

Credit Matrix, Course of Study and Scheme of Examination for M.Sc. Degree Programme in Biochemistry

(With effect from 2019-20)

Programme Code: BIC

Course Type	Credits to be earned				Total Credits
	I Semester	II Semester	III Semester	IV Semester	
Hard Core Course	12	12	12	16	52
Soft Core Course	04	04	04	–	12
Elective Course	04	04	–	–	08
Open Elective Course*	–	–	04	–	04
Semester Total	20	20	20	16	76

*An Open Elective course offered by PG Dept. of Biochemistry to the students of other Depts.

Course Code	Course Type	Course Title	Credit Pattern (L:T:P)	Credits
Semester – I				
BCA040	HC	Analytical Biochemistry–I	3:1:0	4
BCA050	HC	Chemistry and Metabolism of Proteins and Nucleic Acids	3:1:0	4
BCA060	HC	Experiments in Biochemical Techniques and Enzymology** and Seminar	0:0:4	4
BCA230	SC	Enzymology	3:1:0	4
BCA250	Choose any ONE from the following		3:1:0	4
	SC	(i) Chemical Principles and Biochemical Reactions (ii) Plant Biochemistry (iii) Microbial Biochemistry		
Semester Total Credits				20

Course Code	Course Type	Course Title	Credit Pattern (L:T:P)	Credits
Semester – II				
BCB040	HC	Analytical Biochemistry–II	3:1:0	4
BCB050	HC	Chemistry and Metabolism of Carbohydrates and Lipids	3:1:0	4
BCB060	HC	Experiments in Immunology and Biochemical Estimations** and Seminar	0:0:4	4
BCB250	SC	Immunology and Microbiology	3:1:0	4
BCB260	Choose any ONE from the following		3:1:0	4
	SC	(i) Human Physiology and Nutrition (ii) Research Methodology and Biostatistics (iii) Clinical Research Methods and Industrial Biochemistry		
Semester Total Credits				20

Course Code	Course Type	Course Title	Credit Pattern (L:T:P)	Credits
Semester – III				
BCC070	HC	Cell Biology, Endocrinology and Cell Signaling	3:1:0	4
BCC050	HC	Clinical Biochemistry	3:1:0	4
BCC060	HC	Experiments in Clinical Biochemistry and Molecular Biology** and Research Paper Presentation	0:0:4	4
BCC220	Choose any ONE from the following		4:0:0	4
	SC	(i) Genomics, Proteomics and Bioinformatics (ii) Biotechnology (iii) Pharmaceutical Biochemistry		
BCC630	OE	Nutrition and Health	4:0:0	4
Semester Total Credits				20

Course Code	Course Type	Course Title	Credit Pattern (L:T:P)	Credits
Semester – IV				
BCD010	HC	Molecular Biology and Gene Regulation	3:1:0	4
BCD070	HC	Genetics and Genetic Engineering	3:1:0	4
BCD060	HC	Project Work OR Dissertation***	0:4:4	8*
Semester Total Credits				16
Total CREDITS to be earned for M.Sc. BIOCHEMISTRY				76

* Grade Point will be calculated with respect to the allotted credits

HC	Hard Core Course
SC	Soft Core Course
E	Elective Course
OE	Open Elective Course
C1	Component 1 of Internal Assessment (IA)
C2	Component 2 of Internal Assessment (IA)
C3	Component 3 (Semester-end Exam)
L	Lecture (1 Credit=1 hr)
T	Tutorial (1 Credit=2 hrs)
P	Practical (1 Credit=2 hrs)

** Weekly Four hrs of practical for Two days

*** Project work OR Dissertation should be in-house only and may be allotted to the students in the 2nd/3rd semester

Note: Two Practical examinations of four hrs duration each for C3 (component 3) of Hardcore Course with Practical Component Only.

SCHEME OF ASSESSMENT

Course Code	Course Type	Course Title	Exam Hrs	Max. Marks			
				IA		Exam C3	Total
				C1*	C2*		
Semester - I							
BCA040	HC	Analytical Biochemistry–I	3	15	15	70	100
BCA050	HC	Chemistry and Metabolism of Proteins and Nucleic Acids	3	15	15	70	100
BCA060	HC	Experiments in Biochemical Techniques and Enzymology and Seminar	–	15	15	70	100
BCA230	SC	Enzymology	3	15	15	70	100
BCA250	Choose any ONE from the following		3	15	15	70	100
	E	(i) Chemical Principles and Biochemical Reactions (ii) Plant Biochemistry (iii) Microbial Biochemistry					
Semester Total Marks							500

Course Code	Course Type	Course Title	Exam Hrs	Max. Marks			
				IA		Exam C3	Total
				C1*	C2*		
Semester - II							
BCB040	HC	Analytical Biochemistry–II	3	15	15	70	100
BCB050	HC	Chemistry and Metabolism of Carbohydrates and Lipids	3	15	15	70	100
BCB060	HC	Experiments in Immunology and Biochemical Estimations and Seminar	–	15	15	70	100
BCB250	SC	Immunology and Microbiology	3	15	15	70	100
BCB260	Choose any ONE from the following		3	15	15	70	100
	SC	(i) Human Physiology and Nutrition (ii) Research Methodology and Biostatistics (iii) Clinical Research Methods and Industrial Biochemistry					
Semester Total Marks							500

Course Code	Course Type	Course Title	Exam Hrs	Max. Marks			
				IA		Exam C3	Total
				C1*	C2*		
Semester - III							
BCC070	HC	Cell Biology, Endocrinology and Cell Signaling	3	15	15	70	100
BCC050	HC	Clinical Biochemistry	3	15	15	70	100
BCC060	HC	Experiments in Clinical Biochemistry and Molecular Biology and Research Paper Presentation	–	15	15	70	100
BCC220	Choose any ONE from the following		3	15	15	70	100
	SC	(i) Genomics, Proteomics and Bioinformatics (ii) Biotechnology (iii) Pharmaceutical Biochemistry					
BCC630	OE	Clinical Research and Drug Development	3	15	15	70	100
Semester Total Marks							500

Course Code	Course Type	Course Title	Exam Hrs	Max. Marks			
				IA		Exam C3	Total
				C1*	C2*		
Semester - IV							
BCD010	HC	Molecular Biology and Gene Regulation	3	15	15	70	100
BCD070	HC	Genetics and Genetic Engineering	3	15	15	70	100
BCD060	HC	Project Work OR Dissertation**	–	15	15	70	100
Semester Total Marks							300

- C1* & C2* Internal test will be conducted for 20 marks of one hour duration and it is reduced to 10 marks + 5 marks for continuous assessment
- Continuous assessment comprise of assignments, group discussions, seminars and tutorials
- ** The Project evaluation is as below
 - Component 1 (C1): Periodic Progress Report (15%)
 - Component 2 (C2): Periodic Progress Report (15%)
 - Component 3 (C3): Final Viva-Voce and Evaluation (70%)
 - (The report evaluation is for 40% and the Viva-Voce examination is for 30%)

Program Outcome(s):

PO	PO Code	Group
Provides with the necessary knowledge and skills to undertake a career in research, either in industry or in an academic setting	PO1	2019
Provides the breadth and depth of scientific knowledge in 'Biochemistry' and allied areas	PO2	2019
Equips to apply for a PhD or to gain employment in biochemistry and allied areas	PO3	2019
Provides a substantial element of hands-on research experience, with enhanced experimental skills	PO4	2019
Demonstrates detailed knowledge and understanding of the principles and theories of biochemistry	PO5	2019
Helps to understand the principal techniques of biomolecular structural characterization, including spectroscopy	PO6	2019

Program Specific Outcome(s): The Specific Outcome of this programme is to train and provide the candidate with knowledge related to

PSO	PSO Code	Group
Global level research opportunities to pursue PhD programme targeted approach of CSIR–NET examination	PSO1	2019
Enormous job opportunities at all level of chemical, pharmaceutical, food products, life oriented material industries	PSO2	2019
Specific placements in R & D and Quality Control or Analysis division of nutraceutical, pharmaceutical industries & Allied Division	PSO3	2019

Course Code	Title of the Course	Credits
BCA040	ANALYTICAL BIOCHEMISTRY–I	4

COURSE OUTCOME(S):

- CO1 Specify in depth cell fractionation techniques
- CO2 Write down in details with application, if applicable, chromatography and spectroscopy
- CO3 Write down in details with application, if applicable, principle and applications of electrophoresis
- CO4 Understand the classification and characteristics of centrifugation and microscopy

		No. of Lectures
Unit I:		08
1.1	Cell Fractionation	
1.1.1	<u>Cell fractionation techniques</u> : Preparation of extracts for biochemical investigations. Physico-chemical properties of solvents, solubility and miscibility, salting-in and salting-out.	
1.1.2	Choice of solvent for solvent extraction, mixed solvents, solid phase extraction. Cell lysis, dialysis, precipitation and ultra filtration.	

Unit II:		14
2.1	Chromatography and Spectroscopy	
2.1.1	Adsorption <u>vs.</u> Partition chromatography. Paper, TLC, Ion exchange, Reverse phase, Gel filtration, Affinity, HPLC, and Gas chromatographic techniques.	
2.1.2	Beer-Lamberts Law, Its verifications and Deviations, Concept of Absorptions, Transmission, Scattering, Phosphorescence, Fluorescence, Luminescence, Diffraction Spectra.	
2.1.3	Principle, instrumentation, working and applications of-UV and Visible Spectroscopy,	
2.1.4	Turbidometry and Nephelometry.	

Unit III:		12
3.1	Electrophoresis	
3.1.1	Theory of electrophoresis, continuous and discontinuous PAGE, SDS-PAGE.	
3.1.2	Other electrophoretic methods-Isoelectric focusing, 2-dimensional gel electrophoresis, Capillary electrophoresis and PFGE.	
3.1.3	Agarose gel electrophoresis of nucleic acids. Isotachopheresis.	
3.1.4	Separation of proteins, lipoproteins, visualizing separated	

	components–staining, fluorescence, PAS staining, zymogram and reverse zymogram,	
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Unit IV:		
4.1	Centrifugation and Microscopy	
4.1.1	Analytical and Preparative Ultracentrifuge–Principle, instrumentation and applications.	14
4.1.2	Analysis of subcellular fractions, marker enzymes and determination of relative molecular mass–Svedberg's constant, sedimentation velocity and sedimentation equilibrium.	
4.1.3	Theories of Tissue Fixation and Staining Techniques. Principles of Transmission and Scanning Electron Microscopy.	
4.1.4	Principles of Phase Contrast and Fluorescence Microscopy, Confocal Microscopy	

References

- [1] Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
- [2] Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
- [3] Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
- [4] Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
- [5] Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
- [6] Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
- [7] Basic Mathematics for Biochemists; Cornish Bowden, Oxford University Press (1998),.
- [8] Biophysical Tools for Biologists *In Vivo* Techniques; John Correia H. Detrich, III Elsevier (2008).
- [9] Practical Biochemistry by Keith Wilson and Walker 5th ed. Cambridge.
- [10] Biophysical chemistry, Upadhyaya, A., Upadhyaya, K. and Nath, N. Himalayan Publishing House.
- [11] Practical biochemistry- Principles and Techniques. Wilson and Walker. J.Cambridge Uni. Press.
- [12] Physical Biochemistry-David Freifelder, 2nd Edition.
- [13] Principles of Instrumental Analysis. 5th Ed. Douglas A Skoog, James Holler and Timothy A Nieman.
- [14] Introduction to Electron Microscopy for Biologists; Terry Allen, Academic Press (2008).

