AC — 07/07/2023
Item No. — **6.16 (N)**

As Per NEP 2020

University of Mumbai

Title of the program

A- P.G. Diploma in Life Sciences
B- M.Sc. (Life Sciences- Aquaculture Technology) (Two Year)
C- M.Sc. (Life Sciences- Aquaculture Technology) (One Year)-

2o23 - 24

2027-28

Syllabus for

Semester — Sem I & II

Ref: GR dated 16th May, 2023 for Credit Structure of PG

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 toprovide 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 offered by 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 astrong foundation for further studies and research. Students will develop a deepunderstanding 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 inindependent 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), fosteringtheir 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.

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

R_____
Post Graduate Programs in University Parishishta - 1

Year (2 YrPG)	**Level**	**Sem.** (2Yr)	**Major**		**RM**	**OJT / FP**	**RP**	**Cum.Cr.**	**Degree**
			Mandatory*	**ElectivesAny one**					
I	**6.0**	**SemI**	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 OR Course 6	4			22	**PG Diploma(after3YearDegree)**
		SemII	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 OR Course 6		4		22	
Cum. Cr. For PG Diploma			**28**	**8**	**4**	**4**	**-**	**44**	

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 HOD

21/08/23

Dr. Ujwala Jadhav
Department of Life Sciences
University of Mumbai

Sign of Dean,

Garje

Dr. Shivram Garje
Dean Science and Technology
University of Mumbai

Compulsory (Major/ Core)

M.Sc. (Life Sciences - Aquaculture Technology)			Credits
Semester I	LSc501	Cell Biology	4
	LSc502	Cell Biology Practicals	2
	LSc503	Plant Sciences	4
	LSc504	Plant Sciences Practicals	2
	LSc505	Environmental Biology	2
	LSc507	Research Methodology	4
Semester II	LSc508	Animal Sciences	4
	LSc509	Animal Sciences Practicals	2
	LSc510	Biochemical Sciences	4
	LSc511	Biochemical Sciences Practicals	2
	LSc512	Molecular Biology	2
	LSc514	On the Job Training/ Field Project	4
Semester III	LScAQT601	Aquaculture Principle, Production & Practices	4
	LScAQT602	Aquaculture Principle, Production & Practices Practicals	2
	LScAQT603	Mariculture Biotechnology	4
	LScAQT604	Mariculture Biotechnology Practicals	2
	LScAQT605	Physiology of Finfish & Shellfish	2
	LScAQT607	Research Project	4
Semester IV	LScAQT608	Fish Products and Quality Assurance	4
	LScAQT609	Fish Products and Quality Assurance Practicals	2
	LScAQT610	Aquaculture Drugs and Pharmacological Studies	4
	LScAQT611	Aquaculture Drugs and Pharmacological Studies Practicals	2
	LScAQT613	Research Project	6

Electives

M.Sc. (Life Sciences- Aquaculture Technology)			Credits
Semester I	LSc506a	Microbial Techniques	4
	LSc506b	Bio-safety and Quality Assurance	4
	LSc506c	Gene Therapy and Genetic Counselling	4
	LSc506d	Molecular Virology	4
	LSc506e	Integrated Freshwater Aquaculture Techniques	4
	LSc506f	Sleep Sciences: Exploring Disorders, Neurobiologyand Advances	4
Semester II	LSc513a	Scientific Conduct and Communications	4
	LSc513b	Food Technology	4
	LSc513c	Biotechniques	4
	LSc513d	Biostatistics	4
	LSc513e	Remote Sensing	4
	LSc513f	Agri-business management	4
Semester III	LScAQT606a	Blue Revolution	4
	LScAQT606b	Ornamental Fishes and Aquarium Management	4
	LScAQT606c	Fish Nutrition and feed Technology	4
	LScAQT606d	Commercially Important Sea Food	4
	LScAQT606e	Aquatic Waste Product and its Use	4
Semester IV	LScAQT612a	Commercial Pearl Production Process	4
	LScAQT612b	Aquaponics and Aquatic Engineering	4
	LScAQT612c	Fish Processing and Preservation Technology	4
	LScAQT612d	Fish Breeding and Hatchery Management	4
	LScAQT612e	Seaweed Culture & its Economic Importance	4

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4. Credit Distribution Structure for One Year PG Diploma in Life Sciences / Two Years M.Sc. (Life Sciences- Aquaculture Technology)

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Level</th><th rowspan="2">Sem</th><th colspan="4">Major</th><th rowspan="2">RM</th><th rowspan="2">OJT/FP</th><th rowspan="2">RP</th><th rowspan="2">Cum. Cr.</th><th rowspan="2">Degree</th></tr>
<tr><th colspan="3">Mandatory</th><th>Electives</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">6.0</td><td rowspan="2">SemI</td><td colspan="3">2*4+2*2+2</td><td>4</td><td>4</td><td>-</td><td></td><td>22</td><td rowspan="3">PG Diploma(after 3YearsDegre e)</td></tr>
<tr><td>Course LSc501: Cell Biology</td><td>TH</td><td>4</td><td rowspan="6">Course LSc506a : Microbial Techniques
2 TH + 2 PR
OR
Course LSc506b: Bio-safetyand Quality Assurance
2 TH + 2 PR
OR
Course LSc506c: Gene Therapy and Genetic Counselling
2 TH + 2 PR
OR
Course LSc506d: Molecular Virology
2 TH + 2 PR
OR
Course LSc506e: Integrated Freshwater Aquaculture Techniques
2 TH + 2 PR
OR
Course LSc506f: Sleep Sciences: Exploring Disorders,Neurobiology and Advances
2 TH + 2 PR</td><td rowspan="6">Research Methodology (LSc507)</td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>Course LSc502: Cell Biology Practicals</td><td>PR</td><td>2</td></tr>
<tr><td>Course LSc503: Plant Sciences</td><td>TH</td><td>4</td></tr>
<tr><td>Course LSc504: Plant Sciences Practicals</td><td>PR</td><td>2</td></tr>
<tr><td>Course LSc505: Environmental Biology</td><td>TH</td><td>2</td></tr>
<tr><td></td><td colspan="3">2*4+2*2+2</td><td>4</td><td>-</td><td></td><td>-</td><td>22</td></tr>
</table>

Year	Level	Sem	Major				RM	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory			**Electives**					
		SemII	Course LSc508: Animal Sciences	TH	4	Course LSc513a: Scientific Conduct and Communications.2 TH + 2 PR **OR** Course LSc513b: Food Technology 2 TH + 2 PR **OR** Course LSc513c:Biotechniques 2 TH + 2 PR **OR** Course LSc513d: Biostatistics 2 TH + 2 PR **OR** Course LSc513e: RemoteSensing 2 TH + 2 PR **OR** Course LSc513f: Agri-business management 2 TH + 2 PR		LSc514 (4)			
			Course LSc509: Animal Sciences Practicals	PR	2						
			Course LSc510: Biochemical Sciences	TH	4						
			Course LSc511: Biochemical Sciences Practicals	PR	2						
			Course LSc512: Molecular Biology	TH	2						
Cum. Cr. For PG Diploma			28			8	4	4		44	
Exit Option: PG Diploma (44credits) After Three Year UG Degree											

Second Year PG:

Year (2Yr PG)	**Level**	**Sem.** (2Yr)	**Major**		**RM**	**OJT / FP**	**RP**	**Cum.Cr**	**Degree**
			Mandatory	**Electives**					
II	**6.5**	**Sem III**	Course1: LScAQT601: Aquaculture Principle, Production & Practices Credits 4 Course 1: LScAQT602: Aquaculture Principle, Production & Practices Practicals Credits 2 Course 3: LScAQT603: Mariculture Biotechnology Credits 4 Course 4: LScAQT604:Mariculture BiotechnologyPracticals Credits 2 Course 5: LScAQT605:Physiology of Finfish & Shellfish Credits 2	**Credits 4** Course LScAQT606a: Blue Revolution 2 TH + 2 PR **OR** Course LScAQT606b: Ornamental Fishes and Aquarium Management 2 TH + 2 PR **OR** Course LScAQT606c: Fish Nutrition and feed Technology 2 TH + 2 PR **OR** Course LScAQT606d: Commercially Important Sea Food 2 TH + 2 PR **OR** Course LScAQT606e: Aquatic Waste Product and its Use 2 TH + 2 PR			LScAQT607 (4)	22	**PGDegree After3-YrUG**

		Sem IV	Course 1: LScAQT608: Fish Products and Quality Assurance Credits 4 Course 2: LScAQT609: Fish Products and Quality Assurance Practicals Credits 2 Course 3: LScAQT610: Aquaculture Drugs and Pharmacological Studies Credits 4 Course 4: LScAQT611: Aquaculture Drugs and Pharmacological Studies Practicals Credits 2	**Credits 4** Course LScAQT612a: Commercial Pearl Production Process 2 TH + 2 PR **OR** Course LScAQT612b: Aquaponics and Aquatic Engineering 2 TH + 2 PR **OR** Course LScAQT612c: Fish Processing and Preservation Technology 2 TH + 2 PR **OR** Course LScAQT612d: Fish Breeding and Hatchery Management 2 TH + 2 PR **OR** Course LScAQT612e: Seaweed Culture & its Economic Importance 2 TH + 2 PR			LScAQT613 (6)	22	
Cum. Cr. for 1 YrPGDegree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 YrPGDegree			**54**	**16**	**4**	**4**	**10**	**88**	

DETAILED SYLLABUS

SEMESTER I

Paper Code	Unit	Description	Credits	Hrs
Course LSc501		**Cell Biology**	**4**	**60**
Module 1	I	Cell Structure and function	1	
	II	Molecular basis of Cell division	1	
Module 2	III	Cell Communication	1	
	IV	Genetics	1	
Course LSc502		**Cell Biology Practicals**	**2**	**60**
Module 1				
Course LSc503		**Plant Sciences**	**4**	**60**
Module 1	I	Plant development and organogenesis	1	
	II	Material Transport, Photosynthesis and Nitrogen metabolism	1	
Module 2	III	Signalling in plants	1	
	IV	Stress response	1	
Course LSc504		**Plant Sciences Practicals**	**2**	**60**
Module 1				
Course LSc505		**Environmental Biology**	**2**	**30**
Module 1	I	Ecosystems and Biodiversity	1	
	II	Environmental Impact Assessment & Case Studies in EIA	1	
ELECTIVES				
Course LSc506a		**Microbiology and Microbial Techniques**	**4**	**90**
Module 1: **LSc506aT**	I	Microbiology	1	15
	II	Introduction to Gut microflora and human health	1	15
Module 2: **LSc506aP**		Microbiology and Microbial Techniques Practicals	2	60
Course LSc506b		**Bio-safety and Quality Assurance**	**4**	**90**
Module 1: **LSc506bT**	I	Bio-safety, Biological Safety Cabinets, and ISO Standards in Quality Management	1	15
	II	Good Laboratory and Manufacturing Practices (GLP and GMP) in Pharmaceuticals: Microbiological Techniques for Quality Assurance	1	15
Module 2:**LSc506bP**		Bio-safety and Quality Assurance Practicals	2	60
Course LSc506c		**Gene Therapy and Genetic Counselling.**	**4**	**90**
Module 1: **LSc506cT**	I	Gene Therapy	1	15
	II	Basics of Genetic Counselling	1	15
Module 2:**LSc506cP**		Gene Therapy and Genetic Counselling Practicals	2	60
Course LSc506d		**Molecular Virology**	**4**	**90**
Module 1: **LSc506dT**	I	Introduction to Virology	1	15
	II	Viral Immunology	1	15
Module 2:**LSc506dP**		Molecular Virology Practicals	2	60

Paper Code	Unit	Description	Credits	Hrs
Course LSc506e		**Integrated Freshwater Aquaculture Techniques**	**4**	**90**
Module 1: **LSc506eT**	I	Aquaculture Systems & Fish Farming	1	15
	II	Integrated Fish Farming & Wastewater-Fed Aquaculture	1	15
Module 2:**LSc506eP**		Integrated Freshwater Aquaculture Techniques Practicals	2	60
Course LSc506f		**Sleep Sciences: Exploring Disorders, Neurobiology and Advances**	**4**	**90**
Module 1: **LSc506fT**	I	Sleep Disorders: Neurobiology, Diagnosis, and Treatment	1	15
	II	Advances in Sleep Medicine: Research and Special Population	1	15
Module 2:**LSc506fP**		Advances in Sleep Medicine: Research and Special Population Practicals	2	60
Course LSc507		**RESEARCH METHODOLOGY**	**4**	

SEMESTER II

Paper Code	Unit	Description	Credits	Hrs
Course LSc508		**Animal Sciences**	**4**	**60**
Module 1	I	Animal Physiology	1	
	II	Developmental Biology	1	
Module 2	III	Sensory Systems and Neurobiology	1	
	IV	Endocrinology	1	
Course LSc509		**Animal Sciences Practicals**	**2**	**60**
Module 1				
Course LSc510		**Biochemical Sciences**	**4**	**60**
Module 1	I	Carbohydrates, Vitamins, Minerals	1	
	II	Protein and Lipids	1	
Module 2	III	Enzymology	1	
	IV	Biochemical Techniques	1	
Course LSc511		**Biochemical Sciences Practicals**	**2**	**60**
Module 1				
Course LSc512		**Molecular Biology**	**2**	**30**
Module 1	I	Basics of Life Processes I	1	
	II	Basics of Life processes II	1	
ELECTIVES				
Course LSc513a		**Scientific Conduct and Communications.**	**4**	**90**
Module 1: **LSc513aT**	I	Scientific conduct and writing	1	15
	II	IPR	1	15
Module 2: **LSc513aP**		Scientific Conduct and Communications**.** Practicals	2	60
Course LSc513b		**Food Technology**	**4**	**90**
Module 1: **LSc513bT**	I	Food Constituents and Nutrition	1	15
	II	Food Processing and packaging	1	15
Module 2:		Food Technology Practicals	2	60

Paper Code	Unit	Description	Credits	Hrs
LSc513bP				
Course LSc513c		**Biotechniques**	**4**	**90**
Module 1: **LSc513cT**	I	Essentials of Gene cloning	1	15
	II	Cellular and Molecular Techniques	1	15
Module 2: **LSc513cP**		Biotechniques Practicals	2	60
Course LSc513d		**Biostatistics**	**4**	**90**
Module 1: **LSc513dT**	I	Biostatistics I	1	15
	II	Biostatistics II	1	15
Module 2: **LSc513dP**		Biostatistics Practicals	2	60
Course LSc513e		**Remote Sensing**	**4**	**90**
Module 1: **LSc513eT**	I	Remote Sensing: Principles, Applications and Image Processing	1	15
	II	Hyperspectral Remote Sensing for Environmental Monitoring	1	15
Module 2: **LSc513eP**		Remote Sensing Practicals	2	60
Course LSc56f		**Agri-business Management**	**4**	**90**
Module 1: **LSc513fT**	I	Agri-Business	1	15
	II	Financial Management and Sustainable Practices in Agri-business	1	15
Module 2: **LSc513fP**		Practicals in Agri-business	2	60
Course LSc514		On the job Training (OJT)/ Field Project (FP)	4	120

Semester- I

Programme Name: M.Sc. Life Sciences-Aquaculture Technology) Semester I **Total Credits:** 04 **Department assessment:** 50	**Course Name:** Cell Biology **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Review and explore the details of the structure and function of a cell.
2. Explain and compare the steps of cell division and its variations.
3. Capture aspects of cell communication
4. Recognize interactions between cells and their significance.
5. Analyse inheritance patterns using Medelian laws
6. Recognize inheritance patterns in a population
7. Understand and apply the effect of the environment in gene expression.

