

SHSB1102	GENERAL ENGLISH– I	L	T	P	El	Credits	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To provide opportunities for students to read and respond to representations of current issues
- To prepare the students to effectively communicate by applying reflective thinking practices
- To provide an opportunity to the students to improve their vocabulary
- To create and apply lateral and critical thinking
- To learn academic writing strategies

**UNIT 1****9 Hrs.**

Listening to identify vocabularies- Self Introduction - Developing dialogue between characters -Talking about neighbours, family members, likes and dislikes, Reading Comprehension strategies- Parts of Speech- Kinds of Sentences Connectives and Discourse markers - Rearranging the Jumbled sentences, E-Mail Writing.

**UNIT 2****9 Hrs.**

Listening for Inference- Just a Minute speech- Types of words- Compound words, abbreviations and acronyms, Word Association- Tenses and its Types- Voice- Impersonal Passive- Rules of Passive voice formation - Transcoding - Encoding and Decoding- Bar chart, Pie Chart.

**UNIT 3****9 Hrs.**

Listening to telephonic talk to fill blanks- Giving information- travel, hotel booking, making enquiries about availability of seats for admission, asking about courses - Question Tags – Open ended and Close ended questions, Concord, Single - Line Definition - Note Making - Preparing checklists.

**UNIT 4****9 Hrs.**

Listening to summarise the information- Reading and identifying the topic sentence, - Editing - Punctuation- Error Corrections, 'If 'Conditionals, Idioms & Phrases, Instructions & Recommendations – Drafting a brochure/Advertisement.

**UNIT 5****9 Hrs.**

Listening to Movie reviews and book reviews, Listening and summarizing- Giving impromptu talks - Reading and Summarizing -Types of words- Homonyms, Homophones, eponyms, acronyms- Writing a Paragraph, Descriptive Essay, Dialogue Writing.

**Max. 45 Hrs.****COURSE OUTCOMES**

On the completion of the course, the student will be able to

- CO1** - Remember knowledge of linking words related to both spoken and written discourse.
- CO2** - Understand collocations, words to express one's point of view in both writing and speaking.
- CO3** - Apply the rules for writing compare and contrast paragraphs by using cohesive devices based prompts given.
- CO4** - Analyse critical thinking skills by framing questions related to elements of reasoning.
- CO5** - Evaluate written pieces to self-correct in the topic areas of verbs, reported speech, and punctuation.
- CO6** - Equip the students with the required Professional Skills.

**TEXT / REFERENCE BOOKS**

1. Sen S, Mahendra et al. (2015) Communication and Language Skills. Foundation books. Chennai
2. Strunk, William Jr., and E.B. White. The Elements of Style. Allyn and Bacon, 2000.
3. Murphy, Raymond. English Grammar in Use. Cambridge University Press, 2012.
4. Thomson, A.J., and A.V. Martinet. A Practical English Grammar. Oxford University Press, 1986.
5. Straus, Jane. The Blue Book of Grammar and Punctuation. John Wiley & Sons, 2014.
6. O'Conner, Patricia T. Woe is I: The Grammarphobe's Guide to Better English in Plain English. Riverhead Books, 2019

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB1101	BIOMOLECULES	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- To learn about the structure, properties, functions and importance of biomolecules.

**UNIT 1 CARBOHYDRATES****9 Hrs.**

Carbohydrates – Definition and classification. Structure, Chemical properties and role of monosaccharide. Structure, and biological functions of oligosaccharides (Disaccharides and Trisaccharides). Chemistry and biological importance of polysaccharides (Homopolysaccharide and Heteropolysaccharide).

**UNIT 2 LIPIDS****9 Hrs.**

Lipids – Definition and classification of lipids, simple, compound and derived. Simple lipids-Physical and chemical properties of fats. Characterization of fat – Saponification number, Acid number, Iodine number and Reichert Meisel number. Compound lipids – Structure and functions of Phospholipids, sphingolipids, glycolipids and lipoproteins. Derived lipids - Fatty acids- Nomenclature of fatty acids-saturated and unsaturated. Essential fatty acids. Steroids-Structure and function of cholesterol.

**UNIT 3 AMINO ACIDS****9 Hrs.**

Amino acids – Structure, classification and chemical properties. Isoelectric pH, pKa and titration curve of amino acids. Peptides and peptide bond. Proteins – classification and biological importance. Denaturation and precipitation of proteins by salts.

**UNIT 4 NUCLEIC ACIDS****9 Hrs.**

Nucleic acids – purines and pyrimidines. Nucleosides and nucleotides. Polynucleotides: DNA and RNA, biological significance. Structure, forms of DNA and types of RNA. Denaturation and Renaturation.

**UNIT 5 VITAMINS AND MINERALS****9Hrs.**

Vitamins – Source, biological function, daily requirement and deficiency symptoms of fat soluble vitamins (A, D, E and K) and water soluble vitamins (Ascorbic acid, thiamine, riboflavin, pyridoxine, niacin, pantothenic acid, lipoic acid, biotin, folic acid and vitamin B12). Minerals: Mineral requirement, sources and functions of essential macro minerals and essential micro minerals.

**COURSE OUTCOMES****Max. 45 Hrs.**

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

- CO1** - Have exhaustive knowledge about the structure, chemistry and function of carbohydrates
- CO2** - Know In depth knowledge about the significance of the complex lipids
- CO3** - Understand about the importance of proteins and peptides
- CO4** - Categorize the salient structure, chemistry and features of nucleic acids
- CO5** - Understand the importance of vitamins and minerals.
- CO6** - Evaluate the role of vitamins and minerals in human body.

**TEXT / REFERENCE BOOKS**

1. Lehninger, A.L., Nelson, D.L., Cox, M.M., Principles of Biochemistry, W H Freeman Publishers, 8th Edition, 2021.
2. Lubert stryer, Biochemistry, Freeman and company, 9th Edition, 2019.
3. Harper—s Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange Medical Books. 32nd edition, 2022.
4. Jain J.L, Fundamentals of biochemistry, S.Chand Publication 7th Edition, 2016.
5. Ambika Shanmugam, Fundamentals of Biochemistry for Medical Students, Wolters Kluwer India Pvt. Ltd, 8th Edition, 2016
6. Deb, A.C., Fundamentals of Biochemistry, New Central Agency, Calcutta, 10<sup>th</sup> Edition, 2001.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB2101	BASIC BIOCHEMISTRY LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

**COURSE OBJECTIVES**

- The main objectives of this course are to analyze qualitatively the given unknown samples of carbohydrate, amino acids and lipids systematically.

**LIST OF EXPERIMENTS**

1. Analysis of carbohydrates
  - a. Monosaccharides-Glucose, Fructose, Galactose, Mannose, Pentose.
  - b. Disaccharides-Sucrose, Maltose and Lactose.
  - c. Polysaccharides-Starch and Dextrin.
2. Analysis of Amino acids - a) Histidine b) Tyrosine c) Tryptophan d) Methionine e) Cysteine f) Arginine
3. Lipid Analysis
  - a. Determination of Saponification number.
  - b. Determination of Acid number.
4. Demonstration Experiments
  - a. Preparation of buffer and its pH measurements using pH meter.
  - b. Colorimeter

**COURSE OUTCOMES**

- CO1** - Understanding Good laboratory practices in a chemistry/biochemistry laboratory.
- CO2** - Learn safety and precautionary measures for working in a laboratory.
- CO3** - Develop skill and proficiency in preparation of laboratory reagents.
- CO4** - Use of handling of glass wares, minor equipment for conducting experiments.
- CO5** - Develop skills to prepare standard chemical solutions and secondary standards.
- CO6** - Demonstration of basic oxidation and reduction reactions.

**TEXT / REFERENCE BOOKS**

1. Laboratory manual in biochemistry by J.Jayaraman, New Age International Private Limited Publishers, 2011.
2. Biochemical Methods- Sadasivam and Manickam, 3rd Edition, New Age International Pvt Ltd Publishers, 2018.

SHSB1201	GENERAL ENGLISH- II	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

### COURSE OBJECTIVES

- To provide opportunities for students to read and respond to representations of current issues through texts that present themes and topics that are familiar, insightful and informative.
- To provide an opportunity to the students to improve their vocabulary.
- To develop skills relating to creative writing.
- To provide an opportunity to the students to improve their Spoken Language.
- To comprehend the overall idea of a written and oral context.

### UNIT 1

**9 Hrs.**

Listening for details, Speaking - making a presentation, reading for details and Global Comprehension Vocabulary Binomials, Types of Words- Synonyms, Antonyms that describe people, things and their actions - Paired Expressions -Letter Writing - Informal Letters- Letter to a Friend / Family Members - Creating blogs to post written materials.

### UNIT 2

**9 Hrs.**

Listening for details - Speaking: Giving Interview, Public Speech based on specific topics given. Reading for Comprehension and for overall idea - Vocabulary: phrases - Sentence Pattern – Contextual guessing of words– Singular, Plural– Letter writing- Formal letters- Inviting dignitary for a function, Application for job with resume.

### UNIT 3

**9 Hrs.**

Listening for details - Telephonic conversation – Speaking: Narrating a Story - Vocabulary: positive and negative connotations - Language Focus: Adjective- Degrees of Comparison, Direct and Indirect Speech - Types of Sentences (simple, compound, complex) - Collocations -Letter to the Editor (Social Issues) – Hints Development.

### UNIT 4

**9 Hrs.**

Listening for Overall information - Making requests and suggestions - Speaking: Group Discussion - Vocabulary: Homonyms and Homophones - Language Focus: Transitive and Intransitive verbs - Writing: Precis writing, Story Writing - Process description (Flow chart).

### UNIT 5

**9 Hrs.**

Listening for specific details - Speaking using imagination. Reading to identify facts - Language focus: Modal Auxiliary Verbs Writing: Imaginative writing by predicting, Argumentative Essay, Writing a Book or Film review. Vocabulary: Countable and Uncountable Nouns, foreign nouns and framing of plurals.

**Max. 45 Hrs.**

### COURSE OUTCOMES

At the end of the course the students will be able to:

- CO1** - Remember knowledge of linking words related to both spoken and written discourse.
- CO2** - Understand collocations, words to express one's point of view in both writing and speaking.
- CO3** - Apply the rules for writing compare and contrast paragraphs by using cohesive devices based on prompts given.
- CO4** - Analyse critical thinking skills by framing questions related to elements of reasoning.
- CO5** - Evaluate written pieces to self-correct in the topic areas of verbs, reported speech, and punctuation.
- CO6** - Equip the students with the required Professional Skills.

**TEXT / REFERENCE BOOKS**

1. Sen S, Mahendra etal. (2015) *Communication and Language Skills*. Foundation books. Chennai
2. Strunk Jr., William, and E.B. White. *The Elements of Style*. Allyn and Bacon, 2000.
3. Murphy, Raymond. *English Grammar in Use*. Cambridge University Press, 2019.
4. Thomson, A.J., and A.V. Martinet. *A Practical English Grammar*. Oxford University Press, 2013.
5. Straus, Jane. *The Blue Book of Grammar and Punctuation*. John Wiley & Sons, 2014.
6. Swan, Michael. *Practical English Usage*. Oxford University Press, 2016

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBBB1302	IMMUNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- To know the fundamentals of Immunity and understand how immune system fights and combats the infection and diseases.

**UNIT 1 IMMUNITY****9 Hrs.**

History of Immunology – Host-parasite relationship – Immunity – Innate and acquired Immunity – Humoral and Cell mediated Immunity.

**UNIT 2 CELLS AND ORGANS OF THE IMMUNE SYSTEM****9 Hrs.**

Structure, Functions and Properties of Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone marrow, Bursa of Fabricius, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

**UNIT 3 ANTIGENS & ANTIBODIES****9 Hrs.**

Antigens – Types, properties, Immunoglobulins – Structure, types and functions, Monoclonal Antibodies, Complement pathways - Classical and alternative.

**UNIT 4 ANTIGEN – ANTIBODY REACTIONS****9 Hrs.**

Agglutination, Precipitation, Complement fixation, Immunofluorescence – ELISA, RIA

**UNIT 5 AUTOIMMUNITY, HYPERSENSITIVITY AND TRANSPLANTATION****9 Hrs.**

Autoimmunity, Hypersensitivity, Immunohaematology, Transplantation immunology, Tumor immunology.

