CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR

Four Year Undergraduate Programme (FYUP)

BIOCHEMISTRY

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN BIOCHEMISTRY

SESSION 2025-2026 ONWARDS

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Prof. Neelam Pathak (Online)
Prof. Ram Narain (Online)
Prof. B.N. Mishra (Online)

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR
STRUCTURE OF SYLLABUS FOR THE
Program: Four Year Undergraduate Programme (FYUP) for Biochemistry

Syllabus Developed By			
Name of BoS convenor/BoS member	**Designation**	**Department**	**College/University**
Prof. S. K. Awasthi	Dean, Faculty of Life Sciences	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Prof. Varsha Gupta	Director, School of Life Sciences and Biotechnology	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Prof. Neelam Pathak	External Expert	Department of Biochemistry	R.M.L. Awadh University, Ayodhya
Prof. Ram Naraian	External Expert	Department of Biotechnology	V.B.S. Purvanchal University, Jaunpur
Prof. B. N. Mishra	External Expert	Department of Biotechnology	Instt. of Engineering and Technology, Lucknow
Prof. Rolee Sharma	Professor	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Shilpa D. Kaistha	Associate Professor	Department of Biotechnology, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Alok Pandey	Head, Department of Biotechnology	Department of Biotechnology, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Neerja Srivastava	Head, Department of Biochemistry	Department of Biochemistry, School of Life Sciences and Biotechnology	CSJM University, Kanpur

Proposed Year wise Structure of Four Year Undergraduate Program (FYUP) & One Year M.Sc. in Biochemistry

(BOS Year 2025)

Year	Semester	Course Code	Paper Title	Theory /Practical	Credits
1	I	B110101T	Fundamentals of Biochemistry	Theory	4
		B110102P	Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	Practical	2
	II	B110201T	Human Physiology and Clinical Biochemistry	Theory	4
		B110202P	Clinical Biochemistry Lab	Practical	2
2	III	B110301T	Tools and Techniques in Biochemistry	Theory	4
		B110302 P	Biochemical Tools and Techniques Lab	Practical	2
	IV	B110401T	Enzymology and Immunology	Theory	4
		B110402P	Enzymes and Immunological Techniques Lab	Practical	2
3	V	B110501T	Bioenergetics and Metabolism	Theory	4
		B110502T	Fundamentals of Microbiology	Theory	4
		B110503P	Microbial Techniques and Metabolism Lab	Practical	2
	VI	B110601T	Cell, Molecular Biology and Genetic Engineering	Theory	4
		B110602T	Biostatistics, Bioinformatics and computer application in Biochemistry	Theory	4
		B110603P	Genetic Engineering and Bioinformatics Lab	Practical	2
Bachelor of Science(Honours) in Biochemistry					
4	VII	B110701T	General Biochemistry	Theory	4
		B110702T	Cell Biology and Membrane Biochemistry	Theory	4
		B110703T	Biophysical chemistry, techniques, and applications	Theory	4
		B110704T	General Microbiology	Theory	4
		B110705P	Practical	Practical	4

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	VIII	B110801T	Molecular Biology and Genetics		Theory	4
		B110802T	Bioenergetics and Intermediary Metabolism		Theory	4
		B110803T	Enzymology		Theory	4
		B110804T	Human Genetics	Elective (Any one)	Theory	4
		B110805T	Recombinant DNA technology			
		B110806P	Practical		Practical	4

OR						
Bachelor of Science (Honours with Research) in Biochemistry						
4	VII	B110701T	General Biochemistry		Theory	4
		B110702T	Cell Biology and Membrane Biochemistry		Theory	4
		B110703T	Biophysical chemistry, techniques, and applications		Theory	4
		B110704T	General Microbiology		Theory	4
		B110705R	Dissertation/ Internship/ Field or Survey Work (Progressive)		Project	4
	VIII	B110801T	Molecular Biology and Genetics		Theory	4
		B110802T	Bioenergetics and Intermediary Metabolism		Theory	4
		B110803T	Enzymology		Theory	4
		B110804T	Human Genetics	Elective (Any one)	Theory	4
		B110805T	Recombinant DNA Technology			
		B110806R	Dissertation/ Internship/ Field or Survey Work (Submitted)		Project	4
Master of Science Biochemistry (1 Year)						
5	IX	B110901T	Plant Biochemistry		Core	4
		B110902T	Physiology and Clinical Biochemistry		Core	4
		B110903T	Molecular and Cellular Immunology		Core	4
		B110904T	Bioinformatics and Biostatistics		Elective (any two)	4
		B110905T	Proteomics and Genomics			
		B110906T	Biochemical Engineering and Fermentation technology			
		B110907T	Pharmacology and Toxicology			

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		B110908P	Practical	Practical	4
		B110909R	Research project/ Dissertation/ Internship/ Field or Survey Work (Progressive)	Project	4
	X	B1101001T	Environmental Biochemistry (Core)	Core	4
		B1101002T	Industrial Biochemistry (Elective)	Elective (any one)	4
		B1101003T	Cell and Tissue Culture (Elective)		
		B1101004P	Presentation (Summer Internship/Training/ Review/ Case Study	Presentation	4
		B1101005R	Research project/ Dissertation/ Internship/ Field or Survey Work (Submitted)	Project	4

Subject prerequisite	
Certificate Course in Clinical Biochemistry	
B.Sc. I Programme Specific Outcomes (PSOs)	
PSO1	This course introduces fundamentals of structure and function of biomolecules.Studentswill be able to develop an understanding of: the inter relationships within and between anatomical and physiological systems of the humanbody.
PSO1	The students will develop the understanding of basic concepts of clinical biochemistry, they would able to relate clinical disorders with metabolic processes.
PSO1	The students will learn the basic principles of biochemistry relevant to possibilities of employment and research. Stress will be rigorous learning of lab practices likeaccurate preparation of solutions, and buffers. The course is intended to develop a sound, fundamental understanding of Bimolecular testing.
PSO1	The students will have hands-on training on qualitative estimation of important which will help them in getting employment in pathology labs and contribute to health care system.
PSO1	This Certificate courses will enable students to apply for technical positions in government and private labs, academic and research institutes.
Diploma in tools and techniques in biochemistry	
B.Sc. II Programme based outcomes	
PSO 1	Students will develop an understanding of: Principle, working, and applications of Biochemical tools & techniques to prepare–them for independent execution of laboratory experiments using standard methods and techniques.
PSO 2	The objective of this course is to develop an understanding of the concepts of enzyme and enzyme kinetics.
PSO3	The students will develop an understanding of the basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines, and immunization. The students will develop a capability to function as paramedical staff during the current COVID crisis also.
PSO4	The course aims to develop an understanding of the concepts of enzyme dynamics. The students will also have understanding of basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins

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	Subject prerequisite
	Certificate Course in Clinical Biochemistry
	B.Sc. I Programme Specific Outcomes (PSOs)
PSO1	This course introduces fundamentals of structure and function of biomolecules.Studentswill be able to develop an understanding of: the inter relationships within and between anatomical and physiological systems of the humanbody.
PSO1	The students will develop the understanding of basic concepts of clinical biochemistry, they would able to relate clinical disorders with metabolic processes.
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	B.Sc. II Programme-based outcomes
PSO 1	Students will develop an understanding of: Principle, working, and applications of Biochemical tools & techniques to prepare–them for independent execution of laboratory experiments using standard methods and techniques.
PSO 2	The objective of this course is to develop an understanding of the concepts of enzyme and enzyme kinetics.
PSO3	The students will develop an understanding of the basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines, and immunization. The students will develop a capability to function as paramedical staff during the current COVID crisis also.
PSO4	The course aims to develop an understanding of the concepts of enzyme dynamics. The students will also have understanding of basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins.

	The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned national and international labs. Students can have their own start-ups as well.
PSO1	

PSO3	The student will become able to utilize Analytical techniques, Molecular Biology and Genetics, Metabolism, Enzymology and Recombinant DNA Technology to produce pharmaceutically important biomolecules as well as using practical hands-on training to become employed in diagnostic, industrial, pharmaceutical, food and research and development laboratories.
PSO4	After graduation the students may join industry, academia, and public health and play their role as biochemist in a useful manner contributing their role in the development of the welfare society.

Degree in Masters of Science in Biochemistry	
M.Sc. Programme Specific Outcomes	
PSO1	The students will get knowledge and skill of entrepreneurship and start-up ventures by integrating applied biochemistry knowledge with skill-based learning in biochemistry, quality control, and business planning.
PSO2	At the time of completion of the programme the student will have developed extensive knowledge in various areas of Biochemistry. Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice.
PSO3	By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.
PSO4	The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

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Detailed Syllabus of B.Sc. First Year

Programme/Class: Certificate	Year: First	Semester: First
Subject: Biochemistry		
Course Code: B110101 T	Course Title: Fundamental of Biochemistry	

Course outcomes: The student at the completion of the course will learn to understand:

1. Basic details of structure, function of carbohydrate molecules and its classification
2. Details of structure, function and classification of amino acid &structural levels of protein molecules
3. Structure and function offatty acids, storage and structural lipids
4. Details of structure and Function of Nucleotide, DNA and RNA
5. Basic details of Vitamin molecules and its classification
6. Classification, structural features and Function of Plant & Animal Hormone

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks: As per rules

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

Unit	Topics	No. of Lectures (60)
I	Basics of Biochemistry • History of biochemistry with special reference to contribution of Indian biochemists. • General idea about normality, molarity, molality, percentage solutions, mole fraction. W/v and v/v solutions. • Concept of pH determinations using indicators, buffer solutions and their biological importance. • Water as universal solvent	5
II	**Amino acids and proteins** 1. Structural features and classification, Physical properties, optical properties (Stereoisomerism) 2. Chemical properties of amino acids 3. Uncommon amino acids and their function. 4. Classification of protein, structural organization as primary, secondary, tertiary and quaternary structure of protein and characteristics of the peptide bond	10
III	**Carbohydrate** • Monosaccharides - structure of aldoses and ketoses, Ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers • Structure of biologically important sugar derivatives, oxidation and reduction of sugars • Formation of disaccharides, reducing and non-reducing disaccharide • Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides	10

IV	**Lipids** 1. Building blocks of lipids - fatty acids, glycerol, ceramide 2. Storage lipids - triacyl glycerol and waxes 3. Structural lipids in membranes - glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols 4. Plant steroids	10
V	Nucleic acids • Nucleotides - structure and properties • Nucleic acid structure – Watson-Crick model of DNA • Structure of major species of RNA - mRNA, tRNA and rRNA • Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA • Other functions of nucleotides - source of energy, component of coenzymes, second messengers	10
VI	**Vitamins** 1. Structure and active forms of water soluble and fatsoluble vitamins, 2. Deficiency diseases and symptoms, hypervitaminosis 3. Sources, dietary requirements	5
VII	**Plant Hormones** • Classification, structural features & functions in Plants: • Auxins, gibberellins, Ceytokinins, ethylene, and abscisic acid	5
VIII	**Animal Hormones** • Classification, structural features &Functions of hormones secreted by endocrine glands: Hypothalamus, pituitary gland-anterior pituitary and posterior pituitary, thyroid gland, adrenal gland, Pancreas, gonads	5

Suggested readings

1. Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017)*Lehningerprinciplesofbiochemistry/* NewYork:W.H.Freeman.
2. Voet,D.,&Voet,J.G.(2011).Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubertstryer Freeman InternationalEdition.
4. Biochemistry – Keshav Trehan Wiley EasternPublications
5. Fundamentals of Bochemistry-J.L.JainS.Chand andCompany
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.

Course Books published in Hindi must be prescribed by the Universities and Colleges

Biotechnology by B D Singh (Hindi)

Anuvanshiki evam Advik Jeev Vigyan by Jaya Sharma, kailash Pustak Sadan, Bhopal

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.