Course Code	Title of the Course	Credits
BCA050	CHEMISTRY AND METABOLISM OF PROTEINS AND NUCLEIC ACIDS	4

COURSE OUTCOME(S):

- CO1 Identify the details of amino acids and proteins
- CO2 Understand in details with application, if applicable, nitrogen metabolism and degradation
- CO3 Write down the classification and characteristics of synthesis of amino acids and proteins
- CO4 Write down in details with application, if applicable, metabolism of nucleic acids

		No. of Lectures
Unit I:		
1.1	Chemistry of Amino acids and Proteins	
1.1.1	Classification and structure of 20 amino acids, newly discovered amino acids, essential, non-essential, unusual and non-protein	10
1.1.2	General properties of aa, acid-base titrations, pKa Peptide bond-stability and formation, chemical synthesis of peptide. Primary structure and determination, GN Ramachandran plots	
1.1.3	Secondary structure and motifs, α helix, β sheet, Leucine zipper, Zinc finger	
1.1.4	Tertiary & Quaternary structure (myoglobin, hemoglobin) Protein-protein interactions (actin, tubulin) Small peptides (glutathione, peptide hormones), Cyclic peptides (Gramicidin)	
1.1.5	Classification of proteins-globular, fibrous, membrane, metallo-proteins, Denaturation (pH, temperature, chaotropic agents), refolding, Role of chaperones in folding	
Unit II:		
2.1	Nitrogen Metabolism and Degradation of Amino Acids	
2.1.1	Nitrogen cycle, Nitrogen fixation – symbiotic and non-symbiotic, Nitrogenase complex. Assimilation of ammonia	14
2.1.2	Metabolic fate of dietary proteins and amino acids Degradations to glucose and ketone bodies	
2.1.3	Amino acids degraded to Pyruvate, Oxaloacetate	
2.1.4	Amino acids degraded to Acetyl-CoA, Succinyl-CoA Metabolism of branched chain amino acids, urea cycle, regulation of urea cycle	
2.1.5	Genetic defects in metabolism of amino acids (albinism, Phenylketonuria, maple syrup urine disease, homocystinuria, alkaptonuria, methyl malonic Acidemia)	

Unit III:		
3.1	Biosynthesis of Amino Acids and Protein Degradation	
3.1.1	Biosynthesis of amino acids and regulation of amino acid metabolism	08
3.1.2	Biosynthesis and degradation of heme	
3.1.3	Biosynthesis of polyamines, creatine, gramicidine and glutathione	
3.1.4	Biosynthesis and degradation of glycoproteins and proteoglycans	
3.1.5	Protein degradation pathway–Ubiquitin–Proteosome pathway, lysosomal pathway	

Unit IV:		
4.1	Chemistry and Metabolism of Nucleic Acids	
4.1.1	Purines, pyrimidines, nucleosides, nucleotides, unusual bases. Structure of DNA – Watson Crick Model, A- and Z- forms.	16
4.1.2	Supercoiling of DNA – negative and positive, linking number	
4.1.3	Structure of RNA, tRNA, rRNA, siRNA / miRNA Denaturation and renaturation, T _m (factors affecting T _m) and Cot curves, Isolation and purification of nucleic acids from biological sources.	
4.1.4	Biosynthesis of purines and pyrimidines, Degradation of purines and pyrimidines, Regulation: de novo, salvation, nucleotide analogs, conversion of nucleotides to deoxynucleotides, mechanism of action of methotrexate, 5-fluorouridine, azathymidine.	
4.1.5	Gout and Lesch–Nyhan syndrome	
4.1.6	Biosynthesis of NAD, FAD and Co–enzyme A	

References	
[1]	Lehninger Principles of Biochemistry 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman and Company.
[2]	Biochemistry by Lubert Stryer. WH Freeman and Co.
[3]	Biochemistry: The Molecular Basis of Life by Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
[4]	Biochemistry and Molecular biology By William H. Elliott and Daphne C. Elliott. Oxford University Press.
[5]	Biochemistry 3rd Ed. By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
[6]	Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 by D Voet. John Wiley and Sons.

Course Code	Title of the Course	Credits
BCA060	EXPERIMENTS IN BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY AND SEMINAR	4

COURSE OUTCOME(S):

- CO1 Identify the details of spectrophotometer
 CO2 Identify the details of specific activity of enzymes
 CO3 Deliberate the characteristics of gel electrophoresis
 CO4 Deliberate the characteristics of use of pipettes

Group I:	1. Determination of Normality, Molarity and Molality of solutions 2. Preparation of buffers: Acetate, Phosphate and Tris buffer 3. Colorimetry–Beer's law and its applications 4. Determination of Molar Extinction Coefficient 5. Chromatography–Separation of amino acids by ascending, descending, circular paper chromatography 6. TLC of amino acids 7. Gel filtration, Ion exchange chromatography	
Group II:	8. Estimation of protein by Lowry's method. 9. Estimation of protein by Biuret reagent method. 10. Estimation of amino acids by Ninhydrin method 11. Isolation of casein from milk and its quantification 12. Electrophoresis–Separation of proteins by Native and SDS-PAGE 13. Determination of pK_a and pI of amino acid, formal titration. 14. Separation of nucleic acids by agarose gel electrophoresis	
Group III:	15. Isolation of microbes from air, soil and water 16. Gram's staining 17. Determination of growth curve of bacteria 18. Antibiotic sensitivity tests 19. Determination of specific activity of <ol style="list-style-type: none"> (i) Acid Phosphatase (ii) Alkaline Phosphatase (iii) Salivary Amylase (iv) Protease (v) Invertase (vi) Aminotransferase 	
Group Study	Extraction, Isolation, Purification and enzyme characterization. Determination of specific activity, optimum pH, temperature, time and energy of activation. Determination of K_m and V_{max} Enzyme inhibition studies	

References

- [1] Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
- [2] Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
- [3] Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
- [4] Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
- [5] Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
- [6] Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
- [7] Physical Biochemistry, Kansal Edward Van Halde. Prentice Hall.
- [8] Modern Experimental Biochemistry R.F.Boyer [Ed.] (1986) Addition Wesley.
- [9] Analytical Biochemistry; D.J. Holme and H. Pick Longman (1983).
- [10] Principles and techniques of Biochemistry and Molecular Biology; Keith Wilson and John Walker; 6th Edn. (2005) Cambridge University Press.
- [11] Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.

Course Code	Title of the Course	Credits
BCA230	ENZYMOLGY	4

COURSE OUTCOME(S):

- CO1 Write down in details with examples enzyme kinetics
CO2 Identify in details with examples enzyme catalysed reactions
CO3 Identify the characteristics of cooperativity reactions
CO4 Learn the classification and characteristics of multienzyme complex reactions

		No. of Lectures
Unit I:		16
1.1	Enzyme Kinetics and Inhibition	
1.1.1	Nature of enzymes, Nomenclature and IUB classification of enzymes, Units of enzyme activity, IU and activity and specific activity. Localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes. Assay methods—coupled enzyme assays, continuous, end point and kinetic assay.	
1.1.2	<u>Enzyme Kinetics</u> : Rate of a reaction, order and molecularity. Michaelis Menten equation, initial velocity approach, steady state approach. Vmax, Km and their significance. Linear transformation of Michaelis Menten equation—Lineweaver Burk plot, Eadie Hofstee, Haynes–Wolf and Cornish–Bowden.	
1.1.3	<u>Inhibition</u> : Reversible inhibition—Competitive, Non competitive and Uncompetitive, product inhibition, irreversible inhibition—suicide inhibition. Determination of <i>K_i</i> . Fast reactions—Stopped flow, temperature jump method with examples of enzymes.	
Unit II:		08
2.1	Enzyme Catalyzed Reactions	
2.1.1	Bisubstrate enzyme catalysed reactions—Cleland's notation with examples for ordered, ping pong, and random.	
2.1.2	General rate equation. Primary and secondary plots. Mechanisms of enzyme catalysis—Active site structure and its investigation.	
2.1.3	Methods of determining active site structure—isolation of ES/EI complex, affinity labeling, chemical modification studies.	

Unit III:		
3.1	Enzyme Catalysis and Cooperativity	
3.1.1	<u>Nature of enzyme catalysis</u> : Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophilic catalysis, intramolecular catalyses, entropy effects.	12
3.1.2	Effect of temperature and pH on enzyme catalyzed reactions.	
3.1.3	<u>Oligomeric proteins and Cooperativity</u> : Binding of ligands to macromolecules–Scatchard plot, Positive and Negative cooperativity. Oxygen binding to hemoglobin.	
3.1.4	Hill equation, homotropic and heterotropic effectors. Allosteric enzyme–Aspartyl transcarbamylase.	

Unit IV:		
4.1	Multienzyme Complex and Coenzymes	
4.1.1	<u>Mechanisms of action of specific enzyme</u> : Chymotrypsin zymogen activation, acid–base catalysis, charge relay net work. Lysozyme, alcohol dehydrogenase, ribonuclease, Carboxypeptidase–A, RNA as enzyme, coenzymic action of NAD+ FAD, TPP, PLP, biotin, CoA, folic acid and lipoic acid.	12
4.1.2	<u>Multienzyme complexes</u> : Isoenzymes, eg. LDH. Multifunctional enzyme (DNA polymerase) multi enzyme complex (PDC)	
4.1.3	Metabolic regulation of enzyme activity–Feedback regulation.	

<p>References</p> <p>[1] Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).</p> <p>[2] Enzymes; Trevor Palmer, East - West Press Pvt. Ltd., Delhi (2004).</p> <p>[3] Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).</p> <p>[4] Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).</p> <p>[5] Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.</p> <p>[6] The Enzymes; Boyer, Academic Press, (1982).</p> <p>[7] Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) Academic Press.</p> <p>[8] Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), Blackwell Science.</p>
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Course Code	Title of the Course	Credits
BCA250	CHEMICAL PRINCIPLES AND BIOCHEMICAL REACTIONS	4

COURSE OUTCOME(S):

- CO1 Specify in details with examples chemical principles and bonding
 CO2 Write down in depth thermodynamics
 CO3 Learn in details with application, if applicable, stereochemistry
 CO4 Deliberate in depth secondary metabolites

		No. of Lectures
Unit I:		16
1.1	Chemical Principles and Bonding	
1.1.1	<u>Chemical principles</u> : Acids and bases, Buffers. Buffering capacity. Ionic strength- Molarity, Normality, Mole concept, Avogadro number, structure and special properties of water.	
1.1.2	<u>Bonding</u> : Covalent bond, ionic bond, Coordinate bond. Coordinate bond formation by transition metals in biological complex structures.	
1.1.3	Crystal field theory, ligand field theory, valence bond theory.	
1.1.4	Bonding of iron in hemoglobin and cytochromes, cobalt in Vit B12, and Mg ²⁺ in chlorophyll. Chelates and complexes.	

Unit II:		08
2.1	Thermodynamics	
2.1.1	<u>Physiological importance of electrolytes</u> : Osmotic pressure, vapour pressure, vapour pressure osmometer, Donnan membrane equilibrium.	
2.1.2	<u>Introduction to thermodynamics</u> : I, II and III law. Enthalpy, entropy and free energy. Free energy and chemical equilibrium	
2.1.3	<u>Electrodes</u> : Hydrogen electrode, oxygen electrode, oxidation and reduction reactions, redox potential.	

