Pt. Ravishankar Shukla University, Raipur

CURRICULUM & SYLLABI

(Based on CBCS & LOCF)

Part I

M. Sc. Biotechnology
(Semester System)

Semester: I-IV
(Program Code: 0408)

Session: 2025-26 & 2026-27

Approved by

Board of Studies: : Biotechnology
Dates : 21/05/2025
Name of Chairman : Prof. Keshav Kant Sahu
Name of Members : Prof. Ajaya Ghaisthi
: Dr. Sajal Saya Deo
: Dr. Bharti Sahu
:
: Dr. Nagendra K. Chandrakar
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21/5/25
BEchs 21/5/25
29/8/25
Ankita 29/5/25
21/5/25

M. Sc. Biotechnology

The M. Sc. Biotechnology program offered by the School of Studies in Biotechnology of Pt. Ravishankar Shukla University, Raipur, has been meticulously crafted with a focus on a Learning Outcome Based Curriculum Framework (LOCF) approach. This curriculum encompasses both foundational and advanced aspects of Biotechnology, featuring a diverse array of core subjects across each academic term. In addition to imparting traditional knowledge of biotechnology, this program offers ample opportunities for interdisciplinary and multidisciplinary learning through biotechnological electives.

Furthermore, the course addresses skill enhancement of students and encourages collaborative and cross-disciplinary learning by incorporating general elective courses, thereby allowing them to expand their knowledge in complementary fields. Each semester includes a practical component aimed at strengthening student's abilities in designing and conducting experiments within the realm of biotechnology.

The pinnacle of this program is the six-month dissertation undertaken in the final semester, which serves as a pivotal point in preparing students for future endeavours in research and development, be it in academia or industries.

Program Outcomes:

Upon successful completion of the M. Sc. Biotechnology program, students will be able to:

PO-1	**Knowledge:** Above course will impart in-depth knowledge, and develop an understanding of basic and applied aspects of biotechnology, its concepts, various theories and popularly used advanced techniques. Also, make the students aware of industrial applications of biotechnology.
PO-2	**Critical Thinking and Reasoning:** Understand the fundamentals of life-processes particularly at molecular level, and will not only be able to design related experiments but also to execute and derive logical interpretations based on generated data.
PO-3	**Problem Solving:** Utilizing advances of biotechnology, experimental skill and critical thinking, students will be capable of addressing intricate societal and industrial challenges.
PO-4	**Advanced Analytical and Computational Skills:** Students will be proficient in serving and initiating various operations in a wide range of industries, including food processing, sewage treatment plants, breweries, micro propagation units, bio-fuel production plants, bio-fertilizer units, enzyme manufacturing and drug and vaccine development sectors. Moreover, students will possess necessary expertise for collection, organization and analysis of data, and to generate pertinent insights in the field of research & development.
PO-5	**Effective Communication:** This program will make the students efficient in communicating complex concepts of biotechnology and their experimental findings to diverse audiences, including technical/ non-technical backgrounds, *via* written reports, presentations, popular articles, instructional methods, *etc.*

PO-6	**Social/ Interdisciplinary Interaction**: Students will be able to excel both as an individual and as a player or leader within a variety of teams in cross-disciplinary environments. Students will also be efficient in utilizing their contextual understanding to evaluate societal, health, and safety aspects and ensue professional responsibilities.
PO-7	**Self-directed and Life-long Learning**: Students will probably acquire capacity to participate actively in self-directed and continual learning process within the expansive realm of technological advancements.
PO-8	**Effective Citizenship, Leadership and Innovation:** After the completion of this program, the students will come up with a mind-set and attitude of a responsible citizen. Hence, they will be actively involved in society. Moreover, students will play an active role in demonstrating leadership quality and employing innovative approaches of biotechnology to improve well-being of the humans, communities, nation, and the world.
PO-9	**Ethics**: This program will probably set the minds of students to adhere gently with ethical issues, embrace professional ethics and responsibilities, and uphold the standards of biotechnological practices.
PO-10	**Further Education or Employment:** This program will ignite the students to pursue advanced academic endeavours such as Ph. D., *etc.*, in biotechnology or related disciplines. Moreover, it will equip the students with necessary expertise and skill (managerial, planning, experimental, computation, *etc.*), which are essentially required for making career in academia, research and development laboratories/ institutions, industries and, Government and non-Government sectors.
PO-11	**Global Perspective**: This program will make the students a well-suited entity for the academia, research and development laboratories/ institutions, marketing, networking, health and regulatory authorities, industries and Government and non-Government sectors. Hence, they will have an ample opportunity for placements globally.

Programme Specific Outcomes (PSOs): At the end of the program, the student will be able to:

PSO1	Students will imbibe an idea about cellular processes and building blocks (macromolecules) of life; inheritance of characters; knowledge of various diseases; diversity, roles and various biotechnological aspects of microorganisms, *etc.*
PSO2	Expertise in gene sequencing, including primer designing and synthesis; prediction and derivatization of molecular structures; drug discovery and molecular diagnostics; computational skill; idea about micropropagation and secondary metabolites; basics of thermodynamics and bioenergetics; and commercial aspects of biotechnology.
PSO3	Gain knowledge about insights of immune system, immunity and immune responses; r-DNA technology and its applications in gene therapy, diagnostic tools and disease modelling; process of fermentation and its contributions in well-being of society; and roles of microorganisms in making the environment sustainable.

PSO4	Students will perceive both basic and recent knowledge about protein engineering; identification, annotation and global analysis of proteins; IPR and ethical issues of biotechnological research; nanotechnology and its applications; transgenics and several other aspects of animal biotechnology.
PSO5	This program will provide ample opportunities to conduct both basic and advanced hands-on experiments related to various aspects of biotechnology. It aims to equip them with the skills to plan and execute experiments independently, and to draw logical conclusions.
PSO6	Students will not only be able to carry out advanced research within the pure and applied fields of biotechnology but will also be able to write scientific reports independently; will attain eligibility in national level examinations such as NET, GATE, *etc.*; and will be able to get jobs in global market.

M. Sc. Biotechnology

Specification of Course	Semester	No. of Courses	Credits
Core	I - III	17	71
Electives- DCEC*	II - IV	07[a]/ 03[b]	29
Total			100
Additional Courses (Qualifying in nature):			
Electives- Generic	II - III	02	06
Internship[#]	III	01	02
Value Added Courses/ Skill Enhancement	I, III	02	04

*Discipline Centric Elective Courses

[a]Applicable for those students who will opt theory papers and lab courses in their IV Semester.

[b]Applicable for those students who will opt project/ dissertation in their IV Semester.

[#]Offered to the PG students of the School of Studies in Biotechnology only. Internship will be done after the examination of II Semester. Credit earn out of the Internship will be reflected in the score card of III Semester.

M. Sc. Biotechnology

Program Structure

Semester	Course Code	Course Nature	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	EA	Total
Semester-I [25 Credits]	BTMS101	Core	Cell Biology	T	4	4	30	70	100
	BTMS102	Core	Genetics	T	4	4	30	70	100
	BTMS103	Core	Microbial Physiology	T	4	4	30	70	100
	BTMS104	Core	Bio-molecules	T	4	4	30	70	100
	BTMS105	Core	Lab Course 1 (Based on Papers BTMS101& 102)	P	8	4	30	70	100
	BTMS106	Core	Lab Course 2 (Based on Papers BTMS103&104)	P	10	5	30	70	100
Semester-II [25 Credits]	BTMS201	Core	Molecular Biology	T	4	4	30	70	100
	BTMS202	Core	Plant Biotechnology	T	4	4	30	70	100
	BTMS203	Core	Macromolecules & Enzymology	T	4	4	30	70	100
	BTMS204a	DCEC-1 (Select any one)	Biostatistics, Bioinformatics & Computers in Biotechnology	T	4	4	30	70	100
	BTMS204b		Applied Biotechnology	T	4	4	30	70	100
	BTMS205	Core	Lab Course 3 (Based on Papers BTMS201 &202)	P	8	4	30	70	100
	BTMS206a	Core	Lab Course 4 (Based on Papers BTMS203&204a)	P	10	5	30	70	100
	BTMS206b	Core	Lab Course 4 (Based on Papers BTMS203& 204b)	P	10	5	30	70	100
Semester-III [25 Credits]	BTMS301	Core	Genetic Engineering	T	4	4	30	70	100
	BTMS302	Core	Biology of Immune System	T	4	4	30	70	100
	BTMS303	Core	Bioprocess Engineering & Technology	T	4	4	30	70	100
	BTMS304	Core	Environmental Biotechnology	T	4	4	30	70	100
	BTMS305	Core	Lab Course 5 (Based on Papers BTMS 301&302)	P	8	4	30	70	100
	BTMS306	Core	Lab Course 6 (Based on Papers BTMS 303& 304)	P	10	5	30	70	100
Semester-IV [25 Credits]	BTMS401	DCEC-2*	IPR, Biosafety, Bioethics & Nanobiotechnology	T	4	4	30	70	100
	BTMS402		Advanced Techniques in Biotechnology	T	4	4	30	70	100
	BTMS403		Animal Biotechnology	T	4	4	30	70	100
	BTMS404		Genomics & Proteomics	T	4	4	30	70	100
	BTMS405		Lab Course 7 (Based on Papers BTMS 401&402)	P	8	4	30	70	100
	BTMS406		Lab Course 8 (Based on Papers BTMS 403& 404)	P	10	5	30	70	100
	BTMS407	DCEC-3*	Project Work						
			Dissertation	P	23	12	210	90	300
			Seminar based on project			8	160	40	200
			Viva Voce			3	70	30	100
	BTMS408		Methodology, Philosophy and Ethics of Research	T	2	2	30	70	100

T- Theory, P- Practical

1. Students will be able to carry out their Internship (BTINT301) either in this School itself or in any the other Schools of the University Campus or in industries, depending upon their choice. However, those who will be interested to carry out their internship in the School itself, have to pay an Internship Fee of Rs 2,000.00 only. Total duration of the Internship will be of 60 hours. After completion of the Internship, a detailed report, dully signed by the Supervisor and forwarded by the Head of the Institution has to be submitted by each of the student in the Office of the School.

*2. Any student of the IV Semester will have an option to opt for Project Work and a theory paper (taught through online mode only) (DCEC-3) in lieu of the four theory papers and two lab courses (DCEC-2).

