DAV UNIVERSITY, JALANDHAR

Scheme of Courses for
Master of Science (Biochemistry Hons.)

(Program ID – 36)

1st to 4th Semester
Examinations 2014-2015 Session Onwards

Syllabi Applicable for Admissions in 2014

DAV UNIVERSITY JALANDHAR

Course Scheme
M.Sc. Biochemistry (Hons.)

Semester 1

S.No.	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1.	CHE 651	Organic and Biophysical Chemistry	4	1	0	4	25	25	25	25	**100**
2.	BTY 502	Molecular Biology	4	1	0	4	25	25	25	25	**100**
3.	BTY 503	Cell Biology	2	1	0	2	25	25	25	25	**50**
4.	BCH 501	Bioanalytical Techniques	4	1	0	4	25	25	25	25	**100**
5.	BCH 502	Microbial Biochemistry	2	0	0	2	25	25	25	25	**50**
6.	BCH 503	Bioanalytical Techniques Lab.	0	0	3	2	-	-	-	-	**50**
7.	BTY 506	Molecular Biology Lab.	0	0	3	2	-	-	-	-	**50**
8.	BTY 507	Cell Biology Lab.	0	0	2	1	-	-	-	-	**25**
9.	BCH 504	Microbial Biochemistry Lab.	0	0	2	1	-	-	-	-	**25**
10.	BCH 553	Journal Club	0	0	0	2	-	-	-	-	**50**
		Total	**16**	**3**	**10**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY JALANDHAR

Semester 2

S.No.	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1.	BCH 507	Advanced Enzymology	2	0	0	2	25	25	25	25	**50**
2.	BTY 553	Biostatistics	4	1	0	4	25	25	25	25	**100**
3.	BTY 551	Recombinant DNA Technology	4	1	0	4	25	25	25	25	**100**
4.	BCH 509	Bioenergetics and Intermediary Metabolism	4	1	0	4	25	25	25	25	**100**
5.	BCH 603	Clinical Biochemistry	3	1	0	3	25	25	25	25	**75**
6.	BCH 510	Bioenergetics and Intermediary Metabolism Lab.	0	0	3	2	-	-	-	-	**50**
7.	BTY 555	Recombinant DNA Technology Lab	0	0	3	2	-	-	-	-	**50**
8.	BTY 557	Biostatistics Lab.	0	0	3	2	-	-	-	-	**50**
9.	BCH 604	Clinical Biochemistry Lab.	0	0	2	1	-	-	-	-	**25**
		Total	**17**	**4**	**11**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY JALANDHAR

Semester 3

S.No.	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1.	MIC 603	Immunology	4	1	0	4	25	25	25	25	**100**
2.	BTY 504	Genetics	4	1	0	4	25	25	25	25	**100**
3.	BTY 602	Computational Biology and Bioinformatics	3	1	0	3	25	25	25	25	**75**
4.	BCH 601	Biochemical and Environmental Toxicology	4	1	0	4	25	25	25	25	**100**
5.	MIC 607	Immunology Lab.	0	0	3	2	-	-	-	-	**50**
6.	BTY 508	Genetics Lab.	0	0	3	2	-	-	-	-	**50**
7.	BCH 655	Journal Club	0	0	0	2	-	-	-	-	**50**
8.	BTY 606	Computational Biology and Bioinformatics Lab.	0	0	2	1	-	-	-	-	**25**
9.	BCH 609	Biochemical and Environemntal Toxicology Lab.	0	0	3	2	-	-	-	-	**50**
		Total	**15**	**4**	**11**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY JALANDHAR

Semester 4

S.No.	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1.	BTY 652	Genomics, Proteomics and Metabolomics	4	1	0	4	25	25	25	25	**100**
2.	BCH 605	Plant Biochemistry	3	1	0	3	25	25	25	25	**75**
3.	BCH 607	Nutritional Biochemistry	4	1	0	4	25	25	25	25	**100**
4.	BCH 656	Journal Club	2	0	0	2	-	-	-	-	**50**
5.	BCH 610	Thesis Project	0	0	0	6	-	-	-	-	**150**
6.	BTY 657	Genomics, Proteomics and Metabolomics Lab.	0	0	3	2	-	-	-	-	**50**
7.	BCH 606	Plant Biochemistry Lab.	0	0	2	1	-	-	-	-	**25**
8.	BCH 608	Nutritional Biochemistry Lab.	0	0	3	2	-	-	-	-	**50**
		Total	**13**	**3**	**8**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

Instruction for candidates (Theory Paper)

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.
- The books indicated as text-book(s) are suggestive However, any other book may be followed.

* Wherever specific instructions are required these are given at the starting of that particular subject/paper

Instruction for candidates (Practical Paper)

Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

Course Title: Bioanalytical Techniques
Course Code: BCH 501

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course introduces students all the major bioanalytical techniques relevant to students of biochemistry. It covers the theoretical aspects of various techniques, along with their instrumentation and applications.

Unit A **(20 hours)**

Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry, Fluorescence Spectroscopy.

Chromatography – Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit B **(20 hours)**

Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Mass Spectrometry – Principle of MS, ionization modes, equipment, MS of proteins/peptides, interface of MS with other methods – MS/MS, LC/MS, and GC/MS, peptide mapping, post-translation modification analysis of proteins, protein sequencing by MS.

Unit C **(10 hours)**

Electrophoretic techniques – Principles of electrophoretic separation. Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis.

Immunochemical techniques – Making antibodies, Immunoassay formats, Immunomicroscopy, Lateral flow devices, Epitope mapping, Immunoblotting, Fluorescent activated cell sorting (FACS), Cell and tissue staining techniques, Immunocapture, polymerase chain reaction (PCR) Immunoaffinity chromatography (IAC), Antibody-based biosensors, Therapeutic antibodies

Unit D **(10 hours)**

Bioinformatics – Overview, Sequence databases – DNA, protein, genome, EST and SNP databases, BLAST programs, ClustalW, Tertiary protein structure databases, PDB, Rasmol, Pymol and Swiss-PDB viewer, Homology modeling.