Unit III:		12
3.1	Stereochemistry and Heterocyclic Compounds	
3.1.1	Importance of Stereochemistry, position and order of groups around carbon. Geometric and optical isomerism, absolute and relative configuration. Symmetry view of chirality, relation between chirality and optical activity, representation of chiral structures by Fischer.	
3.1.2	Structure and stereochemistry of glucose—anomers, epimers and stereoisomers, D and L, + and – R and S notations.	
3.1.3	Heterocyclic Compounds: Chemistry, biological	

	occurrence of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole.	
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Unit IV:		
4.1	Organic Reactions and Secondary Metabolites	
4.1.1	Mechanism of Organic Reactions: Classification of organic reactions. Reaction intermediates, reaction energetics, rate, order and molecularity of reactions.	12
4.1.2	Mechanisms and stereochemistry of substitution, addition, and elimination. Rearrangements reactions. Mechanisms of ester hydrolysis. Aromaticity and resonance structure. Hydrogenation- homogenous and heterogenous hydrogenation	
4.1.3	Secondary metabolites: Phytochemicals, terpenes, polyphenols, procyanidins, flavonoids, xanthones, alkaloids and pigments.	

References
[1] Basic principles of organic chemistry- Robers and Caserio
[2] Organic chemistry, Hendrickson, Cram and Hammonal.
[3] Organic chemistry, I. L. Finar, Longman group Ltd.
[4] Organic chemistry, Morrison and Boyd, 4th edition Allyn and Bacon Inc.

Course Code	Title of the Course	Credits
BCA250	PLANT BIOCHEMISTRY	4

COURSE OUTCOME(S):

- CO1 Specify in details with examples Photosynthetic pathways and its regulations
CO2 Write down in depth plant growth hormones in the agriculture
CO3 Learn in details with application, if applicable, Medicinal plants
CO4 Deliberate in depth secondary metabolites of plants and its significance

		No. of Lectures
Unit I:		12
1.1	Plant Cell and Photosynthesis	
1.1.1	Plant cell–Structure and functions of subcellular organelles, plant cell wall, Mechanism of water absorption, Ascent of sap. Transpiration - types, stomatal opening, Mechanism and factors affecting transpiration.	
1.1.2	Photosynthesis–Photosynthetic pigments, Photo synthetic apparatus, Light reactions, cyclic and non cyclic Phosphorylation. Calvin cycle, Hatch–Slack cycle, CAM plants.	
1.1.3	Regulation of photosynthesis, Photorespiration.	

Unit II:		12
2.1	Cycles of elements	
2.1.1	Nitrogen cycle, Biochemistry of symbiotic and non symbiotic nitrogen fixation, Sulphur cycle, Phosphorus cycle.	
2.1.2	Plant nutrition–Biological functions of micro and macro nutrients in plants and their deficiency symptoms.	

Unit III:		16
3.1	Growth Regulators	
3.1.1	Plant growth regulators–chemistry, biosynthesis, mode of action, distribution and physiological effects of Auxins, Gibberellins, Cytokinins, ABA and Ethylene.	
3.1.2 3.1.3	Biochemistry of seed dormancy, Seed germination, Fruit ripening and Senescence.	

Unit IV:		08
4.1	Medicinal Importance	
4.1.1	Medicinal value of different parts of plants.	
4.1.2	Basic methods to identify the secondary metabolites. Role of secondary metabolites in Ayurvedha and Siddha treatment.	
4.1.3	Medicinal value of Amla, Stevia, Aswagandha, Turmeric and other Indian medicinal plants.	

References	
[1]	Plant physiology, Verma, 7th Revised edition, Emkay Publications 2001.
[2]	Plant Physiology, S. N. Pandey and B.K. Sinha, Vikas Publishing House Pvt. Ltd, 3rd edition, 1999.
[3]	Plant Biochemistry and Molecular Biology, Peter Jhea, Richard C. Leegood,
[4]	Introduction to plant physiology, William. G.Hopkins, Norman. P.A. Hunger, 3rd edition
[5]	A Handbook of Medicinal Plants –Prajapathi, Purohit,Sharma, Kumar
[6]	Medicinal Plants –a compendium of 500 species.

Course Code	Title of the Course	Credits
BCA250	MICROBIAL BIOCHEMISTRY	4

COURSE OUTCOME(S):

- CO1 Specify in details with examples staining techniques used for the identification of microbes
- CO2 Write down in depth Molecular biology of prokaryotes
- CO3 Learn in details with application, if applicable, Operon systems in gene regulation of bacteria
- CO4 Deliberate in depth antimicrobial drugs are used for the microbial infections

		No. of Lectures
Unit I:		10
1.1	Pure Culture, Staining Technique and Growth	
1.1.1	Principles of microbial nutrition: Nutritional requirements, different kinds of media, factors affecting growth.	
1.1.2	Enrichment culture techniques for isolation of chemoautotroph's, chemoheterotroph's and photosynthetic microorganisms. Modes of reproduction, Biosynthesis of cell wall components, enumeration, growth curve, generation time, synchronous growth, Chemostat. Adaptation to stationary phase, heat and cold shock, osmolarity and salinity, oxidative stress.	
1.1.4	Gram, Acid fast & flagellar staining. Mechanism of bacterial motility.	

Unit II:		14
2.1	Regulation of Genes in Bacteria	
2.1.1	Nucleic Acids as Carriers of Genetics Information, Arrangement and Organization of Gene in Prokaryotes:	
2.1.2	Operon Concept, Catabolite Repression, Instability of Bacterial RNA, Inducers and Co repressors E. coli Lac Operon: Negative Regulation and Positive Regulation, E. Coli Arabinose Operon: Regulation by Attenuation, His and Trp Operons: Anti-termination, Genetic Transfer: Conjugation, Transformation and Transduction.	

Unit III:		
3.1	Virology and Biological Nitrogen Fixation	
3.1.1	Introduction to Virus, Classification, Assay Methods, Properties and Characteristic of Bacterial, Plant and Animal Viruses	16
3.1.2	Virus Host Interaction, Acute Virus Infections, Persistent of Virus Infection, Influenza, Herpes, Hepatitis A and B.	
3.1.3	<u>Nitrogen Metabolism</u> : Mechanism and Regulation of Utilization of Ammonia, Nitrate and other Nitrogen Source	
3.1.4	<u>Nitrogen Fixation</u> : Mechanism and Regulation of Nitrogen Fixation, Symbiotic and Asymbiotic Nitrogen Fixation and Biochemistry of Nitrogenase.	

Unit IV:		
4.1	Antimicrobial Agents	
4.1.1	The Development of Antimicrobial Agents, Past, Present and Future, Selection of Antimicrobial Agents	08
4.1.2	Synthetic Organic Antimicrobials, β -Lactam Antibiotics, Amino glycoside Antibiotics, Antifungal Drugs, Antiviral Drugs	
4.1.3	Resistance to Antimicrobial Drugs	

<p>References</p> <p>[1] Microbial physiology, 2nd Edn. I.W. Dawes and I.W. Sutherland (1991) Blackwell Scientific.</p> <p>[2] Microbial physiology, 4th Edn. Albert G. Moat, John W. Foster and Michael P. Spector, Wiley-Liss (2002).</p> <p>[3] Biology of Microorganisms, Brock Prentice Hall (1996).</p> <p>[4] Microbiology: Lansing M. Prescott, Hartley and Klein, 5th Edn. McGraw Hill (2002).</p> <p>[5] General Microbiology, Stainer <i>et al.</i>, 4th Edn. McMillan (1975).</p> <p>[6] Microbiology, Pelczar, Reid and Kreig Tata McGraw Hill (1996).</p>
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Course Code	Title of the Course	Credits
BCB040	ANALYTICAL BIOCHEMISTRY–II	4

COURSE OUTCOME(S):

- CO1 Identify in details with application, if applicable, flow cytometry
CO2 Specify the characteristics of biosensor technology
CO3 Understand in details with examples spectroscopy
CO4 Write down the details of x-ray crystallography

		No. of Lectures
Unit I:		08
1.1	Flow Cytometry and Model Systems	
1.1.1	<u>Flow Cytometry</u> : Principle and design of flow cytometer, cell sorting.	
1.1.2	<u>Animal models</u> : Choice of animals, types of studies, mutant organisms, cultured cells, plant as models and tissue culture models.	

Unit II:		16
2.1	Biosensor Technology and Radioactivity	
2.1.1	Concept and design of biosensors, types and uses of biosensors.	
2.1.2	Principle and applications of biosensors for glucose, triglyceride, uric acid, cholesterol and oxalate.	
2.1.3	Units of radioactivity. Detection and measurement of radioactivity–solid and liquid scintillation counting, scintillation cocktails and sample preparation. Cerenkov counting. Applications of radioisotopes in biology. Radiation hazards.	
2.1.4	Principle and Applications of Autoradiography	

Unit III:		10
3.1	Spectroscopy	
3.1.1	Principle, instrumentation, working and application of–Spectrofluorimetry, Flame Spectrophotometry, Atomic Absorption Spectrometry.	
3.1.2	<u>IR spectroscopy</u> : Physical basis of IR spectroscopy. Instrumentation, use of IR in structure determination, Fourier Transfer–IR spectroscopy.	
3.1.3	<u>NMR</u> : Principle, effect of atomic, identity on NMR, chemical shift, spin coupling NMR, measurement of NMR spectra, biochemical application of NMR.	
3.1.4	<u>ESR</u> : Principle, measurement of ESR spectra, biochemical application of ESR.	
3.1.5	Principle, instrumentation and applications of ORD and CD	

Unit IV:		
4.1	Mass spectroscopy, X-ray Crystallography and Nanoparticles	
4.1.1	Theory and construction of mass spectrometer. Ionization, fragmentation, m/z , time of flight, MALDI and ESI.	
4.1.2	<u>Other methods:</u> MS/MS, LC/MS, GC/MS, Peptide mapping, post translation modification analysis, determination of disulfide bridges	
4.1.3	X-ray crystallography–Bragg's law, Unit cell, Isomorphous replacement, Fibre pattern of DNA.	14
4.1.4	<u>Introduction to Nanoscience:</u> Importance and fundamental science behind nanotechnology.	
4.1.5	<u>Applications of Nanoparticles:</u> Tools to make nanostructures, Nanoscale lithography, E–beam lithography, molecular synthesis, self assembly. Drug and Gene delivery for human health, Biosensors and sensors, cleaning environment (for heavy metal & Bioremediation).	

References

- [1] Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
- [2] Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
- [3] Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
- [4] Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
- [5] Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
- [6] Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
- [7] Basic Mathematics for Biochemists; Cornish Bowden, Oxford University Press (1998),.
- [8] Biophysical Tools for Biologists *In Vivo* Techniques; John Correia H. Detrich, III Elsevier (2008).
- [9] Practical Biochemistry by Keith Wilson and Walker 5th ed. Cambridge.
- [10] Biophysical chemistry, Upadhyaya, A., Upadhyaya, K. and Nath, N. Himalayan Publishing House.
- [11] Practical biochemistry- Principles and Techniques. Wilson and Walker. J.Cambride Uni. Press.
- [12] Physical Biochemistry-David Freifelder, 2nd Edition.
- [13] Principles of Instrumental Analysis. 5th Ed. Douglas A Skoog, James Holler and Timothy A Nieman.