3. The project work has to be carried out in any of the recognized national laboratories, UGC-recognized Government universities, teaching departments of the PRSU, Government colleges recognized as research centres by the RDC, Biotechnology of PRSU, reputed private institutions namely TIFR, Mumbai, Reliance Life Sciences Pvt. Ltd., Nashik, Thapar Institute, Patiyala, Reddys Laboratory, Hyderabad, Novazyme, Pune, Lupin India, Mumbai, Sisco Research Laboratory, Mumbai, HiMedia Laboratories Pvt. Ltd., Mumbai, Shanta Biotech, Hyderabad, Verda Biotech, Mumbai, Pariyar Chemicals Ltd., Mumbai, Nicholas Piramal Laboratory, Mumbai, Aragen Life Sciences, Hyderabad, Biocon Research Ltd., Bengaluru, Sun Pharma, Mumbai, Panacia Biotech, Mumbai, Cadilla, Mumbai, ITC, Bengaluru, Chambal Biofertilizer & Chemicals, Kota, and any other Publicly Traded Companies. However, any student of School of Studies in Biotechnology willing to carry out his/ her project in the School itself has to pay Rs 30,000.00 only (Rupees Thirty Thousand Only) in addition to the course fee (normal fee or payment seat fee, mentioned in the admission brochure) as Project Fee, without which he/ she will not be permitted to do so in any of the circumstances. No relaxation from payment of the Project Fee will be granted, in any of the circumstances, to any students belonging to any of the categories, domicile, locality, economic status (BPL, APL, *etc.*), gender, *etc.*

4. The valuation of all the projects will be carried out by the external examiner and Head of the School of Studies in Biotechnology or its nominee at the School of Studies in Biotechnology. However; answer books of the online paper Methodology, Philosophy and Ethics of Research will be evaluated at the departmental level and its marks will be sent to the University Administration.

Note:

1. In place of Elective Courses students can choose paper(s) from MOOC Courses (Swayam Portal) subject to the following conditions:
    a. The chosen paper will be other than the papers offered in the current course structure.
    b. The paper will be for PG level with a minimum of 12 weeks duration.
    c. The list of courses on SWAYAM keeps changing, the departmental committee will finalize the list of MOOC courses for each semester.
    d. The paper(s) may be chosen from the Swayam Portal on the recommendation of the Head of the Department.

2. The candidates who have joined M Sc Biotechnology Programme in the School of Studies in Biotechnology, shall undergo Generic Elective Courses (only qualifying in nature) offered by other departments/SoS in Semester II and Semester III.
3. The candidates who have joined the M Sc Biotechnology Programme in the School of Studies in Biotechnology will take Skill Enhancement Course, Value Added Course, and Internship (only qualifying in nature).

Generic Elective Courses: (Offered to PG students of other Departments/SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	EA	Total
II	BTGEC201	Basic Biotechnology	T	3	3	30	70	100
III	BTGEC301	Applications of Biotechnology	T	3	3	30	70	100

Internship: Offered to the PG students of the School of Studies in Biotechnology only. Internship will be done after the examination of II Semester. Credit earn out of the Internship will be reflected in the score card of III Semester.

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	EA	Total
III	BTINT301	Internship	P	60 H	2	30	70	100

Value Added Courses and Skill Enhancement: (Offered to the PG students of School of Studies in Biotechnology only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	BTVAC101	Concepts of Traditional Knowledge	T	2	2	30	70	100
III	BTVAC301	Swiss-Prot, Swiss-Model, & Design Expert	P	4	2	30	70	100

Semester-I

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**I**
Course Code	Course Title		Course Type
BTMS101	**Cell Biology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

L- Lecture, T- Tutorial, P- Practical

Learning Objective (LO):

Upon completion of this course, students will understand cell biology, including structural and functional characteristics of cells. Furthermore, students will explore the roles of various organelles, transport mechanisms across membranes, and cell division processes. The course covers cell signalling pathways, cell motility and the production of gametes, fertilization processes, embryonic development, and gene expression regulation.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	This paper is aimed to provide an understanding regarding structure and functions of both eukaryotic and prokaryotic cells at the molecular level and their diversity.	U	1,2,3,5,7,8,9,10,11	1,3,6
2	Students will be able to imbibe details of each and every organelle of the eukaryotic cell, and their precise functions; along with molecular mechanisms governing cellular trafficking of various nutrients and macromolecules.	An	1,2,3,4,5,6,9,10,11	1,3,5,6
3	Students will acquire knowledge about processes of cell division, mechanisms of gene expression, cell signaling processes, and skill to study cell division and then differentiation.	Ap	1,2,3,4,5,7,9,10,11	1,2,3,5,6
4	Students will gain comprehensive idea of different aspects of reproduction, and processes of development, genetics, and gene regulation.	An	1,2,3,4,5,6,7,8,9,10	1,2,3,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; B-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Cell Theory: History, concept of cell theory, modern cell theory. 2. Prokaryotic cells: structure and function- cell walls of eubacteria (peptidoglycan) and related molecules: outer-membrane of Gram-negative bacteria; cell wall and cell membrane synthesis; cell inclusions like endospores, gas vesicles. 3. Diversity of cell size and shape; diversity in prokaryotic and eukaryotic cells.	15	1
II	1. Eukaryotic cells: cell wall; plasma membrane; endoplasmic reticulum; golgi apparatus; lysosome; peroxisome; ribosome; mitochondria; chloroplast; nucleus; nucleolus; chromosome. 2. Transport of nutrients and macromolecules: osmosis; ion channels; ion pumps, transport across membranes-active transport, passive transport; diffusion: Simple and facilitated diffusion; molecular mechanism of transport; regulation of intracellular transport in endoplasmic reticulum, mitochondria, nuclear transport; chloroplast; intracellular vesicular trafficking	15	2
III	1. Mitosis, meiosis and their regulation; steps in cell cycle; regulation of cell cycle, cell cycle checkpoints, cell cycle arrest. 2. Cell signalling: cellular receptors; role of G-protein coupled receptors; activation of G-protein and receptor tyrosine kinase; tyrosine kinase in cell signal transduction; secondary messengers; signal transduction pathways: cAMP, IP3, MAP kinase pathways; regulation of signalling pathways. 3. Cell motility: Microtubules, cilia and flagella of eukaryotes and prokaryotes, structure of flagella and arrangement of microtubules, movements of cilia and flagella.	15	3
IV	1. Production of gametes- spermatogenesis and oogenesis; cell surface molecules in sperm-egg interaction in animals; molecular events during fertilization in animals, blastula formation, embryonic fields, gastrulation, and formation of germ layers in animals; embryogenesis. 2. Development in Drosophila melanogaster, different gene in the development of Drosophila: maternal, gap and pair rule, segment polarity gene. Floral development in Arabidopsis thaliana; gene expression and its regulation; spatial and temporal regulation of gene expression.	15	4

Books Recommended:

1. Lewis J., Klein S. & Valerie M. Kish (2002) Principles of Cell and Molecular Biology. 3rd Edition. Pearson Publication.
2. Tortora G., Funke B. & Case C. (2004) Microbiology: An Introduction. 11thEdition. Benjamin-Cummings Publication.
3. Albert B., Johnson A., Lewis J., Raff M., Roberts K. & Walter P. (2008) Molecular Biology of the Cell. 5th Edition. New York, Garland Science.
4. Watson J.D. (2008) Molecular Biology of the Gene. 5th Edition. Menlo Park, CA: Benjamin/Cummings. 3rdThird Edition. Himalaya Publishing House.
5. Geoffrey M. Cooper and Robert E. Hausman (2013) The Cell: A Molecular Approach. 6th Edition. Sinauer Associate Publication.
6. Lodish H.F. (2016). Molecular Cell Biology. 8th Edition. New York WH Freeman Publication.
7. Gupta P.K. (2019) Cell and Molecular Biology. 5th Edition. Rastogi Publications.
8. Karp G. (2020) Cell and Molecular Biology. 9th Edition. Wiley Publication.
9. Rastogi V. (2020) A Text Book of Cell Biology and Genetics.Kedar Nath Ram Nath Publisher.

CO-PSO Mapping for the Course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	2	-	3	-	1	2	2	2	2	2	-	2	-	-	3
CO2	3	3	2	2	1	3	-	-	3	3	2	1	-	2	-	2	3
CO3	3	2	1	2	3	-	2	-	3	3	2	2	1	2	-	2	3
CO4	3	2	2	2	1	3	1	3	2	2	-	2	1	3	-	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-I

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**I**
Course Code	Course Title		Course Type
BTMS102	**Genetics**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This paper will provide an understanding regarding fundamental concepts of genetics, structure of genes, mutagen, gene regulation and expression, qualitative genetics, different syndromes, and applied aspects of genetics and its role in the unification of different disciplines of biology.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	This paper will impart knowledge of basic concepts of classical and post-Mendelian genetics; fine structure of genes at molecular level.	U	1,2,3,5,7,8	1,2,5,6
2	Students can understand the regulation of gene expression in prokaryotes and eukaryotes. Also, understand the mutation, its causes and consequences and assay system. Students will also explore the process of pattern of inheritance.	Ap	1,2,3,5.6,7,10,11	1,2,5,6
3	Students will learn to investigate variation, linkage testing, and human genetic disorders. Also, explore and analyze quantitative traits and pedigree.	U	1,2,3,4,5,6,7,10,11	1,2,5,6
4	They will explore and grasp the genetic system of model organisms and genetic maps. In addition, students will gain a comprehensive understanding of genetics at the molecular level.	Ap	1,2,3,5,6,7,8,10,11	1,2,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; B-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Introduction to genetics; Beginning of genetics as a science. Early theories of genetics, pangenesis, germplasm theory. 2. Mendelian inheritance, physical and chemical basis of heredity. 3. Non-Mendelian inheritance, Gene to Phenotype – Interactions between the Alleles of one gene, lethal alleles and interfering gene interactions. 4. Fine structure of gene, prokaryotic and eukaryotic genome organization, DNA supercoiling, chromatin dynamics.	15	1
II	1. Regulation of gene expression in prokaryotes– Operon concept, Lac and Trp operon, positive and negative regulation of Lac operon. Transcriptional attenuation of Trp operon, Regulation of gene expression in eukaryotes by chromatin remodelling and epigenetic modification. 2. Mutations: types, mechanisms, mutagens (UV, chemical); mutation detection and classification. 3. Structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, ploidy and their genetic implications. Dosage compensation. 4. Inheritance: autosomal and sex-linked inheritance, extra chromosomal inheritance, inheritance of organelle genes.	15	2
III	1. Variation; sources of variation; selection; heritability of variation, process of speciation; origin of new genes. Hardy- Weinberg genetic equilibrium. 2. Genes and Quantitative traits; genotypes and Phenotypic distribution; heritability of quantitative character; allele frequencies and genotype frequencies, quantifying heritability; polygenic inheritance, locating genes, QTL mapping. 3. Human genetics: pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.	15	3
IV	1. Bacterial genetic system: transformation, conjugation, transduction. Bacterial genetic map with reference to *E. coli.* 2. Viruses and their genetic system: Phage I and its life cycle; RNA viruses; retroviruses 3. Genetic system of yeast and Neurospora. 4. Gene mapping methods: classical linkage maps, tetrad analysis, molecular marker-based mapping, mapping	15	4

	with molecular markers, mapping by using somatic cell hybrids, mapping, and development of mapping population in plants.		

