



**SIES College of Arts, Science and Commerce
(Empowered Autonomous)**

Affiliated to University of Mumbai

Syllabus under NEP effective from June 2024

Programme: MSc.

Subject: Biochemistry

Core Course I (SIPBCCC611, SIPBCCCP611, SIPBCCC621, SIPBCCCP621)

Core Course II (SIPBCCC612, SIPBCCCP612, SIPBCCC622, SIPBCCCP622)

Class: MSc. - II

Semester: III and IV

Choice Based Credit System (CBCS)

Preamble

Biochemistry is a vibrant and dynamic field that lies at the intersection of biology and chemistry. It seeks to understand the chemical processes and substances that occur within living organisms, thereby providing the foundational knowledge required to explore the complexities of life at the molecular level.

The Masters in Biochemistry program is designed to equip students with advanced knowledge and skills necessary to excel in research, academia, and industry. This program aims to foster a deep understanding of biochemical principles, experimental techniques, and their applications in solving real-world problems.

Under the aegis of New Education Policy 2020, the department offers a two-year Master's program. The curriculum encompasses a blend of core and elective courses, laboratory work, seminars, and a research thesis. Core courses cover essential topics such as enzymology, molecular biology, bioinformatics, and structural biology. Elective courses allow students to tailor their learning to specific interests, such as genetics, applied biochemistry, clinical nutrition and biotechnology.

Laboratory Training:

Hands-on laboratory training is a crucial component of this program, providing practical experience in techniques such as chromatography, electrophoresis, spectroscopy, and molecular cloning.

Research Component:

A significant emphasis is placed on independent research, culminating in a thesis that contributes original knowledge to the field of biochemistry. Students will have the opportunity to work closely with faculty members who are experts in various specializations, ensuring mentorship and guidance throughout their research endeavors.

Career Prospects:

Graduates of the Masters in Biochemistry program will be well-prepared for a variety of career paths, including but not limited to academic research, pharmaceuticals, biotechnology, healthcare, and environmental science. The skills and knowledge gained through this program will also provide a strong foundation for those wishing to pursue doctoral studies.

By completing this program, students will emerge as proficient biochemists, equipped to make significant contributions to the scientific community and society at large

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POs and PSOs for MSc. Biochemistry syllabus (Under NEP)

The characteristic graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science graduate in the subject of Biochemistry are as follows:

Abbreviations used:

PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome

Cognitive Levels:- R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Serial Number	Details of Programme Outcomes (POs)
P01 <i>(Skill level)</i>	<p>Academic competence and problem-solving ability</p> <ul style="list-style-type: none"> ● Understand fundamental concepts and gain in-depth disciplinary knowledge. ● Apply the knowledge of various courses learned under the program to solve societal issues and problems. ● Recognize and appreciate the scope and applications of the discipline of study. <p><i>Cognitive levels: R, U, Ap</i></p>
P02 <i>(Skill level)</i>	<p>Critical Thinking and Analytical skills</p> <ul style="list-style-type: none"> ● Develop critical thinking and a sense of inquiry or asking relevant scientific questions. ● Demonstrate the ability to analyse, interpret and draw conclusions from qualitative/quantitative data. ● Critically evaluate ideas, theories, and concepts by following scientific and interdisciplinary approach <p><i>Cognitive levels: U, An, Ap</i></p>
P03 <i>(Skill level)</i>	<p>Research Aptitude</p> <ul style="list-style-type: none"> ● Utilizing the contextual knowledge in an inter-disciplinary framework. ● Integrating research based knowledge and research methods involving problem definition, analysis and interpretation of data, synthesis of the information to provide valid conclusions. ● Exercising analytical skill, research ability, creativity, for employability and collaborating with industries. <p><i>Cognitive levels: A, An, E, C</i></p>
P04 <i>(Skill level)</i>	<p>Effective Communication Skills</p> <ul style="list-style-type: none"> ● Demonstrate the ability to listen, analyse and reproduce the instructions. ● Express thoughts and ideas effectively through written and oral communication. ● Demonstrate skills to present complex information in a clear, lucid, and concise manner. <p><i>Cognitive levels: Ap, C</i></p>