Course Code	Course Title	Total Credits
LSc501	**Cell Biology**	**04**
MODULE I **Unit I: Cell Structure and function (15 L)** **Plasma membrane:** Ultrastructure of the plasma membrane (protein-lipid ratio), lipid bilayer, membrane fluidity (temperature, lipid composition, and cholesterol content). **Endoplasmic reticulum:** RER and SER, synthesis and transport of protein into the lumen of the ER and its control. Signal Recognition Particles (SRP), SRP Receptor, translocon and signal peptidase. Oil bodies and protein bodies in plants. **Golgi complex:** Cisternal progression, secretory pathway – transport to the plasma membrane and the extracellular space. **Mitochondria:** Ultrastructure, ROS generation, role in metabolic disorders (neurodegenerative and lifestyle disorders). **Nucleus**: Ultrastructure of the nucleus, Nuclear membrane, nuclear pore, lamins, chromatin. **Cytoskeleton:** Actin, Intermediate filaments, tubulin, and concept of cellular architecture and motility (cilia and flagella). **Transport:** Active, passive, gap junctions, tight junctions, desmosomes, plasmodesmata **Unit II: Molecular basis of Cell division (15 L)** **Eukaryotic cell cycle:** Stages of the cell cycle – G0, G1, S, G2 and M. Concept of cyclin and CDKs; activation of the cyclin-CDK complexes. **G1 cyclins**: Cln1, Cln2 and Cln3 and its relevance in commitment to cell division. **S phase and G2 phase**: S phase cyclin, its inhibitors and pre-replication complex and its significance in DNA replication in the cell cycle. **M phase**: Prophase, Metaphase, Anaphase and Telophase, condensins, securin, separase	**02**

and the end of mitosis. **Control of cell division**: Checkpoints of the cell cycle (DNA duplication, spindle assembly checkpoint. chromosome segregation and its disorders related to their failure). **Meiosis:** A specialized cell division and comparison with mitosis. **Bacterial cell cycle:** Nucleoid structure, localization of ori and terminus, function of MreB, PBP2 and RodA in cell shape, Septum formation and its regulation.	
MODULE II **Unit III: Cell Communication (15 L)** **Mechanism of Hormone Action:** Types of hormones and their action. **Concept of receptors:** Cell surface, intracellular and orphan receptors. **Second messengers and regulation of the signalling pathway:** cAMP, Calcium, IP3, Feedback regulation (thyroid hormones). **Signalling pathways:** (a). Receptor tyrosine kinases (RTK), (b) JAK-STAT pathway. (c) G protein coupled receptors. (d) ion channels -Sodium, potassium (e). Toll-like receptors. **Two component signalling:** Histidine kinases and Response regulators (a). Bacterial – chemotaxis, quorum sensing. (b). Plant two component signalling. (c). Bacteriorhodopsin signalling. **Extracellular matrix:** Fibres, cell adhesion molecules and their functions, **Cell signalling in cancer and apoptosis** (extrinsic and intrinsic). **Unit IV: Genetics (15 L)** **Mendelian Principles and their Extensions:** Mendel's laws of inheritance, Codominance, incomplete dominance, Multiple alleles, Lethal and Essential Genes. **Quantitative genetics:** Pleiotropy and epistasis, polygenic inheritance, heritability and its measurements, linkage and crossing over. **Population Genetics:** Gene pool, gene frequency, Hardy Weinberg Law and its role in evolution and speciation, Pedigree analysis. **Gene mapping methods:** Linkage maps and lod score for linkage testing, tetrad analysis, mapping with molecular markers, Quantitative Trait Locus (QTL), mapping by using somatic cell hybrids. **Epigenetics:** History and Hypothesis, Effect on chromatin structure- Nucleosome, Imprinting-DNA Methylation, its mechanism and inheritance, Gene Expression- Histone Modification Mechanism (Methylation, Acetylation, Phosphorylation, Ubiquitination), Effects of Environmental factors, Disorders- Imprinting and Cancer (Oncogene and Tumour Suppressor gene).	**02**

Reference Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter
2. Walter (2002). Molecular biology of the cell 4th edition, Garland Science, New York.
3. Lehninger, Nelson and Cox (): Principles of Biochemistry-
4. Benjamin Lewin (2004): Genes VIII. Publisher - Prentice Hall PTR.
5. Tamarin (1998): Principles of Genetics. Publisher: Brown (William C.) Co, U.S.
6. Russell (2016): iGenetic. Pearson Education India
7. Benjamin Pierce (2020): Genetics – A Conceptual Approach, 7th Edition. Macmillan Publishing.
8. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2003): Molecular Cell biology: W.H.Freeman& Co Ltd.

9. Arnold Berk, Chris A. Kaiser, Harvey Lodish et al. (2016): Molecular Cell biology: W.H.Freeman & Co Ltd.
10. Cell Biology 3rd edition: Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott - Schwarts, Graham Johnson
11. Freifelder (1990); Microbial Genetics, Narosa Publishing House.
12. De Robertis, E.M.F. De Robertis, and Francisco M. De Robertis () Cell and Molecular Biology" 7th Edition;
13. Geoffrey M. Cooper and Robert E. Hausman ():"The Cell: A Molecular Approach";
14. Peter Snustad, Michael J. Simmons, and Michael D. Jenkin (): Principles of Genetics;
15. John H. Gillespi (): Population Genetics: A Concise Guide;

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 02 **Department Assessment: 25 marks**	**Course Name:** Cell Biology Practicals **Total Marks:** 50 **University assessment: 25 marks**

Pre requisite:

Course Outcome:

The learner would be able to:

1. Review and explore the details of the structure of organelle.
2. Explain and compare the steps of cell division.
3. Assess the various secondary messenger systems of cell communication.
4. Analyse inheritance patterns using Medelian laws.
5. Recognize inheritance patterns in a population.

Course Code	Course Title	Credits
LSc502	Cell Biology Practicals	02
1	Micrographs and activity staging of the microstructure of the cell.	
2	Organelle specific staining appropriate tissue: (nucleus, mitochondria)	
3	Study of mitosis cell division from onion root tip.	
4	Assessment of PKC/ IP_3 signalling pathway.	
5	Assessment of Calcium signalling pathway.	
6	Genetic analysis of Mendelian laws, Multiple alleles & Lethal genes.	
7	Analysis of population using Hardy Weinberg equation.	
8	Pedigree analysis.	
9	Micrographs and activity staging of the microstructure of the cell.	

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment:** 50	**Course Name:** Plant Sciences **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Trace the stages and control of plant development.
2. Explain important processes typical to plant metabolism.
3. Explore signalling in plants and compare these processes with the animal systems.
4. Review, predict and summarize the plant responses to stress.
5.

Course Code	Course Title	Total Credits
LSc503	**Plant Sciences**	**04**
Unit I: Plant development and organogenesis (15 L) **The plant Cell wall:** Biosynthesis, assembly, growth and differentiation. **Seed germination:** The hormonal and nutritional aspect of seed germination. **Root and Shoot:** Physiology and regulation of the development, organization of root and shoot apical meristems, tropisms - gravitropism, phototropism, thigmotropism and nastic movements **Leaf:** Development and phyllotaxy, stomatal movement. **Flower development:** Floral organogenesis and the genes involved: Examples Arabidopsis and Antirrhinum, **Genetics of pollen germination**: Self incompatibility (Gametophytic and sporophytic) **Programmed Cell Death and Senescence in plants:** Concept, effect on pigments in plants, environmental factors and hormonal factors. **Unit II: Material Transport, Photosynthesis and Nitrogen metabolism (15 L)** **Source to sink transport and storage**: Vacuoles, regulation of transport through xylem, phloem and plasmodesmata. **Photosynthesis**: Light harvesting complexes; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; Carbon fixation by C3, C4 and CAM pathways; Photoprotective mechanisms; Photorespiration; chloroplast ETC proteins and light harvesting complex; Mechanism of oxidative and photophosphorylation **Nitrogen metabolism:** Symbiotic nitrogen fixation, Ammonia and nitrate uptake and metabolism. Nitrogen use efficiency; Nitrate assimilation in plants: Structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation; Ammonium assimilating enzymes – glutamine synthetase, glutamate synthase and GDH.	**02**
MODULE II **Unit III: Signalling in plants (15 L)** **Plant Hormones:** Structure, Biosynthesis, mechanism of action and cross talk - auxins, cytokinins, gibberellins, Ethylene, Abscissic acid, Salicylates, Jasmonates and Brassinosteroids. **Comparison of Animal and plant signalling systems**: Protein kinases, protein phosphatases, secondary messengers. **Sensory Photobiology**: Cryptochromes, phototropins; photoperiodism and biological clocks Phytochromes and its role in plant development - including flowering, **Unit IV: Stress response (15 L)** **Plant response to abiotic stress:** Molecular response to Water - salt content, drought and flooding and temperature stresses - heat and freezing conditions. **Response and resistance to biotic stress** (viral, fungal and insects): Disease establishment factors, Pre-formed defences - anatomical, secondary metabolites	**02**

(Saponins, glucosinolates, benzoxazinoids, etc), Induced Defence: Plant immunity Local and systemic defence, pathogen or microbe-associated molecular patterns (PAMPs and MAMPs), PRR triggered immunity (PTI), Effector Triggered Susceptibility (ETS), R - avr system., Synthesis of ROS, Fortification of cell walls, biosynthesis of phytoalexins, Role of salicylates, jasmonates and ethylene.	

Reference Books:

1. Bob Buchanan, Wilhelm Gruissem and Russel Jones (2015): Biochemistry and Molecular Biology of Plants. Publisher – Wiley Blackwell.
2. Taiz and Zeiger (2003): Plant Physiology 3rd Edition: Sunderland: Sinauer Associates.
3. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy (2015): Plant
4. Physiology and Development, 6th Edition. Sinauer Associates.
5. Hans-Walter Heldt Birgit Piechulla (2021): Plant Biochemistry 5th Edition. Academic Press.

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 02 **Department Assessment: 25 marks**	**Course Name: Plant Sciences Practical** **Total Marks:** 50 **University assessment: 25 marks**

Pre requisite:

Course Outcome:

The learner would be able to:

1. Study the effects of abiotic stresses on seed germination.
2. Evaluate the enzyme activities under stress conditions.
3. Explore regulation of nitrate assimilation.
4. Understand various phyllotaxy and flower aestivation.

Course Code	Course Title	Credits
LSc504	**Plant Sciences Practical**	**02**
1	Effect of light on seed germination, Stress Tolerance Index,	
2	Effect of PEG on seed germination,	
3	Effect of hormones on seed germination,	
4	Estimation of enzyme activity (RNS/ ROS/antioxidant enzymes) under stress conditions.	
5	Examples of phyllotaxy: spiral, opposite decussate, whorled.	
6	Flower aestivation: valvate, imbricate, twisted and papillionaceous type.	
7	The regulation of nitrate assimilation in plants/ bacteria.	
8	Phytoalexins: induction and bioactivity using suitable plant systems.	

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 02 **Department assessment:** 25	**Course Name:** Environmental Biology **Total Marks:** 50 **University assessment:** 25

Course Outcome:

The learner will be able to:

1. Understand the components of an ecosystem, including abiotic and biotic factors, and analyze their interactions within the ecosystem.
2. Explain the concept of energy flow in ecosystems, including food chains, food webs, and trophic levels, and evaluate the significance of ecological pyramids in representing energy, biomass, and numbers.
3. Describe the process of ecological succession and distinguish between primary and secondary succession.
4. Comprehend the major biogeochemical cycles, such as water, carbon, nitrogen, and phosphorus cycles, and analyze their importance in ecosystem functioning.
6. Evaluate the ecosystem services provided by natural environments and assess the threats posed by human activities to ecosystems and biodiversity.
7. Explore different strategies and approaches for biodiversity conservation, including the use of genetic tools, conservation in human-modified landscapes, and citizen science.
8. Understand the fundamentals of Environmental Impact Assessment (EIA), including its purpose, process, screening, scoping, impact assessment, mitigation measures, monitoring and evaluation, and public participation and stakeholder engagement.
9. Apply the knowledge gained to analyze and assess environmental impacts in specific case studies, such as mining projects and renewable energy projects, and propose appropriate mitigation measures and sustainability considerations.

Course Code	Course Title	Total Credits
LSc505	**Environmental Biology**	**02**
MODULE I **Unit 1: Ecosystems and Biodiversity (1 Credit): Topic 1: Introduction to Ecosystems (7 hours)** □ Components of an Ecosystem: Explanation of abiotic and biotic components and their interactions within an ecosystem. □ Energy Flow in Ecosystems: Overview of food chains, food webs, and trophic levels. **Lecture details (7)** □ Components of an Ecosystem: Explanation of abiotic and biotic components and their interactions within an ecosystem (1); Energy Flow in Ecosystems: Overview of food chains, food webs, and trophic levels (1); Ecological Pyramids: Understanding energy, biomass, and numbers pyramids (1); Energy pyramid: Explanation of how energy is lost as it moves through trophic levels and the shape of the energy pyramid (1); Ecological Succession: Introduction to primary and secondary succession (1); Biogeochemical Cycles: Overview of the water, carbon, nitrogen, and phosphorus cycles (1); Ecosystem Services: Introduction to the benefits provided by ecosystems to humans (1); Threats to Ecosystems and Biodiversity: Discussion of human impacts and conservation efforts (1). **Topic 2: Biodiversity Conservation (8 Hours)** □ Importance of Biodiversity: Discussion on the value of biodiversity in maintaining ecosystem stability and providing ecosystem services. □ Threats to Biodiversity: Identification and analysis of major threats to biodiversity, such as habitat loss, pollution, climate change, and invasive species.	**02**

Lecture details (8)
 Importance of Biodiversity: Discussion on the value of biodiversity in maintaining ecosystem stability and providing ecosystem services (1); Threats to Biodiversity: Identification and analysis of major threats to biodiversity, such as habitat loss,

pollution, climate change, and invasive species (1); Conservation Strategies: Overview of different approaches and strategies for biodiversity conservation (1); Conservation in Action: Exploration of ongoing biodiversity conservation initiatives and success stories(1); Biodiversity Hotspots: Exploration of globally significant regions of high biodiversity and their conservation significance (1); Conservation Genetics: Introduction to the use of genetic tools and techniques in biodiversity conservation (1); Conservation in Human-Modified Landscapes: Understanding the challenges and opportunities for biodiversity conservation in human-dominated environments (1); Citizen Science and Public Engagement: Exploring the role of public participation and citizen science in biodiversity conservation (1).

Unit 2: Environmental Impact Assessment (1 Credit) Topic 1: Introduction to Environmental Impact Assessment (EIA) (7 Hours)
 Definition and Purpose of EIA: Explanation of EIA as a tool for predicting and assessing the potential environmental impacts of development projects.
 EIA Process: Step-by-step description of the EIA process, including scoping, impact assessment, mitigation measures, and monitoring.