Books Recommended:

1. Lindsey & Arthur Ward (2018) Textbook of Evolution and Genetics. Palala Press.
2. Benjamin Pierce (2019) Genetics: A Conceptual Approach. 7thEdition. W. H. Freeman& Co. Ltd.
3. Gardner EJ, Simmons MJ, Snustand DP &Gardner SS (2019) Principles of Genetics. 8th Edition. Wiley Publication.
4. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino& KillianD. (2019) Essentials of Genetics. 10th Edition. Pearson Publication.
5. Michael J., Bamshad Md, Lynn B.,Jorde M.D.& Carey John (2020) Medical Genetics. 6th Edition. Elsevier-Health Science Division.
6. Robert Brokker (2020) Loose Leaf for Genetics: Analysis and Principle, McGraw-Hill Education Ltd.
7. Tara Rodden Robinson & Lisa Spock (2020) Genetics for Dummies. 3rdEdition. Dummies.
8. Benjamin Pierce (2021) Genetics Essentials. W. H. Freeman.
9. Castle William E, Mendel G. & Versuche U (2021) Genetics and Eugenics: a Textbook for Students of Biology and a Reference Book for Animal and Plant Breeders. Legare Street Press.
10. Brokker R. (2023) Genetics: Analysis and Principle ISE, McGraw-Hill Education Ltd.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	2	-	2	-	2	1	-	-	-	1	2	-	-	3	3
CO2	3	2	3	-	2	1	2	-	-	2	2	2	2	-	-	2	3
CO3	3	3	2	1	2	1	2	-	-	3	2	2	1	-	-	2	3
CO4	3	2	3	-	2	1	3	1	-	2	3	2	2	-	-	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-I

Program	Subject	Year	Semester
MSc	Biotechnology	1	I
Course Code	Course Title		Course Type
BTMS103	**Microbial Physiology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This paper will impart knowledge about different areas of microbiology, such as bacteriology, virology, microbial evolution and applied microbiology. It will equip the students with basic and advanced techniques of microbiology. Students will also gain idea of small-scale food processing industries, sewage treatment plants, brewing industries, biogas plants, bio-fertilizer plants, and vaccine development units.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will be able to learn about the basics of microbiology, including the classification of microorganisms, as well as their growth.	U	1,2,7,10	1,5,6
2	Students will also gain an understanding of how microorganisms can be cultivated in synthetic media and explore their metabolic diversity in nature.	Ap	1,2,3,7,10,11	1,5,6
3	Additionally, they will be able to comprehend various microorganisms, such as bacteria, archaea, fungi, and virus, along with their life cycles.	U	1,2,3,6,7,10	1,5,6
4	Furthermore, students will acquire knowledge about different microbial diseases, the host-parasite relationship, and the role of antibiotics.	Ap	1,2,3,6,7,10,11	1,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Introduction of microbiology, microorganisms and their environment, microbial evolution, Systematics and Taxonomy –new approaches to bacterial taxonomy classification including ribotyping; ribosomal RNA sequencing; characteristics of primary domains; 2. Microbial growth and factors affecting: growth curve, temperature, acidity, alkalinity, nutrients, water availability, and oxygen; measurement of growth and growth yields.	15	1
II	1. Methods in microbiology – isolation and pure culture techniques; theory and practice of sterilization; principles of microbial nutrition; types of culture media: defined and undefined media, selective and differential media, minimal and enrichment media; 2. Metabolic diversity among microorganisms– phototrophy, autotrophy, chemolithotrophy and nitrogen fixation	15	2
III	1. Phylogenic and metabolic diversity of bacteria, Types of bacteria- Cyanobacteria, Spirilla; Spirochaetes and Mycoplasmas. 2. Archaea: archaea as earliest life forms; halophiles; methonogens; hyperthermophilic archaea; thermoplasma. 3. Algae, fungi, slime moulds and protozoa, viruses: bacterial, plant and animal viruses; discovery, classification and structure of viruses.	15	3
IV	1. AIDS; diseases transmitted by animals (rabies, plague), insects and ticks. 2. Host-parasite relationships – normal microflora of skin, oral cavity, gastrointestinal tract; types of toxins (Exo –, Endo -, Entero) 3. Antibiotics, sources, types and mode of action	15	4

Books Recommended:

1. Jacquelyn G. Black &Laura J. (2017) Black Microbiology: Principles and Explorations 9th Edition. Wiley Publication.
2. Aneja K. R. (2017) Experiments in Microbiology. 5th Edition. New Age International Publication.
3. Tortora G., Funke B. & Case C. (2018) Microbiology. 13th Edition, Addison-Wesley Publishers.
4. Joanne Willey, Kathleen Sandman & Dorothy Wood (2019) Prescott's Microbiology 11thEdition, McGraw Hills Publication.
5. Dubey R.C. & Maheshwari D.K. (2019) 5th Edition, S Chand Publication.
6. Arora D.R. (2020) Textbook of Microbiology 6 thEdition, CBS Publication.

7. Aneja K. R., Pranay Jain & Raman Aneja (2021) A Textbook of Basic and Applied Microbiology, 2nd Edition, New Age International Private Limited.
8. Ananthanarayan and Jayaram Paniker (2022) Text book of Microbiology, 12th Edition, Universities Press (India) Pvt.
9. Reddy R.S. &Reddy S.M. (2022) Microbial Physiology, Scientific Publication.
10. Michale J. Pelczar J.R., E.C.S. Chan &Noel R. Krieg (2023) Microbiology. 5th Edition. Affiliated East West Press.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	2	3	-	-	-	-	3	-	-	3	-	3	-	-	-	2	2
CO2	3	3	2	-	-	-	3	-	-	3	2	3	-	-	-	2	3
CO3	3	2	1	-	-	2	3	-	-	3	-	3	-	-	-	1	3
CO4	3	3	2	-	-	1	2	-	-	3	3	3	-	-	-	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-I

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**I**
Course Code	Course Title		Course Type
BTMS104	**Biomolecules**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This course provides knowledge of the students relating to structure and function of various biomolecules, which are the building blocks of life, along with an understanding about chemical foundations of biology. It will also impart knowledge regarding life processes, particularly at atomic and molecular levels.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	It will provide a broad overview of the key concepts and principle involved in chemical foundations of biology, and principles of thermodynamics.	An	1,2,3,5,7,10	1,5,6
2	Students will gain idea about structures and functions of different molecules of carbohydrate along with comprehensive knowledge of glycogen metabolism.	R	1,2,5,7,10	1,5,6
3	It will impart detailed knowledge of building blocks of proteins and, structural features, classification, and structures of proteins.	U	1,2,3,5,7,11	1,5,6
4	It will provide fundamental insights of roles of lipids, fatty acid metabolism, and heterocyclic compounds in the processes of life.	U	1,2,5,7,10,11	1,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Chemical foundations of Biology – Weak bonds, Ionization of water, pH scale, p*K*a of weak acids, buffers in biological system, relationship of pH, p*K*a and buffer. 2. Principles of thermodynamics and living system.	15	1
II	1. Carbohydrate: monosaccharides- aldose and ketose, asymmetric centres, cyclic structures, hexose derivatives, reducing agents; disaccharides, polysaccharides-structural feature and roles of homo polysaccharides and hetero polysaccharides 2. Glycogen metabolism: glycogenesis and glycogenolysis	15	2
III	1. Amino acids – structural features, classification based on r group, uncommon amino acids in proteins, titration curves of amino acids. 2. Proteins– hierarchy in structure, Ramachandran plot; primary, secondary, super-secondary, tertiary and quaternary structures.	15	3
IV	1. Lipids and Fat: introduction, classification, storage lipids, structural lipids in biological membranes, lipids as signals, vitamins and pigments. 2. Fatty acid metabolism: fatty acid (palmitate) biosynthesis and catabolism	15	4

Books Recommended:

1. Todd & Howards Mason (2004) Text book of Biochemistry. 4th Edition. Oxford and IBH Publishing Co. Pvt. Ltd.
2. Albert L. Lehninger (2005) Biochemistry. 4th Edition. Palgrave Macmillan.
3. Debnath M. (2011) Tools and Techniques in Biotechnology.Pointer Publication.
4. Buchanan, Gruissemen& Jones (2015) Biochemistry & Molecular Biology of Plant. 2nd Edition. Wiley.
5. Voet D., Voet J.G.& Pratt C.W. (2016) Fundamentals of Biochemistry. 5th Edition. Wiley.
6. Nelson & Cox (2021) Principles of Biochemistry. 8th Edition. W.H. Freeman & Co Ltd.
7. SatyanarayanU. (2021) Biochemistry, 6th Edition. Elsevier
8. Prasad Manjeshwar (2022) Biochemistry Simplified. 6th Edition. Sheetal Distributor Publication.
9. Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell & P. Anthony Weil (2022) Harper's Illustrated Biochemistry, 32nd Edition. McGraw-Hill
10. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer (2023) Biochemistry, 10thEdition.WHFreeman & Co Ltd.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	3	2	-	2	-	2	-	-	1	-	3	-	-	-	1	3
CO2	2	2	-	-	2	-	2	-	-	2	-	3	-	-	-	2	3
CO3	3	3	2	-	2	-	3	-	-	-	3	3	-	-	-	1	3
CO4	2	3	-	-	2	-	3	-	-	1	2	3	-	-	-	-	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-I

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**I**

Course Code	Course Title	Course Type
BTMS105	**Lab Course 1 (Based on Papers BTMS101 & 102)**	**Core**

Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**-**	**-**	**8**

Maximum Marks	CIA	EA
100	**30**	**70**

Learning Objective (LO):

This course aims to provide practical training regarding execution of experiments and handling of both glassware and different instruments utilized during study of plant and animal cells, and fundamentals of genetics.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSONo.
1	The students will gain knowledge and learn different techniques involved in slide preparation and staining plant and animal cells, and recognize the relevance of the mitotic index in various biological and ecological studies, such as growth patterns and effects of various factors governing process of cell division.	B	1,2,3,7,10	1,5
2	Above course will develop an ability in the students to distinguish between normal and abnormal mitosis; how to calculate the meiotic index and its significance in assessing genetic stability.	B	1,2,3,7,10	1,5
3	Enlisted practical's will provide training in regard to fundamental concepts of genetics by offering a comprehensive understanding of principles of genetics, cellular biology, and commonly used various techniques.	B	1,2,3,7,10,11	1,5
4	Students will be able to apply colchicine treatment to induce polyploidy in onion root tips; understand the concept of Barr bodies and their relationship to sex	B	1,2,3,7,10	1,5,6

	chromosome inactivation; comprehend the importance of isolating genetic material from bacteria for various applications.			

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding.