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, the student will be able to

- CO1** - Understand the principles and mechanism of immunity
- CO2** - Understand the immune cells and organs alongside their structure and functions
- CO3** - Distinguish antigens and antibodies, their basic structure and functions
- CO4** - Summarize the various clinically important antigen antibody reactions
- CO5** - Know the various medically important immunological disorders
- CO6** - Write the role of immune system in tumor biology

**TEXT / REFERENCE BOOKS**

1. Text book of Microbiology - Ananthanarayan & Jayaram Panicker
2. Kuby Immunology – Kindt, Goldsby and Osborne
3. Roitt's Essential Immunology - Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**



SMBB2201	IMMUNOLOGY LAB	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

### COURSE OBJECTIVES

- The main objectives of this course, applied immunology laboratory course, which highlights the historic and current methodologies that have been important for elucidation and diagnosis of immune functions.

### EXPERIMENTS

1. Identification of human blood groups.
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. Agglutination reaction
  - i) Widal test
  - ii) ASO test
  - iii) RA test
  - iv) CRP test
  - v) Pregnancy test (Direct/Indirect)
5. To perform immunodiffusion by
  - i. Single Radial Immunodiffusion
  - ii. Ouchterlony double diffusion.
6. To perform DOT ELISA.
7. To perform immunoelectrophoresis.

### COURSE OUTCOME

- CO1** - Demonstrate development of immunology.
- CO2** - Explain surface membrane barriers and their protective functions.
- CO3** - Explain the importance of phagocytosis and natural killer cells in innate body defense.
- CO4** - Describe the roles of different types of T cells, B cells and APCs.
- CO5** - Compare and contrast the origin, maturation process
- CO6** - Explain general function of B and T lymphocytes

SBCB1301	INTERMEDIARY METABOLISM	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- This course aims at understanding the essential metabolic functions of the organism as well as consumption and storage of energy intermediary metabolism of main biomolecules and its regulatory mechanisms.

**UNIT 1 BASIC THERMODYNAMICS****9 Hrs.**

Anabolism – catabolism, Enthalpy enthalpy free energy, forward and reverse reaction equilibrium state.

**UNIT 2 CARBOHYDRATE METABOLISM****9 Hrs.**

Glycolysis, TCA cycle and its energy production. Glycogen metabolism: Glycogenesis and Glycogenolysis, Alternative pathways: HMP pathway, gluconeogenesis.

**UNIT 3 LIPID METABOLISM****9 Hrs.**

Fatty acid oxidation –  $\alpha$ ,  $\beta$ ,  $\omega$  oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of cholesterol, triglycerides.

**UNIT 4 PROTEIN METABOLISM****9 Hrs.**

Ketogenic and Glucogenic amino acids metabolism. Deamination, Transamination and Decarboxylation, Urea cycle.

**UNIT 5 NUCLEIC ACID METABOLISM & ENERGY PRODUCTION****9 Hrs.**

Biosynthesis and degradation of purine and pyrimidine nucleotides. Mitochondrial Electron Transport Chain: Oxidative Phosphorylation.

**Max. 45 Hrs.****COURSE OUTCOME**

- CO1** - Student should know normal blood metabolites and should be able to relate to abnormal metabolic conditions.
- CO2** - Understand diagnosis of metabolic disorders.
- CO3** - Explain the mechanisms of certain enzymecatalyzed reactions.
- CO4** - Demonstrate knowledge of metabolic of catabolic and anabolism pathways.
- CO5** - Understand the catabolic and anabolism functions in the body and interrelation.
- CO6** - Demonstrate knowledge of regulation of key metabolic pathways.

**TEXT / REFERENCE BOOKS**

1. Fundamentals of Biochemistry, J.L. Jain, S.Chand publications, 2004.
2. Lehninger's Principles of Biochemistry (2000) by Nelson, David I. and Cox, M.M. Macmillan /Worth, NY.
3. Harper's Biochemistry Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 24th edition, Prentice Hall International. Inc.
4. Principles of Biochemistry, Geoffrey L. Zubay, 3rd edition William W. Parson, Dennis E. Vance, W.C. Brown Publishers, 1995.
5. Principles of Biochemistry, David L. Nelson, Michael M.Cox, Lehninger, 4th edition, W.H. Freeman and company.
6. Biochemistry, Lubert Stryer, 4th edition, W.H. Freeman & Co, 1995.

7. Fundamentals of Biochemistry (1999) by Donald Voet, Judith G.Voet and Charlotte W Pratt, John Wiley & Sons, NY.

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A :** 10 Questions of 2 marks each-No choice

**20 Marks**

**PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks

**80 Marks**

SBCB1302	ENZYMOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVE**

- To give an insight into the essential concepts of enzymes and their applications.

**UNIT 1 INTRODUCTION****9 Hrs.**

Nomenclature, IUB system of enzyme classification, Specificity, Turn over number, Enzyme units (IU and Katal), Active site, Fischer's Lock and key model, Koshland's induced fit hypothesis, Activation energy, Coenzymes and co-factors.

**UNIT 2 KINETICS AND INHIBITION****9 Hrs.**

Michaelis Menten equation, Lineweaver, Burk plot, Eadie Hofstee, Hanes Woolf Plots – Km and Vmax, Effect of pH, temperature and substrate concentration on the activity of enzyme, Bi-substrate reactions, Enzyme Inhibition - Irreversible, Reversible-Competitive, Uncompetitive and Non-Competitive inhibition.

**UNIT 3 CATALYSIS****9 Hrs.**

Acid Base Catalysis, Covalent Catalysis, Metal ion Catalysis, Electrostatic Catalysis, Catalysis through Proximity and Orientation effects, Catalysis by Transition State Binding. Catalysis in Model Enzymes – Ribonuclease A, Chymotrypsin, Carbonic anhydrase, Lysozyme.

**UNIT 4 REGULATION, ISOLATION AND PURIFICATION****9 Hrs.**

Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation. Enzyme isolation and purification.

**UNIT 5 APPLICATIONS****9 Hrs.**

Immobilized enzymes, methods and applications in industry, medicine, Isoenzymes, properties and physiological significance (lactate dehydrogenase). Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase).

**h****Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, students will be able to

- CO1** - Understand the classification and properties of enzymes
- CO2** - Elucidate the importance of Km and Vmax in enzyme kinetics and inhibition
- CO3** - Analyze the mechanism of action of various enzymes
- CO4** - Identify the type of enzyme regulation in metabolic cycles
- CO5** - Select the specific method of isolation and purification of required enzyme
- CO6** - Interpret the vital role of enzymes in industry and medicine

**TEXT / REFERENCE BOOKS**

1. Trevor Palmer, P. B. (2007). Enzymes. Wood head Publishing - ISBN : 9780857099921, 0857099922
2. Meenakshi Meena, D. C. (2009). Fundamental of Enzymology. Aavinshankar Publisher 2009 - ISBN-10 : 8179102807 / ISBN-13 : 978-8179102800
3. Donald Voet, C. W. (2012). Principles of Biochemistry. Wiley - ISBN 10: 1118092449 / ISBN 13: 9781118092446.
4. David L. Nelson, M. M. (2017). Principles of Biochemistry (7th ed.). Macmillian Education
5. Sathyanarayana. (2017). Biochemistry. Elsevier - ISBN: 9788131236017

6. Rodwell, V. (2018). Harper's Illustrated Biochemistry. McGraw. Hill

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A :** 10 Questions of 2 marks each-No choice

**20 Marks**

**PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks

**80 Marks**

SBCB2301	ENZYMOLGY LAB	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVEE**

- To develop basic laboratory skills essential for enzyme analysis

**SUGGESTED LIST OF EXPERIMENTS**

1. Isolation of Alpha/Beta Amylase
2. Plotting of standard curve
3. Determination of enzyme activity
4. Determination of specific activity
5. Effect of pH on Enzyme activity
6. Effect of temperature on Enzyme activity
7. Effect of substrate concentration on Enzyme activity

**COURSE OUTCOMES**

On completion of the course, students will be able to

- CO1** - Apply the enzyme isolation technique in research and industry
- CO2** - Identify the significance of standard curves in enzyme activity determination
- CO3** - Analyse the enzyme activities in normal and diseased conditions
- CO4** - Evaluate the protein content and purity of enzymes
- CO5** - Identify the factors affecting enzyme activity
- CO6** - Validate the role of enzymes in various biological processes

SBCB1401	MOLECULAR BIOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVE**

- Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development

**UNIT 1 INTRODUCTION TO MOLECULAR BIOLOGY****9 Hrs.**

Overview of the field of molecular biology, its historical background, and the central dogma of molecular biology.

**UNIT 2 DNA STRUCTURE AND REPLICATION****9 Hrs.**

Study of DNA structure, including the double helix, base pairing, and the replication process. Exploration of enzymes involved in DNA replication and mechanisms of fidelity. Understanding the process of transcription, including the initiation, elongation, and termination of RNA synthesis. Introduction to the role of RNA polymerase and transcription factors.

**UNIT 3 GENETIC CODE AND TRANSLATION****9 Hrs.**

Examination of the genetic code and the process of translation, including initiation, elongation, and termination. Introduction to the roles of ribosomes, tRNAs, and translation factors.

**UNIT 4 RECOMBINANT DNA TECHNOLOGY****9 Hrs.**

Introduction to techniques used in recombinant DNA technology, such as DNA cloning, polymerase chain reaction (PCR), and gene expression analysis. Practical experience with molecular biology laboratory technique.

**UNIT 5 GENETIC ENGINEERING AND BIOTECHNOLOGY****9 Hrs.**

Exploration of applications of molecular biology in biotechnology, such as genetically modified organisms (GMOs), gene therapy, and genetic engineering in medicine and agriculture.

**Max. 45 Hrs.****COURSE OUTCOME**

At the end of the course, the students will be able to:

- CO1** - Understand the structure of DNA, RNA and its types
- CO2** - Explain devised to familiarize students with Molecular Biology which chiefly deals with interactions among various systems of the cell,
- CO3** - Explain difference between DNA, RNA and proteins and learning how these are regulated.
- CO4** - Gain an understanding of chemical and molecular processes that occurs in and between cells.
- CO5** - Understand significant molecular and cell-based methods used today to expand our understanding of biology.
- CO6** - Develop design and implement experimental procedures using relevant techniques.

**TEXT / REFERENCE BOOKS**

1. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 6th Edition, Panima Publishing, 1993.
2. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

### END SEMESTER EXAM QUESTION PAPER PATTERN

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A :** 10 Questions of 2 marks each-No choice

**20 Marks**

**PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks

**80 Marks**



SBCB1402	MOLECULAR GENETICS	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- This course provides you with further knowledge associated with molecular biology and inheritance at the molecular, cellular and phenotypic levels

**UNIT 1 DNA AND RNA****9 Hrs.**

Introduction and History of Microbial Genetics. DNA as a Genetic material. Physical structure and Chemical composition of DNA – RNA and its types RNA as a Genetic material. DNA Replication – Types and Experimental proof of replication – Enzymes involved in DNA replication.

**UNIT 2 GENETIC CODE AND GENE EXPRESSION****9 Hrs.**

Prokaryotic Transcription, Translation. Genetic code – Regulation of gene expression in prokaryotes – lac Operon. Gene transfer mechanisms – Transformation, conjugation and Transduction. Plasmid – Characteristics and types.

**UNIT 3 MOLECULAR BASIS OF GENETIC INFORMATION****9 Hrs.**

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

**UNIT 4 CHROMOSOME THEORY OF INHERITANCE AND GENE MAPPING****9 Hrs.**

Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete dominance and Codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance. Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.

**UNIT 5 DNA MUTATION AND REPAIR MECHANISMS****9 Hrs.**

Mutation – types of mutation – Molecular basis of mutation – Mutagenesis, Detection of mutants – Ames test, DNA repair mechanisms. Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

**Max. 45 Hrs.****COURSE OUTCOME**

At the end of the course, the students will be able to:

- CO1** - Memorise the students about genes at molecular level.
- CO2** - Explain about DNA, RNA and their replication, mutations, DNA repair mechanism.
- CO3** - Explain and train the students in understanding genetics.
- CO4** - Understand the modern DNA technology for disease diagnostics and therapy.
- CO5** - Studying the regulatory mechanism of gene.
- CO6** - Write prokaryotic and eukaryotic gene and its types of gene mutation.

**TEXT / REFERENCE BOOKS**

1. David Freifelder (1995). Molecular Biology. Narosa Publishing House, New Delhi.
2. Peter Snustad D and Michael J Simmons (2003). Principles of Genetics. 3rd Edition, John Wiley & Sons, Inc., Publication, New Delhi.
3. Peter J Russel (2002). Genetics. Benjamin Cummings.
4. Robert H Tamarin (2002). Principles of Genetics. 7th Edition, Tata Mc Graw Hill Publication, New Delhi.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB2401	MOLECULAR BIOLOGY LAB	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- The experiments provide hands-on experience in performing basic molecular biology techniques thereby.
- Developing skill in performing molecular biology experiments.
- This will facilitate the students to take up specialized projects in Molecular biology and will be a pre-requisite for research work.