<p>P05 <i>(Skill level)</i></p>	<p>Proficiency with Information and Communication Technology</p> <ul style="list-style-type: none"> ● Use e-resources for effective learning. ● Employ computational tools and internet to retrieve, analyse, present, communicate and disseminate scientific data and information ● Understand the scope and limitations of printed and electronic media in gathering, and disseminating scientific knowledge. <p><i>Cognitive levels: Ap, An, E</i></p>
<p>P06 <i>(Skill level)</i></p>	<p>Personal and behavioral competence</p> <ul style="list-style-type: none"> ● Demonstrate conversational competence through effective communication and interaction with batchmates ● Exhibit time management while completing tasks in classroom and laboratory ● Exhibit adaptability, team building and leadership qualities as a member of diverse groups ● Demonstrate the ability to work independently and responsibly ● Demonstrate awareness towards issues related to environment, sustainability, and gender equity <p>Cognitive levels: U, Ap, An, C,</p>
<p>P07 <i>(Skill level)</i></p>	<p>Reasoning ability and Rational thinking:</p> <ul style="list-style-type: none"> ● Developing rational thinking on the basis of acquired contextual knowledge, ethnic and environmental issues, and performing with decisive responsibility. <p>Cognitive Levels: U, Ap, An, E</p>

Serial Number	Details of Programme Specific Outcomes (PSOs)
<p>PSO1</p>	<p>Academic Competence and problem-solving ability</p> <ul style="list-style-type: none"> ● Imbibe disciplinary knowledge and understand fundamental concepts of molecular biology ● Demonstrate coherent understanding of mechanism of replication, transcription and translation in prokaryotes and eukaryotes ● To understand the concepts and mechanisms of gene regulation ● To understand epigenetics and implications in disease. <p>Cognitive levels: R, U, An</p>
<p>PSO2</p>	<p>Critical thinking and analytical skills</p> <ul style="list-style-type: none"> ● Develop critical thinking and a sense of inquiry for asking relevant questions in the discipline of biochemistry ● Demonstrate the ability to analyse, interpret and draw conclusions from qualitative/quantitative data ● Critically evaluate ideas, theories and concepts by following scientific approach and an open minded and reasoned perspective. ● To develop skills in different analytical techniques as a research point of view. <p><i>Cognitive levels: U, An, E</i></p>

PS03	<p>Experiential learning and Laboratory Skills</p> <ul style="list-style-type: none"> ● Follow and create standard operating procedures and Good Laboratory Practices ● Understand the principles and working of laboratory equipments ● Apply the basic biochemistry knowledge in isolation of biomolecules and appreciate their commercial importance ● To study in depth the various types of vectors, hybridization technique and its application ● To study the techniques for growing animal cell and plant cell invitro. ● To understand immunological surveillance and escape mechanisms in cancer. <p><i>Cognitive levels: R, U, Ap, An, C</i></p>
PS04	<p>Research Aptitude and Interdisciplinary Approach</p> <ul style="list-style-type: none"> ● Employ standard methods in conducting research and develop skills for presenting it. ● Compare and contrast the various designs of experiments and realize their importance in research ● Apply the principles of research design ● Employ research methods and tools for analysis and interpretation of data ● Employ computational tools in overcoming challenges related to applications of biochemistry ● Recognize and express the importance of biological databases and Retrieve biological data from them <p><i>Cognitive levels: Ap, An, E, C</i></p>

Evaluation: Student's understanding of biochemistry will be evaluated through combination of examinations, quizzes, Problem solving ability, laboratory reports, & class participation. These assessments are designed to gauge learner's comprehension of both theoretical concepts and practical applications

Overall Credit Structure for MSc. II

Semester	Core I	Core II	DSE	Research Project	Credit/Semester	Degree/ Cumulative credit
III	6C	6C	4C	6C	22C	Post Graduate Degree 44C
IV	6C	6C	4C	6C	22C	
Total (III + IV)	12C	12C	8C	12C	44C	

DSE: **Discipline** Specific Elective

Credit Structure of courses offered by Biochemistry Department for MSc II Biochemistry

Name of the program: MSc. Biochemistry			Name of the Department: Biochemistry			
Class	Semester	Course Code	Course Title	Credits	L/week	Marks
MSc	III	SIPBCCC611	Molecular Biology	04	04	100
		SIPBCCCP611	Molecular Biology Practical	02	04	50
		SIPBCCC612	Biophysical Techniques	04	04	100
		SIPBCCCP612	Biophysical Techniques Practical	02	04	50
		SIPBCEL611	Clinical Nutrition	03	03	75
		SIPBCELP611	Clinical Nutrition Practical	01	02	25
		SIPBCRP611	Research Project	06	12	150
MSc	IV	SIPBCCC621	Immunology	04	04	100
		SIPBCCCP621	Immunology Practical	02	04	50
		SIPBCCC622	Pharmaceutical Biochemistry	04	04	100
		SIPBCCCP622	Pharmaceutical Biochemistry Practical	02	04	50
		SIPBCEL621	Biotechnology	03	03	75
		SIPBCELP621	Biotechnology Practical	01	02	25
		SIPBCRP621	Research Project	06	12	150