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. To prepare the temporary stained slide of onion bulb peel to study the structure of plant cells. 2. To prepare the temporary stained slide of cheek squamous epithelial cells of the mouth of human beings. 3. Preparation and study of slide of mitosis using onion root tips squash. 4. Schedule for the study of the mitotic index.	5	1
II	1. To determine the abnormal mitotic index. 2. Preparation and study of slide for meiosis using young anthers of *Allium cepa.* 3. To determine the meiotic index in the flower bud of *Allium cepa.*	5	2
III	1. Demonstration of Mendel's experiments. 2. Studies of prokaryotic and eukaryotic cells. 3. Perform karyotype and determine the genetic abnormality of the given sheet. 4. To induce and study Mutation in bacteria.	5	3
IV	1. To study polyploidy in onion root tips after treatment with colchicine. 2. To demonstrate Barr body in cheek squamous epithelial cel a Human mouth. 3. Isolate genetic material from bacteria.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	1	1	1	-	-	-	2	-	-	1	-	3	-	-	-	1	-
CO2	1	1	2	-	-	-	2	-	-	1	-	3	-	-	-	1	-
CO3	1	2	2	-	-	-	2	-	-	2	2	3	-	-	-	2	-
CO4	1	2	2	-	-	-	2	-	-	2	-	2	-	-	-	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-I

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**I**
Course Code	Course Title		Course Type
BTMS106	**Lab Course 2 (Based on Papers BTMS103 &104)**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	**-**	**-**	**10**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

The primary objective of this course is to offer hands-on training to students in the areas of microbial isolation, purification, staining, and culture methods. Moreover, students will gain skills to detect presence of different amino acids, proteins, and carbohydrates in various samples.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will acquire laboratory skills and fundamental idea pertaining to cultivation, isolation, maintenance, and measurement of microorganisms.	B	1,2,3,7,10,11	1,5
2	Students will be able to perform microscopic examination, biochemical characterization of microbes; water portability parameters, and antibiotic-resistance tests.	B	1,2,3,7,10,11	1,5,6
3	It will make the students capable of deciphering precise carbohydrates such as polysaccharides, reducing sugars, and non-reducing sugars.	B	1,2,3,7,10,11	1,5
4	Students will learn to detect amino acids, proteins, and aromatic amino acids present in the samples.	B	1,2,3,7,10,11	1,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding.

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Preparation of liquid and solid media for growth of microorganisms. 2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slants and stab cultures. Storage of microorganisms. 3. Isolation of pure culture from soil and water. 4. Growth; Growth curve; Measurement of bacterial population by turbidity and serial dilution methods. Effect of temperature, pH and carbon nitrogen sources on growth.	5	1
II	1. Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain, staining for spores and lactophenol cotton blue mount. 2. Study of mutations by Ames test. 3. Assay of antibiotics and demonstration of antibiotics resistance. 4. Analysis of water for potability and determination of MPN. 5. Biochemical characterization of selected microbes.	5	2
III	1. Qualitative test for Carbohydrate (Molisch's test) 2. Qualitative test for Carbohydrate(Anthrone test) 3. Qualitative test for reducing sugars (Benedict's test) 4. Qualitative for polysaccharides (Iodine test)	5	3
IV	1. Qualitative test for amino acids & proteins by Ninhydrin reaction. 2. Qualitative test for aromatic amino acids by Xanthoproteic reaction. 3. Qualitative test for proteins using Biuret test. 4. Qualitative test for Tyrosine by Millon's test.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	1	2	3	-	-	-	2	-	-	2	1	3	-	-	-	2	-
CO2	1	3	3	-	-	-	2	-	-	3	3	3	-	-	-	3	3
CO3	1	2	2	-	-	-	2	-	-	2	1	3	-	-	-	1	-
CO4	1	2	2	-	-	-	2	-	-	2	1	3	-	-	-	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**II**
Course Code	Course Title		Course Type
BTMS201	**Molecular Biology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This paper will provide an in-depth understanding of various concepts and processes of molecular biology such as DNA replication, transcription, translation, protein synthesis, oncogenesis, antisense technology and, molecular mapping.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PO No.	PSO No.
1	This paper is intended to provide an understanding of basics of molecular biology such as DNA replication, repair and recombination.	U	1,2,3,4,5,7,8,9,10, 11	1,2,4, 5,6
2	Students will be able to know molecular events of the genome including gene regulation and machinery of transcription and post-transcriptional modifications in prokaryotic and eukaryotic organisms.	An	1,2,3,4,5,6,9,10,1 1	1,2,3,5,6
3	Students will acquire knowledge about genetic code and processes of translation in prokaryotes and eukaryotes, along with post-translational modifications.	An	1,2,3,4,5,7,9,10,1 1	1,2,3,4, 5,6
4	Students will gain an inclusive idea of different aspects of oncogenes and tumor suppressor genes; antisense and ribozyme technology; and techniques of genome mapping.	An	1,2,3,4,5,6,7,9,10	1,2,3,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Molecular structure of DNA and RNA, Chargaff's rules, DNA topology and supercoiling. 2. DNA replication – prokaryotic and eukaryotic dna replication, mechanics of DNA replication in prokaryotes and eukaryotes. enzymes and accessory proteins involved in dna replication. 3. DNA repair- DNA repair pathways – mismatch repair, base excision repair, nucleotide excision repair, non-homologous end joining pathway and recombinational repair. 4. Recombination- homologous and recombination, gene targeting i.e. FLP/FRT and Cre/Lox recombination, RecA and other recombinases.	15	1
II	1. Transcription – prokaryotic transcription: RNA polymerase, regulatory elements and mechanisms of transcription regulation, transcription termination. 2. Transcription – eukaryotic transcription: RNA polymerase, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation. 3. Post-transcriptional processing events- capping, splicing of introns and polyadenylation, Processing of Pre-ribosomal RNA and the assembly of ribosomes, Structure and the maturation of tRNAs and mRNA stability.	15	2
III	1. Genetic code, degeneracy of codons, Wobble hypothesis, codon bias, Mechanism and fidelity of amino acyl tRNA synthetases. 2. Translation – prokaryotic and eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation. 3. Co- and post-translational modifications of proteins, protein targeting and trafficking.	15	3
IV	1. Oncogenes and tumor suppressor genes – viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins. 2. Antisense and ribozyme technology – molecular mechanism of antisense molecules. biochemistry of ribozyme; hammer–head, hairpin and other ribozymes, strategies for designing antisense and ribozymes, applications of antisense and ribozyme technologies. 3. Molecular mapping of genome – genetic and physical mapping and map–based cloning, southern and fluorescence *in situ* hybridization (FISH) and Genomics *in situ* hybridization (GISH) for genome analysis, chromosome microdissection and microcloning. DNA barcoding, molecular taxonomy, and applications in wildlife forensic.	15	4

Books Recommended:

1. Alberts, B. (2017) Molecular Biology of the Cell. New York Garland Science Publication.
2. Jocelyn E. Krebs, Stephen T. Kilpatrick & Elliott S. Goldstein (2017) Lewin's Genes XII, 12th Edition, Jones and Barlett Publishers, Inc.
3. Andreas Hofmann & Samuel Clokie (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. 8th Edition. Cambridge University Press.
4. Richard M. Twyman (2018) Advanced Molecular Biology: A Concise Reference. Garland Science Publication.
5. Gerald Karp, Janet Iwasa & Wallace Marshall (2020) Karp's Cell and Molecular Biology. 9th Edition. Wiley Publication.
6. George Plopper, Diana Bebek Ivankovic & Kristein Van Vlasselar (2020) Principles of Cell Biology.3rdEdition. Jones and Bartlett Publishers.
7. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Kelsey C. Martin, Michael Yaffe& Angelika Amon (2021) Molecular Cell Biology, 9th Edition. WH Freeman Publication.
8. Edward Walker (2022) Molecular biology: Structure and Dynamics. 3rd Edition. Murphy and Moore Publication.
9. William O'brien (2022) Principles and Techniques of Biochemistry and Molecular Biology. 3rd Edition.Syrawood Publishing House.
10. Terry A Brown (2023) Genomes 5th Edition. CRC Press.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	2	2	2	-	1	2	2	2	2	2	1	-	2	3	3
CO2	3	3	2	2	1	2	-	-	2	3	2	2	2	2	-	2	3
CO3	3	2	1	2	3	-	2	-	2	3	2	2	1	2	3	2	3
CO4	3	2	2	2	1	3	1	-	2	2	-	2	2	3	-	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**II**
Course Code	Course Title		Course Type
BTMS202	**Plant Biotechnology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This paper will provide knowledge of principles and techniques of plant tissue culture, focusing its applications in large-scale production of elite crops, disease-free plantlets, and genetic engineering for desired traits in plants. Students will understand genetic modification for increased yield, higher nutritional value, disease-free crops, and conservation of endangered species. They may be able to establish tissue culture industries for floriculture and horticulture.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will be well-versed with the principles, techniques, and applications of plant cell and tissue culture, which will enable them to contribute in plant breeding, and smart agriculture.	**Ap**	1,4,7,10,11	2,5,6
2	Upon completing this unit, students will have a comprehensive understanding of various techniques such as embryo culture, protoplast isolation and fusion, and germplasm conservation.	**Ap**	1,4,7,10,11	2,5,6
3	It will provide an understanding of plant transformation techniques, their applications in crop improvement and disease-free plantlet generation.	**Ap**	1,4,7,10,11	2,5,6
4	Students will gain comprehensive understanding regarding different procedures of secondary metabolite production and an array of molecular markers which play fundamental roles in advancement of genetic research.	**Ap**	1,4,7,10,11	2,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; U-Understanding.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids. 2. Tissue culture media (composition and preparation) 3. Initiation and maintenance of callus and suspension culture; single cell clones. 4. Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil 5. Shoot – tip culture: Rapid clonal propagation and production of virus free plant	15	1
II	1. Embryo culture and embryo rescue 2. Anther, pollen and ovary culture for production of haploid plants and homozygous lines 3. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. 4. Germplasm conservation – Cryopreservation and slow growth cultures	15	2
III	1. Plant transformation technology: basis of tumor formation, Mechanism of DNA transfer, Features of Ti and Ri plasmids, role of virulence genes, use of Ti as vectors, markers, use of reporter genes, 35S and other promoters, multiple gene transfers, particle bombardment, electroporation, microinjection. 2. Chloroplast transformation: advantages, vectors 3. Application of plant transformation for productivity and performance: herbicide resistance, insect resistance, Bt genes, non–Bt like protease inhibitors & amylase inhibitors, virus resistance, nucleocapsid gene, disease resistance, PR proteins, nematode resistance, abiotic stress, long shelf-life of fruits and flowers, male sterile lines, bar and barnase systems.	15	3
IV	1. Metabolic Engineering and Industrial Products: *In vitro* production of plant secondary metabolites, control mechanisms and manipulation of phenyl propanoid pathway, shikimate pathway, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines. 2. Molecular Marker –RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence characterized amplified regions), SSCP (Single strand conformational polymorphism), AFLP, map based cloning, molecular marker assisted selection.	15	4

Books Recommended:

