School of Basic Sciences and Research

Department of Chemistry and Biochemistry

Program Structure: Three Year UP Higher Education for Biochemistry Discipline

AY: 2021-22 Onwards

1.1 Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

Mission of the University

1. **Transformative educational experience**
2. **Enrichment by educational initiatives that encourage global outlook**
3. **Develop research, support disruptive innovations and accelerate entrepreneurship**

Core Values

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

1.2 Vision and Mission of the School

Vision of the School

Achieving excellence in the realm of basic and appliedsciences to address the global challenges of evolving society

Mission of the School

1. **To equip the students with knowledge and skills in basic andapplied sciences**
2. **Capacity building through advanced training and academicflexibility.**
3. **To establish centre of excellence for ecologically and sociallyinnovative research.**
4. **To strengthen interinstitutional and industrial collaboration forskill development and global employability.**

1.3 Vision and Mission of Department of Chemistry and Biochemistry

Vision of Chemistry and Biochemistry Department

Strive to achieve excellence in teaching and research in the field of Chemistryand Biochemistry and to build human resource for solving contemporary problems.

Mission of Chemistry and Biochemistry Department

- **Providing distinctive and relevant education in Chemistry and Biochemistry to students.**
- **Motivating young minds through innovative teaching methods, to acquire theoretical knowledge and practical skills in different disciplines of chemistry and empowering them with problem solving skills.**
- **Nurturing innovation by carrying out world class research and scholarly work**
- **Promoting interdisciplinary research in collaboration with national/international laboratories/Institutions.**

1.4 Programme Educational Objectives (PEO)

PEO 1: Providing distinctive and relevant knɵwledge in Biochemistry to studentsthrough innovative teaching methods.

PEO 2: Motivating young minds to acquire theoretical knowledge and practical skills in diversified disciplines of Biochemistry and empowering them with problem solving skills through knowledge acquired.

PEO 3: Encouraging interdisciplinary research in collaboration with National/ International laboratories/institutes/research and technology organizations.

PEO 4: Inculcating scholarly research aptitude and innovative approach amongstudents.

PEO 5: Imparting ethical understanding about safe handling of chemicals and variousissues related to chemical/biochemical compounds and processes.

PEO 6: Applying Biochemistry as an integral approach to address environmental and societal issues.

PEO 7: Providing education to bridge the research gaps through various advanced toolsand techniques.

1.4.2 Program Outcomes (PO's)

PO1: Ability to gain knowledge of biochemical principles with a thorough understanding in biochemistry and its sub-disciplines such as biomolecules, cell biology, enzymology, genetics and molecular biology.

PO2: Capacity to identify problems and formulate appropriate strategy to find solutions by applying analytical and rational thinking.

PO3: Capability to combine the knowledge in Biochemistry with mathematics, physics and chemistry to solve problems of interdisciplinary nature.

PO4: Attainment of skill in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO5: Acquirement of expertise in understanding and appreciating the central role of biochemistry in our society and use this as a basis for ethical behaviour in issues facing chemists such as safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.

PO6: Ability to explain why biochemistry is an integral activity for addressing social and environmental problems.

PO7: Competency in using modern library search tools to locate and retrieve scientific information.

B. Program Structure

1. TITLE: Three Year UP Higher Education Program Structure for Biochemistry Discipline

2. DURATION OF THE COURSE: 3 Years

3. YEAR OF IMPLIMENTATION

This syllabus will be implemented for the session academic year 2021-22 onwards.

4. PREAMBLE

Total Credits- 150

Minimum credit required for multiple entry and exit:

Total credit of the 03 year UG Program for year wise multiple entry and exit	01st Year	46
	02nd Year	96
	03rd Year	146

Total Number of Semesters – 06 (Two semesters per year)

Total Number of Theory Papers – 28

Total Number of Practical courses – 20

Total Number of Minor Projects/Dissertations- 02

Number of papers (theory) per semester – 04-05

Number of Laboratory courses per semester – 02-04

Community Connect: 01

Internship: 01

Semester wise subjects							
No.	**Course Name**	**Subject**	**Theory/ Practical**	**Credit**		(Min.-Max. Total Credits) After completion {Minimum Credits} [Max Duration in years]
				Total	Min. - Max. of the semester/ year	
Year 01: Certificate in Biochemical Laboratory Techniques (CBLT)						
1.	**Semester1**	Biomolecules	Major I	Theory	04	23	(46-50) {46} [4] Certificate in Biochemical Laboratory Techniques (CBLT)
2.		Biological Science Lab	Major I	Practical	02	
3.		Fundamentals of Chemistry	Major II	Theory	04	
4.		Qualitative Analysis Lab	Major II	Practical	02	
5.		Principle of Physical Chemistry/ Foundation course in Mathematics	Major III	Theory	04	
6.		Physical Chemistry Lab / Mathematics Lab-1	Major III	Practical	02	
7.		Biochemical and analytical Trends in Biochemistry-I	Vocational	Practical	03	
8.		Food, Nutrition and Hygiene	Co-curricular	Theory	02	
Total credit					**23**		
1.	**Semester2**	Cell Biology	Major I	Theory	04	23-27	
2.		Cell Biology Lab	Major I	Practical	02		
3.		Basic Microbiology	Major II	Theory	04		
4.		Basic Microbiology Lab	Major II	Practical	02		
5.		Organic Chemistry-I/ Bioinstrumentation	Major III	Theory	04		
6.		Organic Chemistry Lab / Bioinstrumentation Lab	Major III	Practical	02		
7.		Statistics-I/Food Science/ Basics of Pharmaceuticals	Minor/ Elective	Theory	04		
8.		Biochemical and analytical Trends in Biochemistry-II	Vocational	Practical	03		
9.		Health and Hygiene	Co-curricular	Theory	02		
Total credit					**27**		
Year 02: Diploma in Enzymology and Molecular Biology (DEMB)							

1.	**Semester3**	Genetics	Major I	Theory	04	23-27	96-100 {96} [7] Diploma in Enzymology and Molecular Biology
2.		Genetics Lab	Major I	Practical	02		
3.		Molecular Biology-I	Major II	Theory	04		
4.		Molecular Biology Lab-I	Major II	Practical	02		
5.		Chemical Dynamics and Coordination Chemistry/Animal Biotechnology	Major III	Theory	04		
6.		Physical Analysis Lab/ Animal Biotechnology Lab	Major III	Practical	02		
7.		Statistics-I/Food Science/ Basics of Pharmaceuticals	Minor/ Elective	Theory	04		
8.		Biochemical and analytical Trends in Biochemistry-III	Vocational	Practical	03		
9.		Physical Education	Co-curricular	Theory	02		
Total credit					**27**		
1.	**Semester4**	Enzymology	Major I	Theory	04	23	
2.		Enzymology Lab	Major I	Practical	02		
3.		Molecular Biology-II	Major II	Theory	04		
4.		Molecular Biology Lab-II	Major II	Practical	02		
5.		Analytical Techniques / Chemistry in Action/ Bioinformatics	Major III	Theory	04		
6.		Instrumental Analysis/ Chemistry in Action Lab/ Bioinformatics lab	Major III	Practical	02		
7.		Biochemical and analytical Trends in Biochemistry-IV	Vocational	Practical	03		
8.		Human values and Environment Studies	Co-curricular	Theory	02		
Total credit					**23**		
Year 03: Degree in Bachelor of Science							
1.		Intermediary Metabolism	Major I	Theory	04	25	
2.		Immunology	Major I	Theory	04		
3.		Immunology Lab	Major I	Practical	02		
4.	**Semester5**	Research Project (will be undertaken as a part of internship after semester 4)	Industrial Training/ Survey/ Project	Project	01		
5.		Hormonal Biochemistry	Major II	Theory	04		