SI: SIES

U: Undergraduate

BC: Biochemistry

CC: Core Course

EL: Elective

RP: Research Project

Summary of Syllabus for Semester III

Course Code	Unit	Topic Headings	Credits	L/Week
SIPBCCC611: Molecular Biology	I	DNA Replication; DNA damage & Repair	4	4
	II	Transcription		
	III	Translation and protein sorting		
	IV	Regulation of gene expression		
SIPBCCCP611		Molecular Biology Practical	2	4
SIPBCCCP612: Biophysical Techniques	I	Colligative properties; Radioisotope techniques; Spectroscopy I	4	4
	II	Spectroscopy II		
	III	Chromatography		
	IV	Electrophoresis		
SIPBCCCP612		Biophysical Techniques Practical	2	4
SIPBCEL611: Clinical Nutrition	I	Introduction to nutrition and assessment	3	3
	II	Nutritional diseases & disorders		
	III	Diet in health & diseases; Nutraceuticals		
SIPBCELP611		Clinical Nutrition Practical	1	2
SIPBCRP611		Research Project	6	12

Summary of Syllabus for Semester IV

Course Code	Unit	Topic Headings	Credits	L/Week
SIPBCCC621: Immunology	I	Overview of the immune system; Cytokines	4	4
	II	MHC; Antigen processing & presentation; Complement system		
	III	Immunological Tolerance; Hypersensitivity; Autoimmunity		
	IV	Immune response to infections; Immunodeficiency; Transplantation immunology; Immune response to cancer		
SIPBCCCP621		Immunology Practical	2	4
SIPBCCCP622: Pharmaceutical Biochemistry	I	General Pharmacology	4	4
	II	Mechanism of action of therapeutic drugs- I		
	III	Mechanism of action of therapeutic drugs- II		
	IV	Natural products & drug discovery		
SIPBCCCP622		Pharmaceutical Biochemistry Practical	2	4
SIPBCEL621: Biotechnology	I	Recombinant DNA technology- I	3	3
	II	Recombinant DNA Technology- II		
	III	Scope of biotechnology		
SIPBCELP621		Biotechnology Practical	1	2
SIPBCRP621		Research Project	6	12

Semester III
Syllabus – Core Course-I Theory

Course Title: Molecular Biology
Credits: 04

Course code: SIPBCCC611
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Discuss the mechanism of replication, transcription and translation in eukaryotes.

CO2: Compare & contrast the central dogma as observed in prokaryotes & eukaryotes.

CO3: Explain the regulation of gene expression

CO4: Articulate epigenetics & its implications in disease.

CO5: Describe the different DNA repair mechanisms.

Units	Topics	
Unit 1	<p>DNA Replication; DNA damage and repair</p> <p>1.1 DNA Replication <i>Prerequisites: Modes of replication; Meselson and Stahl's experiment</i> <i>Semiconservative replication: replication of prokaryotic DNA (Guided self study)</i></p> <p>1.1.1 Mechanism of eukaryotic DNA replication: Eukaryotic DNA polymerases; types and their functions, fidelity of replication,</p> <p>1.1.2 Rolling circle replication</p> <p>1.1.3 Inhibitors of DNA replication</p> <p>1.2 DNA Repair mechanisms <i>Prerequisite: Types of mutations; Physical, chemical and Biological agents causing mutation, Mutational hot spot, reverse mutations, Mutagenesis (guided self-study)</i></p> <p>1.2.1 Photoreactivation, nucleotide excision, SOS repair, recombinational repair, mismatch repair.</p>	15L
Unit 2	<p>Transcription</p> <p><i>Prerequisites: Prokaryotic transcription process (Guided self study)</i></p> <p>2.1 DNA dependent RNA polymerases in prokaryotes and eukaryotes, in vitro assay, properties of enzymes, subunit structure.</p> <p>2.2 Mechanism of transcription: template directed synthesis, sigma cycle, promoter recognition. Properties of promoter in prokaryotes and eukaryotes</p> <p>2.3 Post- transcriptional processing; maturation of rRNA & tRNA, RNA splicing mechanism, poly A tail and 5 capping, noncoding sequences</p> <p>2.4 Inhibitors of transcription</p>	15L
Unit 3	<p>Translation and Protein sorting</p> <p><i>Prerequisites: Overview of prokaryotic translation (Guided self-study)</i></p> <p>3.1 Mechanism of translation: activation, initiation (importance of Shine-Dalgarno sequence), elongation and termination, nonsense</p>	15L

