Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF

BIOCHEMISTRY

THREE YEAR B.Sc.

DEGREE COURSE IN

BIOCHEMISTRY

PROGRAMME OUTCOMES

Programme Outcomes (PO)	Short Title of the POs	Description of the Programme Outcomes **Graduates will be able to :**
PO-1	Problem Analysis and Solutions	Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals.
PO-2	Use of Technology	Apply appropriate IT tools efficiently in their daily activities of communication and academics.
PO-3	Environment and Sustainability	Analyze and attempt solutions to environmental issues and commit themselves to sustainable development in the local/ national and global context.
PO-4	Ethics	Recognize and understand professional ethics /human values and be responsible for the same.
PO-5	Individual and Team work	Function effectively at various levels, capacities and situations.
PO-6	Communication	Communicate proficiently (oral and written) as a responsible member of society.
PO-7	Research Aptitude	Understand general research methods and be able to analyse, interpret and derive rational conclusions.
PO-8	Life Skills	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change.

PROGRAMME SPECIFIC OUTCOMES (PSO) After successful completion of a Bachelor's degree in Biochemistry, the students will:		
PSO-1	Fundamental Knowledge of Biochemistry	Possess a fundamental knowledge of the different aspects of Biochemistry, with the means and ability to specialize in a specific field.
PSO-2	Development of practical skills	Be equipped with practical skills and the ability to apply their theoretical concepts to design, perform experiments, analyze and interpret data and thus develop proficiency in laboratory management.
PSO-3	Critical thinking and analytical skills	Be able to demonstrate proficiency in quantitative reasoning (critical thinking) and analytical skills.
PSO-4	Analysis and Problem Solving	Be able to use these skills to analyze and solve industry related problems, thus preparing them for a successful career in industry and research institutes.
PSO-5	Understanding the need for sustainable solutions	Be able to understand the impact of Biochemistry in the development of sustainable solutions for the environment and societal context.
PSO-6	Developing an inclination towards research	Develop an inclination towards research through the compulsory internship in industry/research/academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with a multidisciplinary approach.

B.SC. DEGREE COURSE IN BIOCHEMISTRY - COURSE STRUCTURE

(To be applicable from the academic year 2019)

SEMESTER	CORE		ELECTIVE			
I	**BCH-I.C-1** Molecules of Life	**BCH-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BCH-II.C-3** Protein Chemistry	**BCH-II.C-4** Biophysics	--------	--------	--------	--------
III	**BCH-III.C-5** Metabolism of Biomolecules		**BCH-III.E-1** Tools & Techniques in Biochemistry	**BCH-III.E-2** Enzymology	**BCH-III.E-3** Fundamentals of Microbiology	**BCH-III.E-4** Plant Biochemistry
IV	**BCH-IV.C-6** Immunology		**BCH-IV.E-5** Human Physiology	**BCH-IV.E-6** Nutritional Biochemistry	**BCH-IV.E-7** Endocrinology	**BCH-IV.E-8** Advanced Cell Biology
V	**BCH-V.C-7** Molecular Biology		**BCH-V.E-9** Concepts of Genetics	**BCH-V.E-10** Regulation of Gene Expression	**BCH-V.E-11** Food and Industrial Biochemistry	**BCH-V.E-12** Bioinformatics
VI	**BCH-VI.C-8** Clinical Biochemistry		**BCH-VI.E-13** Introduction to Pharmacology	**BCH-VI.E-14** Intermediary Metabolism	**BCH-VI.E-15** Genetic Engineering and Biotechnology	**BCH-VI.E-16** Environmental Chemistry

Skill Enhancement Courses for the students of Biochemistry

1. Food and Fermentation Technology
2. Horticulture, Floriculture and Landscaping
3. Bioentrepreneurship
4. Waste Management Techniques

SEMESTER I

CORE COURSE: MOLECULES OF LIFE	
COURSE CODE:	**BCH-I.C-1**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (03 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Gain an understanding of the various theories of the origin of life **CO2:** Comprehend the importance of water in the sustenance of life. **CO3:** Compare and contrast the various different biomolecules (carbohydrates, proteins, lipids, nucleic acids, vitamins), their categories as well as functions. **CO4:** Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments. **CO5:** Prepare different solutions such as buffers, reagents and stock solutions for experiments independently.