Course Code	Title of the Course	Credits
BCB050	CHEMISTRY AND METABOLISM OF CARBOHYDRATES AND LIPIDS	4

COURSE OUTCOME(S):

- CO1 Understand the classification and characteristics of chemistry of carbohydrates
CO2 Deliberate the classification and characteristics of bioenergetics
CO3 Write down the characteristics of chemistry of lipids
CO4 Learn in depth metabolism of lipids

		No. of Lectures
Unit I:		10
1.1	Chemistry of Carbohydrates	
1.1.1	Classification, monosaccharides (aldoses & ketoses) Configuration and conformation of monosaccharides (pyranose & furanose, chair & boat).	
1.1.2	Reducing and optical properties of sugars. Stability of glycosidic bond disaccharides, oligosaccharides.	
1.1.3	Structural polysaccharides—cellulose, hemicellulose, pectin, lignin, chitin, chitosan	
1.1.4	Storage polysaccharides: starch, glycogen, inulin Steric factors in polysaccharides folding, blood group polysaccharides and lectins. Glycosaminoglycans, mucopolysaccharides, hyaluronic acid Chondroitin sulfate, keratan sulfate, dermatan sulfate. Bacterial cell wall polysaccharides, proteoglycans (syndecan and agrecan)	

Unit II:		14
2.1	Metabolism of Carbohydrates and Bioenergetics	
2.1.1	Reactions and energy balance in Glycolysis, Gluconeogenesis, TCA cycle, HMP Shunt pathway, Pasteur and Crabtree effect, Anapleurotic reactions	
2.1.2	Glyoxylate cycle, Glucuronic acid cycle, Glycogen metabolism.	
2.1.3	Photosynthesis reactions for biosynthesis of glucose C3 and C4 cycle in plants	
2.1.4	Mitochondrial ETC—Organization of respiratory chain complexes, P/O ratio, ATP synthesis, Mitchell's hypothesis, uncouplers and inhibitors.	

Unit III:		12
3.1	Chemistry of Lipids	
3.1.1	Classification & biological significance of lipids, fatty acids and Steroids	
3.1.2	Bile acids and salts, Phospholipids, Oils, waxes, isoprene units, Lipoproteins, Glycolipids, Sphingolipids	

3.1.3	Cerebrosides, Gangliosides, Prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes, cysteinyl leukotrienes	
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Unit IV:		
4.1	Metabolism of Lipids	
4.1.1	Fate of dietary lipids and Apo-lipoproteins Fatty acid biosynthesis, Desaturation of fatty acids Beta oxidation, breakdown of odd chain fatty acids, energy yields	12
4.1.2	Regulation of β -oxidation, ω -oxidation & α -oxidation Metabolism of phospholipids & Sphingolipids Regulation and Biosynthesis of cholesterol, action of statins	
4.1.3	Fate of acetyl CoA, formation of ketone bodies and ketosis	
4.1.4	Biosynthesis of prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes, Action of aspirin	
4.1.5	Genetic defects in lipid metabolism, Medium chain acyl coenzyme A dehydrogenase deficiency MCAD, Long-chain 3-hydroxyacyl-CoA dehydrogenase (LCHAD) deficiency, Familial hypercholesterolemia	

References

- [1] Lehninger Principles of Biochemistry 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman and Company.
- [2] Biochemistry by Lubert Stryer. WH Freeman and Co.
- [3] Biochemistry: The Molecular Basis of Life by Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
- [4] Biochemistry and Molecular biology By William H. Elliott and Daphne C. Elliott. Oxford University Press.
- [5] Biochemistry 3rd Ed. By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
- [6] Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 by D Voet. John Wiley and Sons.

Course Code	Title of the Course	Credits
BCB060	EXPERIMENTS IN IMMUNOLOGY AND BIOCHEMICAL ESTIMATIONS	4

COURSE OUTCOME(S):

- CO1 Understand in details with examples antigen antibody reactions
CO2 Specify in details with application, if applicable, oils and fats estimation
CO3 Understand in depth acid value principle and determination
CO4 Identify in details with examples mitosis and meiosis

Group I:	<ol style="list-style-type: none"> 1. Demonstration of Ag-Ab interaction: Radial immunodiffusion and ODD. 2. Demonstration of direct agglutination reaction using human blood group antigens. 3. Demonstration of indirect agglutination reaction– latex agglutination. 4. Fluorescence emission of proteins and vitamins 5. UV–Vis spectra of proteins, nucleic acids and other aromatic compounds 6. Extraction of neutral lipids, phospholipids 7. TLC of lipids and estimation of phospholipids 	
Group II:	<ol style="list-style-type: none"> 8. Iodine No. of Oils/Fats 9. Saponification Value of Oils/Fats 10. Acid Value/Peroxide Value of Oils/Fats 11. Estimation of α-Keto-acid 12. Estimation of ascorbic acid 13. Estimation of Iron 14. Estimation of Calcium 	
Group III:	<ol style="list-style-type: none"> 15. Isolation of Starch from potato and purity determination 16. Colorimetric estimation of reducing sugars (DNS reagent method) 17. Estimation of reducing sugar: Hegedorn and Jensen Method 18. Estimation of Phosphate 19. Mitosis in onion root tips 20. Meiosis in <i>tradescantia</i>/grasshopper testis 21. Total and Differential Cell Counting of blood 	
Group Study	Preparation of antigen adjuvant mixture, injection and raising antibodies in rat. Purification of antibodies Antibody titer and ELISA	

References

- [1] Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
- [2] Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
- [3] Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
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- [8] Modern Experimental Biochemistry R.F. Boyer [Ed.] (1986) Addition Wesley.
- [9] Analytical Biochemistry; D.J. Holme and H. Pick Longman (1983).
- [10] Principles and techniques of Biochemistry and Molecular Biology; Keith Wilson and John Walker; 6th Edn. (2005) Cambridge University Press.
- [11] Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
- [12] Methods in Immunology and Immunochemistry; Curtis Williams, Academic Press (1971).
- [13] Immuno Assay Hand Book; David Wild, Elsevier (2013).

Course Code	Title of the Course	Credits
BCB250	IMMUNOLOGY AND MICROBIOLOGY	4

COURSE OUTCOME(S):

- CO1 Identify in details with examples antigens and antibodies
- CO2 Understand the details of cellular basis of immunity
- CO4 Identify the classification and characteristics of MHC Complex
- CO4 Learn in depth basic concepts of microbiology

		No. of Lectures
Unit I:		
1.1	Antigens and Antibodies	
1.1.1	<u>Introduction</u> : Historical development and milestones in immunology. Barriers to infection–skin, mucous membrane, Definitions–Antigenicity, Immunogenicity, primary and secondary lymphoid organs, self and non self discrimination. Innate and acquired immunity.	12
1.1.2	<u>Antigens and Antibodies</u> : Haptens and determinants–Epitopes and paratopes. Antigenicity, carbohydrates, proteins, nucleic acids, and cells as antigens. Valency of antigen.	
1.1.3	Classes and subclasses of immunoglobulins, structure of immunoglobulins, hyper variable region, isotypic, allotypic and idiotypic variations.	
Unit II:		
2.1	Complement and Cellular Basis of Immunity	
2.1.1	<u>Complement</u> : Structure, components, properties and functions of complement pathways, biological consequences of complement activation.	12
2.1.2	Hyper sensitivity reactions (Type I, II, III and IV).	
2.1.3	<u>Cellular basis of immunity</u> : Primary and secondary immune response. Reticuloendothelial system. T, B and accessory cells. Subsets of T (T–helper cells, T–killer cells, T–suppressor cells) and B cells. Development of T and B cells. T and B cell receptors, antigen processing and presentation.	
2.1.4	Cytokines and co–stimulatory molecules–Lymphokines, interleukins structure and function of IL-2, TNF α . T and B interaction. Suppression of immune response, immunoglobulin, diversity of gene rearrangement, factors affecting diversity, class switching and clonal selection theory of Burnet.	

Unit III:		
3.1	MHC, Transplantation, Tumor Immunology and Vaccines	
3.1.1	<u>MHC</u> : MHC gene and its polymorphism, role of MHC in immune response.	16
3.1.2	<u>Transplantation</u> : Autograft, isograft, allograft and xenograft, Graft rejection, graft Vs host reaction, MHC in transplantation.	
3.1.3	<u>Immunochemical techniques</u> : Precipitation, agglutination, complement fixation, immunodiffusion, immunoelectrophoresis, immunofluorescence, RIA, ELISA.	
3.1.4	<u>Tumor immunology</u> : Tumor associated antigens, factors favoring tumor growth, immune surveillance. Tumor necrosis factors α and β Disorders of immunity: Immunological tolerance, auto immune disorders, AIDS, SCID, lupus erythematosus <u>Vaccines</u> : Adjuvants; vaccines and their preparations. Polyclonal and monoclonal antibodies–hybridoma technique.	
Unit IV:		
4.1	Microbiology	
4.1.1	Historical aspects - Discovery of microorganisms. Theory of spontaneous generation. Era of Louis Pasteur. Microbes and fermentation. Microbes and diseases-Koch's Postulates.	08
4.1.2	General characteristics: Morphology, nomenclature and classification of bacteria, virus, yeasts and fungi.	
4.1.3	Microbial nutrition-Factors influencing growth, growth curve of bacteria. Measurement of growth, continuous culture, synchronous culture and chemostat. Auxotrophs, autotrophs, heterotrophs. Methods of cultivations and preservation of microorganisms.	
4.1.4	Methods of control of microorganisms-Sterilization Techniques: Definitions of physical methods, heat (dry & moist) filtration, radiation; chemical agents-phenols, alcohols, halogens, heavy metals, aldehydes, quaternary ammonium compounds & gases.	

References

- [1] Antibodies—A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014).
- [2] Basic and Clinical Immunology; Stites *et al.*, [Ed] (1982) Lange.
- [3] Roitt's Essential Immunology; Ivan, M. Roitt & Peter J Delves (2001) Blackwell Science.
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- [5] Kuby Immunology; Owen, Punt, Stranford, 7th Edn. W. H. Freeman (2013).
- [6] Immune System; M. C. Connel *et al.*, Eds. (1981) Blackwell Science.
- [7] Immunology at a Glance: J.H.L. Playfare [ed.] Blackwell Science, (1987).
- [8] Immunology; Jan Klein [Ed.], Blackwell Science (1990).
- [9] Introduction to Immunology; Kim Bell [Ed.,] 3rd Edn. McMillan (1990).

Course Code	Title of the Course	Credits
BCB260	HUMAN PHYSIOLOGY AND NUTRITION	4

COURSE OUTCOME(S):

- CO1 Specify the classification and characteristics of blood and respiratory systems
CO2 Identify in depth digestive and excretory systems
CO3 Learn in details with application, if applicable, concepts of nutrition
CO4 Specify the details of vitamins and minerals

		No. of Lectures
Unit I:		12
1.1	Blood and Respiratory System	
1.1.1	<u>Blood</u> –Composition, cells. Erythrocytes–structure and function, WBC–types and functions.	
1.1.2	Platelets and their function. Buffer systems; hemostasis–blood volume, blood pressure and its regulation. Blood clotting, Dissolution of clot; anticoagulants. CSF–composition and function.	
1.1.3	<u>Respiratory System</u> –Mechanism of gas exchange, oxygen binding by hemoglobin and factors affecting oxygenation. Acid–base balance and its regulation.	

