University of Mumbai

No. AAMS_UGS/ICC/2024-25/106

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments is invited to this office circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the **Ad-hoc Board of Studies in Life Science** at its meeting held on 01st July, 2024 and subsequently passed by the Board of Deans at its meeting held on 10th July, 2024 **vide** item No.6.8 (N) have been accepted by the Academic Council at its meeting held on 12th July, 2024 **vide** item No.6.8 (N) and that in accordance therewith **syllabus** for the **M.Sc (Life Sciences- Biochemistry) (Sem. III & IV)** is introduced as per appendix (NEP 2020) with effect from the academic year 2024-25.

(The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
22nd August, 2024

(Prof.(Dr) Baliram Gaikwad)
I/c Registrar

To

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Department.

A.C/6.8(N)/12/07/2024

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science & Technology,
3) The Chairman, **Ad-hoc Board of Studies in Life Science,**
4) The Director, Board of Examinations and Evaluation,
5) The Director, Board of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari.
8) The Deputy Registrar, Admissions, Enrolment, Eligibility & Migration Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentre@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

1	The Chairman, Board of Deans
2	The Dean, Faculty of Humanities,
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in@gmail.com DSW direcotr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology,
7	The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari, director@idol.mu.ac.in

AC – 12/07/2024
Item No. – 6.8 (N)

As Per NEP 2020

University of Mumbai

Title of the program

M. Sc. (Life Sciences – Biochemistry)

Syllabus for

Semester – Sem.- III & IV
Ref: GR dated 16th May, 2023 for Credit Structure of PG

(With effect from the academic year 2024-25)

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____ B**	**M.Sc. (Life Science-Biochemistry)**
2	**Scheme of Examination** **R: _____**	**NEP** **50% Internal** **50% External,** **Semester End Examination** **Individual Passing in Internal and External Examination**
3	**Standards of Passing** **R: _____**	**40%**
4	**Credit Structure** **R: SP- 45A** **R: SP- 45B**	**Attached herewith**
5	**Semesters**	**Sem. III**
6	**Program Academic Level**	**6.5**
7	**Pattern**	**Semester**
8	**Status**	**New**
9	**To be implemented from Academic Year**	**2024-25**

Indu Anna George
9/7/2024

Sign of BOS Chairperson
Prof. Indu Anna George
Department of Life Sciences
Ad-hoc BOS in Life Sciences

Sign of Offg. Assoc. Dean
Dr. Madhav Rajvade
Offg. Assoc. Dean
Science and Technology
University of Mumbai

Sign of Offg. Dean
Prof. Shivram Garje
Dean Science and Technology
University of Mumbai

PREAMBLE

1. Introduction:

The Department of Life Sciences at the University is delighted to introduce the Master of Science (MSc) Programme, a comprehensive and dynamic two-year full-time course that aims to provide students with a deep understanding of the diverse aspects of life and its related disciplines. Life Sciences encompass a wide range of fields, offering fundamental knowledge about animals, plants, microorganisms, and the abiotic factors that influence their existence.

This specialized program delves into the intricacies of the biotic world, exploring the structures and functions of living organisms from physical, physiological, metabolic, biochemical, ecological, and socio-economic perspectives. Through this curriculum, students will embark on an exciting journey into the world of various techniques and technologies employed in the study of life, enabling them to appreciate the economic and ecological importance of the living and non-living things.

The MSc Programme in Life Sciences comprises interdisciplinary courses that encompass animal and plant sciences, microbiology, biochemistry and biophysics, molecular biology, and applied genetics. These comprehensive modules empower students to strengthen their knowledge in their respective areas of interest and gain insights into the wide-ranging opportunities available in this field. Additionally, the curriculum is designed to cultivate a deep appreciation for nature and natural resources, fostering skills for data observation and analysis in preparation for future research endeavours.

The Programme structure entails core papers of three theory and two practical in each semester, allowing students to gain theoretical knowledge as well as hands-on experience. With the implementation of the Choice Based Grading System, the evaluation process incorporates continuous assessment throughout the year, including both Internal Assessment and Term End Assessment. This comprehensive evaluation methodology ensures a holistic approach to students' progress and encourages active engagement throughout the academic year.

To further enhance the students' readiness for the industry, the curriculum incorporates a mandatory On Job Training (OJT) component in Semester II. This intensive training, equivalent to a full course, provides invaluable exposure to real-world scenarios within Life Sciences or Life Sciences-related organizations. By applying their theoretical knowledge in practical settings, students gain firsthand experience and develop the necessary skills to thrive in the professional world.

In addition to technical skills, this programme also focuses on cultivating research ethics and promoting a research-oriented mindset among learners. The inclusion of a Research Methodology Course helps students develop a strong research attitude, enabling them to contribute meaningfully to the advancement of Life Sciences.

Acknowledging the evolving trends in education and the need for flexible learning modes, the syllabus has been augmented to include an online component. Embracing the advantages offeredby online learning, this component is designed to be optional, allowing both teaching faculties and students to collaboratively determine the topics to be covered in the online format. The authorities will oversee the final implementation of this innovative concept, recognizing its potential to revolutionize education by overcoming barriers of time, space, and infrastructure.

In conclusion, the MSc Programme in Life Sciences equips students with a comprehensive understanding of the multidimensional aspects of life and its associated disciplines. With a curriculum that combines theoretical knowledge, practical skills, on-the-job training, and the

integration of online learning, students are prepared for diverse career opportunities and future research endeavours. We invite students to embark on this transformative academic journey, here they will unravel the mysteries of life, contribute to the advancement of scientific knowledge, and make valuable contributions to society.

2. Aims and Objectives

The aims and objectives of the M. Sc. Life Sciences programme collectively aim to develop well-rounded Life Sciences professionals who are not only technically competent but also capable of contributing to research, innovation, and the overall advancement of the field.

Objectives:

The M. Sc Life Sciences programme is designed to help students to:

a) Acquire a comprehensive knowledge base in various disciplines of Life Sciences, providing a strong foundation for further studies and research. Students will develop a deep understanding of key concepts, theories, and methodologies in genetics, cellular biology, ecology, physiology, molecular biology, and other relevant areas.

b) Foster a deep interest in the diverse branches of Life Sciences, encouraging curiosity and exploration. Students will be inspired to delve into specialized areas of interest and engage in independent learning.

c) Understand the rich diversity of organisms and appreciate their ecological, genetic, and evolutionary significance. Students will gain insights into the interconnections between different species and ecosystems, recognizing the importance of biodiversity conservation.

d) Develop essential skills in observation, biological techniques, experimental skills, and scientific investigation, enabling them to contribute to the field through rigorous and reliable research. Students will be trained to design and execute experiments, analyze data, and draw scientifically sound conclusions.

e) Cultivate an understanding of the interconnectedness and harmony of different life systems, while recognizing the importance of maintaining good health through appropriate measures. Students will grasp the intricate relationships between organisms and their environment, emphasizing the significance of sustainable practices for both human and ecological well- being.

f) Gain knowledge and skills in applied branches of Life Sciences that can contribute to self-employment and entrepreneurial opportunities. Students will be equipped with practical knowledge and expertise in areas with direct applications, enabling them to explore entrepreneurial ventures or pursue specialized career paths.

g) Promote awareness and concern for the conservation of the biosphere, emphasizing the importance of environmental sustainability and responsible stewardship. Students will develop a deep appreciation for the biosphere and its conservation, becoming advocates for sustainable practices and environmental protection.

h) Enhance students' Social Intelligence Quotient (SIQ) and Emotional Quotient (EQ), fostering their development as well-rounded individuals and responsible citizens who can positively impact humanity through their acquired and developed knowledge. Students will develop strong interpersonal skills, empathy, and cultural sensitivity to effectively collaborate with diverse stakeholders and address societal challenges.

i) Equip students with the necessary skills and mindset to be self-sustainable and encourage them to become future entrepreneurs, fostering innovation and economic growth. Students will cultivate an entrepreneurial mindset, including critical thinking, problem-solving, creativity, and adaptability, preparing them to identify opportunities and contribute to the growth of the life sciences industry.

j) Provide students with a comprehensive understanding of key concepts, theories, and methodologies in Life Sciences. It covers a range of topics including genetics, cellular biology,

ecology, physiology, and molecular biology, enabling students to develop a deep knowledge base in these areas.

k) Equip students with practical skills through hands-on experience with laboratory techniques, data analysis, and scientific methodologies. Students will gain proficiency in conducting experiments, analyzing data, and interpreting results, enhancing their ability to apply theoretical knowledge to practical situations.
l) Enhance students' critical thinking and problem-solving abilities by challenging them to analyze complex biological systems, evaluate scientific literature, and propose innovative solutions to biological problems.
m) Foster collaboration and an interdisciplinary approach to problem-solving by providing opportunities for teamwork, group projects, and interactions with professionals from different scientific disciplines. Students will develop effective communication and teamwork skills, preparing them for collaborative work environments.
n) Stay updated with the latest trends and advancements in Life Sciences to ensure graduates are well-prepared for the demands of the industry. Through industry collaborations, guest lectures, and exposure to emerging technologies, students will acquire knowledge and skills that are relevant and applicable to real-world scenarios.
o) Develop students' professional skills, including scientific writing, presentation skills, project management, and leadership. Students will have opportunities to participate in conferences, workshops, and seminars to enhance their professional development and networking abilities.
p) Cultivate research skills among students by providing training in research methodologies, data analysis techniques, and critical evaluation of scientific literature. Students will have opportunities to engage in independent or collaborative research projects, enabling them to contribute to the advancement of Life Sciences through original research findings.

By incorporating these objectives, the M. Sc. Life Sciences program aims to produce graduates who possess a strong foundation in Life Sciences, are adept at problem-solving and collaboration, have industry-relevant skills, and are well-prepared for both research and professional roles in the field. The program strives to foster a deep understanding of Life Sciences, promote scientific inquiry, nurture innovation, and empower students to make meaningful contributions to society.

3. Learning Outcomes

The proposed M. Sc. Programme in Life Sciences aims to provide students with a comprehensive and holistic understanding of the field, equipping them with the skills and knowledge necessary to excel in the ever-evolving biological sciences domain. Learning outcome of the Programme are:

a) Apply advanced scientific principles and cutting-edge technology to solve complex real- world problems in diverse fields such as healthcare, agriculture, and environmental conservation.
b) Critically analyze and evaluate current research literature and effectively communicate scientific concepts and findings to both scientific and non-scientific audiences.
c) Develop innovative and sustainable research projects that adhere to international standards and consider practical limitations and ethical considerations.
d) Demonstrate an in-depth understanding of the structural organization and functional interactions between organisms and their environments, with an emphasis on the integration of interdisciplinary knowledge.
e) Evaluate and synthesize advanced concepts in plant, microbial, and animal physiology and biotechnology, and apply this knowledge to address contemporary challenges in the field.
f) Conduct quantitative and comparative studies, employing advanced statistical methods, to investigate and elucidate various aspects of biological sciences, including ecological interactions, genetic diversity, and population dynamics.
g) Utilize bioinformatics tools and techniques to generate, analyze, and interpret large-scale

biological data, including the construction of databases, sequence alignments, and predictive modeling.

h) Apply state-of-the-art technologies and methodologies to explore and comprehend the intricate mechanisms underlying genome and protein biology, including gene expression regulation and protein-protein interactions.
i) Discuss and critically evaluate the legal and ethical aspects of intellectual property rights (IPR) and the responsible conduct of research, with an understanding of the social and economic implications of biology-related innovations.
j) Foster cross-cultural competence by actively collaborating in diverse teams, valuing and respecting diverse perspectives, and effectively contributing to scientific projects with individuals from different cultural backgrounds.