Lecture details (7)
 Definition and Purpose of EIA (1); EIA Process (1); Screening and Scoping (1); Impact Assessment (1); Mitigation Measures (1); Monitoring and Evaluation (1); and Public Participation and Stakeholder Engagement (1).

Topic 2: Case Studies in Environmental Impact Assessment (8 Hours)
 Case Study 1: EIA for a Mining Project: Examination of the environmental impacts associated with a mining project and the mitigation measures employed.
 Case Study 2: EIA for a Renewable Energy Project: Analysis of the environmental impacts and sustainability considerations associated with a renewable energy project.

Lecture details (8)
 Case Study 1: EIA for a Mining Project: (4)

Examination of the environmental impacts associated with a mining project and the mitigation measures employed.
 Case Study 2: EIA for a Renewable Energy Project: (4)

Analysis of the environmental impacts and sustainability considerations associated with a renewable energy project.

Reference Books:

1. "Ecology and Environment" by P.D. Sharma. Publisher: Rastogi Publications.
2. "Ecology: Concepts and Applications" by Ramakrishnan, P. S., and R. Sukumar. Publisher: Cambridge University Press India.

3. "Biodiversity and Conservation" by P. Singh. Publisher: Daya Publishing House
4. "Conservation Biology: Principles and Practices" by Rajkamal Goswami and Shreya Yadav. Publisher: Oxford University Press.
5. "Ecosystems and Human Well-being: A Framework for Assessment" by Millennium Ecosystem Assessment. Publisher: Island Press.
6. "Ecology: Concepts and Applications" by Manuel C. Molles Jr. Publisher: McGraw-Hill Education.
7. "Conservation Biology: Concepts and Applications" by B. C. Choudhury. Publisher: ICAR-National Bureau of Plant Genetic Resources.
8. "Conservation Biology: Principles for Forested Landscapes" by Malcolm L. Hunter Jr., James P. Gibbs, and Edward O. Wilson. Publisher: Island Press.
10. "Environmental Impact Assessment: Theory and Practice" by S. K. Gupta. Publisher: Khanna Publishers.
11. "Environmental Impact Assessment: Methodologies, Tools, and Techniques" by Y. Anjaneyulu and V. K. Choudhary. Publisher: BS Publications.
12. "Environmental Impact Assessment: A Comprehensive Guide to Concepts and Practice" by Salim Momtaz and Ravi Naidu. Publisher: CRC Press.
13. "Environmental Impact Assessment: Methods and Techniques" by L.C. De and S.K. Gupta. Publisher: APH Publishing Corporation.
14. "Environmental Impact Assessment: Practical Solutions to Recurrent Problems" by Riki Therivel and Andrea Ross. Publisher: Routledge.
15. "Biodiversity: An Introduction" by Kevin J. Gaston and John I. Spicer. Publisher: Wiley-Blackwell.
16. "Environmental Impact Assessment: Theory and Practice" by Peter Wathern. Publisher: Routledge.
17. "Environmental Impact Assessment: A Guide to Best Professional Practices" by Charles H. Eccleston and Ana I. Canales. Publisher: CRC Press.
18. "Environmental Impact Assessment: Methodologies, Tools, and Techniques" by Y. Anjaneyulu. Publisher: BS Publications.
19. "Environmental Impact Assessment: Practical Solutions to Recurrent Problems" by Riki Therivel and Andrea Ross. Publisher: Routledge.
20. "Environmental Impact Assessment: A Comprehensive Guide to Concepts and Practice" by Salim Momtaz and Ravi Naidu. Publisher: CRC Press.
21. "Handbook of Environmental Impact Assessment: Guidelines for Environmental Assessment Practitioners" by Barry Sadler and Mary McCabe. Publisher: Environmental Resources Management (ERM).

SEMESTER I ELECTIVES

Programme Name: M.Sc. Life Sciences Semester I	**Course Name: Microbiology and microbial techniques**
Total Credits: 04	**Total Marks: 100**
Department assessment: 50	**University assessment: 50**

Course Outcome:
The learner would be able to:
1. Learn basics of microbiology
2. Recognize the importance of interactions between human and microbes.
3. Learn to perform microbial techniques

Course Code	Course Title	Total Credits
LSc506a	**Microbiology and Microbial Techniques**	**04**
MODULE I:		**02**

Course LSc506aT:Microbiology and microbial techniques

Unit I: Microbiology (15L)
Microbial diversity: Bacteria & Archaea their Outline of classification and general characteristics; Eukaryotic microbes general characteristics: Yeasts, molds, fungi, algae and protozoa; Viruses: classification and general characteristics; Molecular approaches to microbial taxonomy.
Prokaryotic Cell Structure- Cell wall, cell membrane synthesis and nucleoid; Flagella and motility; cell inclusions like endospores, gas vesicles.
Microbial Growth: Growth curve; Mathematical expression of exponential growth phase; Measurement of growth and growth yields; Synchronous growth; Continuous culture; Effect of environmental factors on growth; diauxic growth.

Unit II: Introduction to Gut microflora and human health: (15 L)
Beneficial interactions: symbiosis, gut microbiome - composition, secretion of metabolites,
effect on human health, diseases associated with gut microbiota, methods of study

Gut microbiota and their distribution: Different species of gut microbiota, establishment in infants, distribution in the adult gut.

Metabolic activities of the microbiota in the intestine: (carbohydrates, fatty acids, proteins, bile acids, plant secondary metabolites, probiotics and prebiotics).

Communication with the host: (exosomes etc.),

Disbiosis and its causes: Host specific (infection, inflammation, lifestyle), environment (xenobiotics - antibiotics, drugs, food additives; hygiene).

Disbiosis and disease: Concept, examples of diseases due to disbiosis (Irritable

bowel diseases, gut-lung axis, gut-brain axis). Neutragenomics : Nutrition, Development of the microflora, Association with gut-brain access	
MODULE II: **Course LSc506aP: Microbiology and Microbial Techniques Practicals** 1. To study preparation of different Culture media 2. Pure culture isolation: Streaking, serial dilution and plating methods; 3. To study Colony characteristics of isolated colony 4. To study different Staining Methods (simple staining/Gram staining/Acid-fast staining/endospore staining/Capsule staining/Flagella staining/spirochete staining) 5. To study Physical methods of microbial control 6. To study Chemical methods of microbial control 7. To determine Thermal death time of microorganisms 8. To determine Thermal death point of microorganisms	**02**

References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter
2. Walter (2002). Molecular biology of the cell 4th edition, Garland Science, New York.
3. Joanne Willey and Kathleen Sandman and Dorothy Wood (2016) Prescott's
4. Microbiology, 10th edition. McGraw Hill Education.
5. Janis Kuby (2002):5th Immunology 5th Edition, Publisher; W. H. Freeman.
6. Judy Owen , Jenni Punt, Sharon Stranford (2013): Kuby Immunology 7th Edition. W.H.Freeman& Co Ltd.
7. Cell Biology 3rd edition : Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwarts, Graham Johnson
8. Microbiology 7th edition : Prescott and Dunn
9. Andreas Schwiertz (2016): Microbiota of human body - Implications in health and diseases. Springer publication
10. Dirk Haller (2018): The Gut Microbiome in health and diseases. Springer Publication
11. Sayyed R. Z. and Khan Mahejibin (2022): Microbiome-Gut-Brain Axis – Implications on Health. Springer Publication

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name:** Biosafety and Quality Assurance **Total Marks: 100** **University assessment: 50**

Prerequisite:

A fundamental understanding of basic biology and laboratory techniques as well as familiarity with quality management principles, is recommended as a pre-requisite for this Elective.

Course Outcome:

The syllabus covers a comprehensive range of topics related to bio-safety and quality assurance in various fields, including biological safety, ISO standards, GLP and GMP in pharmaceuticals, and microbiological techniques. The syllabus provides a solid foundation for understanding and implementing bio-safety measures and quality assurance practices.

1. Understand the historical background and principles of bio-safety, including the use of biological safety cabinets and primary containment for biohazards.
2. Familiarize with the ISO 9000 family of standards and comprehend the seven key principles of ISO 9000 and their application in different sectors.
3. Gain knowledge of Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) in the pharmaceutical industry, including personnel responsibilities, quality control, and documentation.
4. Acquire proficiency in essential microbiological techniques used in the pharmaceutical industry, such as media preparation, sterilization, culture handling, and environmental monitoring.
5. Recognize the importance of microbiological testing, including limit tests, water sample analysis, and sterility testing, for quality assurance.
6. Develop practical skills through hands-on experience in applying bio-safety and quality assurance principles in laboratory settings.
7. Enhance problem-solving abilities through case studies, practical implementation, and documentation exercises related to bio-safety and quality assurance.

Course Code	Course Title	Total Credits
LSc506b	**Biosafety and Quality Assurance**	**04**
MODULE I: **LSc506bT: Biosafety and Quality Assurance (2 Credits)** **Unit 1: Bio-safety, Biological Safety Cabinets, and ISO Standards in Quality Management (15L)** ▪ **Introduction to Bio-safety and Biological Safety Cabinets:**[Understanding the historical background and principles of bio-safety, including the use of biological safety cabinets and primary containment for biohazards] (8L) Historical Background of Bio-safety (1); Principles of Bio-safety (1); Importance of Bio-safety in Various Fields (1); Biohazards and Risk Assessment (1); Biological Safety Cabinets: Types and Functions (1); Primary Containment for Biohazards (1); Biosafety Guidelines and Best Practices (1); Emerging Trends in Bio-safety (1); ▪ **ISO Standards and Quality Management:** [Exploring the ISO 9000 family of standards, including the seven key principles of ISO 9000 and their application in different sectors. Understanding the importance of customer focus, process improvement, and evidence-based decision making] (7L) Introduction to ISO Standards (1); ISO 9001: Quality Management System (1); ISO 9001: Customer Focus and Leadership (1); ISO 9001: Planning and Risk		**02**

Management as well as Planning for quality management (1); Risk-based thinking in ISO 9001; Identifying and addressing risks and opportunities (1); ISO 9001: Process Management and Performance Evaluation as well as Continual Improvement and Corrective Actions (1); ISO Standards in Different Sectors and their Integration of ISO Standards with Quality Management Systems (1) **Unit 2: Good Laboratory and Manufacturing Practices (GLP and GMP) in Pharmaceuticals: Microbiological Techniques for Quality Assurance (15L)** ▪ **GLP and GMP in Pharmaceuticals:** Studying Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) in the pharmaceutical industry. Understanding the fundamentals of GLP and the requirements of GMP, including personnel responsibilities, quality control, and documentation (8L) Introduction to GLP and GMP (1); Fundamentals of GLP (1); Requirements of GMP (1); Personnel Responsibilities in GLP (1); Personnel Responsibilities in GMP (1); Quality Control in GMP (1); Documentation in GLP and GMP (1); Audits and Inspections in GLP and GMP (1). ▪ **Microbiological Techniques for Quality Assurance:** Learning essential microbiological techniques used in the pharmaceutical industry, such as media preparation, sterilization, culture handling, and environmental monitoring. Understanding the importance of microbiological testing, including limit tests, water sample analysis, and sterility testing (7L) Introduction to Microbiological Techniques (1); Media Preparation and Sterilization (1); Culture Handling and Growth Conditions (1); Environmental Monitoring (1); Microbiological Testing Methods (1); Sterility Testing (1); Quality Control in Microbiology (1).	
MODULE II: **LSc506bP: Biosafety and Quality Assurance Practicals (2 Credits)** **Practicals2 Credits (60 Hours- 10 Practicals of 6 hours each)** ▪ Practical 1: Introduction to Bio-safety and Biological Safety Cabinets (6) ▪ Practical 2: ISO Standards and Quality Management (6) ▪ Practical 3: GLP and GMP in Pharmaceuticals (6) ▪ Practical 4: Microbiological Techniques for Quality Assurance (6) ▪ Practical 5: Application of Bio-safety and Quality Assurance Principles (6) ▪ Practical 6: Case Studies and Problem-Solving Exercises (6) ▪ Practical 7: Practical Implementation and Documentation (6) ▪ Practical 8: Advanced Techniques and Instrumentation (6) ▪ Practical 9: Quality Audits and Compliance (6) ▪ Practical 10: Final Assessment and Evaluation (6)	**02**

References:

1. "Bio-Safety and Quality Assurance in Pharmaceutical Industry" by R.S. Verma
2. "Good Laboratory Practices and Quality Assurance: A Practical Approach" by N.K. Jain
3. "Bio-Safety in Microbiology and Biotechnology" by R. K. Salar

4. "Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control" by S. M. Sait
5. "Handbook of Quality Assurance in Pharmaceuticals" by Ravi K. Gupta
6. "Bio-Safety and Bio-Security" by A. Venkataraman
7. "Good Manufacturing Practices (GMP) for Quality Control Laboratories" by P. Ravi Shankar
8. "Introduction to Bio-safety" by Peter Howard
9. "Quality Assurance: Principles and Practice in the Pharmaceutical Industry" by Ronald H. Hughes
10. "Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices" by Rosamund M. Baird
11. "Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control" by Sidney H. Willig
12. "ISO 9000 Quality Systems Handbook" by David Hoyle
13. "Quality Management in the Imaging Sciences" by Jeffrey Papp
14. "Good Laboratory Practice Regulations" by Sandy Weinberg
15. "Microbiological Quality Assurance: A Guide Towards Relevance and Reproducibility of Inocula" by P. Panjikar.

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I	**Course Name: Gene Therapy and Genetic Counselling**
Total Credits: 04	**Total Marks: 100**
Department assessment: 50	**University assessment: 50**

Course Outcome:

The learner would be able to:

- Develop the concepts of Genetic Mutations and Gene therapy
- Develop with in-depth knowledge in Human Genetics suited for Genetic Counselling.
- Provide intensive practical knowledge of Genetic Counselling.