**LIST OF EXPERIMENTS**

- I. Isolation of nucleic acids
  1. Isolation of Plasmid DNA
  2. Isolation of Plant Genomic DNA/ bacterial genomic DNA
- II. Analysis, separation and staining of Nucleic acids
  1. Estimation of DNA/RNA content in the given sample by spectrophotometer
  2. Determination of T<sub>m</sub> of DNA.
  3. Agarose gel electrophoresis
  4. Poly acrylamide gel electrophoresis
  5. Staining of DNA with ethidium bromide
  6. Staining of proteins with coomassie brilliant blue/ silver

**TEXT / REFERENCE BOOKS**

1. Sambrook, Joseph and David W. Russell "The Condensed Protocols: From Molecular Cloning: A Laboratory Manual" Cold Spring Harbor, 2006.

SBCB1501	GENOMICS AND PROTEOMICS	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**OBJECTIVE OF THE COURSE**

- To provide students with a comprehensive and concise overview of technologies pertinent to Genomics and Proteomics, their applications.

**UNIT 1 INTRODUCTION TO GENOMICS****9 Hrs.**

Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes, computational analysis of sequences, gene annotation, alignment statistics, genetic variation polymorphism, phylogenetics, tools for genome analysis– PCR, RFLP, DNA fingerprinting, RAPD, automated DNA sequencing, linkage and pedigree analysis, construction of genetic maps, FISH to identify chromosome landmarks.

**UNIT 2 INTRODUCTION TO PROTEOMICS****9 Hrs.**

Identification and analysis of proteins by 2D analysis, tryptic digestion of protein and peptide fingerprinting, mass spectrometry, clinical proteomics and disease biomarkers, protein-protein interactions.

**UNIT 3 GENE IDENTIFICATION AND EXPRESSION****9 Hrs.**

Genome annotation, identifying the function of a new gene, gene ontology, comparative genomics, protein structural genomics, determining gene function by sequence comparison and through conserved protein, global expression profiling, analysis of RNA expression, microarray techniques.

**UNIT 4 ANALYSIS OF PROTEOMES****9 Hrs.**

Two-dimensional polyacrylamide gel electrophoresis, mass spectrometry based methods for protein identification, de novo sequencing using mass spectrometric data, correlative mass spectrometric based identification, strategies, 2-D gel electrophoresis coupled with mass spectrometry, case study on proteomic analysis of patient samples.

**UNIT 5 APPLICATIONS OF GENOMICS AND PROTEOMICS****9 Hrs.**

Analysis of human genome, application of proteome analysis- drug development and toxicology, pharmaceutical applications, proteomics in drug discovery in humans, phage antibodies as tools, capstone project on genomics and proteomics.

**Max. 45 Hrs.****COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Explain the current genomics and proteomics technologies.
- CO2** - Interpret data obtained through high throughput expression studies.
- CO3** - Understand the application of genomics and proteomics.
- CO4** - Apply the computational skills to plan and execute a biomedical 'omics' project.
- CO5** - Genome annotation, identifying the function of a new gene.
- CO6** - Analysis of human genome and its function.

**TEXT / REFERENCES BOOKS**

1. Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 8th edition, 2018.

2. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7th Edition, Blackwell Publishing, 2006.
3. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Springer Publication, 2009.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB1502	CLINICAL BIOCHEMISTRY	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

### COURSE OBJECTIVES

- To impart the knowledge of sample collection, processing and diagnostic significance of laboratory investigations.

#### UNIT 1 BASIC CONCEPTS OF CLINICAL BIOCHEMISTRY

9 Hrs.

Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories, safety regulations and first aid. Sample collection and processing, concepts of accuracy, precision, test sensitivity, test specificity in the quantitative assessment of test performance.

#### UNIT 2 HEMATOLOGY

9 Hrs.

Blood:- composition and their functions, Anemia:- classifications, erythrocyte indices. Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count, Platelet count, Differential count, determination of Hb, PCV and ESR. Hemoglobinopathies, Thalassemias.

#### UNIT 3 DISORDERS OF METABOLISM

9 Hrs.

**Diseases related to carbohydrate metabolism:** Diabetes mellitus:- Types, Clinical features, complications, GTT, galactosaemia, fructosuria, and glycogen storage diseases. **Disorders in lipid metabolism:** Atherosclerosis – aetiology, clinical features and its complications. Lipid storage diseases and fatty liver. **Disorders in protein metabolism:** Phenylketonuria, alkaptonuria, cystinuria, albinism and tyrosinemia. **Disorders in nucleic acid metabolism:** Gout:- Types, aetiology and clinical features. Disorders in bilirubin metabolism: Jaundice:- classification, clinical features.

#### UNIT 4 ORGAN FUNCTION TEST

9 Hrs.

Liver function test - Icteric index, Vandenberg test, plasma protein changes, PT. Renal function test: Clearance test – Urea, Creatinine, Inulin, PAH test, Concentration and dilution test. Gastric function test: Collection of gastric contents, examination of gastric residuum, FTM, stimulation test, tubeless gastric analysis.

#### UNIT 5 CLINICAL ENZYMOLOGY

9 Hrs.

Functional and non- Functional plasma enzymes. Isoenzymes with examples. Enzyme patterns in acute pancreatitis, liver damage, bone disorder, myocardial infarction and muscle wasting.

Max. 45 Hrs.

### COURSE OUTCOME

On completion of the course, student will be able to

**CO-1-** Understand clinical samples, their collection, processing and analysis.

**CO-2-** Apply acquired knowledge and techniques in diseases diagnosis.

**CO-3-** Understand diseases associated with metabolic disorders.

**CO-4-** Apply various diagnostic approaches for organs

**CO-5-** Chose diagnostic enzyme level and their importance in clinical laboratory.

**CO-6-** Correlate the sample and theirs diagnostic importance in diseases.

**TEXT / REFERENCE BOOK**

1. Medical Biochemistry by MN Chatterjee, RanaShinde, 8 edition, 2013, Jaypee publications.
2. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkar, Vol 1 and 2 – 2021.
3. Medical Laboratory Technology by Ramniksood, 2006.
4. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 7<sup>th</sup> edition, 2010.
5. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB1503	ENDOCRINOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To impart the knowledge of endocrinology and endocrine system of human body processing diagnostic significance of laboratory investigations.

**UNIT 1 INTRODUCTION TO ENDOCRINOLOGY****9 Hrs.**

Overview of the endocrine system, its functions, and the major endocrine glands and hormones.

**UNIT 2 HORMONE BIOSYNTHESIS AND SECRETION****9 Hrs.**

Study of hormone synthesis, storage, and release mechanisms by various endocrine glands. Hormone Receptors and Signal Transduction: Understanding the interaction of hormones with their target cells, receptor types, and intracellular signaling pathways.

**UNIT 3 HYPOTHALAMUS AND PITUITARY GLAND****9 Hrs.**

Examination of the structure and function of the hypothalamus and pituitary gland, including the regulation of hormone secretion. Thyroid Gland: Study of thyroid hormone synthesis and regulation, the role of thyroid hormones in metabolism, and disorders such as hypothyroidism and hyperthyroidism. Adrenal Glands: Exploration of the adrenal cortex and adrenal medulla, including the synthesis and functions of adrenal hormones, such as cortisol and adrenaline.

**UNIT 4 PANCREATIC ENDOCRINE SYSTEM****9 Hrs.**

Understanding the role of the pancreas in endocrine function, focusing on insulin and glucagon production, regulation, and their involvement in glucose homeostasis. Reproductive Endocrinology: Examination of the male and female reproductive systems, including the synthesis and regulation of sex hormones, and the role of hormones in reproductive processes and menstrual cycles.

**UNIT 5 ENDOCRINE DISORDERS****9 Hrs.**

Exploration of common endocrine disorders, including diabetes mellitus, thyroid disorders, adrenal disorders, and disorders of the reproductive system. Clinical Approaches and Diagnostics: Introduction to diagnostic methods and laboratory tests used in endocrinology, and the interpretation of hormone levels and hormone stimulation tests.

**Max. 45 Hrs.****COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Understand endocrine system and its function.
- CO2** - Classification of the hormones and their basic structure.
- CO3** - Understand diseases associated with endocrine disorders.
- CO4** - Understand regulation of hormone synthesis and secretion.
- CO5** - Apply diagnosis and treatment of the various endocrine disorders.
- CO6** - Correlate the sample and their diagnostic importance in diseases.



**TEXT / REFERENCE BOOKS**

1. Medical Biochemistry by MN Chatterjee, RanaShinde, 8 edition, 2013, Jaypee publications.
2. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkar, Vol 1 and 2 - 2021
3. Medical Laboratory Technology by Ramniksood, 2006
4. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 7<sup>th</sup> edition, 2010
5. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

S77BPB51	RESEARCH METHODOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	2	2	4	100

**COURSE OBJECTIVES**

- This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project.

**UNIT 1 FOUNDATIONS OF RESEARCH****12 Hrs.**

Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method: Understanding the language of research – Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation: Research Question, Investigation Question, Measurement Issues. Hypothesis: Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis; Hypothesis Testing – Logic & Importance. Practical component: Writing an abstract, articulation of null hypothesis and alternate hypothesis.

**UNIT 2 RESEARCH DESIGN****12 Hrs.**

Concept and Importance in Research; Features of a good research design, Exploratory Research Design and Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research Practical component: writing a review paper.

**UNIT 3 MEASUREMENT****12 Hrs.**

Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Practical component: calculation of mean, median and mode in excel.

**UNIT 4 DATA ANALYSIS****12 Hrs.**

Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Practical component: generation of graph in excel, testing hypothesis in excel.

**UNIT 5 INTERPRETATION OF DATA AND PAPER WRITING****12 Hrs.**

Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Practical component: plagiarism checking.

**Max. 60 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Discuss some basic concepts of research and techniques used in research works
- CO2** - Explain how a research should be designed
- CO3** - Understand measurements and sampling
- CO4** - Analysis given research data through various techniques
- CO5** - Understand how to interpret a data through publications
- CO6** - Apply the knowledge of scientific writing

**TEXT / REFERENCE BOOKS**

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBCB2501	GENOMICS AND PROTEOMICS LAB	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVE**

- To understand the engineering of genetic material and thereby utilize DNA effectively.

**SUGGESTED LIST OF EXPERIMENTS**

1. Isolation of genomic DNA from plant/animal source.
2. Isolation of plasmid DNA from E.coli
3. Estimation of DNA by spectrophotometry
4. Agarose Gel Electrophoresis
5. Restriction digestion.
6. Ligation.
7. PCR amplification.
8. SDS PAGE -Separation and staining of proteins.

**COURSE OUTCOMES**

On completion of course, student will able to

- CO1** - Outline fundamentals of steps in a genetic engineering procedure.
- CO2** - Develop the skill in isolation of nucleic acids.
- CO3** - Understand the concept of restriction enzymes.
- CO4** - Improve the knowledge in PCR techniques.
- CO5** - Develop the skill in protein analysis by SDS.
- CO6** - Interpret the role of DNA in genetic engineering.

SBCB2502	CLINICAL BIOCHEMISTRY LAB	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To impart the knowledge of sample collection, processing and laboratory investigations of biochemical profile.

**SUGGESTED LIST OF EXPERIMENTS**

1. Estimation of cholesterol in Human Plasma
2. Isolation of Human RBCs and their susceptibility toward osmotic shock
3. Blood plasma antioxidant potential
4. Lipid peroxidation in RBCs and plasma
5. Determination of SGPT and SGOT
6. Blood sugar determination by Folin -Wu method
7. Estimation of total protein and albumin from serum
8. Estimation of glycosylated hemoglobin
9. Estimation of bilirubin
10. Estimation of blood urea
11. Estimation of creatine phosphokinase
12. Estimation of alkaline phosphatase from serum

**COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Understand blood as major clinical samples, their collection and processing.
- CO2** - Apply protocols to estimate lipid profile in blood.
- CO3** - Apply diagnostic parameters associated with RBCs.
- CO4** - Understand diagnostic approaches for various organs.
- CO5** - Analyze clinical enzymes parameters in blood.
- CO6** - Correlate between sample, their diagnostic importance in various disease.

SBBB1601	BIO SAFETY, BIOETHICS AND IPR	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To understand biosafety and the importance of bioethics.
- To be able to distinguish the different IPR and biotechnological patent.

**UNIT 1 INTRODUCTION TO BIOSAFETY****9 Hrs.**

Biosafety – definition, need, importance, applications, levels of biosafety and criteria for biosafety levels. NIH guidelines for biosafety. Regulations specific to biotechnology companies and research institutions. Biosafety guidelines in India. Role of institutional biosafety committee.