	<p>codons, role of RF1 and RF2 and GTP; Eukaryotic protein synthesis.</p> <p>3.2 Post translational processing and modification, signal hypothesis, zymogen activation.</p> <p>3.3 Specific Inhibition of protein biosynthesis.</p>	
Unit 4	<p>Regulation of gene expression</p> <p><i>Prerequisites: Organization of gene: structural & regulatory elements; split genes (Guided self-study)</i></p> <p>4.1 Prokaryotic gene regulation; positive and negative control, induction and repression, attenuation. Example: lac, trp, his operons</p> <p>4.2 Eukaryotic gene regulation: Role of upstream, downstream and enhancer, elements, cis-trans acting elements in gene expression, examples and experimental evidences.</p> <p>4.3 Epigenetics: Chromatin remodeling; Histone modifications; histone variants; Silencing mechanisms; RNA-based silencing; DNA methylation/imprinting; Epigenetic regulation of transcription.</p> <p>4.4 Medical genetics: Genetic screening, Genetic diagnosis, Genetic counselling</p>	15L

Semester III
Syllabus – Core Course- I - Practical

Course Title: Molecular Biology Practical
Credits: 02

Course code: SIPBCCCP611
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Employ various techniques for isolation of genetic material from plant & microbial sources.

CO2: Apply electrophoretic methods for quantification of isolated genetic material.

CO3: Analyse & interpret electrophoretic results.

CO4: Compare & contrast lab-based and kit-based isolation of genetic material.

CO5: Discuss bacterial transformation & conjugation.

Sr. No.	Title
1.	Isolation of DNA (crude) from germinating moong seeds/ onion tissue/ bacteria and its detection
2.	T _m of DNA
3.	Isolation of RNA (crude) from Baker's yeast and its detection by AGE
4.	AGE of isolated DNA
5.	Staining of cellular DNA and RNA
6.	Study of mutation in bacteria by UV
	Demonstration experiments
7.	Isolation of Plasmid (kit-based)
8.	Study of Bacterial conjugation
9.	Study of Bacterial transformation
10.	Cell free protein synthesis

REFERENCES FOR CORE COURSE I - SEMESTER III

1. Clark, D. P., & Pazdernik, N. J. (2013). Molecular biology. Elsevier.
2. Elliott, W. H., Elliott, D. C., & Jefferson, J. R. (2005). Biochemistry and molecular biology. Oxford: Oxford University Press
3. Lewin, B., & Genes, I. X. (2008). Jones and Bartlett Publishers. Inc., Sudbury.
4. Lin, E. C., & Lynch, A. S. (2012). Regulation of gene expression in Escherichia coli. Springer Science & Business Media.
5. White, R. J. (2009). Gene transcription: mechanisms and control. John Wiley & Sons.
6. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan
7. Introductory Practical Biochemistry, SK Sawhney and Randhir Singh
8. Biochemical Methods Edition 3 by Sadasivam and Manickam.
9. An Introduction to Practical Biochemistry, 3rd edition- David T. Plummer.

Semester III
Syllabus – Core Course-II Theory

Course Title: Biophysical Techniques
Credits: 04

Course code: SIPBCCC612
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Recall the concepts of osmosis, surface tension, viscosity and recognize their application in the study of biochemistry.

CO2: Discuss and explain the role of radioisotopes and techniques used for their measurement.

CO3: Describe the various spectroscopic techniques and appreciate their application in biochemical study and research.

CO4: Explain the principle, working, application and significance of these bioanalytical techniques.

CO5: Apply techniques like chromatography & centrifugation for separation of different biomolecules.

Units	Topics	
Unit 1	Colligative properties; Radioisotope Techniques; Spectroscopy-I 1.1 Colligative properties Definitions; factors affecting, measurement and physiological applications of osmosis, osmotic pressure, adsorption, colloids, surface tension and viscosity. (Guided self-study) 1.2 Radioisotope techniques 1.2.1 Nature of radioactivity & its detection and measurements of radioactivity, radioactive decay, interaction of radioactivity with matter, GM Counter, Scintillation counter 1.2.2 Isotope dilution, analysis, autoradiography, application of radioisotopes in biological sciences. 1.3 Spectroscopy-I Principle, instrumentation, working and applications of UV/Visible Spectroscopy, Turbidimetry, Nephelometry, IR Spectroscopy, Flame photometry, Atomic absorption spectroscopy.	15L
Unit 2	Spectroscopy - II 2.1 Principle, instrumentation, working and applications of fluorescence spectroscopy; fluorescence spectra and the study of protein structure. 2.2 Principle and applications of: Nuclear Magnetic Resonance (NMR); Electron Spin Resonance (ESR); Mass Spectrometry; Matrix Assisted Laser Desorption; Ionization- Time of Flight-Mass Spectrometry (MALDI- TOF); Inductively Coupled Plasma Mass Spectrometer (ICP- MS) 2.3 Principle and applications of X- ray Diffraction Spectra, Optical Rotatory Dispersion (ORD), Circular Dichroism.	15L
Unit 3	Chromatography	15L