6.		Proteins	Major II	Theory	04		(146-150) {146) [10] Degree in Bachelor of Science
7.		Proteins Lab	Major II	Practical	02		
8.		Analytic Ability and Digital Awareness	Co-curricular	Theory	02		
9.		Community connect	Industrial Training/ Survey/ Project	Project	02		
Total credit					25		
1.	**Semester6**	Tools and techniques in Biochemistry	Major I	Theory	04	25	
2.		Recombinant DNA Technology	Major I	Theory	04		
3.		Recombinant DNA Technology Lab	Major I	Practical	02		
4.		Research Project	Industrial Training/ Survey/ Project	Project	03		
5.		Membrane Biochemistry and Bioenergetics	Major II	Theory	04		
6.		Cell signaling and Cancer Biology	Major II	Theory	04		
7.		Advance Biochemistry Lab	Major II	Practical	02		
8.		Communication Skills and Personality Development	Co-curricular	Theory	02		
Total credit					25		

Total credit of the 03 year UG Program: 150	01st Year	46-50	**Minimum credit required:** 146
	02nd Year	96-100	
	03rd Year	146-150	

Semester-3, Paper-1 (Theory)
Course Title: Genetics

Programme/Class: Diploma in Enzymology and Molecular Biology (DEMB)	**Year: Second**	**Semester: Third**
Paper-1 : Theory		Subject: **Biochemistry**
Course Code:	**Course Title: Genetics**	

Course outcomes:

CO1 : Understand not only mechanism behind both the Mendelian and non mendelian genetics but also the various application of genetics in the field of agriculture
CO2: Discuss the various abnormalities associated with the change in chromosome number and structure and to deduce some methods for rectification
CO3: Correlate the effect of gene mutation with environment and other external and spontaneous events
CO4: Understand the genetics in the bacteria and how gene from a dead bacteria finally forms a new bacteria
CO5: Explain how population plays a role in genetics an genetics are applied in the field of agriculture.
CO6: Apply the basic concepts of genetics in doing field related projects or lab based project

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

Total No. of Lectures = 60

Unit	**Topics**	**No. of Lectures**
I	**Mendelian Genetics** History of Genetics; Concept of Genes, Mendelian genetics, monohybrid and dihybrid cross, Mendelian genetics- different type epistasis, Multiple alleles, sickle cell anemia, hemophilia and other genetic disorder	16
II	**Chromosomal Theory of Inheritance** Chromosome Structure; Chromosomal anomalies- changes in chromosome number Non dysjunction mechanism and changes in chromosome structure Sex Chromosomes and sex linkage mechanism in drosophila	12
III	**Gene mutation** Gene fine structure and Molecular concept of gene, mutation and its type: Somatic and germinal mutation, spontaneous and induced mutation, Molecular basis of gene mutation	14
IV	**Microbial Genetics and Extranuclear Genome** Microbial genetics- conjugation, transformation, transduction Extra-nuclear inheritance in Higher plants; transposable element and its role in agriculture An overview of Mitochondrial genome and chloroplast genome	12

V	**Population Genetics** Effect of gene and allelic frequencies in a population (Hardy-Weinberg Principle and equation); Natural Selection: Stabilizing, disruptive and directive selection, Bottle neck effect and founder effect, balanced polymorphism	6

Suggested Readings:

1. Snustad D.P., and Simmons M.J., *Principles of Genetics*, 6th Edition. John Wiley & Sons (2011).
2. Griffiths A.J.F., Wessler S.R., Carroll S.B., and Doebley J., *Introduction to Genetic Analysis, 10th Edition.* W. H. Freeman (2010).
3. Genetics: A conceptual approach,4th edition by Benjamin A Pierce.

Reference Books

Genetics: A conceptual approach,4th edition by Benjamin A Pierce.

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities	**(**05 marks)

Course prerequisites: To study this course, a student must have had the (PCB/PCM) in class 12th Class

Semester-III, Paper-1 (Practical)

Course Title: Genetics Lab

Programme: Diploma in Enzymology and Molecular Biology (DEMB	Year: Second	Semester: III
Practical paper-I		Subject: **Biochemistry**
Course Code:	**Course Title: Genetics Lab**	

Course outcomes:

CO1: Prepare chemical solution and reagents to the precision appropriate to the task.
CO2: Accurately, safely and appropriately use all the equipment regularly used including balances, pipettes, electrophoresis and centrifuges.
CO3: understand the theoretical concepts dealt in classes/ workshops/ seminars with hands on experience
CO4: Able to understand the basic concept of genetics
CO5: Able to understand the concept of polymorphism, cell division
CO6: carry out, design, and interpret the results of the experiments.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:
Practical	**60 h**

Unit	Topics	No of Lectures
I	**Introduction to Genetics and karyotyping** Probability, Mendelian Genetics, chi-square and measurements, Chromosomal alterations and human disease Smear technique to observe Barr Body (sex chromatin) in the buccal epithelial cells of human females Investigation of Human Karyotypes	**15**
II	**Mitosis, Meiosis and monohydrob and dihydrid crosses** *Sordaria* recombination and genetic cross Fruit fly (*Drosphila*) genetics Lab 1	**12**
III	**Types of Polymorphism** Analysis of Variable Number of Tandem Repeat Polymorphism using gene specific primers A) Genomic DNA isolation Analysis of Polymorphism using Variable Number of Tandem Repeat specific primers in human genome B) Quantification by electrophoresis/ spectrophotometer (Absorbance at 260nm) Analysis of Polymorphism using Variable Number of Tandem Repeat specific primers in human genome C) Analysis of polymorphism using gene specific primers in PCR	**25**

IV	**Cell division stages** To study different stages of mitosis by temporary preparation in onion root tip. To study different stages of meiosis by using permanent slides	**08**
	Suggested Readings: 1. **Cell and Molecular Biology: Concepts and Experiments.** (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7 21 2 2. **The Cell: A Molecular Approach**: Geoffrey. M. Cooper and Robert. E. Hausman, Sinauer Associates, 5th Ed.2009. 3. **Molecular Cell Biology:** W. H. Freeman Lodish, 5th Ed. 2003. 4. **Molecular Biology of the cell:** Bruce Alberts, Garland Publishing, 5th Ed. 2008. 5. **Laboratory Manual for Practical Biochemistry**: Ganesh M. K. & Shivashankara A. R., Jaypee Publications, 2nd Ed. 2012. **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by theUniversity	
	This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class	

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

Course prerequisites: To study this course, a student must have had the PCB/PCM in 12th Class

Suggested equivalent online courses:
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Semester-3, Paper-2 (Theory)

Course Title: Molecular Biology –I

Programme: **Diploma in Enzymology and Molecular Biology (DEMB)**	Year: Second	Semester: III

Practical paper-II	Subject: Biochemistry
Course Code:	**Course Title: Molecular Biology-I**

Course outcomes:

CO1: Converts into ss-DNA, vice versa and what factors affect these function.

CO2: differentiate organization of genes among viruses, bacteria, animals and plants, understand how histones protein are associated with DNA and its packing.

CO3: know understand the basic chemical structure of DNA, how ds-DNA DNA polymerase requires a template and primers to synthesize DNA and that double-stranded DNA is replicated semi-discontinuously by experiment proof explain how DNA topology and chromatin structure affects

CO4: explain how DNA topology and chromatin structure affects the processes of DNA replication, repair, and transcription.

