DR. RAM MANOHAR LOHIA AVADH UNIVERSITY, AYODHYA

Structure of Syllabus for the

Program: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry

Syllabus Developed by				
SNo	Name of Expert/BoS Member	Designation	Department	College/ University
1	Prof. Rajeeva Gaur	Dean, Faculty of Science	Microbiology	Dr. Rammanohar Lohia Avadh University, Ayodhya
2	Prof. Bechan Sharma	Prof. & Head, External Expert	Department of Biochemistry	University of Allahabad, Prayagraj
3	Prof. Farrukh Jamal	Professor, Head & Convenor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
4	Prof. Neelam Pathak	Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
5	Dr. Vandana Ranjan	Associate Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
6	Dr. Sangram Singh	Associate Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya
7	Dr. Shivi Srivastava	Assistant Professor	Department of Biochemistry	Dr. Rammanohar Lohia Avadh University, Ayodhya

Neelam Pathak
13/03/2024

13.03.2024
Prof. Farrukh Jamal
Head, Biochemistry
Dr. RMLAU, Ayodhya

13/03/24

13/03/24

Course Code		Course Title	Credits	T/P	Evaluation	
A	B	C			CIE	ETE
B.Sc. 4 Year (Semester VII)/ M.Sc. 1 Year (Semester I)						
B110701T	CORE	Biomolecules: Structure and Functions	4	T	25	75
B110702T	CORE	Bioanalytical Techniques	4	T	25	75
B110703T	CORE	Essentials of Metabolism	4	T	25	75
B110704T	CORE	Essentials of Molecular Biology	4	T	25	75
B110705T	ELECTIVE (Select any one)	Microbial Physiology and Genetics	4	T	25	75
B110706T		Pharmaceutical Biochemistry	4	T	25	75
B110707P	CORE	Biochemistry Laboratory Course-I	4	P	50	50
B110708P		Industrial Training/Survey/ Research Project-A	4	P	50	50
B.Sc. 4 Year (Semester VIII)/ M.Sc. 1 Year (Semester II)						
B110801T	CORE	Cell Biology & Signaling Pathways	4	T	25	75
B110802T	CORE	Genetic Engineering	4	T	25	75
B110803T	CORE	Enzymology and Clinical Biochemistry	4	T	25	75
B110804T	CORE	Fundamentals of Environmental Sciences	4	T	25	75
B110805P	CORE	Biochemistry Laboratory Course -II	4	P	50	50
B110806P		Industrial Training/Survey/ Research Project-B	4	P	50	50
B.Sc. 5 Year (Semester IX)/ M.Sc. 2 Year (Semester III)						
B110901T	CORE	Elements in Microbiology	4	T	25	75
B110902T	CORE	Fundamentals of Immunology	4	T	25	75
B110903T	CORE	Protein Biochemistry, IPR and Biosafety	4	T	25	75
B110904T	CORE	Medical Biochemistry	4	T	25	75
B110905T	CORE	Biochemistry Laboratory Course -III	4	P	25	75
B110906P		Industrial Training/Survey/ Research Project-C	4	P	50	50
B.Sc. 5 Year (Semester X)/ M.Sc. 2 Year (Semester IV)						
B111001T	CORE	Plant Biotechnology and Tissue Culture	4	T	25	75
B111002T	CORE	Fundamentals of Cancer Biology	4	T	25	75
B111003P	CORE	Bioinformatics and Biostatistics	4	T	25	75
B111004P	CORE	Research Methodology	4	T	25	75
B111005P	CORE	Research/Review Assignment	4	P	25	75
B111006P		Industrial Training/Survey/ Research Project-D	4	P	50	50

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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 biochemistry. • The programme includes details of biomolecules, metabolism, tools and techniques molecular biology, clinical biochemistry, proteins &enzymes, immunology, cell biology, genetic engineering, clinical biochemistry, IPR and bioethics followed by applied biotechnology to make the study of living system more comprehensive with in depth knowledge yet interesting which is the need of hour. • The practical courses have been designed to equip the students with the laboratory skills in biochemistry. Students will able to design and conduct experiments, as well as to analyze and interpret scientific data in useful form. • The program will offer students with the knowledge and skill base that would enable them to undertake advanced studies in biochemistry and related areas or in multidisciplinary areas that involve biochemistry. • The students will get exposure of wide range of careers that combine biology, animal science, plant science and medicine. • The students will gain domain knowledge and know-how for successful career in academia, industry and research. • Moreover, students will learn values for lifelong learning to meet the ever-evolving professional demands by developing ethical, inter personal and team skills.

13-03-2024

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

13/03/2024

13/03/24

13/03/24

Semester wise Paper Titles with Details					
Year	**Semester**	**Paper**	**Paper Title**	**Prerequisite for Paper**	**Elective for Major Subjects**
Master in Biochemistry					
B.Sc. Year 4/ M.Sc. Year 1	B.Sc. Sem.-VII/ M.Sc. Sem.-I	Core Theory Paper – I	**Biomolecules:** Structure and Functions	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc.(Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper –II	Bioanalytical Techniques	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – III	Essentials of Metabolism	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – IV	Essentials of Molecular Biology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		MINOR ELECTIVE (Select any one)	Microbial Physiology and Genetics	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
			Pharmaceutical Biochemistry	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core	Biochemistry Laboratory Course -I	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
			Industrial Training/Survey/ Research Project-A	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)

	B.Sc. Sem.-VIII/ M.Sc. Sem.-II	Core Theory Paper – I	Cell Biology and Signaling pathways	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper -II	Genetic Engineering	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – III	Enzymology and Clinical Biochemistry	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – IV	Fundamentals of Environmental Sciences	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Laboratory Course	Biochemistry Laboratory Course -II	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Industrial Training/Survey/ Research Project	Industrial Training/Survey/ Research Project-B	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
B.Sc. Year 5/ M.Sc. Year 2	B.Sc. Sem.-IX/ M.Sc. Sem.-III	Core Theory Paper I	Essentials of Microbiology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper II	Fundamentals of Immunology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – III	Protein Biochemistry, IPR and Biosafety	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)

		Core Theory Paper – IV	Medical Biochemistry	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Laboratory Course	Biochemistry Laboratory Course -III	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Industrial Training/Survey/ Research Project	Industrial Training/Survey/ Research Project-C	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
	B.Sc. Sem.-X/ M.Sc. Sem.-IV	Core Theory Paper – I	Plant Biotechnology and Tissue Culture	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – II	Fundamentals of Cancer Biology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – III	Bioinformatics and Biostatistics	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Core Theory Paper – IV	Research Methodology	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Laboratory Course	Biochemistry Laboratory Course -D	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)
		Industrial Training/Survey/ Research Project	Industrial Training/Survey/ Research Project-D	B.Sc. (Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology)	M.Sc. (Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology)

