Centurion University of Technology and Management

School of Applied Sciences

B. Sc. (Biochemistry Hons.)

CBCS syllabus

Semester – I & II

(Three Years Programme)

2019

Core Courses (CC)

Sl. No	CORE	Code	Subject name	Type of Course	T+P+Pr (Credit)	Credits
1	C-1	BSBC1101	Molecules of Life	Theory + Practice	4+2+0	6
2	C-2	BSBC1102	Cell Biology	Theory + Practice	4+2+0	6
3	C-3	BSBC1201	Proteins	Theory + Practice	4+2+0	6
4	C-4	BSBC1202	Enzymes	Theory + Practice	4+2+0	6

Generic Electives Course (GE)

Sl. No	Code	Subject name	Type of Course	T+P+Pr (Credit)	Credits
1	BSBC1103	Fundamentals Of Cell Biology And Immunology	Theory + Practice	4+2+0	6
2	BSBC1203	Proteins and Enzymes	Theory + Practice	4+2+0	6

Ability Enhancement Compulsory Course (AECC)

Sl. No	Code	Subject name	Type of Course	T+P+Pr (Credit)	Credits
1	BSFL1101	English	**Theory**	**3-0-0**	**3**
2	FCBS0101	Environmental Science	**Theory**	**3-0-0**	**3**

Subject name	Code	Type of Course	T+P+Pr (Credit)	Prerequisite
MOLECULES OF LIFE	BSBC1101	Theory + Practice	4+2+0	NIL

Objectives

- To understand the chemical foundations of life
- To study the structure of different bio-molecules
- To study the classification of different bio-molecules
- To study the role of the bio-molecules

Learning outcomes

- The student will know different biomolecules controlling life.
- The student will know about structure, classification and role of carbohydrates, lipids and proteins.
- The student will know about structure, classification and role of nucleic acids.
- The student will know about structure, classification and role of vitamins.

Unit 1 The foundations of biochemistry No. of Hours: 2
Cellular and chemical foundations of life

Unit 2 Water No. of Hours: 4
Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

Unit 3 Carbohydrates and glycobiology No. of Hours: 16
Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non reducing disaccharides. Polysaccharides – homo- and hetero polysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Unit 4 Lipids No. of Hours: 14
Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerol phospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments

Unit 5 Amino acids No. of Hours: 8
Structure and classification, physical, chemical and optical properties of amino acids

Unit 6 Nucleic acids No. of Hours: 10
Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Unit 7 Vitamins No. of Hours: 6
Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

MOLECULES OF LIFE PRACTICE

SEMESTER - I
TOTAL HOURS: 60 CREDIT: 2

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography.
7. Estimation of vitamin C.

Subject name	Code	Type of Course	T+P+Pr (Credit)	Prerequisite
CELL BIOLOGY	BSBC1102	Theory + Practice	4+2+0	NIL

Objectives

- To understand the unit of life
- To understand different equipment used in biology
- To know about cellular organelles
- To know about cellular chemicals

Learning outcomes

- The student will know about cells.
- The student will know about structure and function of different cellular organelles.
- The student will know the role of proteins in cell
- The student will know about the lifecycle of a cell.

Unit 1 Introduction to cell biology No. of Hours: 4
Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models.

Unit 2 Tools of cell biology No. of Hours: 8
Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation. **Unit 3 Structure of**

Different cell organelles No. of Hours: 10
Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome.

Unit 4 Protein trafficking No. of Hours: 14
Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins.

Unit 5 Cytoskeletal proteins No. of Hours: 8
Structure and organization of actin filaments. Tread milling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

Unit 6 Cell wall and extracellular matrix No. of Hours: 6
Prokaryotic and eukaryotic cell wall, cell matrix proteins, Cell-matrix interactions and cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemi desmosomes, focal adhesions and plasmodesmata.

Unit 7 Cell cycle, cell death and cell renewal No. of Hours: 10
Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

CELL BIOLOGY PRACTICE

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Identification of different stages of meiosis in grasshopper testis.
4. Micrographs of different cell components (dry lab).
5. Sub-cellular fractionation.
6. Visualization of nuclear fraction by acetocarmine stain.
7. Staining and visualization of mitochondria by Janus green stain.