1. Vasil I.K. (1994) Plant Cell and Tissue Culture. Springer.
2. Fu T.J., Singh G. & Curtis W.R. (1999). Plant Cell and Tissue Culture for the production of Food Ingredient. Kluwer Academic/Plenum Press.
3. Bhojwani S.S.& Razdan M.K. (2003) Plant Tissue Culture. Elsevier Revised
4. Slater, A., Scott, N. W., & Fowler, M. R. (2008) Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
5. Primrose S.B., & Twyman R.M. (2013). Principles of Gene Manipulation and Genomics, 7th Edition. Malden, MA: Blackwell Pub.
6. Buchanan, Gruissemen & Jones (2015) Biochemistry & Molecular Biology of Plant, 2nd edition. Wiley Publication.
7. Brown, T. A. (2016) Gene Cloning and DNA Analysis: an Introduction, 7th Edition. Oxford: Blackwell Pub.
8. Glick B.R., & Pasternak J.J. (2017) Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edition. Washington, D.C. ASM Press.
9. Razdan M.K. (2019) Introduction to Plant Tissue Culture. 3rd Edition. Oxford &Ibh Publishing Co. Pvt Ltd.
10. Chawla H.S. (2022) Introduction to Plant Biotechnology, 3rd Edition. Oxford & IBH Publishing Co. (P) Ltd.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	1	-	-	2	-	-	2	-	-	3	3	-	3	-	-	3	1
CO2	2	-	-	3	-	-	2	-	-	3	3	-	3	-	-	2	2
CO3	3	-	-	2	-	-	2	-	-	3	3	-	2	-	-	2	3
CO4	3	-	-	3	-	-	3	-	-	3	3	-	3	-	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**II**
Course Code	Course Title		Course Type
BTMS203	**Macromolecules & Enzymology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This course aims to provide students with a basic knowledge of biomolecular structure and conformation, with a particular emphasis on proteins. It will offer principles underlying enzyme structure, function, and mode of action. The acquired knowledge can be applied in establishing industries focusing on enzyme purification, characterization, and potential applications.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	This paper will help the students to understand basics of macromolecules present in cells. Students will gain knowledge about different molecular assemblies.	U	1,3,4,9,10,11	1,2,4,6
2	Students will learn about different proteins and their structure. They will come to know how functional proteins are formed and gain structures.	An	1,2,3,4,9,10,11	1,2,3,5,6
3	Students will learn how different enzymes will work and do their catalytic activities. How different conditions of reaction will affect their potential. Students also learn about immobilization of enzymes in different matrices and how immobilization is important for industries.	An	1,2,3,4,9,10,11	2,3,4,5,6
4	Students will understand how proteins works inside the cells and helps in immune responses. Students also understand how the structures of proteins are determined.	Ap	1,2,3,4,9,10,11	2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Macromolecules and supra molecules assemblies – Types of macromolecules in biological systems, 2. Molecular assemblies like membranes, ribosomes, extracellular matrix, chromatin 3. Methods and applications of protein and DNA sequencing.	15	1
II	1. Protein – protein and protein – ligand interactions, physical and chemical methods of study. 2. Conformational properties of polynucleotide's and polysaccharides – secondary and tertiary structural features and their analysis – theoretical and experimental; protein folding experiments on RNase A, renaturation of post synthetically modified proteins (insulin), Heat shock proteins, Molecular chaperones.	15	2
III	1. Enzyme catalysis in solution – kinetics analysis, effects of organic solvents on enzyme catalysis and structural consequences. Concept of activation energy for uncatalyzed and catalysed (chemical and enzyme) reaction. Types of reaction (zero-order, first-order and second order). 2. Physical and chemical methods for immobilization of enzyme. Applications of enzyme immobilization. 3. Glyco and lipoproteins – structure and function	15	3
IV	1.Protein denaturation, Causes of protein denaturation 2.Ribozymes Types and applications of ribozymes and Catalytic antibodies – Functional proteins – structure and drug targets (enzymes and receptors) 3. Nucleic acid hybridization – structural analysis and biological study.	15	4

Books Recommended:

1. Todd & Howards Mason (2004) Text book of Biochemistry. 4th Edition. Oxford and IBH Publishing Co. Pvt. Ltd.
2. Albert L. Lehninger (2005) Biochemistry. 4th Edition. Palgrave Macmillan.
3. Debnath M. (2011) Tools and Techniques in Biotechnology. Pointer Publishers.
4. Buchanan, Gruissemen & Jones (2015) Biochemistry & Molecular Biology of Plant. 2nd Edition. Wiley.
5. Voet D., Voet J.G.& Pratt C.W. (2016) Fundamentals of Biochemistry, 5th Edition. Wiley.
6. Nelson and Cox (2021) Principles of Biochemistry, 8th Edition. W.H. Freeman & Co Ltd.
7. Satyanarayan U. (2021) Biochemistry, 6th Edition. Elsevier.
8. Prasad Manjeshwar (2022) Biochemistry Simplified. 6th Edition. Sheetal Distributor Publication

9. Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell & P. Anthony Weil (2022) Harper's Illustrated Biochemistry, 32nd Edition. McGraw-Hill.
10. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer (2023) Biochemistry, 10th Edition. W.H. Freeman& Co Ltd.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	-	3	3	-	-	-	-	3	3	3	3	3	-	3	-	3
CO2	2	3	3	3	-	-	-	-	3	3	3	3	3	3	-	3	3
CO3	3	2	3	3	-	-	-	-	3	3	3	-	2	3	3	2	3
CO4	2	3	3	3	-	-	-	-	3	3	3	-	3	3	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**II**
Course Code	Course Title		Course Type
BTMS204a	**Biostatistics, Bioinformatics & Computers in Biotechnology**		**DCEC-1**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**20**		**70**

Learning Objective (LO):

This course aims to equip the students with skills of data acquisition, handling, tabulation, organization, and processing, computer literacy and applications for the analysis of biological data. It highlights the opportunities for biostatisticians in clinical research, and health management.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Provide an understanding regarding data types, their arrangement and representation; central tendency of data; types of error and hypothesis testing.	Ap	1,2,3,6,7,10,11	1,5,6
2	Students will gain idea of regression and correlation analysis; and various types of tests of significance performed during interpretation of data.	B	1,2,3,4,6,7,10,11	1,5,6
3	Students will acquire knowledge about different software like; MS Word, Excel, Power point, and statistical analysis related ones. They also have an idea about biological data bases and their types.	C	1,2,3,4,5,7,10,11	1,3,5,6
4	Provide idea about tools and techniques of bioinformatics and their applications; biological data-bases; sequence similarity analysis; and BTIS network.	C	1,2,3,4,5,6,7,8,9,10,11	1,2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Biostatistics: Brief introduction and definitions; Brief description of data and its types; Sampling: types and importance; Management of data: tabulation and graphical representation. 2. Measures of central tendency and dispersion: mean, median, mode, relationship between mean-median-mode, skewness, kurtosis, range, standard deviation, Standard error, and variance. Idea of two types of errors- Type I & Type II error and level of significance; hypothesis testing.	15	1
II	2. Simple linear regression: negative and positive; correlation: negative and positive. 3. Test of significance: F test, t test: one sample t-test, matched pair and two sample t-test; chi – square test: goodness of fit, test of independence, test of homogeneity; Analysis of variance (ANOVA): One way ANOVA, Two way ANOVA.	15	2
III	1. Introduction to word processing, spreadsheets and Presentation software: MS Word, MS Excel, MS PowerPoint. Computer oriented statistical techniques in MS Excel: Frequency table of single discrete variable, computation of mean, variance and standard deviation, descriptive statistics. Other statistical software's. 2. Bioinformatics: introduction and its applications. databases: knowledge of the following databases with respect to: organization of data, contents and formats of database entries, biological databases- concept, specialization, limitations, DBMS. 3. Data Base: Types of database, Protein and nucleic acid databases. NCBI; DDBJ; EMBL.	15	3
IV	1. Primary and secondary data base. general concepts of sequence analysis, identification of functional sequences, homology, brief idea of BLAST, ENTREZ, and PuBMed. 2. Different tools of bioinformatics; sequence alignment-global and local alignment, pair wise alignment techniques, multiple sequence alignment; identification of sequence from DNA to DNA, DNA to protein, protein to DNA sequence; database mining tools. 3. Structural bioinformatics: protein structure basics, Ramachandran plot, protein structure- function relationship. SCOP, SwissProt and CATH. 4. BTIS network in India.	15	4

Books Recommended:

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
3. Murthy C.S.V. (2003) Bioinformatics. 1st Edition, Himalaya Publishing House.
4. Rastogi S.C., Namita Mendiratta & Parag Rastogi (2003) Bioinformatics: Concepts, Skills and Applications, CBS Publishers and Distributors, New Delhi.
5. Subramanian C. (2004) A Text Book of Bioinformatics. Dominant Publishers and Distributors, New Delhi.
6. Banerjee P.K. (2006) Introduction to Biostatistics. 3rd Edition. S. Chand & Company Ltd.
7. Animesh K. Dutta (2007) Basic Biostatistics and Its Application. New Central Book Agency (P) Ltd. Kolkata.
8. Khan and Khanam (2010) Fundamental of Biostatistics, Ukaaz Publication, Hyderabad.
9. Johnathan Pevsner (2015) Bioinformatics and Functional, 3rd Edition. Wiley-Blackwell.
10. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Wiley-Blackwell.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	2	-	-	3	2	-	-	2	2	2	-	-	-	2	3
CO2	3	3	2	2	-	3	1	-	-	3	2	2	-	-	-	2	3
CO3	3	2	1	2	3	-	2	-	-	3	2	2	-	3	-	3	3
CO4	3	2	2	2	2	3	1	3	2	3	3	2	3	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
M.Sc.	**Biotechnology**	**1**	**II**
Course Code	Course Title		Course Type
BTMS204b	**Applied Biotechnology**		**DCEC-1**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	**CIA**		**EA**
100	30		70

Learning Objective (LO):