Unit II:		12
2.1	Hepatobiliary, Digestive and Excretory System	
2.1.1	<u>Hepatobiliary system</u> –Anatomy of the liver, blood supply; cells–hepatocytes, endothelial cells, Kupffer cells and paranchymal cells.	
2.1.2	Secretory and excretory function; detoxification and formation of bile	
2.1.3	<u>Digestive system</u> –GI tract, digestion and absorption of carbohydrates, proteins and lipids. Mechanism of HCl production in the stomach. Gastrointestinal hormones.	
2.1.4	<u>Excretory System</u> –Ultra structure of the nephron, glomerular filtration, tubular reabsorption and tubular secretion, formation of urine.	

Unit III:		16
3.1	Nutrition, Carbohydrates, Proteins and Fats	
3.1.1	<u>Nutrition</u> –Concepts of macro and micro nutrients, essential nutrients and their classification. Food groups, proximate analysis of foods, chemical and biological analysis for nutrients.	
3.1.2	Food as source of energy, methods of determining energy value of foods, calorimetry, physiological fuel values and daily requirement of energy, high and low	

	calorie diets. Basal metabolic rate (BMR), factors affecting BMR, specific dynamic action of foods.	
3.1.3	<u>Carbohydrates</u> –dietary sources, dietary fiber essentiality of carbohydrates.	
3.1.4	<u>Proteins</u> –Evaluation of nutritive value of dietary protein PER, BV, essential amino acids, nutritional classification of proteins, supplementary value of proteins, protein calorie malnutrition–Kwashiorkor and Marasmus.	
3.1.4	<u>Fats</u> –Sources, invisible fat, essential fatty acids, PUFA.	

Unit IV:		
4.1	Vitamins and Minerals	
4.1.1	<u>Vitamins</u> –Fat soluble and water soluble vitamins, provitamins, antivitamins, dietary sources, structure, daily requirements and functions.	08
4.1.2	Deficiency symptoms of B complex members and fat soluble vitamins, hypervitaminosis, vitamin like compounds.	
4.1.3	<u>Minerals</u> –Macro and micronutrients, sources, requirements, functions and deficiency symptoms.	
4.1.4	Water metabolism–distribution in body, function and factors affecting water balance.	
4.1.5	Recommended daily allowances, special nutrition for infants, children, during pregnancy, lactation and old age.	

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- [1] The Cell, Copper, Geoffery, M., Oxford University Press, (2001)
- [2] Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley –Liss.
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- [13] Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell (2009).
- [14] Nutrition: Everyday Choices, 1st Edition; Mary B. Grosvenor, Lori A. Smolin Wiley (2006).
- [15] Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease; Watson Elsevier (2012).
- [16] Nutrition and Metabolism, 2nd Edn., Lanham S, Mac Donald I and Roche H. The Nutrition Society, London, UK, (2012).
- [17] Introduction to Human Nutrition, 2nd Edn., Gibney M, Lanham S, Cassidy A and Vorster H. The Nutrition Society, London, UK, (2012).

Course Code	Title of the Course	Credits
BCB260	RESEARCH METHODOLOGY AND BIOSTATISTICS	4

COURSE OUTCOME(S):

- CO1 Specify the classification and characteristics of research methodologies and the experimental designs
- CO2 Identify in depth statistical analysis
- CO3 Learn in details with application, if applicable, scientific write-up
- CO4 Specify the details of Interpretation of data

		No. of Lectures
Unit I:		12
1.1	Research Methodology and Design	
1.1.1	<u>Research Methodology</u> : Meaning of research, Objectives of research, Motivation in Research, Types of Research, and Research approaches.	
1.1.2	Research methods vs. Research Methodology, Research process–scientific method, Criteria for good research, Defining the research problem.	
1.1.3	<u>Research Design</u> : Meaning and need for research design, features of good design. Preparation of Scientific report, presentation of a review.	

Unit II:		12
2.1	Scientific Writing	
2.1.1	Mechanical and stylistic aspects of scientific writing–Precision and clarity of language, writing style, writing process, presentation of numerical data and scientific figures.	
2.1.2	Constraints on scientific writing–audience, format and mechanics (grammar, word choice, punctuation, tenses).	
2.1.3	Objectives and design of experiment–experimental unit, identifying variables, replications & controls, power analysis in planning experiments, treatment structure and design structure.	
2.1.4	Graphical analysis of data and presentation of results.	

Unit III:		16
3.1	Statistical Significance Analysis	
3.1.1	Significance and limitations of statistical calculations, Sampling techniques.	
3.1.2	Probability theory, random variables and distribution functions, Point and interval estimation, linear regression. Statistical evaluation of results–Hypothesis testing, interpretation of statistic for analysis of error.	
3.1.3	Measures of central tendency and dispersion	

Unit IV:		08
4.1	Testing Methods	
4.1.1	ANOVA, F-test, t-test, z-test, chi-square, correlation coefficient.	

References

- [1] Research Methodology: Methods & Techniques By CR Kothari. Publisher: New Age International
- [2] From Research to Manuscript: A Guide to Scientific Writing (Paperback) By Michael Jay Katz. Publisher: Springer
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- [4] Writing Scientific Research Articles: Strategy and Steps (Hardcover) By Margaret Cargill and Patrick O.Connor. Publisher: WileyBlackwell.
- [5] The Mayfield Handbook of Technical and Scientific Writing By Leslie Perelman and Edward Barrett. McGraw-Hill NY
- [6] Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers(Hardcover) 6th Ed By Edward J. Huth. Publisher: Cambridge University Press.
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- [9] The Elements of Technical Writing (Elements of Series) (Paperback) By Gary Blake and Robert W. Bly. Publisher: Longman.
- [10] Technical Writing: Principles, strategies and readings (7th Edition) By Diana C. Reep. Publisher: Longman.
- [11] Biostatistics By PN Arora and PK Malhan, Himalaya Publishing House.
- [12] Experimental Design and Data Analysis for Biologists By Gerry P. Quinn and Michael J. Keough. Publisher: Cambridge University Press.
- [13] Principles of Biostatistics (with CD-ROM) (Hardcover) By Marcello Pagano and Kimberlee Gauvreau. Publishers: Duxbury Press
- [14] Biostatistics: Experimental Design and Statistical Inference (Hardcover) By James F. Zolman. Oxford University Press.
- [15] Intuitive Biostatistics By Harvey Motulsky. Publisher: Oxford University Press

Course Code	Title of the Course	Credits
BCB260	CLINICAL RESEARCH METHODS AND INDUSTRIAL BIOCHEMISTRY	4

COURSE OUTCOME(S):

- CO1 Specify the classification and characteristics of clinical practice and clinical research
- CO2 Identify in depth fermentation technology and downstream processing
- CO3 Learn in details with application, if applicable, clinical research methods
- CO4 Specify the details of steps involved in drug discovery

		No. of Lectures
Unit I:		10
1.1	Introduction to Clinical Research	
1.1.1	Introduction to Clinical Research, Terminologies and definition in Clinical Research, Origin and History of Clinical Research	
1.1.2	Difference between Clinical Research and Clinical Practice, Types of Clinical Research, Phases of clinical research	
1.1.3	Clinical Trials in India–The National Perspective, Post marketing surveillance	
1.1.4	Pharmaceutical Industry–Global and Indian Perspective Clinical Trial market, Career in Clinical Research	

Unit II:		14
2.1	Clinical Research Methods	
2.1.1	Design of experiments, factorial experiments, randomization, interaction among factors.	
2.1.2	Types of studies: Cohort studies, double blind, placebo control, cross over and double dummy.	
2.1.3	Introduction to Good Clinical Practices, Clinical Trial Development: Protocol Design and Development, Case Report Form Design and Development, Principals of Data Management, Clinical Trial Management: Maintaining and Managing Essential Documents, Recording and Reporting Non–Serious and Serious Adverse Events.	

Unit III:		12
3.1	Drug Discovery Concepts and Biostatistics	
3.1.1	Proof of concept, target identification and validation. Identifying the lead compound, optimization of lead compound, mechanism of action, drug target and validation of target.	
3.1.2	Safety pharmacology, pharmaco–kinetics and	

	pharmaco–dynamics, acute and chronic toxicity Development of new drug/molecules and elucidation of their mechanisms of actions, formulations, factors affecting drug efficacy, drug resistance, traditional medicines; biotransformation.	
3.1.3	Statistical concept: Data structure, sampling methods, collection, classification and tabulation of data, graphical and diagrammatic representation, histogram, frequency polygon, frequency curve, bar graph, pie chart.	
3.1.4	Measure of central tendency: Mean, median, mode, mean deviation, standard deviation, standard error Types of distribution of data: Normal, binomial, Poisson,	
3.1.4	Z-test, t-test and ANOVA. Correlation and regression.	
Unit IV:		
4.1	Bioprocess Methods	
4.1.1	Basics of chemical engineering, mass transfer, heat generation and removal, fluid dynamics:	12
4.1.2	Bernoulli's principle, viscosity, hydraulic conductivity, capillary flow, control and applications of industrial processes, process evaluation and development, over production of metabolites and methods;	
4.1.3	Fermentation–Submerged and solid state fermentation Fermentor design, Industrial use of microbes. Strain improvement, Inocula preparation, Downstream processing–Recovery and purification of intracellular and extra cellular products. Methods to maximize the yield.	

References

- [1] Basic Test for Drugs, WHO-GENEVA 1998 edition
- [2] Who Expert Committee on Specification for Pharmaceutical Preparation WHO-GENEVA, 2005 edition
- [3] Who Expert Committee on Biological Standardization WHO-GENEVA 2003 edition
- [4] Clinical Research Fundamental and Practice –Vishal Bansal Parar Medical Publisher, 2010 edition
- [5] Introduction to Pharmacopoeia CBS Publishers and Distributors 1991 edition
- [6] Essential of Clinical Research –Dr. Ravindra B. Ghooi and Sachin C. Itkar Nirali Prakashan 2010 edition
- [7] Basic Principle of Clinical Research and Methodology, Jaypee Brothers Medical Publishers (P) Ltd. 2009 ed.
- [8] A Comprehensive Clinical Research Manual-Samir Malhotra, Nusrat Shafiq, Promila Pandhi Jaypee Brothers Medical Publishers (P) Ltd, 2008 edition
- [9] Industrial microbiology, A.H. Patel
- [10] Principles of Fermentation technology, Stanburry. P. Whitaker and S.J. Hall, 1995
- [11] Biotechnology–U. Sathyanarayana. YLL

Course Code	Title of the Course	Credits
BCC070	CELL BIOLOGY, ENDOCRINOLOGY AND CELL SIGNALING	4

COURSE OUTCOME(S):

- CO1 Specify in details with examples cellular organization
- CO2 Learn the characteristics of endocrinology
- CO3 Learn in depth cell signaling
- CO4 Write down the characteristics of membrane biology

		No. of Lectures
Unit I:		12
1.1	Cellular Organization, Division and Cytoskeletons	
1.1.1	Cell types–organization of prokaryotic and eukaryotic cells.	
1.1.2	Cell division–mitosis and meiosis, cell cycle–phases of cell cycle, cyclins and cdk. Regulation of cell growth and cell cycle.	
1.1.3	Cell motility–molecular motors, microtubules, structure and composition. Microtubular associated proteins–role in intracellular motility.	
1.1.4	Cellular organelles–Nucleus–internal organization, traffic between the nucleus the nucleolus, and cytoplasm. Endoplasmic reticulum–protein sorting and transport, golgi apparatus and lysosomes, morphology and function of mitochondria, chloroplasts and peroxisomes, glyoxysomes.	