CO5: discuss mechanisms by which DNA can be damaged and describe the molecular mechanisms by which protein complexes repair or bypass different forms of DNA damage.

CO6: interpret how DNA is organized in different species, function of different proteins/enzymes responsible for DNA replication and factors associated with DNA repair

Credits:3	Electives
Max. Marks: **25+75=100**	**Min. Passing Marks:**
Practical	**60 h**

Unit	Topics	No. of Lectures
I	**Structure of DNA** DNA structure, features of the double helix, Various forms of DNA, Denaturation and reassociation of DNA.	10
II	**Genes and genomic organization** Genome sequence and chromosome diversity, Definition of a gene, organization of genes in viruses, bacteria, animals and plants, Nucleosome structure and packaging of DNA into higher order structures	10
III	**Replication of DNA** DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, Stages of replication of *E. coli* chromosome, replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes, Inhibitors of DNA replication and applications in medicine, topoisomerase inhibitors and their application in medicine	12

IV	**Recombination of DNA and Molecular basis of mutations** Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases, Biological roles of site-specific recombination. Importance of mutations in evolution of species, Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test	15
V	**Various modes of DNA repair** Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, translation, DNA synthesis	12

Suggested Readings:

1. Principle of Biochemistry by Nelson and Cox, fourth edition.
2. Fundamentals of Biochemistry by Voet and Voet, Third edition.
3. Biochemistry Stryer, Fifth Edition.
4. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia.
5. Harper's Biochemistry

This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class

Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class oron-line tests, home assignments, group discussions or oral presentations, among others

Assessment and presentation of Assignment/ Research Orientation assignment	10 marks
04 tests (Objective): Max marks of each test = 10(average of all 04 tests)	10 marks
Overall performance throughout the semester, Discipline, participation in different activities	05 marks

Course prerequisites: To study this course, a student must have had the PCB/PCM in 12th Class

Suggested equivalent online courses

Further Suggestions:

Semester-III, Paper-2 (Practical)

Course Title: Molecular Biology Lab

Programme: Diploma in Enzymology and Molecular Biology (DEMB)	Year: Second	Semester: III
Practical paper-2		Subject: **Biochemistry**
Course Code:	**Course Title: Molecular Biology I Lab**	

Course outcomes:

CO1: chemical solution and reagents to the precision appropriate to the task.
CO2: Accurately, safely and appropriately use all the equipment regularly used in DNA manipulation, including balances, pipettes, electrophoresis and centrifuges.
CO3: Demonstrate knowledge of the biochemical basis underpinning the molecular biology techniques teach in the class/ workshop.
CO4: Independently handle RNA extraction, reverse transcription, polymerase chain reaction, ligation, bacterial transformation, to DNA extraction, DNA mapping and primer design.
CO5: Transformation of plasmids, extract protein, assess and quantify expression using Western blotting.
CO6 : Carry out molecular biology experiments and interpret the results, designing a strategy to circumvent potential failed experiments.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical **60 h**

Unit	Topics	No of Lectures
I	**Basics of molecular biology lab** To familiarize with how cells are made competent: Preparation of calcium competent *Escherichia coli.* To perform heat-shock transformation method of gene transfer	**12**
II	**Extraction of DNA** To extract and purify plasmid DNA using alkaline lysis method To determine the presence of plasmid DNA and quantify the size (length of the DNA molecule) of the product by an agarose gel electrophoresis	**08**
III	**Designing of primer** To design primer for amplifying gene by polymerase chain reaction To amplify gene *in vitro* by polymerase chain reaction (PCR).	**20**

IV	**Molecular biology techniques** To perform electro-blotting of proteins from SDS-polyacrylamide gel. To determine the antigens qualitatively by immunoblotting (western blotting) Techniques To determine the concentration of a given DNA sample using diphenylamine method	**08**
	Suggested Readings: 1. **Cell and Molecular Biology: Concepts and Experiments.** (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7 21 2 2. **The Cell: A Molecular Approach**: Geoffrey. M. Cooper and Robert. E. Hausman, Sinauer Associates, 5th Ed.2009. **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by theUniversity	
	This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class	

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)
Course prerequisites: To study this course, a student must have had the PCB/PCM in 12thClass	
Suggested equivalent online courses: ……..	
Further Suggestions: ……..	

Semester-4, Paper-1 (Theory)

Course Title: Enzymology

Programme: Diploma in Enzymology and Molecular Biology (DEMB)	Year: Second	Semester: III

Theory paper-1	Subject: Biochemistry
Course Code:	**Course Title: Biochemical and bioanalytical Trends in Biochemistry**-I

Course outcomes:

CO1: Understand the mechanism of action of enzyme

CO2: Understand the various enzyme kinetics and will be able to correlate the Vmax, Km in the Michalis Menton equation

CO3: Correlate the isolation technique of plant cell from that of animal and microbial cells

CO4: Explain the regulation strategies of allosteric enzyme and the mechanism of various inhibition process

CO5:Elaborate the various application of enzyme in different fields

CO6: Apply the overall concepts of enzymology in different field of biochemistry

Credits:3	Electives
Max. Marks: 25+75=100	**Min. Passing Marks:**
Practical	**60 h**

Unit	Topics	No. of Lectures
I	**Enzyme Classification** Classification; Nomenclature and EC number of enzymes, Co-enzyme and Co-factors; NAD/NADH, FAD/FADH2, pyridoxal phosphate, thymine pyrophosphate, Isoenzymes-Lactate dehydrogenase and alkaline phosphatase, Allosteric enzymes: positive and negative regulation	10
II	**Enzyme Kinetics** Enzyme substrate complex and mechanism of enzyme action: Lock and key hypothesis, induced fit theory and acid base catalysis, Factors affecting rates of enzymatic reactions (pH, temperature, substrate concentration, Overview of Michaelis-Menten equation and Line Weaver Burk equation	10
III	**Enzyme Kinetics** Irreversible inhibition with examples, reversible inhibition with examples, Competitive, non-competitive and un-competitive inhibition, Methanol poisoning, transpeptidase inhibition and nerve gas, catalytic antibody	12
IV	**Isolation and Localization of Enzymes** Isolation of enzymes from various sources, Homogenization and centrifugation technique, Purification of enzymes: Ammonium sulphate precipitation, dialysis, Gel filtration chromatography, ion exchange chromatography, affinity chromatography	15

V	**Industrial Applications of enzyme** Applications of enzyme in beverage industry and leather industry, Food processing industry and dairy industry, Pharmaceutical industry, medicine/drug, health and biosensor industry	12

Suggested Readings:

1. Principle of Biochemistry by Nelson and Cox, fourth edition.
2. Fundamentals of Biochemistry by Voet and Voet, Third edition.
3. Biochemistry ByLubertStryer, Fifth Edition.
4. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia.
5. Harper's Biochemistry

This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class

Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class oron-line tests, home assignments, group discussions or oral presentations, among others

Assessment and presentation of Assignment/ Research Orientation assignment	10 marks
04 tests (Objective): Max marks of each test = 10(average of all 04 tests)	10 marks
Overall performance throughout the semester, Discipline, participation in different activities	05 marks

Course prerequisites: To study this course, a student must have had the PCB/PCM in 12th Class

Suggested equivalent online courses

Further Suggestions:

Semester-IV, Paper-I (Practical)

Course Title: Enzymology Lab

Programme: Diploma in Enzymology and Molecular Biology (DEMB)	Year: Second	Semester: IV
Practical paper-1		Subject: **Biochemistry**
Course Code:	**Course Title: Cell Biology Lab**	

Course outcomes:

On successful completion of the course, the student shall be able to:

CO1: Determine the various ways of calculating enzyme activity of alkaline phosphatase, alpha and beta amylase, catalase and cholesterol oxidase

CO2: Draw standard calibration curve of known concentration Vs Absorbance and from that they can determine the product released from the graph

CO3: Find the optimum temperature and p H at which the enzyme activity is maximum

CO4:Able to draw and interpret the Michaelis Menton hyperbolic curve and know the importance of pseudo order kinetics

CO5: Explain the effect of different concentration of substrates on the enzyme activity of various enzymes

CO6: Students will be able to apply and create research and review article based on the above learning

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical		**60 h**
Unit	**Topics**	**No of Lectures**
I	**Basics of enzymology** To determine the salivary amylase activity of person using non spectrophotometric method	**5**
II	**Isolation of enyzmes** To isolate crude form of the beta amylase enzyme from sprouted seeds using mechanical treatment method To extract crude form of papain from Papaya fruit and determine its enzyme activity To study the time course of reaction catalyzed by alkaline phosphatase(EC 3.1.3.1)	**15**
III	**Determination of enzyme activity** To determine the maltose released by the crude beta amylase enzyme isolated from germinated seeds using spectrophotometric method To determine the lambda maximum of the salicylic acid in the given mixture of enzmatic solution. To determine the effect of p H on the activity of alkaline phosphatase	**20**

IV	**Effect of various factor in enzyme activity** To determine the effect of starch (Substrate) concentration on the activity and velocity of alpha amylase To determine the amount of cholesterol in the serum using enzymatic method To determine the activity of the enzyme catalase in a solution and observe the effects of heat and cyanide inhibitor upon this activity	**20**
	Suggested Readings: 6. **Cell and Molecular Biology: Concepts and Experiments.** (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7 21 2 7. **The Cell: A Molecular Approach**: Geoffrey. M. Cooper and Robert. E. Hausman, Sinauer Associates, 5th Ed.2009. 8. **Molecular Cell Biology:** W. H. Freeman Lodish, 5th Ed. 2003. 9. **Molecular Biology of the cell:** Bruce Alberts, Garland Publishing, 5th Ed. 2008. 10. **Laboratory Manual for Practical Biochemistry**: Ganesh M. K. & Shivashankara A. R., Jaypee Publications, 2nd Ed. 2012. **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by theUniversity	
	This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class	

Semester-4, Paper-1 (Theory)

Course Title: Molecular Biology-II

Programme: **Diploma in Enzymology and Molecular Biology (DEMB)**	Year: Second	Semester: IV

Theory paper-	Subject: Biochemistry
Course Code:	**Course Title: Molecular Biology-II**

Course outcomes:

CO1: understand that the genetic code is based on codons that are read sequentially, and that each codon represents one amino acid or a stop signal and that the genetic code is degenerate,nonrandom, and nearly universal, discuss RNA polymerase has a structure and mechanism similar to those of DNA polymerases and that bacterial transcription begins with the RNAP holoenzyme binding to a promoter to melt apart the DNA and differentiate RNA synthesis between prokaryotes and eukaryotes.

CO2: know that initiation factors help to assemble the ribosomal subunits, deliver the initiator tRNA, and in eukaryotes, locate the initiation codon and that the ribosome selects the correct aminoacyl–tRNA, catalyzes the transpeptidation reaction, and then translocates along the mRNA during the elongation phase of protein synthesis also that a release factor and ribosome recycling factor participate in terminating polypeptide synthesis.

CO3: know that eukaryotic mRNAs are modified by a 5' cap and a 3' poly(A) tail, that eukaryotic genes include introns that must be spliced out by the action of snRNPs in the spliceosome.

CO4: know that a single gene can generate several protein products through alternative mRNA splicing and that prokaryotic and eukaryotic rRNA and tRNA precursors are variously processed by endonucleolytic cleavage, covalent modification, splicing, and nucleotide addition, understand how proteins are degraded by proteosomal machinery, and also by another pathway

CO5: differentiate gene expression between prokaryotes and eukaryotes and importance of gene regulation. understand the phenomenon of transcription, how RNA i

CO6: understand the phenomenon of transcription, how RNA is involved in protein synthesis , importance of protein targeting and its modification.

Credits:3	Electives
Max. Marks: 25+75=100	**Min. Passing Marks:**
Practical	**60 h**

Unit	Topics	No. of Lectures
I	**Biosynthesis of RNA in prokaryotes** RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, Three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination, Inhibitors of transcription.	10
II	**Biosynthesis of RNA in eukaryotes** Comparison between prokaryotic and eukaryotic transcription, Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, transcription by RNA polymerase I and III, Inhibitors of eukaryotic transcription and their applications. Various types of RNA processing	10

III	**RNA splicing** Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling, RNA editing	12
IV	**Biosynthesis of proteins , protein targeting and degradation** Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation, Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis, Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for protein degradation.	15
V	**Regulation of gene expression in Prokaryotes and Eukaryotes** Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon, Heterochromatin, euchromatin, chromatin remodeling, regulation by phosphorylation of nuclear transcription factors, regulatory RNAs , RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors	12

Suggested Readings:

1. Principle of Biochemistry by Nelson and Cox, fourth edition.
2. Fundamentals of Biochemistry by Voet and Voet, Third edition.
3. Biochemistry ByLubertStryer, Fifth Edition.
4. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia
5. Harper's Biochemistry
6.Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A.et.al

This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class

Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class oron-line tests, home assignments, group discussions or oral presentations, among others

Assessment and presentation of Assignment/ Research Orientation assignment	10 marks
04 tests (Objective): Max marks of each test = 10(average of all 04 tests	10 marks
Overall performance throughout the semester, Discipline, participation in different activities	15 marks

Course prerequisites: To study this course, a student must have had the PCB/PCM in 12th Class

Suggested equivalent online courses

Further Suggestions:

Programme: Diploma in Enzymology and Molecular Biology (DEMB)	Year: Second	Semester: IV
Practical paper-2		Subject: **Biochemistry**
Course Code:	**Course Title: Molecular Biology I Lab**	

Course outcomes:

CO1: chemical solution and reagents to the precision appropriate to the task.
CO2: Accurately, safely and appropriately use all the equipment regularly used in DNA manipulation, including balances, pipettes, electrophoresis and centrifuges.
CO3: Demonstrate knowledge of the biochemical basis underpinning the molecular biology techniques teach in the class/ workshop.
CO4: Independently handle RNA extraction, reverse transcription, polymerase chain reaction, ligation, bacterial transformation, to DNA extraction, DNA mapping and primer design.
CO5: Transformation of plasmids, extract protein, assess and quantify expression using Western blotting.
CO6 : Carry out molecular biology experiments and interpret the results, designing a strategy to circumvent potential failed experiments.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical **60 h**

Unit	Topics	No of Lectures
I	**Basics of molecular biology lab** To familiarize with how cells are made competent: Preparation of calcium competent *Escherichia coli.* To perform heat-shock transformation method of gene transfer	**12**
II	**Extraction of DNA** To extract and purify plasmid DNA using alkaline lysis method To determine the presence of plasmid DNA and quantify the size (length of the DNA molecule) of the product by an agarose gel electrophoresis	**08**
III	**Designing of primer** To design primer for amplifying gene by polymerase chain reaction To amplify gene *in vitro* by polymerase chain reaction (PCR).	**20**
IV	**Molecular biology techniques** To perform electro-blotting of proteins from SDS-polyacrylamide gel. To determine the antigens qualitatively by immunoblotting (western blotting)	**08**

	Techniques To determine the concentration of a given DNA sample using diphenylamine method	
	Suggested Readings: 3. **Cell and Molecular Biology: Concepts and Experiments.** (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7 21 2 4. **The Cell: A Molecular Approach**: Geoffrey. M. Cooper and Robert. E. Hausman, Sinauer Associates, 5th Ed.2009. **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by theUniversity	
	This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class	

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)
Course prerequisites: To study this course, a student must have had the PCB/PCM in 12th Class	
Suggested equivalent online courses: ……..	
Further Suggestions: ……..	

