Department of Higher Education
U.P. Government, Lucknow

National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities

Semester-wise Titles of the Papers in B.Sc (Biochemistry)

Year	Sem.	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/Field Work	2
	II	B110201T	Human Physiology and Clinical Biochemistry	Theory	4
		B110202P	Clinical Biochemistry Lab	Practical/Field Work	2
2.	III	B110301T	Tools and Techniques in Biochemistry	Theory	4
		B110302P	Biochemical Tools and Techniques Lab.	Practical	
	IV	B110401T	Enzymology andImmunology	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

Proposed Year wise Structure of UG Program in Biochemistry

Program/ Year	Sem.	Course code	Paper title	Credits	Teaching hours
1 **Certificate course in clinical biochemistry**	1	B110101T	Fundamentals of Biochemistry	4	60
		B110102P	Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	2	60
	2	B110201T	Human Physiology and Clinical Biochemistry	4	60
		B110202P	Clinical Biochemistry Lab	2	60
2 **Diploma in tools and techniques in biochemistry**	3	B110301T	Tools and Techniques in Biochemistry	4	60
		B110302P	Biochemical Tools and Techniques Lab	2	60
	4	B110401T	Enzymology and Immunology	4	60
		B110402P	Enzymes and Immunological Techniques Lab	2	60
3 **Degree in Bachelor of Science Biochemistry**	5	B110501T	Bioenergetics and Metabolism	4	60
		B110502T	Fundamentals of Microbiology	4	60
		B110503P	Microbial Techniques and Metabolism Lab	2	60
	6	B110601T	Cell, Molecular Biology and Genetic Engineering	4	60
		B110602T	Biostatistics, Bioinformatics and computer application in Biochemistry	4	60
		B110603P	Genetic Engineering and Bioinformatics Lab	2	60

Subject prerequisite

To study BIOCHEMISTRY at undergraduate, a student must have Chemistry,Biology and /or Biotechnology in Class 12.

Programme Objectives (POs)

1. The programme intends to developa strong theoretical and practical background in various domains of biochemistry.
2. The programme includesdetails of biomolecules, clinical biochemistry, tools and techniques, enzymes, immunology, cell biology,molecular biology, genetic engineering,biostatistics, and bioinformatics to make the living system more interesting human studies, which is the need of the hour.
3. The practical courses will equip the students with laboratory skills in biochemistry. Students will able to design and conduct experiments, as well as to analyze and interpret scientific data
4. The programme will provide students with the knowledge and skill base that would enable them to undertake further studies in biochemistry and related areas or in multidisciplinary areas that involve biochemistry and help develop a range of generic skills that are relevant in enhancing entrepreneurship skills among students
5. The students will be exposed to a wide range of careers that combine biology, plants, and medicine.

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 clinicalbiochemistry, 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 Bimoleculartesting.
PSO1	The students will have hands-on training on qualitative estimation of importantwhich will help them in getting employment inpathology labs and contribute to health care system.
PSO1	This Certificate courses will enable students to apply for technicalpositions 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 prepares them for independent execution of laboratory experiments using standard methods and techniques.
PSO 2	The objective of this course is to develop an understanding ofthe concepts of enzyme andenzyme kinetics.
PSO3	The students will develop anunderstanding of the basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines, and immunization. Thestudents 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
PSO5	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.

Degree in Bachelor of Science	
B.Sc III Programme Specific Outcomes (PSOs)	
PSO1	The student at the completion of the course will be able to have a detailed and conceptual understanding of molecular processes.
PSO2	The students will be able to understand and apply the principles andtechniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.
PSO3	The principles of genetic engineering, gene cloning and related technologies will enable students to play an important role in applications of biotechnology in various fields like agriculture, forensic sciences, industry and human health and make a career out of it. Students can have their own start-ups as well.
PSO4	The basic tools of bioinformatics will enable students to analyze largeamount of genomic data and its application to evolutionary biology. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
PSO5	**The Degree courses will enable students to go for higher studies like Masters and Ph.D in Biochemistry and Allied subjects.**

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:

- 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 offatty 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	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** • Structural features and classification, Physical properties, optical properties (Stereoisomerism) • Chemical properties of amino acids • Uncommon amino acids and their function. • 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** • Building blocks of lipids - fatty acids, glycerol, ceramide • Storage lipids - triacyl glycerol and waxes • Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols • 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** • Structure and active forms of water soluble and fatsoluble vitamins, • Deficiency diseases and symptoms, hypervitaminosis • 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
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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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: Second
Subject: Biochemistry		
Course Code: B110201 T	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

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

Programme/Class: DIPLOMA	Year: SECOND	Semester: THIRD
Subject: Biochemistry		
Course Code: B110301 T	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** • Chemical bonding – Ionic bond, covalent bond, hydrogen bond andVander-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** • Principle of centrifugation • Basic rules of sedimentation, sedimentation coefficient. • Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, • types of rotors. • Application of centrifugation, • 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

1. Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012,
2. Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 2006.
3. Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010
4. 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

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

Programme/Class: DIPLOMA	Year: SECOND	Semester: THIRD

Course Code: B110201 T	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+75 Min.	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:

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

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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: B110301 T	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
III	**Enzyme inhibition and Regulation** • Reversible inhibition (competitive, uncompetitive, non-competitive and mixed)	8

	• 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

	• Clinical manifestations • Immunosuppressive therapy and privileged sites	

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.

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 T **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

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: 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 ofThermodynamics • 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

Programme/Class: DIGREE	Year: THIRD	Semester: FIFTH
Course Code: B110503P T	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)

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

Programme/Class: DEGREE	Year: THIRD	Semester: SIXTH
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

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
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
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 T	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