Reference Books:

1. Sheehan, David. *Physical Biochemistry: Principles and Applications.* 2nd Edition. Wiley (2009).

2. Holme, David and Peck, Hazel. *Analytical Chemistry*. 3rd Edition. Prentice Hall (1998).

Course Title: Microbial Biochemistry
Course Code: BCH 502

L	T	P	Credits	Marks
4	0	0	4	100

Course Objectives: The course introduces students to biochemical concepts relevant to microbial physiology and metabolism.

Unit A **(15 hours)**

Types of microorganisms, general characteristics of main groups of microorganisms. Criteria used in classification of microorganisms – cytology, genetics, host specialization, serology, different phases of growth.

Unit B **(15 hours)**

Nutrition, physiology and growth of microbial cells.Gram-positive and Gram-negative organisms. Structure and function of peptidoglycan in gram-positive and gram-negative organisms. Functions of polymeric components in outer membrane and acidic polymers in gram-negative organisms.Special features of bacterial metabolism.

Unit C **(15 hours)**

Food spoilage, fermentation, food-borne infection.Role of microorganisms in domestic and industrial sewage.Microbiological standards.

Unit D **(15 hours)**

Virus structure, virus proteins, virus classification and methods of assay.Replication of RNA viruses – negative strand (VSV), positive strand (polio), retroviruses (to include all events in the infectious cycle) Replication of DNA viruses (Adenovirus or SV40) Virus-host interaction Vaccines and prevention – smallpox/polio/AIDS

Reference Books:

1. White, D., Dummond, J., and Fuqua, C. *The Physiology and Biochemistry of Prokaryotes.* 4th edition, Oxford University Press (2009).

2. Nelson, D.L. and Cox, M.M. *Lehninger Principles of Biochemistry.* 5th Edition, W.H. Freeman and Company, New York. (2008).

3. Stanier R. Y., Adelberg E. A., Ingraham J. L., *General Microbiology*. 4th edition, Macmillan Press, London (1976).

4. Madigan, M.T., Martinko, J.M., Stahl, D.A., and Clark, D.P. *Biology of microorganisms*, 13th edition. Benjamin Cummings, USA (2011).

Course Title: Bioanalytical Techniques Laboratory

L	T	P	Credits	Marks
0	0	2	1	25

Course Code: BCH 503

Experiments:

1. Titration of a weak acid using a pH meter, preparation of buffers

2. Verification of Beer-Lambert's law and determination of absorption coefficients

3. Paper chromatography – Separation of amino acids and carbohydrates in a mixture

4. Thin layer chromatography of fatty acids

5. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column

6. Electrophoresis

Course Title: Microbial Biochemistry Laboratory
Course Code: BCH 504
Experiments:

L	T	P	Credits	Marks
0	0	2	1	25

1. Preparation and sterilization of culture media

2. Simple staining, gram staining, endospore staining and capsule staining.

3. Preparation of bacterial growth curve.

4. Estimation of viable cells in a bacterial suspension.

5. Determination on minimum inhibitory concentration (MIC) of antibiotic.

6. Isolation of microorganisms from air and soil

7. Bacteriological analysis of water – (1) presumptive test, (2) confirmed test, (3) completed test.

8. Biochemical tests of bacteria: - indole production. Tests for catalase, protease, amylase and oxidase. Starch hydrolysis test. Methyl red test.

Course Title: Advanced Enzymology
Course Code: BCH 507

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: The course is an advanced treatment of enzymology and covers specialized techniques used to investigate enzyme mechanism, various types of enzyme reactions and enzyme kinetics.

Unit A **(7 hours)**

Enzyme diversity: concept of convergent and divergent evolution of enzymes, kinetics of multi substrate enzyme catalyzed reactions: classification, kinetics of multisubstrate reactions, derivation of rate of expression for ordered, ping-pong and Bi-Bi reaction mechanisms, investigation of reaction mechanism by using initial velocity, inhibition and isotope exchange studies.

Unit B **(8 hours)**

Methods of measuring enzymatic rate constants and their magnitude: Rapid mixing and sampling techniques, relaxation methods, absolute concentration of enzymes, sigmoidal kinetics: cooperativity phenomenon for protein ligand binding, symmetric & sequential models for action of allosteric enzymes and their significance, Hill and Scatchard plots.

Unit C **(10 hours)**

Identification of active site of enzymes: by trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with proteases and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, structures & mechanisms of selected enzymes: the dehydrogenases, the proteases, ribonuclease and lysozyme.

Unit D **(5 hours)**

Enzyme turnover: kinetics of turnover, methods for measuring rates of enzymes turnover, correlation between rates of turnover and the structure and functions of enzymes, mechanism of enzyme degradation, significance of enzyme turnover.

Reference Books:

1. Palmer, T., and Bonner, P. *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*, 2nd Edition, Affiliated East-West press Pvt. Ltd., New Delhi (2008)

2. Price, N.C., and Stevens, L., *Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins*, 3rd Edition. Oxford University Press (1999).

3. Fersht, A. *Enzyme Structure and Mechanisms*. 2nd Edition, W. H. Freeman & Company, New York (1985).

Course Title: Advanced Enzymology Laboratory
Course Code: BCH 508
Experiments:

L	T	P	Credits	Marks
0	0	2	1	25

1. Assay of enzyme activity

2. Isolation and purification of urease

3. Time course of enzymatic reaction

4. Influence of substrate concentration on the rate of enzymatic reaction

5. Effect of pH and temperature on the rate of enzyme reaction

6. Specificity of enzyme action

7. Inhibition of enzyme activity. Determination of Ki values

8. Molecular weight determination of enzyme by gel filtration

9. Isozyme detection

10. Immobilization studies:

(a) Preparation of urease entrapped in alginate beads and determination of percent entrapment

(b) Study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads

(c) Study of reusability and storage stability of urease entrapped alginate beads

(d) Immobilization of urease by covalent attachment to solid support.