Second Year PG:

R: SP- 45B									
Year (2Yr PG)	**Level**	**Sem.** (2Yr)	**Major**		**RM**	**OJT / FP**	**RP**	**Cum. Cr.**	**Degree**
			Mandatory	**Electives**					
II	**6.5**	**Sem III**	Course LScBCM601: Primary Metabolism Credits 4 Course LScBCM602: Primary Metabolism Practicals Credits 2 Course LScBCM603: Biomolecular Structure Credits 4 Course LScBCM604 :Biomolecular Structure Practicals Credits 2 Course LScBCM605: Advanced Techniques in Biochemistry Credits 2	**Credits 4** Course LScBCM606a: Nutritional and Clinical Biochemistry 2 TH + 2 PR **OR** Course LScBCM606b: Enzyme Technology 2 TH + 2 PR **OR** Course LScBCM606c: Fermentation Technology 2 TH + 2 PR **OR** Course LScBCM606d: Neurochemistry 2 TH + 2 PR **OR** Course LScBCM606e: Biochemical Toxicology 2 TH + 2 PR			LScBCM607 (4)	22	**PG Degree After 3-Yr UG**

		Sem IV	Course LScBCM608: Molecular Cell Biology Credits 4 Course LScBCM609: Molecular Cell Biology Practicals Credits 2 Course LScBCM610: Bioactives and Drug Development Credits 4 Course LScBCM611: Bioactives and Drug Development Practicals Credits 2	**Credits 4** Course LScBCM612a: Lifestyle Disorders 2 TH + 2 PR **OR** Course LScBCM612b: Immunology and Immunotechniques 2 TH + 2 PR **OR** Course LScBCM61c: Omics Technology 2 TH + 2 PR **OR** Course LScBCM612d: Pharmaceutical biochemistry 2 TH + 2 PR **OR** Course LScBCM612e: Environmental biochemistry 2 TH + 2 PR			LScBCM613 (6)	22	
Cum. Cr. for 1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

1) Credit Structure of the Program (Sem III & IV) (Table as per Parishisht 1 with sign of HOD and Dean)

R_____

Post Graduate Programs in University Parishishta - 1

Exit option: PG Diploma (44Credits)after Three Year UG Degree								
II	**6.5**	**SemIII**	Course1 Credits 4 Course 2 Credits 2 Course 3 Credits 4 Course 4 Credits 2 Course 5 Credit 2	**Credits4** Course1 OR Course 2 OR Course 3 OR Course 4 OR Course 5			4	22	**PG Degree After3-YrUG**
		SemIV	Course1 Credits 4 Course 2 Credits 2 Course 3 Credits 4 Course 4 Credits 2	**Credits4** Course1 OR Course 2 OR Course 3 OR Course 4 OR Course 5			6	22	
Cum.Cr. for1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum.Cr. for2 Yr PG Degree			**54**	**16**	**4**	**4**	**10**	**88**	

Sign of BOS Chairperson	Sign of Offg. Assoc. Dean	Sign of Offg. Dean
Indu Anna George 9/7/2024		
Prof. Indu Anna George Department of Life Sciences University of Mumbai	**Dr. Madhav Rajvade Offg. Assoc. Dean Science and Technology University of Mumbai**	**Prof. Shivram Garje Dean Science and Technology University of Mumbai**

Detailed Syllabus
M.Sc. (Life Sciences - Biochemistry)

SEMESTER III

Paper Code	Unit	Description	Credits	Hrs
Course LScBCM601		**Primary Metabolism**	**4**	**60**
Module 1	I	Bioenergetics and Carbohydrate Metabolism	1	
	II	Lipid Metabolism	1	
Module 2	III	Amino acid Metabolism	1	
	IV	Nucleotide Metabolism	1	
Course LScBCM602		**Primary Metabolism Practicals**	**2**	**60**
Module 1				
Course LScBCM603		**Biomolecular Structure**	**4**	**60**
Module 1	I	Chemical Bonds and Spectroscopic Techniques	1	
	II	Protein and Nucleic acid structure	1	
Module 2	III	Supramolecular Assemblies	1	
	IV	Biomolecular structure and Diseases	1	
Course LScBCM604		**Biomolecular Structure Practicals**	**2**	**60**
Module 1				
Course LScBCM605		**Advanced Techniques in Biochemistry**	**2**	**30**
Module 1	I	Nanotechnology	1	
	II	Cell and Molecular Biology Techniques	1	
ELECTIVES				
Course LScBCM606a		**Nutritional and Clinical Biochemistry**	**4**	**90**
Module 1: **LScBCM606aT**	I	Nutritional Biochemistry	1	15
	II	Clinical Biochemistry	1	15
Module 2: **LScBCM606aP**		Nutritional and Clinical Biochemistry Practicals	2	60
Course LScBCM606b		**Enzyme Technology**	**4**	**90**
Module 1: **LScBCM606bT**	I	Enzyme Kinetics and Applications	1	15
	II	Enzyme Technology	1	15
Module 2: **LScBCM606bP**		Enzyme Technology Practicals	2	60
Course LScBCM606c		**Fermentation Technology**	**4**	**90**
Module 1: **LScBCM606c T**	I	Upstream & Downstream Processes	1	15
	II	Fermentation Process	1	15
Module2: **LScBCM606cP**		Fermentation Technology Practicals	2	60
Course LScBCM606d		**Neurochemistry**	**4**	**90**
Module 1:	I	Neurotransmitters	1	15

LScBCM606dT	II	Neurological Disorders	1	15
Module2: **LScBCM606dP**		Neurochemistry Practicals	2	60
Course LScBCM606e		**Biochemical Toxicology**	**4**	**90**
Module 1: **LScBCM606eT**	I	Principle of Toxicology	1	15
	II	Effects of Toxicants on Humans	1	15
Module 2: **LScBCM606eP**		Biochemical Toxicology Practicals	2	60
Course LScBCM607		**Research Project**	**4**	**60**

SEMESTER IV

Paper Code	Unit	Description	Credits	Hrs
Course LScBCM608		**Molecular Cell Biology**	**4**	**60**
Module 1	I	Biomembrane and Cell Matrix	1	
	II	Protein Trafficking and Targeting	1	
Module 2	III	Kinetics in Biological Systems and Protein Engineering	1	
	IV	Animal Tissue culture and Programmed cell death	1	
Course LScBCM609		**Molecular Cell Biology Practicals**	**2**	**60**
Module 1				
Course LScBCM610		**Bioactives and Drug Development**	**4**	**60**
Module 1	I	Natural Products	1	
	II	Free radicals and Antioxidant Biology	1	
Module 2	III	Plant Tissue Culture and Allied Topics	1	
	IV	Pharmacognosy and Bio-efficacy studies	1	
Course LScBCM611		**Bioactives and Drug Development Practicals**	**2**	**60**
Module 1				
Course LScBCM613		**Research Project**	**6**	**90**
ELECTIVES				
Course LScBCM612a		**Lifestyle Disorders**	**4**	**90**
Module 1: **LScBCM612aT**	I	Metabolic Disorders	1	15
	II	Cardiovascular Diseases	1	15
Module 2: **LScBCM612aP**		Lifestyle Disorders Practicals	2	60
Course LScBCM612b		**Immunology and Immunotechniques**	**4**	**90**
Module 1: **LScBCM612bT**	I	Immunology	1	15
	II	Immunotechniques	1	15

Module 2:		Immunology and Immunotechniques Practicals	2	60
LScBCM612bP				
Course LScBCM612c		**Omics Technology**	**4**	**90**
Module 1: **LScBCM612cT**	I	Bioinformatics	1	15
	II	Genomics,Transcriptomics, Proteomics and Metabolomics	1	15
Module 2: **LScBCM612cP**		Omics Technology Practicals	2	60
Course LScBCM612d		**Pharmaceutical Biochemistry**	**4**	**90**
Module 1: **LScBCM612dT**	I	Drug metabolism & interactions	1	15
	II	Adverse Responses and Drug Trials	1	15
Module 2: **LScBCM612dP**		Pharmaceutical Biochemistry Practicals	2	60
Course LScBCM612e		**Environmental Biochemistry**	**4**	**90**
Module 1: **LScBCM612eT**	I	Pollution and its accumulation	1	15
	II	Pollution control tehniques	1	15
Module 2: **LScBCM612eP**		Environmental Biochemistry Practicals	2	60

Sem. - III

M.Sc. (Life Sciences - Biochemistry)
(Semester- III)

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Primary Metabolism**
Total Credits: 04	**Total Marks:** 100
Department assessment: 50	**University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the concept of bioenergetics and detailed study of metabolic processes like carbohydrate metabolism
2. Comprehend the basic concept of catabolic processes of fatty acids that generate energy, and anabolic processes that create biologically important molecules.
3. Be acquainted with the significance of amino acid metabolism and key role of TCA cycle in various metabolic processes; inborn errors associated with amino acid metabolic pathways
4. Acknowledge the metabolic pathways of nucleotides and their exploitation for curing lethal diseases.

Course Code	Course Title	Total Credits
LScBCM601	**Primary Metabolism**	**04**
MODULE I **Unit I: Bioenergetics and Carbohydrate Metabolism (15L)** **Bioenergetics:** Concept of free energy, standard free energy, determination of ΔG for a reaction; Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions; Biological oxidation-reduction reactions; Redox potentials; Relation between standard reduction potentials & free energy change; High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates alongwith reasons for high ΔG. **Carbohydrate Metabolism:** Glycolysis in higher organisms and microorganisms; Pentose phosphate pathway and its regulation; Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate shunt pathways; Cori cycle; Anaplerotic reactions; Entner-Doudoroff pathway; Glucuronate pathway; Metabolism of disaccharides; Hormonal regulation of carbohydrate metabolism; Inborn errors of carbohydrate metabolism. **Unit II: Lipid Metabolism (15L)** **Fatty acid catabolism:** Hydrolysis of triacylglycerols; α-, β-, ω- oxidation of fatty acids; Oxidation of odd numbered fatty acids – fate of propionate; Role of carnitine; Degradation of complex lipids; Formation of ketone bodies; Energetics and regulation of beta oxidation. **Fatty acid biosynthesis:** Acetyl CoA carboxylase; Fatty acid synthase; ACP structure and		**02**

function; Lipid biosynthesis; Biosynthetic pathway for triacylglycerols, phosphoglycerides, sphingomyelin and prostaglandins; Metabolism of cholesterol and its regulation; Biosynthesis of bile acids and steroid hormones; Alternative pathway for isoprenoid biosynthesis in chloroplast; Inborn errors of fatty acid metabolism.	
MODULE II **Unit III Amino Acid Metabolism (15L)** **Amino acid catabolism:** Proteolysis; General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids; Acetyl CoA, alpha ketoglutarate, acetoacetyl CoA, succinate, fumarate and oxaloacetate pathway; Urea cycle and its regulation; Ammonia excretion, Inborn errors of Urea cycle **Biosynthesis of Amino Acids:** Biosynthesis and regulation of aromatic amino acids and Histidine; One carbon atom transfer by folic acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine); Conversion of amino acids to specialised products; Inborn errors of protein metabolism. **TCA cycle:** Central role of TCA cycle in energy generation and biosynthesis of energy rich bond; Integration/regulation of carbohydrate, lipid and protein metabolism. **Unit IV: Nucleotide Metabolism (15L)** **Nucleotide Metabolism:** Role of nucleases and phosphodiesterases in the degradation of nucleic acids; Biosynthesis and degradation of purines and pyrimidine nucleotides and their regulation; Thymine biosynthesis; Role of folic acid in nucleotide biosynthesis; Purine salvage pathway; Role of ribonucleotide reductase; Biosynthesis of deoxyribonucleotides and polynucleotides; Inhibitors of nucleic acid biosynthesis; Inherited disorders of nucleotide metabolism; Anticancer drugs; Nucleotide metabolism as target for cancer, antiviral therapy and malaria.	**02**

Reference Books:

1. L. Stryer, Biochemistry, W.H. Freeman and Co. 5th 2002
2. Voet, Donald, Voe Judith, Pratt, Charlotte W. Fundamentals of Biochemistry: Life at the molecular Level 2nd Edition. Publisher: Asia, John Wiley & Sons. 2006.
3. Nelson David L., Cox Michale. Lehninger Principles of Biochemistry 5th Edition.Publisher: New York. W. H. Freeman. 2008.
4. Text Book of Biochemistry with clinical correlation by Thomas M. Devlin, John Wiley - Liss, Hobokhen NJ publishers (2006)
5. Zubey, Biochemistry GL WCB Publishers.
6. Purich Daniel L., Allison R. Donald. The Enzyme Reference: A Comprehensive Guidebook to Enzyme Nomenclature, Reactions, and Methods. Publisher: California, Academic Press.