**UNIT 2 IMPLICATIONS OF BIOSAFETY****9 Hrs.**

Guidelines for research with transgenic organisms. Environmental impact of genetically modified organisms (beneficial and hazardous impact), Field trials with GMO, Containment levels. Biosafety protocol, Cartagena Biosafety protocol, Mechanism of implementation of biosafety guidelines. Biosafety and politics. Biosafety database.

**UNIT 3 INTRODUCTION TO BIOETHICS****9 Hrs.**

Bioethics – need, applications. Impact of bioethics to the environment and society. Bioethical issues pertaining to various aspects of Biotechnology. Bioengineering ethics, responsible researchers, research ethics, ethical decision making. Biowarfare and biopiracy.

**UNIT 4 INTELLECTUAL PROPERTY RIGHTS****9 Hrs.**

Forms of Intellectual property – patent, copyright, trademark, design, trade secret, domain name and geographical indications. WTO treaties, GATT articles, main features of TRIPS agreement, practical aspects of WIPO. IPR related legislatures in India.

**UNIT 5 PATENT****9 Hrs.**

History of Indian patent system and law. Patenting authority. Different types of patent. Requirements and procedure for patenting. Patentable and Non-patentable things. Patent search and patent co-operation treaty (PCT). Farmer's right and plant breeders right. Importance, social consequences and controversies on biotechnology patents.

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of course, student will able to

- CO1** - Understand biosafety, bioethics and intellectual property rights.
- CO2** - Discuss the different regulations pertaining to biosafety.
- CO3** - Categorize the various forms of IPR.
- CO4** - Appraise the importance of bioethics in biotechnology.
- CO5** - Elaborate the different patents and the process of patenting.
- CO6** - Interpret biotechnological novelty as patents.

**TEXT / REFERENCE BOOKS**

1. Sateesh M.K., Bioethics and Biosafety, I.K. International Publishing House Pvt. Ltd., 2013.
2. Fleming D.O. and Hunt D.L., Biological Safety: Principles and Practices, ASM Press, 2006.
3. Goel D. and Parashar S., IPR Biosafety and Bioethics, Pearson Education India, 2013.
4. Pandey N. and Dharni K., Intellectual Property Rights, PHI Learning, 2014.

5. Singh K.K., Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India, 2014.
6. Young T.R., Policy I. and Group G.C., Genetically Modified Organisms and Biosafety: A Background Paper for Decision-makers and Others to Assist in Consideration of GMO Issues. IUCN, 2004.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

S77BLH61	BIOSTATISTICS	L	T	P	EL	Credit	Total Marks
		3	0	2	2	4	100

**COURSE OBJECTIVES**

- This course aim to use and interpret results of, descriptive statistical methods effectively
- Demonstrate an understanding of the central concepts of basic biomathematics and biostatistical theory

**UNIT 1 INTRODUCTION TO BIOSTATISTICS****12 Hrs.**

Definitions in Statistics, Sample and Population, Variables: Discrete and Continuous, Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives. Practical component: generation of different graph in excel.

**UNIT 2 SAMPLING AND MEASURES OF DEVIATION****12 Hrs.**

Concept of Sampling and Sampling Distribution. Measures of Central tendency (Mean, Median, Mode), Measures of deviation (Standard deviation, variance and coefficient of variation). Practical component: measures of central tendency and deviation in R.

**UNIT 3 TEST AND LEVEL OF SIGNIFICANCE****12 Hrs.**

Test of significance, Hypothesis Testing, Null and Alternate Hypothesis, Level of significance, Confidence Limit Student, T and F Test, Chi-square test Practical component: test of significance in excel.

**UNIT 4 PROBABILITY AND DISTRIBUTION****12 Hrs.**

Probability and Distribution, Concepts and problems on probability, Binomial, Poisson, Normal Distribution and their applications Practical component: distribution analysis in excel.

**UNIT 5 ANALYTICAL METHODS****12 Hrs.**

Simple Regression and Correlation, Concept of analysis of variance (one-way classification, Practical component: regression line in excel, Correlation in excel and annova in excel.

**Max. 60 Hrs.****COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Familiarize students about the principal concepts of biostatistics.
- CO2** - Provide the knowledge of sampling and sample analysis.
- CO3** - Identify distribution form relating to the variable/variables.
- CO4** - Discuss the test of significance and ANOVA.
- CO5** - Explain different types of probability distribution.
- CO6** - Apply hypothesis testing via some of the statistical distributions.

**TEXT / REFERENCE BOOKS**

1. Fundamentals of Biostatistics. by Irfan A Khan.
2. An introduction to Biostatistics. by PSS Sunder Rao.
3. Introduction to the Practice of Statistics by Moore and McCabe.



**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBCB1102	ANCILLARY ZOOLOGY I	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To know the fundamentals of animal sciences, understands the complex interactions among various living organisms.

**UNIT 1 INTRODUCTION TO ZOOLOGY****9 Hrs.**

Overview of the field of zoology, its history, branches, and importance in understanding animal life and biodiversity. Study of the principles of classification and nomenclature of animals. Introduction to different taxonomic levels, identification techniques, and use of taxonomic keys.

**UNIT 2 ANIMAL DIVERSITY AND CLASSIFICATION****9 Hrs.**

Examination of major animal phyla, focusing on their morphological characteristics, ecological adaptations, and evolutionary relationships.

**UNIT 3 ANIMAL TISSUES AND ORGANS****9 Hrs.**

Understanding of the organization of animal tissues into organs and systems. Study of the structure and function of major organ systems, including digestive, circulatory, respiratory, excretory, and reproductive systems.

**UNIT 4 ANIMAL PHYSIOLOGY****9 Hrs.**

Introduction to animal physiology, including homeostasis, nutrition, digestion, respiration, circulation, excretion, and reproduction. Animal Behavior: Study of animal behavior, including its types, adaptive significance, and ecological implications. Introduction to ethology and basic concepts in behavioral ecology.

**UNIT 5 CONSERVATION BIOLOGY****9 Hrs.**

Introduction to the principles of conservation biology and the importance of preserving biodiversity. Exploration of conservation strategies and the role of zoology in conservation efforts. Laboratory Techniques: Practical training in basic laboratory techniques used in zoology, including microscopy, dissection, observation, and recording of animal behavior, and data analysis.

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Describe general taxonomic rules on animal classification.
- CO2** - Classify Phylum Protozoa to Echinodermata with taxonomic keys.
- CO3** - Imparts conceptual knowledge of vertebrates, their adaptations and associations in relation to their environment.
- CO4** - Classify phylum Protochordates to Mammalia.
- CO5** - Complex Vertebrate interactions.
- CO6** - Concept of hormonal regulation of reproduction.

**TEXT / REFERENCE BOOKS**

1. A Text Book of Invertebrata – Arumugam. N et al., 2017, SARAs Publication, Kottar, Nagercoil.
2. Invertebrate Zoology – Jordan. E.L. and Verma. P.S., 2010 (Reprint), S. Chand and Company Ltd., Ram Nagar, New Delhi.
3. Modern Text Book of Zoology Invertebrates, 11th Edition, Kotpal. R.L., 2014, Rastogi Publications, Meerut, India.
4. Biology of the Invertebrates, 7th Edition, Jan A Pechenik, 2014, McGraw-Hill Education, India.
5. Invertebrates, 3rd Edition, Richard C. Brusca, Wendy Moore, Stephen M. Shuster, 2016, Sinauer Associates, Oxford University Press, UK.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB1201	ANCILLARY ZOOLOGY II	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To know the fundamentals of complex evolutionary processes and behaviour of animals.

**UNIT 1 ANIMAL PHYSIOLOGY****9 Hrs.**

In-depth study of animal physiological processes, including nervous system function, sensory systems, muscle physiology, endocrine system, and hormonal regulation. Comparative Anatomy: Comparative study of animal anatomy, including the structure and function of major organ systems in different animal groups. Emphasis on understanding evolutionary adaptations.

**UNIT 2 ANIMAL ECOLOGY****9 Hrs.**

Study of animal ecology, including population dynamics, community ecology, behavioural ecology, and ecological interactions such as predation, competition and symbiosis.

**UNIT 3 ANIMAL PARASITOLOGY****9 Hrs.**

Introduction to parasitic relationships between animals and their hosts. Study of different types of parasites, their life cycles, and the impact of parasitic infections on host populations.

**UNIT 4 APPLIED ZOOLOGY****9 Hrs.**

Application of zoological knowledge in various fields such as conservation biology, wildlife management, animal agriculture, and biotechnology.

**UNIT 5 CURRENT TRENDS IN ZOOLOGY****9 Hrs.**

Introduction to research methods used in zoology, including experimental design, data collection, statistical analysis, and interpretation of research findings. Exploration of current advancements and research topics in zoology, such as molecular techniques, genomics, conservation genetics, and emerging fields of study.

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Describe general physiology of animals.
- CO2** - Understand the animal ecology with taxonomic keys.
- CO3** - Animal parasitology of vertebrates, their adaptations and associations in relation to their environment.
- CO4** - Understand the animal biotechnology and wild life mangemnet
- CO5** - Describe themodern tool in animal biotechnology
- CO6** - Understand the concept of experimental design.

**TEXT / REFERENCE BOOKS**

1. A Text Book of Invertebrata – Arumugam. N et al., 2017, SARAs Publication, Kottar, Nagercoil.
2. Invertebrate Zoology – Jordan. E.L. and Verma. P.S., 2010 (Reprint), S. Chand and Company Ltd., Ram Nagar, New Delhi.
3. Modern Text Book of Zoology Invertebrates, 11th Edition, Kotpal. R.L., 2014, Rastogi Publications, Meerut, India.
4. Biology of the Invertebrates, 7th Edition, Jan A Pechenik, 2014, McGraw-Hill Education, India.

5. Invertebrates, 3rd Edition, Richard C. Brusca, Wendy Moore, Stephen M. Shuster, 2016, Sinauer Associates, Oxford University Press, UK.

### END SEMESTER EXAM QUESTION PAPER PATTERN

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A :** 10 Questions of 2 marks each-No choice

**20 Marks**

**PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks

**80 Marks**

SCYB1303	ANCILLARY CHEMISTRY – I (B.Sc., Mathematics, Bio, Physics Department only)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To know about the water quality parameters and the methods to estimate the hardness of water.
- To understand the charging and discharging characteristics in batteries.
- To understand the various synthesis of nanomaterials, organic materials and their applications.

**UNIT 1 WATER TECHNOLOGY****9 Hrs.**

Introduction: Water quality parameters - Contamination of water by arsenic, lead, fluoride, mercury and their removal. Hardness: Types - Expression - Units. Estimation of hardness of water by EDTA method - Problems. Estimation of iron, calcium and magnesium: AAS method. Water softening: Zeolite process - Demineralization process. Desalination: Reverse osmosis - Electrodialysis.

**UNIT 2 ELECTROCHEMICAL POWER SOURCES****9 Hrs.**

Electrochemistry: Galvanic cell - Electrochemical cell representation - EMF series and its significance. Batteries: Terminology - Lead-acid accumulator - Nickel-cadmium batteries. Lithium batteries: Li/SOCl<sub>2</sub> cell- Lithium ion batteries. Fuel Cells: Hydrogen-oxygen fuel cells - Solid oxide fuel cell (SOFC).

**UNIT 3 PHASE EQUILIBRIA****9 Hrs.**

Introduction: Definition of phase rule - Terms involved in phase rule with examples. One component system: Water system. Two component alloy systems: Classification - Reduced phase rule - Thermal analysis. Simple eutectic system: Lead-silver system. Congruent system: Zinc-magnesium system. Incongruent system: Sodium potassium system.

**UNIT 4 SYNTHESIS OF NANOMATERIALS****9 Hrs.**

Introduction: Nanomaterials: Definition - Classification based on dimensions - Size dependent properties. Types of nanomaterials: Nanoparticles: Synthesis by chemical reduction method. Nanoporous materials: Synthesis by sol-gel method. Nanowires: Synthesis by VLS mechanism. Carbon Nanotubes (CNTs): Single walled and multi walled nanotubes - Applications of CNTs - Synthesis of CNTs by electric arc discharge method and laser ablation method.

**UNIT 5 POLYMER CHEMISTRY****9 Hrs.**

Introduction to polymers: Nomenclature - Functionality. Types of polymerization. Mechanism of polymerization: Free radical mechanism - Cationic mechanism - Anionic mechanism. Plastics: Types - Thermoplastics and thermosetting plastics. Properties: Strength - Crystalline and amorphous state - Average molecular weight - Polydispersity. Compounding of plastics. Moulding of plastics: Compression moulding - Injection moulding - Extrusion moulding. Introduction to conducting polymers.