	<p><i>Prerequisite: Basic principles; instrumentation, working and applications of partition chromatography (paper), adsorption chromatography (TLC, Column) (Guided self-study)</i></p> <p>3.1 Principle and applications of ion exchange, gel permeation chromatography, and Affinity chromatography</p> <p>3.2 Basic principles, instrumentation, working and applications of HPLC, HPTLC, gas-liquid chromatography, High Resolution Liquid Chromatography Mass Spectrometry (HR LC- MS)</p>	
Unit 4	<p>Electrophoresis</p> <p>4.1 Basic principle, factors affecting electrophoresis, support media used.</p> <p>4.2 Instrumentation, working and applications of electrophoretic techniques-zone, Disc, Capillary, 2-D, Pulsed Field Gel, Diagonal, Isoelectric Focussing, immuno-electrophoresis.</p>	15L

Semester III
Syllabus – Core Course- II - Practical

Course Title: Biophysical Techniques Practical
Credits: 02

Course code: SIPBCCCP612
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Apply biophysical techniques for extraction, separation and characterisation of biomolecules.

CO2: Compare and choose the best separation technique based on the molecule of interest.

CO3: Interpret chromatogram and electrophoretic results.

CO4: Discuss various chromatographic techniques with respect to their principle, working and applications

Sr. No.	Title
1.	Extraction of plant pigments from spinach leaves and their separation by column chromatography.
2.	Ascending and circular paper chromatography of amino acids
3.	Ascending and circular paper chromatography of sugars
4.	Circular paper chromatography of organic acids
5.	Thin layer chromatography of oils
6.	2D TLC/ paper chromatography of amino acids
7.	Separation using density gradient centrifugation
8.	Separation of serum proteins by electrophoresis (PAGE/ AGE)
9.	Separation of proteins by PAGE (seed extract/ bacterial cell extract)
10.	Separation of glucose and starch/ separation of starch and casein by gel filtration (demonstration)

REFERENCES FOR CORE COURSE II - SEMESTER III

1. Upadhyay and Upadhyay Nath. Biophysical Chemistry. Himalayan Publications.
2. Freifelder, D. M. (1982). Physical Biochemistry: Application to Biochemistry and Molecular Biology (Life Sciences/Biochemistry).
3. Segel, I. H., & Segel, A. H. (1976). Biochemical calculations: how to solve mathematical problems in general biochemistry (No. 04; QD415. 3, S4 1976.). New York: Wiley.
4. Sheehan, D. (2013). Physical biochemistry: principles and applications. John Wiley & Sons.
5. Van Holde, K. E., Johnson, W. C., & Ho, P. S. (2006). Principles of physical biochemistry.S
6. Wilson, K., & Walker, J. (Eds.). (2010). Principles and techniques of biochemistry and molecular biology. Cambridge university press.

Semester IV
Syllabus – Core Course-I Theory

Course Title: Immunology
Credits: 04

Course code: SIPBCCC621
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Discuss the effectors of adaptive and cell-mediated immune system

CO2: Describe the biochemical mechanisms involved in immune responses and immune-mediated diseases.

CO3: Summarize the inflammatory responses, hypersensitivity reactions and immunological tolerance observed in humans.

CO4: Compare the impact on the human body of different hypersensitivity reactions.

CO5: Express the importance of immunosuppression during transplantation.

CO6: Explain the immunological surveillance and escape mechanisms in cancer.