DAV UNIVERSITY JALANDHAR

Course Title: Bioenergetics and Intermediary Metabolism
Course Code: BCH 509

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The course covers the concepts of bioenergetics and pathways of metabolism with emphasis on animal cells.

Unit A **(15 hours)**

Bioenergetics – Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change (derivations and numericals included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy charge.

Coenzymes and Cofactors – Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples.

Unit B **(15 hours)**

Carbohydrates – Glycolysis, various forms of fermentations in micro-organisms, citric acid cycle, its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway and its regulation. Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate (GABA) shunt pathways, Cori cycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway. Metabolism of disaccharides. Hormonal regulation of carbohydrate metabolism. Energetics of metabolic cycle.

Unit C **(20 hours)**

Amino Acids – General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation.

Lipids – Introduction, hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids. Oxidation of odd numbered fatty acids – fate of propionate, role of carnitine, degradation of complex lipids. Fatty acid biosynthesis, Acetyl CoA carboxylase, fatty acid synthase, ACP structure and function, Lipid biosynthesis, biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle. (20)

Unit D **(10 hours)**

Nucleotides – Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. Purine salvage pathway. Role of ribonucleotide reductase. Biosynthesis of deoxyribonucleotides and polynucleotides, including inhibitors of nucleic acid biosynthesis.

Other Molecules - Porphyrins – Biosynthesis and degradation of porphyrins. Production of bile pigments, Biochemistry of biological nitrogen fixation, plant hormones – Growth regulating substances and their mode of action, molecular effects of auxin in regulation of cell extension, effects of gibberllic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development, Biosynthesis of Vitamins – Ascorbic acid, thiamine, pantothenic acid and Folic acid.

Reference Books:

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition, W.H. Freeman & Company, New York, 2008. Print.

2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.

3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

Course Title: Bioenergetics and Intermediary Metabolism Laboratory
Course Code: BCH 510

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Estimation of proteins by Lowry method

2. Estimation of proteins by Bradford's method

3. Estimation of total sugars

4. Estimation of reducing sugars

5. Extraction of total lipids

6. Estimation of glycolipids and phospholipids

7. Determination of acid value of a fat

8. Determination of saponification number of a fat

9. Determination of iodine value of a fat

Course Title: Biochemistry
Course Code: BCH 551

L	T	P	Credits	Marks
2	1	0	2	50

Course Objective: The course is intended for master's course students in disciplines other than Biochemistry. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their biochemistry.

Unit A **(10 hours)**

Introduction - Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance.

Carbohydrates - Monosaccharides: Classification and nomenclature, Biological importance, Structural representations of sugars- Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Glycosidic bond. Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose. Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Proteins Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pK value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins. Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Fibrous muscle proteins). Chaperons. Tertiary structure- e.g. Myoglobin. Quaternary structure – e.g. Haemoglobin.

Unit B **(10 hours)**

Lipids - Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification, nomenclature. Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes. Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens. Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins. Prostaglandins- structure, types, synthesis and functions.

Unit C **(5 hours)**

Nucleic Acids - Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Unit D **(5 hours)**

Enzymes - Classification- (I.U.B. system), co-enzymes, isoenzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering

of activation energy, Various theories, Active site. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering.

Reference Books:

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition, WH Freeman & Company, New York, 2008. Print.

2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.

3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

4. Conn, E.E., Stumpf, P.K., Bruening, G., and Doi, R.H. *Outlines of Biochemistry*. 5th edition, John Wiley & Sons Inc, 1987. Print.

Course Title: Biochemistry Laboratory
Course Code: BCH 552

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNS/O-Toluidine/Enzymatic method

2. Estimation of proteins by Biuret/ Lowry et al. method

3. Quantitative estimation of blood urea/ creatine/ uric acid

4. Quantitative estimation of cholesterol in the blood

5. Estimation of alkaline and acid phosphatases

Course Title: General Biochemistry
Course Code: BCH 553

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective: The course is intended for master's course students in disciplines other than master's degree students of Biochemistry. This course is a broad survey of all the major concepts of biochemistry with emphasis on biomolecules and their metabolism.

Unit A **(10 hours)**

Introduction - Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance.

Carbohydrates - Monosaccharides: Classification and nomenclature, Biological importance, Structural representations of sugars- Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Glycosidic bond. Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose. Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Proteins Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pK value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins. Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Fibrous muscle proteins). Chaperons. Tertiary structure- e.g. Myoglobin. Quaternary structure – e.g. Haemoglobin.

Unit B **(15 hours)**

Lipids - Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification, nomenclature. Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes. Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens. Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins. Prostaglandins- structure, types, synthesis and functions.

Nucleic Acids - Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Enzymes - Classification- (I.U.B.system), co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Active site. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme

regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering.

Unit C **(10 hours)**

Carbohydrate Metabolism - Major metabolic pathways- Glycolysis – Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis, Cori cycle. Glycogen metabolism- Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca+2 Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis. Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Galactose metabolism. Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria.

Metabolism of Proteins – Amino acid metabolism - Deamination, Transamination and Trans-deamination. Formation and disposal of ammonia. Urea cycle. Fate of carbon skeletons of amino acids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different amino acids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan.

Unit D **(10 hours)**

Metabolism of Lipids - Beta oxidation, alpha oxidation and omega oxidation of fatty acids. De novo synthesis of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies - Ketogenesis, Ketolysis, Ketosis.

Nucleic Acid and Mineral Metabolism - Catabolism of purines and pyrimidines. Major and minor nutrients. Role of Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride, Sulphur and Iron. Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Lipid peroxidation. Preventive antioxidants.

Reference Books:

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition, WH Freeman & Company, New York, 2008. Print.

2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.

3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

4. Conn, E.E., Stumpf, P.K., Bruening, G., and Doi, R.H. *Outlines of Biochemistry*. 5th edition, John Wiley & Sons Inc, 1987. Print.