BCH-I.C-1: MOLECULES OF LIFE (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: **The foundations of Biochemistry, Water, Carbohydrates**	**1.1 : The foundations of Biochemistry** Chemical and cellular foundations of life **1.2 : Water** Unique properties of water; Weak interactions in aqueous systems; Ionization of water; Water as a reactant and fitness of the aqueous environment **1.3 : Carbohydrates** Classification of carbohydrates; Monosaccharides - structures of aldoses and ketoses, ring structure of sugars, conformations of sugars; Stereochemistry: mutarotation, anomers, epimers, and enantiomers; The formation of disaccharides; Reducing and non-reducing disaccharides; Polysaccharides: homo and heteropolysaccharides; Structural and storage polysaccharides; Glycoconjugates; Functions of carbohydrates	**02** **03** **10**	**15**
MODULE 2: **Proteins and Lipids**	**2.1 : Proteins** Amino acids - structure, classification; Derivatives of amino acids and their biological role. Titration of amino acids; Introduction to biologically important peptides; Polypeptides and proteins. **2.2 : Lipids**	**08**	

	Classification of lipids and their distribution; Storage lipids; Structural lipids; Lipids as signaling molecules, cofactors and pigments	**07**	**15**
MODULE 3:	**3.1 : Nucleic Acids** Nucleotides and nucleic acids, phosphodiester bond; Nucleic acid structure and chemistry: DNA as genetic material; DNA structures and their importance, unusual DNA structures; Different types of RNA; Other functions of nucleotides: a source of energy, a component of coenzymes, second messengers. **3.2 : Vitamins** Structure and active forms of water soluble and fat soluble vitamins; Deficiency diseases and symptoms; Hypervitaminosis	**10** **05**	**15**

BCH-I.C-1: MOLECULES OF LIFE (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to safety measures in laboratories	01
2.	Preparation of buffers & solutions (normal, molar, ppm , %)	01
3.	Mutarotation of sugars	01
4.	Qualitative tests for carbohydrates, lipids, proteins and nucleic acids	04
5.	Estimation of reducing sugars by DNSA method	01
6.	Determination of pKa of amino acids	02
7.	Preparation of TLC plates and separation of amino acids and sugars by thin layer chromatography	04
8.	Determination of peroxide value of oil	01
9.	Estimation of Vitamin C	01

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Sadasivam,S. andManickam, A. (1996), Biochemical Methods, New Age International (P) Limited
- Jayaraman, J. (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

SEMESTER I

CORE COURSE: CELL BIOLOGY	
COURSE CODE:	**BCH-I.C-2**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	Theory: 45 Hours (03 Lectures per week) Practical: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Demonstrate an understanding of cell communication **CO2:** Correlate the function of each cell organelle with proper coordination. **CO3:** Identify and analyse different biological cells using a compound microscope **CO4:** Prepare various plant and animal specimens for the observation of cell structures.

BCH-I.C-2: CELL BIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: **Introduction to Cell Biology, Cell Wall and Plasma Membrane**	**1.1 : Introduction to cell biology** Cell theory; ultrastructure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix. **1.2 : Cell wall & Plasma membrane** Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planar bilayer and liposomes as model membrane systems; Fluid mosaic model; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP.	**06** **09**	**15**
MODULE 2: **Ultrastructure and Function of Organelles**	**2.1 : Ultrastructure and function of organelles** Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; Lysosomes; Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.	**15**	**15**
MODULE 3: **Cell Cycle and Cell-cell Interactions**	**3.1 : Cell Cycle** Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis. **3.2 : Cell-Cell interaction** Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the	**05** **10**	

	immunoglobulin superfamily, cadherins, adherens junctions and desmosomes; tight junctions, gap junctions and plasmodesmata		**15**