Course Code	Course Title	Total Credits
LSc506c	**Gene Therapy and Genetic Counselling**	**04**
MODULE I: **Course LSc506cT: Gene Therapy and Genetic Counselling** **Unit I: Gene Therapy (15 L)** **Mutation**: Types of Mutations: Structural and Number, Spontaneous and induced mutations, Molecular basis of Human disorders, Techniques to detect mutations. **Human Genetic Disorders**: Molecular genetics of metabolic disorders; Inborn errors of metabolism; Glycogen storage diseases **Antisense therapy**: Introduction, strategies. oligodeoxyribonucleotide, catalytic antisense RNA, triple - helix forming oligonucleotides (TFOs), production, and limitations, first generation antisense drugs, second generation antisense drugs.		**02**

Applications: cancer therapy, viral diseases, gene function analysis and in agriculture. Gene therapy: Overview, viral and non viral Vectors for somatic cell gene therapy, FDA approvals **Unit II: Basics of Genetic Counselling (15 L)** **Genetic Counselling**: pedigree analysis, diagnostic information, risks and odds Hardy-Weinberg Equilibrium **Psychological and Communication Skills**: The concept of psychology, Emphasis on empathy, Good listening skills, Communication Skills: Clear voice modulations, Good eye contact, Presentation skills **Pre-Conceptional Counselling**: Counselling recurrent pregnancy loss, history of familial disorders, and detection of carrier mutations in the couples. **Prenatal Counselling**: Counselling based on common congenital anomalies, observed fetal ultrasonography and biochemical tests, various prenatal diagnosis techniques, risks associated with invasive procedures (amniocentesis, chorionic villus sampling, cordocentesis), interpretation of laboratory results and their limitations, outcomes of the full term pregnancy. **Post natal counselling**: Counselling on developmental delays, behavioural issues due to neurological changes, observed biomedical tests and their interpretations, available nutritional and behavioural management. Adult Counselling: Counselling on various disorders (Infertility, Neurological disorders) and dysfunctional metabolism (Cancer, Obesity, Diabetes) in adult hood.	
MODULE II: Practicals **Course LSc506cP: Gene Therapy and Genetic Counselling Practicals (Credits 2)** 1. Case Study of Gene therapy in Thallassemia. 2. Case Study of Gene therapy in Cystic fibrosis. 3. Case Study of Gene therapy in Adenosine deaminase deficiency. 4. Case Study of Gene therapy in Gaucher's disease 5. Case Study of Gene therapy in HIV. 6. Case Study of Gene therapy in SCID. 7. Case Study of Gene therapy in Cancer. 8. Case Study of Gene therapy in Infertility. 9. Case Study of Genetic Counselling in Euploidy, Developmental Defects, Neurological Defects, Congenital Heart Defects, Musculoskeletal disorders, Oncology 10. Case Study of Genetic Counselling in Euploidy. 11. Case Study of Genetic Counselling in Developmental Defects. 12. Case Study of Genetic Counselling in Neurological Defects. 13. Case Study of Genetic Counselling in Congenital Heart Defects. 14. Case Study of Genetic Counselling in Musculoskeletal disorders. 15. Case Study of Genetic Counselling in Oncology.	**02**

References:

1. Thompson and Thompson, Genetics in Medicine

2. Russell iGenetics
3. Gardner, Simmons, Snustad, Principle of Genetics, 8th Edition
4. Tom Strachan and Andrew P. Read, Human Molecular Genetics, 2nd edition
5. S. Raghunathan & B. Santhanam , Business Communication, N – Margham Publications, 2011.
6. Murphy, Herta, Herbert W Hildebrandt, and Jane P Thomas, Effective Business
7. Raman, Meenakhshi, and Prakash Singh, Business Communication. O U P, New Delhi, 2nd Edition, 2012
8. Atkinson, R.L., Atkinson, R.C., Smith, E.E., & Hilgard, E.R.: Introduction to Psychology,
9. Atlas of Inherited Metabolic Diseases Mendelian
10. Victor A. McKusick , Inheritance in Man: A Catalog of Human Genes and Genetic Disorders, Vol I & II

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name: Molecular Virology** **Total Marks: 100** **University assessment: 50**

Course Outcome:
The learner will be able to:
1. Get an insight on the evolution, history, structure and classification of RNA and DNA viruses.
2. Acquire knowledge on the molecular aspects of the viral life cycle.
3. Develop awareness about the viral diseases and their preventive measures
4. Understanding of the viral vaccine development strategies at molecular level.

Course Code	Course Title	Total Credits
LSc506d	**Molecular Virology**	**04**
MODULE I: **Course LSc506dT: Molecular Virology** **Unit I: Introduction to Virology (15 L)** **Introduction to virology**: Evolution, History and Classification of virus (DNA, RNA, Enveloped and Non-Enveloped viruses) **Characterization**: Morphological, Molecular (genome), Cataloging of viruses, Cultivation of viruses. **Viral Genome**: DNA and RNA viral replication, transcription, translation, assembly, maturation and exit of virus. **Viral Genome Integration**: Lytic and Lysogenic cycle. **Epigenetics**: Histone modification in viral gene expression. **Unit II: Viral Immunology (15 L)** **Viral Immunology**: Viral transmission, Infection, Diagnosis and Epidemiology. **Retroviruses**: HIV, HTLV, SARS-CoV **Oncolytic Viruses**: Examples of oncolytic viruses, Viral Oncogenes, Human cancer due to oncolytic viruses. **Antiviral therapies**: History of viral vaccines, aspects, DNA vaccines, mRNA vaccine, Antiviral drugs, vaccine production strategies against COVID19. **Viral Vectors**: Adenoviral, Adeno Associated Viral vectors, Retroviral. **Viral Nanotechnology:**		**02**
MODULE II: **Course LSc506dP: Molecular Virology Practicals** 1. Introduction to bioinformatics databases and tools 2. Overview of Viral databases 3. Analysis of Viral genome using Bioinformatic tools 4. Translation of Viral genome using ExPasy 5. Structural analysis of viral proteins		**02**

6. Introduction to viral vaccine development using Bioinformatics tools 7. Visit to Virology laboratories 8. Report submission on the visit to Virology laboratories	

References:

1. Principles of Virology 2nd Edition (2004) - Flint, Enquist, Racaniello and Skalka. ASM Press.
2. Microbiology - Prescott, Harley and Klein, Mc Graw Hill Publishers.
3. Foundations of Microbiology - Alcamo, Jones and Bartlett Publishers
4. Fields B, Knipe D, Howley P. Fields Virology. 5th ed. Lippincott Williams and Wilkins, 2007.
5. White DO, Fenner FJ. Medical Virology. 4th ed. Academic Press, 1994.
6. MacLachlan NJ, Dubovi EJ. Fenner's Veterinary Virology. 4th ed. Academic Press, 2011.

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I	**Course Name: Aquaculture Techniques & Integrated Freshwater Fish Farming**
Total Credits: 04	**Total Marks: 100**
Department assessment: 50	**University assessment: 50**

Course Outcome:

The learner would be able to:

1. Explain different types of aquaculture systems.
2. Understand the general physiology of finfish/shellfish.
3. Understand the concepts of carp culture and its management.
4. Explain the integrated farming systems and its importance.
5. Importance of waste water treatment methods in aquaculture.

Course Code	Course Title	Total Credits
LSc506e	**Aquaculture Techniques & Integrated Freshwater Fish Farming**	**04**
MODULE I: **Course LSc506eT: Aquaculture Techniques & Integrated Freshwater Fish Farming (2 Credits)** **Unit I: Aquaculture Systems & Fish Farming (15 L)** **Aquaculture Systems**: Introduction: history of aquaculture, present status, problems and scope of fish farming in global and Indian perspective; Study of Finfish & Shellfish; extensive, semi-intensive and intensive culture of fish, polyculture, composite fish culture. **Fish Farming:** Carp culture: Types of carps, important Indian carps, Nursery pond		**02**

preparation and management, control of aquatic weeds, microorganism and animals, fertilization of pond, Seed stocking, feeding, water and soil quality management of pond, harvesting of fishes on different stages, health management and marketing. **Unit II: Integrated Fish Farming & Wastewater-Fed Aquaculture (15 L)** **Integrated Farming**: Introduction: History, basic principle and global status, Design of integrated farm, constraints of integrated farming, Advantages of integrated fish system; Types of integrated farming systems: 1. Agricultural (paddy) & horticultural (vegetable & fruits) based system 2. Livestock based system: poultry-fish system, duck-fish system, goat-fish system, cattle-fish system, pig-fish system, rabbit-fish system. **Wastewater-Fed Aquaculture**: Wastewater-fed aquaculture in India, species suitable for wastewater aquaculture, identification and isolation of heavy metal in the wastewater-fed system; Waste water treatment methods (primary, secondary and tertiary), trickling filters, activated sludge, problems, wastewater aquaculture in different countries (China, USA, Germany etc.).	
MODULE II: **Course LSc506eP: Aquaculture Techniques & Integrated Freshwater Fish Farming Practicals (2 Credits)** 1. Identification of commercially important freshwater Finfish. 2. Identification of commercially important freshwater Shellfish. 3. Morphological study of Finfish. 4. Morphological study of Shellfish. 5. Water analysis of fish ponds (pH, hardness, dissolved oxygen). 6. Soil analysis of aquatic ponds (pH, alkalinity, texture). 7. Visit to freshwater Finfish & Shellfish farms. 8. Visit to agriculture/livestock integrated fish farm systems.	**02**

References:

1. Pillay T.V.R. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambridge University Press, Cambridge.
2. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR. Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication.
3. Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication.
4. Agarwal S.C. 2008. A Handbook of Fish Farming. 2nd Ed. Narendra Publ. House.
5. Kluwer. De Silva S.S. (Ed.). 2001. Reservoir and Culture Based Fisheries: Biology and Management.
6. Midlen & Redding T.A., 1998. Environmental Management for Aquaculture.
7. Venugopal S. 2005. Aquaculture. Pointer Publ.
8. Welcomme R.L., 2001. Inland Fisheries: Ecology and Management. FishingNews Books.

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I	**Course Name: Sleep Sciences: Exploring Disorders, Neurobiology and Advances**
Total Credits: 04	**Total Marks: 100**
Department assessment: 50	**University assessment: 50**

Course Outcome:

1. Demonstrate knowledge of various sleep disorders, their classification, and diagnostic criteria.
2. Apply appropriate assessment and treatment approaches for common sleep disorders such as insomnia, sleep apnoea, narcolepsy, restless legs syndrome, parasomnias, circadian rhythm sleep-wake disorders, and pediatric sleep disorders.
3. Understand the neurobiology of sleep and circadian rhythms, including brain wave patterns, sleep stages, sleep regulation, and the role of the hypothalamus, suprachiasmatic nucleus, neurotransmitters, genetics, memory, and mood disorders.
4. Evaluate and analyze the advancements in sleep medicine research, including research methods, technological innovations in sleep disorder diagnosis, insights from genetic research, pharmacological advances in sleep medications, cognitive-behavioral therapy for insomnia, emerging trends in sleep monitoring devices, and the relationship between sleep and mental health.
5. Recognize the unique challenges and management strategies for sleep disorders in special populations, such as children, the elderly, shift workers, individuals with neurodevelopmental disorders, pregnant women, individuals with chronic medical conditions, and athletes.
6. Critically evaluate and discuss the efficacy, safety, and implications of sleep medicine interventions and treatments.
7. Synthesize and communicate the importance of sleep medicine in improving overall health, well-being, and performance in various populations.

Course Code	Course Title	Total Credits
LSc506f	**Sleep Sciences: Exploring Disorders, Neurobiology and Advances**	**04**
MODULE I: Course LSc506fT: Advances in Sleep Medicine: Research and Special Population (2 Credits) **Unit 1: Sleep Disorders: Neurobiology, Diagnosis, and Treatment (15L)** Sleep Disorders: Diagnosis and Treatment (8L) Introduction to Sleep Disorders and Classification (1); Insomnia: Assessment and Treatment Approaches (1); Sleep Apnoea: Diagnosis and Treatment Options (1); Narcolepsy: Understanding and Managing Excessive Daytime Sleepiness (1); Restless Legs Syndrome and Periodic Limb Movement Disorder (1); Parasomnias: Exploring Abnormal Behaviours during Sleep (1); Circadian Rhythm Sleep-Wake		**02**

Disorders (1); Paediatric Sleep Disorders: Evaluation and Intervention (1). Neurobiology of Sleep and Circadian Rhythms (7L) Sleep Neurophysiology: Brain Waves and Sleep Stages (1); Sleep Regulation: Homeostatic and Circadian Factors (1); The Role of Hypothalamus and Suprachiasmatic Nucleus (1); Neurotransmitters and Sleep: Insights into Sleep-Wake Control (1); Genetics and Sleep: Exploring Genetic Influences on Sleep Patterns (1); Sleep and Memory: Understanding the Relationship (1); Sleep and Mood Disorders: Connections and Implications (1). **Unit 2: Advances in Sleep Medicine: Research and Special Population (15L)** Sleep Medicine Research and Advances (8L): Introduction to Sleep Medicine Research: Methods and Approaches (1); Recent Advances in Sleep Disorder Diagnosis: Technological Innovations (1); Sleep Medicine and Genetics: Insights from Genetic Research (1); Pharmacological Advances in Sleep Medications: Efficacy and Safety (1); Cognitive Behavioural Therapy for Insomnia: Latest Research Findings (1); Emerging Trends in Sleep Monitoring Devices: Wearables and Beyond (1); Sleep and Mental Health: Current Research and Treatment Strategies (1); Future Directions in Sleep Medicine Research: Promising Areas of Study (1). Sleep Disorders in Special Populations (7L) Sleep Disorders in Children: Unique Challenges and Management (1); Sleep Disorders in the Elderly: Age-related Changes and Interventions (1); Sleep Disorders in Shift Workers: Coping Strategies and Adaptations (1); Sleep Disorders in Individuals with Neuro-developmental Disorders (1); Sleep Disorders in Pregnancy: Impact on Maternal and Fetal Health (1); Sleep Disorders in Individuals with Chronic Medical Conditions (1); Sleep Disorders in Athletes: Performance Implications and Management (1).	
MODULE II: **Course LSc506fP: Advances in Sleep Medicine: Research and Special Population Practicals: (Credits 2)** **(60 Hours- 20 Practicals of 3 hours each)** Practical sessions will cover various hands-on activities related to the theoretical concepts discussed in the lectures, as follows: **Sleep Disorders: Diagnosis and Treatment (24 Hours)** Practical 1: Sleep Disorders Classification and Assessment Techniques Practical 2: Insomnia Assessment and Treatment Approaches Practical 3: Sleep Apnoea Diagnosis and Treatment Options Practical 4: Narcolepsy Management and Excessive Daytime Sleepiness Practical 5: Restless Legs Syndrome and Periodic Limb Movement Disorder Evaluation Practical 6: Exploring Abnormal Behaviours during Sleep (Parasomnias)	**02**

Practical 7: Evaluation and Intervention for Pediatric Sleep Disorders Practical 8: Circadian Rhythm Sleep-Wake Disorders Evaluation and Intervention **Advances in Sleep Medicine: Research and Special Population (36 hours)** Practical 9: Introduction to Sleep Medicine Research Methods and Approaches Practical 10: Technological Innovations in Sleep Disorder Diagnosis Practical 11: Genetic Research Insights in Sleep Medicine Practical 12: Pharmacological Advances in Sleep Medications: Efficacy and Safety Evaluation Practical 13: Cognitive Behavioral Therapy for Insomnia: Application and Latest Research Findings Practical 14: Emerging Trends in Sleep Monitoring Devices: Hands-on Experience Practical 15: Sleep and Mental Health Research and Treatment Strategies Practical 16: Future Directions in Sleep Medicine Research: Promising Areas of Study Practical 17: Unique Challenges and Management Strategies for Sleep Disorders in Children Practical 18: Age-related Changes and Interventions for Sleep Disorders in the Elderly Practical 19: Coping Strategies and Adaptations for Sleep Disorders in Shift Workers Practical 20: Performance Implications and Management of Sleep Disorders in Athletes	

References:

1. "Clinical Sleep Medicine: A Practical Guide" by V. Mohan and R. Gupta
2. "Sleep Medicine Made Easy" by Ravi Gupta
3. "Principles and Practice of Sleep Medicine in the Indian Context" by Deepak Shrivastava
4. "Sleep Disorders: A Clinical Approach" by U. Singh and R. Kapoor
5. "Textbook of Sleep Medicine" by Rakesh K. Gupta
6. "Pediatric Sleep Medicine: A Comprehensive Guide to the Diagnosis and Treatment of Sleep Disorders" by Meenakshi Dwivedi
7. "Sleep Disorders: Diagnosis, Management, and Treatment" by Seema Mishra
8. "Principles and Practice of Sleep Medicine" by Meir H. Kryger, Thomas Roth, and William C. Dement
9. "Atlas of Sleep Medicine" by Sudhansu Chokroverty and Robert J. Thomas
10. "Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem" by Institute of Medicine (US) Committee on Sleep Medicine and Research
11. "Fundamentals of Sleep Medicine" by Richard B. Berry
12. "Sleep Medicine: Essentials and Review" by Teofilo Lee-Chiong
13. "Sleep Medicine Pearls" by Richard B. Berry
14. "Sleep Disorders Medicine: Basic Science, Technical Considerations, and Clinical Aspects" by Sudhansu Chokroverty.