Course Title: General Biochemistry Laboratory
Course Code: BCH 552

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNS/O-Toluidine/Enzymatic method

2. Estimation of proteins by Biuret/ Lowry et al. method

3. Quantitative estimation of blood urea/ creatine/ uric acid

4. Quantitative estimation of cholesterol in the blood

5. Estimation of alkaline and acid phosphatases

Course Title: Biochemical and Environmental Toxicology
Course Code: BCH 601

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course introduces students to basic concepts of toxicology and mechanism of action of various toxins, along with various techniques used in toxicology.

Unit A **(15 hours)**

Definition, scope and relationship of toxicology to other sciences. Nature of toxic effects. Acute and chronic exposure.Dose: response relationship, determination of LD-50, no effect observe level, acceptable daily intake, bioavailability, volume of distribution, plasma half life, total body burden, total body clearane. Synergism and antagonism

Unit B **(15 hours)**

Metabolism of toxicant- Introduction, absorption and distribution. Cytochorome P-450, MFO system and their role in xenobiotic metabolism. Non-microsomal oxidation. Phase-I and Phase-II reactions, conjugations, glucoronide conjugates, conjugations catalysed by sulfotransfereases, methyl transferases and acetyl transferases. Glutathione conjugation and amino acid conjugations.

Unit C **(15 hours)**

Toxicity testing- Decision-tree protocol, Ames test, Host mediated assay and dominant lethal test,Drosophila sex linked recessive lethal test, micronucleus test.

Unit D **(15 hours)**

Toxicity of pesticides-Classes of pesticides: organochlorine, organophosphates and carbamates. DDT: metabolism, toxicity, persistence and bioaccumulation. Organophosphate-metabolism and mechanism of insecticidal action. Metal toxicity-Toxicity of lead and its effect on heme synthesis. Toxicology of various forms of mercury. Drug toxicity-Paracetamol, metabolism and its toxic effects.

Reference Books:

1. Kacew, S., and Lee, B-M. *Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment.* 6th edition, CRC Press (2012).

2. Hayes, A.W. *Principles and methods of toxicology.* 5th edition, CRC Press (2007).

3. Hodgson, E., and Smart, R.C. *Introduction to Biochemical Toxicology* 3rd edition (2001).

4. Klassen, C. *Casarett & Doull's Toxicology: The basic science of poisons.* 8th edition, McGraw Hill Medical (2013).

Course Title: Clinical Biochemistry
Course Code: BCH 603

L	T	P	Credits	Marks
3	1	0	3	75

Course Objective: This course covers various aspects of clinical biochemistry with relevance to their mechanistic aspects and diagnostic applications.

Unit A **(10 hours)**

Diagnostic enzymology-enzyme determination in serum/plasma, urine and cells. Clinically important enzymes, use of isoenzymes in diagnosis.

Function tests: Hepatic: Tests based upon the metabolism of carbohydrates, lipids, protein and detoxification. Differential diagnosis of jaundice

Renal: GFR and its clinical importance, clearance tests (urea and creatinine) Intestinal: Malabsorption of fats, carbohydrates and proteins.

Pancreas: amylase, lipase and trypsin assays in serum

Unit B **(15 hours)**

Disorders of metabolism: Carbohydrates- glycogen storage diseases, galactosemia Amino acids- disorders of glycine, sulphur-containing amino acids, aromatic amino acids, histidine, branched chain amino acids and proline, disorders of propionate and methylmalonate metabolism. Disorders in urea biosynthesis.

Unit C **(10 hours)**

Lipids: hyperlipoproteinemia, hyperlipidemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick disease, Gaucher's disease, Krabb's disease, Metachromatic leukodystrophy and Fabry's Disease, Wolman's Disease. Disorders of porphyrin and heme metabolism

Unit D **(10 hours)**

Myocardial infarction and atherosclerosis Quality control in clinical Biochemistry Water & electrolyte balance, acid base balance

Reference Books:

1. Longo, D.L., Fauci, A.S., Kasper, D.L., Hauser, S.L., Jameson, J.L., and Loscalzo, J. *Harrison's Principles of Internal Medicine.* 18th edition, McGraw-Hill Medical (2011).

2. Walker, S.W., Beckett, G.J., Rae, P., and Ashby, P. *Lecture Notes: Clinical Biochemistry.* 9th edition, Wiley (2013).

3. Stanbury, J.B. *et al. Metabolic Basis of Inherited Disease*. 5th edition, McGraw-Hill Inc. (1982).

4. Marshall W.J. and Bangert, S.K. *Clinical Biochemistry: Metabolic and Clinical Aspects.* 2nd edition, Churchill Livingstone (2008).

5. Burtis, C.A., Ashwood, E.R. and Bruns, D.E. *Tietz Text book of Clinical Chemistry and Molecular Diagnostics*, 4th edition, Saunders (2005).

6. Bishop, M.L., Fody, E.P and Schoeff, L.E. *Clinical Chemistry- Principles, Procedures, Correlations.* 5th edition, Lippincott Williams & Wilkins (2004).

7. Peet, A., Lieberman, M.A., and Marks, A. *Marks' basic medical biochemistry: a clinical approach.* 4th edition, Lippincott Williams & Wilkins (2012).

Course Title: Clinical Biochemistry Laboratory
Course Code: BCH 604

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Fractionation of cell organelles from liver and plant tissues

2. Preparation of Cytochrome C from goat heart

3. Isolation of NAD from brewer's yeast

4. Isolation and estimation of RNA and DNA from yeast, liver, and plants

5. Extraction, separation and determination of absorption spectra of plant pigments

6. Isolation and estimation of serum cholesterol

7. Qualitative and quantitative analysis of:

(i) Saliva (α-amylase)

(ii) Urine (urea, uric acid, glucose, proteins, Bence-Jones proteins, Cl^-, PO_3^{-3}, Ca^{+2})

8. Experiments on blood

(a) Identification and count of blood corpuscles

(b) Estimation of haemoglobin

(c) Determination of A/G ratio in serum

(d) Serum creatinine and uric acid

(e) Serum enzyme assays: alkaline phosphates, SGOT, SGPT

9. Gel Electrophoresis of serum proteins

Course Title: Plant Biochemistry
Course Code: BCH 605

L	T	P	Credits	Marks
3	1	0	3	75

Course Objective: The course covers in detail various aspects of biochemistry involved in plant physiology and metabolism.