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. I	Semester: B.Sc. VII/M.Sc. I
Subject: Biochemistry		
Course Code: B110701T	**Course Title: Biomolecules: Structure & 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:		
After completion of this course, a student will be able to: CO1: Learn about the chemical structures of significant/major carbohydrate, and their structural and metabolic role in cellular system. CO2: Learn about structure and functions of major lipid subclasses, circulating lipids etc. They will also learn about primary, secondary, tertiary, quaternary structure of proteins. CO3: Understand about the structure and function of nucleosides and nucleotides, Physical & biochemical properties of DNA, Classification structure and function of different types of RNA, DNA topology and DNA supercoiling CO4: Develop understanding of other accessory molecules like vitamins, plant and animal hormones.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	**Contribution of Indian scientists to biological sciences**: Jagdish Chandra Bose, Har Gobind Khorana, Ananda Mohan Chakrabarty, Birbal Sahni, Lalji Singh; Physical & Chemical properties of Water, pH and buffer system, titration curves, basic biochemical calculations.	10
II	**Carbohydrates:** Classification and properties of simple carbohydrates; monosaccharide, oligosaccharide, and polysaccharides; Reducing and Non-Reducing Sugar, Enantiomers, Structural Polysaccharides: Cellulose, Chitin, Storage Polysaccharides: Starch and Glycogen, Glycoproteins and Glycolipids. Biological Importance of carbohydrates	12
III	**Proteins:** Amino acids: Chemical structure and general properties; Protein classification – globular, fibrous & membrane proteins, Ramachandran plot, Protein folding & denaturation, sequencing; Biological Importance of amino acids and proteins. **Lipids:** Fatty acids: General formula, nomenclature, and chemical properties; Lipid classification: simple, complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids, and prostaglandins & free fatty acids; Circulating lipids - chylomicrons. LDL, HDL and VLDL.	14
IV	**Nucleic Acids:** Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA: A, B and Z DNA & Triplet DNA, their structure and significance; Chargaff's Rule, DNA denaturation and Tm value, Types of repetitive nucleic acid sequences, Satellite DNA, DNA topology: Supercoiling, Linking number,	12

	Twist and Writhe, Classification structure and function of different types of RNA: mRNA, tRNA, rRNA, hnRNA; snRNA, snoRNA, miRNA, gRNA. Primary, secondary, and tertiary structures of RNA.	
V	**Vitamins and Hormones**: Vitamins – internal & external sources, structure, properties, and functions including biochemical reactions, symptoms of hyper & hypo-vitaminosis. Hormones – Source organs, Structure, classification, properties & functions of animal & plant hormones.	12

Suggested Readings:

1. Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017)*Lehningerprinciplesofbiochemistry*/NewYork:W.H .Freeman.
2. Voet,D.,&Voet,J.G.(2011).Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubertstryer Freeman International Edition
4. Biochemistry – Keshav Trehan Wiley Eastern Publications
5. Fundamentals of Bochemistry -J.L.JainS. Chand and Company
6. Voet &Voet: Biochemistry Vols 1 & 2: Wiley (2004)
7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
8. Biochemistry and Molecular Biology: Oxford University Press
9. Taiz, L., Zeiger, E., Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
10. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons,
11. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
12. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.

Suggestive digital platforms web links

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

Suggested Continuous Internal Evaluation Methods:

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

External Evaluation: 75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VII/M.Sc. 1
Subject: **Biochemistry**		
Course Code: B110702T	**Course Title: Bioanalytical Techniques**	

Course Objectives:

COURSE OBJECTIVES:
Bioanalytical techniques are used to understand the theoretical principles involved in bioinstrumentation which may further utilized 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:

After completion of this course, a student will be able to:
CO1: Acquaint with basic instrumentation, principle and procedure of various sophisticated instruments.
CO2: Get the theoretical knowledge of various instruments and their practical applications.
CO3 Learn about Centrifugation & Electrophoresis.
CO4: Implement the use of instruments like chromatography, UV-VIS spectroscopy, NMR, CD, ORD in biological research
CO5: Understand the basics of handling of data, measures of central tendency like mean, median and mode, Measures of dispersion like mean deviation and standard deviation and Coefficient of variation.
CO6: To apprise students about bioinformatics tools.

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

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

Unit	Topics	No. of Lectures
I	**Spectroscopy**- Concepts of spectroscopy, Visible and UV spectroscopy, Beer-Lambert's Law, Principles and applications of NMR, ESR, Raman, Mass atomic absorption and atomic emission spectroscopy and X-ray crystallography	12
II	**Chromatography and Microscopy**- Principles of partition chromatography, Paper, Thin layer, Ion exchange and affinity chromatography, Gel permeation Chromatography, HPLC & FPLC. Transmission and scanning EM: Freeze fracture techniques, Specific staining of biological materials.	12
III	**Centrifugation & Radioactive Techniques**- Principles of centrifugation, Concepts of RCF, Different types of instruments and rotors, Preparative, Differential and density gradient centrifugation, Analytical Ultra-centrifugation, Determination of molecular weights and other application, subcellular fractionation.	12
IV	**Electrophoretic techniques & Viscosity**- Principles of electrophoretic separation. Continuous, Zonal and Capillary electrophoresis, Different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, Pulse field gel electrophoresis. Viscosity- Viscosity of macromolecules, Relationship with conformational changes.	12
V	**Radioactive Techniques**- Introduction to radiations and their uses in biology, Safety measures, Principles and Applications of Liquid scintillation counting (LSC), Gamma counting and Autoradiography.	12

Suggested Readings:

1. Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques. 6th ed., Boston, Mass: Prentice Hall, 2012,
2. Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 2006.
3. Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010