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Primary Metabolism Practicals**
Total Credits: 02	**Total Marks:** 50
Department assessment: 25	**University assessment:** 25

Course Outcome:

The learner would be able to:

1. Get practical knowledge of estimation of biomolecules.
2. Acquire practical knowledge of isolation of biomolecules.
3. Understand assay of enzymes and parameters affecting enzyme activity.

Course Code	Course Title	Total Credits
LScBCM602	**Primary Metabolism Practicals**	**02**
MODULE I 1. Estimation of inorganic phosphorus by Fiske and SubbaRao method 2. Determination of pyruvate by 2,4-dinitrophenyl hydrazine method 3, Isolation of cholesterol and lecithin from egg yolk 4. Assay of alanine and aspartate aminotransferases 5. Effect of metal ions on the activity of enzymes/proteins 6. Determination of Molar absorption coefficient of tyrosine		**02**

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Biomolecular structure**
Total Credits: 04	**Total Marks:** 100
Department assessment: 50	**University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the role of chemical interaction in stabilizing the structure and conformation of biomolecules; Principle, methodology and applications of spectroscopic techniques.
2. Understand the relevance of the covalent and synthetic modifications of protein, their application; DNA structure and its different isoform.
3. Be acquainted with the supramolecular assemblies of Viral structural component, nucleic acid binding motifs in proteins; function of metalloproteins and transport protein inside the living system.
4. Be familiar with biomolecular interactions; analyze molecular basis of diseases and basic mechanisms behind the prominent genetic and metabolic disorders.

Course Code	Course Title	Total Credits
LScBCM603	**Biomolecular structure**	**04**
MODULE I		**02**

Unit I: Chemical Bonds and Spectroscopic Techniques (15L)

Interatomic interactions, ionic, covalent and metallic bonds; Importance of weak, non-covalent bonded interactions in biomolecules, such as Van der Waals forces and hydrogen bonding; Energies and geometrics of these interactions and their roles in structure and conformation of biomolecules.

Spectroscopic techniques: Principle, methodology and applications of Infrared, Raman, ESR, Atomic absorption spectroscopy; Principle, methodology and applications of spectrofluorimetry techniques

Optical Activity: Importance of chirality in biomolecules; Principles and applications of CD and ORD.

Unit II: Protein and Nucleic Acid Structure (15L)

Structure and Stability of Proteins: Myoglobin, Haemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin; Conformation of proteins by Ramachandran plot; N and C terminal analysis of proteins.

Synthetic protein modifications: Protein-based hybrid structures and protein polymer systems; applications of protein polymer systems; Amino acid targeting for synthetic protein modification; Synthetic approaches for polymer-protein hybrid structure; Non-covalent approaches for polymerprotein conjugates; Protein - nanoparticle hybrids via surface conjugation; Biocatalytic approaches for biohybrid structures.

DNA structure: A/B/Z/D forms of double helical structure of DNA; Triple helix; DNA supercoiling and topoisomerases.

MODULE II **Unit III Supramolecular Assemblies (15L)** **Viruses:** Viral assembly; Capsid; Capsomere, eg., TMV, HIV, Adenovirus, Influenza. **Nucleic Acid Binding Motifs in Proteins:** Leucine zipper; Zinc fingers; Helix-turn-helix; Beta barrel; OB fold and their role in regulation of gene expression. **Metalloproteins:** General principles of metal coordination; Storage and transport metalloproteins (Rubredoxin, Plastocyanin, Ferritin, Ceruloplasmin); Signal-transduction metalloproteins (Calmodulin, Troponin); Metalloenzymes (Carbonic anhydrase, SOD, Hydrogenase). **Transport proteins:** Oxygen transport proteins from vertebrates and invertebrates (hemoerythrin, cytochrome C), Albumin. **Unit IV: Biomolecular Structure and Diseases (15L)** **Structural and functional aspects of proteins and DNA:** Relationships between structure and function and their role in human disease; DNA-protein interactions; Protein-RNA interactions; Proteinprotein interactions; Protein aggregation; Non-enzymatic glycosylation (Protein-sugar interaction); Methods to study these interactions. **Molecular basis of disease:** methods for prevention, diagnosis, and treatment; Advanced techniques used in the diagnostics of diseases due to structural alteration. **Diseases:** Huntington's disease, Sickle-cell anaemia; Cataract; Alzheimer's disease; p53 in cancer; Von Hippel-Lindau syndrome; Metabolic syndrome (Diabetes).	**02**

Reference Books:

1. K. Wilson and I. Walker, Practical Biochemistry, 5th edition, University press (2000)
2. Shawney, Practical Biochemistry
3. P. Asokan, Analytical Biochemistry. China publications, (2003)
4. David Frifelder, Physical Biochemistry, W. H. Freeman; 2nd edition (1982)
5. Sheehan, D. (2009) Physical Biochemistry: Principles and Applications. John Wiley & Sons Ltd., UK.
6. Branden, C. I. and Tooze, T.(1999) Introduction to Protein Structure. Garland Publishing, USA.
7. Lesk, A. M. (2004) Introduction to Protein Science: Architecture, Function and Genomics. Oxford University Press, UK.
8. Creighton, T.E. (1983) Proteins: Structures and Molecular Properties. W.H. Freeman and Co., USA.
9. Pain, R.H. (2000) Mechanism of Protein Folding. Oxford University Press, UK.
10. Arai, M. and Kuwajima, K. (2000) Advances in Protein Chemistry. Academic Press, USA
11. The Chemical Reactions of Living Cells: David E Metzler
12. William J. Marshall, Stephan K. Bangert, Elizabeth S.M. Ed. S.M (ed) Marshall, Clinical Biochemistry: Metabolic and Clinical Aspects by (2008) Publisher: Elsevier Science Health Science Div

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Biomolecular Structure Practicals**
Total Credits: 02	**Total Marks:** 50
Department assessment: 25	**University assessment:** 25

Course Outcome:

The learner would be able to:

1. Get practical knowledge of purification of biomolecules.
2. Acquire practical knowledge of conformational analysis of biomolecules.
3. Understand the experimental details of biomolecular interaction.

Course Code	Course Title	Total Credits
LScBCM604	**Biomolecular Structure Practicals**	**02**
MODULE I 1. Protein purification methods: a. Isolation of casein from milk b. Purification of an enzyme by ion exchange chromatography/affinity chromatography c. Use of ammonium sulphate precipitation and dialysis d. Use of gel filtration e. SDS-PAGE 2. Polyacrylamide gel electrophoresis under non-denaturing conditions a. Silver staining b. Activity staining of enzymes c. Determination of effect of acrylamide concentration on the mobility of proteins 3. Determination of melting temperature (Tm) of DNA. 4. Analysis of DNA a. Estimation of DNA and RNA by UV absorption method b. Determination of purity of nucleic acids c.Conformational analysis of plasmid DNA by agarose gel electrophoresis (Oxidative/carbonyl stress induced damage). 5. Spectrofluorimetric analysis of proteins 6. Determination of N- and C-terminal amino acids (demonstration). 7. Protein aggregation studies by Congo Red and Thioflavin T 8. Generation and measurement of non-enzymatic glycosylated products (Protein/DNA). 9. Assay of transport protein (BSA) – esterase activity. 10. Analysis of protein-sugar-DNA interactions		**02**

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Advanced Techniques in Biochemistry**
Total Credits: 02	**Total Marks:** 50
Department assessment: 25	**University assessment:** 25

Course Outcome:

The learner would be able to:

1. Design methodology for synthesis and characterization of nanomaterials.
2. Explanation of concept of metabolic engineering and working principles of System Biology; use them or exploiting plants and microbes for production of metabolites.
3. Become familiar with the modern concept of gene expression & regulation and their application in gene
4. therapy and apply methods for isolation and analysis of metabolites and gene expression.
5. Isolate and quantify cellular or molecular samples.

Course Code	Course Title	Total Credits
LScBCM605	**Advanced Techniques in Biochemistry**	**02**
MODULE I **Unit I: Nanotechnology (15L)** **Introduction:** Nanoscience; Nanobiotechnology; Nanodevices; Applications in various fields viz. Physical and Chemical, Materials and Life Sciences, advantages and disadvantages of nanotechnology **Application:** Gold bonding proteins; Nanopharmaceuticals such as liposomal formulations; Membrane nanodiscs; Biosensors; Nanowires. **Synthesis of nanostructure:** Physical, chemical and biological methods. **Properties and Characterization of nanomaterials:** Optical (UV-Vis / Fluorescence), X-ray diffraction; Imaging and size (Electron microscopy, Light scattering, Zeta potential), Surface and composition (ECSA, EDAX, AFM/STM). **Unit II: Cell and Molecular Biology Techniques (15L)** **Cell Biology Techniques:** Principles, Instrument overview, and Applications of flow cytometry, Fluorescence Resonance Energy Transfer (FRET); Surface Plasmon resonance. **Proteomics:** Peptide synthesis and Protein sequencing methods, detection of post-translational modification of proteins; 2-D gel electrophoresis; Mass spectrometry; X-ray diffraction methods; Static and dynamic light scattering (SLS and DLS); Capillary electrophoresis; Protein chips; Differential scanning calorimetry; Isothermal titration calorimetry. **Genomics:** Oligonucleotide synthesis; DNA chips/microarrays; DNA hybridization; DNA sequencing methods; Strategies for genome sequencing; Methods for analysis of gene expression at RNA and protein level; Site directed mutagenesis; Gene knockdown; Differential display; Serial analysis of gene expression (SAGE).		**02**

References:

1. David S. Goodsell, Bionanotechnology: Lessons from Nature, 1st Edition, Wiley-Liss, 2004.
2. Madhuri Sharon () Bio-Nanotechology
3. Sulabha K. Kulkarni () Nanotechnology: Principles and Practices - 3rd Edition.
4. Elisabeth S. Papazoglou, Aravind Parthasarathy () BioNanotechnology:
5. Stephanopoulos Gregory N., Aristidou Aristos A., Nielsen Jens. Metabolic Engineering: Principles and Methodologies. Publisher: New Delhi, Reed Elsevier India Pvt. Ltd. 2006.
6. Andres Kriete (Editor), Roland Eils (Editor). System Biology: Computational Systems Biology (Hardcover)
7. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC Press, Mathematical and Computational Biology, 2nd edition, 2006.
8. David Hoyle () Automotive Quality Systems Handbook Second Edition ISO/TS 16949:2002 Publisher Elsevier
9. Edda Klipp, Wolfram Liebermeister, Christoph Wierling and Axel Kowald (2016). Systems Biology A Textbook, 2nd Edition, Wiley - VCH Verlag GmbH & Co. KGaA
10. Jens Nielsen, Stefan Hohmann, Sang Yup Lee and George Stephanopoulos (2017). Systems Biology, Wiley - VCH Verlag GmbH & Co. KGaA
11. Markus W. Covert (2015). Fundamentals of Systems Biology - From Synthetic Circuits to Whole-cell Models, CRC Press, Taylor & Francis Group.
12. W. Weckwerth, Metabolomics: Methods and Protocols, Humana Press, USA (2006).
13. M. Tomita and T. Nishioka, Metabolomics: The Frontier of Systems Biology, Springer Verlag, Japan (2005).

SEMESTER III ELECTIVES

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Nutritional and Clinical Biochemistry**
Total Credits: 04	**Total Marks:** 100
Department assessment: 50	**University assessment:** 50

Course Outcome:

The learner would be able to:

1. Know the sources, nutritional importance of macro and micro nutrients.
2. Explain the energy content, measurement and metabolic rate.
3. Understand the diseases associated with macro and micro nutrients.
4. Establish role of enzymes and other biochemical markers in clinical diagnostics and organ function tests

Course Code	Course Title	Total Credits
LScBCM606a	**Nutritional and Clinical Biochemistry**	**04**

MODULE I: **02**

Course LScBCM606aT: Nutritional and Clinical Biochemistry

Unit I: Nutritional Biochemistry (15L)

Food constituents, sources and their functions: Carbohydrate, lipids, proteins, vitamins, minerals and water; RDA and ICMR recommendations for calorie requirement of food for men, women and children; Energy content of foods. Measurement of energy expenditure: direct & indirect calorimetry, Basal metabolic rate and specific dynamic action (SDA) and factors affecting BMR, measurement and calculation of BMR

Nutritional disorders and management – Malnutrition, Kwashiorkor, Marasmus and nitrogen imbalance. Obesity and secondary causes of obesity, appetite and eating disorders. Physicochemical properties and physiological functions of dietary fibres.