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

Further Suggestions:**None**

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

Programme/Class: Certificate	Year: First	Semester: First
Subject: Biochemistry		
Course Code: B110102 P	**Course Title:** Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	

Course outcomes: After the successful course completion, learners will develop following attributes

- **Preparation of various solutions**
- **Preparation of Buffers**
- **Perform Qualitative test of Biomolecules**
- **Estimation of vitamin C**
- **Perform spot test for amino acids in a given sample**

Credits: 4	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:As per rules**

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

	Topics	**Total No. of Lectures**
I	• Safety measures in laboratories • Preparation of normal and molar solutions • Preparation of buffers • Determination of pKa of acetic acid and glycine • Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids • Estimation of vitamin C • Perform spot test for amino acids in a given sample	60

Suggested readings

1. Principles of Biochemistry- Albert L. Lehninger CBS Publishers &Distributors
2. Texbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
3. An Introduction to Practical Biochemistry, David T. Plummer (2006)Tata McGraw Hill Education, 3rd edition

Course Books published in Hindi must be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.
The eligibility for this paper is 10+2 from Arts/ Commerce/ Science

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

Further Suggestions: **None**

Programme/Class: Certificate	Year: First	Semester: Second
Subject: Biochemistry		
Course Code: B110201 T	Course Title:Human Physiology and Clinical Biochemistry	

Course outcomes-

After the successful course completion, learners will develop following attributes

- Develop an understanding of the inter relationships within and between anatomical and physiological systems of the humanbody.
- Develop the understanding of basic concepts of clinicalbiochemistry.
- To understand disorder related with bio molecules metabolism.
- Anticoagulant preservatives for blood and urine.
- Metabolism of bilirubin, jaundice - types, differential diagnosis and Liver function.

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

Total No. of Lectures (in hours per week):

Unit	Topics	No. of Lectures (60)
I	**Digestion and Respiration** • Structural organization and functions of gastrointestinal tract andassociated glands • Mechanical and chemical and enzymatic digestion of food, Absorptions of • carbohydrates, lipids, proteins, water, minerals and vitamins, • Mechanism of respiration, Pulmonary ventilation, Respiratory volumes and capacities, Transport of oxygen and carbon dioxide inblood Respiratory pigments, Dissociation curves and the factorsinfluencing it, Control of respiration	8
II	**Circulation and Excretion** • Components of blood and their functions Haemostasis: Blood clotting system, Blood groups: Rh factor, ABOand MN • Cardiac cycle, Cardiac output and its regulation, Electrocardiogram,Blood pressure and its regulation • Structure of kidney and its functional unit, Mechanism of urineformation	8
III	**Nervous System and Muscular System** • Structure of neuron, and physiology of nerve impulse transmission • Histology of different types of muscle, Ultra structure of skeletal muscle • Molecular and chemical basis of muscle contraction • Control of muscle contraction by nerve impulses	8

IV	Basic concepts of Clinical Biochemistry • A Brief review of units and abbreviations used in expressing concentrations and standard solutions • Specimen collection and processing (Blood, urine, feces) • Anticoagulant and preservatives for blood and urine samples • Transport of specimens	8
V	Hematology: Blood • Composition and functions of various components, • Anemia:- classifications, erythrocyte indices • Blood coagulation system, Clotting time, Bleeding time Prothrombin time, RBC count, WBC count,Platelet count Differential count • determination of Hb, PCV and ESR. Hemoglobinopathies, Thalassemia	8
VI	Disorders of Carbohydrate metabolism • Regulation of blood sugar • Glycosuria-types of Glycosuria • Oral glucose tolerance test in normal and diabetic condition • Diabetes mellitus and Diabetic insipidus - hypoglycemia, hyperglycemia. Ketonuria, ketosis	4
VII	Disorders of Lipid metabolism • Cholesterol: Factors affecting blood cholesterol level • Dyslipoproteinemia, atherosclerosis risk factor and fatty liver. • Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin	4
VIII	Liver function test • Types, differential diagnosis • Liver function test - Icteric index, Vandenberg test, plasma protein changes. Renal function test: Clearance test–Urea, Creatinine • Para- aminohippuric acid (PAH) test, Concentration and dilution test. Enzymology: Clinical significance of SGOT, SGPT, ALP, ACP, CPK and LDH	8

Suggested readings

1. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
2. Physiological basis of Medical practice, West J.B., Best and Taylor.
3. Introduction to Physiology by Davidson H and Segal M.B. Academic Press.
4. Sherwood L – Human Pysiology: From Cells to Systems, (Wadsworth Publishing, 2000,ISBN: 0534568262)
5. Tortora G J Principles of Anatomy & Physiology, (John Wiley & Sons, 1999, ISBN: 0471366927)
6. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8 edition, 2013, Jaypee publications.
7. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkarth
8. Medical Laboratory Technology by Ramniksood, 5 Edition, 1999, Jaypee publishers.
9. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 3rd edition, A. JohnWiley-Liss Inc. Publication.
10. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

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Biotechnology by B D Singh (Hindi)
Anuvanshiki evam Advik Jeev Vigyan by Jaya Sharma, kailash Pustak Sadan, Bhopal

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.

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

Further Suggestions: None

Programme/Class: certificate	Year: First	Semester: Second
Subject: Biochemistry		
Course Code: B110202 P	Course Title: Clinical Biochemistry Lab	

Course outcomes-

- To learn qualitative and quantitative analysis of constituents of biological fluids such as urine, blood and their estimation using standard methods.
- Students will able to Perform basic hematological laboratory testing

Credits: 4	**Core Compulsory**
Max. Marks: 25+75Min.	**Passing Marks:As per rules**

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

UNIT	Topic	Total No.of Lectures
	• Qualitative and quantitative analysis of urine : proteins, Bence-Jones proteins, Cl- , Ca+2 • Qualitative analysis of abnormal constituents in urine - glucose, albumin, bile pigments,bile salts and ketone bodies. • Experiments on blood (a) Estimation of haemoglobin by cyanmethemoglobin method (b) Determination of A/G ratio in serum • Isolation and estimation of serum cholesterol • Serum enzyme assays: alkaline phosphatase, SGOT, SGPT • Estimation of haemoglobin using Sahli's haemoglobinometer • Recording of blood pressure using a sphygmomanometer • Recording of blood glucose level by using glucometer • Ninhydrin test for Ñ-amino acids. • Test for sugar and acetone in urine.	60

Suggested Readings:

1. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8 edition, 2013, Jaypee publications.
2. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkarth
3. Medical Laboratory Technology by Ramniksood, 5 Edition, 1999, Jaypee publishers.
4. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 3rd edition, A. JohnWiley-Liss Inc. Publication.
5. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

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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

Further Suggestions: None

Detailed Syllabus
of
B.Sc. Second Year

Programme/Class: DIPLOMA	Year: SECOND	Semester: THIRD
Subject: Biochemistry		
Course Code: B110301T	Course Title: Tools and Technique in Biochemistry	

Course outcomes:

- The objective of the course is to introduce various techniques to the students, which are used in biological research.
- Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.
- Students will learn about the principle and application of electrophoresis, centrifugation techniques, microscopic and molecular biological techniques.

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

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

Unit	Topics	No. of Lectures (60)
I	**Basics of Biophysics** 1. Chemical bonding – Ionic bond, covalent bond, hydrogen bond and Vander-Waals force.	4
II	**Chromatography** • Introduction & Principle of Chromatography • Paper, thin-layer, column, • HPLC, GLC and molecular sieving., • Ion exchange chromatography • Affinity Chromatography	8
III	**Centrifugation** 1. Principle of centrifugation 2. Basic rules of sedimentation, sedimentation coefficient. 3. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, 4. types of rotors. 5. Application of centrifugation, 6. differential centrifugation, density gradient centrifugation-zonal and isopycnic.	8
IV	**Electrophoresis:** • **Basic** Principle of electrophoresis, • Gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels • Agarose gel electrophoresis,	8

VI	Microscopy • Principle of light microscopy, • Phase contrast microscopy • Fluorescence microscopy • Electron microscopy • Permanent and temporary slide preparation, histology and staining.	8
VII	**Radioactivity** • Types, their importance in biological studies • Measure of radioactivity • GM counters and Scintillation counting.	4
VIII	Fundamental principles and basics of instrument design of: • UV-Visible spectrophotometry and Beer-Lambert law • Fluorescence techniques • Infra-Red and Raman spectrometry • Circular Dichroism and Optical Rotatory dispersion • Nuclear Magnetic Resonance spectrometry • Atomic absorption and emission spectrometry • X Ray diffraction • Mass spectrometry	8

Suggested readings

- Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012,
- Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 2006.
- Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010
- Rastogi & Pathak, Genetic Engineering, Oxford University Press,2009

Course Books published in Hindi must be prescribed by the Universities and Colleges.

This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject

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

Further Suggestions: None

Programme/Class: DIPLOMA	Year: SECOND	Semester: THIRD
Course Code: B110302 P	Course Title: Biochemical Tools and Techniques Lab	

Course outcomes-
It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a pathology/diagnostic/research lab.

Credits: 4	**Core Compulsory**
Max. Marks: 25+75Min.	**Passing Marks:As per rules**

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

UNIT	Topic	Total No.of Lectures
	• Verification of Beer's Law • Estimation of proteins by Biuret/Lowry method • Separation of amino acid acids by TLC/paper chromatography • To perform agarose gel electrophoresis • To isolate mitochondria by differential centrifugation • Visualization of cells by methylene blue • SDS PAGE	60

Suggested Readings:

- Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi.
- Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency.
- Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 1998,
- Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010

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Biotechnology by B D Singh (Hindi)
Anuvanshiki evam Advik Jeev Vigyan by Jaya Sharma, kailash Pustak Sadan, Bhopal

This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject

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

Further Suggestions: None

Programme/Class: DIPLOMA	Year: SECOND	Semester: FOURTH
Subject: Biochemistry		
Course Code: B110401T	Course Title: Enzymes and Immunology	

Course outcomes:

- The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life.
- Students will learn the nature and importance of enzymes in living systems
- Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
- Students will learn about the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
- Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
- Students will develop the understanding of basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines and immunization

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

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

Unit	Topics	No. of Lectures (60)
I	**Introduction to enzymes** • General characteristics of enzymes • Co-factor and prosthetic group, apoenzyme, holoenzyme. Classification and nomenclature of enzymes. • Enzyme assays- • Enzyme activity, specific activity, units to express enzyme activity. Features of enzyme catalysis • Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis • Koshland's induced fit hypothesis.	8
II	**Enzyme kinetics** • Relationship between initial velocity and substrate concentration Michaelis-Menten equation • Lineweaver-Burk plot, • Eadie-Hofstee and Hanes plot • Determination of Km and Vmax, Kcat, specificity constant • Effect of pH and temperature on the activity of enzymes.	8

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	• Irreversible inhibition • Substrate inhibition • Allosteric regulation and feedback inhibition (ATPase) • Isoenzymes • Enzyme immobilization and its applications	
IV	**Introduction of Immunology** • Types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity • Antigens: haptens, epitopes and Factors influencing immunogenicity • Antibodies: Structure, types, production and functions of immunoglobulins Clonal selection theory. • Antigen Antibody reaction: Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA. • Cell and organsof immune responses and their functions • B & T cells • factors responsible for immunogenicity • Monoclonal antibodies production and applications	8
VI	**Histocompatibility** • Structure of MHC class I, II & III antigens and their mode of antigen presentation • MHC restriction, • Complement system: Components, Classical and alternate pathways of complement activation • Hypersensitivity • Autoimmunity.	8
VII	**Vaccines and Immunization** • Passive and Active immunization • Types of Vaccines: Inactivated, Attenuated, Recombinant and Vaccines • Peptide and DNA Vaccines • RNA Vaccines	4
VIII	**Transplantation immunology** • Immunological basis of graft rejection	4
III	**Enzyme inhibition and Regulation** Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) • Clinical manifestations • Immunosuppressive therapy and privileged sites	8

Suggested readings

1. Lehninger, AL "Principles of Biochemistry".
2. LubertStryer "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 ndedn 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, 5 thedn Cambridge University PressPalmer "Enzymes"
10. Dixon & Webb "Enzymes
11. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York)
12. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
13. William, R. Clark (1991) the Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
14. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company
15. Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins
16. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell).

