsis of a defined research problem. CO 2:Perform the bench work. CO 3: Prepare the research report and its oral presentations. CO4:Get exposure of vigorous laboratory training which will help students to boost their research carrier.	
Credits:10	**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	
Internal Evaluation:50	
External Evaluation:50	