Functional Foods and Nutraceuticals - Introduction - Defining the concept – Cereals and pulses and functional food. Dietary Supplements – role of nutraceuticals in the management of Inborn errors of metabolism

Unit II: Clinical Biochemistry (15L)

Biological samples (blood, urine and cerebrospinal fluid): chemical composition, collection, processing, storage and preservation; Quality control: accuracy, precision, Specificity, Sensitivity, Levy Jenning's chart.Clinical manifestations and biochemical changes in liver diseases, Diagnosis of liver disorders with special reference to jaundice and cirrhosis. Liver function tests, Gastric function tests, Malabsorption syndrome

Renal function tests - Diseases of the kidney, Drugs and toxins associated with renal diseases, Hemodialysis and peritoneal dialysis

Clinical enzymology – Enzymes in plasma and their origin, general principles of assay, Clinical significance of enzymes and isoenzymes, measurement of serum enzymes in diagnosis

MODULE II: **Course LScBCM606aP: Nutritional and Clinical Biochemistry Practicals** **Practicals:**Collection, preservation and physical examination of urine sample 1. Tests for analysis of abnormal urine constituents 2. Collection, preservation and separation of blood plasma and serum 3. To estimate urea/creatinine in the given blood sample 4. Estimation of haemoglobin by Sahl's method 5. Quantitative estimation of alkaline phosphatase in the given serum sample 6. To determine serum proteins and albumin-globulin ratio by Biuret method 7. Quantitative estimation of SGOT/SGPT in the given serum sample 8. Quantitative estimation of LDH in the given serum sample	**02**

Reference Books:

1. Modern Nutrition in health and disease, Robert S Goodhart, 2012, 11 edition, Lippincott Williams and Wilkins.
2. Advanced Text book on Food & Nutrition: 2nd Edition; Swaminathan M, Bappco publishers.
3. Nutritional and Clinical Biochemistry course https://onlinecourses.swayam2.ac.in/cec20_ag01/preview
4. Nutritional Biochemistry: 2nd edition, Tom Brody; Academic press.
5. Normal and Therapeutic Nutrition: 17th edition, Robinson C H, Lawler M R, CheiToweth W L and Garwick AE ; Mac Millan publishing Co.
6. Textbook of Biochemistry with Clinical Correlations: 7th edition, Devlin TM; Wiley-Liss
7. Handbook of Clinical Biochemistry: 2nd edition,Swaminathan R; Oxford University Press, USA
8. Tietz Fundamentals of Clinical Chemistry: 6th edition, Burtis CA and Ashwood ER; Saunders Elsevier
9. Harper's Illustrated Biochemistry: 31st edition,

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III **Total Credits:** 04 **Department assessment:** 50	**Course Name: Enzyme Technology** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the kinetics of enzyme catalysed reactions.
2. Explain the concept and application of immobilization of enzymes.
3. Learn the purification, characterization and estimation of enzymes.
4. Understand the applications of protein engineering for novel enzyme design.

Course Code	Course Title	Total Credits
LScBCM606b	**Enzyme Technology**	**04**
MODULE I: **Course LScBCM606bT: Enzyme Technology** **Unit I: Enzyme Kinetics and Applications (15L)** **Enzyme Kinetics:** Enzyme catalysis and factors contributing to high catalytic rates; Molecular aspects of catalysis for specific enzyme substrate complexes (Lysozyme, carbonic anhydrase, carboxypeptidase and chymotrypsin); Multisite binding of ligands to proteins; Bohr's effect; Models of Allostery – MWC and KNF models, Hill's equation coefficient; **Kinetics of multisubstrate enzyme**-catalysed reactions; Ping-pong bi-bi, random order and compulsory order mechanism. Immobilised enzymes: Methods and applications. Enzyme therapy, enzyme inhibitors and drug design; enzymes as biosensors, enzyme reactors; **Applications of enzymes**: in medicine, textile, leather, detergent, paper, bakery, dairy industry, beverage and fruit processing, food processing and preservation, clinical applications of enzyme estimation. **Unit II: Enzyme Technology (15L)** Strategies used for enzyme production, isolation and purification at laboratory and industrial scale from plant, animal and microbial sources, purification fold; estimation of enzyme activity; characterization of an enzyme, criteria of enzyme purity, determination of the molecular weight (MW) and the number of sub-units of an enzyme; Protein Engineering Design and construction of novel proteins and enzymes using site-directed mutagenesis and Random/directed evolution strategies; Conformation of proteins in general and enzymes in particular; Effect of amino acids on structure of proteins; Energy status of a protein molecule, Structure- function relations of enzymes. Basic concepts for design of a new protein/enzyme molecule; Specific examples of enzyme engineering – Dihydrofolate reductase and Subtilisin	**02**
MODULE II **Course LScBCM606bP: Enzyme Technology Practicals**		**02**

1. Enzyme inhibition a. Inhibition of enzyme activity b. Determination of Ki values 2. Immobilization studies a. Preparation of urease entrapped in alginate beads and determination of percent entrapment b. Study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads c. Study of reusability and storage stability of urease entrapped alginate beads d. Immobilization of urease by covalent attachment to solid support 3. Protein purification methods: a. Isolation of casein from milk b. Purification of an enzyme by ion exchange chromatography/affinity chromatography c. Use of ammonium sulphate precipitation and dialysis d. Use of gel filtration e. SDS-PAGE 4. Polyacrylamide gel electrophoresis under non-denaturing conditions a. Silver staining b. Activity staining of enzymes c. Determination of effect of acrylamide concentration on the mobility of proteins	

Reference Books:

1. Bailey JE, Ollis, DF: Biochemical Engineering Fundamentals
2. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker
3. Schugerl K., Bellgart KH (Eds): Biorection Engineering, modeling and control: Springer-Verlag, Berlin.
4. Nicholas C. Price, Lewis Stevens, and Lewis Stevens, Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by (2000) Publisher: Oxford University Press, USA
5. Alejandro G. Marangoni, Enzyme Kinetics: A modern Approach Book: Enzyme Kinetics: A Modern
6. Approach, (2003) Publisher: Wiley-Interscience Enzyme Kinetics and Mechanisms by Taylor Publisher: Springer
7. Christian Müller (Editor), Protein Engineering Protocols (Methods in Molecular Biology) K, Publisher: Humana Press; Softcover reprint of hardcover 1st ed. 2007
8. Anders Liljas, Structural Aspects of Protein Synthesis Publisher: World Scientific Pub Co Inc; 1 edition (November 2004)
9. Wiseman, A: Handbook of Enzyme Biotechnlogy, 3rd Edition, Ellis Horwood Publication
10. Moser, A: Bioprocess technology, kinetics and reactors: Springer Verlag

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III **Total Credits:** 04 **Department assessment:** 50	**Course Name: Fermentation Technology** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Explain various fermentation processes.
2. Develop and fabricate fermenters and products.
3. Capture the convenience of bio-transformations in this industry.
4. Extend secondary metabolite for production.
5. Discuss Effluent treatment.
6. Explain the working of a bioreactor.
7. Screen and isolate economically important naturally occurring microorganisms.

Course Code	Course Title	Total Credits
LScBCM606c	**Fermentation Technology**	**04**
MODULE I: **Course LScBCM606cT: Fermentation Technology** **Unit I: Upstream & Downstream Processes (15L)** **Isolation and Screening of microorganisms:** Isolation of microorganisms from various sources, Preservation, Primary and Secondary Screening of microorganisms. **Fermentation Media:** Definition, Criteria, Various components, Types: crude and synthetic, sterilization, rheology of various components of media. **Fermenter design:** Components of the fermenter, sterilization, aeration and agitation. **Types of Fermenters:** batch, continuous, air lift, fluidized bed, stirred tank. **Downstream Processes** **Product recovery:** Product: internal, external, cell disruption methods: physical, chemical and biological, precipitation, filtration, centrifugation, extraction and purification, drying. **Effluent Treatment:** Need, Traditional methods disposal and disadvantage, physical, chemical and biological methods. **Unit II: Fermentation Process (15L)** **Single Cell Protein, Biomass and Immobilization:** Need of single cell production, production of bacteria, yeast, algae and fungi. Immobilization: cells and enzymes, methods of immobilization, applications. **Commercial Fermentations:** Cheese, Wine **Secondary metabolite production (**industrial scale**)**: [shikonin, taxol (biosynthesis and bioreactor production) capsasin/ berbrine]. **From microbes:** Polymers [dextrans, xanthan gums, alginate], antibiotics [peptide, lantibiotics, aminoglycosides, beta lactam], cyclosporins, medicinal mushrooms, biosurfactants.		**02**

MODULE II: **Course LScBCM606cP: Fermentation Technology Practicals** **Practicals:** 1. Immobilization of cells 2. Demonstration of fermenter/ chemostat 3. Estimation of alcohol production: Sucrose/ fruit (s)/ sugarcane juice. 4. Preparation of media for isolation of cellulase producing microorganisms from natural source(s). 5. Determination of cellulase activity using Filter paper assay/ carboxy-methyl cellulose assay. 6. Pilot Fermentation for Biomass Production 7. Secondary metabolite production using plant tissue culture (dye/ drug Alkaloids etc.) 8. Separation of bioactive compounds using HPTLC and Bioautography. 9. Visit to Effluent Treatment Plant**.**	**02**

Reference Books:

1. Principles of Fermentation Technology byStanbury and Whitaker
2. Industrial Microbiology by Casida
3. Industrial Microbiology by Prescott and Dunn
4. Industrial Biotrasformations by A. Liese, K. Seelbach and C. Wandrey; Wiley – VCH
5. Role of Biotechnology in Medicinal and Aromatics Plants by Khan and Khanum Vol. 1 to 6. Plant Tissue Culture by M. K. Razdan

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III	**Course Name: Neurochemistry**
Total Credits: 04	**Total Marks:** 100
Department assessment: 50	**University assessment:** 50

Course Outcome:

The learner would be able to:

1. Acquiring Knowledge about the functioning of neurotransmitters.
2. Explain the signalling and downstream events of neurotransmission
3. Understanding the concept of various neurological disorders such as Parkinson, Alzheimer etc.

Course Code	Course Title	Total Credits
LScBCM606d	**Neurochemistry**	**04**
MODULE I: **Course LScBCM606dT: Neurochemistry** **Unit I: Neurotransmitters (15L)** **Classes of Neurotransmitters**- chemistry, synthesis, storage and release of neurotransmitters: Acetylcholine, dopamine, norepinephrine, Amino acids. **Neurotransmitter signalling**: Classification of neurotransmitter receptors, Receptor agonists and antagonists, Second messengers, Phospholipase C pathways, cross-talk between signalling pathways. **Nuclear receptors**: Super families, mechanism of steroid hormone action, transmission, synaptic modulation, and mechanism of neuronal integration. **Unit II: Neurological Disorders (15L)** **Nervous System Disorders**: Neurochemical and molecular mechanisms of peripheral Neuropathy, Ischemia and hypoxia, Epileptic seizures, Metabolic Encephalopathies and Coma. **Myelin Sheath Disorders**: Multiple sclerosis and other demyelinated disorders, **Neurodegenerative Disorders**: Alzheimer's disease, Dementia, Prion's Disease **Neuromuscular Disorder**: Parkinson's disease **Psychotic disorders:** Anxiety and Mood disorders, Schizophrenia **Substance abuse**: Molecular targets of abused drugs, Alcoholic Cerebellar Degeneration		**02**
MODULE II: **Course LScBCM606dP: Neurochemistry Practicals** **Practicals:** 1. Case study on Epileptic seizures 2. Case study on Multiple sclerosis 3. Case study on Dementia 4. Case study on Parkinson's disease		**02**

5. Case study on Schizophrenia 6. Case study on Depression 7. Case study on Drug addiction 8. Case study on Schizophrenia	

Reference Books:

1. Brady, Basic Neurochemistry (8th Edition) Academic Press, 2012
2. Siegel et al., Basic Neurochemistry, 6th Edition,
3. Kandel et al., Principles of Neural science, 4 Edition, McGraw-Hill Medical, 2000.
4. Zegmond, Fundamentals of Neuroscience, 1st Edition, Academic Press, 1999
5. Squire, Fundamental Neuroscience (4th Edition), Elsevier,2013
6. Kandel, Principles of Neural Science (5th edition), McGraw Hill,2013
7. Duchene E. Haines, Fundamental Neuroscience for Basic & Clinical Applications (3rd Edition), Churchill Livingstone, 2006
8. Bear, Neuroscience-Exploring the Brain (3rd Edition), Lippincott, 2007
9. Lippincott Williams & Wilkins, 2001 C. Pharmaceutical

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III **Total Credits:** 04 **Department assessment:** 50	**Course Name: Biochemical Toxicology** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the principles of toxicology
2. Explain the dose response of the toxicants and their risk assessment
3. Analyse the physiological effect of toxicant on humans
4. Familiar with various regulatory policies and treaties related to toxicants

Course Code	Course Title	Total Credits
LScBCM606e	**Biochemical Toxicology**	**04**
MODULE I: **Course LScBCM606eT: Biochemical Toxicology** **Unit I: Basics of toxicology and toxicants (15L)** **Principles of toxicology:** Introduction to toxicology, toxicants and its types, The Importance of Dose and the Dose–Response Relationship, Factors Influencing Dose–Response Curves, Descriptive Toxicology: Testing Adverse Effects of Chemicals and Generating Dose–Response Data, Extrapolation of Animal Test Data to Human Exposure **Absorption, Distribution, and Elimination of Toxic Agents :** Toxicology and the Safety and Health Professions, Risk Assessment, Transfer across Membrane Barriers, Absorption, Disposition: Distribution and Elimination **Biotransformation:** Sites of Biotransformation, Biotransformation Reactions **Unit II: Effects of Toxicants on humans (15L)** **Xenobiotics :** Mode of Entry of Toxins, Translocation of Xenobiotics, Phases of Metabolism, Disposition of Epoxides, Conjugations, Glutathione, Induction and Inhibition of P-450 Isozymes, Activation of Precarcinogens **Organ directed toxicology :** Hematotoxicology, Hepatotoxicology, Nephrotoxicology, Neurotoxicology, Dermal and Ocular Toxicology, Pulmonotoxicity, Immunotoxicity, Reproductive Toxicology, Mutagenesis and Genetic toxicology **Regulatory Policies & International Treaties:** The National Environmental Policy Act, Environmental Regulatory framework, EPA and its responsibilities, OSHA and its responsibilities, Miscellaneous Environmental Acts and Treaties	**02**
MODULE II: **Course LScBCM606eP: Biochemical Toxicology Practicals** **Practicals:** 1. To study dose response curves of toxicants w.r.t. LD_{50}, LC_{50}, EC_{50}, IC_{50} using appropriate animals (example *Daphnia*) 2. To study effect of toxicants on growth of Moong seeds. 3. Assessment of heavy metal toxicity using Beta-galactosidase 4. In vitro Toxicity Evaluation of on animal/plant cell culture	**02**

5. Microsomal Mutagenicity Assay (AMES Test) 6. To study Metal ion toxicity (oligo dynamic effect) on microorganisms. 7. To study Inhibition of phosphatase by cyanotoxin (Extraction, detection and bioactivity). 8. Case study : DDT, Asbestos, Bhopal gas tragedy, Acid rain, Minamata disease	

Reference Books:

1. An introduction to environmental toxicology by Dong, Michael H (2014) Publisher : North Charleston, SC : Create Space Publishing
2. Essentials of Toxicology, 3e by Curtis D. Klaassen, John B. Watkins III (2015) The McGraw-Hill publication
3. Environmental Toxicology 3rd edition 2002 By Sigmund F. Zakrzewski Oxford University press
4. PRINCIPLES OF TOXICOLOGY Environmental and Industrial Applications SECOND EDITION (2000) by Phillip L. Williams, Robert C. James and Stephen M. Roberts. A Wiley-Interscience Publication
5. Introduction to environmental toxicology: impacts of chemicals upon ecological systems Wayne G. Landis, Ming-Ho Yu.—3rd ed. (2003) Lewis Publishers

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester III **Total Credits:** 04 **Department assessment:** 50	**Course Name: Research Project I** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to

1. Correlate the theoretical and practical aspects of research. The learner would be able to:
2. Collate, organize and analyze the existing literature in any given field of study.
3. Formulate a hypothesis following literature review.
4. Design a study to prove/ disprove the hypothesis using the tenets of Research Methodology.
5. Design data/ sample collection.
6. Prepare a presentation and appropriately record the studies done in this course.

Course Code	Course Title	Total Credits
LScBCM607	**Research Project I**	**04**
MODULE I: This course is designed to extend the concepts captured in the theory lectures into practical applications and discovery. The learner would be able to identify and organize the existing literature on a given topic and plan experiments to prove a hypothesis. The research project is aimed to enhance research temper in the learner. The learner would be able to formulate a hypothesis and design a research project using the concepts of research methodology. The learner would be able to effectively document and present the parameters of the research project. What is required: There are four credits assigned to the course. As this is of a practical and hands-on nature, every two hours spent on the project in a week would earn a credit. The course spans over 15 weeks and hence the time that needs to be devoted would be 120 hours. This could be planned and completed over a span of 15 weeks or continuously 4 - 5 weeks. Where can these projects be done: The projects could be conducted in-house or could be in industry or research institutes or recognized institutes that carry out research. The host institution would be from any field of Life Sciences. The project would be carried out with the consent and understanding between the University Department of Life Sciences and the relevant Academic/ research Institute or the Industry Documentation for the Research Project I: The proforma for internal evaluation by the mentor (at the place of work) is given at the end of the syllabus. This evaluation along with a thesis submission would be proportionately added for the calculation of the internal marks. The scheme for the same is given at the end of the syllabus. A draft paper of the project and its presentation would be evaluated by external examiners as the external evaluation. The relevant weightages are given at the end of the document. The reports will be governed by the plagiarism rules as dictated in the document No.		**04**

Th./ICD/2018 – 19/ 448 **Research Project (I):** *Internal Assessment: 50 mks.* Thesis submission and evaluation: 25 mks Viva: by an Internal Committee (2 members): 25 mks. *External Assessment: 50 mks.* Draft Paper submission: 25 mks Presentation: 25 mks.	

Sem. - IV

M.Sc. (Life Sciences - Biochemistry)
(Semester - IV)

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV	**Course Name: Molecular Cell Biology**
Total Credits: 04	**Total Marks:** 100
Department assessment: 50	**University assessment:** 50

Course Outcome:

The learner would be able to:

1. Analyze the membrane structures and nuclear pore; molecular arrangement of microfilaments
2. Understand the mechanism of post translational modification of proteins and their significance in sorting of proteins
3. Explore the kinetics of enzyme catalyzed reactions and preparation of immobilized enzymes.
4. Design and formulate animal tissue culture experiments for various applications.

Course Code	Course Title	Total Credits
LScBCM608	**Molecular Cell Biology**	**04**
MODULE I **Unit I: Biomembrane and Cell Matrix (15L)** **Biomembranes:** Structure and assembly; Orientation of membrane proteins, their solubilisation with detergents and enzymes; Membrane reconstitution; Liposomes and their application in biology and medicine. **Nuclear pore complex:** Structure; Assembly and disassembly; RNA transport; Role in macromolecular exchange and regulation; nuclear import–export cycle. **Molecules of the matrix:** Proteins of the microfilament, microtubules and intermediate filaments; Structure, properties and assembly of actin and tubulin, examples and roles of these filaments in cell structure and function, e.g., dynamics and roles of kinesin and dynein; Organization of proteins on microvillus; Cell-cell/cell-matrix interactions. **Unit II: Protein Trafficking and Targeting (15L)** N-glycosylation in the ER and Golgi (quality control, UPR, ERAD and proteasomal degradation. Intracellular and membrane protein trafficking and targeting; Secretory pathways in prokaryotes and eukaryotes; Endocytic pathways; Signal sequences; Co-translational transport (protease protection assay); Targeting of mitochondrial, chloroplast, peroxisomal and nuclear proteins; Vesicle biogenesis and ER to Golgi transport; ER translocation of polypeptides (soluble and transmembrane); ER chaperons; SNAPs and SNAREs; Methods of studying Protein Transport; Disorders of protein transport		**02**

MODULE II **Unit III Kinetics in Biological Systems and Protein Engineering (15L)** **Enzyme Kinetics:** Enzyme catalysis and factors contributing to high catalytic rates; Molecular aspects of catalysis for specific enzyme substrate complexes (Lysozyme, carbonic anhydrase, carboxypeptidase and chymotrypsin); Multisite binding of ligands to proteins; Bohr's effect; Models of Allostery - MWC and KNF models Hill's equation coefficient; Kinetics of multisubstrate enzyme-catalysed reactions; Ping-pong bi-bi, random order and compulsory order mechanism. **Immobilised enzymes:** Methods and applications. **Protein Engineering:** Design and construction of novel proteins and enzymes using site-directed mutagenesis and Random/directed evolution strategies; Conformation of proteins in general and enzymes in particular; Effect of amino acids on structure of proteins; Energy status of a protein molecule, Structure- function relations of enzymes. Basic concepts for design of a new protein/enzyme molecule; Specific examples of enzyme engineering – Dihydrofolate reductase and Subtilisin. **Unit IV: Animal Tissue Culture & Programmed cell death (15L)** **Animal Cell Culture:** Primary Culture, Stem cells, Short term culture, cell lines, therapeutic cloning, Gene therapy (HIV, CarT cell), Mass cultivation- cytodex and biofermentors, **Tissue engineering and 3D printing** - bone, skin, vascular grafts, Artificial meat (culturing muscle and fat cells) and their environmental advantage. **Molecular Pharming of animals:** Recombinant proteins and vaccines. insect larvae as mini bioreactors. **Apoptosis:** Molecular mechanisms of caspase dependent (Apoptosis and Pyroptosis) and caspase independent cell death (Necrosis, Necroptosis, Autophagy - Macro, micro and CMA, Mitotic Catastrophe). Regulation of various cell death mechanisms. Interplay between various pathways of cell death. **Ethical issues in Animal tissue culture:** Ethical approval for the use of Animal and Human Tissue, Informed Consent, Material transfer agreements	**02**

Reference Books:

1. Kleinsmith and Harden, The World of the cell, Becker, Academic Internet Publishers; 5th edition (2006)
2. Geoffrey M. Cooper and Robert E. Hausman. The Cell: A Molecular Approach, Fourth Edition
3. Harvey Lodish. Molecular cell Biology. W. H. Freeman; Sol edition (2007)
4. Alberts B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. (2002) Molecular Biology of the Cell. Garland Publishing, Taylor & Francis Group, USA.
5. Karp, J.G. (2007) Cell and Molecular Biology. John Wiley & Sons, USA.
6. Kleinsmith, L.J.and Kish, V.M. (1996) Principles of Cell & Molecular Biology. Second Edition. Harper Collins College Publishers, USA.
7. Pollard, T.D. and Earnshow, W.C.(2002) Principles of Cell and Molecular Biology, Saunders, USA.
8. Ross Dalbey (Editor), Protein Targeting, Transport, and Translocation:, Publisher: Academic Press; 1 edition (May 13, 2002)
9. Nicholas C. Price, Lewis Stevens, and Lewis stevens, Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by (2000) Publisher: Oxford University Press, USA
10. Alejandro G. Marangoni, Enzyme Kinetics: A modern Approach Book: Enzyme Kinetics: A Modern Approach, (2003) Publisher: Wiley-Interscience Enzyme Kinetics and Mechanisms by Taylor Publisher: Springer

11. Christian Müller (Editor), Protein Engineering Protocols (Methods in Molecular Biology) K, Publisher: Humana Press; Softcover reprint of hardcover 1st ed. 2007
12. Anders Liljas, Structural Aspects of Protein Synthesis Publisher: World Scientific Pub Co Inc; 1 edition
(November 2004)
13. Ed. John R.W Masters Animal cell culture-Practical approach 3rd edition, Oxford university press-2000
14. In vitro cultivation of Animal cells. Elsevier India PVT LTD-17-A/1 Main Ring Road, New Delhi-110024
15. R. Sasidhara, Animal Biotechnology MJP publishers-Chennai.
16. Animal Cell Culture by Ian Freshney
17. Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press
18. Animal Cell Culture SudhaGangal