Course Books published in Hindi must be prescribed by the Universities and Colleges.

Biotechnology by B D Singh (Hindi)

Anuvanshiki evam Advik Jeev Vigyan by Jaya Sharma, kailash Pustak Sadan, Bhopal

This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject .

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

Further Suggestions: None

Programme/Class: DIPLOMA	Year: SECOND	Semester: FOURTH
Course Code: B110402P	Course Title: Enzymes and Immunological Techniques Lab	

Course outcomes- After the successful course completion, learners will develop following attributes:

- Know how to isolate enzyme and determine enzyme activity.
- Know how to study the effect of pH and temperature on the enzyme activity.
- Know how to study the effect of varying substrate and inhibitor concentration on the enzyme activity
- Know how to detect Amino acids by Paper chromatography and TLC
- This course aims to develop the understanding of basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins
- It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a pathology/diagnostic/research lab.

Credits: 4	Core Compulsory
Max. Marks: 25+75Min.	Passing Marks: As per rules

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

UNIT	Topic	Total No.of Lectures
	• Isolation of enzyme and determination of enzyme activity • Study of the effect of pH on the enzyme activity. • Study of the effect of varying substrate concentration on the enzyme activity and determination of Km and Vmax. • Study of the effect of temperature on the enzyme activity. • Study of the effect of inhibitors on the enzyme activity. • Blood grouping • Differential Count of WBC • Detergent lysis of RBC • Dot ELISA • ELISA – Demonstration • Ouchterlony Double diffusion (ODD) • Separation of serum from blood & precipitation of Immunoglobulins	60

Suggested Readings:

1. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
2. Trevor Palmer and Philip Bonner 2008 Enzymes Biochemistry,Biotechnology, Clinical Chemistry, 2 ndedn EWP
3. Wilson, K and Walker, J ..(eds 2000 Principles and Techniques of Practical Biochemistry, 5 thedn Cambridge University Press
4. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York)
5. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
6. William, R. Clark (1991) the Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
7. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company

Course Books published in Hindi must be prescribed by the Universities and Colleges **Biotechnology by B D Singh (Hindi)** **Anuvanshiki evam Advik Jeev Vigyan by Jaya Sharma, kailash Pustak Sadan, Bhopal** **Koshika vigyan evam Pratiraksha, kailash Pustak Sadan, Bhopal**
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject
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
Further Suggestions: None

Detailed Syllabus
of
B.Sc. Third Year

Programme/Class: DEGREE	Year: THIRD	Semester: FIFTH
Subject: Biochemistry		
Course Code: B110501 T	Course Title **Bioenergetics and Metabolism**	

Course outcomes:
The learners will be able to:

- Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
- Gain a detailed knowledge of various catabolic and anabolic pathways
- Understand the regulation of various pathways
- Gain knowledge about the diseases caused by defects in metabolism with emphasis on the metabolic control

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures (in hours per week):	

Unit	Topics	No. of Lectures
I	**Principle of Bioenergetics:** • Bioenergetics and thermodynamics, • Laws of Thermodynamics • Gibbs free energy, enthalpy • Entropy and their relationships • Free energy change • ATP as universal currency in biological system • Coenzymes and proteins as universal electron carriers	60
II	**Oxidative phosphorylation** • The electron transport chain - its organization and function • Peter Mitchell's chemiosmotic hypothesis and Proton motive force • FoF_1ATP synthase, structure and mechanism of ATP synthesis • Metabolite transporters in mitochondria • Regulation of oxidative phosphorylation • ROS production and antioxidant mechanisms • Oxidative phosphorylation and ATP synthesis uncouplers	4
III	**Carbohydrate Metabolism:** • Glycolysis • TCA cycle • Electron Transport Chain • Pentose phosphate pathway • Gluconeogenesis and Glycogen metabolism • Diseases associated with metabolic irregularities.	8

IV	Photosynthesis • Light harvesting and photosynthetic electron transport • Water splitting, formation of H+ gradient and photophosphorylation • Calvin cycle, and its regulation • Photo respiration • C4 and CAM pathways in plants	8
V	Lipid Metabolism: • Degradation of fatty acids • β oxidation • regulation of fatty acid oxidation • ω oxidation and α oxidation • Ketone-body metabolism • Cholesterol synthesis • Fatty acid synthase complex enzyme • Synthesis of saturated, unsaturated, odd and even chain fatty acids • Regulation of fatty acid metabolism • Diseases associated with abnormal lipid metabolism	8
VI	Protein Metabolism • Urea Cycle • Transport of ammonia • Deamination and transaminationreactions • Inborn errors of protein metabolism • Glucogenic and ketogenic amino acids Overview of amino acid synthesis.	8
VII	Nucleic Acid Metabolism • De novo synthesis of purine and pyrimidine nucleotides • regulation and salvage pathways • degradation of purine and pyrimidine nucleotides • Inhibitors of nucleotide metabolism • Disorders of purine and pyrimidine metabolism	8
VIII	Nitrogen metabolism • Biological nitrogen fixation by free living and in symbiotic association Structure and function of the enzyme nitrogenase • Nitrate assimilation: Nitrate and Nitrite reductase • Primary and secondary ammonia assimilation in plants • ammonia assimilation by gutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway	8

Suggested readings

1. Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017)*Lehningerprinciplesofbiochemistry/*

NewYork:W.H.Freeman.
2. Voet,D.,&Voet,J.G.(2011).Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubertstryer Freeman InternationalEdition.
4. Biochemistry – Keshav Trehan Wiley EasternPublications
5. Fundamentals of Bochemistry-J.L.JainS.Chand andCompany
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,

This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject

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

Further Suggestions: None

Programme/Class: DEGREE	Year: THIRD	Semester: FIFTH
Subject: Biochemistry		
Course Code: B110502 T	Course Title **Fundamentals of Microbiology**	

Course outcomes: After the successful course completion, learners will develop following attributes

- Know the basics of microbiology
- Have knowledge of the general classification of microbes
- understand basics of Control of Microorganisms
- Study microbes in extreme environments and microbial interactions
- Know the basics of recombination in Prokaryotes
- Food & Industrial Microbiology
- Basics of virology

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

Total No. of Lectures (in hours per week):

Unit	Topics	No. of Lectures (60)
I	**History of Microbiology** • Spontaneous generation versus biogenesis • Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming • Various forms of microorganisms (bacteria, fungi, viruses, protozoa, PPLOs)	4
II	**Classification of microbiology** • Nutritional classification of microorganisms • Nature of the microbial cell surface • Gram positive and Gram negative bacteria • Growth curve	8
III	**Control of Microorganisms** • Physical agents (Autoclave, Hot air oven, Laminar airflow and membrane filter.) • Chemical agents (Alcohol, Halogens and Gaseous agents antibiotics), Radiation Methods (UV rays)	8
IV	**Pathogenicity of Microorganisms and Antimicrobial Chemotherapy** • Introduction to pathogenic microbes, Bacteria, Viruses, Algae, protozoa and fungi • General Characteristics of antimicrobial drugs • determining the level of microbial activity • dilution susceptibility test and disc diffusion test • Range of activity and mechanism of action of penicillin, vancomycin and tetracycline.	8
V	**Microbes in extreme environments and microbial interactions** • The thermophiles alkalophiles, acidophiles • symbiosis and antibiosis among microbial population • N_2 fixing microbes in agriculture and forestry.	8

VI	**Recombination in Prokaryotes** • Transformation • Conjugation • Transduction	4
VII	**Food and Industrial Microbiology** • Importance of microbiology in food and industries • Basic design of fermenter • Continuous and discontinuous culture • Preparation of fermented food products such as yoghurt, curd and cheese. Preparation of alcoholic beverages like wine and beer • Single cell proteins • Treatment of wastewater and sewage bBioremediation and biodegradation	8
VIII	**Brief outline of virology** • Discovery of virus • Early development of virology • nomenclature • classification and taxonomy of viruses - based on host, nucleic acids and structure • Evolution of viruses	8

Suggested readings

- Brock Biology of Microorganisms 11thedition and Brock Biology of Microorganisms ILLUSTRATIONS ISBN 0-13-196893-9 © Prentice Hall
- **MICROBIOLOGY** - AN INTRODUCTION, 8th edition Gerard J. Tortora, Bergen Community College by Berdell R. Funke, North Dakota State University Christine L. Case, Skyline College©2004 |Pearson
- J. Willey, L. Sherwood & C. Woolverton, Prescott's Microbiology,. 10th Ed., McGraw Hill international, (2017). ISBN 13: 9781259657573 2. MJ Chan, ECS Krieg & NR Pelczar, Microbiology, 5th Ed. McGraw Hill International, (2004)

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology in class/12th/ certificate/diploma.

Suggested Continuous Evaluation Methods:

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

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

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Programme/Class: DEGREE	Year: THIRD	Semester: FIFTH
Course Code: B110503P	Course Title: Microbial Techniques and Metabolism Lab	

Course outcomes

- On successful completion of this paper, students should be able to:
- Perform enzyme assay
- Identify different microbes
- Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, staining etc.
- To carry out research using microbes.
- To test microbial culture for antibiotic resistance.

Credits: 4	Core Compulsory
Max. Marks: 25+75Min.	Passing Marks: As per rules

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

UNIT	Topic	Total No. of Lectures
	• Enzyme assay (one example) • Biochemical tests–starch hydrolysis, gelatin liquefaction. • Assay of salivary amylase. • Cholesterol estimation. • Cleaning and sterilization of glassware. • Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge • Media preparation: Nutrients agar, Nutrient broth and LB. • Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining, fungal staining. • Isolation of bacteria and fungi from soil/ air/water – dilution and pour plate methods • Study of Rhizobium from root nodules of legumes • Growth curve of bacteria	60

Suggested Readings:

- Wilson, K and Walker, J ..(eds 2000 Principles and Techniques of Practical Biochemistry, 5 thedn Cambridge University Press
- M.T. Madigan, J.M. Martinko& D.A. Stahl, Brock Biology of Microorganisms, 13th Ed., Pearson Education International. (2010)
- J.G. Cappuccino, and N. Sherman, Microbiology: A Laboratory manual, 10th Ed. Benajamin/ Cummings (2013)

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Anuvanshiki evam Advik Jeev Vigyan by Jaya Sharma, kailash Pustak Sadan, Bhopal
Koshika vigyan evam Pratiraksha, kailash Pustak Sadan, Bhopal
Anuvanshiki Evam Koshika anuvanshiki by Pooja Rai, kailash Pustak Sadan, Bhopal

This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject

Programme/Class: DEGREE	Year: THIRD	Semester: SIXTH

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**
Further Suggestions: None

Subject: Biochemistry	
Course Code: B110601 T	Course Title:**Cell, Molecular Biology and Genetic Engineering**

Course outcomes:**After the successful course completion, learners will develop following attributes:**

- Distinguish between the cellular organization of prokaryotic and eukaryotic cells
- Would have deeper understanding of cell at structural and functional level.
- Will able to understand details of central dogma of life
- Get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.
- Gain knowledge about In vitro construction of recombinant DNA molecules vector DNA
- learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques, Expression of cloned DNA
- Have knowledge of Application of r-DNA technique in human health and quality crop production

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

Total No. of Lectures (in hours per week):

Unit	Topics	Total no. of Lectures (60)
I	**Cell Biology:** • Intracellular organization: • Cell Membrane, Fluid Mosaic Model, and membrane transport. • Structure and functions of organelles, • Prokaryotic and eukaryotic cell wall, • Cell cycle, cell death and cell renewal: • Eukaryotic cell cycle, restriction point, andcheckpoints. • Cell division: Mitosis and Meiosis. • Apoptosis and necrosis	4