Subject name	Code	Type of Course	T+P+Pr (Credit)	Prerequisite
PROTEINS	BSBC1201	Theory + Practice	4+2+0	NIL

Objectives

- To understand amino acids, peptides and proteins
- To understand downstream processing of proteins
- To understand structure and characterization of different proteins
- To understand the protein extraction methods

Learning outcomes

- The student will know about different types of amino acids, peptides and proteins.
- The student will know different extraction methods of proteins.
- The student will know the application of proteins in different places.
- The student will know the structural details of protein.
- The student will know different techniques to characterize (physical and chemical) proteins.

Unit 1 Introduction to amino acids, peptides and proteins No. of Hours: 2
Amino acids and their properties - hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function

Unit 2 Extraction of proteins for downstream processing No. of Hours: 4
Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation.

Unit 3 Separation techniques No. of Hours: 10
Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilisation. Ionexchange
chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC

Unit 4 Characterization of proteins No. of Hours: 8
Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.

Unit 5 Covalent structure of proteins No. of Hours: 12
Organization of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass spectrometric analysis, tandem MS. Solid phase peptide synthesis

Unit 6 Three dimensional structures of proteins No. of Hours: 6
Nature of stabilizing bonds - covalent and non covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures - X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin

Unit 7 Protein folding and conformational diseases No. of Hours: 4
Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based.

Unit 8 Introduction to protein structure databases No. of Hours: 2
Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using *in silico* tools.

Unit 9 Myoglobin and haemoglobin No. of Hours: 6
Oxygen binding curves, influence of 2,3-BPG, CO2 and Cl-. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders.

Unit 10 Specialized proteins - antibodies and actin-myosin motors No. of Hours: 4
Antibody structure and binding to antigens. ATP activated actin - myosin contractions.

Unit 11 Membrane proteins No. of Hours: 2
Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin.

PROTEINS PRACTICE

1. Estimation of proteins using UV absorbance and Biuret method.
2. Micro assay of proteins using Lowry/Bradford method.
3. Isoelectric pH.
4. Ammonium sulphate fractionation of serum proteins.
5. SDS-PAGE analysis of proteins.

Subject name	Code	Type of Course	T+P+Pr (Credit)	Prerequisite
ENZYMES	BSBC1202	Theory + Practice	4+2+0	NIL

Objectives

- To understand the classification, structure and use of enzymes.
- To understand kinetics of enzymatic reactions
- To understand inhibitors of enzyme activity
- To understand the mechanism of enzymatic action

Learning outcomes

- The student will know about enzymes and their constituents.
- The student will know different theories explaining the mechanism of action of enzyme.
- The student will know the kinetic expressions for enzyme activity.
- The student will know the enzyme inhibition mechanism.
- The student will know the applications of enzymes.

Unit 1 Introduction to enzymes No. of Hours: 2
Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes.*]*

Unit 2 Features of enzyme catalysis No. of Hours: 6
Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis,
Koshland's induced fit hypothesis.

Unit 3 Enzyme kinetics No. of Hours: 10
Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-
Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme.

Unit 4 Bisubstrate reactions No. of Hours: 2
Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Unit 5 Enzyme inhibition No. of Hours: 8
Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors.

Unit 6 Mechanism of action of enzymes No. of Hours: 8
General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues.

Unit 7 Regulation of enzyme activity No. of Hours: 8
Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen**.** Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit 8 Involvement of coenzymes in enzyme catalysed reactions No. of Hours: 6
TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.

Unit 9 Applications of enzymes No. of Hours: 10
Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.

ENZYMES PRACTICE

1. Partial purification of acid phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity.
3. Effect of pH on enzyme activity
4. Determination of Km and Vmax using Lineweaver-Burk graph.
5. Enzyme inhibition - calculation of Ki for competitive inhibition.
6. Continuous assay.
7. Coupled assay.