Semester-V
Paper-1 (Theory)
Course Title: Intermediary Metabolism

Programme: Degree in Bachelor of Science	**Year:** Third	**Semester:** Vth
Paper-1: Theory		**Subject:** Biochemistry
Course Code: BBY 301	**Course Title:** Intermediary Metabolism	

Course outcomes:

This module is an overall in-depth concepts of biochemistry which goals to deliver students with an understanding of metabolism of the body and functions of biomolecules which includes carbohydrates, lipids, amino acids and nucleotide's. On the successful completion of the course, student will be able to:

CO1: Describe the energy generated from the carbohydrate metabolism.

CO2: Understand the energy generated from the carbohydrate metabolism.

CO3: Acquire the knowledge of energy production in living systems by the degradation of fatty acids.

CO4: Deliberate breakdown and synthesis of amino acids in humans and recognize its relevance with respect to nutrition and human diseases and describe how amino acids are converted into a variety of precursors.

CO5: Define biosynthesis and degradation of nucleotides in humans and be familiar with its consequence with respect to humans.

CO6: Understand the importance of all macromolecules and their impact on human beings.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Carbohydrate Metabolism-I :** Carbohydrate metabolism: Detailed account of glycolysis with energy considerations & regulation, Entry of fructose, mannose & galactose in glycolysis, Cori cycle, Futile or substrate cycles in carbohydrate metabolism, Glycogenolysis, Glycogenesis and hormonal control. Glycogen storage diseases, Formation of acetyl CoA & detailed account of TCA Cycle, Regulation, Amphibolic and anaplerotic nature of TCA cycle.	12

II	**Carbohydrate metabolism-II :** Glyoxylate cycle and its role in conversion of fats into carbohydrates, Gluconeogenesis– Detailed account of bypass reactions, Regulation, Malate & glycerophosphate shuttle system, Electron Transport chain-Structure of mitochondria, oxidative and substrate level phosphorylation, Electron carriers of ETC, Incomplete reduction of oxygen (Cell injury – superoxide radicle), ATP Synthase (F1 F0 ATPase), Chemiosmotic hypothesis, Sites of ATP synthesis, Specific inhibitors and uncouplers of oxidative phosphorylation.	12
III	**Lipid metabolism:** Hydrolysis of triacylglycerols, transport of fatty acids into mitochondria (Carnitine), Detailed account of - oxidation of fatty acids (β-oxidation in mitochondria and peroxisomes), Oxidation of unsaturated fatty acids & odd carbon fatty acids. Oxidation Brief idea. ATP yield from fatty acid oxidation. Regulation, Detailed account of HMP Shunt & its significance in general, its connection to lipid metabolism**.**	10
IV	**Amino Acids metabolism:** Digestion, absorption and uptake of Amino Acids including γglutamyl cycle; Transamination, oxidative and nonoxidative deamination, glucose-alanine cycle, urea cycle and inherited defects of urea cycle, Glucogenic and ketogenic amino acids, catabolic pathways for the standard amino acids; Metabolism of one-carbon units, Biosynthesis of non-essential amino acids; biosynthesis of Essential amino acids (Only overview-in plants) and their regulation. Disorders of amino acid metabolism: Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Methylmalonic aciduria, Parkinson's disease, Homocystinuria, and Hartnup's disease.	12
V	**Biosynthesis of purine nucleotides:** Biosynthesis of IMP; pathways from IMP to AMP and GMP; conversion to triphosphates; regulation of purine nucleotide biosynthesis, salvage Pathways **Matabolic pathway of pyrimidine nucleotides**: Biosynthesis of UMP, conversion of triphosphate and regulation of Biosynthesis of pyrimidine nucleotide synthesis; Deoxy ribonucleotides and synthesis of dTTP; inhibitors of nucleotide metabolism and their use as anti-bacterial / anticancer drugs. Degradation of purine and pyrimidine nucleotides. Disorders of nucleotide metabolism: Lesch Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency.	14

Recommended Books

1. Harper's Biochemistry: Murray, Granner, Mayes, Rodwell , Prentice Hall International Inc. 28th Ed. 2009.
2. Lehninger Principles of Biochemistry: D. L. Nelson, Michael M. Cox, International Edition, CBS publishers, 4th
3. Ed. 2004.
4. Biochemistry: Stryer: W. H. Freeman & Co., Scintific Research an Academic Publisher, New York. 4th Ed. 1995.
5. Biochemistry: Geoffrey L. Zubay, McGraw Hill. 1997.
6. Biochemistry: J. David Rawn, Neil Patterson publs. NC. 1989.
7. Textbook of Biochemistry: West, Todd, Mason, Bruggen – Amerind Publishing Co. Pvt. Ltd. 4th Ed. 1986.
8. Biochemistry: U Satyanarayana, U. Chakrapani, Elsevier, 4th Ed. 2013.
9. Biochemistry- U Satyanarayana, U. Chakrapani, Elsevier, 4th edition. (2013). **Note**: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the (PCB/PCM) in class 12th Class

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Semester-V, Paper-2 (Theory)

Course Title: Immunology

Programme: Degree in Bachelor of Science	**Year:** Third	**Semester:** Vth
Paper-1: Theory		**Subject**: Biochemistry
Course Code: BBY302	**Course Title:** Immunology	

Course outcomes:

This module is a general introduction to the basic concepts of immunity of the body and how it works. The module also gives insight to importance of immunity.

CO1: Describe cells and organs of the immune system.
CO2: Explain innate immunity, cell adhesion molecules, cytokines and complement system.
CO3: Define the structure of antibody, B-cell development, receptor diversity and humoral immune response.
CO4: Execute knowledge about significance of the T-cell biology and MHC restriction
CO5: Acquire the insight into mucosal immune system.
CO6: Understand the importance, organization, diversity and basic functions of an immune systems and various cells to apply the basic concepts to enhance their research skills.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Cells and organs of the immune system**, : hematopoiesis, HSC, Hematopoiesis and the role of Stromal cells in blood cell formation, structure and function of primary and secondary lymphoid tissues and organs; lymphatic circulation	12

II	**Innate immunity**: cells and soluble mediators of innate immunity, induced innate response and acute phase proteins; acute inflammatory response, Complement system, biological consequences of activation and complement regulatory proteins. Adaptive immunity: salient features, clonal selection theory, collaboration between adaptive and innate immunity, Autoimmunity: organ specific and systemic, induction of autoimmunity, immunodeficiency	12
III	**Cell mediated immune response :** B cell development and maturation, T cell development and maturation, antibody and its types, antigen antibody interaction	12
IV	**Transplantation immunology:** Typing of tissues, characteristics of graft rejection, immunosuppressive Therapy, Vaccines - active and passive immunization, types of vaccines	12
V	**Techniques used in immunology:** antigen antibody interaction, ELISA and types, RIA, Immunofluorescence and immunoprecipitation Hypersensitivity: Gellnad Coombs classification, auto-anti gen and harmful antigen	12

Recommended Books:

1. Pathology Practical Book: Harsh Mohan, Japee Brothers Medical Publishers, Indain Edition 2002.
2. Experiments in Microbiology, Plant Pathology and Biotechnology: Aneja, K.R., New Age International Publishers. 2015.
3. Kuby Immunology: Kindt, T.J., Goldsby, R.A. & Osborne, B.A., W.H. Freeman & Co, New York, 2007.
4. Janeway's Immunobiology, Garland Science: Murphy, K, Travers, P. and Walport, M.,Taylor & Francis Group, LLC. 2008.Suggested online links:
https://nptel.ac.in/courses/102/103/102103012/

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the PCB/PCM in class 12th

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Semester-V, Paper-1
(Practical)
Course Title: Immunology Lab

Programme: Degree in Bachelor of Science	**Year**: Third	**Semester**: Vth
Practical paper-2		**Subject**: Biochemistry
Course Code: BBY351	**Course Title:** Immunology Lab	

Course outcomes:

On successful completion of the course, the student shall be able to:

CO.1 – Apply the isolation of blood cells from various samples or tissues.