II	• Fundamental principles of cell signalling. Concept of signalling as a two-box system • G-Protein and Receptor Tyrosine Kinase mediated signalling • Elements of eukaryotic cytoskeleton. Organisation and dynamics of actin microfilaments and microtubules • Endomembrane system, secretory pathways and vesicular trafficking	8
III	Basics of Molecular Biology: • Central dogma of Life • Organization of Genetic Material, • DNA Replication • Prokaryotic- Enzymes and proteins involved in replication • Spontaneous and induced mutations, • Physical and chemical mutagens, • Mutation at the molecular level, • DNA damage &Repair • Mutations in plants, animals, and microbes for economic benefit of man.	10
IV	Transcription: • Transcription in prokaryotes, • Mechanism, Promoters • RNA polymerase • Transcription factors	8
V	Translation: • Genetic code, • Properties and Wobble hypothesis. • Translation: Mechanism of translation inProkaryotes • Regulation of Gene expression: • Regulation of Gene expression in Prokaryotes: • Operonconcept (Lac)	8

VI	Recombinant DNA Technology: • DNA manipulative enzymes • Restriction enzymes and DNA ligases, • Gene cloning vectors:Plasmids, Bacteriophage and Chimeric plasmids, • Creation of r-DNA, • Transformation of r-DNA by differentmethods, • Screening and selection of recombinant host cells, • Gene Libraries: Genomic DNA and cDNA cloning techniques	8
VII	Applications of r-DNA technique in human health • Production of Insulin, • Production of recombinant vaccines: Hepatitis B, • Production of human growth hormone	6
VIII	Transgenic plants • Methods of plant transformation • Agrobacterium mediated plant transformation • Application of plant genetic engineering: • Insect resistance, • Disease resistance, • Herbicide resistance • Abiotic stress tolerance • Delayed fruit ripening	8

Suggested readings

1. Lehninger, Albert L., Cox, Michael M.Nelson, David L. (2017) *Lehninger principles of biochemistry* /New York : W.H. Freeman
2. **Watson**, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., &Losick, R. M. (2013). **Molecular biology of the gene**.
3. Voet, D., & Voet, J. G. (2011). Biochemistry. New York: J. Wiley & Sons.
4. Ulrich Hubscher,Giovanni Maga, and Silvio Spadari(2007),Eukaryotic dna polymerasesAnnu. Rev. Biochem. 2002. 71:133–63 DOI:10.1146/annurev.biochem.71.090501.150041.
5. Smita Rastogi and Neelam Pathak (2009), Genetic Engineering, Oxfoed University Press.
6. 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)
7. 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),
8. 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

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.

Suggested Continuous Evaluation Methods:

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

Further Suggestions:None

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

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Programme/Class: DEGREE	Year: THIRD	Semester: SIXTH
Subject: Biochemistry		
Course Code: B110602 T	Course Title: **Biostatistics, Bioinformatics and computer application in Biochemistry**	

Course outcomes: **After the successful course completion, learners will develop following attributes:**

- Understand the principles of biological data collection, statistical analysis and presentation.
- Learn and appreciate various factors that influence type of sample collected and sample size.
- Collect, analyze and interpret biological data using appropriate statistical tools
- Improvise their computational, mathematical and computer skills, which would increase their eligibility to pursue research based higher education.
- Formulate and justify appropriate choices in technology, strategy, and analysis for a range of projects involving DNA, RNA, or protein sequence data.
- Explain common methods and applications for analysis of gene or protein expression.
- Use data visualization software to effectively communicate results.

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

Total No. of Lectures (in hours per week):

Unit	Topics	No. of Lectures (60)
I	**Handling** of data • Tabulation and diagrammatic representation of data • Bar diagram and pie diagram. • Measures of central tendency: mean, median and mode. Measures of dispersion: range, quartile deviation, mean deviation and standard deviation. • Coefficient of variation.	4
II	**Tests of significance:** • Null hypothesis and alternative hypothesis, • Z-test, • Student's distribution, • Paired t – test, • F-test for equality of population variances. • Contingency table, • Chi-square test for goodness of fit and independence of attributes, Correlation analysis	8

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III	• **Molecular Techniques** • DNA sequencing, Polymerase Chain Reaction (PCR) • Primer designing, DNA fingerprinting, site directed mutagenesis, RFLP, RAPD • Southern, Northern and Western Blotting	4
IV	**Basics of Computer and Bioinformatics** • Operating systems • Hardware, Software, • DOS, Data Access Using Data Control • Internet, LAN, WAN, Web servers. • MS word office, excel ,powerpoint • Definition and need of Bioinformatics, • Brief history of biological databases • International nucleotide databases (e.g., Gen Bank, European Molecular Biology Laboratory (EMBL) • Bio information and DNA Data Bank of Japan (DDBJ) Center) • International Nucleotide Sequence Database Collaboration (INSDC).	8
V	**Protein Databases** • Classification of protein databases (e.g., primary, secondary, and composite databases) • Brief overview of ExPASy (Expert Protein Analysis System) bioinformatics resource portal • Protein 3D structural databases (e.g., RCSB-PDB (Research Collaboratory for Structural Bioinformatics Protein Data Bank), and MMDB (Molecular Modeling Database) of NCBI)	8
	Database Similarity Searches: • BLAST, • FASTA, • PSI-BLAST, algorithms, • Multiple sequence alignments - CLUSTAL, PRAS. Primer Designing, • Homology Modeling, • Phylogenetic analysis • Drug Designing, • Determination of Secondary & Tertiary of proteins.	8
VII	**Biological File Formats and Literatures Databases** • Brief overview of biological sequence and 3D structure file formats (e.g., GenBank/GenPept, EMBL, FASTA, PIR, and PDB), • NCBI's literature databases (e.g., PubMed, PubMed Central, PubChem Project and OMIM database	8

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VIII	**Database Similarity Searching and Phylogenetics** • Requirements of database searching, • BLAST (Basic Local Alignment Search Tool) algorithm, • Statistical significance and variants of BLAST • FASTA algorithm and its statistical significance • Comparison of BLAST and FASTA • Brief Overview of phyogenetic analysis	8

Suggested readings

1. Analysis of biological data, M. Whitlock and D. Schluter (2009), Roberts and company publishers
2. Principles of biostatistics, M. Pagano and K. Gauvreau (2000), Duxbury Thomas learnings
3. **Protein Bioinformatics: From Sequence to Function, Academic Press, 2011, ISBN 0123884241, 9780123884244.**
4. **Essential Bioinformatics, Cambridge University Press, 2006, ISBN 113945062X, 9781139450621**
5. **Kerns EH, Di L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008**

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.

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

Further Suggestions: None

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

Programme/Class: DIGREE	Year: THIRD	Semester: Sixth
Course Code: B110603P	Course Title: Genetic Engineering and Bioinformatics Lab	

Course outcomes

On completion of this course, students will be able to:

- Isolate genomic DNA from bacteria, plant and animal tissues
- Isolate plasmid DNA (E. coli)
- Perform restriction digestion of DNA
- Perform Agarose Gel Electrophoresis
- Develop understanding of Bioinformatics as tools for Sequence Alignment, FASTA & BLASTsearch, Multiple Sequence Alignment, Protein Structure Visualization, as well as for Gene Finding

Credits: 4	**Core Compulsory**
Max. Marks: 25+75Min.	**Passing Marks: As per rules**

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

UNIT	Topic	Total No. of Lectures
	• Isolate genomic DNA from bacteria, plant and animal tissues • Isolate plasmid DNA (E. coli) • Perform restriction digestion of DNA • Perform Agarose Gel Electrophoresis • Learning to analyze data using SPSS or R software • Introduction to types of sequence databases (Nucleotides & Protein) • Pair wise Sequence Alignment (NW and SW approach) • FASTA & BLAST search • Multiple Sequence Alignment (ClustalX&Treeview)	60

Suggested Readings:

1. Molecular Cloning: A laboratory manual (2014),4nd ed., Michael R Green and J. SambrookCold spring Harbor laboratory press (3vol.),
2. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India)

Course Books published in Hindi must be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject

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

Further Suggestions: None

Detail Syllabus of B.Sc.

IV Year Biochemistry

Or

Bachelor of Science in Biochemistry (Honors)/ Bachelor of Science in Biochemistry (Honors with Research)

Programme / Class	Honours	Year	B.Sc. 4	Semester	Seventh
Subject			Biochemistry		
Course Code	B110701T		Course Title	General Biochemistry	

- **Course Outcome-**
- Understanding Basic details of structure, function of carbohydrate molecules and its classification
- Details of structure, function and classification of amino acid &structural levels of protein molecules
- Structure and function of fatty acids, storage and structural lipids
- Details of structure and Function of Nucleotide, DNA and RNA
- Basic details of Vitamin molecules and its classification
- Classification, structural features and Function of Plant & Animal Hormone

Credits – 4	Max. Marks : 100	Min. Passing Marks :33

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

Unit	Topic	No of Lectures
UNIT-I	Introduction of Biochemistry, Structure of atoms, molecule and chemical bonds; Structure of water, its Physicochemical property and interaction with ions, nature significance of week acids and bases. Application of the Henderson-Hasselbalach equation . pH and buffers. Biochemistry through Ayurveda	12
UNIT-II	Carbohydrate Classification, Structure of Monosaccharides Stereoisomerisms and optical isomerism of sugar, Ring structure and anomeric forms, mutarotation. Structure and general function of amino sugar, sugar nucleotide and mucopolysaccharides. Important biological importance of monosaccharides, oligosaccharides and polysaccharides.	12
UNIT-III .	Classification of lipids, Fatty acids: introduction classification, nomenclature and properties of saturated and unsaturated fatty acids. Essential fatty acids prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats-hydrolysis saponification, rancidity of fats. Sphingolipids, Glycolipids, Properties and function of phospholipids, isoprenoids, and sterols	12
UNIT-IV	Introduction, Classification and function of proteins. Amino acids: Common structural feature, stereoisomerism and RS system of designating optical isomers, classification, physical and chemical properties, titration of amino acids. Essential amino acids. Chemical synthesis of peptides. Ramachandran Plot, primary, secondary, tertiary and quaternary structure of protein, protein folding. Structure stabilizing the protein. Protein structure evolution, structural and functional relationship of some model proteins like myoglobin, haemoglobin.	12
UNIT-V	Nature of genetic materials; evidence that DNA genetic material. Structure. chemistry and biological properties of purine and pyrimidine, nucleosides and nucleotides, DNA and RNA structure, physicochemical properties and their various functions. Vitamins-Structure, properties and functions including biochemical reactions and deficiency symptoms.	12

Suggested Readings:

Suggested readings

1. Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017)*Lehningerprinciplesofbiochemistry/* NewYork:W.H.Freeman.
2. Voet,D.,&Voet,J.G.(2011).Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubertstryer Freeman InternationalEdition.

4. Biochemistry – Keshav Trehan Wiley EasternPublications

Syllabus for B.Sc. Fourth Year /Sem Seventh/Paper- Second

Programme / Class	Honours	Year	B.Sc. 4	Semester	VII
Subject			Biochemistry		
Course Code	B110702T		Course Title	Cell Biology and Membrane Biochemistry	

Course Outcome-

- Students will learn about cell theory, cell cycle mechanisms, various cellular organelles and their fractionation
- Students will acquire insight into the processes of transport across cell membranes, process of endocytosis and protein sorting/translocation to various organelles.
- Students will gain knowledge about the concepts of various cellular signal transduction pathways
- Students will acquire insight into the mechanisms of cellular responses under varying conditions
- Students will learn the association of the defects in the signaling processes to various diseases.