Semester- II

Programme Name: M.Sc. Life Sciences Semester II **Total Credits:** 04 **Department assessment:** 50	**Course Name: Animal Sciences** **Total Marks:** 100 **University assessment:** 50

Course Outcome:
The learner would be able to:
1. Explain the anatomy and physiology of cardiovascular, digestive and excretory systems.
2. Describe the general physiology of finfish/shellfish.
3. Understand the concepts of development, mechanism of gamete production and fertilization in animals.
4. Explain the anatomy and physiology of the central nervous system and the peripheral nervous system including the structure and function of the sensory and motor systems.
5. Describe the structure, functions and disorders of different endocrine glands.

Course Code	Course Title	Total Credits
LSc508	**Animal Sciences**	**04**
MODULE I **UNIT I: Animal Physiology (15 L)** **Blood**: Blood corpuscles, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, haemostasis. **Cardiovascular System**: Structure of heart, cardiac cycle, blood pressure, control of blood pressure, neural and chemical regulation. **Physiological Systems**: Digestive system, excretory system and Reproductive system. **General Physiology of Aquatic Life**: With example of Finfish/Shellfish. **UNIT II: Developmental Biology (15 L)** **Concepts of Development:** Brief history of developmental biology, Potency, commitment, specification, induction, competence, determination and differentiation; Gametogenesis, Fertilization and Early Development: Production of gametes, fecundity, cryopreservation of gametes, cell surface molecules in sperm-egg recognition in animals; cell division (mitosis, meiosis), zygote formation, cleavage, blastula formation, gastrulation, formation of germ layers and extra embryonic membranes in animals **Morphogenesis and organogenesis**: Axes and pattern formation in Drosophila; Vertebrate eye lens induction; limb development and regeneration in vertebrates; Differentiation of neurons; metamorphosis.		**02**

MODULE II **UNIT III: Sensory Systems and Neurobiology (15 L)** **Sense Organs:** Visual and hearing systems: structure, functions, diseases. **Overview**: Central Nervous System (CNS), Peripheral Nervous System (PNS) and Autonomic **Nervous System (ANS):** Structure and function. **Cellular Perspective**: Types of cells and function **Impulse Generation and Conduction**: Nerve impulse **Synaptic Transmission**: Electrical and chemical with examples of two neurotransmitters and their receptors, Neuromuscular junctions: structure and function. **Motor Systems**: Overview of motor circuits and neural control. **Unit IV: Endocrinology (15 L)** **Endocrine System**: Introduction and principle of endocrine system, types of endocrine glands of vertebrates (human), mechanism of hormones action. 1. Structure and functions of Pituitary gland 2. Structure and functions of Thyroid gland 3. Structure and functions of Parathyroid gland 4. Structure and functions of Pancreas gland 5. Structure and functions of Adrenal gland	**02**

Reference Books:

1. L. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrence. (2002): Principles of Development, Oxford University Press.
2. W.A. Miller (1997): Developmental Biology. Springer – Verlag.
3. S.F. Gilbert.(1994): Developmental Biology, Sinauer Associates Inc. Publishers (4th edition).
4. Scott F. Gilbert (2010): Developmental Biology, Sinauer Associates, Inc., Sunderland, MA Ninth Edition
6. B. I. Ballinsky' Saunders (1960): An Introduction to Embryology, College Publishing Co. 4th Ed.
7. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2007/2014). Molecular Biology of the Cell, 5th or 6th Edition Pub: Garland Science.
8. D. Purves, G. Augustine, D Fitzpatrick, W. Hall, A. LaMantia, L.(2012). Neuroscience, White. Sinauer Associate Inc 5th edition.
9. E. R. Kandel, J.H.Schwartz and T.M. Jessel (2012): Principles of Neural Science, Hall International.
10. M. F. Baer, B.W.Connors& M. A. Paradiso, William & Wilkins, Baltimore (2020): Neuroscience: Exploring the brain. 4th edition. Jones & Bartlett Learning;
11. C. Guyton and J.E.Hall (2006): Text Book of Medical Physiology 11th Edition. College Publishers.
12. G. Tortora and S. Grabowski John. (2003): Principles of Anatomy and Physiology, 10th edition. Wiley & Sons, Inc. G. M. Shepherd: Fundamentals of Neurobiology, University Press, 3rd Edition.
13. C.U.M. Smith (2002): Elements of Molecular Neurobiology, Wiley and sons Publication.
14. Talwar and Srivastava (2002): Text Book of Biochemistry and Human Biology: (3rd Edition). PHI learning

15. Dr. Himanshu Arora Dr. Mohan P. Arora (2016): Developmental Biology. Himalaya Publishing House.
16. Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication.
17. Pillay T.V.R. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambrige University Press, Cambridge.
18. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR. Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication.

Programme Name: M.Sc. Life Sciences Semester II **Total Credits:** 02 **Department Assessment: 25 marks**	**Course Name:** Animal Sciences Practicals **Total Marks:** 50 **University assessment: 25 marks**

Course Outcome:

The learner would be able to:

1. Explain the anatomy of Finfish.
2. Explain the anatomy of Shellfish.
3. Understand the concepts of development in chick embryo.
6. Explain the various stages of cell division.
7. Understand the sense organs and nervous system.
8. Describe the structure and functions of different endocrine glands.

Course Code	Course Title	Credits
LSc509	**Animal Sciences Practicals**	**02**
1	Animal physiology dissection of Finfish to study internal organs.	
2	Animal physiology dissection of Shellfish to study internal organs.	
3	Study of ECG in humans.	
4	Preparation of temporary mounting of chick embryos up to 48 hours of incubation.	
5	Study of cell division.	
6	Visit to a fish/ poultry farm.	
7	Study of endocrine glands (Demonstration).	
8	Study of EEG in humans.	

Programme Name: M.Sc. Life Sciences Semester II **Total Credits:** 04 **Department assessment:** 50	**Course Name: Biochemical Sciences** **Total Marks:** 100 **University assessment:** 50

Course Outcome:

The learner would be able to:

1. Understand the classification, structure and biological role of various carbohydrates, vitamins and minerals.

2. Explore the structural and functional aspects of proteins and lipids
3. Explain the mechanism of action of enzymes and their regulation
4. Recognize the significance of biochemical techniques in understanding the structure function relationship of the biomolecules

Course Code	Course Title	Total Credits
LSc510	**Biochemical Sciences**	**04**
MODULE I **UNIT I: Carbohydrates, Vitamins, Minerals (15 L)** **Carbohydrate:** Classification and stereochemistry, structure, properties and biological roles of storage and structural carbohydrates such as sucrose, starch, glycogen, cellulose, pectin,hemicelluloses, chitin, mucopolysaccharides. Glycoproteins, proteoglycans, glycolipids. Applications of carbohydrates (biofuel, industrial and therapeutic). **Vitamins**: Structure, sources and biological roles of water soluble and lipid soluble vitamins, Nutritional requirements of vitamins (National and international), Deficiency and excess disorders of vitamins **Minerals**: Sources and biological roles of bulk and trace elements, Nutritional requirements of minerals (National and international), Deficiency and excess disorders of minerals **UNIT II: Protein and Lipids (15 L)** **Protein**: Structure, classification and properties of Amino acids; Peptide bonds and Primary Structure; Secondary structure eg. Keratin, Collagen; Ramachandran plot; Tertiary structure and the underlying interactions/ forces, quaternary structure and with references to haemoglobin; and Quaternary structure. Protein folding and denaturation; Domains and motifs; Cytoskeletal and extracellular proteins; Isolation, purification and characterization of proteins; Applications of proteins (industrial and therapeutic); Parameters of protein quality (Biological value, net protein utilization, protein efficiency rate, digestibility) **Lipids**: Structure, classification and properties of lipids; Lipid peroxidation; Lipid analysis in Foods; Formation of liposomes and drug targeting.	**02**
MODULE II **UNIT III: Enzymology (15 L)** **Enzyme:** Enzyme and enzyme substrate interactions; chemical modification and identification of active site amino acids; Enzyme kinetics (Michaelis-Menten equation and plot, Lineweaver-Burk plot, significance of Km and Vmax); **Catalytic efficiency of enzymes;** Mechanism of enzyme catalysis with reference to chymotrypsin/lysozymes/metalloenzymes; Role of metals in catalysis with reference to carboxypeptidase; Isozymes with reference to LDH; Coenzymes and their roles; Ribozymes and **Abzymes**; Therapeutic and industrial applications of enzymes. **Enzyme Regulation**: Regulation of enzyme action; Theory of allostery with reference to ATCase **Enzyme inhibitors**: types and their kinetics; Enzyme inhibitors as drugs. **UNIT IV: Biochemical Techniques (15 L)** **pH and Buffers**: Principles and theory, Henderson and Hasselbach equation, design and working of pH meters. **Centrifugation**: Principles and types, simple and differential, ultracentrifugation – preparative and analytical.	**02**

Chromatography: Principle, methodology and applications of chromatography using (paper, thin layer, column (gel filtration, ion exchange, affinity, gas, HPLC, FPLC etc). **Electrophoresis**: Principles and types of electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse-field gel electrophoresis, gel matrices polyacrylamide, agarose etc, critical parameters for optimum separation and resolution, two-dimensional electrophoresis (IEF). **Colorimetry and spectroscopy**: Basic principles, nature of electromagnetic radiation, Beer-Lambert laws, colorimetric methods and instruments, principles of spectroscopy, types of spectra (absorbance, emission, fluorescence and action spectra), single and double beam spectrophotometers, densitometers, circular dichroism and their applications.	

Reference Books:

1. Jeremy Berg; Gregory Gatto Jr.; Justin Hines; John L. Tymoczko; LubertStryer. Biochemistry, 10th Edition, 2023. Springer/Macmillan
2. Voet, Donald, Voet Judith, Pratt, Charlotte W. (2016): Fundamentals of Biochemistry:
3. Life at the molecular Level 5thEdition. John Wiley & Sons.
4. Nelson David L., Cox Michale. Lehninger Principles of Biochemistry (2021): 8thEdition.Macmillan Learning, New York.
5. Thomas M. Devlin Text Book of Biochemistry with clinical correlation (2010), 7th Edition John Wiley -Liss, Hobokhen NJ publishers
6. Purich Daniel L., Allison R. Donald. (2002): The Enzyme Reference: A Comprehensive
7. Guidebook to Enzyme Nomenclature, Reactions, and Methods. Publisher: California, Academic Press.
8. K. Wilson and I. Walker, (2018): Principles and Techniques of Biochemistry and Molecular Biology, 8th Edition, Cambridge University Press.
9. David Frifelder (1982): Physical Biochemistry, 2ndeditionW. H. FreemanSan Francisco:
10. Ranade, Rashmi and Sanjay Deshmukh. 2013. Handbook of Techniques in Biotechnology. Stadium Press India Pvt. Ltd., New Delhi, India.379p. ISBN: 9978-93-80012-55-1.
11. Sheehan, D. (2009) Physical Biochemistry: Principles and Applications. John Wiley & Sons Ltd., UK.
12. Lesk, A. M. (2004) Introduction to Protein Science: Architecture, Function and
13. Genomics. Oxford University Press, UK.
14. Creighton, T.E. (1983) Proteins: Structures and Molecular Properties. W.H. Freeman and Co., USA.
15. Arai, M. and Kuwajima, K. (2000) Advances in Protein Chemistry. Academic Press,
16. USA
17. David E Metzler (2001. 2002): The Chemical Reactions of Living Cells – Vol1 and 2.
18. William J. Marshall, Stephan K. Bangert, Elizabeth S.M. Ed. S.M (ed) Marshall, Clinical
19. Biochemistry: Metabolic and Clinical Aspects by (2008) Publisher: Elsevier Science

Programme Name: M.Sc. Life Sciences Semester II	**Course Name: Biochemical Sciences Practicals**
Total Credits: 02	**Total Marks:** 50
Department Assessment: 25 marks	**University assessment: 25 marks**

Course Outcome:

The learner would be able to:

1. Understanding Enzyme kinetics and effect of various parameters on enzyme activity.
2. Purification of proteins using various methods.
3. Analyze lipids
4. Isolate various organelles using density gradient.
5. Separate macromolecules using gel electrophoresis.

Course Code	Course Title	Credits
LSc511	**Biochemical Sciences Practicals**	**02**
1	Enzyme kinetics: effects of pH, temperature, time and substrate concentration, determination of Km and Vmax using acid or alkaline phosphatase/Amylase, specific activity.	
2	Extraction of proteins from plants/bacteria	
3	Purification of proteins/enzymes a. Partial purification using salt fractionation and dialysis b. Purification using chromatographic and/or electrophoretic techniques c. Measurement of purification fold	
4	Analysis of lipids (iodine number/acid value/ saponification number/Peroxide value	
5	Lipid peroxidation by Thiobarbituric acid reactive substances (TBARS) method	
6	Estimation of protein by Bradford/Lowry's method	
7	Isolation of cell organelles to demonstrate Density gradient centrifugation	
8	Separation of proteins/nucleic acids by gel electrophoresis	

Programme Name: M.Sc. Life Sciences Semester II **Total Credits:** 02 **Department assessment:** 25	**Course Name:** Molecular Biology **Total Marks:** 50 **University assessment:** 25

Course Outcome:

The learner would be able to:

1. Obtain an in depth understanding of the basic processes of life
2. Get an insight into the molecular mechanisms that govern the various life processes
3. Gain extensive knowledge of the synthesis and processing of both RNA and proteins and their interactions with other macromolecules
4. Get an understanding of the regulatory mechanisms that operate within prokaryotes and eukaryotes to control gene expression
5. Be able to apply the knowledge gained in research and industry environments.