CO.2 – Demonstrate purification process of antibodies from various types of sample.

CO.3 – Analyze precipitation reaction by different methods.

CO.4 – Examine the agglutination reactions by different methods.

CO.5 – Examine the reaction of antigen –antibody.

CO.6 – Analyze immunodiffusion reaction by various methods, understand the SOP and execute the preparation of experiments.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical **60 h**

Unit	Topics	No of Lectures
I	1. Isolation of lymphocytes from blood / spleen. 2. Purification of immunoglobulins.	**20**
II	1. Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID). 2. Assays based on agglutination reactions - Blood typing (active) & passive Agglutination, Latex Agglutination, Bacterial Agglutination.	**20**
III	1. Enzyme linked immunosorbent assay (ELISA) & DOT ELISA. 2. Immunodiffusion	**20**
	Recommended Books:	

	1. Pathology Practical Book: Harsh Mohan, Japee Brothers Medical Publishers, Indain Edition 2002. 2. Experiments in Microbiology, Plant Pathology and Biotechnology: Aneja, K.R., New Age International Publishers. 2015. 3. Kuby Immunology: Kindt, T.J., Goldsby, R.A. & Osborne, B.A., W.H. Freeman & Co, New York, 2007. 4. Janeway's Immunobiology, Garland Science: Murphy, K, Travers, P. and Walport, M.,Taylor & Francis Group, LLC. 2008	
	This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class	

Semester-V, Paper-3
(Theory)
Course Title: Hormonal Biochemistry

Programme: Degree in Bachelor of Science	**Year:** Third	**Semester:** Vth
Paper-3: Theory	**Subject**: Hormonal Biochemistry	
Course Code : BBY303	**Course Title:** Hormonal Biochemistry	

Course outcomes:

Course Objective: This module is a general introduction to the basic concepts of hormones and their functions. The module also gives insight to importance of hormones.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the functions, regulation, classification, transport and chemical signaling mechanisms of hormones as well as hormone therapy and endocrine methodology.

CO.2 – Describe the physiological and biochemical actions as well as endocrine disorders of hypothalamic hormones and pituitary hormones.

CO.3 – Explain the biosynthesis, regulation, physiological and biochemical action as well as the pathophysiology of thyroid hormone.

CO.4 – Explain the PTH, Vitamin D, calcitonin, mechanism of Ca2+ regulation and pathway as well as the pathophysiology of the parathyroid gland.

CO.5 – Describe the regulations, physiological and biochemical actions as well as the pathophysiology of pancreatic and GI tract hormones.

CO.6- Understand the basic concepts of structure of hormone with special reference to human and its role in human welfare, reproduction and its applications in industry, medical, industry and research.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Introduction to endocrinology:** Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms, Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology. Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca^{2+}, Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin and Ras - MAP kinase cascade. Non receptor tyrosine kinase-erythropoietin receptor JAK - STAT pathway. Steroid hormone Receptor. Receptor regulation and cross talk.	14

II	**Hypothalamic and pituitary hormones:** Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.	10
III	**Thyroid hormone:** Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves' disease, cretinism, myxedema, Hashimato's disease	12
IV	**Hormones regulating Ca^{2+} homeostasis:** PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology- rickets, osteomalacia, osteoporosis.	12
V	**Pancreatic and GI tract hormones:** Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipolectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II. Reproductive hormones: Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based contraception. Understand conditions like ammenorrheas, menorrhagia, PMS, PCOS, Menopause.	12

Recommended Books:

1. Lehninger Principles of Biochemistry: Nelson, D. L. & Cox, M.M., W.H. Freeman & Com. 4th Ed. 2005.
2. Vander,Sherman,Luciano's Human Physiology, The Mechanism of Body Function: Widmaier, E.P.,Raff, H.and Strang, K.T., McGraw- Hill Higher Education. 9th Ed.2008.
3. Molecular Cell Biology: Darnell, J., Lodish, H. & Baltimore, D., Scientific American Books, Oxford. 2008.
4. Anatomy & Physiology: Gerard J. Tortora and Bryan Derrickson: Willey, Indian Edition. 2016.

This course is compulsory for the students of following subjects: PCB/ PCM in 12th Class

Continuous Evaluation Methods: Students will be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline,participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the PCB/ PCM in12th class

Semester-V, Paper-4
Course Title: Proteins

Programme: Degree in Bachelor of Science	**Year**: Third	**Semester**: Vth
Paper-4 Theory	**Subject:** Biochemistry	
Course Code: BBY304	**Course Title:** Proteins	

Course Objective: This module is elucidating the detailed molecular structure of proteins and their functions. The module also gives insight to importance of proteins.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the hierarchy of protein architecture with the features of conjugated and metallo proteins.
CO.2 – Examine solubilisation of proteins from their cellular and extracellular locations through different grinding methods.
CO.3 – Classify the databases related to protein sequence and its structure.
CO.4 – Summarize the fundamental mechanisms of protein folding and stability and their relation toconformational diseases.
CO.5 – Demonstrate protein databases to protein sequence and structure.

Credits:4	Electives
Max. Marks: 25+75=100	**Min. Passing Marks:**
Practical	**60 h**

Unit	Topics	No. of Lectures
I	**Introduction to amino acids, peptides and proteins:** Amino acids and their properties-hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors, Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function. Motor proteins-Actin and myosin. Defense proteins- Antibodies, Membrane proteins- Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains**.**	12
II	**Extraction of proteins for downstream processing,** Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation. Separation techniques & Characterization of proteins: Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.	12
III	**Three dimensional structures of proteins:** Nature of stabilizing bonds - covalent and non-covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns, Ramachandran map. Techniques used in studying 3-D structures -X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin.	12
IV	**Protein folding and conformational diseases:** Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamic of folding & and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based.	10

V	**Introduction to Protein Databases:** Introduction to protein sequence and structure databases (UNIPROT, SWISS-PROT & PDB), Protein sequence file Format (FASTA) and Visualization softwares.	10

Reference Books:

1. Lehninger, Principles of Biochemistry: Nelson, D. L. & Cox, M.M., W.H. Freeman & Company, N.Y., USA. 5th Ed. 2008.
2. Biochemistry: Voet, D. &Voet, J.G., John Wiley & Sons, Inc. USA, 3rd Ed. 2004.
3. Fundamentals of Enzymology: The Cell & Molecular Biology of Catalytic protein: Price,N. C.& Stevens, L.,Oxford University Press Inc. 3rd Ed. 1996.
4. Biochemistry: Satyanarayana U. & Chakrapani U., Elsevier 4th 2016.
5. Biochemistry: Voet, D. and Voet, J.G., John Wiley & Sons, Inc. USA. 3rd Ed. 2004.