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV	**Course Name: Molecular Cell Biology Practicals**
Total Credits: 02	**Total Marks:** 50
Department assessment: 25	**University assessment:** 25

Course Outcome:

The learner would be able to:

1. Get practical knowledge of isolation of biomembrane.
2. Acquire practical knowledge of enzyme kinetics using inhibitors.
3. Understand the experimental details of enzyme immobilization

Course Code	Course Title	Total Credits
LScBCM609	**Molecular Cell Biology Practicals**	**02**
MODULE I **Practicals:** Preparation of lipid bilayer vesicles (liposomes) using the purified lipids 2. Effect of detergents on membranes 3. Protease protection assay to study protein transport and secretion 4. Enzyme inhibition A. Inhibition of enzyme activity B. Determination of Ki values 5. Immobilization studies A. Preparation of urease entrapped in alginate beads and determination of percent entrapment B. Study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads C. Study of reusability and storage stability of urease entrapped alginate beads D. Immobilization of urease by covalent attachment to solid support 6. Establishment of Primary Culture (ATC)/ short term culture using a suitable source. 7. Isolation of DNA and demonstration of apoptosis of DNA laddering		**02**

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV	**Course Name: Bioactives and Drug Development**
Total Credits: 04	**Total Marks:** 100
Department assessment: 50	**University assessment:** 50

Course Outcome:

The learner would be able to:

1. Analyze the potential role of free radicals in structural alteration of biomolecules, health and Diseases
2. Design and execute micropropagation procedures for plants.
3. Understand and apply propagation techniques in vertical farming

4. Demonstrate Green-house management
5. Basic differences between primary and secondary metabolites.
6. Qualitative and Quantitative methods of identification of natural products and their biological application.

Course Code	Course Title	Total Credits
LScBCM610	**Bioactives and Drug Development**	**04**
MODULE I **Unit I: Natural Products (15L)** **Natural products:** History of natural drugs, Sources of natural drugs - Plants, Animals, Microorganisms; medicinal mushrooms **Primary metabolites:** carbohydrates, proteins, nucleic acids and lipids and their importance to plants; **Secondary metabolites:** Types (Terpenoid, Nitrogenous, Phenolic pathways) mechanism of synthesis and modification of their skeletons and their importance in plants. **Principles used as:** Medicine (Artemisinin, paclitaxel, digitoxin, morphine, acetyl salicylate, colchicine) nutraceuticals (isoflavonoids, glucosamine, phytosterol, resveratrol, carotene, lycopene), insecticide (rotenone, pyrethrin, azadirachtin), pigments (cochneal, annato, indigo), fragrance (linalool, geraniol) flavours (vanillin) and other applications. **Unit II: Free radicals and Antioxidant Biology (15L)** **Free radicals:** Introduction & Chemistry of Reactive Oxygen/Nitrogen Species (ROS/RNS); Sources of ROS/RNS; Transition metals as catalyst; ROS and Signal Transduction; Glycation mediated free radicals; Carbonyl and oxidative stress; Beneficial Aspects of Oxidative Metabolism. Oxidative damage markers, Methods of Detecting ROS/RNS; Detection of free radicals in biological systems; EPR spectroscopy principles and determination. **Antioxidants:** Diet-Derived Antioxidants; Enzymatic and non-enzymatic components of antioxidative defense mechanism (catalase, peroxidase, superoxide dismutases, vitamins E and C, uric acid, glutathione, metal chelators); Chemical scavengers; Antioxidant therapy. **Role of free radicals in development of diseases:** Mechanisms of Protein oxidation, Lipid peroxidation, DNA oxidation. Types of oxidized lesions and their biological importance.		**02**
MODULE II **Unit III Plant Tissue Culture and Allied topics (15L)** **Basics of plant tissue culture:** totipotency, macro and micro nutrients, media. Culture: micropropagation - Types of Micropropagation methods, Callus culture, Suspension cell culture, Protoplast culture, Somatic hybridization, Cybrids, Somatic embryogenesis and synthetic seed production. **Secondary metabolite production:**(industrial scale): [shikonin, taxol (biosynthesis and bioreactor production) capsaicin / berberine]. **Green-House Management:** Greenhouse structure, and design, Environmental Control Systems, Pest management. medicinal plant cultivation. **Vertical Farming:** Concept, examples and methods (hydroponics, aquaponics and aeroponics), advantages, Vertical Farming in India, Challenges.		**02**

Unit IV: Pharmacognosy and Bio-efficacy studies (15L) **Activity Guided Drug Development:** Plant collection and Extract preparations: Methods of Plant collection, solvent extraction (cold, hot, critical fluid extraction etc), methods of identification (Qualitative and Quantitative), isolation and purification (Chromatography), Characterization (LC-MS, GC-MS, NMR, XRD, Elemental analysis etc); **In vitro testing -** Antimicrobial, Antidiabetic, Antioxidant, Anti-inflammatory, anti-larvicidal; **In vivo testing -** Pre-clinical and clinical trials	

Reference Books:

1. Packer L and Helumt S. Oxidative Stress and Inflammatory Mechanisms in Obesity, Diabetes, and the Metabolic Syndrome. CRC Press.
2. Milan Lazár, Free Radicals in Chemistry and Biology,
3. Barry Halliwell, Free Radicals in Biology and Medicine (Paperback), John Gutteridge
4. Barry Halliwell, DNA & Free Radicals (Textbook Binding), Okezie I. Aruoma (Editor)
5. DIEGO A. SAMPIETRO, CESAR A.N. CATALAN, MARTA A. VATTUONE (2009) Isolation, Identification and Characterization of Allelochemicals/Natural Products. Series Editor S. S. NARWAL Science publishers US
6. Khan and Khanum () Role of Biotechnology in Medicinal and Aromatics Plants by Vol. 1 to 4.
7. Arupratan Ghosh (2019) Greenhouse Technology: Principle and Practices;
8. Dr. Dickson Despommier (2011) The Vertical Farm: Feeding the World in the 21st Century Paperback – 25 October 2011 by (Author), Majora Carter (Foreword)
9. Gary Grending (2019) Vertical Farming: How to combine business with environmental awareness.
10. Relevant Research/ Review papers.

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV	**Course Name: Bioactives and Drug Development Practicals**
Total Credits: 02	**Total Marks:** 50
Department assessment: 25	**University assessment:** 25

Course Outcome:

The learner would be able to:

1. Get practical knowledge of isolation and bioassay of natural products.
2. Acquire practical knowledge of extraction and analysis of plant pigments.
3. Understand the experimental details of plant tissue culture.

Course Code	Course Title	Total Credits
LScBCM611	**Bioactives and Drug Development Practicals**	**02**
MODULE I **Practicals:** 1. Measurement of free radicals by spectrophotometric method (Total phenolics, DPPH assay, ABTS assay, FRAP assay) 2. Analysis of free radical scavengers and antioxidant enzymes (Assay of any one - peroxidase,		**02**

catalase, phenol oxidase, ascorbic acid oxidase, SOD) 3. Generation and measurement of oxidative and carbonyl stress in proteins and DNA (Protein oxidation method/DNA cleavage assay) 4. Plant pigments a. Extraction of plant pigments from spinach b. Separation by column chromatography c. Determination of absorption spectra of plant pigments 5. Micropropagation: a. Media preparation b. Shoot culture establishment c. Rooting of the obtained shoots. d. Hardening and Acclimatization of plantlets. 6. Natural product from animals: extraction of chitin/ chitosan from a suitable source. 7. Production of bioactives/ pigments/ secondary metabolites from a suitable callus. 8. Study of the Greenhouse. 9. Vertical farming demonstration. 10. Antimicrobial activity of bioactives and secondary metabolites 11. Bioautography and other bioactive guided isolation 12. Separation of compounds using HPLC/ HPTLC/ 13. Detection and quantitation of compounds using Spectrofluoro/ UV-VIS Spectrophotometry	

ELECTIVES – SEMESTER IV

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV **Total Credits:** 04 **Department assessment:** 50	**Course Name: Lifestyle disorders** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Define lifestyle diseases and health conditions associated with them
2. ldentify common lifestyle-related diseases, their molecular basis and treatment
3. Learn about various techniques for preliminary diagnosis of lifestyle disorders
4. Understand methods of prevention, treatment and management of the diseases.

Course Code	Course Title	Total Credits
LScBCM612a	**Lifestyle disorders**	**04**
MODULE I :		**02**

Course LScBCM612aT: Lifestyle disorders

Unit I: Metabolic Disorders (15 L)

Definition of Lifestyle disorders, common lifestyle disorders in India.
Definition and types of Metabolic Disorders, Nutritional and Molecular Perspectives.
Diabetes: Introduction, types of Diabetes, causes and risk factors, role of insulin and other hormones, involvement of metabolic pathways and enzymes in Diabetes, pathophysiology of type I and type II diabetes, Glycation and oxidative stress as modern theory of diabetes, significance of glycated hemoglobin as measurement index for hyperglycemica, secondary complications of Diabetes, management of diabetes, mechanism of action of modern and traditional therapeutic approaches.
Obesity: Introduction, causes and risk factors, indices for obesity, fat deposits, hormonal control of obesity (Leptin, Adiponectin, Gherlin, Resistin), pathophysiology of obesity, health risks associated with obesity, regulation of metabolic pathways and enzymes in obesity, Signaling pathways in the pathogenesis of obesity, management of obesity, mechanism of action of modern and traditional therapeutic approaches.
Biochemical basis of PolyCystic Ovarian Syndrome, relationship between PCOS, obesity, Diabetes and Insulin

Unit II: Cardiovascular Diseases (15 L)

Definition of Cardiovascular Diseases, Risk factors for cardiovascular diseases, Common symptoms, Types of CVD (Brief description of coronary heart disease - angina, myocardial infarction and/or heart failure, Atherosclerosis; cerebrovascular disease - stroke, peripheral arterial disease, rheumatic heart disease; congenital heart disease, and deep vein thrombosis and pulmonary embolism), Genetic and Molecular bases of CVDs, Lipids and lipoportoeins in CVDs, Biomarkers in CVD, Biochemical diagnostic tests for CVDs, Management and prevention of CVDs, Nutrition and CVDs, Diabetes and CVDs, Obesity and CVDs.

MODULE II: **Course LScBCM612aP: Lifestyle disorders Practicals/ Case studies** **Practicals:** 1. Estimation of blood glucose parameters 2. Analysis of Glycation and oxidative stress parameters 3. Analysis of damage of proteins during diabetes/hyperglycemia 4. Analysis of glycoxidation damage of DNA during diabetes/hyperglycemia 5. Determination and significance of BMI and other obesity indices 6. Project Work based on Case studies related to risk factors of Diabetes/obesity/PCOS/CVD 7. Antidiabetic, antiobesity and cardiovascular health natural products analysis 8. Databases for lifestyle disorders	**02**

Reference Books:

1.Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd/W.B. Saunders Company.

2.Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body Functions. McGraw-Hill Education 13th Edition.

3. Kathleen Botham, Owen McGuinness, P. Anthony Weil, Peter Kennelly, Victor Rodwell. Harper's Illustrated Biochemistry, Thirty-Second Edition

4.Devlin, Thomas M, Textbook of biochemistry with clinical correlations Edition: 5th

5.Chatterjea, MN , Shinde, Rana, Textbook of Medical Biochemistry

6.D.M.Vasudevan & S.Sree Kumari, Textbook of Biochemistry for Medical Students 4/e, 2004

7.Colleen Smith, Allan D. Marks, Michael Lieberman, Mark's Basic Medical Biochemistry - A Clinical Approach 2nd Edition

8.Richard Harvey and Denise Ferrier, Lippincott's Illustrated Reviews - Biochemistry 5th Edition

9.Michael L. Bishop, Edward P. Fody, Larry Schoeff, Clinical Chemistry – Principles, procedures, correlations 5th Edition

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV **Total Credits:** 04 **Department assessment:** 50	**Course Name: Immunology and Immunotechniques** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Explain the cellular and organ systems involved in immune responses.
2. Understand the immunological manifestation of infectious diseases.
3. Know and use the antigen-antibody interactions and techniques based on these interactions.