**Max. 45 Hrs.**

**COURSE OUTCOMES**

On completion of the course, student will be able to:

- CO1** - Outline the water quality parameters of domestic and industrial water.
- CO2** - Evaluate the charging and discharging characteristics of batteries and fuel cells.
- CO3** - Construct the phase diagram to alloy systems for optimizing their mechanical and thermal properties
- CO4** - Understand the synthesis of nanomaterials and their applications.
- CO5** - Interpret various properties of polymeric materials and its industrial applications.
- CO6** - Evaluate the chemistry materials for real world applications.

**TEXT / REFERENCES BOOKS**

1. Jain P.C. and Monica Jain, Engineering Chemistry, 15th Edition Dhanpat Rai Publishing Co., 2009.
2. Dara S.S., Text Book of Engineering Chemistry, S. Chand & Co, 2008.
3. Sheik Mideen A., Engineering Chemistry (I & II), 13th Edition, Shruthi Publishers, 2010.
4. Kuriakose J.C. and Rajaram J., Chemistry in Engineering and Technology". Vol.1 & 2, 5th reprint, Tata McGraw Hill, Publishing Company (P) Ltd., 2010.

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A : 10 Questions of 2 marks each-No choice**

**20 Marks**

**PART B : 2 Questions from each unit with internal choice, each carrying 16 marks**

**80 Marks**

SCYB1403	ANCILLARY CHEMISTRY – II (B.Sc., Mathematics, Bio, Physics Department only)	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To know about the types and properties of solutions and their laws.
- To expose various separation techniques for the purification of compounds.
- To provide an idea about the chemical kinetics in terms of order, molecularity and catalytic properties.

**UNIT 1 SOLUTIONS****9 Hrs.**

Introduction: Solid solution - Hume Rothery's rule. Types of solid solutions: Liquid solutions: Solubility of partially miscible liquids - Phenol-water system. Colligative properties: Lowering of vapour pressure. Raoult's law: Derivation - Osmotic pressure - Isotonic solution - Relationship between osmotic pressure and vapour pressure. Depression in freezing point - Derivation. Elevation in boiling point - Derivation - Problems.

**UNIT 2 INTRODUCTION TO SPECTROSCOPY****9 Hrs.**

Electromagnetic spectrum, Absorption of radiation, electronic transition – Vibrational transition – Rotational transition – Intensities of spectral lines – Beer- Lamberts law – Colorimetric analysis – Estimation of concentration of a solution by colorimetry – Flame photometry – Theory, Instrumentation(block diagram only) and application – UV-Visible spectroscopy – principles, instrumentation(block diagram only) and IR spectroscopy – simple application only.

**UNIT 3 CHEMICAL KINETICS****9 Hrs.**

Introduction, Basic Concepts, Factors affecting reaction rates, rate equations for different orders – Derivation of Zero order, First order, Second order (A+A and A+B) reactions, Half life, problem based on First order and second order kinetics. Methods for the determination of the order of a reaction, Steady state hypothesis, Arrhenius Equation, Energy of activation, complex reactions – kinetics of opposing, parallel and consecutive reactions, Theories of reaction rates – Collision theory, Absoulte reaction rate theory.

**UNIT 4 SURFACE CHEMISTRY AND CATALYSIS****9 Hrs.**

Adsorption – types of adsorption – Adsorption of gases on solids – adsorption isotherm – Freundlich, Langmuir isotherms – Adsorption of solutes from solutions – applications – Role of adsorption in catalytic reactions – Ion exchange adsorption – basic principles in adsorption chromatography – catalysis – classification – characteristic of catalysts – Auto catalysis – Enzyme catalysis – Michaelis – Menten equation – Acid – base catalysis.

**UNIT 5 SEPARATION TECHNIQUES****9 Hrs.**

Distillation techniques: Fractional distillation - Steam distillation - Vacuum distillation. Chromatography: Elution analysis - Paper chromatography - Thin layer chromatography - Liquid chromatography - High performance liquid chromatography (HPLC) - Gas chromatography (GC).

**Max. 45 Hrs.**



**COURSE OUTCOMES**

On completion of the course, student will be able to:

- CO1** - Examine the types of solutions and the colligative properties.
- CO2** - Interpret the spectral transition of simple molecules and its applications.
- CO3** - Determine the sequence of elementary reactions that comprise complex reactions.
- CO4** - Analyze the surface phenomenon and study the types of catalyst reactions.
- CO5** - Evaluate various separation techniques and its uses.
- CO6** - Evaluate the materials for real world applications.

**TEXT / REFERENCES BOOKS**

1. B. R. Puri and L.R. Sharma, *Principles of Physical Chemistry*, Vishal Publishing Co, 48<sup>th</sup> edition, 2020.
2. Keith J. Laidler, *Chemical Kinetics*, Third Edition, Pearson education limited, 2004.
3. Atkins P. W., *Physical Chemistry*, 6 edition, Oxford University press, 1998.
4. Barrow G. M., *Physical Chemistry*, 5th edition, McGraw-Hill, 1988.

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A : 10 Questions of 2 marks each-No choice**

**20 Marks**

**PART B : 2 Questions from each unit with internal choice, each carrying 16 marks**

**80 Marks**

SBCB2102	ANCILLARY ZOOLOGY LAB I	L	T	P	EL	Credit	Total Marks
		0	0	2	0	2	100

### COURSE OBJECTIVES

- The main objectives of this course are to know the basic structure of animal and their anatomy.

### SUGGESTED LIST OF EXPERIMENTS

- 1) Observation of animal associations: symbiosis, commensalism, parasitism and predation
- 2) Collection, preservation and identification of plankton.
- 3) Collection, preservation and identification of locally available insects
- 4) Study of adaptive radiations in mouth parts of insects viz Mosquito, Housefly, Honeybee, Dragonfly, Butterfly and Grasshopper.

### SPOTTERS

- 1) Amoeba, Paramecium, Plasmodium, Hydra, Obelia, medusa, Tape worm, Liver fluke, Ascaris, Wucheraria, Earthworm, Leech, Clams, Mussels, oysters, Star fish, Amphioxus, Balanoglossus, Any two edible fishes, Cobra, Natrix, Viper.
- 2) Observation of frog development and tadpole regeneration

### COURSE OUTCOMES

On completion of the course, student will be able to

- CO1** - Dissections of different systems of invertebrate animals are to be studied
- CO2** - Temporary slides are prepared from different organs to study the details of their structures prepared by students
- CO3** - Develop skill and proficiency in preservation and identification
- CO4** - Use of handling of glass wares, minor equipment for conducting experiments.
- CO5** - Prepared slides are studied in this part to understand the structures and arrangement of different muscular regions.
- CO6** - Identified and classified the specimens which are present the departmental museum

SBCB2202	ANCILLARY ZOOLOGY LAB II	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

### COURSE OBJECTIVES

The main objectives of this course are to know the basic structure of animal and their anatomy.

- 1) Anatomy of Shrimp and Anatomy of Fish
- 2) Collection and identification of Placoid, Cycloid and Ctenoid scales of fish
- 3) Estimation of oxygen consumption of fish with reference to body weight
- 4) Report bird biodiversity in your area
- 5) Maintenance of a freshwater aquarium

### SPOTTERS

- 1) Developmental stages of frog embryo: egg, sperm, blastula and gastrula.
- 2) Sheep placenta Homologous and Analogous organs. 5) Fossils – Archaeopteryx, Peripatus and Limulus.

### COURSE OUTCOME

- CO1** - Exposure to diversity in animal groups (invertebrates) and Ecology.
- CO2** - To inculcate good laboratory practices in students and to train them about proper handling of lab instruments.
- CO3** - Understand about Animal systematic
- CO4** - Understand animal diversity and applied zoology field such as Fisheries, Apiculture, Sericulture etc.
- CO5** - Explain students with laboratory skills as well as field based studies.
- CO6** - About ways of conservation and sustainability

SCYB2302	ANCILLARY CHEMISTRY LAB – I (B.Sc., Mathematics, Bio, Physics Department only)	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To understand the basics of chemistry laboratory
- To understand and correlate the theory with laboratory
- To understand the basic concepts of real sample results interpretation.

**LIST OF EXPERIMENTS**

1. Estimation of Total hardness of water sample by EDTA method.
2. Estimation of glycine by Sorenson method.
3. Estimation of Ferrous ion by potentiometric method.
4. Determination of pH of a strong acid using pH meter.
5. Estimation of mixture of acids by conductometric method.
6. Determination of molecular weight of unknown solute.
7. Estimation of Fe by photo color meter.
8. Estimation of Nickel in a Nickel-Steel alloy.

**COURSE OUTCOME**

At the end of the course, the students will be able to:

- CO1** - Estimate ionic conductance ( $\Lambda_c$ ) in samples.  
**CO2** - Evaluate the aminoacid content in samples.  
**CO3** - Construct the redox cell and measure emf ( $E_{cell}$ ) of the cell  
**CO4** - Analyse the hardness in water samples.  
**CO5** - Relate viscosity ( $\eta$ ) in determining molecular weight of a polymer.  
**CO6** - Assess the iron content in samples by photocolourimetry.

**TEXT / REFERENCE BOOKS**

1. Vogel's Text Book of Inorganic Qualitative Analysis, 4th ed., ELBS, London, 1974.
2. Inorganic lab manual by S.Mumazuddin, Shailendra Kumar Sinha. 2009.

SCYB2402	ANCILLARY CHEMISTRY LAB – II (B.Sc., Mathematics, Bio, Physics Department only)	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To understand the basics of chemistry laboratory
- To understand and correlate the theory with laboratory
- To enable the students to understand better the concepts of organic analysis and appreciate better the applications of organic chemistry towards biological systems.

**ORGANIC ANALYSIS**

- a) Identification of acidic, basic, phenolic and neutral organic substances
- b) Detection of N, S and halogens
- c) Test for aliphatic and aromatic nature of substances.
- d) Test for saturation and unsaturation.
- e) Identification of functional groups    i) Carboxylic acid    ii) Phenols    iii) Aldehydes    iv) Ketones  
v) Esters

**COURSE OUTCOME**

On successful completion of the course, student will be able to

- CO1** - Understand the systematic identification of mixtures containing two compounds
- CO2** - Separation and identification simple binary mixtures having acidic, basic and neutral components by chemical methods
- CO3** - Preparation of the identified compound derivatives
- CO4** - Recognize the chemical reactions in identifying the chemical compounds
- CO5** - Identify the compounds containing one or more functional groups
- CO6** - Execute practical knowledge in real world application

SBBB3001	ANIMAL CELL CULTURE: PRINCIPLES & APPLICATIONS	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- To study about the knowledge in tumour, oncogenes, signals and diagnosis and treatment of Cancer.

**UNIT 1 CELL CULTURE LABORATORY DESIGN AND EQUIPEMENTS 9 Hrs.**

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubator; CO<sub>2</sub> incubator; Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer; Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

**UNIT 2 CELL CULTURE MEDIA AND REAGENTS 9 Hrs.**

Types of cell culture media; Ingredients of media; Physiochemical properties; CO<sub>2</sub> and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

**UNIT 3 CELL CULTURE TECHNIQUES 9 Hrs.**

History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

**UNIT 4 APPLICATIONS OF CELL CULTURE 9 Hrs.**

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

**UNIT 5 SCALE UP TECHNIQUE 9 Hrs.**

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring Recommended.

**Max. 45 Hrs.**

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to:

- CO1** - Acquaint fundamentals of Animal cell culture.
- CO2** - Utilize skills of cell culture for development of biomolecules of clinical importance
- CO3** - Describe the relevance of cell cycle regulations in reference to cellular metabolism
- CO4** - Understand the mechanism of cellular cytotoxicity.
- CO5** - To get knowledge on applications of cell culture
- CO6** - Get to know about scale up of animal cell culture

**TEXT / REFERENCE BOOKS**

1. Culture of Animal Cells (2005) 5th Edition, Freshney Wiley-Liss,
2. Animal Cell Culture - Practical Approach (2000), 3rd Edition, Ed. John R.W. Masters Oxford University Press
3. Animal Cell Culture Techniques. (1998). Ed. Martin Clynes Springer,

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A : 10 Questions of 2 marks each-No choice**

**20 Marks**

**PART B : 2 Questions from each unit with internal choice, each carrying 16 marks**

**80 Marks**

SBCB3002	STEM CELL BIOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To study about the knowledge in tumour, oncogenes, signals and diagnosis and treatment of stem cell biology.

**UNIT 1 STEM CELL BASICS****9 Hrs.**

Introduction to stem cells Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

**UNIT 2 EMBRYONIC STEM CELLS AND ETHICAL ISSUES****9 Hrs.**

Types of stem cells. Stem Cell biology and therapy, types embryonic stem cell, Adult stem cell, Stem Cell Biology and Therapy, Embryonic Stem Cells, culture and the potential benefits of stem cell technology.