Unit A **(10 hours)**

Plant Cell wall: Chemical and physical composition of higher plant cell wall

Photosynthesis: Introduction, photosynthetic pigments, biosynthesis of chlorophyll and its regulation, absorption of sunlight and transfer of the excitation energy of the photons to the reaction canters, van Niel's equation, Hill equation, electron transport in photosynthetic reaction center of purple bacterium, Red drop and Emerson enhancement effect, photosynthetic electron transport chain- Non-cyclic, cyclic and pseudocyclic, reagents affecting photosynthetic electron flow- electron acceptors, electron donors, inhibitors of electron flow and herbicides as inhibitors of photosynthesis, regulation of energy distribution between PS I and PS II, Photophosphorylation- chemiosmotic mechanism, chloroplast ATP synthase, binding change mechanism of ATP synthesis and uncouplers of photophosphorylation. Transport of light- generated ATP from the chloroplast into the cytosol.

Unit B (15 hours)

Pathway of CO_2 assimilation and its regulation in C3, C4, & CAM plantsPhotorespiration-pathway and its role Sucrose and starch: Biosynthesis and regulation of Starch (in chloroplasts and amyloplasts), degradation of starch, biosynthesis and degradation of sucrose, and role of fructose 2, 6- bisphosphate in carbon partitioning between sucrose and starch Plant mitochondrial electron transport chain: Electron transport complexes and pathway of electron flow in plant mitochondria and cyanide - resistant respiratory pathway.

Unit C (10 hours)

Nitrate Assimilation- nitrate uptake, nitrate & nitrite reductases and regulation of nitrate assimilation. Sulphate assimilation: sulphate uptake and assimilation of sulphate into cysteine

Biological N2-fixation: N2 - fixing organisms, structure and mechanism of action of nitrogenase, A brief account of legume-Rhizobium symbiosis, Leghaemoglobin, strategies for protection of nitrogenase against the inhibitory effect of oxygen, hydrogen evolution and uptake, ammonia assimilation, nif genes of Klebsiella pneumoniae including their regulation, synthesis of amides and ureides.

Unit D **(10 hours)**

Biochemical defense mechanisms in plants, plant hormones: Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ABA and ethylene

Reference Books:

1. Buchanan, B., Gruissem, W., and Jones, R.L. *Biochemistry and Molecular Biology of Plants*. 1st edition, Wiley (2002).

2. Lea, P., and Leegood, R.C. *Plant Biochemistry and Molecular Biology.* 2nd edition, John Wiley and Sons (1999).

3. Heldt, H-W., and Piechulla, B. *Plant Biochemistry.* 4th edition, Academic Press (2010).

4. Goodwin, T.W., and Mercer, E.I. *Introduction to Plant Biochemistry*. 2nd edition, Pergamon Press (1990).

5. Taiz, L., and Zieger, E. *Plant physiology.* 5th edition, Sinauer associates Inc. (2010).

Course Title: Plant Biochemistry Laboratory
Course Code: BCH 606

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Estimation of chlorophyll in leaves

2. Estimation of phenols in plant tissues

3. Estimation of free proline in stressed plant tissues

4. Extraction and estimation of free amino acid content in germinating seeds

5. Determination of amylase activity in germinating seeds

6. Estimation of soluble protein content in plant tissue

7. Estimation of starch in plant tissue

8. Assay of nitrate reductase activity from plant tissue

9. Assay of malate dehydrogenase activity from plant tissue

10. Assay of polyphenoloxidase activity from plant tissue

11. Fractionation of seed storage proteins into albumins & globulins

Course Title: Nutritional Biochemistry
Course Code: BCH 607

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course is intended to cover all the basic aspects of biochemistry relevant in human nutrition.

Unit A **(15 hours)**

Basic concepts – Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements. Specific dynamic action of proteins.

Unit B **(15 hours)**

Elements of nutrition – Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions.

Unit C **(15 hours)**

Minerals – Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.

Unit D **(15 hours)**

Malnutrition – Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.

Starvation – Techniques for the study of starvation. Protein metabolism in prolonged fasting.

Obesity – Definition, Genetic and environmental factors leading to obesity.

Reference Books:

1. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

2. Devlin, T.M. *Textbook of Biochemistry with Clinical Correlations.* 7th edition, John Wiley and sons (2010).

3. Grodner, M., Roth, S.L., and Walkingshaw, B.C. *Nutritional Foundations and Clinical Applications: A Nursing Approach.* 5th edition, Mosby (2011).

4. Ross, A.C., Caballero, B., Cousins, R.J., Tucker, K.L., and Ziegler, T.R. *Modern Nutrition in Health & Disease.* 11th edition, Lippincott Williams and Wilkins (2012).

Course Title: Nutritional Biochemistry Laboratory
Course Code: BCH 608

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Analysis of milk and milk products- lactose content of milk by phosphomolybdic acid. Lactose content by benedict titration. Protein content of milk by biuret method. Phosphatase test for pasteurization. Dry weight of milk powder.

2. Phosphorus content of milk powder. Calcium content of milk powder. Riboflavin content of milk powder. Vitamin a content of milk powder.

3. Analysis of cereal products: - dry weight of cereal powder. Ash content of cereal powder. Protein content of cereal powder by Kjeldahl method. Carbohydrate content of cereal powder.

4. Analysis of fats oils:- iodine number, Vitamin A, Vitamin E, Vitamin D, Rancidity of Fat.

5. Detection of adulterants of food: - $NaHCO_3$ in milk. Glucose in milk. Starch in milk. Borax in milk. Argemone oil in oil. Mineral oil in vegetable oil. Dalda in ghee.