Subject name	**Code**	**Type of Course**	**T+P+Pr (Credit)**	**Prerequisite**
FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY	BSBC1103	Theory + Practice	4+2+0	NIL

Objectives

- To understand different types of cell and their constituents
- To understand immunity
- To understand different organelles controlling immunity
- To understand the mechanism of increasing immunity

Learning outcomes

- The student will know about cells and cellular organelles responsible for immunity.
- The student will know immunity.
- The student will know the role of different organelles to provide immunity
- The student will know the cell cycle and the mechanism of immunity.
- The student will know about auto-immunity.

Unit 1 Cells and organelles No. of Hours: 6
Prokaryotic and eukaryotic cells. Plasma membrane, the nucleus, intracellular membranes and organelles, mitochondria, chloroplast, endoplasmic reticulum, Golgi complex, lysosome, peroxisome, cytoskeleton, extracellular matrix, cell wall. Mitosis and meiosis.

Unit 2 Membrane structure and function No. of Hours: 8
Composition of membranes, membrane lipids, membrane proteins, isolation and characterization. Integral, peripheral and lipid anchored protein. Transport across membranes, simple and facilitated diffusion, active transport.

Unit 3 Endoplasmic reticulum and Golgi complex No. of Hours: 6
The two types of endoplasmic reticulum, rough and smooth. The Golgi complex. Role of Golgi in protein glycosylation and protein trafficking.

Unit 4 Signalling mechanisms, messengers and receptors No. of Hours: 8
Chemical signals and cellular receptors. G-protein linked receptors, protein kinase associated receptors. Hormonal signalling, cell signals and apoptosis.

Unit 5 Cell cycle and its regulation No. of Hours: 4
Overview of the cell cycle. Regulation of the cell cycle, cyclin dependent kinases.

Unit 6 Overview of the immune system No. of Hours: 4
Self versus non self. Humoral and cellular immunity. Innate and adaptive immunity. Cells of the immune system, primary and secondary lymphoid tissues and organs. Cellular and humoral responses.

Unit 7 Innate immunity No. of Hours: 8
Defensins. Non-immunological barriers. Cells and soluble mediators of innate immunity. Acute phase proteins. Cytokines. Complement system.

Unit 8 Humoral B cell response No. of Hours: 8
Structure of antibodies, types of immunoglobulins, generation of antibody diversity, B cell activation, theory of clonal selection, formation of plasma and memory cells; T-independent B-response; antigens, haptens carriers and adjuvants.

Unit 9 Cell mediated immunity No. of Hours: 8
T-cell development, MHC locus. Structure, function and distribution of MHC glycoproteins. Antigen processing and presentation. Cell mediated immune responses by different T-cell sub populations. Hypersensitive reactions. Concept of autoimmunity.

FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY PRACTICE

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Isolation of organelles by sub-cellular fractionation.
4. Isolation of IgG from serum by ion exchange chromatography.
5. Antigen-antibody interaction by Ouchterlony double diffusion.

Subject name	Code	Type of Course	T+P+Pr (Credit)	Prerequisite
PROTEINS AND ENZYMES	BSBC1203	Theory + Practice	4+2+0	NIL

Objectives

- To understand different types of proteins and enzymes
- To understand different characterization and separation methods
- To understand the kinetics of catalytic action of enzymes
- To understand the applications of enzyme

Learning outcomes

- The students will learn different types of proteins
- The students will learn different protein characterization and isolation methods
- The students will learn the kinetics of catalytic action of enzymes
- The students will learn mechanism of enzyme activity
- The students will learn the applications of enzymes in medical sectors and industry .

Unit 1 Introduction to proteins No. of Hours: 4
Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Unit 2 Isolation and analysis of proteins No. of Hours: 12
Techniques to isolate and analyze proteins- salt fractionation, ion-exchange hromatography, 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 Merrifeld method.

Unit 3 Introduction to protein three-dimensional structures No. of Hours: 10
Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent onds and covalent bonds in protein folding. Tertiary and quaternary structures.