**UNIT 3 ADULT STEM CELLS****9 Hrs.**

Somatic stem cells, Test for identification of adult stem cells, Adult stem cell differentiation – Trans differentiation -Plasticity - Different types of adult stem cells- Isolation of haemopoietic stem cell, Muscle and Cardiac stem cell and their applications.

**UNIT 4 ADVANCEMENT OF STEM CELL IN TISSUE ENGINEERING****9 Hrs.**

Tissue engineering triad, ECM components and their role in tissue development, Tissue engineering application - Production of complete organ - Kidney - Eyes - Heart - Brain.

**UNIT 5 THERAPEUTIC APPLICATION OF STEM CELLS****9 Hrs.**

Gene therapy - genetically engineered stem cells - stem cells and Animal cloning - transgenic animals and stem cells - Therapeutic applications – Parkinson's disease - Neurological disorder - limb amputation - heart disease – spinal cord injuries - diabetes -burns - HLA typing- Alzheimer's disease.

**Max.45 Hrs.****TEXT / REFERENCE BOOKS**

1. Kursad and Turksen, Embryonic Stem cells, Humana Press, 2002
2. Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research 12 National Academic press, 2002.

**COURSE OUTCOME**

At the end of course, the students will

- CO1** - Explain the basics of stem cell  
**CO2** - Appraise the ethical implications in using stem cells  
**CO3** - Point out the applications of adult stem cells  
**CO4** - Elaborate on the advancement of stem cells in tissue engineering  
**CO5** - Compile the therapeutic applications of stem cells  
**CO6** - Assess the role of stem cell in gene therapy



**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBCB3003	CANCER BIOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To study about the knowledge in tumour, oncogenes, signals and diagnosis and treatment of Cancer.

**UNIT 1 FUNDAMENTALS OF CANCER BIOLOGY****9 Hrs.**

Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumour markers, molecular tools for early diagnosis of cancer.

**UNIT 2 PRINCIPLES OF CARCINOGENESIS****9 Hrs.**

Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, X –ray radiation - mechanisms of radiation carcinogenesis.

**UNIT 3 PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER****9 Hrs.**

Signal targets and cancer, activation of kinases, Oncogenes, Identification of oncogenes, retroviruses and oncogenes, Oncogenes/proto oncogene activity. Growth factors related to transformation, telomerases.

**UNIT 4 PRINCIPLES OF CANCER METASTASIS****9 Hrs.**

Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

**UNIT 5 NEW MOLECULES FOR CANCER THERAPY****9 Hrs.**

Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, advances in cancer detection. Use of signal targets towards therapy of cancer, Gene therapy.

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Understand the nature of cancer and the processes underlying cancer formation and progression.
- CO2** - Understand the application of radiation carcinogenesis
- CO3** - Explore the molecular biology of cancer cells
- CO4** - Understand the principles of clinical significances
- CO5** - Explain the gene therapy and advances in cancer detection
- CO6** - Understand the cancer therapy treatments

**TEXT / REFERENCE BOOKS**

- King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996. 2. Ruddon, Raymond W. "Cancer Biology" Illrd Edition . Oxford University Press, 1995.
- Weinberg RA. The Biology of Cancer, 2nd Edition. Garland Science, 2013.
- Cellular signal processing , 2nd Edition by Friedrich Marks, Ursula Klingmuller and Karin Muller-Decker, Garland Science

**TEXT / REFERENCE BOOKS**

Selected reviews and primary scientific literature

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2. McDonald, F et al., "Molecular Biology of Cancer" II<sup>nd</sup> Edition. Taylor & Francis, 2004.

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A :** 10 Questions of 2 marks each-No choice

**20 Marks**

**PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks

**80 Marks**

SBCB3001	BIOCHEMISTRY OF DISEASES	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

## COURSE OBJECTIVES

- To impart the knowledge of human disease and importance of cellular biochemical reaction.

### UNIT 1 HEPATIC DISORDERS

9 Hrs.

Hepatic disorder/ Diseases - Biochemical functions - Excretory and Secretory, Synthetic, Detoxification and Drug Metabolism, Liver function alterations during disease – Jaundice, Fatty liver, Cirrhosis, Tumors, Reye Syndrome, Drug- and Alcohol-Related Disorders, Assessment of liver function/liver - Function tests: Bilirubin, Urobilinogen in Urine and Faeces, Serum Bile Acids, Enzymes, Tests Measuring Hepatic Synthetic Ability.

### UNIT 2 CARDIOVASCULAR DISORDER

9 Hrs.

Cardiovascular disorder/Diseases - Pathologic conditions of the heart, Cardiovascular Disease, Congenital heart Defects, Heart Failure, Diagnosis of heart disease - Laboratory Diagnosis of Myocardial Infarction, biomolecular markers, Electrocardiogram (ECG), Echocardiography. Effects of blood pressure on various organ functions.

### UNIT 3 RENAL DISORDER

9 Hrs.

Renal disorder/Diseases - Glomerular Filtration, Tubular Function, Elimination of Nonprotein Nitrogen Compounds, Gall stone formation, Clearance Measurements,. Alteration of urine composition under pathological condition and clinical significance Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance. Kidney and bladder problems with ageing, Enlarged prostate.

### UNIT 4 NEUROLOGICAL DISORDERS

9 Hrs.

Neurological Disorders/Disease- Neurological disorder in progressive ageing, Parkinson's and Alzheimer's disease, Dementia, Multiple sclerosis, Circadian rhythm and disorders, Arthritis, Macular degeneration, Bipolar disorder.

### UNIT 5 SKELETAL SYSTEM AND VISION DISORDERS

9 Hrs.

Skeletal system and Bone Related disorder/Diseases - Osteoporosis, Arthritis, osteoarthritis, rheumatoid arthritis. Eye/ Vision related disorder/Diseases- Cataract, Night Blindness, glaucoma, color blindness.

Max. 45 Hrs.

## COURSE OUTCOME

On completion of the course, student will be able to

- CO1** - Understand types of liver disease and hepatocytes metabolic alternation.
- CO2** - Acquired knowledge about cardiovascular disorder and prevention mechanism.
- CO3** - Identify the renal disease and their importance in human physiology.
- CO4** - Analyze the mechanism of Neurological Disorders and biochemistry.
- CO5** - Analyze biochemical alternation in Skeletal System and Vision Disorders.
- CO6** - Explain the biochemistry of human diseases related with liver, heart, kidney, nervous system and eyes.

**TEXT / REFERENCE BOOKS**

1. Molecular Biology of the cells: Alberts et. al., Garland Publications Inc. NY, 2014.
2. Cell and Molecular Biology by E D P de Robertis and E M F de Robertis. 8<sup>th</sup> Ed, 2017.
3. Text book of Medical Physiology by A. C. Guyton and J. E. Harcourt. Elsevier; 14<sup>th</sup> edition, 2020.
4. Ganong's Review of Medical Physiology, Twenty sixth Edition, 2019.
5. Text book of Biochemistry and Human Biology by Talwar. 2002.
6. Tortora's Principles of Anatomy and Physiology Paperback – 2017.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks****80 Marks**

SBCB3002	MEDICAL LABORATORY TECHNIQUES	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- The main purpose of the program is to provide the students with the good knowledge of the basic techniques used in the laboratory.

**UNIT 1 DISEASES****9 Hrs.**

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

**UNIT 2 COLLECTION OF SAMPLES****9 Hrs.**

Collection of clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

**UNIT 3 EXAMINATION OF SAMPLES****9 Hrs.**

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

**UNIT 4 SEROLOGICAL ANALYSIS****9 Hrs.**

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes.

**UNIT 5 ANALYSIS METHODS****9 Hrs.**

Typhoid, Dengue and HIV, Swine flu Testing for Antibiotic Sensitivity in Bacteria Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.

**Max. 45 Hrs.****COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Understand types of disease and diagnosis method.
- CO2** - Acquired knowledge about collection of sample.
- CO3** - Identify the method of transport samples.
- CO4** - Understand the various bacterial pathogens.
- CO5** - Understand the serological methods.
- CO6** - Various analysis method used for diseases.

**TEXT / REFERENCE BOOKS**

- Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
- Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
- Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
- Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby Collee JG, Fraser, AG, Marmion, BP.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBCB3003	MOLECULAR DIAGNOSTICS	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To impart the knowledge of Molecular Diagnostics in communicable and non-communicable human diseases.

**UNIT 1 BIOMARKERS OF DISEASE****9 Hrs.**

Biomarkers in diagnostics: FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumor & cancer markers, markers in inflammation, and diagnosis of cytoskeletal disorders.

**UNIT 2 ENZYMES****9 Hrs.**

Enzymes as diagnostic tools – Enzymes in health and diseases. Serum Enzymes, Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT, aldolase, amylase, CPK, cholinesterase, LDH. Clinical aspects of gastric secretion analysis, tests of gastric, bio-molecular markers.

**UNIT 3 MOLECULAR DIAGNOSTICS: INFECTIOUS DISEASES AND CANCER****9 Hrs.**

History, Traditional typing methods, Nucleic acid-based typing, PCR, Electrophoresis based diagnosis. Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes, and Tumor suppressors.

**UNIT 4 IMMUNODIAGNOSTIC TECHNIQUES****9 Hrs.**

Immunodiagnostic techniques: Introduction, Radioactive isotopes, DNA reporters, fluorogenic reporters, electro-chemiluminescent tags & label-free immunoassays. Immunoassays – precipitation, agglutination hemagglutination, RIA, ELISA, RIA, MELISA, and specific applications. Quantum dots. Immunohistochemistry – principle, and techniques.

**UNIT 5 METABOLIC DISORDERS****9 Hrs.**

Disorders of carbohydrate metabolism – Hemoglobin A1c (HbA1c) Test for Diabetes, glucose and galactose tolerance tests, renal threshold for glucose, melituria, glycogen storage diseases, pentosuria, galactosemia. hyperlipidemia, Gaucher's disease, ketone bodies, Obesity, Ketosis. Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Gout, BMR, measurement and calculation of BMR. Body mass index (BMI), Calorific value and biological, Specific Dynamic action (SDA).

**Max. 45 Hrs.****COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Understand types of diseases and their biomarkers.  
**CO2** - Acquired knowledge about enzymes as biomarkers in several diseases.  
**CO3** - Identify the infectious disease and prevention mechanism.  
**CO4** - Acquired knowledge about the uses of Immunodiagnostic techniques.  
**CO5** - Analyze biochemical alternation in metabolic disorders.  
**CO6** - Constructs various molecular diagnostic methods for human communicable and non-communicable diseases.



**TEXT / REFERENCE BOOKS**

1. Cell and Molecular Biology by E D P de Robertis and E M F de Robertis. 8<sup>th</sup> Ed, 2017.
2. Text book of Medical Physiology by A. C. Guyton and J. E. Harcourt. Elsevier; 14th edition, 2020.
3. Ganong's Review of Medical Physiology, Twenty sixth Edition, 2019.
4. Text book of Biochemistry and Human Biology by Talwar. 2002.
5. Tortora's Principles of Anatomy and Physiology Paperback – 2017.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBCB3003	FOOD CHEMISTRY	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To be able to control the major chemical/biochemical (enzymatic) reactions that influence food quality with emphasis on home and food industry applications.
- To demonstrate the properties of different food components and interactions among these components modulate the specific quality attributes of food systems.

**UNIT 1 GENERAL FOOD ANALYSIS****9 Hrs.**

Expression of reagent concentrations. Measurement of pH, the use of mass balance, titration methods, refractometry, density and brix value. Buffer capacity and buffer preparation. Expression of the results. Repeatability and reproducibility. Trueness and recovery. Concentration calculation and preparation of standard solutions. Calibration curves, sensitivity, linearity and limit of detection.

**UNIT 2 CHEMISTRY OF FRUITS****9 Hrs.**

Main compounds present in fruits: reducing sugars, antioxidants, vitamins. The role of pectin, pectin properties, formation of pectin gel. The role of water activity, pH and organic acids in fruits. Enzymatic and non-enzymatic browning reactions. Effect of thermal treatments on the chemical quality of processed fruits (fruit juices, canned fruits, jams, jellies and marmalades). Main chemical analysis for the quality control of fruit products.

**UNIT 3 CHEMISTRY OF MILK AND DAIRY PRODUCTS****9 Hrs.**

Main compounds in milk and dairy products: lactose, proteins (casein and whey proteins), lipids. Concept of emulsion, foaming, creaming phenomena. Chemical reactions during dairy product preparation: yogurt gelation, cheese curd formation, ice-cream overrun. Cheese maturation and effect on flavor and taste. Methods for chemical analysis in the quality control of milk and dairy products. Methods for protein analysis (Kjeldahl, Dumas, spectrophotometric assays).