This course will provide knowledge and practical skills of various aspects of biotechnology; promote inclination of students for careers in industrial, sustainable, plant, and medical biotechnology.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Overall, students will gain a comprehensive understanding of the key principles and practices of industrial biotechnology enabling them to contribute effectively to the sustainable and responsible development of bioprocesses in various industrial applications.	Ap	1,2,4,6,9,10,11	2,3,5,6
2	Students will gain an understanding of key environmental challenges, focusing on pollution and contamination in air, water, and soil. Additionally, students will delve into advanced biotechnological approaches such as bioremediation, phytoremediation, and bioventing.	Ap	1,3,4,6,8,10,11	2,3,5,6
3	Students will develop a comprehensive understanding of cutting-edge biotechnological approaches to address diverse challenges in plant science and agriculture.	U	1,2,6,7,8,10,11	3,6
4	Students will gain knowledge of immune response of body during infections or different disease. Imbibe deep knowledge of cancer and its development. They also gain knowledge of animal cell culture and development of vaccines.	U	1,2,3,4,9,10,11	1,2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Industrial Biotechnology 1. Isolation, screening and maintenance of industrial microorganisms. 2. Fermenter and bioreactor types and components, production parameters. 3. Industrial production of biofuel, acids, antibiotics, enzymes, etc. 4. Product recovery and purification, food preservation, canning and packaging.	15	1
II	Biotechnology for Sustainable Development 1. Environmental issues: pollution and contaminations, sources, air, water and soil pollution. 2. Measurement of water pollution. Waste water treatment, waste management. 3. Bioremediation, phytoremediation, bioventing, etc. 4. Bio-pesticides, bio-energy, bio-fertilizers.	15	2
III	Applied Plant Biotechnology 1. Plant nutrition enhancement: amino acids, vitamin a, iron, sweetness 2. Modification of flower pigmentation 3. Plant engineering for phytoremediation	15	3
IV	Medical Biotechnology 1. Primary and specific immune defence system, antimicrobial peptides, cytokine, lymphocyte activation, pathogenicity & virulence factors and investigation of epidemics. 2. Cancer immunology, mechanic insights of anti-tumour immunity, immunosuppressive mechanisms, inhibitory receptors and cancer vaccines. 3. Principle and application of gene silencing, disease model; somatic and germ-line therapy and gene targeting. 4. Mammalian and stem cell culture, medium preparation, characterization and scale up techniques.	15	4

Books Recommended:

1. Stanbury & Whittaker (1997) Principles of Sterilization techniques, 1st Indian reprint Edition. Aditya Book (P) Ltd. New Delhi.
2. Shuler M.L.& Kargi F. (2002) Bioprocess Engineering: Basic concepts. 2nd Edition, Prentice Hall, Engelwood Cliffs.
3. Patel A.H. (2003) Industrial Microbiology. 4th Edition. Laxmi Publications
4. Hans-Joachim Jördening & Josef Winter (2005) Environmental Biotechnology: Concepts and Applications; Wiley-VCH.
5. Indu Shekhar Thakur (2006) Environmental Biotechnology: Basic concepts and Applications.1st Edition. I. K. International Pvt. Ltd.

6. Michael J. Waites (2008) Industrial Microbiology: An Introduction 7th Edition; Wiley-Blackwell.
7. Gareth G. Evans & Judy Furlong (2011) Environmental Biotechnology: Theory and Application. 2nd Edition; John Wiley and Sons.
8. Jenni Punt, Sharon Stranford, Patricia Jones & Judy Owen (2018) Kuby Immunology. W. H. Freeman.
9. John E. Hall & Michael E. Hall (2020) Guyton and Hall Textbook of Medical Physiology. Elsevier Health Sciences.
10. Bernard R Glick & Cheryl L Patten (2022) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	1	1	1	2	3	4	5	6
CO1	3	3	-	3	-	3	-	-	3	3	3	-	3	3	-	3	3
CO2	2	-	3	3	-	3	-	3	-	3	3	-	3	3	-	3	3
CO3	3	3	-	-	-	3	3	3		3	3	-	-	3	-	-	3
CO4	3	3	3	4	-	-	-	-	3	3	3	3	3	3	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
MSc	Biotechnology	I	II
Course Code	**Course Title**		**Course Type**
BTMS205	**Lab Course 3 (Based on Papers BTMS201 & 202)**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**-**	**-**	**8**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This course explores molecular mechanisms of DNA replication, transcription, translation, protein synthesis, oncogenesis, antisense technology, and molecular mapping. It also provides an understanding of plant tissue culture, covering principles and techniques of it. Students will gain knowledge of both basic and applied aspects thereby contribute in large-scale production of clones and generate disease-free plantlets.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	These experiments would contribute in obtaining high-quality DNA samples suitable for various molecular biology applications, such as PCR, sequencing, or cloning.	B	1,2,3,7,10,11	2,5,6
2	It will ensure gaining hands-on experience in laboratory techniques on DNA, RNA and proteins.	B	1,2,3,7,10,11	2,5,6
3	Students will acquire comprehensive knowledge and practical skills of plant tissue culture.	C	1,2,3,7,10,11	2,5,6
4	Students will acquire a complete understanding of key techniques and processes of plant biotechnology.	C	1,2,3,7,10,11	2,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Extraction of DNA from plant leaves by CTAB methods. 2. Estimation of plant genomic DNA by spectrophotometer methods. 3. Separation of plant genomic DNA by agarose gel electrophoresis. 4. Extraction of DNA from animal cells. 5. Estimation of animal genomic DNA by spectrophotometer methods.	5	1
II	1. Separation of animal genomic DNA by agarose gel electrophoresis. 2. Separation of bacterial proteins by SDS-PAGE electrophoresis. 3. Extraction of RNA from yeast cells. 4. Estimation of yeast RNA by spectrophotometer methods.	5	2
III	1. Plant tissue culture media préparation. 2. Meristem / bud culture. 3. Shoot proliferation. 4. Rooting. 5. Callus culture.	5	3
IV	1. Organogenesis. 2. Plantlet acclimatization. 3. Extraction of DNA from plant tissue. 4. Estimation of DNA by spectrophotometer and its separation following agarose gel electrophoresis 5. Study of molecular markers.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	3	3	-	-	-	3	-	-	3	3	-	3	-	-	3	3
CO2	3	3	3	-	-	-	3	-	-	3	3	-	3	-	-	3	3
CO3	3	3	3	-	-	-	3	-	-	3	3	-	3	-	-	3	3
CO4	3	3	3	-	-	-	3	-	-	3	3	-	3	-	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-II

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**II**
Course Code	**Course Title**		**Course Type**
BTMS206a	**Lab Course 4 (Based on Papers BTMS203 & 204a)**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	**-**	**-**	**10**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

Students will develop proficiency in determining concentrations of various macromolecules and enzymes through experimental methods. Acquire skills in performing statistical analysis of experimental data, including hypothesis testing and comparing means across different datasets. Demonstrate the ability to arrange and represent data effectively, utilizing bioinformatics tools to search and compare databases relevant to molecular biology.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will learn determining concentrations of different macromolecules and enzymes.	B	1,2,3,4,7,9,10,11	1,4,5,6
2	Will learn to assay activities and functions of enzymes; enzyme kinetics; and separation of proteins.	B	1,2,3,4,7,9,10,11	1,4,5,6
3	Students will learn to perform statistical analysis of data; hypothesis testing; and comparing means of different data-sets.	B	1,2,3,4,7,10,11	1,2,5,6
4	Students will be able to arrange/ represent data; gain knowledge of bioinformatics tools and search/ compare databases; and structural analysis of different sequences.	C	1,2,3,4,5,6,8,9,10,11	1,2,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Qualitative assay of protein by the Biuret method. 2. Quantitative estimation of protein by following Folin Lowry Method. 3. Estimation of cholesterol by the method of Crawford 4. Determine activity of alkalie protease. 5. Determine activity of neutral protease.	5	1
II	1. Effect of temperature on activity of α-amylase. 2. Determine activity of catalase. 3. Determine activity of urease. 4. Separation of protein by SDS-PAGE. 5. Determination of enzyme kinetics.	5	2
III	1. Calculate the mean value of given leaves samples. 2. Calculate the median of the given sample of leaves samples. 3. Find out the mode value of given leaves samples. 4. To determine correlation between given samples. 5. To perform the t-test of the given data/ sample. 6. To perform the Chi- Square test of given data. 7. To calculate standard deviation, and variance of the data set.	5	3
IV	1. Draw Histogram, Pie, Graph, Line graph. 2. Prepare presentation using MS Power point software. 3. Use of Internet in biotechnological Research. 4. Perform various applications of spreadsheet. 5. Calculate various statistical parameters using MS Excel. 6. Search nucleotide sequence of a target gene on NCBI website and, align and compare with other database using BLAST tool. 7. Find out amino acid sequence of a particular protein from protein database available on public domain and compare it with other proteins.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	3	2	-	-	2	-	3	2	3	2	-	-	2	3	3
CO2	2	2	3	3	-	-	3	-	2	2	2	3	-	-	3	2	2
CO3	3	2	2	2	-	-	2	-	-	3	3	3	3	-	-	3	3
CO4	2	2	3	2	3	3	-	2	2	1	3	2	3	-	-	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

OR

Semester-II

Program	Subject	Year	Semester
MSc	**Biotechnology**	**1**	**II**
Course Code	Course Title		Course Type
BTMS206b	**Lab Course 4 (Based on Papers BTMS203 & 204b)**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	-	-	**10**
Maximum Marks	CIA		EA
100	**30**		**70**

Learning Objective (LO):

This course will enhance understanding and skills of various biotechnological techniques for protein and enzyme analysis production of bioethanol, antibiotic, and bio-fertilizer, including immunological techniques and applications.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will learn determining concentrations of different macromolecules and enzymes.	B	1,2,3,4,7,9,10,11	1,4,5,6
2	Will learn to assay activities and functions of enzymes; enzyme kinetics; and separation of proteins.	B	1,2,3,4,7,9,10,11	1,4,5,6
3	Through practical experiences, the students will learn bioethanol, antibiotic, enzyme and bio-fertilizer production.	B	1,2,3,4,7,8,9,10,11	1,3,5,6
4	These practicals provide a comprehensive learning experience in immunology techniques.	B	1,2,3,4,7,10,11	3,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Qualitative assay of protein by the Biuret method. 2. Quantitative estimation of protein by following Folin Lowry Method. 3. Estimation of cholesterol by the method of Crawford 4. Determine activity of alkalie protease. 5. Determine activity of neutral protease.	5	1
II	1. Effect of temperature on activity of α-amylase. 2. Determine activity of catalase. 3. Determine activity of urease. 4. Separation of protein by SDS PAGE. 5. Determination of enzyme kinetics.	5	2
III	1. Production of Bioethanol from different wastes. 2. Antibiotic production 3. Production and purification of enzyme 4. Treatment of different waste water and analyze its physico-chemical parameters. 5. Production of bio-fertilizer	5	3
IV	1. Study of Agglutination reaction. 2. Isolation of Immunoglobulin and biochemical estimation. 3. Radial and double immunodiffusion. 4. Perform ELISA techniques.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	3	2	-	-	2	-	3	2	2	3	-	-	2	2	3
CO2	2	2	3	3	-	-	3	-	2	2	2	2	-	-	3	3	2
CO3	2	3	3	3	-	-	3	3	3	3	3	2	-	3	-	3	3
CO4	3	3	3	3	-	-	3	-	-	3	3	-	-	3	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Pt. Ravishankar Shukla University, Raipur

CURRICULUM & SYLLABI

(Based on CBCS & LOCF)

M. Sc. Biotechnology

Semester System

(Program Code: 0408)

PART II

Session: 2024-25 & 2025-26

Approved by	Board of Studies	Academic Council
Date	14/05/2024	11/06/2024

M. Sc. Biotechnology

The M. Sc. Biotechnology program offered by the School of Studies in Biotechnology of Pt. Ravishankar Shukla University, Raipur, has been meticulously crafted with a focus on a Learning Outcome Based Curriculum Framework (LOCF) approach. This curriculum encompasses both foundational and advanced aspects of Biotechnology, featuring a diverse array of core subjects across each academic term. In addition to imparting traditional knowledge of biotechnology, this program offers ample opportunities for interdisciplinary and multidisciplinary learning through biotechnological electives.