Units	Topics	
Unit 1	<p>Overview of the immune system; Cytokines (Prerequisite: Types of immunity, effectors of innate and adaptive response; Cells and organs of immune system; Haematopoiesis, cells of the immune system; Primary and secondary lymphoid organs.)</p> <p>1.1 B cell maturation, activation & differentiation</p> <p>1.2 T cell subsets and their function: T cell receptor, structure, organization and rearrangement of TCR genes. T cell receptor complex- TCR-CD3. T cell accessory membrane molecule. Ternary TCR-Peptide-MHC Complex. T cell- Maturation, activation & differentiation.</p> <p>1.3 Cytokines: General structure & function of cytokines; Cytokine receptor, cytokine antagonists; Cytokine secretion by TH1 and TH2 subsets; Therapeutic uses of cytokines;</p>	15L
Unit 2	<p>MHC, Antigen presentation and processing; Complement system</p> <p>2.1 Major Histocompatibility Complex</p> <p>2.1.1 General organization and inheritance of MHC; Structure of Class I and Class II HLA molecules. Cellular distribution of MHC molecules.</p> <p>2.1.2 Regulation of MHC expression</p> <p>2.2 Antigen processing & presentation</p> <p>2.2.1 Self MHC restriction of T cell, role of antigen presenting cells</p> <p>2.2.2 Pathways for antigen processing, cytosolic and endocytic pathway, clinical application</p> <p>2.3 Complement system</p> <p>2.3.1 Components and function; Complement activation, classical and alternative pathways of membrane attack complex</p> <p>2.3.2 Complement receptor and biological consequences of Complement activation, cell lysis, inflammatory response, opsonization of antigen, viral neutralization, solubilisation of immune complexes.</p>	15L
Unit 3	Immunological tolerance; hypersensitivity; autoimmunity	15L

	<p>3.1 Immunological tolerance</p> <p>3.1.1 Pathways to B and T cell tolerance; Mechanism of tolerance induction</p> <p>3.2 Hypersensitivity: Gell and Coomb's classification of hypersensitivity</p> <p>3.3 Autoimmunity</p> <p>3.3.1 Organ specific autoimmune disorders (Hashimoto's thyroiditis and insulin dependent diabetes mellitus, SLE, Myasthenia gravis, Rheumatoid arthritis, Grave's disease, Multiple sclerosis)</p> <p>3.3.2 Role of CD4, T cell, MHC and TCR in autoimmunity</p> <p>3.3.3 Proposed mechanism for induction of autoimmunity</p> <p>3.4 Immunodeficiency: Classification of immunodeficiencies</p> <p>3.4.1 Immunology of HIV/ AIDS: Discovery, causes, structure, process of infection, destruction of CD4 T cells, clinical diagnosis</p>	
Unit 4	<p>Immune response to infections; Transplantation immunology</p> <p>4.1 Immune response to infections</p> <p>4.1.1 Viral, bacterial, fungal and protozoal diseases, Helminthes (parasitic worms) infections- effector mechanism</p> <p>4.2 Transplantation Immunology</p> <p>4.2.1 Types of graft, immunological basis of graft rejection- 1st set, 2nd set rejection- role of T lymphocytes</p> <p>4.2.2 Tissue typing and laboratory investigations- micro cytotoxicity test, mixed lymphocyte reaction (HLA typing)</p> <p>4.2.3 General and specific immunosuppressive therapy</p> <p>4.3 Immune Response to Cancer</p> <p>4.3.1 Tumor antigens, immune response to tumor antigens.</p> <p>4.3.2 Immunosurveillance, Immunological escape mechanism</p> <p>4.3.3 Immunotherapy of tumors</p>	15L

Semester IV
Syllabus – Core Course- I - Practical

Course Title: Immunology Practical
Credits: 02

Course code: SIPBCCCP621
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Perform haematology tests for estimating various parameters of the blood and interpret the result

CO2: Discuss the various techniques employed in the study of immunology and diagnosis of diseases.

CO3: Recognize the applications of techniques used in immunology and interpret the results

Sr. No.	Title
1.	Blood Grouping
2.	CBC: RBC count, WBC count, differential WBC count, Hb by Sahli's method and Drabkin's method, PCV, RCI
3.	Serological tests- Rheumatoid Arthritis factor, C- reactive protein, Widal, VDRL, Pregnancy test
	Demonstration
4.	ELISA
5.	RIA
6.	Hybridoma Technology
7.	Immunofluorescence
8.	Biotin-Avidin Ab Technique
9.	Blotting Techniques (Southern, Northern & Western)
10.	Erythrocyte sedimentation rate
11.	Reticulocyte count
12.	Inflammatory markers: CRP, ferritin; Tumor markers
13.	Experimental animal models: SCID Mice, SCID Human Mice
14.	Cell culture system: Primary lymphoid cell culture, clone lymphoid cell line, hybrid lymphoid cell line.