Unit II:		12
2.1	Membrane Biology	
2.1.1	Organization of lipid monolayer, bilayer, Physicochemical properties of biological membranes - compositions, supra molecular organization - Singer and Nicolson's model.	
2.1.2	Membrane asymmetry-lipids proteins and carbohydrates, lateral diffusion, biogenesis of lipids and proteins. Polarized cells, membrane domains- caveolae, rafts, Membrane lipid and protein turnover, intracellular targeting of proteins. Factors influencing fluidity of membrane	
2.1.3	Membrane transport - Laws of diffusion across membranes, simple diffusion, facilitated diffusion and active transport - glucose transporter Na ⁺ K ⁺ ATPase (Structure and mechanism of action), bacterial phosphotransferase system. Endocytosis, receptor mediated endocytosis, exocytosis, ion channels, aquaporin channel, ionophores. Patch clamp technique.	

Unit III:		
3.1	ENDOCRINOLOGY	
3.1.1	<u>Endocrine System</u> –Endocrine organs in man. Hierarchy and regulation of hormone release.	12
3.1.2	Structure and control of hypothalamus, GRH, somatostatin, TRH, CRH, GnRH. Pituitary-anatomy and structure.	
3.1.3	Hormones of anterior, posterior and median lobes. Pro-opiomelanocortin. Thyroid, parathyroid, adrenals, gonads–Testes and ovaries. Menstrual cycle. Hypothalamus–pituitary target organ axis and regulation by feedback mechanism, Pineal gland, melatonin and circadian rhythm	
3.1.4	Classification of hormones based on solubility and structure, mechanism of action of water soluble and lipid soluble hormones.	
Unit IV:		
4.1	Cell Signaling	
4.1.1	Nerve transmission–Central and peripheral nervous systems. Structure of neuron, axon, dendrites, synapse neuromuscular junction. Neurotransmitters- mechanisms of nerve conduction. α and β adrenergic neurons, nicotinic and muscarinic neurons.	12
4.1.2	Muscle contraction–Skeletal muscle and smooth muscle contraction, muscle proteins–actin, myosin, tropomyosine, troponins, mechanisms of muscle contraction, role of calcium and calmodulin Biochemistry of vision	
4.1.3	Cellular signaling: Extra cellular signaling–G Protein linked receptors ,Role of cyclic AMP, IP3, DAG, Ca^{2+} as a second messenger, receptor tyrosine kinases , MAP kinase pathway, NFkB pathway, apoptosis, Cell survival pathway, Jak/Stat pathway, TGF β Signaling. Multiple signaling path ways–Insulin receptor (regulation of blood glucose)	
4.1.4	Steroid hormone receptors, structural organization of receptor protein, hormone binding domain, antigenic domain and DNA binding domain.	

References

- [1] The World of the cell by Becker, Kleinsmith and Harden Academic Internet Publishers; 5th edition (2006)
- [2] The Cell: A Molecular Approach, Fourth Edition by Geoffrey M. Cooper and Robert E. Hausman.
- [3] Cell and Molecular Biology by concepts and experiments by Gerald Karp (2005) John Wiley sons & Inc.
- [4] Molecular cell Biology by Harvey Lodish. W. H. Freeman; 6th edition (2007)
- [5] The Cell–Biochemistry, physiology and morphology by J. Brachet and A. E. Mirsky, Academic Press (1963)

Course Code	Title of the Course	Credits
BCC050	CLINICAL BIOCHEMISTRY	4

COURSE OUTCOME(S):

- CO1 Identify in details with application, if applicable, specimen collection and analysis
- CO2 Specify in details with application, if applicable, metabolic disorders
- CO3 Write down the characteristics of hormonal disorders
- CO4 Write down in details with application, if applicable, hematology

		No. of Lectures
Unit I:		10
1.1	Specimen Collection and Analysis	
1.1.1	Concepts of accuracy, precision, reproducibility, reliability, and other factors in quality control.	
1.1.2	Normal values. Specimen collection and Processing: Collection of blood–venipuncture, skin puncture, arterial puncture. Anticoagulants. Collection and analysis of normal and abnormal urine–timed urine specimens, preservatives.	
1.1.3	Clinical significance of sugars, proteins, ketone bodies, bilirubin and porphyrins. CSF–collection, composition and analysis. Amniotic fluid–Origin, collection, composition.	

Unit II:		14
2.1	Disorders	
2.1.1	Disorders of carbohydrate metabolism: Diabetes mellitus, glycohemoglobins, hypoglycemias, galactosemia and ketone bodies.	
2.1.2	Various types of glucose tolerance tests. Glycogen storage diseases.	
2.1.3	Lipid profile, lipidosis and multiple sclerosis. Causes and diagnosis of the disorders of HDL–cholesterol, LDL–cholesterol and triglycerides.	
2.1.4	Cancer: Etiology, diagnosis, treatment and prognosis. Carcinogens, oncogens, mechanism.	
2.1.5	Biochemistry of ageing: Cellular senescence, Role of Telomerase in aging, Alzheimer’s disease, Parkinson’s disease.	

Unit III:		12
3.1	Enzymes and Hormonal Disorders	
3.1.1	<u>Evaluation of organ function tests</u> : Clinical assessment of renal, hepatic, pancreatic, gastric, intestinal and thyroid functions. Clinical importance of bilirubin.	
3.1.2	<u>Diagnostic enzymes</u> : Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine	

3.1.3	kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.	
3.1.4	<u>Hormonal disorders</u> : Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disorders of thyroid hormones.	

Unit IV:		
4.1	Hematology	
4.1.1	<u>Biochemical aspects of hematology</u> : Total cell count, differential count, hematocrit.	12
4.1.2	Disorders of erythrocyte metabolism, hemoglobinopathies, thalassemias, thrombosis, porphyrias and anemias. Laboratory tests to measure coagulation and thrombolysis.	
4.1.3	Doping	
4.1.4	<u>Detoxification in the body</u> : Enzymes of detoxification, polymorphism in drug metabolizing enzymes. Mechanism of drug action and channels of its excretion.	
4.1.5	Test for lung function: Chest X-ray, Spirometry. Test for Brain function: EEG, MRI, CT.	

<p>References</p> <ol style="list-style-type: none"> [1] Textbook of Medical Biochemistry by MN Chatterjea and Rana Shinde, Jaypee Brothers. [2] Lehninger Principles of Biochemistry 5th Ed by David L. Nelson and Michael M. Cox, WH Freeman and Company. [3] Davidson's Principles and Practice of Medicine: A Textbook for Students and Doctors (Hardcover) 15th Ed by LSP Davidson, J MacLeod and CRW Edwards. Publisher: Churchill Livingstone. [4] Medical Biochemistry (Paperback) by John W. Baynes and Marek Dominiczak. Publisher: Mosby. [5] Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3rd Ed By Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone. [6] Review of Medical Physiology (Lange Basic Science) (Paperback) By William F. Ganong. Publisher: McGraw-Hill Medical [7] Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appleton and Lange. [8] Clinical Biochemistry by Richard Luxton. Scion Publishing Ltd. [9] Principles of Medical Biochemistry: With STUDENT CONSULT Online Access (Paperback) by Gerhard Meisenberg and William H. Simmons. Publisher: Mosby.

Course Code	Title of the Course	Credits
BCC060	EXPERIMENTS IN CLINICAL BIOCHEMISTRY AND MOLECULAR BIOLOGY	4

COURSE OUTCOME(S):

- CO1 Specify the details of urine and blood analysis
- CO2 Specify the characteristics of determination of enzyme activity
- CO3 Identify the classification and characteristics of DNA quantification and analysis
- CO4 Deliberate the details of isolation of nucleic acids from plant, animal and microbial sources

Group I:	<p>Urine analysis</p> <ol style="list-style-type: none"> 1. Qualitative analysis of urine for normal organic and inorganic constituents 2. Qualitative analysis of urine for abnormal constituents- Glucose, albumin, Ketone bodies. 3. Quantitative estimation of Creatine and Creatinine, Urea, Uric acid, Sulphate, Chloride 4. Titrable acidity <p>Blood analysis</p> <ol style="list-style-type: none"> 5. Quantitative estimation of Urea, Uric acid, Creatine, Cholesterol HDL-C and LDL-C 6. Blood glucose and GTT 	
Group II:	<p>Determination of Enzyme activity of</p> <ol style="list-style-type: none"> 7. Alkaline phosphatase 8. SGOT 9. SGPT 10. LDH 11. Electrophoresis of lipoproteins: Serum proteins. 12. Albumin/Globulin Ratio. 13. Fractionation of serum proteins-Ammonium sulphate precipitation. 14. Isolation of DNA and RNA from biological sources. 15. Quantitative determination of DNA and RNA. 	
Group III:	<ol style="list-style-type: none"> 16. Determination of melting temperature of DNA (T_m) 17. Sub-cellular fractionation of rat liver by differential centrifugation and marker analysis 18. Determination of activities of marker enzymes 19. Preparation of erythrocyte ghosts 20. Kinetics of uptake of glucose by erythrocytes 21. Viability of cells by trypan blue dye exclusion 22. Study of morphology of <i>Drosophila melanogaster</i> 	

	23. Study of mutants of <i>Drosophila melanogaster</i> 24. Study of polytene chromosomes of <i>Drosophila melanogaster</i>	
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Group Study	Isolation of plasmid DNA, Restriction digestion of plasmid DNA, ligation of DNA fragment into a plasmid vector, preparation of competent cells, <i>E.Coli</i> transformation and amplification of DNA by PCR.	
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References

- [1] Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (1988).
- [2] Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).
- [3] Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajana Publishers (1994).
- [4] Hawk' s Physiological Chemistry, ed. Oser, 14th Edn.(1976), Tata-McGrawHill.
- [5] Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).
- [6] Molecular Biology Techniques; Sue Carson, Heather Miller and D. Scott Witherow, Academic Press (2011).
- [7] Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
- [8] Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
- [9] Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell (2006).
- [10] Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).
- [11] Gene Cloning Laboratory Manual 4th Edn. Michael R. Green and Joseph Sambrook, CSHL Press (2014).
- [12] Current Protocols in Molecular Biology; S Gallagher, Wiley Interscience (2008).

Course Code	Title of the Course	Credits
BCC220	GENOMICS, PROTEOMICS AND BIOINFORMATICS	4

COURSE OUTCOME(S):

- CO1 Specify the details of DNA sequencing methods
- CO2 Specify the characteristics of determination of Proteins
- CO3 Identify the classification and characteristics of microarray data
- CO4 Deliberate the details of bioinformatics in biological databases and sequencing analysis

		No. of Lectures
Unit I:		12
1.1	Structural Organization of Genome and Sequencing	
1.1.1	Structural organization of genome in Prokaryotes and Eukaryotes, Organelle DNA–mitochondrial, chloroplast,	
1.1.2	DNA sequencing–principles and translation to large scale projects, Recognition of coding and non–coding sequences and gene annotation. Tools for genome analysis–RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis–physical and genetic mapping.	
1.1.3	Microbes, plants and animals, Accessing and retrieving genome project information from web, Comparative genomics, ESTs and SNPs.	