6. Chemical estimation of thiamine, riboflavin and niacin in foodstuffs.

Course Title: Biochemical and Environmental Toxicology Laboratory
Course Code: BCH 609

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Qualitative detection of various toxicants in biological samples:

Phenothiazine derivatives, Organochlorine compounds (Fujiwara test), Phenol, Methanol, Arsenic (As), Antimony (Sb), Selenium (Se), Mercury (Hg), Bismuth (Bi), Fluoride (F), Boron (Bo), Gutzeit test for Antimony (Sb) and Arsenic (As), Spot test for metal toxicants.

2. Quantitative determination of Salicylate, Paracetamol (acetaminophen), Sulphonamide in biological samples.

3. Enzyme assay in toxic conditions:

GOT (AST), GPT (ALT), Acid phosphatase, Alkaline phosphatase, Acetyl cholinesterase etc.

4. Construction of dose-response curves.

5. Determination of LD50 value of a toxicant.

6. Induction of hepatotoxicity / diabetes / skin lesions / teratogenesis.

7. Organ / tissue morphology / histopathology

8. Assay of toxicant biotransformation enzyme-cytochrome P450.

9. Test for teratogenecity / carcinogenecity / Ames test.

10. Assay of biomarkers of environmental pollution / toxicity.

DAV UNIVERSITY JALANDHAR

Course Title: Immunology
Course Code: MIC503

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course is to learn basic and advanced immunology.

Unit-A

History of immunology.
Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory.
Lymphocytes : B lymphocyte, T lymphocyte
Antibodies : structure , classes and function **10 hours**

Unit-B

Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors;
Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); **8 hours**
Markers of suppressor / regulatory T cells - CD4+ CD25+
Genetic organization: Organization of the genes for B and T cell receptors.
Genetic organization of MHC-I and MHC-II complex, Peptide loading and expression of MHC-I and MHC-II molecules.
Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors.;
Hybridoma technology and monoclonal antibodies. **12 hour**

Unit-C

Immune response and signaling: Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; **6 hours**
Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, IL-10,IL-12, IL-17, TGFβ; Cell signaling through MAP kinases and NF-κB. **4 hours**
Tolerance and autoimmunity and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases.
6 hours

Unit-D

Immunological disorders and hypersensitivity: Deficiencies / defects of T cells, B cells, complement and phagocytic cells; **4 hours**
Comparative study of Type I-V hypersensitivities with examples. **4 hours**
Transplantation and tumor immunology: Alloreactive response; Graft rejection ; HLA-matching; **3 hours**
Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy of tumors. **3 hours**

60 hours

Reference books

1. Kindt, Thomas J., Goldsby, Richard A. and Osborne, Barbara A. *Kuby Immunology.* 6th edition. W.H. Freeman and Co. Publishers. 2007. Print
2. Murphy, Kenneth. Trevers, Paul and Walpart, Mark. *Janeway's Immunobiology.* Garland Science Publishers. 2012. Print.
3. Roitt, Ivan M. and Delves, Peter J. *Roitt's Essential Immunology.* 10th edition. Blackwell Publishing Limited. 2001. Print.
4. Paul, William E., Williams, Lippincott and Wilkins, *Fundamental Immunology.* 6th edition. Wolters Kluwer business. 2008. Print.

Course Title: Immunology Lab
Course Code: MIC507

L	T	P	Credits	Marks
0	0	2	1	25

1. Agglutination of bacteria
2. SDS-PAGE electrophoresis
3. Separation of IgG by ammonium sulfate precipitation
4. Reduction of IgG with mercaptoethanol to four chain
5. Papain digestion of IgG
6. Pepsin digestion of IgG
7. Gel precipitation
8. ELISA
9. Western Blotting
10. Separation of white blood cells from blood
11. Total leukocyte count and differential leukocyte count
12. Blood typing

30 hours

DAV UNIVERSITY JALANDHAR

Course Title: Recombinant DNA technology
Course Code: BTY551

L	T	P	Credits	Marks
4	**0**	**0**	**4**	**100**

Course objective: The basic objective of the paper is to present the principles of gene manipulation and its associated technologies. How developments in gene manipulation have revolutionized medicine, agriculture and health.

- Introduction and scope of Recombinant DNA Technology. **2 hour**
- DNA modifying enzymes- Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases, Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing, Restriction Endonucleases. **8 hours**
- Isolation and Purification of nucleic acid: Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA. **4 hours**
- Cloning and expression vector: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors. **10 hours**
- Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes. **4 hours**
- DNA Cloning Strategies: Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone. **6 hours**
- Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting. **4 hours**
- Expression of cloned genes :Expression of cloned genes in *E. coli*, *Bacillus subtilis*, s*treptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes. **8 hours**
- Protein-Protein interactions-Phage display (*in vivo*, *in vitro* and *in planta*, Yeast two hybrid system, Yeast three hybrid system. Bicomplementation and Florescence Resonance Energy Transfer (FRET). **3 hours**
- Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, random mutagenesis, site-directed mutagenesis and protein engineering. **4 hours**
- Impact of rDNA on human genetics: Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope.
  - **4 hours**

- Applications of r-DNA technology in industry, agriculture and forensic science.

3 hours

Books:

1. Brown, T.A. *Gene cloning and DNA analysis: An introduction*. 5th Edition. Wiley-Blackwell. 2010. Print.
2. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition. Cold Spring Harbor Laboratory, 1989. Print.
3. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. *Recombinant DNA: Genes and Genomes.* 3rd Edition. W.H. Freeman & Company. 2006. Print.
4. Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation & Genomics.* 7th Edition. Oxford University Press. 2006. Print.
5. Lodge, J., Lund, P. and Minchin, S. Gene Cloning: Principles and Applications. 1st Edition. Taylor & Francis. 2006. Print.
6. Glick, B.R., Pasternak, J.J. and Patten, C.L. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition. ASM Press. 2009. Print.