**UNIT 4 CHEMISTRY OF BAKERY PRODUCTS****9 Hrs.**

Chemistry of cereals and flour. Main reactions in dough and bakery products: reducing group reactions. Starch and degraded starch properties. Gelation, gelatinization and retrogradation reactions. Gluten formation. Shortening in biscuits and pastry. Heat induced changes in bakery product quality. Maillard Reaction. Main chemical analysis in the quality control of bakery products. Methods for analysis of lipids.

**UNIT 5 FOOD OXIDATION****9 Hrs.**

Oxidation reactions in food. Lipid oxidation. Radical chain reactions. Role and functions of antioxidants. Water soluble and lipid soluble antioxidants. Methods of analysis for antioxidant and radical scavenging activity.

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Understand and be able to control the major chemical and biochemical (enzymatic) reactions that influence food quality with emphasis on food analysis techniques.
- CO2** - Understand how the properties of different food components and interactions among these components modulate the specific quality attributes of food systems.

- C03** - Apply the theoretical knowledge of on the chemical changes occurring to foods. Student will be able to apply the theoretical knowledge of analytical methods in practice during laboratory exercises.
- C04** - To analyze and compare the chemical properties of foods and their effect on its quality
- C05** - Evaluated in class through the discussion of case studies and in the lab through the evaluation of the laboratory activity
- C06** - Learn practical laboratory methods to analysis the chemical properties of foods.

**TEXT / REFERENCE BOOKS**

1. H. D. Belitz, Foods chemistry, Springer, Doi: 10.1007/9783-540-69934-7.
2. Nielsen, S. Suzanne, ed. Food analysis. New York: Springer, 2010.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A** : 10 Questions of 2 marks each-No choice**20 Marks****PART B** : 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBBB3008	FOOD QUALITY ANALYTICS	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVE**

- To explore the food safety and quality assurance in national and international levels.

**UNIT 1 GENERAL PRINCIPLES FOR FOOD SAFETY AND HYGIENE****9 Hrs.**

Principles of food safety and quality - Food Safety System - Quality attributes - Total Quality Management. Good Hygienic Practices, Good Manufacturing Practices – HACCP - Risk Analysis, Risk Management, Risk Assessment, Risk Communication - Traceability and authentication.

**UNIT 2 GENERAL PRINCIPLES FOR FOOD SAFETY REGULATION AT NATIONAL / REGIONAL LEVEL****9 Hrs.**

The Structure of Food Law, Food Regulation , Laws and Regulations to Prevent Adulteration and Cross Contamination, Microbial Contamination, Hygienic Practice, Chemical and Environmental Contamination, Food Additives, Labeling, Food Laws and Regulations at the International Level for Harmonization.

**UNIT 3 NATIONAL STANDARDS****9 Hrs.**

Food Safety and Standard Authority of India regulations - Agricultural and Processed food Export Development Authority - Marine Product Export Development Authority - Export Inspection council and Export Inspection Agency.

**UNIT 4 INTERNATIONAL BODIES DEALING IN STANDARIZATION****9 Hrs.**

International Standardization Organization (ISO), Joint FAO/WHO Food Standards Program. Codex Alimentarius Commission (CAC), Other International Organizations Active in Food Standard Harmonization. Advantages of Utilizing International Standards. Rapid Alert system.

**UNIT 5 COUNTRY SPECIFIC STANDARDS****9 Hrs.**

European Committee for Standardization (CEN), PAN American Standards Commission (COPANT), Euro-Asian Council for Standardization, FDA, EPA, EU, ASEAN, EFSA (European Food Safety Authority).

**Max. 45 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Understand the basic principles of food safety
- CO2** - Summarize the general principles of food safety at national and international levels
- CO3** - Explore national standards in food safety
- CO4** - Construct the knowledge about international standards in food safety
- CO5** - Role of country specific standards
- CO6** - Evaluate about the overall quality assurance.

**TEXT / REFERENCE BOOKS**

1. Neal D. Fortin. 2009. Food regulation, Wiley Publishers.
2. Naomi Rees. David Watson. 2000. International standards for food safety, An Aspen Publications.
3. O'Rourke. 2005. European Food law, 3rd Edition, Thomson, Sweet and Maxwell.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SBBB3009	FOOD PROCESSING TECHNOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVE**

- To impart knowledge of various areas about the food processing and safety technology.

**UNIT 1 PROPERTIES OF FOODS AND PROCESSING THEORY****9 Hrs.**

Properties of Food – Intrinsic and Extrinsic properties - Effects of processing on sensory characteristics of foods – Effects of processing on nutritional properties - Food safety, good manufacturing practice and quality assurance: HACCP, Hurdle technology - Process control - Automatic control, Computer-based systems.

**UNIT 2 AMBIENT-TEMPERATURE PROCESSING****9 Hrs.**

Raw material preparation : Cleaning, Sorting, Grading, Peeling - Size reduction in solid and liquid foods – separation and concentration of food components – fermentation and enzyme technology – Irradiation – processing using electric fields, high pressure, pulsed light and ultrasound.

**UNIT 3 PROCESSING BY APPLICATION OF HEAT****9 Hrs.**

Heat processing using steam and water – Blanching – Pasteurization – Heat sterilization – Evaporation and distillation – Extrusion : Heat processing using hot air – Dehydration – Baking and roasting : Heat processing using hot oils – Frying :Heat processing by direct and radiated energy – Dielectric , ohmic and infrared heating.

**UNIT 4 PROCESSING BY REMOVAL OF HEAT****9 Hrs.**

Chilling – Controlled or modified atmosphere storage and packaging – Freezing – Freeze drying and Freeze concentration.

**UNIT 5 POST – PROCESSING OPERATIONS****9 Hrs.**

Coating or enrobing – Packaging – Types of packaging materials – printing – interactions between packaging and foods – environmental considerations – Filling and sealing of containers – materials handling, storage and distribution.

**Max.45 Hrs.****COURSE OUTCOMES**

On completion of course, student will able to

- CO1** - Learning of properties of food and food safety.
- CO2** - Knowledge about the food processing by using ambient temperature
- CO3** - Study of processing of food by using heat
- CO4** - Processing of food by removal of heat using direct and radiant energy
- CO5** - Scrutinizing of Post processing of food
- CO6** - Gain wide knowledge about the processing technology of food

**TEXT / REFERENCE BOOKS**

1. Amit K Jaiswal , Food processing Technologies – impact on product attributes , CRC Press Taylor & Francis Group, 2017.
2. Sivashakar B., Food processing preservation, Prentice Hall of India Pvt. Ltd., 2002.
3. Fellows P., Food processing and technology, Principles and Practice, 4th Edition, Woodhead Publishing Limited,Cambridge – England, 2016.
4. Da-Wen Sun, Emerging Technologies for food, 2nd Edition, Academic Press, 2014.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SMBB3001	DESIGN AND OPERATION OF BIOREACTORS	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- To develop knowledge in bioreactors and its types.
- To make understand the knowledge in microbial growth parameters

**UNIT 1 INTRODUCTION****9 Hrs.**

Concept of Bioreactors, Overview of SLF and SSF. Medium optimization-Plackett Burman method. Introduction to bioreactor configuration.

**UNIT 2 DESIGN AND OPERATION****9 Hrs.**

Basic mode of operation batch, fed-batch and continuous reactor, Kinetics of batch and continuous culture.

**UNIT 3 IDEAL CONTINUOUS STIRRED TANK BIOREACTOR****9 Hrs.**

Material balance-Evaluation of Monod Kinetic parameter, Alternatives to Monod equation-Blackman, Tessier, Moser, Contois equation -Comparison of batch and CSTB-Multiple CSTB connected in series-CSTB with cell recycling.

**UNIT 4 GENERAL CHARACTERISTIC OF MODELS****9 Hrs.**

Unstructured and structured models. Models with growth inhibitors- Substrate inhibition, Product Inhibition-Competitive and Noncompetitive product inhibition. Rate. Mass transfer and rheology: Rheology of broths - impact on transfer processes Oxygen transport from the bubble to the cell.

**UNIT 5 DESIGN CONSIDERATIONS****9 Hrs.**

Animal and plant cell bioreactors. Determination of  $k_L a$  - Correlation for  $k_L a$ . Introduction to Single Use, Bioreactors (SUBs),

**Max.45 Hrs.****COURSE OUTCOMES**

On completion of course, student will able to

- CO1** - Learn basic working principle of bioreactors
- CO2** - Design and operation of industrial bioreactors
- CO3** - Evaluate the various microbial growth kinetics
- CO4** - Discuss the microbial growth kinetics using models
- CO5** - Critique on the validity of experimental data and measurements of mass transfer rate
- CO6** - Analyse various economical important products

**TEXT / REFERENCE BOOKS**

1. Shuler.M.L. and Kargi.F, Bioprocess Engineering Basic concepts, Pearson Education India, 1<sup>st</sup> Edition, 2003.
2. Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, 2nd Edition, 1997.
3. Pauline M. Doran, Bioprocess Engineering Principles.2012.



**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**

SMBB3002	FERMENTATION TECHNOLOGY AND DOWNSTREAM PROCESSING	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- To understand and improve the knowledge in fermentation technology
- To gain knowledge in growth kinetics, fermenter control process and various downstream process techniques

**UNIT 1 INTRODUCTION TO FERMENTATION PROCESS****9 Hrs.**

The range of fermentation processes, culture collection management, Inoculum preparation: Scale up of the inoculum for Bacteria and fungi. Sterilization: Batch and Continuous sterilization of medium, Filter sterilization.

**UNIT 2 MICROBIAL GROWTH KINETICS****9 Hrs.**

Bacterial growth kinetics, Monod model, Comparison of Continuous Batch and continuous culture. Design of a fermenter – ancillary equipment fermenter and Bioreactor types.

**UNIT 3 INSTRUMENTATION AND CONTROL****9 Hrs.**

Fermentation control systems – manual and automatic control in fermentation processes. temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen, Computer applications in fermentation technology: Artificial neural network.

**UNIT 4 DOWNSTREAM PROCESSING****9 Hrs.**

Separation and recovery of fermented products- precipitation, filtration, centrifugation, flocculation, coagulation- cell disruption –physical and chemical methods, Solvent extraction: liquid – liquid, aqueous two phase extraction, supercritical fluid extraction.

**UNIT 5 PURIFICATION PROCESSES****9 Hrs.**

Drying, whole broth processing, Chromatography - Adsorption Chromatography, gel permeation, Affinity Chromatography, High performance liquid. Chromatography. Lyophilization.

**Max.45 Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1** - Understand basic knowledge in range of fermentation process.
- CO2** - Learn the various types of sterilization techniques.
- CO3** - Apply Artificial intelligence in instrument and control system.
- CO4** - Evaluate the product separation by solvent extraction techniques.
- CO5** - Assess a suitable method for downstream processing and its potential applications.
- CO6** - Competently produce various biotechnologically important products

**TEXT / REFERENCE BOOKS**

1. Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, 2nd Edition, Elsevier Science Publishers, 2003.
2. Belter P.A, Cursler E.L, and Hu W.S., Bioseparation - Downstream Processing for Biotechnology John Wiley & Sons, publishers, 1990.
3. Harrison R.G, Todd P., Rudge S.R and Petrides D.P, Bioseparations Science and Engineering, Oxford Press, 2002.

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SMBB3003	MICROBIAL PRODUCTS FOR AGRICULTURE AND INDUSTRIES	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVES**

- To make the students to understand role of bio-products and its applications.
- To make the students understand the basic principles of Biofuels and Biopesticides

**UNIT 1 BIOFERTILIZERS****9 Hrs.**

General account about the microbes used as bio-fertilizer – Rhizobium, Azotobacter, Phosphate solubilizing microbes, azospirillum- isolation, identification, mass multiplication, carrier-based inoculants.

**UNIT 2 BIOPESTICIDES****9 Hrs.**

History and concept of biopesticides. Importance, scope and potential of biopesticide. Mass production technology of bio-pesticides. Virulence, pathogenicity and Symptoms of entomopathogenic pathogens and nematodes.

**UNIT 3 BIOSTIMULANTS****9 Hrs.**

Humic acids and Fulvic acids, seaweeds, amino acids, microbial inoculants, plant growth promoters, mycorrhiza- isolation, identification, mass multiplication, carrier-based inoculants.

**UNIT 4 INDUSTRIAL PRODUCTS****9 Hrs.**

Production of Protease, Amylase, lipase and its applications. Production of Citric acid, Lactic acid, Acetic acid. Production of Probiotics, biosurfactant, Microbial fuel cell and its applications.