Unit 4 Myoglobin and haemoglobin - structure and function No. of Hours: 4
Oxygen binding curves, cooperativity models for haemoglobin.

Unit 5 Introduction to enzyme catalysis No. of Hours: 8
Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

Unit 6 Enzyme kinetics No. of Hours: 10
Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit 7 Mechanisms of enzyme action and regulation No. of Hours: 6
Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarbamoylase.

Unit 8 Enzymes in medicine and industry No. of Hours: 6
Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

PROTEINS AND ENZYMES PRACTICE

1. Protein estimation by UV absorbance and Biuret method.
2. Protein microassay by Lowry/Bradford method.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
4. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
5. Determination of Km and Vmax of enzyme enriched fraction.
   Inhibition of acid phosphatase activity by inorganic phosphate.

Subject name	**Code**	**Type of Course**	**T+P+Pr (Credit)**	**Prerequisite**
ENGLISH	**BSFL1101**	Theory	3+0+0	NIL

Course Outline
Module-I: Communication Skill
Communication: Definition, concept
Channels of Communication: Sender, receiver, channel, message, encoding, decoding, context, feedback
Verbal & Non-Verbal Communication: Spoken & written-advantages & disadvantages, Bias free English,
Formal & informal style.

Module-II: Communicative Grammar
Time, Tense & Aspect
Verbs of state & events
Modality
Active & Passive voice
Antonyms, Synonyms, Homonyms, one word substitutions & correction of errors

Module-III: Sounds of English
Length of vowels:
Long vowels as in the words feel, food, shoot, card etc.
Short vowels as in the words pen, sun, cut, shut, etc.
Consonants
Stress pattern
Intonation: Rising & Falling.

Text Book:
1. Effective technical communication by M.A. Rizvi
Reference Books:
1. Communicative English & Business Communication by R.K.Panda, J.Khuntia, M.Pati, Alok Publication.
2. Communicative Grammar of English Geoffery Leech

Subject name	**Code**	**Type of Course**	**T+P+Pr (Credit)**	**Prerequisite**
ENVIRONMENTAL SCIENCE	**FCBS0101**	Theory	3+0+0	NIL

Course Objectives:

1. To understand the concept of multi-disciplinary nature of Environmental Science where different aspects are dealt with a holistic approach.
2. Students will develop a sense of community responsibility by becoming aware of environmental issues in the larger social context.
3. One must be environmentally educated

Learning Outcomes:

1. Understand the natural environment and its relationships with human activities.
2. Characterize and analyze human impacts on the environment.
3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
4. Design and evaluate strategies, technologies and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Course Outline

MODULE-I
Environment and its multidisciplinary nature; Need for public awareness; Renewable and non - renewable resources–forest, water, mineral, land, food and energy resources; Structure and function of ecosystems of forest, grass land, desert and aquatic types.

MODULE -II
Biodiversity and its conservation: Biodiversity at global, national and local levels; Threats to biodiversity - Habitat loss; wild life poaching and man - wildlife conflicts; Endangered and endemic species; conservation measures.

Causes, effects and control measures of pollution, air, water and noise pollution; Nuclear hazards; solid-waste management–Causes, effects and control measures; Management of disasters due to natural causes of floods, earthquakes, cyclones and landslides.

MODULE-III
Social issues and the environment; Sustainable environment, Water conservation measures; Rain water harvesting; Resettlement and rehabilitation of people; Climate change and global warming; Acid rain; Ozone layer depletion; water land reclamation; Consumerism and waste products; Features of Environment Protection Act, Air pollution and Control of Pollution Acts; Water Pollution and its Control Act. Effects of Pollution explosion on environment and public health; Need for value education to Protect environment and resources.

Text Book:
1. Anubhav Kaushik & C.P. Kaushik: Environmental Studies-New age International Publishers.

Reference Books:
1. Benny Joseph: Environmental Studies-Tata Mac Graw Hill

2. E. Bharucha: Text book of Environmental Studies for under graduate courses– Universities Press. (Book prepared by UGC Committee).