BCH-I.C-2: CELL BIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Examination of prokaryotic cell, eukaryotic cell and cell organelles using photomicrographs	01
2.	Visualization of animal and plant cell using methylene blue	01
3.	Study of cell viability using phenol red / trypan blue	01
4.	Visualization of Permanent slides of: A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell B. Different stages of cell division	02
5.	Identification of different stages of mitosis in onion root tip `	02
6.	Identification of different stages of meiosis in onion flower buds	02
7.	Isolation of chloroplast from spinach leaves	04
8.	Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods	02

REFERENCES

- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- Robertis, E.D.P. &Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5thedition. ASM Press & Sunderland, Washington, D.C.
- Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. 14 thed

SEMESTER II

CORE COURSE: PROTEIN CHEMISTRY	
COURSE CODE:	**BCH-II.C-3**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	Theory: 45 Hours (03 Lectures per week) Practical: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, students will be able to: **CO1:** Comprehend the various levels of protein structure **CO2:** Explain the mechanism and significance of membrane proteins. **CO3:** Correlate the techniques used in studying protein structure **CO4:** Review enzymes and their classification system. **CO5:** Assess and compare the various methods employed in protein estimation/concentration and measuring the protein content.

BCH-II.C-3: PROTEIN CHEMISTRY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: **Protein Structure**	**1.1 : Protein structure** Bonds in protein structure (covalent, non covalent, peptide), importance of primary & secondary structure, tertiary and quaternary structures, bond lengths and configuration, Dihedral angles, psi and phi, helices, sheets and turns, Ramachandran map; techniques used in studying 3-D structures - X-ray diffraction and NMR; motifs and domains; structures of myoglobin and haemoglobin, multimeric proteins and conjugated proteins, diversity of function.	**15**	**15**
MODULE 2: **Isolation & Analysis of proteins**	**2.1 : Isolation & analysis of protein** Techniques to isolate and analyze proteins: salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF; Protein primary structure: sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides, synthesis of peptides using Merrifield method **2.2 : Characterization of proteins** Determination of purity, molecular weight, extinction coefficient, sedimentation coefficient, 2-D electrophoresis	**12** **03**	**15**
MODULE 3:	**3.1 : Enzymes** Nature of enzymes: protein and non-protein (ribozyme); cofactor and prosthetic group, apoenzyme, holoenzyme; IUBMB classification of enzymes; mechanism of enzyme activity	**06**	

	3.2 : Membrane and Transport proteins Integral and membrane associated proteins, hydropathy plots to predict transmembrane domains; significance of functional proteins - bacteriorhodopsin, myoglobin and haemoglobin: structure and function (Oxygen binding curves, cooperativity models for haemoglobin)	**09**	**15**

BCH-II.C-3: PROTEIN CHEMISTRY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Determination of absorption maxima and molar extinction coefficient of protein sample	02
2.	Protein Assay (Biuret/Lowry/Bradford method)	02
3.	Ammonium sulphate fractionation of proteins	02
4.	Protein Dialysis	02
5.	Solubility of proteins in distilled water and salt solutions	02
6.	Denaturation of proteins by pH and temperature	01
7.	Separation of proteins by SDS-PAGE (demonstration)	02
8.	Gel filtration chromatography (demonstration)	02

REFERENCES

- Nelson D.L and Cox M.M (2013). Lehninger's Principles of Biochemistry, Worth Publishers, New York, USA.
- Cooper T.G (2011). The Tools of Biochemistry, Wiley India Pvt. Ltd, New Delhi.
- Voet, D. and Voet, J.G (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA.
- Plummer D. T (1998). An Introduction to Practical Biochemistry, 3rd ed., Tata McGraw Hill Education Pvt. Ltd. New Delhi.
- Sadasivam S. and A. Manickam (1996), Biochemical Methods, New Age International (P) Limited, New Delhi.
- J. Jayaraman (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited, New Delhi.