**UNIT 5 MICROBIAL QUALITY CONTROL****9 Hrs.**

Estimation of nitrogen content by kjeldahl method, MPN test, air sampling procedure, Principles of quality assurance and quality management systems. Good Manufacturing Practices (GMP) and regulatory guidelines. Auditing and documentation in industrial microbiology.

**Max.45 Hrs.****COURSE OUTCOMES**

On the successful completion of the course, student will be able to

- CO1** - Understand the role of microorganism in agriculture
- CO2** - Describe production steps and specific requirements for bio-fertilizers
- CO3** - Learn the importance of bio stimulant in agriculture
- CO4** - Apply the knowledge gained to generate opportunities of self- employability.
- CO5** - Evaluate Auditing and documentation in industrial microbiology
- CO6** - Determine nitrogen content by kjeldahl method

**TEXTBOOKS AND REFERENCES**

1. Biostimulants for crop production and sustainable agriculture, 2022
2. Handbook of microbiological quality control in pharmaceuticals and medical devices.
3. Bio-fertilizers and organic \_farming vayas, s.c, vayas, s. And modi, h.a. (1998) akta prakashan, nadiad
4. Biotechnology of biofertilizers kannaiyan, s., (2003), chips, texas.
5. Hand book of microbial biofertilizers rai, m.k., (2005), the haworth press, inc. Newyork

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3****Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB3007	HUMAN PHYSIOLOGY	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVES**

- To impart the knowledge of human digestive system, respiratory system, nervous system, endocrine system and reproductive system.

**UNIT 1 DIGESTIVE SYSTEM****9 Hrs.**

Structure of alimentary canal and digestive gland - stomach, Intestine, salivary glands, pancreas, liver. Peristaltic Movements and their regulations during digestion. Role of digestive juice in digestion. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.

**UNIT 2 RESPIRATORY****9 Hrs.**

Respiratory System: Structure of the lung, Mechanics of breathing -- role of respiratory muscles and diaphragm, glottis. Diffusion and Transport of gases in body. Oxygen dissociation curve, role of 2, 3 BPG, Hypoxia – types, effects.

**UNIT 3 NERVOUS SYSTEM****9 Hrs.**

Organization and basic functions of the nervous system. Different parts of brain and spinal cord. Generation of Action potential and their transmission, threshold value, Reflex action, neurotransmitter and synaptic cleft.

**UNIT 4 ENDOCRINE SYSTEM****9 Hrs.**

Classification of endocrine glands and hormones. Pituitary gland, Pineal, Thyroid, Adrenal, Pancreatic - structure and function of the gland. Regulation of endocrine synthesis - Feedback mechanism

**UNIT 5 REPRODUCTIVE SYSTEM****9 Hrs.**

Primary and accessory sex organs and secondary sex characters. Structure of testis, endocrine functions, Spermatogenesis. Structure of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Physiology of puberty

**Max 45 Hrs.****COURSE OUTCOME**

On completion of the course, student will be able to

- CO1** - Understand types of digestive gland and their role in digestion.
- CO2** - Acquired knowledge about oxygen and CO<sub>2</sub> role in respiration.
- CO3** - Identify the nervous system and their importance in human physiology.
- CO4** - Analyze the mechanism of various endocrine gland and their hormone in human physiology.
- CO5** - Analyze sex hormones and their importance in development of sexual character and behavior.
- CO6** - Explain physiology of digestion, respiration, Neurons, Hormones and reproduction.

**TEXT / REFERENCE BOOK**

1. Molecular Biology of the cells: Alberts et. al., Garland Publications Inc. NY, 2014
2. Cell and Molecular Biology by E D P de Robertis and E M F de Robertis. 8<sup>th</sup> Ed, 2017
3. Text book of Medical Physiology by A. C. Guyton and J. E. Harcourt. Elsevier; 14th edition, 2020
4. Ganong's Review of Medical Physiology, Twenty sixth Edition, 2019.
5. Text book of Biochemistry and Human Biology by Talwar. 2002
6. Tortora's Principles of Anatomy and Physiology Paperback – 2017

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A : 10 Questions of 2 marks each-No choice****20 Marks****PART B : 2 Questions from each unit with internal choice, each carrying 16 marks****80 Marks**

SBCB3008	INTRODUCTION TO BIOPHARMACEUTICS	L	T	P	EL	Credit	Total Marks
		3	0	0	0	3	100

**COURSE OBJECTIVE**

- To impart knowledge and skills of Biopharmaceutics and pharmacokinetics and their applications in pharmaceutical development.

**UNIT 1 INTRODUCTION TO****9 Hrs.**

Absorption; Mechanisms of drug absorption through GIT, factors influencing drug absorption through GIT, absorption of drug from Non per oral extra-vascular routes, Distribution Tissue permeability of drugs, binding of drugs, plasma and tissue protein binding of drugs, factors affecting protein-drug binding. Kinetics of protein binding, Clinical significance of protein binding of drugs.

**UNIT 2 ELIMINATION, BIOAVAILABILITY AND BIOEQUIVALENCE OF BIOPHARMACEUTICS****9 Hrs.**

Drug metabolism and basic understanding metabolic pathways renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non renal routes of drug excretion of drugs. Definition and Objectives of bioavailability, absolute and relative bioavailability, measurement of bioavailability, in-vitro drug dissolution models, in-vitro-in-vivo correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs

**UNIT 3 PHARMACOKINETICS AND METABOLISM OF BIOPHARMACEUTICS****9 Hrs.**

Definition and introduction to Pharmacokinetics, Compartment models, Non compartment models, physiological models, One compartment open model. (a). Intravenous Injection (Bolus) (b). Intravenous infusion and (c) Extra vascular administrations. Pharmacokinetics parameters -  $KE$ ,  $t_{1/2}$ ,  $V_d$ ,  $AUC$ ,  $K_a$ ,  $Cl_t$  and  $CL_R$ - definitions methods of eliminations, understanding of their significance and application. Absorption, distribution, metabolism, and excretion (ADME) of drugs, Metabolic transformations (phase I and phase II reactions).

**UNIT 4 OPTIMIZATION OF BIOPHARMACEUTICS****9 Hrs.**

Drug formulation and dosage forms, Drug delivery systems and strategies, Study of drug classes such as antibiotics, antivirals, anticancer agents, CNS drugs, cardiovascular drugs, etc. Mechanisms of action, structure-activity relationships, and therapeutic uses. Biopharmaceutics in Pharmaceutical Industries.

**UNIT 5 COMPUTATIONAL APPROACHES FOR DESIGNING OF BIOPHARMACEUTICS****9 Hrs.**

Quantitative structure-activity relationships (QSAR), Computational methods and bioinformatics in drug discovery - Structure-based drug design (protein structure determination, molecular docking), Computer Aided Drug Designing (CADD) and molecular modelling.

**Max 45 Hrs.**



**COURSE OUTCOMES**

On completion of course, student will be able to:

- CO1** - Evaluate the absorption mechanism, and protein binding kinetics of Biopharmaceuticals.
- CO2** - Analyze the mechanisms involved in the elimination, bioavailability and bioequivalence of biopharmaceuticals.
- CO3** - Comprehensively understand the pharmacokinetics of biopharmaceuticals.
- CO4** - Analyze the process of drug development and optimization.
- CO5** - Evaluate the use of computational approaches in Biopharmaceutical discovery.
- CO6** - Acquire a scientific understanding of basic concepts about Biopharmaceuticals and their applications in pharmaceutical development.

**TEXT / REFERENCE BOOK**

1. Biopharmaceutics and Pharmacokinetics: A Treatise" by D. M. Brahmkar and S. B. Jaiswal Edition: 2nd Edition Year: 2009
2. Biopharmaceutics and Clinical Pharmacokinetics" by Milo Gibaldi and Donald Perrier Edition: 5th Edition Year: 2009
3. Pharmacokinetics: Principles and Applications" by Malcolm Rowland and Thomas N. Tozer Edition: 5th Edition Year: 2018
4. Biopharmaceutics and Pharmacokinetics: An Introduction" by P. N. Reddy and S. Ramachandran, Edition: 2nd Edition Year: 2012
5. Biopharmaceutics and Pharmacokinetics: A Comprehensive Guide" by D. M. Brahmkar and S. B. Jaiswal Edition: 1st Edition, Year: 2009.
6. Applied Biopharmaceutics and Pharmacokinetics" by Leon Shargel, Andrew B.C. Yu, and Susanna Wu-Pong Edition: 7th Edition, Year: 2015
8. Medicinal Chemistry: The Modern Drug Discovery Process" by Erland Stevens and Wei-Chiang Shen (2nd Edition, 2012)
9. Essentials of Pharmaceutical Chemistry" by Donald Cairns (4th Edition, 2012)

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks : 100**

**Exam Duration : 3 Hrs.**

**PART A : 10 Questions of 2 marks each-No choice**

**20 Marks**

**PART B : 2 Questions from each unit with internal choice, each carrying 16 marks**

**80 Marks**

SBCB3009	DRUG DESIGN AND DELIVERY	L	T	P	EL	Credit	Total Marks
		3	0	0	2	3	100

**COURSE OBJECTIVE**

- To impart in-depth knowledge about novel, pharmacologically active molecules designed to treat human diseases.

**UNIT 1 INTRODUCTION TO MEDICINAL CHEMISTRY****9 Hrs.**

Definition, history and scope of medicinal chemistry, Physicochemical properties in relation to biological action, Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism. Role of medicinal chemistry in the pharmaceutical industry.

**UNIT 2 DRUG TARGETS AND RECEPTOR****9 Hrs.**

Theories of drug-receptor interaction. Introduction to drug targets (enzymes, receptors, ion channels, etc.) Drug- receptor interactions (binding kinetics, affinity, efficacy, agonists vs antagonists, artificial enzymes) drug target inhibitors.

**UNIT 3 DRUG METABOLISM AND PHARMACOKINETICS****9 Hrs.**

Absorption, distribution, metabolism, and excretion (ADME) of drugs, Metabolic transformations (phase I and phase II reactions), Pharmacokinetic properties (bioavailability, half-life, clearance)

**UNIT 4 DRUG DEVELOPMENT AND OPTIMIZATION****9 Hrs.**

Preclinical and clinical development phases, Drug formulation and dosage forms, Drug delivery systems and strategies, Study of drug classes such as antibiotics, antivirals, anticancer agents, CNS drugs, cardiovascular drugs, etc. Mechanisms of action, structure-activity relationships, and therapeutic uses, Drug toxicity and adverse effects.

**UNIT 5 COMPUTATIONAL APPROACHES FOR DRUG DESIGNING****9 Hrs.**

Quantitative structure-activity relationships (QSAR), Computational methods and bioinformatics in drug discovery - Structure-based drug design (protein structure determination, molecular docking), Computer Aided Drug Designing (CADD) and molecular modelling.

**Max 45 Hrs.****COURSE OUTCOMES**

On completion of course, student will able to

- CO1** - Understand the history and scope of medicinal chemistry and role of medicinal chemistry in Pharmaceutical Industries.
- CO2** - Explain the mechanisms involved in drug-receptor interaction.
- CO3** - Comprehensively understand the Absorption, distribution, metabolism, and excretion of drugs and other pharmacokinetic properties.
- CO4** - Analyze the process of drug development, optimization and delivery methods.
- CO5** - Evaluate the use of computational approaches in drug discovery.
- CO6** - Acquire a scientific understanding of basic concepts and principles of drug designing.

**TEXT / REFERENCE BOOK**

1. Medicinal Chemistry: The Modern Drug Discovery Process" by Erland Stevens and Wei-Chiang Shen (2nd Edition, 2012)
2. Principles of Medicinal Chemistry" by William O. Foye, Thomas L. Lemke, and David A. Williams (7th Edition, 2012)
3. Contemporary Drug Synthesis" by Jie Jack Li (1st Edition, 2004)
4. Medicinal Chemistry: A Molecular and Biochemical Approach" by Thomas Nogrady and Donald F. Weaver (3<sup>rd</sup> Edition, 2005)
5. Essentials of Pharmaceutical Chemistry" by Donald Cairns (4th Edition, 2012)
6. Introduction to Medicinal Chemistry: How Drugs Act and Why" by Alex Gringauz (4th Edition, 2013)
7. Organic Chemistry of Medicinal Agents" by Adam Renslo (2nd Edition, 2017)
8. Medicinal Chemistry: An Introduction" by Gareth Thomas (2nd Edition, 2018)

**END SEMESTER EXAM QUESTION PAPER PATTERN****Max. Marks : 100****Exam Duration : 3 Hrs.****PART A :** 10 Questions of 2 marks each-No choice**20 Marks****PART B :** 2 Questions from each unit with internal choice, each carrying 16 marks**80 Marks**