Course Code	Course Title	Total Credits
LSc512	**Molecular Biology**	**02**
MODULE I **UNIT I: Basics of Life Processes I (15 L)** **Genome Complexity**: C value paradox and Cot analysis, repetitive (satellite, tandem repeats, LINEs, SINEs, gene families (immunoglobulin, tRNA, rRNA, histones), pseudogenes). **Gene structure in prokaryotic and eukaryotic systems**: Components of gene (promoter, operator, terminator), monocistronic (ORF, introns & exons, split genes and overlap genes), polycistronic (operons), regulatory elements (response elements, enhancers/ mediators, silencers). **DNA replication**: Fidelity and processivity of replication, DNA Polymerases - subunits and functions. The clamp and its loader- leading and lagging strand. Primer removal- leading and lagging strand. **DNA repair and recombination**: Direct repair, Excision of base pair, Post replicative, SOS. **Recombination**: Homologous and Non Homologous. **Extrachromosomal genome**: Plasmid (F plasmid and yeast 2µm plasmid), Mitochondria, Chloroplast, concept of maternal inheritance (cytoplasmic inheritance/organelle genetics). **UNIT II: Basics of Life processes II (15L)** **Transcription Components in prokaryotes and eukaryotes**: (TATA box, GC box, CAAT box, transcription factors, Rho dependent and independent termination) **Transcription Mechanism in prokaryotes and eukaryotes**: RNA polymerases (sigma factors, positive and negative regulators) initiation, elongation and termination. **Transcription Regulation in prokaryotes and eukaryotes**: concept of regulation - inducible and repressible systems, positive and negative regulation of operons (Tryptophan, Arabinose), regulons and stimulons, catabolite repression (lac operon), tissue and developmental stage specific transcription factors/ master switch. **RNA processing and post transcriptional gene regulation**: Capping and polyadenylation of hnRNA, splicing and spliceosome, ribozymes, Processing of mRNA, tRNA molecules and rRNA, post transcriptional mRNA stability and degradation. Translation: **Ribosomes**: structure and assembly of the prokaryotic and eukaryotic ribosomes, **Translation process**: Translation factors - mechanism of initiation, elongation and termination in prokaryotes and eukaryotes and regulation, mechanisms to overcome premature translation termination, role of suppressor tRNAs. **Inhibitors of protein synthesis**: Prokaryotic and eukaryotic protein synthesis inhibitors and their significance.	**02**

Reference Books:

1. Benjamin Pierce (2013). Genetics: A Conceptual Approach 5th Edition. W. H. Freeman And Company
1. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell Molecular Cell biology: 5th Edition and above.
2. Geoffrey Cooper (2018). The Cell: A Molecular Approach 8th Edition. Oxford University

Press
5. An introduction to Molecular Biotechnology- Molecular fundamentals, methods and applications in Modern Biotechnology (2006): ed. Micheal Wink
6. Walker John M. and Ralph Rapley (2015). Molecular Biology and Biotechnology 6th Edition. RSC Publishing
7. Lehninger, Nelson and Micheal Cox (2017). Principles of Biochemistry 7th Edition. W. H. Freeman and Macmillan Learning, New York
8. Lewin B. Micheal Stone (2008). Genes IX. Jones and Barlett Publishers Ltd.
9. Russell P. (2010). Genetics: A Molecular Approach 3rd Edition. Pearson Publishers
10. Robert Weaver (2012). Molecular Biology 5th edition McGraw Hill
11. James D. Watson, A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael,
3. Losick Richard (2016). Molecular Biology of the gene 7th edition Pearson Publishers
4. M. Green and J. Sambrook (2012). Molecular Biology: A laboratory Manual, 4th edition.
5. Cold Spring
6. T.A. Brown (2012): Introduction to Genetics. Publisher - Garland Science.
7. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and
8. Genomics.

ELECTIVES SEMESTER II

Programme Name: M.Sc. Life Sciences Semester II	**Course Name: Scientific conduct and Communication**
Total Credits: 04	**Total Marks: 100**
Department assessment: 50	**University assessment: 50**

Course Outcome:

The learner would be able to:

1. Develop soft skills in compilation and presentation of their research work.
2. Prepare a draft research/ review article based on a Literature Review.
3. Combine and relate the concepts of IPR and ethics in biology.

Course Code	Course Title	Total Credits
LSc513a	**Scientific conduct and Communication**	**04**
MODULE I **Course LSc513aT: Scientific conduct and Communication (Credits 2)** **Unit I: Scientific conduct and writing (15L)** **Ethics with respect to science and research**; Intellectual honesty and research integrity; Framework for Good Academic Research Practices (UGC Guidelines 2020); Scientific/research misconducts (SM/RM): Falsification, Fabrication, and Plagiarism (FFP; Factors influencing scientific misconduct; National and International agencies for prevention of SM; Redundant publications: duplicate and overlapping publications, salami slicing 5. Selective reporting and		**02**

misrepresentation of data. **Meaning of Scientific and non scientific writings**; Structures of Research and grant proposals, Synopsis, Dissertations, Thesis, Research paper writings (Abstract, Introduction, Review literature, methodology, Results, Discussions, Summary, Conclusion, Bibliography etc); Presentations: Graphical, Tabular, Animation, Power point etc. Referencing styles and online tools **Unit II: IPR (15 L)** **Introduction to IPR**; Types of Intellectual property; Traditional vs. Novelty; Importance of intellectual property rights in the modern global economic environment, Importance of intellectual property rights in India; IPR and its relevance in biology and environmental sciences; **Agreements** - Evolution of GATT and WTO and IPR provisions under TRIPS; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970). **Patents**: Definition, patentable and non-patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition; Concept of Prior Art; Precautions while patenting - disclosure / non- disclosure; Time frame and cost; Patent databases, Searching International databases; Patent licensing and agreement; Patent infringement – meaning, scope, litigation, case studies.	
MODULE II: **Course LSc513aP: Scientific conduct and Communications Practicals (Credits 2)** 1. Write down the components of a research paper and explain the significance of each component. 2. Case study on Enola Beans case 3. Case study on Turmeric case 4. Case study on Neem case 5. Case study on Basmati case 6. Case study on Golden Rice 7. Case study on Bt Brinjal 8. Case study on Myriad case on gene patenting 9. Case studies on Falsification 10. Case studies on Fabrication 11. Case studies on Plagiarism	**02**

References:

1. The Oxford Book of Modern Science Writing (Oxford Landmark Science) 2009 by Richard Dawkins
2. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded (2012) by Joshua Schimel
3. The Best of the Best of American Science Writing (The Best American Science Writing) 2010 by Jesse Cohen
4. From Research to Manuscript A Guide to Scientific Writing (Second Edition) By Katz, Michael J. (Springer Publication)

5. Science Research Writing for Non-Native Speakers of English by Hilary Glasman-Deal, Imperial College Press, London, UK
6. Scientific Writing and Communication by Angellka Hofmann, Oxford University Press (2014)
7. Law Of Intellectual Property Rights-Shiv Sahai Singh
8. WTO And Intellectual Property Rights-Talwar Sabanna
9. IPR: Unleashing the Knowledge Economy- Prabuddha Ganguli
10. Good Academic Research Practices https://www.ugc.ac.in/e-book/UGC_GARP_2020_Good%20Academic%20Research%20Practices.pdf

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name: Food Technology** **Total Marks: 100** **University assessment: 50**

Course Outcome:

The learner will be able to:

1. Differentiate between nutritionally healthy and unhealthy food.
2. Evaluate various food processing techniques.
3. Understand fish product development and it's preservation techniques.
4. Familiar with the regulatory guidelines of biological safety and GMOs that govern food and pharma and food labelling,

Course Code	Course Title	Total Credits
LSc513b	**Food Technology**	**04**
MODULE I		**02**

Course LSc513bT: Food Technology (Credits 2)

Unit I: Food Constituents and Nutrition

Food Constituents, Sources and Function: Carbohydrate, lipids, proteins, vitamins, minerals and water; RDA and ICMR recommendations for calorie requirement of food for men, women and children;
Food Spoilage: Chemical, biochemical and microbial
Methods of Food Preservation: Dehydration, chemical, freezing etc.
Food Additives: classes and safety
Food Poisoning: chemical and microbial
Alternative foods: Plant based meat, plants/ algae/yeast: production, nutritional scoring and effect on health. Artificial milk: sources, advantages and challenges.

Unit II: Food Processing and packaging

Types of Food: Cereals and pulses; Milling process, Nutritive loss; Indian cereal products; Bakery and Pasta products; Types of Milk products; Fruit products and

confectionaries; Food beverages; **Food analysis and nutritional labelling** **Food Processing**: History, objectives and quality control **Food Packaging**: Types and functions; Health Foods: Functional foods, Prebiotics, Probiotics, Nutraceuticals, organic foods, GM foods. **Ready to eat foods**. **Modular Fish Product Development**: Fish product: Introduction, types of fishery product: mince based products, surimi based products, ready to eat products in retortable pouch, extruded products, Battered & breaded products, formation of vitamins and minerals rich product from seafood **Fish Food Preservation Techniques**: Drying, freezing, salting, canning etc. Preparation of some popular products: 1. Finfish/Shellfish pickle 2. Finfish/Shellfish soup product 3. Finfish/Shellfish wafers 3. Finfish/Shellfish chakli 4. Finfish/Shellfish sev 5. Finfish/Shellfish Noodles 6. Finfish/Shellfish cutlet 7. Quality sea food (Shrimp/Oyster).	
MODULE II: **Course LSc513bP: Food Technology Practicals (Credits 2)** 1. Microbiological analysis of food A. Determination of bacteria in samples and presumptive test for coliforms B. Cultural Characterization and Biochemical Studies of the Sample Micro flora 2. Microbiological analysis of Milk A. Enzymatic test of milk by Methylene Blue Reductase Test (MBRT) B. Quality testing of milk by Resazurin Test 3. Microbiological analysis of drinking water: Determination of Most Probable Number (MPN) test 4. Chemical testing of food items A. Determination of Total Soluble Solids or Sugar (TSS) by Refractometer 5. Determination of volatile amines: Dimethylamine (DMA) / Trimethylamine (TMA) / Total volatile base (TVB) 6. Detection for the Presence of Hydrogen Peroxide 7. Alkaline Phosphatase Test for Checking Efficiency of pasteurization 8. Finfish/Shellfish product development. 9. Sensory analysis of fish product. 10. Visit to Fishery institutes and fishery processing industry.	**02**

References:

1. Sumati R Mudambi , Rajagopal M V. Fundamentals of Food and Nutrition. New Age International Publishers
1. Potter NN , Hotchkiss JH. Food Science. CBS publishers and distributers
2. S. Manany, N S. Swamy Food Facts and Principles. New Age International Publishers
3. Pomrenz Y&Meloan CE 1996 Food Analysis Theory and Practice CBS
4. Jay JM, Loessner MJ & Golden D A 2005. Modern Food Microbiology. Springer Verlag

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name: Biotechniques** **Total Marks: 100** **University assessment: 50**

Course Outcome:

The learner would be able to:

1. Explain various concepts and methods used in Gene cloning and molecular techniques.

Course Code	Course Title	Total Credits
LSc513c	**Biotechniques**	**04**
MODULE I **Course LSc513cT: Biotechniques (Credits 2)** **Unit I: Essentials of Gene cloning (15 L)** **Cloning**: Importance of DNA Cloning, Principles of Cell-based DNA Cloning and cell independent DNA cloning, Primers, PCR and its types, Cutting and Joining DNA methods - nucleases, polymerases, phosphatases, kinases, terminal transferase, adaptors and linkers, homopolymer tailing. Construction of Genomic and cDNA libraries **Vectors**: Essential components of vectors and their significance **Natural Vectors**: F Plasmid, R Plasmid, Col Plasmids, Tol Plasmid, Vir Plasmids, **Artificial Plasmid vectors** - pBR322 and pUC18, Vectors based on the bacteriophage Lambda, Cosmids, M13 vectors, Yeast Plasmids, YACs and BACs. **Expression vectors** - bacterial, mammalian and plant. Use of plant viruses as episomal expression vectors. Use of *Agrobacterium tumefaciens* and *A. rhizogenes* plasmids, Direct DNA transfer to plants, Production of transgenic mice, ES cells can be used for gene targeting in mice. **Unit II: Cellular and Molecular Techniques (15 L)** **Horizontal Transfer of Genes**: transformation, conjugation, transduction-general and specialized, mapping genes by interrupted mating. **Methods of DNA transfer in eukaryotic and prokaryotic cells:** Transfection methods, use of liposomes, adenovirus, biolistics, microinjection, electroporation, and transformation, transduction, and protoplasts transformation, ultrasonication. **Microtomy**: Principles and types, sample preparation and sectioning parameters. Histology Microscopy: Basic principles, instrumentation, sample preparation for optical, phase- contrast, interference, polarisation, inverted, fluorescence, confocal and electron microscopes and their applications **Molecular Techniques**: ELISA, RIA, Immunoprecipitation - single and double, RFLP, RAPD, AFLP, Blotting techniques: Southern, Western and Northern, In - situ Hybridization: FISH, GISH SKY, Chromosome Painting.	**02**

MODULE II: **Course LSc513cP: Biotechniques Practicals (Credits 2)** 1. Isolation of plasmid from E. coli. 2. Agarose gel electrophoresis of isolated plasmid DNA 3. Transformation of E. coli cells 4. Electroporation of E coli. (Demonstration) 5. PCR amplification of 16s rDNA from E. coli 6. Western Blotting (Demonstration). 7. Sandwich ELISA. (Demonstration) 8. RAPD of plants/microorganisms/animal systems 9. Cloning of GFP gene.	**02**

References:

1. Brown T. A (2016). Gene Cloning and DNA Analysis: An Introduction. 7th Edition. Wiley and Sons
2. M. Green and J. Sambrook (2012). Molecular Biology: A laboratory Manual, 4th edition. Cold Spring Harbor Laboratory Press
3. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic
4. Manipulation of Plants. Oxford: Oxford University Press.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics.
6. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
7. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.
8. Ranade, Rashmi and Sanjay Deshmukh. 2013. Handbook of Techniques in Biotechnology. Stadium Press India Pvt. Ltd., New Delhi, India.379p. ISBN: 9978-93-80012-55-1.
9. Keith Wilson and James Walker (2010). Principles and Techniques of Biochemistry and
10. Molecular Biology, 7th edition. Cambridge University Press
11. Andreas Hofmann and Samuel Clokie (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 8th edition. Cambridge University Press

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name: Biostatistics** **Total Marks: 100** **University assessment: 50**

Course Outcome:

The learner would be able to:

1. Study and describe the various concepts of statistics and its applications in biology.
2. Determine and validate the results of a hypothesis.
3.

Course Code	Course Title	Total Credits
LSc513d	**Biostatistics**	**04**
MODULE I		**02**

Course LSc513dT : Biostatistics (Credits 2)

Unit I: Biostatistics I (15L)

Introduction: Introduction, scope, application and uses of statistics, collection and classification of data, census and sampling, graphs and diagrams, arithmetic mean, median, standard deviation.

Correlation and regression: for ungrouped data, scatter diagram, calculation of correlation coefficient, linear regression coefficient and equation of the lines of regression, non-linear relationship transformable to linear form ($Y=ab^X$, $Y=a^xb$).

Probability: definition, addition and multiplicative laws (without proof). Random variable and its distribution, binomial probability distribution, examples and conditions, means and variance, Poisson probability distribution, examples and conditions, means and variance, continuous variable, normal distribution, use of normal probability table for finding probabilities.

Population Statistics: Population parameters and sample statistics, sampling techniques, simple random sampling, stratified random sampling, systematic sampling, standard error of mean.