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: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VII/M.Sc. 1
Subject: Biochemistry		
Course Code: B1107031	**Course Title:** Essentials of Metabolism	
Course Objectives:		
The objectives of the course are to learn and understand the fundamentals of cellular metabolism of carbohydrates, lipids, amino acids, and nucleic acids and their association with various metabolic diseases.		
Course outcomes:		
After completion of this course, a student will be able to: CO1: Learn Carbohydrate catabolism, and its association with cellular energy production, and carbohydrate anabolism in plants and animal cells. CO2: Understand Lipid biosynthesis, Degradation of fatty acids and cholesterol, ketone bodies, acidosis, ketosis. CO3: Understand about the Biosynthesis of purines and pyrimidine nucleotides, degradation of nucleotides, salvage pathways, biosynthesis and biodegradation of amino acids. Inborn errors of metabolism. CO4: Understand detailed mechanism of nitrogen metabolism and photo synthesis.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	**Principle of bioenergetics:** Laws of Thermodynamics, Energy cycle and specialized role of ATP as universal currency of energy, **Energy transduction:** energy transducing membranes from organelles in animals, plants and bacteria, Phosphorylation – Oxidative and Photophosphorylation, Chemiosmotic theory of phosphorylation. Photosynthetic light receptors and light harvesting complexes, Hill reaction, its components and products, Redox potential and electron flow through electron transport chain complexes in bacteria, chloroplast & mitochondria. Uphill and downhill flow of electrons, difference between cyclic and non-cyclic phosphorylation, regulation of ETC, Inhibitors of ETC, uncouplers, Bioluminescence,	12
II	**Carbohydrate metabolism:** Catabolic pathways – Glycolysis and Non-glycolytic pathways, Hexose monophosphate shunt and its modes, Tricarboxylic acid cycle. Anaplerotic reactions sequences in metabolism, fate and role of metabolic byproducts -NADH, $FADH_2$, Glycogenolysis, Krebs- Kornberg pathway Glyoxylate pathway. Glucose catabolism in cancerous tissue, aerobic and anaerobic catabolism of glucose in terms of respiration, Biosynthesis/Anabolic pathways with Regulation –Gluconeogenesis, Biosynthesis of disaccharides – sucrose, lactose, Biosynthesis of polysaccharides - glycogen synthesis, Starch synthesis, Cellulose synthesis, Glucosaminoglycans synthesis and their biological roles.	12
III	**Lipid Metabolism: Biosynthesis** – synthesis of saturated and unsaturated fatty acids, biosynthesis of triacylglycerols glycerophospholipids and membrane phospholipids, sphingolipids, cholesterol. Degradation of fatty acids: Carnitine transporters, α, β, ω oxidation; Ketone bodies, acidosis, ketosis, Cholesterol degradation and production bile acids and bile salts.	12
IV	**Metabolism of Nitrogenous compounds:** Biosynthesis of amino acids and Urea cycle, associated metabolic disorders, Kreb-Urea bicycle, Biosynthesis of Nucleotides – salvage and de-novo synthesis of purines and pyrimidines,	12

	Catabolism of amino acids and nucleosides, and nucleic acids, Inborn errors of metabolism related to amino acids and nucleosides	
V	**Biochemistry of Nitrogen fixation:** Diazotrophy and its components, Nitrogen fixing organism, symbiotic and non-symbiotic modes, Physiology of nodule formation, Nitrogenase complex and its oxygen sensitivity with protection methods, Ammonia assimilation and regulation system, Ammonia and nitrate transport, nif gene, nod gene. **Photosynthesis:** Carbon fixation/reduction pathways - Calvin cycle, C3, C4 and CAM pathway, photorespiration and C2 pathway	12

Suggested readings

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

Suggestive digital platforms web links

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

Suggested Continuous Internal Evaluation Methods:

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

External Evaluation: 75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VII/M.Sc. 1
Subject: Biochemistry		
Course Code: B110704T	Course Title: Essentials of Molecular Biology	

Course Objectives:

The objective of the course is learning and understanding the fundamentals of molecular biology like nucleic 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: Develop Understanding 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:4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:40

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

Unit	Topics	No. of Lectures
I	**Organization of Genetic materials in prokaryotes and Eukaryotes:** Genetic material, Genome type, Size, Genome Organization - Structural Maintenance of Chromosomes (SMC) Protein, Eukaryotic Nucleosomes, Histones, Chromatin, Concept of Gene, mono-cistronic and poly-cistronic genes, Gene Structure with various functional units - replicon, muton, recon, C-value and C-value paradox; Unique sequences and Cot value, reassociation kinetics, Split genes: Exons and Introns, DNA transposon.	12
II	**Replication:** Modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication: Origin and Initiation, elongation and termination; Roles, properties and mechanism of action of DnaA, Helicase, Primase, DNA gyrase, Topoisomerases, DNA Polymerases, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA primers; Regulation of replication; Fidelity of replication; Viral replication, σ or Rolling circle replication in ϕX174.	12
III	Eukaryotic DNA replication: Initiation, elongation and termination; Multiple replicons/initiation sites; Autonomously replicating sequence; Mechanism and significance of Origin recognition complex, Mini-chromosome maintenance proteins, DNA dependent DNA polymerases α, δ, ε, Nucleases, DNA ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplast DNA replication,	12
IV	Transcription in prokaryotes: Initiation, elongation and termination; Prokaryotic promoter; weak and strong promoters, DNA dependent RNA polymerase: Physical properties, Templet strand, non-template strand, coding strand, Subunits, σ factor, its types and function; Recognition of promoter; Transcription bubble, Direction of Transcription; Abortive initiations; Promoter clearance; Elongation factor Gre and its role, Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase and Reverse transcription.	12
V	**DNA damage and DNA Repair:** Types of DNA damages, Types of DNA Repair systems, Photoreactivation, BER,NER, Mismatch Correction,	12

	Homologous recombination and NHEJ method, SOS Repair,	

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. Lubert Stryer "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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VII/M.Sc. 1
Subject: Biochemistry		
Course Code: B110705T	Course Title: Microbial Physiology and Genetics	

Course Objectives:

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:

Course outcomes Upon successful completion of the course,

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

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

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

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

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

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

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

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

Unit	Topics	No. of Lectures
I	History, development and scope of microbiology, Structure and function of prokaryotic cells, classification of bacteria: modern approaches of bacterial taxonomy (Numerical Taxonomy, 16S rRNA analysis), 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."

Suggestive digital platforms web links

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

Suggested Continuous internal Evaluation Methods:

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

External evaluation: 75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VII/M.Sc. 1
Subject: Biochemistry		
Course Code: B110706T	**Course Title:** Pharmaceutical Biochemistry	

Course Objectives:

The course is designed to make the students understand the concept and basic steps of pharmaceutical biochemistry which emphasizes on the production of monoclonal antibodies and its applications, different formulations of proteins and peptides, pulmonary drug delivery systems for example aerosols along with polymers for controlled drug delivery and nucleic acid drug delivery systems etc.

Course outcomes:

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

CO1: Understand about monoclonal antibodies and its applications along with regulatory requirements

CO2: Understand about formulation of proteins and peptides, adult-phase drug delivery systems

CO3: Understand about injectable lipid emulsions, liposomes, polymeric systems for oral protein and peptide delivery.

CO4: Understand about the pulmonary drug delivery systems for biomacromolecules; Lipid based pulmonary delivery, Aerosols etc.