Unit II:		12
2.1	Proteomics	
2.1.1	Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing),	
2.1.2	2–D electrophoresis of proteins, Microscale solution isoelectricfocusing, Peptide fingerprinting,	
2.1.3	LC/MS-MS for identification of proteins and modified proteins, MALDI-TOF	
2.1.4	SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid systems.	

Unit III:		08
3.1	Functional Genomics, Proteomics and Metabolomics	
3.1.1	Analysis of microarray data, Protein and peptide microarray–based technology; PCR–directed protein <i>in situ</i> arrays	
3.1.2	Structural proteomics	
3.1.3	Metabolomics	

Unit IV:		
4.1	Biological Databases and Sequence Analysis	
4.1.1	<u>Introduction biological databases:</u> Types (relational & object-oriented). Primary, secondary & specialized databases.	16
4.1.2	Types of databases–Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase (Swiss–prot & Trembl and Motif) and 3D structure databases (PDB, SCOP, Cath, Genecards, SRS & Entrez).	
4.1.3	Computational approaches for gene identification, ORF and Human Genome Project.	
4.1.4	<u>Basics of sequence analysis:</u> Alignments using BLAST and FASTA, Multiple Sequence Alignment (CLUSTAL–X and CLUSTAL–W), Application of multiple sequence alignment	
4.1.5	Protein Structure Prediction in Bioinformatics– <i>Ab initio</i> based methods, Homology based methods, secondary structure prediction.	
4.1.6	Protein structure comparison–intermolecular and intramolecular methods. Phylogenetic construction by distance based methods	

References

- [1] Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
- [2] Brown TA, Genomes, 3rd Edition. Garland Science 2006
- [3] Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
- [4] Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
- [5] Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
- [6] Essential Bioinformatics (Paperback) by Jin Xiong. Cambridge University Press.
- [7] Bioinformatics: Methods & Protocols by Stephen Misener and Stephen A. Krawetz, Humana Press.
- [8] Humana Press.
- [9] Essentials of Bioinformatics by Irfan Ali Khan and Atiya Khanum. Publisher: Ukaaz Publications.
- [10] Bioinformatics: Sequence and Genome Analysis (Hardcover) by David W. Mount. Cold Spring Harbor Laboratory Press
- [11] Introduction to Bioinformatics (Paperback) by Arthur M. Lesk. Oxford Univ Press.
- [12] Introduction to Bioinformatics: A Theoretical and Practical Approach (Paperback) by David Womble, Stephen A. Krawetz and David D. Womble. Humana Press Inc., U.S.
- [13] Applied Bioinformatics: An Introduction (Paperback) by Paul M. Selzer, Richard Marhofer and Andreas Rohwer. Publisher: Springer-Verlag Berlin and Heidelberg GmbH & Co. K.
- [14]

Course Code	Title of the Course	Credits
BCC220	BIOTECHNOLOGY	4

COURSE OUTCOME(S):

- CO1 Write down the characteristics of tools of genetic engineering
- CO2 Learn in depth DNA Cloning
- CO3 Write down the characteristics of Industrial biotechnology and gene therapy
- CO4 Identify in depth biosafety and bioethics

		No. of Lectures
Unit I:		12
1.1	Tools of Genetic Engineering	
1.1.1	Basic principles–mechanism of natural gene transfer by Agrobacterium, generation of foreign DNA molecules.	
1.1.2	Restriction enzymes, their types and target sites, cutting and joining DNA molecules, linkers, adapters, homopolymers, enzymes used in genetic engineering.	
1.1.3	Cloning vehicles and their properties, natural plasmids, in vitro vectors, cosmids and T-DNA based hybrid vectors.	
1.1.4	Cloning strategies–cloning with single strand DNA vectors, cDNA cloning and gene libraries, recombinant selection and screening methods, expression of cloned genes–problems and solutions, shuffle vectors.	
1.1.5	DNA sequencing strategies–Sanger’s and Maxam–Gilbert’s methods, applications of PCR and DNA hybridization, Southern, Northern and Western blotting.	

Unit II:		12
2.1	DNA Cloning and Sequencing	
2.1.1	Techniques of tissue culture–culturing explants and haploids, protoplasts fusion and embryoids.	
2.1.2	Methods of gene transfer to plants, animals and bacteria–Ca transfection, electroporation, shotgun and others.	
2.1.3	Transgenic plants, GM foods and Biopesticides, gene knockouts and transgenic animals.	
2.1.4	Biodegradation and its applications, bioleaching.	

Unit III:		
3.1	Industrial Biotechnology and Gene Therapy	
3.1.1	Applications of biotechnology–industrial biotechnology–Fermentors, principle, types product recovery and purification of ethanol, citric acid, vitamin B12, streptomycin.	16
3.1.2	Enzyme biotechnology–production and uses of industrially important enzymes such as protease, immobilization of enzymes and their applications	
3.1.3	Waste treatment, bioenergy and biogas production.	
3.1.4	Gene therapy (somatic)-the principle and approaches.	

Unit IV:		
4.1	Biosafety and Bioethics	
4.1.1	Biotechnology–potential hazards, biological weapons, biosafety of GM foods and GMOs–substantial equivalence and safety testing, gene drain, the tangled genes	08
4.1.2	Human genome research–the objectives and approaches, genomics and genome prospecting–the controversies, issues of biotechnology-social and scientific, technology protecting systems and the terminator.	
4.1.3	IPR, its concepts and conditions–patenting of genes, cells and life forms, evaluation of life patenting.	

<p>References</p> <p>[1] Fermentation Biotechnology O.P. Ward. 1989 Prentice Hall.</p> <p>[2] Biotechnology J.E. Smith Cambridge University Press 1996.</p> <p>[3] Introduction to Biotechnology Brown, Campbell and Priest Blackwell Science 1987.</p> <p>[4] A Textbook on Biotechnology H.D. Kumar 2nd edition East West Press 1998.</p> <p>[5] Molecular Biotechnology Glick and Pasternak, Panima Publ.</p> <p>[6] From Genes to clones Winnaecker VCH Publication.</p> <p>[7] Elements of Biotechnology P.K. Gupta, Rastogi Publication, 1998.</p> <p>[8] Molecular Biology and Biotechnology. Walker and Gingold. 3rd ed. Panima Publ. 1999.</p> <p>[9] Plant Biotechnology. Ignacimuthu, Oxford, IBH.</p> <p>[10] Recombinant DNA Technology, Watson, Scientific American Publ.</p> <p>[11] Principles of Genome analysis, Primrose, Oxford University Press, 1998.</p>
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Course Code	Title of the Course	Credits
BCC220	PHARMACEUTICAL BIOCHEMISTRY	4

COURSE OUTCOME(S):

- CO1 Identify the details of ADME mechanism of drugs
- CO2 Learn in details with application, if applicable, Drug receptor interactions
- CO3 Deliberate in details with application, if applicable, Mode of action of anti cancer drugs
- CO4 Write down in depth Drug tolerance and abuse

		No. of Lectures
Unit I:		10
1.1	Drugs	
1.1.1	Drugs: History of Drugs Classification of drugs, routes of drug administration, absorption and distribution of drugs.	
1.1.2	Factors influencing drug absorption and elimination of drugs.	

Unit II:		14
2.1	Drug Receptor and Metabolism	
2.1.1	Drug-Receptor interactions involvements of binding forces in drug receptor interaction, drug action not mediated by receptors.	
2.1.2	Drug metabolism: Mechanism of phase I and II enzyme reactions, biochemical importance of xenobiotic metabolism.	

Unit III:		12
3.1	Anticancer Drugs	
3.1.1	Cancer: Cancer and principles of cancer chemotherapy, mode of action of anti cancer drugs.	
3.1.2	Antimetabolites, antibiotics, alkylating agents and other agents,	

Unit IV:		12
4.1	Adverse Drug Reactions	
4.1.1	Adverse drug reactions and drug induced side effects.	
4.1.2	Biological effects of drug abuse and drug dependence.	
4.1.3	Drug tolerance and intolerance.	

References

- [1] The Pharmacology volume I and II –Goodman and Gillman
- [2] Basic Pharmacology –Foxter Cox
- [3] Oxford text book of Clinical Pharmacology and Drug Theraphy ,D.G Grahme Smith and J.K.Aronson
- [4] Pharmacology and Pharmatherapeutics – R.S.Satoskar,S.D.Bhandhakarand
- [5] Essentials of Pharmacotherapeutics ,Barav.F.S.K
- [6] Lippincotts illustrated review Pharmacology, Mary.J.Mycek,Richards ,Pamela

Course Code	Title of the Course (Open Elective)	Credits
BCC630	NUTRITION AND HEALTH	4

COURSE OUTCOME(S):

- CO1 Identify the details of basic concepts of nutrition
CO2 Learn in details with application, if applicable, nutrients
CO3 Deliberate in details with application, if applicable, nutrition associated problems
CO4 Write down in depth social health problems

		No. of Lectures
Unit I:		10
1.1	Basic Concepts in Nutrition	
1.1.1	Understanding relationship between food, nutrition, health and food pyramid.	
1.1.2	Functions of food: Physiological, psychological and social Basic food groups and concept of balanced diet	
1.1.3	Energy: Functions, sources and concept of energy balance.	
1.1.4	Nutritional requirements: Physiological considerations and nutritional concerns for the following life stages: Adult man / woman Preschool children Adolescent children Pregnant woman, Nursing woman and infant Geriatrics	

Unit II:		14
2.1	Nutrients	
2.1.1	Functions, Recommended Dietary Allowances, dietary sources, effects of deficiency and/ or excess consumption on health of the following nutrients: Carbohydrates and dietary fibre Lipids Proteins Fat soluble vitamins: A, D, E and K Water soluble vitamins: Thiamin, Riboflavin, Niacin, Pyridoxine, Folate, Vitamin B12 and Vitamin C Minerals: Calcium, Iron, Zinc and Iodine	
2.1.2	Gut Microbiome	

Unit III:		
3.1	Nutritional problems, their implications and related nutrition programmes	
3.1.1	Etiology, prevalence, clinical features and preventive strategies of <u>Undernutrition:</u> Protein energy malnutrition, nutritional anemia's, vitamin A deficiency and iodine deficiency disorders <u>Overnutrition:</u> Obesity, Coronary Heart Disease and Diabetes	14
3.1.2	<u>National Nutrition Policy and Programmes:</u> Integrated Child Development Services (ICDS) Scheme Mid day Meal Programme (MDMP) National programmes for prevention of Anemia Vitamin A deficiency and Iodine Deficiency Disorders	

Unit IV:		
4.1	Social health problems	
4.1.1	Smoking Alcoholism AIDS including AIDS Control Programme	10
4.1.2	<u>Nutrition for special conditions:</u> Nutrition for physical fitness and sport, BMI Feeding problems in children with special needs Considerations during natural and man-made disasters e.g. floods, war. Basic guidelines in disaster management	