Credits – 4	Max. Marks : 100	Min. Passing Marks :33

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

Unit	Topic	No of Lecture
UNIT-I	Cell classification, cell variability (size, shape, complexity, function), Structural organization of prokaryotic and eukaryotic cells, cell types, differences in plant and animals. Concept related to compartmentalization in eukaryotic cells; cell –ECM and cell-cell interaction; Basics of IKS	10
UNIT-II	Detailed descriptions of eukaryotic cell structure. The ultra-structure of nucleus. Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi apparatus, Lysosomes, peroxisomes and their function. Cell cycle and cell division, (Mitosis and Meiosis steps, regulation and control of cell cycle)	12
UNIT-III	Cellular communication, general principle of Cellular interaction, Assembly of various extracellular matrix and their role in integrating cells into tissues and cell-cell interactions. Restriction point of cell cycle and Quiescent cells. Role of various cycle-CDK complexes in the transition of various checkpoint of cell cycle. Role of ubiquitin-protein ligase –SCF and APC/C in the control of cell cycle. Cytokinesis.	12
UNIT-IV	Chemical composition of biomembrane. Gap and tight junctions. Physical and biochemical methods to study membrane structure and properties. Different models of cell membrane-historical perspective. Function of biomembranes with examples Energy transduction-mitochondria and chloroplast, signal recognition. Programmed cell death, aging and senescence.	12
UNIT-V	Transport across bio membrane,, Simple diffusion, Fick's law, porins, facilitated diffusion, porter molecules, kinetics of facilitated transport, symport, antiport, uniport. Red cell-membrane proteins, anion porter and glucose porter. Active transport, proton and Na+-K+ pumps- examples and metabolic significance, Donnan's membrane equilibrium.	12

5. Fundamentals of Bochemistry-J.L.JainS.Chand andCompany
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

Suggested Readings:

1. H. Lodish, A. Berk, C.A. Kaiser, M. Kreiger, M. P. Scott, A. Bretscher, H. Ploegh, P. Matsudaria. 2008. Molecular Cell Biology, W.H. Freeman and Company, New York., USA.
2. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P Walter. 2002. Molecular Biology of the Cell, Garland Publishing, Inc. New York. USA.
3. G.M. Cooper. 2000. The Cell: Molecular Approach, ASM Press, Washington, D.C. USA.
4. J.M. Graham and R. Rickwood. 1997. Subcellular Fractionation: A Practical Approach, IRL Press, Oxford University Press. U.K.

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.

Syllabus for B.Sc. Fourth Year /Sem Seventh/Paper-Third

Programme / Class	Honours	Year	BSc fourth Year	Semester	Seventh
Subject			Biochemistry		
Course Code	B110703T		Course Title	Biophysical chemistry, techniques and applications	

Course Outcome-

- **The objective of the course is to introduce various techniques to the students, which are used in biological research.**
- **Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab.**
- **Students will learn about the principle and application of electrophoresis, centrifugation techniques, microscopic and molecular biological techniques.**

Credits – 4	Max. Marks : 100	Min. Passing Marks :33

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

Unit	Topic	No of Lectures
Unit – I	pH meter, centrifugation techniques and their application: Basic principles (RCF, RPM, Sedimentation coefficient etc); Technique and applications; Types of centrifuges- Microcentrifuge, High speed and Ultracentrifuges; Types of Rotors: fixed angle, swinging bucket. Preparative centrifugation; Differential and density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods. Introduction of Indian Scientist (IKS).	12
Unit – II	Chromatography - Theory and general techniques of absorption, partition, ion exchange, gel filtration, TLC, paper chromatography, chromatofocussing, covalent, Gas chromatology, Affinity, FPLC, HPLC and reverse phase HPLC.	12
Unit – III	Electrophoresis, Basic principle of agarose electrophoresis, PAGE and SDS-PAGE and their applications. Capillary electrophoresis, Two-dimensional electrophoresis, disc gel electrophoresis; Pulsed field gel electrophoresis and its importance Isoelectricfocussing, immunodiffusion and immunoelectrophoresis (different types).	12
Unit –IV	Spectroscopic Techniques - Theory, principle and applications of UV-Visible, Raman Spectroscopy, fluorimetry, Circular Dichroism; NMR, PMR, ESR and Plasma Emission spectroscopy, Mass Spectroscopy, Different types of microscopic techniques and X-ray crystallography.	12
Unit – V	Tracer techniques- Detection measurement of isotopes and application of isotopes in biochemistry, RIA, IRMA, and ELISA. Units of radioactivity, biological hazards of radiation and safety measures in handling radioisotopes.	12

Suggested reading:

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman and Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
3. D. Holme and H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

Syllabus for B.Sc. Fourth Year /Sem Seventh/Paper- Four

Programme / Class	Honours	Year	B.Sc. 4	Semester	Seventh
Subject			Biochemistry		
Course Code	B110704T		Course Title	Microbiology	

Course Outcome-

1 Demonstrate theory and practical skills in microscopy and their handling techniques and staining Procedures

2 Identify use of different culture media and their applications and microbial techniques for microbial growth estimation, cultivation and culture preservation for routine microbiological skill handling

3 Develop methods associated with the various physical and chemical growth requirements of bacteria and get equipped with various methods of disinfection and sterilization.

4 Understand different systems for microbial classification and nomenclature for study of biodiversity.

5 Apply the knowledge to understand the differentiating microbial characteristics for their identification and further characterization

Credits – 4	Max. Marks : 100	Min. Passing Marks :33

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

Unit	Topic	No of Lectures
Unit-I	History, development and scope of microbiology. Major contributions of scientist to microbiology (Antony van Leeuwenhoek, Lazzaro Spallanzani, John Tyndall, Louis Pasteur, Joseph Lister, Iwanowski, Robert Koch). #Contribution of Indian researchers, Indian Knowledge System, Pure culture Isolation Techniques; Microscopy and preparation of microbial samples: wet mount, smear; Staining: types; simple and differential staining, Introduction of Indian Scientist (IKS)	12
Unit-II	Nutritional requirement and Growth of microorganism: culture media- types, factors affecting growth, Measurement of growth, growth phases, growth kinetics, diauxic growth, synchronous and asynchronous culture; batch, fed batch and continuous culture; Growth of aerobic and anaerobic bacteria. Culture preservation and Culture Collection.	12
Unit-III	Physical and Chemical control of microorganisms: Disinfectants and Sterilization principles. Antimicrobial chemotherapy	12
Unit-IV	Microbial Taxonomy, Systematics, Phylogeny and Nomenclature. Hierarchial organization of organisms- Haeckel, Whittaker and Woese classification. Numerical and Chemotaxanomy of microorganism. Salient features of archaebacteria and eubacteria. Classification of bacteria according to Bergey' s Manual of Determinative Bacteriology.	12
Unit-V	Differentiating features, habitats, reproduction and classification of Mollicutes, Slime Molds, Algae, Fungi, Viruses	12

Suggested reading

1. Microbiology: Prescott L M, Harley JP, Klein DA. Microbiology. Edition. McGraw Hill Publication, New York
2. Microbiology. M J Pelczar, Chan, Krieg. 5th Edition. Mc Graw Hill
3. Microbiology. RP Singh. Kalyani Publisher
4. Textbook of Microbiology. Dubey & Maheshwari. S Chand Publications.

Syllabus for B.Sc. Fourth Year /Sem Seventh/Paper-Fifth Practical

Programme / Class	Honours	Year	B.Sc. 4	Semester	Seventh
Subject			Biochemistry		
Course Code	B110705P		Course Title	Practical-1	

Course Outcome:

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Credits – 4 | Max. Marks : 100 | Min. Passing Marks :33

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

	Topic	No of Labs
		60
	1 Biochemical estimation of carbohydrates 2 Biochemical tests for amino acids and proteins. 3. Isolation of proteins. 4. Separation and estimation of lipids by using TLC. 5. Separation of proteins by SDS-PAGE. 6. Estimation of protein by Lowry's and Bradford methods. 7. Estimation of DNA by DPA method. 8. Estimation of RNA by orchol. 9. Preparation of various culture media for growing microorganism. 10. Gram Staining of Bacteria.	

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Programme / Class	Honours	Year	B.Sc. 4	Semester	VIII
Subject			Biochemistry		
Course Code	B110801T		Course Title	Molecular Biology and Genetics	

Course Outcome- The aim of this core-course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.

2. The course has been devised to familiarize students with molecular biology which mainly deals with interactions among various systems of the cell, including those between DNA, RNA and proteins and learning how these are regulated.

3. To illustrate creative use of modern tools and techniques and expose students to application of recombinant DNA technology in scientific research.

4. To train students in strategizing research methodologies employing genetic engineering techniques.

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Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
Unit – I	DNA replication and its regulation: Mechanism of DNA Replication: Structure and function of DNA polymerases. Role of Replisome, Primosome, Okazaki fragments, helicase, primase, gyrase, topoisomerase and other proteins in DNA replication in E. coli and eukaryotes, initiation of replication, elongation and termination of DNA synthesis. DNA Repair -Mutation, mutagenes, paramutations, molecular basis of gene mutation, Disease associated with repair mechanisms, DNA replication inhibitors. Introduction of Indian Scientist related to molecular biology (IKS).	12
Unit – II	***Transcription*:** Prokaryotic and eukaryotic transcription: Initiation, elongation and termination; Structure and function of RNA -mRNA, tRNA, rRNA, snRNA, Concept of intron & exon, DNA - dependent RNA polymerase (RNA Pol in prokaryotes and RNA Pol I, II, III). Promoter; Enhancer and other regulatory elements; Transcription factors; Reverse transcription; Post- transcriptional / Co-transcriptional processing: Regulation of transcription in prokaryotes and eukaryotes.	12
Unit – III	***Genetic code, Translation:** Translation in Prokaryotes & Eukaryotes. Inhibition of protein synthesis by antibiotics. Regulation of protein synthesis, post translation modification. Protein targeting in prokaryotes and eukaryotes, Chaperones, heat shock proteins, inhibitors of protein synthesis.*	12
Unit – IV	**Regulation of gene expression** in prokaryotes, Coordinated control of clustered genes-operon model, with example of inducible Systems like lac- Operon. Arabinose operon and repressible systems like Trp operon. Role of repressors and activators of transcription in regulation of phage-lytic and lysogeic pathways, lambda repressor. Regulation of gene expression in eukaryotes, Organization of genes in eukaryotic DNA- Repititive DNA sequences, activators, enhancers. Post transcriptional regulation splicing, capping, methylation, acetylation, heat shock protein. Diseases linked with gene expression.	12
Unit – V	**Linkage and crossing over,** Linkage mapping, Sex determination and sex- linked inheritance, Sex determination in plant and animal, Population and evolutionary genetics.	12

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Suggested reading:

1. Freifelder, DM "Molecular Biology" .
2. Brown, TA "Genomes" .
3. Rastogi &Pathak Genetic Engineering
4. Brown, T.A. "Gene cloning: An introduction"
5. Old & Primrose "Principles of Gene Manipulation"
6. Primrose, SB "Molecular Biotechnology"
7. The Cell - by Geoffrey M. Cooper
8.

Syllabus for B.Sc. Forth Year /Sem Eight /Paper-second

Programme / Class	Honours	Year	B.Sc. 4	Semester	VIII
Subject			Biochemistry		
Course Code	B110802T		Course Title	Bioenergetics and Intermediary Metabolism	

Course Outcome- 1. Explain the role of catabolic and anabolic pathways in cellular metabolism.
2. Distinguish between kinetic and potential energy.
3. Distinguish between exergonic and endergonic reactions in terms of available energy change.
4. Describe the structure of ATP and identify the major class of macromolecules to which ATP belongs.