REFERENCES FOR CORE COURSE I - SEMESTER IV

1. Kuby Immunology- 5th edition.
2. Chapel, H., Haeney, M., Misbah, S., & Snowden, N. (2013). Essentials of clinical immunology. John Wiley & Sons.
3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). Essential immunology. John Wiley & Sons.
4. Khan, F. H. (2009). The elements of immunology. Pearson Education India
5. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Kuby immunology. Macmillan
6. Textbook of Medical Biochemistry: Eighth Edition, M.N Chatterjea and Rana Shinde Jaypee Publication
7. Introductory Practical Biochemistry, SK Sawhney and Randhir Singh
8. Biochemical Methods Edition 3 by Sadasivam and Manickam.
9. An Introduction to Practical Biochemistry, 3rd edition- David T. Plummer.
10. Practical Biochemistry by Geetha Damodaran, Jaypee Brothers Medical Publishers

Semester III
Syllabus – Core Course-II Theory

Course Title: Pharmaceutical Biochemistry
Credits: 04

Course code: SIPBCCC622
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Discuss the basic concepts of drug absorption, distribution, metabolism and excretion.

CO2: Explain the chemistry of drugs with respect to their pharmacological activity, metabolic pathway, adverse effects and therapeutic value.

CO3: Compare the efficacy of natural products isolated from different sources as potential drugs.

CO4: Summarize the steps involved in drug discovery.

Units	Topics	
Unit 1	General Pharmacology 1.1 Sources of drugs 1.2 Methods for measuring drug effects 1.2.1 Bioassay: General principles 1.2.2 Clinical Trials: Phases I to IV 1.3 Measurement of Toxicity - LD50, ED50, Therapeutic index, number-needed-to-treat (NNT) principle 1.4 Pharmacokinetics - Parameters, rate constants for absorption and elimination, half-life, volume of distribution, clearance, steady state plasma drug concentration & factors affecting it. 1.5 Pharmacodynamics-1 1.5.1 Drug absorption: routes of administration 1.5.2 Bioavailability and bioequivalence 1.5.3 Drug distribution: Translocation of drugs, bulk flow & diffusional transfer, binding to plasma protein	15L
Unit 2	Mechanism of action of therapeutic drugs- I 2.1 Pharmacodynamics -2 2.1.1 Drug metabolism: Phase I & Phase II 2.1.2 Drug elimination: Renal & Biliary 2.2 General mechanism- Molecular basis of drug action & pharmacological selectivity; Drug receptor theory, stimulus response, classification of receptors. 2.3 Mechanism of action of therapeutic drugs- I 2.3.1 Anti-inflammatory drugs: NSAID (Ibuprofen), salicylates (Aspirin) 2.3.2 CVS drugs: Cardiac glycosides, calcium channel blocker-amlodipine & β - blocker- Propranolol 2.3.3 Antacids: Proton pump blocker (Omeprazole), H2 receptor antagonists (Ranitidine), antacids (Mg hydroxide, Mg trisilicate, aluminium hydroxide), cytoprotective (Bismuth chelate, sucralfate)	15L

	<p>2.3.4 Lipid lowering drugs: Statins, Bile acid sequesterants, Nicotinic acid</p> <p>2.3.5 Anticoagulants: Heparin, warfarin, glycosaminoglycans</p>	
Unit 3	<p>Mechanism of action of therapeutic drugs- II</p> <p>3.1 Antidiabetics (Biguanides and sulfonylureas; insulin)</p> <p>3.2 Antipsychotic drugs: tricyclic antidepressants; Monoamine oxidase inhibitors</p> <p>3.3 Analgesics: morphine, codeine</p> <p>3.4 Antibacterial: Sulphonamides, penicillin, drugs inhibiting topoisomerase II and drugs affecting protein synthesis (tetracycline, streptomycin) Ciprofloxacin, Antituberculosis-Isoniazid, Rifampicin</p> <p>3.5 Antiviral: DNA polymerase inhibitors (Aciclovir), reverse transcriptase inhibitor (Zalcitabine/ddc), protease inhibitors.</p> <p>3.6 Cancer chemotherapy: Cytotoxic drugs (Alkylating agents, antimetabolites, cytotoxic antibiotics, plant derivatives), hormones (glucocorticoids, estrogens, androgens as hormone antagonist) and miscellaneous agents.</p> <p>3.7 Adverse drug reactions</p>	15L
Unit 4	<p>Natural Products and Drug Discovery</p> <p>4.1 Phytochemicals</p> <p>4.1.1 Chemistry of natural products: Polyphenols (flavonols, tannins) glycosides, alkaloids, saponins, terpenes, volatile oils.</p> <p>4.1.2 Schematic of biosynthesis of natural products</p> <p>4.1.3 Advantages of natural product as drug; pharmacologically important primary & secondary metabolites from living cells (plant, bacteria, fungi and marine sources)</p> <p>4.2 New Drug Development</p> <p>4.2.1 Steps in new drug development: Target identification and validation, lead identification (random screening and rational drug design approach) and optimization; Clinical trials</p> <p>4.2.2 Role of regulatory authority -FDA, Investigational new drug and New drug application.</p>	15L