SEMESTER II

CORE COURSE: BIOPHYSICS	
COURSE CODE:	**BCH-II.C-4**
MARKS:	**100** (75 – Theory; 25 – Practical)
CREDITS:	**4** (03 – Theory; 01 – Practical)
CONTACT HOURS:	**Theory**: 45 Hours (03 Lectures per week) **Practical**: 30 Hours (01 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Explain the basic concepts of the origin and evolution of life **CO2:** Understand how cellular reactions take place in accordance with thermodynamic principles **CO3:** Describe the mechanism of derivation of energy through bioenergetic reactions in living cells **CO4:** Elucidate energy transductions in organisms. **CO5:** Understand concepts of buffer capacity and osmolarity. **CO6:** Demonstrate a practical understanding of spectrophotometry.

BCH-II.C-4: BIOPHYSICS (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL HOURS
MODULE 1: **The chemical basis of life, Basic principles of biochemical studies, Ion channels**	**1.1 : The chemical basis of life** Introduction, prebiotic earth, theories of origin and evolution of life; covalent bonds, non-covalent bonds: ionic bonds, hydrogen bonds, hydrophobic interactions, van der Waals forces **1.2 : Basic principles of biochemical studies** Units of measurement; weak electrolytes- the biochemical importance of weak electrolytes, ionisation of weak acids and bases, calculation of pH, ionisation of a weak electrolyte, buffer solutions, buffer capacity, buffer action and pH of blood, measurement of pH, pH meters **1.3 : Ion Channels** Sodium, Potassium, Calcium, Chlorine, ligand gated, Donnan's equilibrium experiments	**05** **06** **04**	**15**
MODULE 2: **Bioenergetics and oxidative phosphorylation**	**2.1 : Introduction to bioenergetics** Laws of thermodynamics, equilibrium constant, coupled reactions, ATP cycle, phosphoryl group transfers; chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation, universal electron carriers **2.2 : Oxidative phosphorylation** Mitochondrial electron transport chain: its organization and function, inhibitors of ETC and uncouplers, Peter Mitchell's chemiosmotic	**08** **07**	**15**

	hypothesis, proton motive force, structure and mechanism of ATP synthesis, regulation of oxidative phosphorylation		
MODULE 3: **Photo-phosphorylation**	**3.1 : Photo-phosphorylation** General features of photophosphorylation, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes; bacterial photophosphorylation in purple bacteria, green sulfur bacteria. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides; cyclic photophosphorylation and its significance; photo inhibition, evolution of oxygenic photosynthesis; Comparison of phosphorylation in mitochondria and chloroplasts	**15**	**15**

BIO-II.C-4: BIOPHYSICS (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Preparation of buffers	01
2.	Determination of buffer capacity	02
3.	To determine osmolarity of solutions proteins/sugars/lipids/ nucleic acids using osmometer	04
4.	Effect of detergents and other membrane active substances on cells	02
5.	Determination of lambda max and molar extinction coefficient of a given compound	02
6.	Determination of pKa of Bromophenol blue	02
7.	Photooxidation of photosynthetic pigments (demonstration)	01
8.	Oxygen evolution (by Hydrilla) (demonstration)	01

REFERENCES

- Nelson D.L and Cox M.M (2013). Lehninger's Principles of Biochemistry, Worth Publishers, New York, USA.
- Cooper T.G (2011). The Tools of Biochemistry, Wiley India Pvt. Ltd, New Delhi.
- Voet, D. and Voet, J.G (2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Wilson K and Walker J (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition Cambridge University Press, UK.

LIST OF COMMON COURSES WITH THE DEPARTMENT OF BIOTECHNOLOGY

1. Cell Biology (Semester II)
2. Enzymology (Semester III)
3. Metabolism of Biomolecules (Semester III)
4. Immunology (Semester IV)