This course can be opted as an elective by the students of following subjects: PCB/PCM in 12th Class

Continuous Evaluation Methods:	
Viva Voce	10 marks
Mock test	10 marks
Overall performance	15 marks

Course prerequisites: To study this course, a student must have had the PCB/PCM in 12th Class

Suggested equivalent online courses:
……

Further Suggestions:
……

Semester V
Paper title: Proteins Lab

Programme: Degree in Bachelor of Science	**Year**: Third	**Semester**: Vth
Practical paper-2		Subject: Biochemistry
Course Code: BBY 352	**Course Title:** Proteins Lab	

Course outcomes:
On successful completion of the course, the student shall be able to:
CO 1- Demonstrate assay for protein by various methods.
CO 2- Demonstrate effect of physical parameters effect on different samples containing proteins.
CO 3- Illustrate protein leakage experiment by various methods.
CO 4- Practice amino acids analysis by different chromatographic techniques.
CO 5- Illustrate isoelectric principle by casein protein.
CO 6- Demonstrate salt fractionation of crude homogenate from various samples and analyze protein by SDS-PAGE.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:
Practical	**60 h**

Unit	Topics	No of Lectures
I	**Basics of Proteins Lab** 1. Estimation of proteins by Biuret/Lowry method/Bradford method 2. Effect of temperature and pH on various functionally important Proteins Protein leakage analysis 3. Different Amino acid analysis by paper chromatography (ninhydrin reagent) 4. Isoelectric pH of casein.	**20**
II	**Advance Proteins Lab** 1. Ammonium sulphate fractionation of crude homogenate from germinated mung beans 2. SDS-PAGE analysis of proteins 3. Separation of proteins using anion-exchange chromatography 4. Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB	**40**

	Reference Books: 1. Lehninger, Principles of Biochemistry: Nelson, D. L. & Cox, M.M., W.H. Freeman & Company, N.Y., USA. 5th Ed. 2008. 2. Biochemistry: Voet, D. &Voet, J.G., John Wiley & Sons, Inc. USA, 3rd Ed. 2004. 3. Fundamentals of Enzymology: The Cell & Molecular Biology of Catalytic protein: Price,N. C. & Stevens, L.,Oxford University Press Inc. 3rd Ed. 1996. 4. Biochemistry: Satyanarayana U. & Chakrapani U., Elsevier 4th 2016. Biochemistry: Voet, D. and Voet, J.G., John Wiley & Sons, Inc. USA. 3rd Ed. 2004.	

Semester-VI
Paper-1 (Theory)
Course Title: Tools and Techniques in Biochemistry

Programme: Degree inBachelor of Science	**Year: Third**	**Semester:** VIth
Paper-1: Theory		**Subject:** Biochemistry
Course Code: BBY305	**Course Title:** Tools and Techniques in Biochemistry	

Course Objective: This module introduces experimental techniques used in biochemistry and these includemethods of protein purification and analyzing biomolecules.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:

CO.1- Describe various separation techniques for different molecules present in the cell.

CO.2- Discuss the theoretical principles of various separation techniques in chromatography and typicalapplications of chromatographic techniques.

CO.3- Define an adequate knowledge of the principles, instrumentation and applications of electrophoresis.

CO. 4- Explain and understand the basic instrumentation of Centrifugation and radioisotope techniques forseparation, identification and characterization of compounds.

CO. 5- Explain the theoretical principles of selected instrumental methods within electro analytical, spectrometric/spectrophotometric methods.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Separation techniques:** Different methods of protein precipitation: Precipitation using inorganic salts (salting out) and organic solvents, isoelectric precipitation, Dialysis, Ultrafiltration, Lyophilization	10

II	**Chromatography:** Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparativeand analytical applications, LPLC and HPLC, Different types of chromatography: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Liquid Chromatography	14
III	**Electrophoresis:** Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weightdetermination, Isoelectric Focusing of proteins.	12
IV	**Centrifugation:** Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation,density gradient centrifugation (Rate zonal and Isopycnic)	12
V	**Spectrophotometry:** Principle of UV-Visible absorption spectrophotometry, instrumentation and applications Fluorimetry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence,instrumentation and applications	12

Recommended Books:

1. Principles and Techniques of Biochemistry & Molecular Biology: Wilson K and Walker J, Cambridge University Press, 7th Ed. 2010.
2. Cell and Molecular Biology: Concepts & Experiments: Karp G, John Wiley & Sons.Inc. , 6th Ed. 2010.
3. Cell and Molecular Biology: De Robertis & De Robertis, Wolters Kluwer Pvt. Ltd. (India) 8th Ed. 2010.

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class oron-line tests, home assignments, group discussions or oral presentations, among others .

Or

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the (PCB/PCM) in class 12 th Class
Suggested equivalent online courses: **……..**
Further Suggestions: **……..**

Semester-VI,
Paper-2 (Theory)
Course Title: Genetic Engineering

Programme/Class: Degree in Bachelor of Science	**Year: Third**	**Semester:** VIth
Paper-1: Theory		**Subject:** Biochemistry
Course Code: BBY306	**Course Title:** Genetic Engineering	

Course Objective: This module is a general introduction of both the principles and application of molecular and genetic engineering. The module aims to understand the mechanisms of living, from the molecular basis of cell function to the integrated behaviour of the whole body.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Compute the basic steps of genetic engineering according to the species.
CO.2 – Modify the DNA recombinant molecules according to the target cell.
CO.3 – Apply the knowledge of DNA sequencing while genetic engineering.
CO.4 – Convert the genetic information into cDNA library and genomic library that would be beneficial for the preparation of transgenic organisms.
CO.5 – Choose the appropriate gene delivery system for the target cell.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Introduction to Genetic Engineering:** Milestones in genetic engineering and biotechnology, Restriction modification systems: types i, ii and iii. Mode of action, nomenclature, applications of type ii restriction enzymes in genetic engineering, Analysis of restricted DNA: agarose gel electrophoresis and southern blotting, DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyltransferase, kinases and phosphatases, and ligases, Cloning: use of linkers and adaptors, Transformation of DNA: By chemical method	14
II	**Vectors: Cloning vectors:** definition and properties, Plasmid vectors: pBR322 and pUC8, pGEM3Z series, Cloning based vectors λ bacteriophage and M13, Cosmids, BACs, YAC Expression vectors: E. coli lac and t7 promoter-based vectors, yeast YIP, YEP and YCP vectors, baculovirus based vectors mammalian sv40-based expression vectors. Vectors for yeast, Ti-plasmid, and retroviral vectors, high capacity vectors BAC and YAC	14
III	**DNA Amplification And DNA Sequencing:** PCR: basics of PCR, rt-PCR, real-time PCR, Sanger's method of DNA sequencing: traditional and automated sequencing Primer walking and shotgun sequencing.	10

IV	**Construction and screening of genomic and cDNA libraries, Genomic and cDNA libraries:** preparation and uses, Screening of libraries: colony hybridization and colony PCR, Chromosome walking and chromosome jumping**.**	11
V	**Applications of DNA Technology:** Gene delivery: microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Products of recombinant DNA technology: products of human therapeutic interest - insulin, hGH, factor VIII. Recombinant vaccines. Gene therapy (SCID), Applications in agriculture – Bt cotton glyphosate herbicide resistant crops, ethical concerns.	11

Recommended Books:

1. Gene Cloning & DNA Analysis: Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), 6th Ed. 2010.
2. Principles of Gene Manipulation & Genomics Primrose: S. B., and Twyman, R. M., Blackwell publishing (Oxford,UK), 7th Ed. 2006.
3. Molecular Biotechnology: Principles &Applications of Recombinant DNA: Lick B. R., Pasternak, J. J. and Patten, C. L., ASM Press (Washington DC), 4th Ed. 2010.
4. Molecular Cloning: A laboratory manual: Michael R. Green & J. Sambrook Cold spring Harbor laboratory press, 4th Ed. 2014.