CO5: Understand about different polymers used for controlled drug delivery.

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

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

Unit	Topics	No. of Lectures
I	Monoclonal antibodies: applications, generation, recombinant antibodies, production methods, Pharmaceutical, regulatory and commercial aspects.	12
II	Formulation of proteins and peptides: making small protein particles, precipitation of proteins, quality control issues, multi-phase drug delivery system; Preparation of collagen, gelatin particles, albumin microparticles	12
III	Proteins and phospholipids: structural properties of phospholipids, injectable lipid emulsions, liposomes, cochleal phospholipids structures; Polymeric systems for oral protein and peptide delivery.	12
IV	Pulmonary drug delivery systems for biomacromolecules; Lipid based pulmonary delivery; Solid colloidal particles; Polycyanoacrylates; Poly (ether-anhydrides); Diketopiperazine derivatives; Poly ethylene glycol conjugates; Factors affecting pulmonary dosing. Aerosols, propellents, containers types, preparation and evaluation, intra nasal route delivery systems: Types, preparation and evaluation.	12
V	Polymers used for controlled drug delivery: Hydrophobic polymers poly(esters), poly(cyanoacrylate), poly (ortho esters), poly (phosphazenes), Hydrophobic polymers poly (alkyl methacrylates), poly (methacrylates), poly (acrylates)], alginates, chitosan, polyethylene glycol. Gene therapy: the current viral and non-viral vectors. Nucleic Acid Based Delivery System: Gene therapy, introduction of ex-vivo and in-vivo gene therapy. Potential target diseases for gene therapy. Gene expression systems (viral & nonviral gene transfer). Liposomal gene delivery systems. Biodistribution and pharmacokinetics. Knowledge of therapeutic antisense molecules and aptamers as drugs of future.	12

Suggested Readings:

1. Groves MJ 'Pharmaceutical Biotechnology', Taylor and Francis Group.
2. Crommelin DJA, Robert D, Sindelar 'Pharmaceutical Biotechnology'.

3. Kayser O, Muller R 'Pharmaceutical Biotechnology'.
4. Banga AK 'Therapeutic peptides and proteins'.
5. Molecular Cell Biology- by Lodish H., Berk A., Matsudiaira P., Kaiser C.A., Krieger M. and Scott M.P., W. H. Freeman and Company, New York.
6. Vyas S.P. and Kohli D.V., Pharmaceutical Biochemistry, 1st Edition, CBS Publishers & Distributors, New Delhi
7. Principles and Techniques of Biochemistry and Molecular Biology by Wilson K. and Walker J., Cambridge University Press

Suggestive digital platforms web links

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

Suggested Continuous Evaluation Methods:

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

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VII/M.Sc. 1
Subject: Biochemistry		
Course Code: B110707P	Course Title: Biochemistry Lab. 1	

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 this course, a student will be able to:
CO1: Get practical knowledge ofQualitative and Quantitative Analysis ofbiological molecules.
CO2: Learn isolation of egg proteins and milk protein.
CO3: Performexperiments on blood.
CO4: Acquaint with determination of clinically important enzymes

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

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-5

Unit	Topics	No. of Lectures
I	1. Qualitative and Quantitative Analysis of- a. Carbohydrates b. Amino acids and Proteins 3. Fractionation of egg proteins and its quantification. 4. Isolation of casein from milk and its quantification. 5. Isolation and estimation of serum cholesterol. 6. Qualitative and quantitative analysis of (a) Saliva (alpha-amylase) (b) Urine (urea,uric acid, glucose, proteins) 7.Determination of serum enzyme assays: Alkaline phosphatase, SGOT, SGPT.	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"

Suggestive digital platforms web links

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

Suggested Continuous Evaluation Methods:

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

Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.
Suggested equivalent online courses: .....
Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B110801T	Course Title: Cell Biology and Signaling Pathways	
Course Objectives:		
The objectives of the course are to learn and understand the fundamentals of cell biology like cell organelles, cytoskeleton, cellular transport, cell-extracellular matrix interaction, cell division, and protein trafficking and signal transduction etc.		
Course outcomes:		
After completion of this course, a student will be able to: CO1: Learn about structural organization of prokaryotic and eukaryotic cells, ultra structure and functions of cell organelles. CO2: Understand about cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in cell cycle regulation, CO3: Acquire knowledge about Basics of signal transduction CO4: Understand about protein trafficking in cells, Protein sorting, vesicular Transport and protein targeting.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	**Ultrastructure of cell and membrane transport**: Structural organization and function of various subcellular organelles, Cytoskeleton (Microtubules, Microfilaments, actins etc.) **Cell membrane & Transport**: Structure and functions of cell membrane, physiochemical and electrical properties of membrane, Membrane Transport: Diffusion, Facilitated diffusion, Active transport, and its types. Techniques to study biomembranes - FRAP, FRET, Freeze Fracture Technique.	12
II	**Cell cycle and Cell division**: Overview of cell cycle, Check points, role of cyclin and cyclin dependent kinases, Strategies of cell cycle regulation, Positive & Negative regulators, Mitosis and Meiosis; Programmed cell death, aging, and senescence.	12
III	**Cell communication and Cell signaling**: GPCR structure and function, Ligand binding and activation, signal amplification, heterotrimeric G-protein, adenyl cyclase, receptor tyrosine kinases, signaling pathways: AKT, c-MET, HER2, Nf-Kb, NOTCH, p53, JAKSTAT, Hedgehog, and Wnt signaling pathways (mechanisms and physiological significance), Phosphodiesterase, Phosphoinositide pathway, Calmodulin, DAG.	14
IV	**Protein traffic in cells**: Secretory and non-secretory proteins, Endocytic and Exocytic pathways, Protein sorting and signal sequences; protein translocation in ER and vesicular transport to Golgi, Lysosomes, and plasma membrane; Protein import into nuclei, mitochondria, chloroplasts, and peroxisomes, Clathrin mediated endocytosis.	12
V	**Applied Cell Biology**: Basic techniques in mammalian cell culture; Cell & tissue culture media; Serum free media; maintenance of the culture and cell lines; Stem cell and their applications.	10
Suggested Readings:		

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

Suggestive digital platforms web links

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

Suggested Continuous Evaluation Methods:

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

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B110802T	**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 DNA technology, transformation and screening techniques.

Course outcomes: After completion of the course, a student will be able to:

CO1: Develop understanding about enzymes used in rDNA technology and basics of cloning.

CO2: Learn about features of various types of vectors like plasmid vectors, phage vectors, hybrid vectors, artificial chromosomes.