Furthermore, the course addresses skill enhancement of students and encourages collaborative and cross-disciplinary learning by incorporating general elective courses, thereby allowing them to expand their knowledge in complementary fields. Each semester includes a practical component aimed at strengthening student's abilities in designing and conducting experiments within the realm of biotechnology.

The pinnacle of this program is the six-month dissertation undertaken in the final semester, which serves as a pivotal point in preparing students for future endeavours in research and development, be it in academia or industries.

Program Outcomes:

Upon successful completion of the M. Sc. Biotechnology program, students will be able to:

PO-1	**Knowledge:** Above course will impart in-depth knowledge, and develop an understanding of basic and applied aspects of biotechnology, its concepts, various theories and popularly used advanced techniques. Also, make the students aware of industrial applications of biotechnology.
PO-2	**Critical Thinking and Reasoning:**Understand thefundamentals of life-processes particularly at molecular level, and will not only be able to design related experiments but also to execute and derive logical interpretations based on generated data.
PO-3	**Problem Solving:** Utilizing advances of biotechnology, experimental skill and critical thinking, students will be capable of addressing intricate societal and industrial challenges.
PO-4	**Advanced Analytical and Computational Skills:** Students will be proficient in serving and initiating various operations in a wide range of industries, including food processing, sewage treatment plants, breweries, micro propagation units, bio-fuel production plants, bio-fertilizer units, enzyme manufacturing and drug and vaccine development sectors. Moreover, students will possess necessary expertise for collection, organization and analysis of data, and to generate pertinent insights in the field of research & development.
PO-5	**Effective Communication**: This program will make the students efficient in communicating complex concepts of biotechnology and their experimental findings to diverse audiences, including technical/ non-technical backgrounds, *via* written reports, presentations, popular articles, instructional methods, *etc*.

PO-6	**Social/ Interdisciplinary Interaction:**Students will be able to excel both as an individual and as a player or leader within a variety of teams in cross-disciplinary environments. Students will also be efficient in utilizing their contextual understanding to evaluate societal, health, and safety aspects and ensue professional responsibilities.
PO-7	**Self-directed and Life-long Learning:** Students will probably acquire capacity to participate actively in self-directed and continual learning process within the expansive realm of technological advancements.
PO-8	**Effective Citizenship,Leadership and Innovation:** After the completion of this program, the students will come up with a mind-set and attitude of a responsible citizen. Hence, they will be actively involved in society. Moreover, students will play an active role in demonstrating leadership quality and employing innovative approaches of biotechnology to improve well-being of the humans, communities, nation, and the world.
PO-9	**Ethics:** This program will probably set the minds of students to adhere gently with ethical issues, embrace professional ethics and responsibilities, and uphold the standards of biotechnological practices.
PO-10	**Further Education or Employment:** This program will ignite the students to pursue advanced academic endeavours such as Ph. D., *etc.*, in biotechnology or related disciplines. Moreover, it will equip the students with necessary expertise and skill (managerial, planning, experimental, computation, *etc.*), which are essentially required for making career in academia, research and development laboratories/ institutions, industries and, Government and non-Government sectors.
PO-11	**Global Perspective:** This program will make the students a well-suited entity for the academia, research and development laboratories/ institutions, marketing, networking, health and regulatory authorities, industries and Government and non-Government sectors. Hence, they will have an ample opportunity for placements globally.

Programme Specific Outcomes (PSOs): At the end of the program, the student will be able to:

PSO1	Students will imbibe an idea about cellular processes and building blocks (macromolecules) of life; inheritance of characters; knowledge of various diseases; diversity, roles and various biotechnological aspects of microorganisms, *etc.*
PSO2	Expertise in gene sequencing, including primer designing and synthesis; prediction and derivatization of molecular structures; drug discovery and molecular diagnostics; computational skill; idea about micropropagation and secondary metabolites; basics of thermodynamics and bioenergetics; and commercial aspects of biotechnology.
PSO3	Gain knowledge about insights of immune system, immunity and immune responses; r-DNA technology and its applications in gene therapy, diagnostic tools and disease modelling; process of fermentation and its contributions in well-being of society; and roles of microorganisms in making the environment sustainable.
PSO4	Students will perceive both basic and recent knowledge about protein engineering; identification, annotation and global analysis of proteins; IPR and ethical issues of biotechnological research; nanotechnology and its applications; transgenics and several other aspects of animal biotechnology.
PSO5	This program will provide ample opportunities to conduct both basic and advanced hands-on experiments related to various aspects of biotechnology. It aims to equip them with the skills to plan and execute experiments independently, and to draw logical conclusions.
PSO6	Students will not only be able to carry out advanced research within the pure and applied fields of biotechnology but will also be able to write scientific reports independently; will attain eligibility in national level examinations such as NET, GATE, *etc.*; and will be able to get jobs in global market.

M. Sc. Biotechnology

Specification of Course	Semester	No. of Courses	Credits
Core	I - III	17	71
Electives- DCEC*	III - IV	09	29
Total			100
Additional Courses (Qualifying in nature):			
Electives- Generic	II - III	02	06
Skill Enhancement (Value Added Courses)	I, II	02	04

*Discipline Centric Elective Courses

M. Sc. Biotechnology

Program Structure

Semester	Course Code	Course Nature	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	EA	Total
Semester-I [25 Credits]	LSBTMS101	Core	Cell Biology	T	4	4	25	75	100
	LSBTMS102	Core	Genetics	T	4	4	25	75	100
	LSBTMS103	Core	Microbial Physiology	T	4	4	25	75	100
	LSBTMS104	Core	Bio-molecules	T	4	4	25	75	100
	LSBTMS105	Core	Lab Course 1 (Based on Papers LSBTMS101& 102)	P	8	4	25	75	100
	LSBTMS106	Core	Lab Course 2 (Based on Papers LSBTMS103&104)	P	10	5	25	75	100
Semester-II [25 Credits]	LSBTMS201	Core	Molecular Biology	T	4	4	25	75	100
	LSBTMS202	Core	Plant Biotechnology	T	4	4	25	75	100
	LSBTMS203	Core	Macromolecules & Enzymology	T	4	4	25	75	100
	LSBTMS204a	DCEC-1 (Select any one)	Biostatistics, Bioinformatics & Computers in Biotechnology	T	4	4	25	75	100
	LSBTMS204b		Applied Biotechnology	T	4	4	25	75	100
	LSBTMS205	Core	Lab Course 3 (Based on Papers LSBTMS 201 &202)	P	10	5	25	75	100
	LSBTMS206a	Core	Lab Course 4 (Based on Papers LSBTMS 203&204a)	P	8	4	25	75	100
	LSBTMS206b	Core	Lab Course 4 (Based on Papers LSBTMS203& 204b)	P	8	4	25	75	100
Semester-III [24 Credits]	LSBTMS301	Core	Genetic Engineering	T	4	4	25	75	100
	LSBTMS302	Core	Biology of Immune System	T	4	4	25	75	100
	LSBTMS303	Core	Bioprocess Engineering & Technology	T	4	4	25	75	100
	LSBTMS304	Core	Environmental Biotechnology	T	4	4	25	75	100
	LSBTMS305	Core	Lab Course 5 (Based on Papers LSBTMS 301&302)	P	8	4	25	75	100
	LSBTMS306	Core	Lab Course 6 (Based on Papers LSBTMS 303& 304)	P	8	4	25	75	100
Semester-IV [26 Credits]	LSBTMS401	DCEC-2*	IPR, Biosafety, Bioethics & Nanobiotechnology	T	4	4	25	75	100
	LSBTMS402		Advanced Techniques in Biotechnology	T	4	4	25	75	100
	LSBTMS403		Animal Biotechnology	T	4	4	25	75	100
	LSBTMS404		Genomics & Proteomics	T	4	4	25	75	100
	LSBTMS405		Lab Course 7 (Based on Papers LSBTMS 401&402)	P	8	4	25	75	100
	LSBTMS406		Lab Course 8 (Based on Papers LSBTMS 403& 404)	P	8	4	25	75	100
	LSBTMS407#		Internship#	P#	60 H#	2#	25#	75#	100#
	LSBTMS408	DCEC-3*	Project Work / Internship#						
			Dissertation	P	26	12	200	100	300
			Seminar based on project			8	150	50	200
			Viva Voce			4	75	25	100
	LSBTMS409		Methodology, Philosophy and Ethics of Research	T	2	2	25	75	100

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1. Students will be able to carry out their Internship (LSBTMS407[#]) either in this School itself or in any the other Schools of the University Campus or in industries, depending upon their choice. However, those who will be interested to carry out their internship in the School itself, have to pay an Internship Fee of Rs 2000.00 only.Total duration of the Internship will be of 60 hours. After completion of the Internship, a detailed report, dully signed by the Supervisor and forwarded by the Head of the Institution has to be submitted by each of the student in the Office of the School.

2. Any student of the IV Semester will have an option to opt for Project Work and a theory paper (taught through online mode only) (DCEC-2) in lieu of the four theory papers and two lab courses (DCEC-3).

3. The project work has to be carried out in any of the recognized national laboratories, UGC-recognized Government universities, teaching departments of the PRSU, Government colleges recognized as research centres by the RDC, Biotechnology of PRSU, reputed private institutions namely TIFR, Mumbai, Reliance Life Sciences Pvt. Ltd., Nashik, Thapar Institute, Patiyala, Reddys Laboratory, Hyderabad, Novazyme, Pune, Lupin India, Mumbai, Sisco Research Laboratory, Mumbai, HiMedia Laboratories Pvt. Ltd., Mumbai, Shanta Biotech, Hyderabad, Verda Biotech, Mumbai, Pariyar Chemicals Ltd., Mumbai, Nicholas Piramal Laboratory, Mumbai, Aragen Life Sciences, Hyderabad, Biocon Research Ltd., Bengaluru, Sun Pharma, Mumbai, Panacia Biotech, Mumbai, Cadilla, Mumbai, ITC, Bengaluru, Chambal Biofertilizer & Chemicals, Kota, and any other Publicly Traded Companies. However, any student of School of Studies in Biotechnology willing to carry out his/ her project in the School itself has to pay Rs 30,000.00 only (Rupees Thirty Thousand Only) in addition to the course fee (normal fee or payment seat fee, mentioned in the admission brochure) as Project Fee, without which he/ she will not be permitted to do so in any of the circumstances. No relaxation from payment of the Project Fee will be granted, in any of the circumstances, to any students belonging to any of the categories, domicile, locality, economic status (BPL, APL, *etc.*), gender, *etc.*

4. The valuation of all the projects will be carried out by the external examiner and Head of the School of Studies in Biotechnology or its nominee at the School of Studies in Biotechnology. However; answer books of the online paper Methodology, Philosophy and Ethics of Research will be evaluated at the departmental level and its marks will be sent to the University Administration.