DAV UNIVERSITY JALANDHAR

Course Title: Recombinant DNA technology-LAB
Course Code: BTY555

L	T	P	Credits	Marks
0	**0**	**3**	**2**	**50**

1. Preparation and purification of pUC plasmid.
2. Preparation and purification of genomic DNA
3. Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
4. Gene cloning
5. Bacterial transformation
6. Southern blotting and hybridization with non-radioactive probes.
7. Amplification of DNA with PCR Temperature cycler.

Course Title: Molecular Biology
Course Code: BTY502

L	T	P	Credits	Marks
4	**1**	**0**	**4**	**100**

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

- Introduction to molecular biology, basic techniques in molecular biology. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA protein interaction, DNA super coiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination. **12 hours**
- Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA & tRNA. **12 hours**
- Protein synthesis and processing: Ribosome structure, genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, Post- translational modification of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome. **10 hours**
- Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Cell signaling: signal transduction pathways and their regulation. **10 hours**
- Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, and strategies for sequencing genome, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. **8 hours**
- Photoregulation and phytochrome regulation of nuclear and chloroplastic gene expression. Molecular mechanism of nitrogen fixation. Molecular biology of various stresses, viz. abiotic stresses like drought, salt, heavy metals and tempreture; and biotic stresses like bacterial, fungal and viral disease. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. **8 hours**

Books:

1. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print.
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. *Lewin's GENES XI.* 11th Edition. Jones & Bartlett Learning. 2012. Print.
3. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition. Cold Spring Harbor Laboratory, 1989. Print.
4. Watson, J.D. *Molecular Biology of the Gene.* 7th Edition. Benjamin Cummings. 2013. Print.

Course Title: Molecular Biology-LAB

DAV UNIVERSITY JALANDHAR

L	T	P	Credits	Marks
0	**0**	**2**	**1**	**25**

Course Code: BTY506

1. Isolation of genomic DNA from bacteria.
2. Isolation of genomic DNA from plant.
3. Isolation of total RNA from tissue.
4. Demonstration of DNA protein interaction.
5. Quantitation of nucleic acids and proteins.
6. Gel electrophoresis:
   - Nucleic acid
   - Protein

DAV UNIVERSITY JALANDHAR

L	T	P	Credits	Marks
4	1	0	4	100

Course Title: Biostatistics
Course Code: BTY553

Course objective: The course aims to develop expertise in the application of statistical methods applied to biological data obtained in experimental findings.

- Brief description and tabulation of data and its graphical representation. Measures of Central Tendency (Mean, Median, Mode), Measures of dispersion (Range, Mean Deviation, Standard Deviation, Quartile Deviation), combined mean and variance, covariance, Graphs (Bar Chart, Pie Chart, Box Plot, Histogram, Ogive, scatter plot) Probability: Experimental probability, probability when outcomes are equally likely, subjective probabilities. **12 hours**
- Probability (Addition and Multiplication Theorem), Bayes theorem, Binomial, Poisson and Normal distribution. Correlation and linear regression **8 hours**
- Random variables and distributions, Discrete and continuous random variables, Cumulative distribution function, Probability mass function and probability, Density function, Expectation of random variable– experimental Approach and theoretical approach. **10 hours**
- Formulation of Hypothesis (One-tailed & Two-tailed), Type I and Type II errors, power of a test, Significance of a test, P-value testing, Hypothesis Testing (students T-test, Chi-square test). Analysis of variance (ANOVA) one and two way. Pearson correlation test. **8 hours**
- Biological experimental designs- CRD, RBD, factorial designs, latin square designs. **6 hours**
- Application of statistics biological experimental design: Data collection and explanation and conclusion case studies. **8 hours**
- Sampling theory and different techniques,Applications of statistical methods using statistical software , SAS. **8 hours**

Books:

1. Banerjee, P.K. *Introduction to Biostatistics.* 4th Edition. S. Chand & Co. Ltd. 2013. Print.
2. Sokal, R.R. and Rohlf, F.J. *Introduction to Biostatistics*. 2nd Edition. Dover Publications. 2009. Print.
3. Daniel, W.W. and Cross, C.L. *Biostatistics: A foundation for analysis in the Health Sciences*. 10th Edition. John Wiley and Sons. 2013. Print.
4. Arora, P.N. and Malhan, P.K. *Biostatistics*. Himalaya Publishing House. 2012. Print.
5. Forthfer, R.H., Lee, E.S. and Hernandez, M. *Introduction to Biostatistics*. Academic Press. 2006. Print.
6. Gupta, S.P. *Statistical Methods*. 43rd Edition. S.Chand & Co. 2013. Print.

Course Title: Biostatistics – LAB
Course Code: BTY557

L	T	P	Credits	Marks
0	**0**	**3**	**2**	**50**

Experiments based on measures of central tendency.
Experiments based on measures of dispersion.
Experiments based on analysis of data obtained in lab for different biological experiments
Questions based on various distributions like Binomial, Poisson, Bernoulli.
Practical on question of probability.
Practical based on hypothesis testing.
Biological experimental designs- CRD, RBD, factorial designs, latin square designs.

DAV UNIVERSITY JALANDHAR

L	T	P	Credits	Marks
4	**1**	**0**	**4**	**100**

Course Title: Genomics, Proteomics and Metabolomics
Course Code: BTY652

Course Objective: The aim of the course is to provide students practical and bioinformatical skills in genomics, transcriptomics, proteomics and metabolomics, knowledge and the notion about how the methods are applied in real-life scientific research.