Semester IV
Syllabus – Core Course- II - Practical

Course Title: Pharmaceutical Biochemistry Practical
Credits: 02

Course code: SIPBCCCP622
Hours/week: 04

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Understand the principles of various organ functions and co-relate it with metabolic disorders

CO2: Estimate various biomolecules in normal and diseased state

CO3: Analyze the electrolyte composition and compare the derangement in different metabolic disorders

CO4: Apply in silico molecular docking tool in drug binding and other related study

Sr. No.	Title
1.	Preparation of aspirin
2.	Estimation of aspirin
3.	Isolation of phytoconstituents like alkaloids, flavonoids from suitable source.
4.	Determination of LD50 of a cytotoxic drug- zebra fish
5.	Protective effect of antioxidants (vitamin C/ natural extract/ phytoconstituents) against drug induced cytotoxicity using chick embryo/ zebra fish embryo.
6.	Use of molecular docking tools for drug binding studies

REFERENCES FOR CORE COURSE II - SEMESTER IV

1. Barar, F. S. K. (2000). Essentials of pharmaco-therapeutics. S. Chand Publishing.
2. Foye, W. O. (2008). Foye's principles of medicinal chemistry. Lippincott Williams & Wilkins.
3. Golan, D. E., Tashjian, A. H., & Armstrong, E. J. (Eds.). (2011). Principles of pharmacology: the pathophysiologic basis of drug therapy. Lippincott Williams & Wilkins.
4. Goodman, L. S. (1996). Goodman and Gilman's the pharmacological basis of therapeutics (Vol. 1549). New York: McGraw-Hill.
5. Katzung, B. G., Masters, S. B., & Trevor, A. J. (2012). Basic and Clinical Pharmacology (LANGE Basic Science). McGraw-Hill Education.
6. Rang, H. P., Ritter, J. M., Flower, R. J., & Henderson, G. (2014). Rang & Dale's Pharmacology E-Book: with STUDENT CONSULT Online Access. Elsevier Health Sciences.
7. Satoskar, R. S., Rege, N., & Bhandarkar, S. D. (2015). Pharmacology and Pharmacotherapeutics-E-Book. Elsevier Health Science

General Scheme of Examination

Credits	Course Type	Distribution of Credits	Sem end	Internal	Practical	Total
6	Core with Practical	With Practical 4T+2P	60	40	50	150
6	Core with Practical	With Practical 4T+2P	60	40	50	150
4	DSE	3T+1P	50	25	25	100
6	RP	6 C /6 P	150		150	150

Semester end, Internal and Practical as in the above Table, will be separate heads of passing.

1. Details for Internal Assessment:

Weightage for Internal (marks)	Min. marks required for passing	Pattern of Evaluation
40 (Core)	16	20 marks- class test (No retest) + 20 marks- Assignment/ Project/ Viva
20 (Core)	8	10 marks- class test (No retest) + 10 marks- Assignment/ Project/ Viva
25 (DSE)	10	15 marks- class test (No retest) + 10 marks- Assignment/ Project/ Viva

Internal evaluation: Quizzes, Presentations, Surveys, Internship, Tutorials, Role Play

2. Details for Semester End Examination:

- For semester end exam, two types of Patterns are given.
- Students should be informed by the department concerned about the pattern.

Sem End	Min. Re.	Duration	Pattern	
			Type I	Type II
60	24	2.5 hrs.	<ul style="list-style-type: none"> • 4 units: 4 questions of 15 marks each on each unit. • 3 units: 3 questions of 15 marks on each unit and one question of mixed type for 15 marks. 	4 questions for 10 marks each and 5th question is 4 Short Notes for 5 marks each.

50	20	2 hrs.	<ul style="list-style-type: none"> • 4 units: 4 questions of 12, 13, 12, 13 marks on 4 units. • units: 3 questions on 3 units of 12 marks each and 4th question of mixed type for 14 marks. • 2 units: 2 questions of 20 marks each on each unit and one question of mixed type for 10 marks. 	4 questions for 10 marks each and 5 th question is 2 Short notes for 5 marks each.
30	12	1 hr.	<ul style="list-style-type: none"> • 3 units: 3 questions of 10 marks each on each unit. • 2 units: 2 questions of 15 marks each on each unit / 2 questions of 10 marks each on each unit and one question of mixed type for 10 marks. 	2 questions for 10 marks each and 3 rd question is 2 Short Notes for 5 marks.