Course Code	Course Title	Total Credits
LScBCM612b	**Immunology and Immunotechniques**	**04**
MODULE I: **Course LScBCM612bT: Immunology and Immunotechniques** **Unit I: Immunology (15L)** **Lymphatic system**, structure and function of spleen and lymph node. **Major Histocompatiility Complex** I and II and their importance. **B cells:** Development, generation of antibody diversity, activation somatic hypermutation and class switch. Primary and secondary immune modulation **T cells:** Development, TCR diversity, selection and types of T cells and activation. **The Complement** and its regulation. **Immune response to infectious diseases:** Viral, Bacterial, Parasitic, AIDS. **Congenital immunodeficiencies**: SCID. **Autoimmune diseases -** Myasthenia gravis, Rheumatoid arthritis. **Unit II: Immunotechniques (15L)** **Immuno- techniques**: Precipitation, agglutination and complement mediated immune reactions **Advanced immunological techniques**: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs	**02**
MODULE II: **Course LScBCM612bP: Immunology and Immunotechniques Practicals** **Practicals:** 1. Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF) 2. Separation of lymphocytes on Ficoll Histopaque and viability count 3. Study of precipitation reactions- Ouchterlony and Mancini 4. Demonstration of Western blotting 5. Widal test- quantitative	**02**

6. RPR (Rapid Plasma Reagin)- kit based 7. Determination of ESR	

Reference Books:

1. Janis Kuby (2002):5th Immunology 5th Edition, Publisher; W. H. Freeman.
2. Judy Owen , Jenni Punt, Sharon Stranford (2013): Kuby Immunology 7th Edition. W.H.Freeman & Co Ltd.
3. Cell Biology 3rd edition : Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwarts, Graham Johnson

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV **Total Credits:** 04 **Department assessment:** 50	**Course Name: Omics Technology** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Capture the essence of bioinformatics.
2. Handle and analyze biological sequences.
3. Design and evaluate the biological experimental systems using bioinformatics tools.

Course Code	Course Title	Total Credits
LScBCM612c	**Omics Technology**	**04**
MODULE I:		**02**

Course LScBCM612cT: Omics Technology

Unit I: Bioinformatics (15 L)

Introduction to Bioinformatics: History of Bioinformatics, Different Omics and its application and Current status.

Biological databases: Primary DNA and Protein Databases, Secondary Protein Databases, Secondary Composite Structure Databases, Protein Databank (PDB), Metabolism Database (KEGG).

Multiple Sequence Alignment (MSA): Definition, Objective, Motif, Consensus, Methods for MSA, Heuristic approach, Dynamic programming approach.

Pairwise Alignment: Introduction, PAM Matrix, BLOSUM Matrix, The Dot Plot, Global alignment, Local alignment, FastA and BLAST. Statistics: P and E value.

Phylogenetic Analysis: Terminology of tree- reconstruction, rooted and un- rooted trees. Methods: UPGMA, Neighbor- Joining Method, Maximum Parsimony.

Unit II: Genomics,Transcriptomics, Proteomics and Metabolomics (15L)

Genomics: Gene finding, OMIM database, reference genome sequence, integrated genomic maps, SNP database (DbSNP).

Transcriptomics: RNA- types and their analysis, Gene expression profiling (SAGE, qPCR) Genome wide associated studies, Manhattan Plot.

Proteomics: Introduction and current status

Prediction of secondary structure: PHD and PSI- PRED method.

Tertiary (3- D) Structure prediction: Fundamentals of the methods for 3D structure prediction (sequence similarity/identity of target proteins of known structure, fundamental principles of protein folding etc.) Homology Modelling, fold recognition, threading approaches, and ab- initio structure prediction methods.

In silico drug designing: Computer aided Drug Designing (CADD)

Metabolomics: Introduction, Current status, Technology (Microarray, GWAS, LC-MS, GC-MS), Applications

MODULE II:	**02**
Course LScBCM612cP: Omics Technology Practicals **Practicals:** 1. Multiple sequence alignment and Phylogenetic tree analysis 2. BLAST- BLASTn, BLASTp, primer BLAST. 3. Motif Finding- MEME and myhits 4. Secondary Structure Prediction: Interproscan 5. CATH and SCOP 6. KEGG 7. Tertiary Structure: PDB, Rasmol 8. Homology Modelling – SWISS- MODEL 9. In silico drug designing- Swiss-ADME	

Reference Books:

1. Attwood T. K., Parry-Smith D. J and Phukan S. (2009). Introduction to Bioinformatics. Pearson Education
2. 2. Mount D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Habour Laboratory
3. Pevsner J. (2015). Bioinformatics and Functional Genomics. Wiley-Blackwell
4. Harisha S. (2019). Fundamentals of Bioinformatics. Dreamtech Press
5. Higgs P. G. and Attwood T. K. (2005). Bioinformatics and Molecular Evolution. Wiley
6. Bal H. P. (2004). Bioinformatics: Principles and Applications. McGraw Hill Education

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV **Total Credits:** 04 **Department assessment:** 50	**Course Name: Pharmaceutical Biochemistry** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the principles of pharmacology and pharmaceutical biochemistry.
2. Capture the biochemical approach to drugs and drug mechanism.
3. Explain the benefits of drug components and adverse drug effects
4. Discuss the concept and stages of drug trials

Course Code	Course Title	Total Credits
LScBCM612d	**Pharmaceutical biochemistry**	**04**
MODULE I: **Course LScBCM612dT: Pharmaceutical biochemistry** **Unit I: Drug metabolism & interactions (15L)** Introduction to Pharmacology and pharmaceutical biochemistry. History of Drugs, Sources and Classification of drugs Principles & Mechanism of Drug action though Chemicals, Enzymes (Stimulation and Inhibition), Drug-dose response, combined effect of Drugs, Drug Dosage. Factors modifying Drug action. Basic ligand concepts-agonist, antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification, Drug Receptor Interaction, Receptor binding assays - measurement of Kd, Bmax and IC50. Introduction to QSAR. Chemical information computing system in drug discovery. Molecular modeling drug action **Unit II: Adverse Responses and Drug Trials (15L)** Adverse responses – Side effects, Secondary effects, Toxic effects, Intolerance, Idiosyncrasy, and Allergy of drugs. (Mechanisms and Types of allergic reactions). Photosensitivity due to drugs. Drug Dependence – Drug abuse and addiction. Drug withdrawal reactions, Teratogenicity, Carcinogenicity, Mutagenicity. Drug induced Diseases. Overview of the list of banned drugs in India and WHO recommendations General principles of screening, various animal models and human situations, Comparison between in-vitro and in-vivo screens; Special emphasis on cell-based assay, biochemical assay, Pharmacological assay, In vitro, In vivo & Ex-vivo experiments, Preclinical and clinical trials (Phase-I, Phase-II, Phase-III and Phase-IV clinical trial). Main features of clinical trials.		**02**
MODULE II: **Course LScBCM612dP: Pharmaceutical biochemistry Practicals** **Practicals:** 1. Study and applications of enzymes Kinetics, Inhibition and Immobilization. 2. Determination of pKa value.		**02**

3. Synthesis of drugs using basic operations like Molecular distillation, fractional crystallization, and purification by column chromatography. Preparative TLC. 4. Mixture analysis of 2/3 organic compounds. 5. Application of partition coefficient, pKa. Stearic factors, electronic factors in QSAR studies with example. Use of statistical regression analysis.	

Reference Books:

1. Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc.
2. 3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien ESCOM. Revised M.Sc. Biochemistry from 2019 16
3. Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, 2004
4. The Pharmacology volume I and II –Goodman and Gillman.
5. Essentials of Pharmaceutical biochemistry including practical exercises (EDN 2) by HarbansLal, International Edition, 2019.
6. Biochemistry for the pharmaceutical sciences by Charles P. Woodbury, 2011.
7. Pharmacology and Pharmatherapeutics – R.S.Satoskar,S.D.Bhandhakarand.
8. Lippincotts illustrated review Pharmacology.
9. Essentials of Medical Pharmacology by K D Tripathi.
10. Clinical Chemistry by Bishop, Duben- Engelkirk&Fody.

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV **Total Credits:** 04 **Department assessment:** 50	**Course Name: Environmental Biochemistry** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the role Pollutants in the environment
2. Will learn importance of microbiota.
3. Explain the control techniques of pollutants.

Course Code	Course Title	Total Credits
LScBCM612e	**Environmental Biochemistry**	**04**
MODULE I:		**02**

Course LScBCM612eT: Environmental Biochemistry

Unit I: Pollution and its accumulation **(15L)**

Introduction, Basic environmental chemistry: soil, air and water,
Pollution: sources, fates and cleanup, Atmospheric composition and principles of contaminant behaviour in the environment, Greenhouse effect, Global temperature, Acid rain and Ozone layer depletion.
Monitoring pollution- Bioindicators , Biomarkers
Anabolism: The effect of the anabolism on the environment, Synthesis of the most common natural polymers.
Catabolism: The effects of the catabolic processes on the environment. Basics of co-oxidation (co-metabolism) and bioaccumulation.
Microbial degradation: aromatic, aliphatic and chlorinated organic compounds, Regulation of degradative processes and strain construction, Biochemistry and microbiology in deep-subsurface environments.

Unit II: Pollution control tehniques **(15L)**

Soil enzymology: Introduction, Biochemical and microbiological aspects of the soil – plant interaction. Biochemistry of plant-soil-soil animal-microbe interactions.
Interaction of the aquatic environment with the atmosphere. Biochemical processes with global effect. The effect of secondary metabolites on the environment. Environmental biochemistry of antibiotics and compounds with hormone effect. Toxin production and fate of toxins in the environment, Fate of pathogens in the environment. Biosensors for detecting chemical pollutants
Pollution control techniques : Air Pollution Control Techniques,
Water Pollution Treatment : Chemical Degradation of wastes and Chemicals, Coagulation and flocculation, Photocatalytic degradation of pollutants, Supercritical water oxidation, Bioremediation and Phytoremediation

MODULE II: **Course LScBCM612eP: Environmental Biochemistry Practicals** **Practicals:** 1. Determination of total organic matter in soil. 2. Determine the total phosphorus in given soil sample. 4. Determination of pH value of different types of soil 5. Determination of water holding capacity of soil. 6. Determination of Nitrate, phosphate and sulphate from soil / water 7. To study the effect of pollutant on plant GROWTH 8. Isolation of Microorganisms form polluted environment/Soil /Water resources /Air 9. Detection and isolation of industrially important microorganisms – lipase producers, oil degraders, antibiotic producers. 10. Microbial degradation of textile/dyes/pesticides, Hydrocarbon and oils. 11. Case study – biotransformation, Bioremediation, Phytoremediation	**02**

Reference Books:

- Konhauser, K., 2009: Introduction to Geomicrobiology. Blackwell,
- Madigan, M.T., Martinko, J.M., Stahl, D.A., Clark, D.P. (2011): Brock Biology of Microorganisms. Benjamin Cummings
- Tóth, E., Márialigeti, K. (2013): Practical microbiology. Eötvös University
- J. Jeffrey Peirce,P.AarneVesilind, Ruth F. Weiner Environmental Pollution and Control, 4th ed.Elsevier Science & Technology Books 1997
- Manahan,Stanley E. Fundamentals of Environmental Chemistry Boca Raton: CRC Press LLC,2001
- Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong Chemistry of the Environment,Elsevier Science & Technology Books 2002
- Eugene R. Weiner Applications of Environmental Chemistry 2000 CRC Press, LLC
- By Clair N.Sawyer,Perry L. McCarty, Gene F.Parkin Chemistry for environmental engineering and science (5th edition) McGrawHill Professional

Programme Name: M.Sc. (Life Sciences - Biochemistry) Semester IV **Total Credits:** 06 **Department assessment:** 75	**Course Name: Research Project II** **Total Marks:** 150 **University assessment:** 75

Course Outcome:

The learner would be able to:

1. Analyze and determine the lacunae of the existing literature in any given field of study.
2. Formulate a hypothesis based on a focussed literature review.
3. Use the tenets of research methodology to design an effective research study.
4. Demonstrate the actual execution of the research design
5. Highlight the weaknesses and strengths of the study.
6. Prepare a presentation and appropriately record the studies done in this course.