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the (PCB/PCM) in class 12th Class

Suggested equivalent online courses:
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Further Suggestions:
……..

Semester-VI,
Paper-3 (Theory)
Course Title: Membrane Biochemistry and Bioenergetics

Programme/Class: Degree in Bachelor of Science	**Year: Third**	**Semester:** VIth
Paper-3: Theory		**Subject:** Biochemistry
Course Code: BBY307	**Course Title:** Membrane Biochemistry and Bioenergetics	

Course Objective: This course covers the role of various proteins and receptors in the membranes and their mode of action and function, also the thermodynamics involved in it.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:

CO.1 – Understand the complex transport mechanism in a more simplified manner by the use of various diagrams and models.
CO.2- Discuss the overall classification and composition of membranes and their role in the human body
CO.3- Understand the concept behind the liposome and the ways to deliver drugs in the tissues of affected organs.
CO.4- Differentiate between porous and non-porous membrane and their methods of transport through them.
CO.5- Understand the role receptors, protein pumps another junctions in the transport
CO.6- Understand the fundamentals of membrane and its importance to life, different proteins and lipids associated with the membrane.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Membranes :** Membranes and their biological and non-biological classification, Different models of lipid bilayer, synthetic membrane, types and their role reverse osmosis, functions of membranes	14
II	**Composition of Biological Membranes:** Integral proteins, their types and functions, peripheral proteins, their types and functions, Channel proteins, protein pumps Membrane lipids, classification and structure.	14
III	**Introduction to bioenergetics:** Laws of thermodynamics, Mitochondrial membrane and Electron transport chain - its organization and function Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure Mechanism of ATP synthesis. Metabolite transporters in mitochondria. ROS production and antioxidant mechanisms.	10

IV	**Membrane transport :** Active and passive diffusion, Fick's law; Transport through porous, non-porous, and ion exchange membranes Symport, antiport and uniport; Anion and glucose transporter Sodium-potassium pumps- examples and metabolic significance.	11
V	**Membrane receptors:** Structure and functions of GPCR, Methods for studying membrane receptors, Functions and mechanism of adrenergic and cholinergic receptors, Neural receptors and its significance.	11

Recommended Books:

1. Cox, M.M. and Nelson, D.L. (2008) Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA

2. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA. 35

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the (PCB/PCM) in class 12th Class

Suggested equivalent online courses:
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Further Suggestions:
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Semester-VI,
Paper-4 (Theory)
Course Title: Cell Signaling and Cancer Biology

Programme: Degree in Bachelor of Science	**Year: Third**	**Semester:** VIth
Paper-4: Theory		**Subject:** Biochemistry
Course Code: BBY308	**Course Title:** Cell Signaling and Cancer Biology	

Course Objective: This course covers the concept of cell signaling involving intracellular communication for the coordination of a good signal. In addition the role of various signaling pathways involved in cellular proliferation, apoptosis and therapeutics for the cure of cancer.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:

CO.1 – Understand the main principles of signaling, concept of a good signal, different ways in which the cell signal to each other and the coordination of signaling. This will inculcate the knowledge and research avenues for students.

CO.2 – Understand the applications of signaling in cellular proliferation and apoptosis to raise their interest in interdisciplinary research.

CO.3 – Understand the significance of cell signaling and signal transduction.

CO.4 – Understanding of various pathways involved in signal transduction. This will give them a vision and provide them an option for higher studies.

CO.5 – Understanding of signal transduction pathways involved in therapeutics for cure of cancer. This learning will increase their research potential to serve the society.

CO.6 – Understanding of concept of cell signaling involving intracellular communication for the coordination of a good signal. In addition the role of various signaling pathways involved in cellular proliferation, apoptosis and therapeutics for the cure of cancer and introducing this knowledge for betterment of society.

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

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Overview of signaling:** Basic introduction of cell signaling, description of good signal Different ways in which the cell signal to each other, coordination of signaling Brief history and techniques of cell signaling	14
II	**Cellular communication:** Main principles of cell signaling Intracellular communication; various ways of intracellular communication Extracellular matrix; Neurotransmitters; Neurohormones; Regulation by neurotransmitters and neurohormones.	14

III	**Signal transduction:** Transcription factors Receptors, Involvement of receptors in signaling, Types of receptors in signaling, G-protein coupled receptor mediated signaling, Secondary messengers and modulation of different signaling.	10
IV	**Serine/Threonine and Tyrosine Specific Protein Kinases:** Classification and regulation of protein kinases Protein kinase pathway, Regulation of P13K and Akt pathway.	11
V	**Map kinases and their regulation:** Concept of kinases and their function MAPK cascades, Regulation of MAPK pathway, Role of MAPK in cell proliferation Possible roles of phosphatides and inhibitory proteins.	11

Recommended Books:

1. Hancock J.T., "Cell Signaling", Oxford University Press, 2010.
2. Gomperts B.D., Kramer I.M. and Tatham P.E.R., "Signal Transduction", Academic Press, 2009.
3. Krauss G., "Biochemistry of Signal Transduction and Regulation", Wiley-VCH, 2008.

This course is compulsory for the students of following subjects: PCB/PCM in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment/ Research Orientation assignment	(10 marks)
04 tests (Objective): Max marks of each test = 10 (average of all 04 tests)	(10 marks)
Overall performance throughout the semester, Discipline, participation in different activities)	**(**05 marks)

Course prerequisites: To study this course, a student must have had the (PCB/PCM) in class 12th Class

Suggested equivalent online courses:
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Further Suggestions:
……..

Semester VI
Paper title: Genetic Engineering Lab

Programme: Degree in Bachelor of Science	Year: Third	Semester: VIth
Practical paper-2		Subject: Biochemistry
Course Code: BBY 353	**Course Title:** Genetic Engineering Lab	

Course outcomes:
On successful completion of the course, the student shall be able to:
CO. 1- Demonstrate isolation of nucleic acid from microorganisms.
CO. 2- Demonstrate digestion reaction in nucleic acids of various samples.
CO. 3- Illustrate PCR methods.
CO. 4- Sketch Complementation by various techniques.
CO. 5- Illustrate hyper expression of poly histidine-tagged recombinant protein and purification.

Credits: 2	Elective
Max. Marks: 25+75 = 100	Min. Passing Marks:

Practical **60 h**

Unit	Topics	No of Lectures
I	**Basics of Genetic Engineering Lab** 1. Isolation of plasmid DNA from E. coli cells 2. Digestion of plasmid DNA with restriction enzymes 3. Amplification of a DNA fragment by PCR	**20**
II	**Advance Genetic Engineering Lab** 1. Complementation of β-galactosidase for Blue and White selection 2. Hyper expression of poly histidine-tagged recombinant protein and purification using Ni–affinity resin	**40**
	Recommended Books: 1. Gene Cloning & DNA Analysis: Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), 6th Ed. 2010. 2. Principles of Gene Manipulation & Genomics Primrose: S. B., and Twyman, R. M., Blackwell publishing (Oxford, UK), 7th Ed. 2006. 3. Molecular Biotechnology: Principles &Applications of Recombinant DNA: Lick B. R., Pasternak, J. J. and Patten, C. L., ASM Press (Washington DC), 4th Ed. 2010. 4. Molecular Cloning: A laboratory manual: Michael R. Green & J. Sambrook Cold spring Harbor laboratory press, 4th Ed. 2014.	