References

- [1] Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley –Liss.
- [2] Harper's Review of Biochemistry, Murray et. al., (1997) 24th Edn., Lange
- [3] Bryan Derrickson, Gerard J Tortora Principles of Anatomy and Physiology , twelfth Ed, 2011, Wiley & Sons Limited.
- [4] Bamji MS, Krishnaswamy K and Brahmam GNV (Eds) (2009). Textbook of Human Nutrition, 3rd edition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- [5] Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; 2012; New Age International Publishers
- [6] Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- [7] Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
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- [9] Edelstein S, Sharlin J (ed). Life Cycle Nutrition- An Evidence Based Approach; 2009; Jones and Barlett Publishers.
- [10] ICMR (1989) Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad.
- [11] ICMR (2011) Dietary Guidelines for Indians – A Manual. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad
- [12] World Health Organization (2006). WHO Child Growth Standards: Methods and development: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age (d).
- [13] Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic 14 Excellence

Course Code	Title of the Course	Credits
BCD010	MOLECULAR BIOLOGY AND GENE REGULATION	4

COURSE OUTCOME(S):

- CO1 Write down the characteristics of DNA characteristics and replication
- CO2 Write down in depth Transcription and regulation
- CO3 Learn in depth translation
- CO4 Identify in depth translational regulation

		No. of Lectures
Unit I:		14
1.1	DNA Replication and Gene Expression	
1.1.1	<u>Introduction</u> : Historical perspective, types of RNA, Central dogma of molecular biology.	
1.1.2	<u>DNA Replication</u> : Nearest neighbor base frequency analysis. Replication of DNA semiconservative model- Meselson and Stahl experiment. Direction of replication of <i>E.coli</i> , discontinuous replication-Okazaki fragments.	
1.1.3	Composition and properties of DNA polymerase I, II and III. of <i>E.coli</i> DNA ligase, fidelity of replication. DNA topoisomerases and gyrases.	
1.1.4	Replication in viruses single stranded DNA virus, ϕ X174, rolling circle model. Replication of mitochondrial DNA.	
1.1.5	Organization of prokaryotic and eukaryotic gene-promoters, introns, exons, other regulatory sequences, enhancers, silencers, function of introns.	
1.1.6	<u>Regulation of Gene expression in prokaryotes</u> : Operon model-Lac operon-structure and regulation; Galactose operon-role of two promoters; Arabinose operon-positive control; tryptophan operon-attenuation control.	
1.1.7	<u>Regulation of gene expression at the level of DNA structure</u> : Super coiling, DNA methylation, role of nucleosome structure of eukaryotic DNA in gene expression-eg. glucocorticoid gene, chromatin remodeling	

Unit II:		
2.1	Transcription and Regulation	
2.1.1	<u>Transcription:</u> RNA biosynthesis in prokaryotes and eukaryotes- initiation, elongation and termination. RNA polymerase I, II and III. RNA dependent RNA synthesis - RNA replicase of QB virus.	10
2.1.2	Processing of eukaryotic mRNA–cap addition, poly A tail addition, intron splicing, RNA editing. Processing of t–RNA.	
2.1.3	<u>Regulation at the level of transcription:</u> Transcription factors, TF II. Formation of initiation complex. Role of enhancers	
2.1.4	<u>Regulation at the level of RNA processing:</u> RNA export and RNA stability. Factors affecting RNA stability. RNA degradation.	
Unit III:		
3.1	Translation	
3.1.1	<u>Translation:</u> Genetic code, triplet codon, Universality features of the genetic code, assignment of codons studies of Khorana, Nirenberg, triplet binding techniques, degeneracy of codons, wobble hypothesis, evolution of genetic code and codon usage, variation in the codon usage.	12
3.1.2	<u>3D structure of prokaryotic and eukaryotic ribosomes,</u> <u>Translation:</u> initiation, elongation and termination. Role of m–RNA and t–RNA; aminoacyl t–RNA synthetase and its role in translation accuracy, signal sequence, translational proof-reading, translational inhibitors.	
3.1.3	<u>Post translational modification of proteins</u> –signal peptide cleavage, disulphide bond formation, O–and N–Glycosylation, folding of nascent protein, role of chaperones, attachment of glycosyl anchor, and other modifications.	
Unit IV:		
4.1	Translational Regulation	
4.1.1	<u>Regulation at the level of translation:</u> Secondary structure in the 5' and 3' untranslated region–eg. Regulation of Ferritin and Transformation of m-RNA. Role of upstream AUG codons. (eg. GCN 4 gene regulation), transplicing and translational introns, protein splicing introns.	12
4.1.2	<u>Role of ribosomes in the regulation of translation:</u> Proof–reading mechanism. Ribosomal optimization of translation. Regulation at the level of ribosome assembly. Regulation at the level of post-translational modification, protein stability, N–end rule, PEST and other sequences	

References

- [1] Molecular Biology of the Cell, Alberts et al., Garland Publications, (2012).
- [2] Molecular Biology, David Freifelder, Narosa Publishers, (1997).
- [3] Molecular Biology Robert F. Weaver, McGraw Hill (2012).
- [4] Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education; (2004).
- [5] Principles of Virology; S.J. Flint et al., ASM Press (2000).
- [6] Biochemistry and Molecular Biology; 5th Edn. D.Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott Oxford University Press (2014)
- [7] Chromatin structure and Gene Expression; 2nd Edn. Sarah Elgin, Jerry Workman, Oxford University Press (2000)
- [8] Molecular Cell Biology; Harvey Lodish 5th Edn. (2010)
- [9] Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (2011).
- [10] Genome Stability: DNA Repair and Recombination; James Haber, Garland Science (2013)

Course Code	Title of the Course	Credits
BCD070	GENETICS AND GENETIC ENGINEERING	4

COURSE OUTCOME(S):

- CO1 Deliberate in details with examples gene organization
- CO2 Understand the classification and characteristics of population genetics
- CO3 Deliberate the details of cloning vectors
- CO4 Understand the details of applications of genetic engineering

		No. of Lectures
Unit I:		12
1.1	Mendelism and Gene Organization	
1.1.1	Basic principles of Mendelism–Laws of inheritance, dominance, codominance, epistasis, (eg. Comb shape in chickens). Pleiotropism. Cytoplasmic inheritances (eg. Shell Coiling)	
1.1.2	Organisation of genes in chromosomes–Single copy gene, gene families, tandemly repeating genes, pseudo genes	
1.1.3	Chromosome number–Ploidy, karyotyping, sex chromosome and dosage compensation. Mobile genetic elements,	
1.1.4	Chromosomal basis of human diseases–Extra or missing chromosome, abnormality in chromosome structure–deletion duplication, inversion and translocation.	
1.1.5	Gene and development–Model systems for studying development in Drosophila, genetic control of development in Drosophila, anteroposterior axis, specification role of maternal genes, segmentation of larval body, gap genes, pair rule genes, homeotic genes, complex gene interaction in development, sequential gene action.	

Unit II:		12
2.1	Population Genetics and Mutations	
2.1.1	Population Genetics–Genetic variation, Hardy–Weinberg Law, genetic frequency, migration, genetic equilibrium	
2.1.2	Mutations- nature of mutations–spontaneous and induced mutation, conditional lethal (eg. Temperature sensitive) mutation. Biochemical basis of mutation. Point mutation, base substitution mutation, missense, nonsense and silent mutations. Mutation rates. Chemical mutagens, radiation induced mutation, reverse mutations and suppressor mutations–intergenic and intragenic suppression, reversion as a means of detecting mutagens - Ames test	
2.1.3	Repair Mechanism–DNA repair mechanisms. Reciprocal	

	recombination, site specific recombination, <i>E. coli</i> rec system. Holliday model of recombination, SOS repair.	
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Unit III:		
3.1	Cloning Vectors, Gene Transfer and Sequencing Methods	
3.1.1	Introduction to genetic engineering: Basic steps of gene cloning, enzymes used in genetic engineering.	08
3.1.2	Cloning vectors: Plasmids, Phages, Cosmids, Phagemids, Yeast vectors, Shuttle vectors, Ti Plasmids, Ri plasmids.	
3.1.3	Methods of gene transfer. Isolation and purification of cellular and plasmid DNA.	
3.1.4	Methods for labeling nucleic acids and probes. Methods of DNA sequencing. DNA Microarray	

Unit IV:		
4.1	Amplification & Applications of Genetic Engineering	
4.1.1	Amplification of DNA by PCR technique and applications.	16
4.1.2	<i>In situ</i> hybridization, analysis of DNA, RNA and protein by blotting techniques.	
4.1.3	Marker and Reporter genes. Applications of genetic engineering: Transgenic plants and animals DNA vaccines Gene therapy	

References

- [1] Singh, J.S., Singh, S.P. and Gupta, S. (2006) Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi
- [2] Wilkinson, D.M. (2007). Fundamental Processes in Ecology. An Earth System Approach. Oxford.
- [3] Daubenmier, R.F. (1970). Plants and Environment: A text book of Plant Autoecology, Wiley Eastern Private Limited
- [4] Daubenmier, R.F. (1970), Plant Communities, Wiley Eastern Private Limited
- [5] Odum, E. (2008) Ecology. Oxford and IBH Publisher.
- [6] Sharma, P.D. (2010) Ecology and Environment, (8th Ed.) Rastogi Publications, Meerut.
- [7] Tom Strachan & Andrew P.Read 1999. Human Molecular Genetics (2nd Edition), John Wiley & Sons.
- [8] Ricki Lewis, 1998. Human Genetics-Concepts & Applications (3rd Edition), McGraw-Hill.
- [9] T. A. Brown, 1999. Genomes, John Wiley & Sons (Asia) PTE Ltd.
- [10] Scott Freeman & Jon C. Herron, 2001. Evolutionary Analysis (2nd Edition), Prentice Hall.
- [11] Garner E.J, Simmons, M.J. & Snustad, D.P.1991. Principles of Genetics, John Wiley & Sons Inc, N.Y
- [12] Watson, J.D., Hopkins, N. H., Roberts, J. W. Steitz & Weiner, A. M., 1987. Molecular Biology of the Genes, The Benjamin/Cummings Publishing Company Inc., Tokyo.

Course Code	Title of the Course	Credits
BCD060	PROJECT WORK OR DISSERTATION	8

COURSE OUTCOME(S):

- CO1 Identify the classification and characteristics of literature survey
- CO3 Learn in depth define of objective of project work
- CO3 Write down the classification and characteristics of design of experimental methods
- CO4 Understand the details of result analysis and interpretation

BLUE PRINT OF QUESTION PAPER FOR C1 & C2 COMPONENT

JSS Mahavidyapeetha
JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(Autonomous) B N Road, Mysuru - 25

M.Sc. Biochemistry

I/II/III/IV Semester First/Second Internal Assessment Test (Component 1/2)

Title of the Course & Code

Duration: 1hr

Max Marks: 20

A) Answer any FOUR of the following

4X2=08

- 1.
- 2.
- 3.
- 4.
- 5.

B) Answer any ONE of the following

4X1=04

- 1.
- 2.

C) Answer any ONE of the following

8X1=08

- 1.
- 2.

BLUE PRINT OF QUESTION PAPER FOR C3 COMPONENT

JSS Mahavidyapeetha
JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(Autonomous), Ooty Road, Mysuru – 570025

M.Sc Degree

I/II/III/IV Semester Examination, _____

BIOCHEMISTRY

Course Title & QP Code

Time: 3 Hours

Max. Marks: 70

Instructions to Candidates:

Answer any Five questions from Part – A

Any Four questions from Part – B

Any Three questions from Part – C

Part – A

2X5=10

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

Part – B

6X4=24

- 8.
- 9.
- 10.
- 11.
- 12.
- 13.

Part – C

12X3=36

- 14.
- 15.
- 16.
- 17.
- 18.