- Introduction to –omes and –omics. Gene, Genome and Genomics. **2 hour**

- Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries. Genome analysis for global patterns of gene expression using fluorescent-labelled cDNA or end-labelled RNA probes.
  - **6 hours**

- FISH, Sequencing: Conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing, analysis of sequence information FISH. Analysis of single nucleotide polymorphism using DNA chips. **4 hours**

- Transcriptomics. Microarray, EST, SAGE. Bioinformatical methods in transcriptomics. Application of transcriptomics. Genome sequencing projects (technology of sequencing and assembly, bioinformatics of genome annotation, current status of genome sequencing projects) Genomic browsers and databases Orthology prediction (comparative genomics), Search for transcription factor binding sites (TFBS), Computational prediction of miRNA target genes *De novo* prediction of regulatory motifs in genome, Single nucleotide polymorphisms (SNP) in medical genetics and basic research. **10 hours**

- Next generation sequencing using new technologies. Alignment of pairs of sequences of DNA and proteins. Multiple sequence alignment. Searching databases for similar sequences. Phylogeny: Different approaches to tree construction. Analyze sequences and its role in understanding the evolution of organisms and genes. **6 hours**

- **Proteomics.** Aims, strategies and methods. Bioinformatics tools in proteomics. Application of proteomics. Protein microarrays. Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry, yeast 2-hybrid system. Protein-protein interactions: experimental and computational methods, databases. **8 hours**

- Types of data and databases, quality of annotation. Protein structure prediction. The proteome. High throughput proteomics and its use to the biologists. **4 hours**

- Novel approaches to protein expression analysis: Scope of functional proteomics. Proteome analysis: 2DE based strategy. Alternatives to 2DE for protein expression analysis. **5 hours**

- Application of proteome analysis to drug development and toxicology: Basic principle and making use of the data. **4 hours**

- Protien-DNA interactions. Cancer profiling using DNA microarrays. Proteomics as tool for plant genetics and breeding. **5 hours**

- Introduction to metabolomics. Technologies in metabolomics. Nutrigenomics. Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics. Metabolic pathways resources: KEGG, Biocarta. Nutrigenomics and metabolic health. Solved problems and future challenges. **6 hours**

Books:

1. Gibson, G. and Muse, S.V. *A primer of genome science.* 3rd Edition. Sinauer Associates, Inc. Sunderland, MA. 2009. Print.
2. Jurisica, I. and Wigle, D. *Knowledge discovery in proteomics*. 1st Edition. Chapman & Hall / CRC). 2004. Print.
3. Pennington, S.R. and Dunn, M.J. *Proteomics: From protein sequence to function.* 1st Edition. Springer-Verlag Telos. 2001. Print.
4. Srivastava, S. *Informatics in proteomics.* 1st Edition. Taylor & Francis Group / CRC. 2005. Print.
5. Akay, M. *Genomics and proteomics engineering in medicine and biology.* 1st Edition. Wiley-IEEE Press. 2007. Print.
6. Sensen, C.W. *Essentials of genomics and bioinformatics.* 1st Edition. Wiley-Blackwell. 2002. Print.
7. Baxevanis, A.D., Francis Ouellette, B.F. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. 3rd Edition. Wiley-Interscience. 2004. Print.

Course Title: Genomics, Proteomics and Metabolomics-LAB
Course Code: BTY656

L	T	P	Credits	Marks
0	0	3	2	50

- Site directed mutagenesis. Deleting a DNA sequence from a plasmid and introduction into *E. coli.*
- Functional validation of gene expression.
- Analysis of mutants using Southern blot and PCR analysis.
- Introduction to DNA sequencing.

Course Title: Organic and Biophysical Chemistry
Course Code: CHE651

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course is intended to learn the basic concepts of organic and biophysical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Learning Outcomes: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of organic and bio-physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in the course.

PART A

Organic Chemistry **(11 Hrs)**

Electronic theory of valency, dipole moments. Electronic displacements in a molecule: inductive effect, electronic effect, resonance. The hydrogen bond, hydrophobic interactions. Atomic and molecular orbitals. Shapes of biomolecules, hybridization and tetracovalency of carbon.**Isomerism:** Structural isomerism, stereoisomerism, geometrical isomerism (E & Z nomenclature)

Types of organic chemical reactions: Substitution, addition, elimination, rearrangement, condensation and polymerization.

PART B

Free radicals in biological systems **(10 Hrs)**

Oxygen as a free radical in the auto oxidation of fats. Antioxidants – Vitamin A, Vitamin E, Vitamin C

Mechanism of substitution in the benzene ring: o-, p- and m-directing groups. The concept of resonance with reference to benzene derivatives. Direct influence of substituents – electronic interpretation.

PART C

(13 Hrs)

Stereochemistry: Optical Isomerism, optical activity, meso-compounds, specific rotation, chirality, chiral center, enantiomers, diastereoisomers, D-L, R-S, threo-erythro notations, conformation and configuration, dihedral angles, conformational analysis of ethane, n-butane,

cyclohexane, mono- and di-substituted cyclohexane, monosaccharides - boat and chair forms, eclipsed, gauche and staggered conformations, axial and equatorial bonds, Anomers and mutarotation, glycoside, epimers, glucopyranose, fructopyranose, periodic acid oxidation of sugars.

Heterocyclic systems occurring in living systems: Numbering of the ring and properties of pyran, furan, thiozole, indole, pyridine, pyrimidine, quinone, purine and pteridine.

PART D (13 Hrs

Thermodynamics studies in chemistry and biochemistry: Open, closed and isolated system. First law of thermodynamics, heat of formation and heat of reaction, second law of thermodynamics, molecular basis of entropy, Helmholtz and Gibbs free energy, third law of thermodynamics and calculation of entropy, application of the first and second law of thermodynamics in understanding energies in living cells, chemical potential, equilibrium constant.

Types of electrodes, standard electrode potential and its determination, its relationship with emf, electron transfer measures. Phosphate group transfer potentials, coupled reactions.

Water: Physical properties and structure of water, hydrogen bonding, ionization of water, pH scale, acids-bases, Henderson-Hasselbalch equation, buffers, ionization behaviour of amino acids and proteins, titration curve, buffer solutions and their action.

Reference Books:

1. Nelson, David L., and Cox, Michael M., Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman & Company, New York, 2008. Print.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. 7th edition, W.H. Freeman, 2010. Print.

3. Voet, Donald and Voet, Judith G., Biochemistry, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.

4. Wold, F. *Macromolecules: Structure and Function,* Prentice Hall, 1971.

5. Billmeyer, F.W. *Text Book of Polymer Science.* 3rd edition, 1984.