CO3: Introduced with cDNA synthesis and chemical DNA synthesis.

CO4: Learn about screening and selection of recombinants.

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

Unit	Topics	No. of Lectures
I	**Enzymes used in rDNA Technology: Outline of cloning procedure**, Host controlled restriction and modification: Restriction endonucleases and cognate methylases, Class I, II & III restriction enzymes, Variants of Type II Restriction enzyme, Restriction digestion, Star activity, Restriction mapping, Formation of chimeric DNA, Homopolymer tailing, Synthetic Linkers, Adaptors and DNA ligase; Filling in and Trimming back; Significance of T4 DNA polymerase &Klenow Fragment, Alkaline phosphatase, Reverse transcriptase in cloning.Overview of the methods for introduction of DNA into living cells: Chemical transformation, microprojectile bombardment, electroporation and microinjection.	12
II	**DNA synthesis**: Purification of mRNAs; mRNA abundance; Synthesis of cDNA: Various methods for first and second strand DNA synthesis; cDNA and Genomic library construction; Chemical synthesis of oligonucleotides by Phosphoramidite and Photolithographic methods; Preparation of probe DNA by radioactive and non-radioactive labeling methods: Nick translation, End filling, Random primer methods.	12
III	**Plasmids**: Plasmid classification on basis of phenotypic traits: Relaxed and stringent control of copy number; Plasmid incompatibility; Plasmid host range, Mobilizable plasmids and Triparental mating; Plasmid as cloning vector (recombinant plasmids): Properties of ideal plasmid cloning vectors, pBR322, pUC& pGEM3Z series, Transcriptional and translational fusion vectors; Fusion proteins; Selectable markers; Reporter genes	12
IV	**Phage as a cloning vector:** Advantage of using phage lambda vector, Genome map of phage lambda, In vitro packaging, Insertional and replacement vectors: Cosmid vectors; M13 phage and its role in single stranded DNA production, M13 series of vectors; Phagemids; Yeast as cloning vector: Basic principles of development of yeast vectors, 2μplasmid, YEP, YRP YCP, YIP; Artificial chromosomes: YACs, BACs and PACs	12
1V	**Screening and selection of recombinants**: Functional (genetic) complementation (Blue-white screening, Red-white screening), Nutritional complementation, Gain of function, Colony hybridization, Plaque	12

	hybridization, Southern blotting and hybridization, Dot blot, Zoo blot, Plus-Minus screening, Northern blotting, Immunological screening, Western blotting, South-Western blotting, North-Western blotting, HART, HAT	

Suggested Readings:

1. Smita Rastogi and Neelam Pathak (2009), Genetic Engineering, Oxford University Press.
2. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK)
3. Old & Primrose
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC),
5. Molecular Cloning: A laboratory manual (2014),4nd ed., Michael R Green and J. SambrookCold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2

Suggestive digital platforms web links

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

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B110803T	Course Title: Enzymology and Clinical Biochemistry	

Course Objectives:

The main objective of this course is to learn and understand the fundamentals of physiology and its association with clinical biochemistry. Moreover, they will also learn about IPR and Biosafety.

Course outcomes:

After completion of the course, a student will be able to:
CO1: Learn the basics composition of body fluids.
CO2: Understand the fundamentals of digestive system.
CO3: Understand the fundamentals of Respiratory system and Neural & chemical regulation of respiration.
CO4: Aid in understanding of the basics aboutclinical and biochemical aspects of atherosclerosis, jaundice, diabetes, hepatitis, glomerular nephritis, gall stones, Addison's disease
CO5: Understand about IPR and Biosafety.

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

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

Unit	Topics	No. of Lectures
I	Steady state and equilibrium hypotheses of enzyme kinetics,Michaelis-Menten and Briggs-Haldane equations,significance of Michaelis-Menten parameters i.e.,Vmax,Km,Kcat and Kcat/Km;Mechanism and features of different types of enzyme inhibition;Breakdown of the Michaelis-Menten equation;Mechanism and kinetics of multisubstrate reactions.	12
II	Enzyme induction,repression and covalent modification;feed backinhibition;importance of isozymes and zymogen in enzyme regulation;allosteric enzymes and their regulations;Hills coefficient and the determination of enzyme-ligand binding/dissociation constant.EnzymeImmobilization:Immobilization; kinetics of immobilized systems	12
III	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
IV	Nerve impulse transmission: excitation-its conduction and synaptic transmission by neural systems, neurotransmitters, venoms and nerve poisons.	12
V	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

Suggested Readings:

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

Suggestive digital platforms web links

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

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. I	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B110804T	Course Title: Fundamentals of Environmental Sciences	
Course Objectives:		
The objectives of the course are to develop the ability to solve the problems related to the environment, to make them aware of various eco-friendly techniques and modern techniques to solve various environment-related problems.		
Course outcomes:		
After completion of this course, a student will he able to: CO1: Understand pollution and its impact on environment and health. CO2: Able to devise and suggest means for tackling the problem of pollution and abatement. CO3 : Understand the generation of various toxicants and suggest means to safeguard health from its effect. CO4: Get familiarized with Xenobiotic toxicity, Bioaccumulation, bioremediation and toxicogenomics		
Credits:4	**Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Air pollution, Sound,thermal,and radioactive pollution, harmful effects of UV-Rays,Ozone layer depletion,Ozone hole, Acid Rain, CFCs,and their substitutes. Global warming and its effect on flora and fauna. Water pollution: types of water bodies and their general characteristics, chief pollutant in domestic, industrial and agricultural wastes, effects of pollutants on flora and fauna.	12
II	Nature of agriculture and industrial wastes and by-products and their treatment and recycling Microbial degradation of pesticides, Lignin, Detergents, Dyes, Petrol and petroleum products, Use of microorganism in pollution control, ways and means for abatement of environmental pollution.	12
III	Principle of Biochemical toxicology; Properties of Xenobiotics, Type of chemical alteration, molecular mechanism of toxicology development, dose response relationship, risk assessment of chemicals; acute, short term and chronic toxicity studies, metabolic disposition, Carcinogenicity and mutagenicity studies.	12
IV	Recycling of organic waste: Major sources of recyclable materials including agricultural waste. Key technology in recycling of crop residues, human and animal wastes. Composting and vermicomposting; Production and application. Role of microbes in composting and biogas production. Municipal solid waste treatment and management.	12
V	Xenobiotic toxicity/ genotoxicity, Mode of action of pesticides, fungicides and insecticides; Mutation detection by Ames test, microsomal assay. Bioaccumulation and bioremediation, Biosensors, DNA probes and their environmental applications, Toxicogenomics.	12

Suggested Readings:

1. Environmental biotechnology (Industrial pollution Management). Jogdand S.N., Himalaya pub. house.
2. Waste water treatment – Rao M.N. and A.K.Datta
3. Industrial pollution Control, Vol. 1, E. Joe, Middle Brooks.
4. The treatment of industrial wastes, 2nd Ed. Edmund D. Besselievere and Max Schwartz.
5. Water and water pollution hand book, Vol. 1, Leonard L., Ciaccio
6. EcEldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment Longman Scientific Technical.