Estimation, point and interval, confidence interval for population, mean and proportion.

Unit II: Biostatistics II (15L)

Hypothesis testing: Type-1 and Type-2 errors, levels of significance, one tailed and two tailed tests, application to single mean and single proportion, equality of two population means and two population proportions for small and large sample size.

Students test for significance for correlation, coefficient r for =0 (small sample

tests). Fishers Z transformation coefficient for getting r0 in large samples, test of significance for r (=0). **Variance ratio F tests**: Analysis of variance in one-way and two-way classification. **Design of experiment:** Principles and concepts of completely randomized design, randomized block design and Latin square design. **Non-parametric tests**: Chi-square test for independent attributes in rxc table, special case 2x2 table. Distribution free methods, Sign test for method pairs, Wilcoxon test for unpaired data, Run test, Kruskal Wallis test. Friedman test.	
MODULE II: **Course LSc513dP : Biostatistics Practicals (Credits 2)** 1. Biostatistics: Solving problems using: a. Students t Test, b. ANOVA c. Regression analysis. 2. Digital Packages for Data Analysis: The appropriate use of various statistical packages for data analysis such as: a. SPSS b. R c. Matlab d. Tableau e. Graphpad Prism	**02**

References:

1. B Antonisamy, Prasanna S. Premkumar, Solomon Christopher (2017): Principles and Practice of Biostatistics. Elsevier India
2. Jatinder Bali (2017): Basics of Biostatistics: A Manual for Medical Practitioners. JaypeeBrothers Medical Publishers.
3. Bratati Banerjee (2018): Mahajan's Methods In Biostatistics For Medical Students And Research Workers.
4. K. Janardhan P. Hanmanth Rao (2019): Fundamentals of Biostatistics. Publisher Dreamtech Press.

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name: Remote sensing** **Total Marks: 100** **University assessment: 50**

Prerequisite: A fundamental understanding of basic principles in earth sciences and familiarity with digital image processing concepts are recommended as pre-requisites for this Elective.

Course Outcome:

These course outcomes are designed to ensure that students develop a comprehensive understanding of remote sensing principles, gain practical skills in image analysis and processing, and apply remote sensing techniques for environmental monitoring and management. Upon completion of the elective course on Remote Sensing, students will be able to:

1. Understand the principles and fundamentals of remote sensing and its applications in various fields.
2. Demonstrate proficiency in image processing techniques and analysis for extracting valuable information from remote sensing data.
3. Apply hyperspectral remote sensing methods for data acquisition, preprocessing, spectral analysis, and classification.
4. Utilize remote sensing techniques for environmental monitoring, including land cover and land use change, vegetation and ecosystem monitoring, water resource assessment, and climate change studies.
5. Gain hands-on experience in using remote sensing tools, software, and specialized techniques for image interpretation, enhancement, feature extraction, and change detection.
6. Analyze and interpret remote sensing data to generate meaningful insights and make informed decisions in environmental monitoring and management.
7. Apply remote sensing knowledge and skills to real-world scenarios through practical projects, demonstrating the ability to address specific challenges and contribute to the field of remote sensing.

Course Code	Course Title	Total Credits
LSc513e	**Remote sensing**	**04**
MODULE I: **Course LSc513eT: Remote Sensing (2 Credits)** **Unit 1: Remote Sensing: Principles, Applications and Image Processing (15L)** ▪ **Principles and Applications of Remote Sensing (8L)** Introduction to remote sensing (2); Electromagnetic radiation and remote sensing systems (2); Remote sensing platforms and sensors (1); Image interpretation and analysis (1); Applications of remote sensing in various fields (2).		**02**

▪ **Image Processing and Analysis in Remote Sensing (7L)** Digital image processing fundamentals (2); Image enhancement techniques (2); Image classification and feature extraction (1); Change detection and image fusion (1); Object-based image analysis (1). **Unit 2: Hyperspectral Remote Sensing for Environmental Monitoring** ▪ **Hyperspectral Remote Sensing (8L)** Introduction to hyperspectral remote sensing (1); Hyperspectral data acquisition and preprocessing (2); Spectral analysis and feature extraction (2); Hyperspectral data classification (2); Applications of hyperspectral remote sensing (1). ▪ **Remote Sensing for Environmental Monitoring (7L)** Introduction to environmental monitoring (1); Remote sensing of land cover and land use change (2); Monitoring of vegetation and ecosystems (1); Remote sensing of water resources (1); Remote sensing in climate change studies (1).	
MODULE II: **Course LSc513eP: Remote Sensing Practicals (2 Credits)** **Practicals: 2 Credits (60 Hours- 10 Practicals of 6 hours each)** Practical sessions will cover various hands-on activities related to the theoretical concepts discussed in the lectures, as follows: ▪ **Principles and Applications of Remote Sensing (2 Practicals- 12 hours)** Hands-on introduction to remote sensing tools and software (3); Image interpretation and analysis exercises (3); Application-oriented remote sensing projects (6). ▪ **Image Processing and Analysis in Remote Sensing (2 Practicals- 12 Hours)** Digital image processing techniques using software (3); Image enhancement and feature extraction exercises (3); Image classification and change detection projects (6). ▪ **Hyperspectral Remote Sensing (3 practicals - 18 hours)** Hyperspectral data preprocessing and analysis using specialized software (6); Hyperspectral image classification and spectral analysis exercises (6); Hyperspectral data application projects (6). ▪ **Remote Sensing for Environmental Monitoring (3 practicals-- 18 hours)** Land cover classification and change detection exercises (6); Vegetation and ecosystem monitoring projects (6); Water resources and climate change studies using remote sensing data (6).	**02**

References:

1. "Remote Sensing and GIS" by Basudeb Bhatta
2. "Remote Sensing and Image Interpretation" by P.S. Roy and A. Singh
3. "Digital Image Processing" by S. Jayaraman, S. Esakkirajan, and T. Veerakumar
4. "Remote Sensing and GIS Integration" by M. Anji Reddy
5. "Hyperspectral Remote Sensing: Principles and Applications" by M. S. John Wesley and S. Prasanna Venkatesan
6. "Principles of Remote Sensing" by R. S. Dwivedi and T. Sarveshwar Rao

7. "Remote Sensing of the Environment: An Earth Resource Perspective" by A. N. Reddy and P. Sanjeeva Rao
8. "Image Analysis, Classification, and Change Detection in Remote Sensing: With Algorithms for ENVI/IDL and Python" by S. Narayanamoorthy
9. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman
10. "Introduction to Remote Sensing" by James B. Campbell and Randolph H. Wynne
11. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Wood
12. "Remote Sensing of the Environment: An Earth Resource Perspective" by John R. Jensen
13. "Hyperspectral Remote Sensing: Principles and Applications" by Marcus Borengasser
14. "Remote Sensing for GIS Managers" by Stan Aronoff
15. "Introduction to Remote Sensing and GIS" by Basudeb Bhatta
16. "Remote Sensing: Principles and Interpretation" by Floyd F. Sabins Jr.
17. "Digital Image Processing: An Algorithmic Introduction Using Java" by Wilhelm Burger and Mark J. Burge
18. "Introduction to Environmental Remote Sensing" by Eric C. Barrett and Lars E. T. Johnson
19. "Remote Sensing and Image Interpretation" by Jonathan W. Chipman and Thomas Lillesand
20. "Principles of Remote Sensing" by Floyd M. Henderson and Eduardo A. Balceiro
21. "Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land, and Cryosphere Applications" by William Emery and Joan Gardner
22. "Remote Sensing of the Environment: An Earth Resource Perspective" by John R. Jensen
23. "Remote Sensing: Models and Methods for Image Processing" by Robert A. Schowengerdt.

ELECTIVE

Programme Name: M.Sc. Life Sciences Semester I **Total Credits:** 04 **Department assessment: 50**	**Course Name:** Agri-business Management **Total Marks: 100** **University assessment: 50**

Prerequisite: A basic understanding of agriculture and business principles is recommended as pre-requisite for this Elective.

Course Outcome:

The course outcomes aim to encapsulate the key knowledge and skills students will gain upon completing the elective. Specific outcome details are provided below:

1. Understand the concepts and principles of agricultural marketing and supply chain management, including market structure, pricing, distribution channels, and retailing.
2. Identify and evaluate business opportunities in agriculture and develop effective business plans for agri-entrepreneurship initiatives.
3. Apply financial management techniques in agri-business, including financial statement analysis, budgeting, investment appraisal, and risk management.
4. Gain knowledge about sustainable agriculture practices and their importance in conserving natural resources, promoting organic farming, and managing pest control and irrigation systems.
5. Analyze and utilize market information and intelligence to make informed marketing decisions and strategies for agricultural products in domestic and international markets.

6. Understand the government schemes and support available for rural development and explore the social and environmental sustainability aspects of agri-business ventures.
7. Acquire practical skills through hands-on activities, such as market surveys, price determination, supply chain mapping, business plan development, financial analysis, field visits to sustainable farms, and implementing sustainable practices in livestock management, organic farming, and water management.

Course Code	Course Title	Total Credits
LSc506f	**Agri-business Management**	**04**
MODULE I **Course LSc506fT: Agri-business Management (Credits 2)** **Unit 1: Agri-Business: Marketing, Supply Chain Management, Entrepreneurship, and Rural Development (15L)** ▪ **Agricultural Marketing and Supply Chain Management (8L)** Introduction to agricultural marketing (1); Market structure and organization (1); Market information and intelligence (1); Pricing and price risk management (1); Distribution channels and supply chain management (1); Retailing and consumer behaviour (1); International agricultural marketing (1); Marketing strategies for agricultural products (1). ▪ **Agri-Entrepreneurship and Rural Development (7L):** Introduction to agri-entrepreneurship (1); Identification of business opportunities in agriculture (1); Business planning and feasibility analysis (1); Marketing and sales management for agri-entrepreneurs (1); Financial management for agri-entrepreneurs (1); Government schemes and support for rural development (1); Social and environmental sustainability in rural development (1). **Unit 2: Financial Management and Sustainable Practices in Agri-business (15L)** ▪ **Financial Management in Agri-business (7L)** Introduction to financial management in agri-business (1);Financial statements and analysis (1); Budgeting and financial planning (1); Investment appraisal and capital budgeting (1); Working capital management (1); Risk management and insurance in agri-business (1); Financing options for agri-businesses (1). ▪ **Sustainable Agri-business Practices (8L)** Introduction to sustainable agriculture (1); Conservation and management of natural resources (1); Organic farming and certification (1); Integrated pest management (1); Sustainable irrigation and water management (1); Climate-smart agriculture (1); Sustainable livestock management (1); Agroecology and biodiversity conservation (1)		**02**
MODULE II: **Course LSc506fP: Practicals in Agri-business Management (Credits 2)** **Practicals: 2 Credits (60 Hours- 10 Practicals of 6 hours each)**		**02**

Practical sessions will cover various hands-on activities related to the theoretical concepts discussed in the lectures, as follows: ▪ **Agricultural Marketing and Supply Chain Management (2 Practicals- 12 Hours):** Market survey and analysis (3 Hours); Price determination and negotiation exercises (3 Hours); Supply chain mapping and optimization (3 Hours); Retail store visits and observations (2 Hours). ▪ **Agri-Entrepreneurship and Rural Development (2 Practicals- 12 hours):** Business opportunity identification and evaluation (3 Hours); Business plan development (3 Hours); Case studies on successful agri-entrepreneurs (3 Hours); Field visits to rural development projects (3 Hours). ▪ **Financial Management in Agri-business (2 Practicals- 12 hours):** Financial statement analysis using real-life data (3 Hours); Budget preparation and analysis (3 Hours); Investment appraisal exercises (3 Hours); Simulation games on financial decision making (3 Hours). ▪ **Sustainable Agri-business Practices (4 Practicals- 24 hours):** Field visits to sustainable farms and agri-businesses (6 Hours); Hands-on activities related to organic farming (6 Hours); Water management and irrigation techniques (6 Hours); Livestock management and sustainable practices (6 Hours).	

References:

1. "Agricultural Marketing and Price Analysis" by Bailey, DeeVon
2. "Agri-Business Management: Towards Sustainable Development" by Tewari, Rakesh
3. "Marketing of Agricultural Products" by Doering, Otto
4. "Entrepreneurship in Agriculture" by Shepherd, William
5. "Rural Development: Principles, Policies, and Management" by Ponniah, M.
6. "Financial Management in Agriculture" by Hossain, Mahabub
7. "Agricultural Finance and Management" by Coyle, William T.
8. "Sustainable Agriculture and Food Security in an Era of Oil Scarcity" by Lal, Rattan
9. "Principles of Agribusiness Management" by Schrader, Lee F.
10. "Marketing Management for Agri-business" by Holcomb, Rodney
11. "Sustainable Agriculture: Principles, Practices, and Policies" by Pretty, Jules
12. "Agri-business Management: Global Issues and Practices" by Weatherspoon, Dave
13. "Agricultural Marketing and Agri-business Management" by Nwankwo, Okey C.
14. "Financial Management in Agriculture" by Smith, Lynne
15. "Sustainable Agri-food Supply Chains" by Canavari, Maurizio

ON JOB TRAINING

Programme Name: M.Sc. Life Sciences Semester II	**Course Name:** On Job Training
Total Credits: 04	**Total Marks:** 100
Departmental assessment: 50	**University assessment:** 50

A. Introduction

- On Job Training (OJT) holds immense importance within the M.Sc. Life Sciences program as it serves as a vital bridge between theoretical knowledge acquired in the classroom and practical application in real-world settings. This integral component aims to equip students with a comprehensive skill set encompassing both technical and non-technical proficiencies that are essential for success in the industry. By actively engaging in OJT, students have the invaluable opportunity to apply the concepts and theories learned during their coursework to real-life scenarios within the field of Life Sciences. This hands-on experience enables them to cultivate problem-solving skills and gain a profound understanding of industry practices, ultimately enhancing their competence and confidence in preparation for the challenges they may encounter in their professional careers.
- Moreover, hosting OJT programs benefits not only the participating students but also the organizations involved. By gaining insights into the curriculum and content of the M.Sc. Life Sciences program, organizations can provide valuable feedback on the relevance of the coursework and industry requirements. This collaborative exchange facilitates the continuous improvement of the program, ensuring its alignment with industry needs. Through this symbiotic relationship between academia and industry, graduates are equipped with the necessary skills and knowledge to excel in the competitive job market, contributing meaningfully to the field of Life Sciences.
- Additionally, faculty members involved in OJT also reap significant benefits. Through firsthand exposure to the industry and observation of practical work within the field of Life Sciences, faculty members can enhance their teaching methodologies and delivery techniques. This experience enables them to stay updated with the latest industry practices, enabling them to effectively impart relevant guidance and mentorship to students. By incorporating insights gained from OJT, faculty members play a crucial role in preparing students for successful careers in the dynamic and ever-evolving field of Life Sciences.