Course Code	Course Title	Total Credits
LScBCM613	**Research Project II**	**06**
Introduction This course is designed to extend the concepts in Research Methodology to address a lacuna in the existing knowledge in a particular area of the discipline of Life Sciences. The learner would be able to identify and organize the existing literature on a given topic, formulate a hypothesis, design a research project and plan experiments to prove a hypothesis. The research project is aimed to enable the researcher to conduct scientifically designed experiments for a meaningful assessment and conclusion of the observations and results. The learner would be able to effectively document and present the parameters and findings of the research project. There are six credits assigned to the course. As this is of a practical and hands-on nature, every two hours spent on the project in a week would earn a credit. The course spans over 15 weeks and hence the time that needs to be devoted would be 180 hours. This could be planned and completed over a span of 15 weeks or continuously 6 - 8 weeks. Where can these projects be done: The projects could be conducted in-house or could be in industry or research institutes or recognized institutes that carry out research. The host institution would be from any field of Life Sciences. The project would be carried out with the consent and understanding between the University Department of Life Sciences and the relevant Academic/ research Institute or the Industry Documentation for the Research Project II: The proforma for internal evaluation by the mentor (at the place of work) is given at the end of the syllabus. The formulation of the project, the application and attendance of the learner would be evaluated on a continuous basis. This would be the backbone of the internal assessment. The scheme for the same is given at the end of the syllabus. The submitted thesis of the project, a draft research paper based on the results obtained in Research Project II and its presentation would be evaluated by external examiners The relevant weightages are given at the end of the document.		**06**

Research Project (II): *Internal Assessment: 75 mks* • Research/ Grant Proposal: 25 mks • Progress evaluation by internal committee and/or with Feedback From the external organization: 25 • Attendance: 25 *External Assessment: 75 mks.* • Thesis submission and evaluation: 25 • Draft paper/ Presentation: 25 • Viva: 25	

EVALUATION SCHEME

Evaluation: SEMESTER III

Paper Code	Theory		Practical		Total
	Internal	External	Internal	External	
LSc601	50	50			100
LSc602			25	25	50
LSc603	50	50			100
LSc604			25	25	50
LSc605	25	25			50
LSc606 (Electives: a to e)	25	25	25	25	100
LSc607 (ResearchProject I)	Evaluation scheme at the end of the Document				100

Evaluation: SEMESTER IV

Paper Code	Theory		Practical		Total
	Internal	External	Internal	External	
LSc608	50	50			100
LSc609			25	25	50
LSc6010	50	50			100
LSc611	25	25			50
LSc612 (Electives: a to e)	25	25	25	25	100
LSc613 (ResearchProject II)	Evaluation scheme at the end of the Document				100

A. Evaluation for Mandatory Theory Courses (4 Credit Courses)

I. Internal Evaluation for Mandatory Theory Courses: 50 Marks

The internal evaluation for mandatory theory courses comprises two components, each carrying a specific weightage. Students can choose between the following options to fulfil the evaluation requirements:

Option 1: (i) The course teacher will have the liberty to choose the assessment tools/ methods (class test/assignment/record book/tutorials/seminars/case study/ field work/ project work/ quiz/ etc.) – 50 marks.

Option 2: (i) Completion of SWAYAM (Advanced Course) of minimum 2 credits and certification exam - 50 Marks

Option 3: (i) Completion of NPTEL (Advanced Course) of minimum 2 credits and certification exam - 50 Marks

Option 4: (i) Possession of valid International Certifications from recognized providers such as Prometric, Pearson, Certiport, Coursera, Udemy, or similar platforms - 50 Marks

Note: It's important to note that each certification will be awarded marks for only one course. For example, if a student completes four courses, they will need to obtain four different certifications to fulfil the certification marks requirement for each course.

II. External Examination for Mandatory Theory Courses- 50 Marks

- Duration: **2.0 Hours**
- Theory question paper pattern:

	All questions are compulsory.		
Question	**Based on**	**Options**	**Marks**
Q.1	Unit I	Any 1 out of 2 (1 or 1 a, b)	10
Q.2	Unit II	Any 1 out of 2 (2 or 2 a, b)	10
Q.3	Unit III	Any 1 out of 2 (3 or 3 a, b)	10
Q.4	Unit IV	Any 1 out of 2 (4 or 4 a, b)	10
Q.5	Unit I, II, III& IV	Any 4 out of 8 (short notes)	10

B. Evaluation for Elective Theory Courses (4 Credit Courses)

Evaluation for Elective Theory Courses (2 Credit Courses)

I. Internal Evaluation for Elective Theory Courses: 25 Marks

The internal evaluation for elective theory courses consists of two components, each carrying a specific weightage. These components are as follows:

The course teacher will have the liberty to choose the assessment tools/ methods (class test/assignment/record book/tutorials/seminars/case study/ field work/ project work/ quiz/ etc.) – 50 marks.

II. External Examination for Elective Theory Courses- 25 Marks

- Duration: **1 Hour**
- Theory question paper pattern:

	All questions are compulsory.		
Question	**Based on**	**Options**	**Marks**
Q.1	Unit I	Any 1 out of 2 (1 or 1 a, b)	10
Q.2	Unit II	Any 1 out of 2 (2 or 2 a, b)	10
Q.3	Unit I & II	Any 2 out of 4 (short notes)	5

C. Evaluation for Mandatory & Elective Practical Courses (2 Credit Courses)

The evaluation for both mandatory and elective practical courses is conducted according to the following criteria:

- Each practical course carries a **total of 50 Marks**, distributed as follows:
  - University Assessment: 25 Marks for practical performance (1 question of 15 marks, spot tests for 5 marks and viva for 5 marks)
  - Departmental Assessment: 5 Marks for the journal, 5 marks for attendance, 5 marks for participation and 10 marks for viva – total 25 marks.
  - The duration of each practical course is 6 to 8 hours.
- To be eligible for evaluation, students must complete a minimum of 80% of the practical work assigned in each core subject.
- It is mandatory for students to submit a certified journal at the time of the practical examination. The journal serves as a record of their practical work and is an essential component of the evaluation process.

Evaluation of Research Project Work I (4 Credit Course):

(Proforma for the Evaluation of the learner by the industry mentor /to whom the learner was reporting in the organization)

Internal Evaluation (by the institution/ at place of Internship by Mentor): 50 Marks

No	Particular	Excellent	Very Good	Good	Moderate	Satisfactory
1	Attendance & Punctuality					
2	Ability to work in a team					
3	Written and oral communication skills					
4	Problem solving skills					
5	Ability to grasp new concepts					
6	Technical skill in terms of technology, programming, etc					
7	Ability to complete tasks					
8	Quality of overall work done					
9	Time management*					
10	Critical thinking*					

- **Time Management:** Evaluating the ability to effectively manage time and meet deadlines.
- **Critical Thinking:** Assessing the ability to analyze information, evaluate options, and make reasoned decisions.

- **Patterns of Marks: out of 50 as per marks obtained in each of the 10 categories**

Excellent	Very Good	Good	Moderate	Satisfactory
5	4	3	2	1

Comments:_____

Signature: _____

Name:

Designation:

Contact details:

Email:

(Seal of the organization)

Research Project (I): Total Marks = 100.
Internal Assessment: 50 mks.
Thesis submission and evaluation along with Feedback From the organization: 25 mks
Viva: by an Internal Committee (2 members): 25 mks.

External Assessment: 50 mks.
Draft Paper submission: 25 mks
Presentation: 25 mks.

D. Evaluation of Research Project Work II (6 Credit Course):

(Proforma for the Evaluation of the learner by the industry mentor /to whom the learner was reporting in the organization)

Internal Evaluation (by the institution/ at place of Internship by Mentor): 50 Marks

No	Particular	Excellent	Very Good	Good	Moderate	Satisfactory
1	Attendance & Punctuality					
2	Ability to work in a team					
3	Written and oral communication skills					
4	Problem solving skills					
5	Ability to grasp new concepts					
6	Technical skill in terms of technology, programming, etc					
7	Ability to complete tasks					
8	Quality of overall work done					
9	Time management*					
10	Critical thinking*					

- **Time Management:** Evaluating the ability to effectively manage time and meet deadlines.
- **Critical Thinking:** Assessing the ability to analyze information, evaluate options, and make reasoned decisions.

- **Patterns of Marks: out of 50 as per marks obtained in each of the 10 categories**

Excellent	Very Good	Good	Moderate	Satisfactory
5	4	3	2	1

Comments:_____

Signature: _____

Name:

Designation:

Contact details:

Email:

(Seal of the organization)

Research Project (II): Total Marks = 150.

Internal Assessment: 75 mks

- Research Proposal: 25 mks
- Progress evaluation by internal committee or along with Feedback from the organization: 25
- Attendance: 25

External Assessment: 75 mks.

- Thesis submission and evaluation: 25
- Draft paper/ Presentation: 25
- Viva: 25

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result
9.00 - 10.00	90.0 - 100	O (Outstanding)
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)
5.00 - < 5.50	50.0 - < 55.0	C (Average)
4.00 - < 5.00	40.0 - < 50.0	P (Pass)
Below 4.00	Below 40.0	F (Fail)
Ab (Absent)	-	Absent

Appendix-I

Maintain the weekly online diary for each week in the following format.

	Day	Date	Name of the Topic/Module Completed	Remarks
1st WEEK	Monday			
	Tuesday			
	Wednesday			
	Thursday			
	Friday			
	Saturday			

Signature of the Faculty mentor: _____

Seal of the University
Department

Appendix-II

(Proforma for the certificate for internship in official letter head)

This is to certify that Mr. /Ms. ……..... of University Dept of Life Sciences worked as an intern as part of his/her M.Sc. course in Life Sciences of University of Mumbai. The particulars of internship are given below:

Internship starting date: _____

Internship ending date: _____

Actual number of days worked: _____

Tentative number of hours worked:_____Hours

Broad area of work: _____

A small description of work done by the intern during the period:

Signature: _____

Name:

Designation:

Contact details:

Email:

(Seal of the organization)

Appendix-III

(Proforma for the certificate for Project Work in official letter head)

This is to certify that Mr. /Ms. ……..... of University Dept of Life Sciences worked as an Project Student as part of his/her M.Sc. course in Life Sciences of University of Mumbai. The particulars of internship are given below:

Project Work starting date: _____

Project Work ending date: _____

Actual number of days worked: _____

Tentative number of hours worked:_____Hours

Broad area of work: _____

A small description of work done by the Project Student during the period:

Signature: _____

Name:

Designation:

Contact details:

Email:

(Seal of the organization)

Team for Creation of Syllabus (M. Sc. Life Sciences - Biotechnology)

Name	College Name	Sign
Prof. Indu Anna George	Department of Life Sciences, University of Mumbai	
Dr. Tejashree Shanbag	Principal, K.C. College, HSNC University	
Dr. Prashant Ratnaparkhi	Head, Department of Life Science, St. Xaviers College	
Prof. Priya Sundarrajan	Department of Life Science, St. Xaviers College	
Dr. Nilima Gajbhiye	Department of Life Science, Ramnarain Ruia College	
Dr. Kanchan Chitnis	Department of Life Science, Ramnarain Ruia College	
Dr. Ahmad Ali	Department of Life Sciences, University of Mumbai	
Dr. Suruchi Jamkhedkar	Department of Life Sciences, University of Mumbai	
Dr. Nisha Shah	Department of Life Sciences, University of Mumbai	
Dr. Hina Alim	Department of Life Sciences, University of Mumbai	
Dr. Vikrant Bhor	ICMR-National Institute for Research in Reproductive and Child Health (ICMR-NIRRCH)	
Dr. Pamela Jha	SuSunandan Divatia School of Science, SVKM's Narsee Monjee Institute of Management Studies,	
Dr Kafeel Ahmed	Director and CEO Resinno Biotech Private Limited	

Indu Anna George
9/7/2024

Sign of BOS Chairperson
Prof. Indu Anna George
Department of Life Sciences
Ad-hoc BOS in Life Sciences

Sign of Offg. Assoc. Dean
Dr. Madhav Rajvade
Offg. Assoc. Dean
Science and Technology
University of Mumbai

Sign of Offg. Dean
Prof. Shivram Garje
Dean Science and Technology
University of Mumbai