7. Grant WD, Long PL. (1981) Environmental Microbiology. Blackie Glasgow and London
8. Paul EA, Clark FF Soil Microbiology and Biochemistry, Academic Press, San Diego.
9. Rogers JE and Writman WB (1991) Microbial production and consumption and green house gases: Methane. Nitrogen oxides and Halomethanes. ASM, Washington DC.

Suggestive digital platforms web links

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

Suggested Continuous Evaluation Methods:

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

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 4/M.Sc. 1	Semester: B.Sc. VIII/M.Sc. II
Subject: Biochemistry		
Course Code: B110805P	**Course Title:** Biochemistry Lab. II	

Course Objectives:

The lab is designed to train the students in basic techniques of Analytical Biochemistry like chromatography, electrophoresis, determination of isoelectric point of protein, and protein separation.

Course outcomes:

After completion of the course, a student will be able to:
CO1: Get practical knowledge of Preparation of buffers and measurement of pH,
CO2: Learn various chromatography techniques.
CO3: Know to perform electrophoresis.
CO4: Acquire the skill to performenzyme assay.

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

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

Unit	Topics	No. of Lectures
I	1. Titration of weak acid using a pH meter, preparation of buffers. 2. Verification of Beer-Lambert's law and determination of absorption coefficients. 3. Paper Chromatography-Separation of amino acids and carbohydrates in a mixture. 4. Thin Layer chromatography of fatty acids. 5. Column Chromatography-Separation of mixture of proteins and salt using Sephadex column. 6. Electrophoresis. 7. Gel electrophoresis of serum proteins. 8. SDS-PAGE of proteins. 9. Assay of enzyme activity. 10. Isolation and purification of urease. 11. Time course of enzymatic reaction. 12. Influence of substrate concentration of the rate of enzymatic reaction. 13. Effect of pH and temp. on the rate of enzyme reaction. Inhibition of enzyme activity.	60

Suggested Readings:

1. Keith Wilson, John Walker, John Walker, John M. Walker "Principles and Techniques of Practical Biochemistry"
2. Chirikjian "Biotechnology Theory & Techniques"
3. Joseph Sambrook, David W. Russel, Joe Sambrook "Molecular Cloning: A Laboratory Manual"
4. William M, O'Leary Robert, Dony Wu "Practical Handbook of Microbiology"
5. Principles of Biochemistry- Albert L. Lehninger CBS Publishers &Distributors
6. Texbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
7. An Introduction to Practical Biochemistry, David T. Plummer (2006) Tata McGraw Hill Education, 3rd edition
8. Sadasivam "Biochemical Methods

Suggestive digital platforms web links

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

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. IX/M.Sc. III
Subject: Biochemistry		
Course Code: B110901T	Course Title: Essentials of Microbiology	

Course Objectives:

The objective of the course is learning and understanding the fundamentals of Microbiology like important characteristics and biology of bacteria, fungi, mycoplasma, viruses etc. Moreover, this course is designed to learn basic knowledge of fermentation process.

Course outcomes:

After completion of the course, a student will be able to:
CO1 Understand the basics of microbiology like Characterization andclassification of microorganisms, cultivation, nutrition, physiologyand growth of microbial cells, Genetic recombination in bacteria.
CO2 Learn and understand the basics of mycology, virology and production of mutants and their characterization.
CO3 Understnd about Bacterial toxins, and mode of action ofbacterial protein toxins. Host Microbe Interactions.
CO4 Learn about basics of Industrial Fermentation.

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

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

Unit	Topics	No. of Lectures
I	Prokaryotes: Bacteria: Morphology and structure of bacterial cell; Staining procedures; Criteria used in classification; Bacterial taxonomy; Phenetic and phylogenetic classification; Numerical taxonomy; General characteristics of major groups of bacteria. Bacterial Growth and Nutrition: General nutritional requirements; Culture media; Types of bacterial cultures; Measurement of bacterial growth; Control of microorganism by physical and chemical methods.Gene transfer in bacteria: Conjugation, Transformation and Transduction. Archaebacteria: Archaea as a separate lineage; Differences from eubacteria.	12
II	Eukaryotic Microorganisms: Structure of fungus: yeast and mold. Fundamentals of control of microbial growth, control by physical and chemical agents. Production of mutants by chemical and physical agents and their characterizations	12
III	Viruses: General characteristics of virions; Classification; ; Isolation, cultivation and assay methods; One-step growth curve of bacteriophages; Lysogeny and lytic cycle; Satellite and defective viruses; Viral interference; Common viral infections. Virusoids ,Viroids, Diseases caused in plants. Prions: Characteristics; Prion diseases; Hypotheses regarding nature and pathogenesis of prions.	12
IV	Microorganisms and Diseases General concepts: Normal human microbiota; Opportunistic microorganisms; Koch's postulates; River's postulates; Classification of diseases; Modes of transmission of diseases; Stages in progress of a disease.	12
V	Bacterial toxins – Exotoxins, endotoxins, enterotoxins their structure and mode of action, Antimicrobial agents, supha drugs, Penicillins and Cephalosporins, antibiotics, resistance to antibiotics. Media for Industrial Fermentation: Substrates for bioconversion processes, preparation, sterilization, design. Large scale production and commercial applications of enzymes: proteases and amylases.	12

Suggested Readings: 1. Pelczar MJ Jr.; Chan ECS and Kreig NR.; Microbiology; 5th Edition; Tata McGraw Hill; 1993. 2. Maloy SR; Cronan JE Jr.; and Freifelder D; Microbial Genetics; Jones Bartlett Publishers; Sudbury; Massachusetts; 2006. 3. Crueger and A Crueger; (English Ed.; TDW Brock); Biotechnology: A textbook of 4. Industrial Microbiology; Sinaeur Associates; 1990. 5. G Reed; Prescott and Dunn's; Industrial Microbiology; 4th Edition; CBS Publishers; 1987.M.T. Madigan and J.M. Martinko; Biology of Microorganisms; 11th Edition; Pearson Prentice Hall; USA; 2006 **Suggestive digital platforms web links**		
This course can be opted as an elective by the students of following subjects: M.Sc Microbiology, Biotechnology, Environmental Science, Chemistry, Botany, Zoology		
Suggested Continuous Evaluation Methods: Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		
Course prerequisites: To study this course, a student must have had theBotany/Zoology/Chemistry/Biochemistry/Microbiology/Biotechnology/Chemistry in B.Sc.		
Suggested equivalent online courses:		
Further Suggestions: None		

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. IX/M.Sc. III
Subject: Biochemistry		
Course Code: B110902T	Course Title: **Fundamentals of Immunology**	

Course Objectives:

The objective of the course is to apprise the students about components associated with immune system and molecular mechanism of their working. The course also deals with implications of deregulation of basic regulatory networks that lead to immune system related disorders. The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.

