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

Discipline Specific Elective

(SIPBCEL611, SIPBCELP611, SIPBCEL621, SIPBCELP621)

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)
PO1 *(Skill level)*	**Academic competence and problem-solving ability** ● 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. *Cognitive levels*: *R, U, Ap*
PO2 *(Skill level)*	**Critical Thinking and Analytical skills** ● 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 *Cognitive levels: U, An, Ap*
PO3 *(Skill level)*	**Research Aptitude** ● 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. *Cognitive levels: A, An, E, C*
PO4 *(Skill level)*	**Effective Communication Skills** ● 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. *Cognitive levels: Ap, C*

PO5 *(Skill level)*	**Proficiency with Information and Communication Technology** • 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. *Cognitive levels: Ap, An, E*
PO6 *(Skill level)*	**Personal and behavioral competence** • 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 **Cognitive levels: U, Ap, An, C,**
PO7 *(Skill level)*	**Reasoning ability and Rational thinking:** • Developing rational thinking on the basis of acquired contextual knowledge, ethnic and environmental issues, and performing with decisive responsibility. **Cognitive Levels: U, Ap, An, E**

Serial Number	Details of Programme Specific Outcomes (PSOs)
PSO1	**Academic Competence and problem-solving ability** • 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. **Cognitive levels: R, U, An**
PSO2	**Critical thinking and analytical skills** • 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. *Cognitive levels: U, An, E*

PSO3	**Experiential learning and Laboratory Skills** ● 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. *Cognitive levels: R, U, Ap, An, C*
PSO4	**Research Aptitude and Interdisciplinary Approach** ● 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 *Cognitive levels: Ap, An, E, C*

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 – DS-Elective Theory

Course Title: Clinical Nutrition	**Course code: SIPBCEL611**
Credits: 03	**Hours/week: 03**

Expected Course Outcomes

On completion of this course, learner should be able to
CO1: Explain the different methods of energy assessment
CO2: Summarize and apply anthropometric methods of nutrition assessment.
CO3: Recall the role played by various food safety organizations.
CO4: Understand the importance of nutrition in the treatment of various diseases and disorders.
CO5: Choose and make sound decisions with regards to diet during various disease states.
CO6: Explain the role of nutraceuticals in various disease states.

Units	Topics	
Unit 1	**Introduction to nutrition and assessment** 1.1 Concepts in nutrition 1.1.1 Macronutrients and their calorific value. RDA for carbohydrates, proteins and lipids; Concept of Glycemic Index; artificial sweeteners; semisynthetic and synthetic lipids 1.1.2 Essential and nonessential amino acids, Nitrogen Balance. Protein quality and methods of determination (BV, PER, NPU), Complementary proteins 1.1.3 Macronutrient metabolism in the fed state. 1.1.4 Anti-nutritional Factors: Trypsin Inhibitors, pressor amines, phytates, oxalates. 1.1.5 Probiotics and Prebiotics, Role of gut microflora in health, Role of dietary fibres 1.2 Energy assessment 1.2.1 Energy requirements, Components of energy expenditure: basal and resting energy expenditure (REE), Factors affecting REE; thermic effect of food. 1.2.2 Measurement of energy expenditure- Direct and indirect calorimetry, Doubly labelled water technique.	**15L**
Unit 2	**Nutritional diseases & disorders** 2.1 Regulators of gastrointestinal activity- enteric nervous system and neuropeptide hormones 2.2 Primary nutritional diseases Protein energy malnutrition; Eating Disorders: Anorexia nervosa, Bulimia nervosa, Obesity, Vitamin deficiency disorders; Biochemical basis, etiology and diagnosis of nutritional anemias. 2.3 Conditioned Nutritional disorders Disorders of GI tract: Celiac disease, Lactose intolerance, IBS, alcoholic liver disease. 2.3 Nutrient- gene interaction 2.4 Drug-nutrient interaction	**15L**

Unit 3	**Diet in health and diseases; Nutraceuticals** 3.1 Diet in health and diseased states 3.1.1 Nutrition during pregnancy, lactation, infancy, childhood, adolescence, adulthood, ageing 3.1.2 Nutrition for health & weight management 3.1.3 Nutrition for exercise and sport performance 3.1.4 Nutrition for bone health 3.1.5 Nutrition for therapeutic conditions: Hypertension, CVD, GI disorders, (peptic ulcer. H. pylori), Diabetes mellitus, anemia, Renal disorders, CRF, ARF, Jaundice 3.2 Nutraceuticals 3.2.1 Functional food, nutraceuticals, dietary supplements 3.2.2 Dietary supplements in management of chronic diseases; study of following herbs: Alfalfa, ginger, fenugreek, garlic, honey, amla, ginseng, ashwagandha, spirulina. 3.2.3 Vitamin-like factors: Choline, Betaine, myo- inositol, ubiquinone, bioflavonoids 3.2.4 Bioactive proteins and peptides as functional foods. 3.2.5 Food Safety: Role of National and International Agencies: : WHO, FAO, UNICEF, ICAR, NIN, ICMR, Food Nutrition Board, CFTRI, NSI, IDA, ICDS	**15L**

Semester III
Syllabus – DS-Elective - Practical

Course Title: Clinical Nutrition Practical	**Course code: SIPBCELP611**
Credits: 01	**Hours/week: 02**

Expected Course Outcomes

On completion of this course, learner should be able to
CO1: Compute the energy requirement and energy expenditure of an individual.
CO2: Characterize a probiotic organism by staining and biochemical tests.
CO3: Analyse the nutrient profile (moisture content, ash content, antioxidant property) of food.