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
Unit – I	Bioenergetics- Energy transduction, Law of thermodynamics, Biological Oxidation. Gibb' s energy, energy changes and redox potential, electrochemical and membrane potential, High energy compounds and low energy compounds, ATP cycle. Introduction of Indian Scientist (IKS).	12
Unit – II	The mitochondrial respiratory chain, order and organization of carriers, proton gradient, cytochromes and their characterization. Respiratory control and oxidative phosphorylation. Fractionation and reconstitution of respiratory chain complex, oxidative phosphorylation and theories.	12
Unit – III	Methods and Techniques in the study of Intermediary metabolism. Multienzyme complex. Metabolism of carbohydrates and their regulation. Biosynthesis of glycogen and starch. Fatty acids biosynthesis & oxidation; lipid biosynthesis; biosynthesis of triglycerols, phosphoglycerides and sphingolipids. Biosynthesis of steroids, ketone bodies formation, and utilization.	12
Unit – IV	Biosynthesis and degradation of amino acids and their regulation, Specific aspects of amino acid metabolism. Urea cycle and its regulation, Inborn error of metabolism.	12
Unit – V	Biosynthesis and regulation of purines and pyrimidines. degradation of purines and pyrimidines., structure and regulation of ribonucleotides deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. Disorders of purine and pyrimidine metabolism.	12

Suggested Reading:

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

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Syllabus for B.Sc. Forth Year /Sem Eight /Paper-Third

Programme / Class	Honours	Year	B.Sc. 4	Semester	VIII
Subject			Biochemistry		
Course Code	B110803T		Course Title	Enzymology	

Course Outcome-

1. To learn about general properties of enzymes like activation energy, active site, etc.; definition of enzyme activity and its various units; classes of enzymes and international nomenclature, the types of enzyme assays; and the various kinds of techniques employed for purification
2. To know about the concepts of enzyme kinetics
3. To study about Mechanism of enzyme action
4. To understand the concept of Enzyme Regulation
5. To know about Multienzyme complexes and isozymes

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
Unit – I	Isolation and purification of enzymes, purity of enzymes, enzyme activity and specific activity, native, inactive and denature state of enzymes. Nomenclature and classification of enzymes, general structure and properties of enzymes, enzyme assay, factors affecting enzyme activity, Introduction of Indian Scientist (IKS).	12
Unit – II	Kinetics of enzyme action - Concept of ES complex, active site, specificity, derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of Km & Vmax and their physiological significances. Importance of Keat/Km. Kinetics of zero & first order reactions. Classification of multi substrate reactions with examples. Derivation of the rate of expression for Ping Pong, random & ordered BiBi mechanisms. Reversible and irreversible inhibition. Competitive, non- competitive, uncompetitive, type inhibitions and their kinetics.	12
Unit – III	Mechanism of Enzyme Action - Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of ribonuclease, chymotrypsin, lysozyme and carboxypeptidase.	12
Unit – IV	Enzyme Regulation - General mechanisms of enzyme regulation. Reversible and irreversible covalent modifications of enzymes. Feedback inhibition, Allosteric enzymes, qualitative description of "concerted" & "sequential" models for allosteric enzymes. Half site reactivity, Flipflop mechanism. positive and negative cooperativity with special reference to aspartate transcarbamoylase & phosphofructokinase. Protein ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.	12
Unit – V	Multienzyme system - Occurrence, isolation & their properties: Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes. Enzymeenzyme interaction, isoenzymes with special reference to lactate dehydrogenase and phasphocreatine kinase.	12

Suggested Reading:

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.

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2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

Syllabus for B.Sc. Forth Year /Sem Eight /Paper-Four (Elective)

Programme / Class	Honours	Year	B.Sc. 4	Semester	VIII
Subject			Biochemistry		
Course Code	B110804T		Course Title	Human Genetics (Elective)	

Course Outcome-

1. The student will learn and understand the genome organization, cytogenetics, and genetic control of development.
2. The student will learn and understand the principles of Mendelian inheritance, linkage and genetic mapping; extrachromosomal inheritance, sex-linked inheritance and genetic disorders, somatic cell genetics, population genetics.
3. The course will aid to learn about physical and chemical mutagens, drug metabolism and detoxification; DNA damage, DNA repair mechanisms, oncogenes, proto-oncogenes, and tumour suppressor genes from humans.
4. The student will learn and understand the Human Genome Project, gene therapy, genetic testing, and genetic counselling.

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
Unit – I	Introduction to Human Genetics: History; Early perception, development and documentation; Genome organization; Chromosome structure, function and implications for disease. Study tools in Human Genetics: Pedigree analysis- Mendelian inheritance and exceptions; Chromosomal analysis (in vitro, in vivo), Biochemical analysis; Somatic cell genetics (somatic cell hybrids, monochromosome hybrid panels, gene mapping); Molecular genetic analysis.	12
Unit – II	Human genome mapping methods: Physical mapping: Introduction to physical map markers Chromosomal, G/Q-banding, radiation hybrid, Fluorescence in situ hybridization, comparative genome hybridization, long range restriction mapping, high resolution mapping STS/EST/MS/SNP/sequencing; Genetic mapping: Linkage analysis (RFLP/MS/SNP); Applications of mapping in normal and disease genome analysis; Gene identification using positional and functional cloning approach.	
Unit – III	Human genome analysis: Conception, mapping, cloning and sequencing, Outcome-Generation of `OMICS' era, significant leads. Genetic variation in health and disease: Human genetic diversity- Methods of study- Biochemical/molecular genetic markers; some examples. Tracing human migrations with autosomal, Y chromosomal and mitochondria] markers.	12

Unit – IV	Diseases and disorders: Chromosomal disorders: Structural and numerical; Autosomal/sex chromosomal/sex reversal; Mechanisms- mitotic/meiotic non-disjunction/ chromosomal rearrangements; Some examples (Syndromes/Cancer/Infertility); Single gene and disease: Inborn errors of metabolism, Haemoglobinopathies; Multifactorial disorders: Introduction; Methods of study (Epidemiological, Twin/ adoption and Family studies); Etiology - genetic and nongenetic determinants; Common examples.	**12**
Unit – V	Epigenetics and disease: Mechanisms (Imprinting/methylation; chromatin remodeling); Current understanding; examples. Mitochondria' myopathies. Ethical, legal and social issues in Human genetics: Prenatal/adult (individual/family/population) screening of mutation/risk factor for genetic	**12**
	diseases; Confidentiality/privacy, Discrimination, Ethical dilemma, Human rights, Surrogate mothers; Human cloning and eugenics; Organ banking and transplantation; Research ethics; Medical ethics in India.	

Suggested Reading:

1. The Cell: A Molecular Approach, by Geoffrey M Cooper, Robert E Hausman, 15 Dec 2015
2. Molecular Cell Biology Hardcover -by Harvey Lodish (Author), Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, 1 Apr 2016
3. Molecular Biology of THE CELL: by Bruce Alberts, Alexander Johnson, Julian Lewis. Publisher Garland Science, December 2014
4. Human Molecular Genetics, 3rdEdittion, Tom Strachan, Andrew P. Read.
5. Emery 's Elements of Medical Genetics 12th edition, Peter Turnpeeny Sian Ellard, Elsevier publications.
6. Human Molecular Genetics, Jack J Pasternak 2nd Edition, John Wiley and sons

Syllabus for B.Sc.4 /Sem Eight/Paper-Fifth (Elective)

Programme / Class	**Honours**	**Year**	**B.Sc. 4**	**Semester**	**VIII**
Subject			**Biochemistry**		
Course Code	**B110805T**		**Course Title**	**Recombinant DNA Technology (Elective)**	

Course Outcome-

1. Understand the concept of recombinant DNA technology, technique, application and limitations.
2. Understand the concept of gene manipulation.
3. Explain the general principles and applications of RDT

Credits – 4	**Max. Marks : 100**	**Min. Passing Marks:33**

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

Unit	Topic	No of Lectures
UNIT-I	Restriction Enzymes DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes.	

UNIT-II	Plasmids, Phagemids and Expression Vectors M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Yeast vectors, Shuttle vectors, siRNA technology.	
UNIT-III	Expression strategies for heterologous genes vector engineering, codon optimization, host engineering, in vitro transcription & in vitro translation, expression in bacteria, expression in yeast, Inclusion bodies; Methodologies to reduce formation of inclusion bodies.	
UNIT IV	Linkers and Adaptors Homopolymeric tailing, strategies for cDNA libraries; Transformation; Northern, Southern and Colony hybridization, Southwestern and Far-western cloning; Phage display; cloning differentially expressed genes (mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay; DNaseI footprinting)	
UNIT-V	**PCR and Its Applications** Primer design; Fidelity of thermostable enzymes (Taq & Pfu polymerases); DNA polymerases; Types of PCR — multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in gene recombination; SOEing; Site specific mutagenesis; deletion; addition.	

Suggested Reading:

1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001. 3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Syllabus for B.Sc.4 /Sem VIII/Paper-VI

Programme / Class	Honours	Year	B.Sc. 4	Semester	VIII
Subject			Biochemistry		
Course Code	B110806P		Course Title	Practicals-2	

Course Outcome-

1. To learn about general properties of enzymes like activation energy, active site, etc.; definition of enzyme activity and its various units; classes of enzymes and international nomenclature, the types of enzyme assays; and the various kinds of techniques employed for purification
2. To know about the concepts of enzyme kinetics
3. To study about Mechanism of enzyme action
4. To understand the concept of Enzyme Regulation
5. To know about Multienzyme complexes and isozymes

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
	1. Isolation of enzymes from different sources. 2. Assay of enzyme activity (acid phosphatase, peroxidase). 3. Enzyme kinetics calculation of Km and Vmax using MM graph and LB plot. 4. Purification of protein by column chromatography. 5. Plasmid isolation by alkaline lysis method. 6. Bacterial genomic DNA isolation by CTAB 7. RNA isolation from plant tissue 8. Separation of DNA and RNA by Agarose Gel Electrophoresis. 9. Microbial cultures, competent cell preparation and cloning. 10. PCR	60

Subject		Biochemistry	
Course Code	B110806R	Course Title	Research Project
Credits – 4	Max. Marks: 100		Min. Passing Marks: 33

Total No. of Lectures - Tutorials - Practical (in hours per week) : 0-0-as per norms

Research Project/synopsis presentation **Credits 60**

Detail Syllabus of

V Year

Master of Science (M.Sc.)
In
Biochemistry

Syllabus for M.Sc.2 /Sem IX /Paper-First

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B110901T		Course Title	Plant Biochemistry	

Course Outcome-

1. The course is designed to know the structure and function of plant cell and role of different organelles.
2. Students will be able to learn the general process of photosynthesis in the plants and energy transfer
3. To know the general metabolism in plants such as respiration, lipid biosynthesis and other key process such as nitrogen metabolism
4. Students will also gather information on metabolites and hormones, important in the development of plants.

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	Structure and function of plant cell (including cell -wall. plasmodesmata, meristmetic cells, \'acuoles, secretory system root quiescent zone), Isolation of cell organelles, absorption, transport of water & ion in plants, Evapotranspiration , Introduction of Indian Plant Biochemist (IKS)	
UNIT-II	Photosynthesis, Photosystem l & ll their location. Mechanism of quant um capture & energy transfer bet ween photo system. hill reaction, photophosphorylation, & reduction of C02, C3, C4, and CAM metabolism. light and dark reaction. Light activation of enzy mes, Regulation of photosynthesis. Photorespiration	
UNIT-III	Biological nitrogen fixation and ammonia assirnibtion. ni trate and sulphate reduction and their incorporation into amino acids translocation of inorganic and organic substances. Role of microbes in nitrogen, sulph ur. carbon and phosphorous cycles	
UNIT IV	Special features of secondary plant metabolism, formation of phenolic acids, tannins. lignins, lignans. pigments, terpenes. terpenoids, plant, phenolic, alkaloids and surface waxes -their biosynthesis and function	
UNIT-V	Plant hormones - growth regulating substances and their mode of action . Biological ruld Molecular aspects of auxins, Gibberllins, abscisic acid, cytokinins and ethylene. Biochemistry of seed developmen t and frui t ripening. Defense system in plants	

Suggested Reading:

1. Stryer. L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet. J. G. (2016). Biochemistry (5th ed.). Hoboken. NJ: J. Wiley & Sons.