Course outcomes:

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

CO1 Learn the fundamental principles of immune response including molecular, biochemical and cellular basis of immune homeostasis.

CO2 Aid in understanding various aspects of immunological response and how its triggered and regulated.

CO3 Understand the rationale behind various assays used in immune diagnosis of diseases and will be able to transfer knowledge of immunology in clinical perspective.

CO4 Develop understanding of principles of Graft rejection, Auto immunity and Antibody based therapy.

CO5 Develop the capacity for problem-solving about immune responsiveness, knowledge of pathogenesis of diseases and designing of immunology based interventions for effective treatment.

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

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

Unit	Topics	No. of Lectures
I	Introduction of cells and organs of immunity; basic concept of innate and acquired immunity, host specialization, granulocytes (neutrophils, eosinophils, basophils) and their functions, Antigens, immunogens and heptane, structure and classification of antibody, isotype, allotype, idiotypes.	12
II	Comparison of receptors on T&B lymphocytes, CD Markers, Concept of Histocompatibility: Major Histocompatibility Complex (MHC),MHC restriction for CD4 & CD8 subset of T cells, Role of MHC complex and transplantation, Generation of diversity in immune response; clonal selection theory, the gene encoding antigen specific receptors on T&B lymphocytes immunoglobin genes, Activation of T&B lymphocytes immunoglobin genes, Activation of T&B cells by antigen, Antigen processing and presentation	12
III	The complement system; biological role of complement system, components of classical and alternative pathways, mechanism of NK cell mediated cytotoxicity, Inflammation, Its physiological basis and relevance, General properties of cytokines and interferons and their applications	12
IV	Allergy and hypersensitivity, autoimmunity, autoimmune diseases, Vaccines: preparation and delivery system, immune adjuvants, Raising of antisera and monoclonal antibodies	12
V	Measurement of antigen and antibody interaction: direct binding assay, agglutination and precipitation reaction in gels; immune electrophoresis,	12

	immunoprecipitation, RIA & ELISA, Biotin-avidin based immunoassay, immunofluorescence assay (IFA), immunohistochemistry, immunoblotting.	

1. **Suggested Readings:**
2. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York)
3. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
4. William, R. Clark (1991) the Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
5. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company
6. Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins
7. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell)

Suggestive digital platforms web links

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

Suggested Continuous Evaluation Methods:

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

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. IX/M.Sc. III
Subject: Biochemistry		
Course Code: B110903T	Course Title: Protein Biochemistry, IPR & Biosafety	

Course Objectives:

The objective of this course is to understand the importance of enzymes, their classification, and properties, to understand the mechanism of enzyme action, their kinetics and types of enzyme inhibitions, and to know about the advantages of immobilization of enzymes, methods of immobilization.

Course outcomes:

After completion of this course, a student will be able to:
CO1: Acquire the knowledge of characteristics and importance of different levels of protein structure.
CO2: Learn about protein folding
CO3: Acquire the knowledge of enzymes their properties and classification, Mechanism of action, Michaelis-Menten initial rate equation, methods for the determination of Km and Vmax.
CO4: Learn different immobilization techniques and Industrial and clinical scope of enzymes.

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

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

Unit	Topics	No. of Lectures
I	The native state of proteins; denaturation and inactivation of proteins; characteristics and importance of different levels of protein structure; protein evolution; assembly of fibrous proteins; the concept and importance of domain structure in proteins.	12
II	Measurement of stability of the native state; the role of short, medium, and long- range interactions in protein folding; mechanism of protein folding; the thermodynamics and kinetics of protein folding; determinants of protein folding with special reference to the roles of molecular chaperones, signal peptides and the environment in the protein folding; the problem of inclusion body formation and recovery of active proteins, Intein, Intein Splicing	12
III	The living state and role of enzymes in its substance; chemical catalysis; general acid-base, covalent and intramolecular catalysis; detection of intermediates in enzymatic reactions; features and mechanism of action of lysozyme, chymotrypsin and carboxypeptidase A.	12
IV	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 communication. Biocthics: Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of biocthics.	12

Suggested Readings:

1. Lehninger, AL "Principles of Biochemistry".

2. Lubert Stryer "Biochemistry".
3. Voet &Voet "Biochemistry"
4. Alan Fersht "Enzyme Structure and Mechanism".
5. David S. Sigman, Paul S. Sigman "The Enzymes: Mechanisms of Catalysis".
6. Trevor Palmer and Philip Bonner 2008 Enzymes Biochemistry, Biotechnology, Clinical Chemistry, 2 nd edn EWP
7. Gerhartz W 2003 Enzymes in Industry Production and Applications, Wiley VCH
8. Wilson, K and Walker, J. (eds 2000 Principles and Techniques of
9. Practical Biochemistry, 5th edn Cambridge University Press Palmer "Enzymes"
10. Dixon & Webb "Enzymes
11. Shuler "Bioprocess Engineering"
"

Suggestive digital platforms web links

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

Suggested Continuous internal Evaluation Methods:

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

External evaluation: 75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. IX/M.Sc. III
Subject: Biochemistry		
Course Code: B110904T	Course Title: Medical Biochemistry	

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

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

Unit	Topics	No. of Lectures
I	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 and Biochemistry: Adenoviruses, Pox viruses, Hepadnaviruses, Retroviruses, Coronavirus Medical Mycology: Fungi, Yeast, Pathogenic fungi, Mycoses.	12
III	Blood formation, Anemia; Blood loss anemia, Megaloblastic anemia, Leukemia, Stem cells: stem cell or Bone marrow transplant, Biochemistry of diseases: 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 David S. Sigman, Paul S. Sigman "The Enzymes: Mechanisms of Catalysis".

Suggestive digital platforms web links

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

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. IX/M.Sc. III
Subject: Biochemistry		
Course Code: BI10905P	**Course Title: Biochemistry Lab. III**	

Course Objectives:

The lab is designed to train the students in basic and some advanced techniques of microbiology and immunology. It also deals with molecular biology techniques of isolation and purification of bacterial plasmid and chromosomal DNA and their application in cloning.