B. Enhancing Practical Skills through OJT

- The On-the-Job Training (OJT) program within the M.Sc. Life Sciences curriculum offers a valuable opportunity for students to enhance their practical skills and gain real-world experience. This program typically spans 4-6 weeks, requiring a minimum of 120 hours of physical presence at the organization. It is designed to ensure that students actively apply their classroom learning in a professional work environment.
- While students are expected to secure their own OJT placements, the institution provides support and guidance to help them secure positions with reputable organizations. The aim is to expose students to diverse work environments outside of the home institution, allowing them to gain a comprehensive understanding of the industry.
- The OJT program covers a wide range of subjects within the syllabus, providing students with the flexibility to align their OJT experience with their academic interests. This ensures that students can apply their theoretical knowledge to practical scenarios relevant to their chosen areas of specialization.

- Recognizing the changing dynamics of work environments, the program also offers the option for some OJT sessions to be conducted online. This flexibility accommodates virtual work environments, enabling students to gain valuable experience and exposure in a remote setting.
- The OJT experience offers mutual benefits for both students and organizations. Students have the opportunity to apply their classroom learning in a real-world setting, fostering the development of both technical and non-technical skills. They gain valuable insights into the industry and are better prepared for successful careers in the field of Life Sciences.
- For organizations, hosting OJT provides valuable insights into the program's curriculum and industry requirements. This allows them to provide constructive feedback and enhance the relevance of the coursework, ensuring that graduates are well-prepared to meet the demands of the industry.
- Overall, the OJT program serves as a bridge between theoretical knowledge and practical application, equipping students with the necessary skills and experience to thrive in their future careers within the field of Life Sciences.

C. Interning organization:

Students enrolled in the M.Sc. Life Sciences program have the flexibility to pursue their On-the-Job Training (OJT) in various types of organizations within the field of Life Sciences. These include, but are not limited to:

- Biotechnology Companies: Gain practical experience in biotechnology research and development, working on projects related to genetic engineering, drug discovery, and molecular diagnostics.
- Pharmaceutical Industries: Explore opportunities in pharmaceutical companies, where students can contribute to the development and testing of new drugs, learn about regulatory processes, and gain insights into the manufacturing and quality control aspects of the industry.
- Environmental and Conservation Organizations: Engage with organizations dedicated to environmental preservation and conservation. Students can contribute to biodiversity surveys, ecological restoration projects, and environmental impact assessments.
- Government Research Institutes: Contribute as research assistants in government research institutes focused on life sciences. This offers students the chance to work on cutting-edge research projects, collaborate with renowned scientists, and gain exposure to the latest advancements in the field.
- Academic Institutions: Collaborate with university departments, research centres, or colleges as research assistants. Students can actively participate in ongoing research projects, assisting faculty members and researchers in data collection, analysis, and interpretation.

It is important to note that the options provided above offer a range of possible OJT placements, providing students with valuable exposure to different sectors and professional settings within the field of Life Sciences. This variety ensures that students can choose internships aligned with their specific interests and career goals, allowing them to gain practical experience and develop relevant skills in their chosen areas of specialization.

D. OJT mentors:

In order to enhance the learning experience and maintain the quality of the MSc program, each student participating in the On-the-Job Training (OJT) will be assigned two mentors: a faculty mentor from the institution and an industry mentor from the organization where the student is interning.

- Industry Mentor Role: The industry mentor plays a crucial role in guiding the student during the internship, ensuring that they fulfil the requirements of the organization and

successfully meet the demands of the assigned project. Leveraging their expertise and experience, industry mentors provide valuable insights into real-world practices and industry expectations. They offer guidance on industry-specific techniques, provide feedback on the internee's performance, and help bridge the gap between academic knowledge and practical application.

- Faculty Mentor Role: The faculty mentor serves as the overall coordinator of the OJT program. They oversee the entire internship process and evaluate the quality of the OJT in a consistent manner across all students. The faculty mentor ensures that the OJT aligns with the program's objectives and provides valuable learning opportunities for the students. They act as a liaison between the institution, industry mentor, and student, facilitating effective communication and ensuring a fruitful OJT experience. Additionally, faculty mentors offer academic support, share insights from their own research or industry connections, and provide guidance on career development within the field of Life Sciences.

By having both an industry mentor and a faculty mentor, students benefit from a comprehensive guidance system that combines industry expertise and academic support. This dual mentoring approach ensures a well-rounded and rigorous OJT experience for every student in the program, bridging the gap between theoretical knowledge and practical application while preparing them for successful careers in the dynamic field of Life Sciences.

E. Submission of Documentation for OJT

During the On-the-Job Training (OJT), students are required to submit two important documents to ensure proper documentation and assessment of their internship experience:

- Online Diary: As part of the OJT, students are expected to maintain an online diary to record their daily activities and learning experiences. The diary serves as a logbook that can be accessed by both the faculty mentor and industry mentor. Each daily entry should provide a brief account, typically consisting of 3-4 sentences, highlighting the key activities, learnings, and interactions of the day. The faculty mentor regularly monitors the diary entries to stay informed about the student's progress and engagement throughout the internship.
- OJT Report: Upon completion of the OJT, students are required to prepare a comprehensive report based on their experiences in the organization. The report should include the following components:
  - Certificate: A certificate in the prescribed format (given in Appendix II and Appendix III) should be obtained from the organization where the OJT was conducted. This certificate validates the student's participation and provides official recognition of their internship.
  - Title: The report should have a suitable title that succinctly reflects the nature of the work the student performed during the OJT.
  - Description of the Organization: A brief description of the organization where the student interned should be provided. This description gives an overview of the organization's purpose, scope, and relevance to the field of Life Sciences.
  - Description of the Activities: A detailed description of the activities conducted within the specific section or department where the intern was assigned. This section should provide insights into the type of tasks and responsibilities typically assigned to new employees in that particular area.
  - Work Allotted and Accomplished: A comprehensive account of the tasks and projects assigned to the intern, along with a detailed description of the work performed during the OJT period. This section should be a condensed and structured version of the daily reports maintained in the online diary.

- Self-Assessment: The report should include a self-assessment by the intern, reflecting on the technical and interpersonal skills acquired and developed throughout the OJT period. This self-assessment should highlight the key learnings, challenges overcome, and personal growth experienced during the internship.

By submitting these documents, students provide a comprehensive overview of their OJT experience, allowing the mentors and evaluators to assess their engagement, learning outcomes, and overall performance during the internship. The documentation ensures that students receive proper recognition for their efforts and allows them to reflect on their professional growth within the field of Life Sciences.

F. Interaction between Mentors

- To facilitate effective communication and ensure the successful implementation of the OJT, a mid-term review meeting involving the intern, industry mentor, and faculty mentor will be scheduled. This meeting serves as a platform for all stakeholders to come together and discuss the progress and experiences of the intern during the internship period.
- The mid-term review meeting can be conducted online to optimize time and resources. Typically, the meeting lasts for approximately 15 minutes. During the initial stage of the meeting, the intern provides a brief overview of their work and shares insights into their interactions and experiences. This segment allows the intern to highlight key achievements, challenges faced, and lessons learned during the internship.
- Following the intern's presentation, the industry mentor and faculty mentor engage in a discussion, providing an opportunity to exchange feedback, address any issues, and ensure a harmonious working relationship between the intern and the organization. This interaction between the mentors, in the absence of the intern, allows for open dialogue and collaborative problem-solving, ensuring that any concerns or challenges are promptly identified and resolved in a supportive and amicable manner.

By facilitating regular interactions between the mentors, the mid-term review meeting fosters effective communication, alignment of expectations, and the overall success of the OJT. It serves as a platform for mentor collaboration and ensures a cohesive and supportive environment for the intern's professional growth and development in the field of Life Sciences.

G. OJT workload for the faculty:

G. Faculty Workload for OJT

In order to ensure the smooth implementation of the OJT, each student is assigned a dedicated faculty mentor who serves as their primary point of contact and provides guidance throughout the internship period. The faculty mentor takes overall responsibility for supervising and supporting the student's OJT experience.

The faculty mentor is responsible for monitoring the progress of the OJT by regularly reviewing the online diary, engaging in discussions with the industry mentor, and providing guidance on the preparation of the OJT report. This continuous involvement allows the faculty mentor to stay informed about the student's activities, address any concerns or challenges that may arise, and ensure that the OJT aligns with the program's objectives.

Considering the time and effort required for effective mentorship, a faculty mentor who oversees approximately 20 students will be allocated a workload of 3 hours. This allocation allows the faculty mentor to dedicate sufficient time to each student, providing the necessary support, feedback, and guidance throughout the OJT journey. It is essential to maintain an appropriate

faculty-to-student ratio to ensure quality mentorship and to ensure that each student receives personalized attention and support during their OJT experience.

EVALUATION SCHEME

Evaluation: SEMESTER I

Paper Code	Theory		Practicals		Total
	Internal	External	Internal	External	
LSc501	50	50			100
LSc502			25	25	50
LSc503	50	50			100
LSc504			25	25	50
LSc505	25	25			50
LSc506 (Electives: a to f)	25	25	25	25	100
LSc507 (Research Methodology)					

Evaluation: SEMESTER II

Paper Code	Theory		Practicals		Total
	Internal	External	Internal	External	
LSc508	50	50			100
LSc509			25	25	50
LSc510	50	50			100
LSc511			25	25	50
LSc512	25	25			50
LSc513 (Electives: a to f)	25	25	25	25	100

LSc514 (OJT/ FP)* Structure for the Internal/ Departmental Evaluation

Module	Unit		Percentage	Marks
		Project Report	100%	100
1	Basic structure of society, Key definition of the problem area, analysis of preliminary data	Literature Review	30%	30
2	Class – work correspondence , formats, interactions and liaisons	Feedback from the laboratory or Organization	10%	10
3	Field work or data gathering	Materials, Methods, Observations and Results	30%	30
4	Analysis and Reporting	Presentation/Viva	20%	20
5	Feedback to community	Poster Presentation (1m x 1m)	10%	10

(On the Job Training/ Field Project)

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 questions 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.

D. Evaluation of On Job Training Course (4 Credit Course):

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

External Evaluation (to be conducted at the time of Practical Examination): 50 Marks

Module	**Unit**		**Percentage**	**Marks**
		Project Report	100%	50
1	Basic structure of society, Key definition of the problem area, analysis of preliminary data	Literature Review	30%	15
2	Class- work correspondence , formats, interactions and liaisons	Feedback from the laboratory or Organization	10%	5
3	Field work or data gathering	Materials, Methods, Observations and Results	30%	15
4	Analysis and Reporting	Presentation/Viva	20%	10
5	Feedback to community	Poster Presentation (1m x 1m)	10%	5

Professional Evaluation of intern:

Name of intern: _____

Institution: _____

[Note: Give a score in one of the columns by putting √ in the respective cells]

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)

Letter Grades and Grade Points:

Semester GPA/j 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)

SYLLABUS
M.sc Life Sciences
(Sem. I & II)

Team for Creation of Syllabus

Name	College Name	Sign
Dr. Ujwala Jadhav	University Department of Life Sciences, University of Mumbai	
Prof. Sanjay Deshmukh	University Department of Life Sciences, University of Mumbai	
Prof. Indu George	University Department of Life Sciences, University of Mumbai	
Dr. Ahamad Ali	University Department of Life Sciences, University of Mumbai	

Sign of HOD

Dr Ujwala Jadhav
University Department of Life Sciences
University of Mumbai

Sign of Dean

Dr Shivram Garje
Dean Science and Technology
University of Mumbai

Appendix-B

Justification for M.Sc. (Life Sciences- Aquaculture)

1.	**Necessity for starting the program:**	The two-year, 4-semester Master's Degree Programme (Life Sciences- Aquaculture Technology) is a necessary and transformative academic journey for aspiring scholars in the field. The interdisciplinary courses offered in this program encompass various essential areas such as animal and plant sciences, microbiology, biochemistry, molecular biology, and applied genetics. By studying these comprehensive modules, students can strengthen their expertise in their areas of interest and understand the diverse opportunities available in this dynamic field. The curriculum not only imparts theoretical knowledge but also fosters a deep appreciation for nature and natural resources. It equips students with vital skills for data observation and analysis, preparing them for future research endeavours. The inclusion of a mandatory On Job Training (OJT) component in Semester II further enhances students' readiness for the industry. This intensive training exposes them to real-world scenarios, allowing them to apply their theoretical knowledge in practical settings and develop essential skills required to excel in the professional world. Through this program, students gain a comprehensive understanding of the multidimensional aspects of life sciences, making them well-prepared for diverse career opportunities and future research undertakings. The integration of online learning also ensures a flexible and enriched learning experience. By embarking on this academic journey, students can unravel the mysteries of life, contribute to the advancement of scientific knowledge, and make valuable contributions to society.
2.	**Whether the UGC has recommended the program:**	**Yes**
3.	**Whether all the programs have commenced from the academic year 2023-24**	**Yes**
4.	**The programs started by the University are self-financed, whether adequate number of eligible permanent faculties are available?**	**No, the Programme is an aided Programme. However, against the desired number of 27 faculty positions (based on work-load), 22 positions are vacant.** Guest Faculty /Adjunct Professors/ Industry Experts/ relevant Professionals would be engaged to compensate for this.
5.	**To give details regarding the duration of the program and is it possible to compress the program?**	**2 years.** It is NOT possible to compress the programme
6.	**The intake capacity of each program and no. of admissions given in the current academic year:**	**20 seats** 2023-2024 admission starts from July 2023

7.	**Opportunities of Employability / Employment available after undertaking these courses:**	The two-year, 4-semester full-time MSc Degree Programme in Life Sciences opens up a multitude of opportunities for employability and employment in various fields. Upon completion of this comprehensive program, students are equipped with a diverse skill set and knowledge base, making them highly sought-after professionals in the ever-evolving biological sciences domain. Graduates of this program can pursue careers in Aquacultural farms, aquatic food processing industries, aqua feed technology and water quality management applying advanced scientific principles and cutting-edge technology to solve complex real-world problems in these sectors. Their ability to critically analyze and evaluate current research literature enables them to communicate scientific concepts effectively to both scientific and non-scientific audiences, making them valuable assets in research institutions, government organizations, and communication industries. Moreover, the program's focus on developing innovative and sustainable research projects adhering to international standards and ethical considerations opens doors to positions in research and development, consulting, and policymaking. Graduates' in-depth understanding of organismal structures and interactions, coupled with knowledge of interdisciplinary integration, allows them to excel in fields such as ecology, genetics, and biotechnology Furthermore, their proficiency in quantitative studies and advanced statistical methods makes them ideal candidates for roles involving data analysis and modeling, while their expertise in bioinformatics tools enables them to work in genomics, proteomics, and data-driven research. The program's emphasis on legal and ethical aspects, intellectual property rights, and responsible research conduct prepares graduates for roles in biotechnology companies, patenting agencies, and regulatory bodies, where they can navigate the social and economic implications of biology-related innovations. Additionally, the cross-cultural competence fostered through collaboration in diverse teams makes graduates well-suited for global research collaborations, international NGOs, and organizations that focus on sustainable development and global health. In conclusion, the MSc Degree Programme in Life Sciences offers an array of employment opportunities in research, industry, healthcare, and conservation sectors. Graduates emerge as versatile professionals capable of addressing contemporary challenges in the biological sciences and contributing significantly to scientific advancements and societal well-being.

Sign of HOD

Dr Ujwala Jadhav
University Department of Life Sciences
University of Mumbai

Sign of Dean

Dr Shivram Garje
Dean Science and Technology
University of Mumbai