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Syllabus for M.Sc.2 /Sem IX /Paper-second

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B110902T		Course Title	Physiology and Clinical Biochemistry	

Course Outcome-

1. Understand and explain the acid-base. water-electrolyte and redox biology balance in the body.
2. Understand the difference between plasma, serum, normal and abnormal constituents in various body fluids. blood clotting mechanism and anticoagulants.
3. Explain the nature and function of various enzymes, normal levels and elevated levels in various diseases. Also, learning on various systems of the body.
4. Studies on blood and urine other circulatory systems and related disorders.
5. Learn that many diseases result from imbalance in certain biomolecules and helps in diagnosis of liver. cardiac, gastrointestinal, kidney diseases.
6. The course will also aid to learn about kidney diseases liver diseases and other metabolic disorders.

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	Nutrition and balanced diet vitamins and minerals. Digestion and Absorption of food (Carbohydrates, Lipid and protein), Chemistry of respiration, homeostasis, regulation of acid base balance. factor affecting acid base balance, Introduction of Indian Scientist (IKS)	
UNIT-II	Body fluids — Composition and functions, Blood groups, Rh factor, Plasma protein. coagulation. clotting formation, Anemia, Urine -Composition & function, formation in health and disease	
UNIT-III	A brief outline of various endocrine glands. Classification, Structure, and function of Hormones. Feedback regulation of hormone secretion. Mechanism of extracellular and intracellular hormone action. Metabolic and physiologic role of hormones secreted by pituitary. thyroids. parathyroid, adrenals, pancreas and gonad. disorders due to over and under secretion.	
UNIT IV	Biochemical basis of drugs action. Biotransformation and detoxification mechanism, Role of glutathione in drug resistance	
UNIT-V	Clinical and Bio-chemical aspects of disease- cancer. AIDS, jaundice, cushing, syndrome, diabetes mellitus, atherosclerosis, protein calorie malnutrition	

Suggested Readings:

1. Textbook of Medical Biochemistry by M.N. Chatterjee and Raneshincle
2. Textbook of Medical Laboratory Technology by DP. Godkar and PB. Godk.ur.
3. Textbook of Medical physiology by Guyton & Hall

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Syllabus for M.Sc.2 /Sem IX /Paper-Third

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B110903T		Course Title	Molecular and Cellular Immunology	

Course Outcome-

1. This course is focused upon molecular and cellular aspects of immunology.
2. This course will cover the basic concepts underlying the mechanisms of innate and adaptive immunity, as well as key experimentnl methods currently used in the field.
3. The students will be able to describe the roles of the immune system in both maintaining health and comributing co disease.
4. The students will be able to describe immunological responses and how they are triggered and regulated.
5. The students will be able to transfer knowledge of immunology *into* clinical decision-making through case studies presented in class.

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	Immunology- Fundamental concepts and anatomy of the immune system; Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs-Bone marrow, thymus, lymph nodes, spleen; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosa! and Cutaneous associnted Lymphoid tissue (MALT and CALT); Mucosa!Immunity. Toll-like receptors, inflanullation. Antigens - haptens, antigenicity and immunogenicity, Introduction of Indian Scientist (!KS)	
UNIT-II	Humoral and Cell-Mediated Immune responses, primary and secondary immune modulation, Immunoglobulins: Basic structure, Classes and Subclasses of immunoglobulins, ADCC; antigenic determinanrs; Band T cell epit0pes; Band T cell receptors; Immune responses generated by B and T lymphocytes: activation and differentiation of B and T cells, Memory B cell maturation, activation and differentiation; Cell-mediated effector functions; Functional T Cell Subsets; Cell-mediated immune responses.Cytokines-properties, receptors and therapeutic uses. Structure and function of antibody molecules: Multigene organization of immunoglobulin genes: lmmunoglobulin supelfamily; Generation of antibody diversity	
UNIT-III	Major Histocompatibil ity Complex - MHC genes, MHC and immune responsiveness and disea e susceptibility, HLA typing; MHC molecules, antigen processing and presentation, endogenous amigens, exogenous antigens, non-peptide bacterial antigens and super-antigens	
UNIT IV	Antigen-antibody interactions- Kinetics of immune response; Precipitation, agglutin at ion and complement mediated immune reactions; Advanced iinmunological techniques: RIA, ELISA, Western blotting. EUSPOT assay, immunofluorescence. flow cytometry and inununoelectron microscopy; Surface plasmon resonance. I3iosensor assays for assessing ligand-receptor interaction, CMT techniques- lymphoprol iferation assay. Mixed lymphocyte reaction, Cell	

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	Cytotoxicity assays. Apoptosis, Microarrays	
UNIT-V	Clinical Immunology: Immunity to Infection Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+T cells; MHC and TCR in autoImmunity; Treatment of autoimmune diseases; Transplantation Immunology- Immunological basis of graft rejection; congenital and acquired immunodeficiencies, Cancer: Tumor immunology; Oncogenes, Tumor Suppressor Genes; Immune response to tumors and tumor evasion of the immune system	

Suggested Readings:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff J, Seaddin JK, Male D, Raitt IM., Clinical Immunology, 6th Edition, Gower Medical Publshing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science

Programme / Class	**Honours**	**Year**	**M.Sc. 2nd year**	**Semester**	**IX**
Subject			**Biochemistry**		
Course Code (Elective)		**B110905 T**	**Course Title**	**Proteomics and Genomics (Elective)**	

Course Outcome-

1. Demonstrate the importance of proteomics
2. Develop an understanding of data analysis
3. Assess the uses of proteorn.ics
4. Assess & analyze the genomic study of organisms

Credits – 4	**Max. Marks : 100**	**Min. Passing Marks:33**

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

Unit	Topic	No of Lectures
UNIT-I	Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, hotgun libraries, comparative genomes (Arabidopsis, rice and panda)	
UNIT-II	Conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing. automated sequencing, translation to large scale projects, epigenomics, cancer genome. FISH. Comparative Genomic Hybridization (CGH), SKY (Spectral Karyotyping)	
UNIT-III	Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips. Gene identificacion and Expression Analysis: DNA microarrays, ESTs. SAGE, MPSS	
UNIT IV	Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarrays. differential display proteomics. yeast 2-hybrid system. FRET. bimolecular fluorescence complementation assay	
UNIT-V	Advantages and disadvantages of DNA and protein	

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	microarrays. Total expression vs functional proteomics. oligosaccharide microarrays for glycomics. pharmacogenomics, introduction to metabolomics	

Suggested Reading: 1. Developing Bioinformatics Computer Skills: Cynthia Gibas & Per Jambeck - 200 I Shroff

2. Bioinformatics Basic : Applications in Biologi cal Science and Medicine - 2002 - HH Rashid i & LK Buchler, CRC Press, London

3. Bioinformnatics: Sequence, structure and darnbanks - 2000 - Des Higgins & Willie Taylor

4.Bioinformatics: A practica l guide to the analysis of genes and proteins - 200 I - AD Baxevanis & BFF Ouellette -Wiley Interscience -New York

5. Biostatistics (1996) Arora PN & Malhon PK - Imalaya Publishing House. Mumbai.

6. Primer of Biostatistics -Stanton A & Clantz -The McGraw Hi l l Inc., New York

Programme / Class	**Honours**	**Year**	**M.Sc. 2nd year**	**Semester**	**IX**
Subject			**Biochemistry**		
Course Code (Elective)	**B110906 T**		**Course Title**	**Biochemical Engineering and Fermentation technology (Elective)**	

Course Outcome-

1. Students will learn sterilization of air and medium; sterilization of fermenters, thermal death kinetics of microorganisms.
2. The course will develop knowledge o)1 enzyme kinetics with one or two substrates. mod ulation and regu lation of enzyme activity, enzyme reactions in heterogeneous systems, immobilized enzyme technology, and industiial application of enzymes.
3. This course will help students to acquire basic knowledge of microbial fermentation kinetics. biorcactors bioprocess system and commercial production of bioproduct

Credits – 4	**Max. Marks : 100**	**Min. Passing Marks:33**

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

Unit	**Topic**	**No of Lectures**
UNIT-I	Biochemical engi neering principals. range of fermentation process: microbial biomass, microbi al enzyme, microbial metabolites recombinant products transformation process. Chronological developme nt of fermentation indust ly, componentpare of the fermentation process	
UNIT-II	Microbial fermentation kinetics: growth cycle, phase for batch cultivation, kinetics of garden type I and II fermentation system, determination of kinetics parameter using batch reactor with and without inhibition. thermal death kinetics	
UNIT-III	Transport phenomena in bioprocess: Mixing and agitation, mechanical and non-mechanical agitation and oxygen - substrate mass transfer equipment, heat transfer energy balanced and transfer correl n tion. sterilization centrifugation filtration and drying	

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UNIT IV	Introduction of bio reactors: Batch, CSTR and plug flow bioreactors performance equation, fermenter design, elementary treatmem of non-ideal bioreactors - TD function and their application	
UNIT-V	Dynamic modeling of batch and CSTR type bioreacrors dimensional analysis and scale up fermentation econom ics	

Suggested Readings:

1. **Principles of Fermentation Technology** (Paperback) | **Released:** 15 Sep 2016 **By:** Peter Stanbury (Author) , Allan Whitaker (Author) , Peter F Stanbury (Author) , Stephen J Hall (Author) , Peter F (Visiting Lecturer at University of Hertfordshire) Stanbury (Author) | Publisher: Butterworth-Heinemann | Publisher Imprint: Butterworth-Heinemann
2. Biochemical Engineering Fundamentals. Bailey and Ollis

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B110907 T		Course Title	Pharmacology and Toxicology (Elective)	

Course Outcome-

1. Demonstrate the principles of pharmacodynamic s and pharmacokinetics
2. Discuss drug dosage, exposure and target specificity
3. Demonstrate the basic principles of toxicology
4. illustrate toxicity risk assessment and fate of toxicants in humans
5. Demonstrate the experimental approach for analyzing drug action
6. Evaluate acute and chronic toxicity of environmental chemicals
7. Develop competence in handling drug and toxic materials
8. Integrate theoretical and practical knowledge acquired in pharmacology and toxicology for advanced studies

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	General Pharmacology: Introduction to Pharmacology, Sources of Drugs, Dosage forms, Routes of Drug administration, Pharmacokinetics (ADME), Pharmacodynamics- (Receptors-Classification of receptors), Combined effect of drugs, Factors modifying drug action, Drug interactions, Overview of drug discovery and development.	
UNIT-II	Drug metabolism and basic understanding metabolic pathways renal excretion of drugs, factors affecting renal excretion of drugs. renal clearance. Nonrenal routes of drug excretion of drugs. Bioavailability and Bioequivalence: Definition and Objectives of bioavailability, absolute and relati ve bioavailab ility, measurement of bioavailability, in-vitro drug dissolution models, in-vitro-in-vivo correlni on s, bioeq u ivalence studies. methods to enhance the dissolution rates and bioavailabili ty of poorly soluble drugs	
UNIT-III	Pharmacology of Central nervous System: General anestherics, sedatives, hypnotics, Analgesics and antiinflammatory agents, Anti-Anxiety. Pharmacology of Peripheral Nervous System: Local Anaesthet ics, Skeletal Muscle Relaxant . Pharmacoiogy of Gastroinest i nal tract system: Antacids, anti-ulcer drugs. Laxative and Antidi:uThocal drugs. Emetics and anti-emetics. Pharmacolog y of Urinary System: Diuretics and Anti-diuretics	
UNIT IV	Chemotherapy: Genera! plinciples 0f chemothernpy, Antibiotics – Penicillins, Chloramphen icol . Chemotherapy of malignancy. Pharmacology of Cardiac Vascu lar System: Cardiac glycosideg and drugs for heart failure. Antihypcrtensive drugs. Pharmacology of Respiratory system: Anti-asthmatic drug including bronchodilators, Anti-tussives and expectorants. Pharmcology of Endocrine System: Insu lin. oral hypoglycaemic agents & glucagon	