Course outcomes:

After completion of this course, a student will be able to:
CO1: Practically learn about preparation of culture media, broth and slants, staining of bacteria and determination of growth curve.
CO2: Practically learn and understand the antigen-antibody interaction by Double Immunodiffusion method, Ouchterlony's Method, Immunoelectrophoresis, Western Blotting and ELISA.
CO2: Practically learn to isolate plasmid DNA and genomic DNA from E. coli and will learn to perform Agarose gel electrophoresis of DNA
CO3: The course will aid to learn Restriction digestion of DNA and its application in cloning and to perform PCR

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

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

Unit	Topics	No. of Lectures
I	1. Preparation of Culture media. 2. Preparation of broth and slants. 3. Sterilization of culture media by autoclave method. 4. Isolation and propagation of bacteria. 5. Staining of bacteria-Simple staining, differential staining, staining of spores and capsules. 6. Determination of growth curve of bacteria. 7. Biochemical tests and motility for the identification of bacteria. 8. Precipitin reaction by double immunodiffusion and radial immunodiffusion (Ouchterlony) 9. Detection of antibodies or antigen by ELISA. 10. Detection of antigens by immunoblotting techniques. 11. Experiments on restriction digestion, ligation and cloning. 12. Experiments on western blotting. 13. Experiments on plasmid isolation. 14. Isolation of genomic DNA from bacteria, plant and animal. 15. Amplification of DNA by PCR	60

Suggested Readings:

1. Molecular Cloning: A laboratory manual (2014),4nd ed., Michael R Green and J. SambrookCold spring Harbor laboratory press (3vol.),
2. Wilson, K and Walker, J ..(eds 2000 Principles and Techniques of Practical Biochemistry, 5 thedn Cambridge University Press
3. M.T. Madigan, J.M. Martinko& D.A. Stahl, Brock Biology of Microorganisms, 13th Ed., Pearson Education International. (2010)
4. J.G. Cappuccino, and N. Sherman, Microbiology: A Lahoratory manual, 10th Ed. Benajamin/ Cummings (2013)

Suggestive digital platforms web links

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

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. X/M.Sc. 1V
Subject: Biochemistry		
Course Code: B111001T	Course Title: Plant Biotechnology and Tissue Culture	

Course Objectives:

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

Course outcomes:

- **CO.1** The students will learn about the basic techniques of plant tissue culture to produce novel plants and hybrids, virus-free plants, cybrids and haploid plants and homozygous lines.
- **CO.2** The student will learn and understand the basic principle of cryopreservation, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines and purification strategies.
- **CO.3** The student will learn about plant transformation technology, chloroplast transformation and viral vectors and their applications.
- **CO.4** Student will learn about basics of application of plant transformation for productivity and performance.
- **CO.5** They will be able to understand the Molecular marker, linkage analysis, QTL, marker assisted selection, arid and semi-arid plant biotechnology, green house technology.

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

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

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

	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.	
V	Molecular marker-aided breeding: RFLP RAPD, AFLP, STS, SSR, SCAR, SSCP markers, linkage analysis, marker assisted selection, plant biotechnology, green house technology.	12

Suggested Readings:

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

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

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. X/M.Sc. 1V
Subject: Biochemistry		
Course Code: B111002T	Course Title: Fundamentals of Cancer Biology	

Course Objectives:

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

Course outcomes: The course would facilitate the students

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

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

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

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

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

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

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

Suggested Readings:

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004

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

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

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. X/M.Sc. 1V
Subject: Biochemistry		
Course Code: B111003T	**Course Title: Bio-informatics and Biostatistics**	

Course Objectives:

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

Course outcomes:

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

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

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

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

V	Measurement of central tendencies: Mean, Median, Mode, Percentile, Standard deviation, t-test, f-test, Correlation coefficient, ANOVA	12

Suggested Readings:

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

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

Suggested Internal Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

External Evaluation:75 Marks

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

Suggested equivalent online courses:

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Further Suggestions: None

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

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. X/M.Sc. IV
Subject: Biochemistry		
Course Code: B111004T	**Course Title: Research Methodology**	
Course Objectives:		
To equip the students with knowledge of framing and analyzing research related issues.		
Course outcomes:		
After completion of this course, a student will be able to: CO1: Learn about various aspects of research design. CO2: Learn about analysis of research findings through statistical means. CO3: Train students about presenting research findings and publishing them. CO4: Learn about computer applications in research.		
Credits:4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Unit	Topics	No. of Lectures
I	Research Methodology: definition, purpose, Process of Research; Objectives and Dimensions of Research, Design Tools of Research: Library, Field, Laboratory; Methods of research: Qualitative and Quantitative. Systematic review of literature, Features of good research study. Research Ethics (Issues relating to referencing and documentation, copyrights, plagiarism etc), Impact Factor, H-Index, Citation Index, references/ bibliography	12
II	Data Collection, presentation, data processing, classification and tabulation. Dispersion. Quantitative Techniques: Levels of significance	10
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.	14
IV	Basics of Computers- classification, computer system components (CPU, Input/output devices, internal memory i.e. RAM, ROM & Cache and external memory i.e. secondary storage devices). Computers networks and introduction of internet. MS-Office .	12
V	Computer applications in Biology -tools: Introduction to spreadsheet applications, features, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts / graph and other features, Presentation of Power Point Presentation, Customizing	12

	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: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. X/M.Sc. 1V
Subject: Biochemistry		
Course Code: B111005P	Course Title: Research Review and assignment	
Course Objectives: The objective is to study about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

Program/Class: Bachelor (Research) in Biochemistry/M.Sc. Biochemistry	Year: B.Sc. 5/M.Sc. 2	Semester: B.Sc. X/M.Sc. 1V
Subject: Biochemistry		
Course Code: B111006P	Course Title: Research Project-D	
Course Objectives: The objective is to understand about the structure and biological functions of macromolecules of living systems like carbohydrates, proteins, lipids, and nucleic acids laying the foundation for other advanced courses like physiology, cell biology, molecular biology, and immunology.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 3-1-0		

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

Regulation/ Ordinance of the Certificate Course

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

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

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

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

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

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

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

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

Farrukh Jamal 13.03.2024

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

Singh 13.03.24

P.K. Singh 13.03.24

13/03/24

Course Title: Certificate Course in 'Advance Genetic Engineering'

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

Suggested Readings:

1. Genes VIII by Benjamin Lewis

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

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

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

13.03.2024

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

13.03.24

P.K. Singh 13.03.24

13/03/24