Sr. No.	Title
1.	Problems on measurement of food energy
2.	Estimation of energy requirement and energy expenditure: Mifflin-St. Jeor equation, from energy intake. Prediction equations at four levels of physical activity (sedentary, low active, active and very active)
3.	Problems on BMI, Hip: waist ratio
4.	Characterization of a probiotic preparation (Gram staining, Colony characteristics and Biochemical tests)
5.	Estimation of serum iron/serum ferritin
6.	Nutritional profile of food (Processed/ Unprocessed/Natural) i) Moisture content ii) Carbohydrate content, gluten content iii) Protein content iv) Preparation of ash and determination of mineral content (Ca, P, Mg, Fe) v) Antioxidant activity of bioflavonoids (from citrus or any other source/quercetin) by FRAP assay

REFERENCES FOR DS-ELECTIVE- SEMESTER III

1. Carson, P. A., & Dent, N. J. (Eds.). (2007). Good clinical, laboratory and manufacturing practices: techniques for the QA professional. Royal Society of Chemistry
2. Hallberg, L., Sandström, B., Aggett, P. J., Garrow, J. S., & James, W. P. T. (1993). Human nutrition and dietetics.
3. Kathleen, M. L., Mahan, L. K., & Escott-Stump, S. (2004). Krause's food, nutrition, and diet therapy.
4. Murray, R., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2003). Harper's illustrated biochemistry (LANGE basic science).

Semester IV
Syllabus – DS-Elective Theory

Course Title: Clinical Nutrition	**Course code: SIPBCEL621**
Credits: 03	**Hours/week: 03**

Expected Course Outcomes

On completion of this course, learner should be able to
CO1: Explain the steps in gene cloning
CO2: Discuss and compare the various types of cloning vectors and methods to introduce DNA in host cells
CO3: Describe, compare and analyze various blotting techniques
CO4: Discuss the principles and recognize the applications of tools and techniques used in nucleic acid analysis
CO5: Recognize and describe the applications of biotechnology in medicine, agriculture and industry
CO6: Explain the principle and appreciate the applications of techniques like RFLP, and RAPD, Crispr Cas and gene editing
CO7: Discuss the production of biopolymers and their applications in Biosensors, membrane- bound diagnostic systems, tissue engineering

Units	Topics	
Unit 1	**Recombinant DNA Technology-I** 1.1 Gene cloning 1.1.1 General steps in gene cloning; 1.1.2 Enzymes that degrade DNA & RNA: DNAases, RNAases, Modification and restriction of DNA; DNA methylases, restriction endonucleases – properties and mode of action 1.1.3 Prokaryotic cloning vectors and expression vectors- pUC 19, Bacteriophage derived vector : M13 vector, lambda vector, Phagemid vector 1.1.4 Introducing DNA into cells (transformation, microinjection, electroporation) 1.1.5 Selection of recombinant clones, colony hybridization, Southern & Northern hybridization, use of probes, Reporter gene assay (GUS assay, luciferase, GFP assay)	**15L**
Unit 2	**Recombinant DNA Technology-II** 2.1 Eukaryotic cloning vectors 2.1.1 Yeast vectors- Yeast episomal plasmids (YEp), Yeast replicative plasmids (YRp), Yeast integrative plasmids (YIp) 2.1.2 Cloning in plant cells, suitable vectors –caulimoviruses, Ti plasmids 2.1.3 Cloning in mammalian cells, viral vectors, shuttle vectors 2.2 Gene Library 2.2.1 cDNA synthesis, chemical synthesis of genes, shotgun experiments, gene bank, gene library 2.3 Tools and Techniques in nucleic acid analysis 2.3.1 Restriction mapping, DNA sequencing methods: , RNA sequencing technique, Oligonucleotide synthesis , Allele specific oligonucleotide (ASO)	**15L**

Unit 3	**Scope of Biotechnology** 3.1 Applications of rDNA technology 3.1.1 Medical and Biological applications of recombinant DNA technology (RDT), Diagnostic probes for genetic and other diseases, Anti-sense technology and therapeutics. 3.1.2 Agricultural, industrial and commercial applications of RDT 3.1.3 RFLP, SNPS, RAPD 3.1.4 Crispr Cas and gene editing 3.2 Production and uses of Biopolymers: 3.2.1 Introduction to biopolymers 3.2.2 Production of biopolymers like Dextran, chitosan, Polyhydroxyalkanoates 3.2.3 Application of biopolymers: Biosensors, membrane-bound diagnostic systems, tissue engineering	**15L**

Semester IV
Syllabus – DS-Elective - Practical

Course Title: Clinical Nutrition Practical	**Course code: SIPBCELP621**
Credits: 01	**Hours/week: 02**

Expected Course Outcomes

On completion of this course, learner should be able to

CO1: Apply the concepts of restriction digestion and DNA fingerprinting to solve case studies/problems
CO2: Design primers and explain the steps for designing primers that are used for molecular biology experiments.
CO3: Demonstrate the steps required to prepare competent cells
CO4: Experimentally induce callus generation by plant tissue culture
CO5: Explain steps and applications of western blot technique

Sr. No.	Title
1.	Problems/Case studies on restriction enzyme digestion, RFLP, DNA fingerprinting
2.	Primer designing
3.	In vitro amplification of DNA: PCR and its types (Virtual laboratory)
4.	Preparation of competent cells of E coli
5.	Preparation of plant tissue culture media and callus induction
6.	Western blot (demonstration)

REFERENCES FOR DS-ELECTIVE- SEMESTER IV

1. Molecular Cloning: Meniates et al
2. Gene cloning and DNA analysis by T.A. Brown
3. Principles of gene manipulation by Old and Primrose.
4. Genetic engineering: Smita Rastogi and Neelam Pathak, Oxford press.

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.	• 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.	• 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 5th question is 2 Short notes for 5 marks each.
30	12	1 hr.	• 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 3rd question is 2 Short Notes for 5 marks.