UNIT-V	Toxicology: a). Principles of toxicology. actute. sub-acute and chronic toxicity, Types of toxic reaction, Definition of poison, general principles of treatment of poisoning. Heavy metals poisoning incidence of acute poisoning, prevention and treatment of poisoning. b). Abnormal action of drugs such as tolerance, addiction, habituation, i<liosyncracy, allergy, hypersensitivity, antagonism, synergism, potentiation, tachyphylax is. Adverse drug reactions	

Suggested Readings:

1. Satoskar, RS, Bhandarkar, SD., and Regc, NN., — Phamacology and Pharmacotherapeuticsl Popular Prakashan (P) Ltd 2006.
2. Tripathi, KO. -Essentials of Medical Pharmacology!4th Edition. Jaypce Brothers Mediral Publishers (P) Ltd 1000.
3. Hardman, JG and Limbrid, LE -Goodman and Gilmanls: The Pharmacological Basis of Therapeutics 10th edition, Medical Publishing Division, 2001.
4. Murugesh. N,-Aconcise textbook of Pharmacology!, fifth edition, Prabhu offset printers.
5. Das, MM, Pharmacology for second professional students 5th edition, Books and allied (P) Ltd 2004.
6. Lawrence, DR, Bennett,PN, and Brown MJ., Clinical Pharmacologyl 8th Edition, Churchil

Programme / Class	**Honours**	**Year**	**M.Sc. 2nd year**	**Semester**	**IX**
Subject			**Biochemistry**		
Course Code		**B110908P**	**Course Title**	**Practical**	
Course Outcome- 1.					
Credits – 4		**Max. Marks : 100**		**Min. Passing Marks:33**	
Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0					
Unit	**Topic**				**No of Lectures**
UNIT-I	1. Total leukocytes count 2. Different ial leukocyte count 3. Haemagglutination assay 4. Separation of serum from blood 5. Doubleimmunodiffusion test and dot immunoblot assay 6. Estimation of chlorophyll				**60**

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Ninth
Subject: Biochemistry		
Course Code: B110909R	**Course Title: Research Project/ Dissertation/ Internship/ Field or Survey Work**	

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B110904 T		Course Title	Bioinformatics and Biostatistics (Elective)	

Course Outcome-

1. Develop learning and experience on computers, and biostatistics in students for their future personal and professional development.
2. Construct knowledge about the various applications of softwares and statistics to the students
3. Solve mathematical and statistical problems with fellow class mates as well as individually.
4. To understand the alignment between two sequences.
5. To learn different bioinformatics tool and techniques and gain knowledge of their use in different scientific problems.
6. To demonstrate the role of computer in genomics and proteomics.

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	Basics of bioinformatics. Origin and Overview of bioinformatics- Application of bioinformatics - ·National and International bioinformatics Insritutes and Indnstries - Research in bioinformatics -Define-Homologs, Orthologs, Paralogs and Xenologs - various OMES and OMICS. Role of computers in biology (biocomputi ng), Basics of computer& -block diagram of computer, input and output devices, storage devices, operating systems – DOS. Windows, Linux. Basics of networking and their types, topologies, INTERNET: TCPfIP, World Wide Web, e-mai	
UNIT-II	Biological databases.biological data file formats: *. FASTA. *.PIR, *.GOE. *.PDB. Alignment files (".AL!\) etc. access bliographic resources and li terature daiabases: PubMed. PMC and Public library of Sciences (PLoS) - Sequences Databases: GenBabk, DDBJ, EMBL, PIR and Swiss-Port- Pattern and Motif Searches: PROSITE, BLOCKS, PRINTS, PFAM- Structure: PDB and IVTDB Structural classification databases: SCOP, CATH- Metabolic pathways and enzymatic database: KEGG. MetaCyc, BRE!TDA. Microbiology DATABASES: ICTV, Animal Virus Information System (AVJS)	
UNIT-III	Sequence analysis -Pair wise Sequence Alignment: Needleman wunsch, Smith Watermann algori thms, Sequence similarity search program'> – BLAST and PASTA. Substitution matrices: PAM. BLOSSVM. Mul tiple sequence alignments: Center Stai method. Clustal. PR.AS. Phylogenetic analysis: Character based (Parsimony) and distance-based mt:thods (UPGMA, neighbor joining), Protein strucrure prediction: Homology modeling, Primer Designing. Multi dimentional protein identification technology – identification using database. Phylogenic analysis: Sequence – based taxonomy – From Multiple Alignment to Phylogeny – methods for Construction & representation 0f phy logenetic tree using MEGA software	
UNIT IV	Genomics and proreomics. Genome Database: GOLD -Gene finders: GLIMMER and GENSCA N -Genome projects: Human. Features of proteir. sequence :ind strucrure – Proteornics tools in Expasy Server- Protein secondary structure prediction: GOR and SOPMA – Teniary structure prediction: Homology modeling – protein structure Visualization tools: RasMol Viewer, UCSF-CHIMERA. Advancement of bioinformatics: Overview- Systems biology- E. Coil. Chemoinformatics-drug database: ZINC. PubChem. DR UG BANK-Protein engineering- CUPSAT, SOB	
UNIT-V	Biostatistics: Measures of cemral tendency – mean (arithmetic, harmonic & geometric) median and mode; Measures of dispersion- range, quartile deviation, mean deviation and standard deviation. Coefficient of variation. Correlation	

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	analysis: positive and negati ve correlation, Karl Pearson's coefficient of correlation. Spearman's rank correlation. Regression analysis: regression line Y on X and X on Y, angle bet\\een two regression lines. Test of significance: null and alternative hypothesis, level of signifi cance, Z-test, Studen t's 't'-test, Chi-square test for goodness of fit and independence of attribu tes	

Course outcomes:

1. List the objectives and state the hypothesis of the research project.
2. Outline the methodology that will be followed to achieve the listed objectives.
3. Employ the finalised methodology to solve the problem which has been undertaken.
4. Analyse the data which has been generated by carrying out several experiments.
5. Evaluate the data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results.
6. Organize the inferences to prove the hypothesis.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

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

S. No.	Objectives	Total No. of Lectures/ Hours (60)
	This course objective is to impart competent skills to thrive in research institutions and industries	

Note:

1. Project work will involve experimental work.
2. Students are required to do an individual research project.
3. Students are required to submit a report for assessment and need to demonstrate the working of research findings.
4. Students will be asked their choice for Project work at the end of ninth semester and all formalities of topic and mentor selection will be completed by this time.
5. The IPR rights of all such work lie with the University only.

Syllabus for M.Sc.2 /Sem X /Paper-First

Suggested Readings:

Environmental Biology by Odum
Ecology by P.D. Sharma
Environmental biochemistry by Victor Perry

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B1101002T		Course Title	Industrial Biochemistry (Elective)	

Course Outcome-

1. The course will enhance learning and understanding of the fundamentals of microbiology like important characteristics and biology of bacteria, fungi, mycoplasma, viruses etc.
2. This course will help students to acquire basic knowledge of fermentation process and industrial application of microbes for the production various useful products.
3. Learn different .immobilization techniques and Industrial and clinical scope of enzymes.
4. Develop understanding of state-ofthe-a.rt technique/instruments used in various reputed research institutions. and industlic

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	Basics of biochemical engineering: material and energy balances, heat transfer. mass transfer, mass transfer correlations with oxygen transfer, fluid flow, non-Newtonian fluids. Bedouin's principle, viscosity. hydraulic conductivity. capillary flow, conuol and applications of industri al processes. Flux and metabolic cont rol analysis, stoichi ometric analysis, strntegies for manipulating carbon fluxes in intermediary metabolism Fermenters, general design of bioreactor, fermentation processes; type of cult ure- Batch, Plug.flow. Chemostat and Fed batch, Growth kinetics of batch and continuous culture	
UNIT-II	Over production of metabolites, downstream processing, gene dosage and its applications in industri al processes, large scale production of enzymes from trad itional sources and genetically engineered organisms, proteases, amylases. cellu lases, lipases, industrial scale production of lactic acid, alcohol, amino acids, antibiotics and secondary metabolites. Production of biopesticides, biofertilizers, biopreservat ives (Nisin). cheese, biopol ymers, (xanthan gum, PHB etc) and dyes	
UNIT-III	Intrinsic and extrinsic parameters affecting qual ity of Foods, food preservation, characteristi cs of radiations of in terest i n food preservation, pri nci ples underlying the destruction of microorganisms by irradiation, physical and chemical methods of food preservation, legal status of food preservation, al terations during food processing. Maillard reaction, non-enzymatic browning reaction and nutritional effects. fatty acids hydrogenation, lipid peroxidation and protein degradation	
UNIT IV	Pesticides and biopesticides in integrated pest management, physical, chemical and biological tratmcnt of waste water, bioremed iation of contaminated soils and waste lands	
UNIT-V	Development of new drug/molecules and elucidation of their mechan isms of	

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	actions; pharrnacoki netics and pharmacodynamics. Factors affecti ng- drug efficacy. drug resistance and biotransformation	

1. **Principles of Fermentation Technology** (Paperback) | Released: 15 Sep 2016 By: Peter Stanbury (Author) , Allan Whitaker (Author) , Peter F Stanbury (Author) , Stephen J Hall (Author) , Peter F (Visiting Lecturer at University of Hertfordshire) Stanbury (Author) | Publisher: Butterworth-Heinemann | Publisher Imprint: Butterworth-Heinemann
2. Biochemical Engineering Fundamentals. Bailey and Ollis

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	IX
Subject			Biochemistry		
Course Code	B1101003T		Course Title	Cell and Tissue Culture (Elective)	

Course Outcome-

1. 1. To know and understanding of the principles and applications of cell and tissue culture techniques.
2. To know and understand the cell culture problems and possibilities.
3. To understand advance basis of genetic engineering and transgenic biology.
4. To learn about definition, complexity, classification and overall analysis of plant genomics

Credits – 4	Max. Marks : 100	Min. Passing Marks:33

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

Unit	Topic	No of Lectures
UNIT-I	Plant tissue culture: historical perspectivr:; Culture Media: Preparation and Sterilization; nutrients and plant hormones; sterilization techniqu s; Cell and Tissue culture techniques; Introduction to d i fferent types of culture; Subculturing; Cell Induction and Mai ntenance. totipotency; organogenesis: Somatic embryogenesis: establ ishment of cultures ·callus culture, cell suspension culture	
UNIT-II	Tissue culture techniques - micropropagation: semicolonial variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation ; synthetic seed production; protoplast culture and somatic hybtidization - protoplast isolation: culture and usage: somatic hybridiz.ali on - methods and appl ications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production and uses	
UNIT-III	Genetic engineering: Agrobacte lium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer: disarmed Ti plasmid; Genetic transforma tion - Agrobacterium-mediated gene delivery: cointegrate and binary vectors and their utility; direct gene transfer - PEG-media ted, electroporation, particle bombardment and alternative methods: screenable and selectable markers	
UNIT IV	Characterization of transgen ics: chloroplast transformati on: marker-free methodologies: advanced methodologies - CIS genesis, intrageneric and genome editing; Secondary metabolites, production and uses	
UNIT-V	Overview of plant genomics - definition, complex.ity and classification; need for genomics level analysis: method s of anal yzing genome at various levels - DNA, RNA, protein, merabolites and phenotype: genome projects and bioi nforma tics resources for genome research	

Suggested Readings:

1.Cell and Tissue Culture by Bhojwani and Rajdan

2. Animal Culture by Freshney

Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	X
Subject			Biochemistry		
Course Code		B1101004P	Course Title	Presentation (Com pulsory) Summer internship/training/review/case study	
Programme / Class	Honours	Year	M.Sc. 2nd year	Semester	X
Subject			Biochemistry		
Course Code		B1101005R	Course Title	Research Project / Dissertation	
Credits – 4		Max. Marks : 100		Min. Passing Marks:33	
Total No. of Lectures - Tutorials - Practical (in hours per week) : 4-0-0					

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