Note:

1. In place of Elective Courses students can choose paper(s) from MOOC Courses (Swayam Portal) subject to the following conditions:
    a. The chosen paper will be other than the papers offered in the current course structure.
    b. The paper will be for PG level with a minimum of 12 weeks duration.
    c. The list of courses on SWAYAM keeps changing, the departmental committee will finalize the list of MOOC courses for each semester.
    d. The paper(s) may be chosen from the Swayam Portal on the recommendation of the Head of the Department.

2. The candidates who have joined M Sc Biotechnology Programme in the School of Studies in Biotechnology, shall undergo Generic Elective Courses (only qualifying in nature) offered by other departments/SoS in Semester II and Semester III.
3. The candidates who have joined the M Sc Biotechnology Programme in the School of Studies in Biotechnology, shall opt Skill Enhancement Course/ Value Added Course (only qualifying in nature) in Semester I and Semester IV.

Generic Elective Courses: (Offered to PG students of other Departments/SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	EA	Total
II	LSBTGEC201	Basic Biotechnology	T	3	3	25	75	100
III	LSBTGEC301	Applications of Biotechnology	T	3	3	25	75	100

Skill Enhancement/Value Added Courses: (Offered to the PG students of School of Studies in Biotechnology only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	LSBTVAC101	Concepts of Traditional Knowledge	T	2	2	25	75	100
IV	LSBTVAC401	Swiss-Prot, Swiss-Model, & Design Expert	P	4	2	25	75	100

Semester-III

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**III**
Course Code	Course Title		Course Type
LSBTMS301	**Genetic Engineering**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	-
Maximum Marks	CIA		EA
100	**25**		75

Learning Objective (LO):

Students will learn principles and procedures of recombinant DNA technology, and will be capable of applying this knowledge to produce insulin, growth hormones, albumin, vaccines, and pharmaceuticals. Students will become proficient in using molecular tools and techniques, and will be able to work in pharmaceutical companies, research organizations, hospitals, and universities to improve organism's genetic makeup for their better survival in challenging environments.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	It will provide an in-depth understanding of genetic engineering, its tools, and practical applications, and equip them with skills of recombinant technology.	Ap	1,3,7,9,10, 11	3,4,6
2	Students will have a solid foundation of fundamental techniques and tools of molecular biology necessary for genetic engineering, gene cloning, and gene expression analysis.	Ap	1,3,7,10,11	3,6
3	Will make the students capable of doing gene manipulation, gene/ protein expression, and bioengineering.	Ap	1,3,7,10,11	3,6
4	Students will gain an understanding of recombinant protein processing, gene tagging techniques, and principles and applications of gene therapy.	Ap	1,3,7,10,11	3,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

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Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Scope of Genetic Engineering. 2. Cloning and patenting of life forms. Genetic engineering guidelines. 3. Molecular tools and their application: Restriction enzymes, modification enzymes, molecular markers. 4. Nucleic acid purification, yield analysis 5. Nucleic acid amplification and its applications: Polymerase Chain Reaction (PCR), Reverse transcriptase PCR, Multiplex PCR, Quantitative PCR	15	1
II	1. Cloning vectors: Plasmids, bacteriphages, phagemids, cosmids, Artificial chromosomes 2. Restriction Mapping of DNA Fragments and Map Construction, Nucleic acid sequencing. 3. cDNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening. 4. Cloning interacting genes – Two and three hybrid systems. Nucleic acid micro array assay.	15	2
III	1. Site – directed mutagenesis and protein engineering. 2. DNA Transfection, Southern blot, Northern blot, Western blot, Primer extension, S1 mapping. RNase protection assay. 3. Expression Strategies for hetrologous genes: Vector engineering and codon optimization, host engineering; expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells 4. Phage display: Technique and applications	15	3
IV	1. Processing of recombinant Proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins. 2. T – DNA and transposon tagging: Role of gene tagging in gene analysis, t – DNA and transposon tagging, Identification and isolation of genes through T – DNA or transposon. 3. Cisgenesis, intragenesis and genome editing by CRISPR-Cas9. 4. Gene therapy: Vector engineering. Strategies of gene delivery – Viral & non-viral, gene knockout, gene augmentation, gene correction / gene editing, gene regulation and silencing.	15	4

Books Recommended:

1. Eldon John Gardner, Michael J. Simmons and Peter Snustad (2006) Principles of Genetics. 8th Edition, John Wiley and Sons, INC.
2. James D Watson, Richard M. Myers, Amy A. Caudy and Jan A. Witkowski (2007) Recombinant DNA: Genes and Genomes 3rd Edition; WH Freeman.
3. Old and Primrose (2013) Principles of Gene Manipulation. 7th Edition. Blackwell Publishing.
4. Sandy Primrose and Richard Twyman (2013) Principles of Gene Manipulation and Genomics 7th Edition; Wiley-Blackwell.
5. Buchanan, Gruissemen& Jones (2015) Biochemistry & Molecular Biology of Plant, 2nd Edition. Wiley-Blackwell.
6. Rusell&Peter (2016) Genetics 3rd Edition. Pearson Education, Inc, San Francisco.
7. Benjamin Lewin (2017) Genes XII. 12th Edition Pearson Education International.
8. W.H. Elliott&D. C. Elliott (2018) Biochemical and Molecular Biology. 6th Edition. Oxford University Press.
9. Brown T.A. (2020) Gene Cloning and DNA Analysis. 8th Edition.Wiley-Blackwell.
10. B.D. Singh (2023) Biotechnology: An Expanding Horizons, 5th Edition.MedTech Science Press.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	-	2	-	-	-	3	-	3	3	3	-	-	3	3	-	3
CO2	3	-	3	-	-	-	3	-	-	3	3	-	-	3	-	-	3
CO3	3	-	3	-	-	-	3	-	-	3	3	-	-	3	-	-	3
CO4	3	-	3	-	-	-	3	-	-	3	3	-	-	3	-	-	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-III

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**III**
Course Code	Course Title		Course Type
LSBTMS302	**Biology of Immune System**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This paper intends to understand fundamental concepts of the immune system, anatomical functions of immune cells, insight into pathogenesis, host-pathogen interaction, and immuno-modulators during pathogenesis, diagnostics, tolerance, transplant and vaccine development.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	It intends to provide an in-depth understanding regarding mechanisms of the immune system; along with concepts of antigen and antibody.	An	1,2,3,5,7,8,9,10,11	1,3,5, 6
2	Students will be able to understand MHC, BCR, TCR and complement systems; and learn regulatory aspects of immune system.	An	1,2,3,4,5,6,9,10,11	1,3,5,6
3	Acquire knowledge about processes of antigen-antibody interaction; mechanisms of cell-mediated cytotoxicity; cytokines; and hypersensitivity.	AP	1,2,3,4,5,7,9,10,11	1,2,3,4, 5,6
4	Gain a comprehensive idea of different aspects of organ transplantation and antibody engineering; along with immunity against infectious agents and cancer immunotherapy.	An	1,2,3,4,5,6,7,8,9,10	1,2,3,4, 5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Introduction – Phylogeny of immune system, innate and acquired immunity, Clonal nature of immune response. 2. Organization and structure of lymphoid organs. 3. Cells of immune system – Hematopoiesis and differentiation, B – lymphocyte, T – lymphocyte, Macrophages, Dendritic cells, Natural Killer and lymphokine-activated killer cells, Eosinophils, Neutrophils and Mast cells. Lymphocyte trafficking. 4. Nature and biology of antigens and super antigens. 5. Antibody structure and function.	15	1
II	1. Major histocompatibility complex (MHC); MHC genes, and immune responsiveness & MHC restriction. 2. BCR &TCR, generation of diversity. 3. Complement system. 4. Regulation of immune response – Antigen processing and presentation, generation of humoral and cell mediated immune responses; Activation of B – and T – lymphocytes; cytokines and their role in immune regulation; T – cell regulation.	15	2
III	1. Antigen – antibody interactions. 2. Cell – mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. 3. Immunological tolerance & Autoimmunity; types of autoimmune diseases. 4. Hypersensitivity.	15	3
IV	1. Transplantation: General concept of immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy. 2. Immunity to infectious agents (intracellular parasites (malaria), helminthes, bacterial (tuberculosis), viruses, (AIDS) infections and other congenital and acquired immunodeficiency' vaccines. 3. Antibody engineering: Chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies. 4. Tumor immunology and Cancer immunotherapy.	15	4

Books Recommended:

1. Peter J. Delves, Ivan Maurice Roitt, Seamus J. Martin and Dennis & R. Burton (2017). Roitt's Essential Immunology. 13th Edition. Wiley-Blackwell.
2. Jenni Punt, Sharon Straford, Patricia Jones, Judith A. Owen, Judith A. Cohen (2018) Immunology. 8th Edition. WH Freeman & Co Ltd.
3. Canadian Networking (2021) Manual of Immunological Methods. CRC Press.
4. David Male & Milton Keynes (2021) Immunology: An Illustrated Outline. Taylor & Francis Ltd, UK.
5. Frances Fischbach, Margaret Fischbach & Kate Stout (2021) Fischbach's A Manual of Laboratory and Diagnostic Tests. Lippincott Williams & Wilkins Publication.
6. Linda E. Miller, Christine &Dorresteyn Stevens (2021) Clinical Immunology and Serology: A Laboratory Perspective. 5th edition. FA Davis Publication.
7. Mary Louise Turgeon (2021) Immunology & Serology in Laboratory Medicine. Elsevier Health Sciences.
8. Richard Coico (2021) Immunology: A Short Course. John Wiley and Sons Ltd. US.
9. Rezaei &Nima (2022) Clinical Immunology. 1st edition. Academic Press Publication.
10. Robert R. Rich, Thomas A. Fleisher, Cornelia M. Weyand, David B. Corry and Jennifer &M. Puck (2022) Clinical Immunology: Principles and Practice. Elsevier.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	2	-	3	-	1	2	2	2	2	2	-	3	-	2	3
CO2	3	3	2	2	1	3	-	-	3	2	2	2	-	2	-	2	3
CO3	3	2	1	2	3	-	2	-	2	3	2	2	2	2	3	2	3
CO4	3	2	2	2	1	3	1	3	2	2	-	2	1	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-III

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**III**
Course Code	Course Title		Course Type
LSBTMS303	**Bioprocess Engineering & Technology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

Above paper emphasizes on principles followed for designing and development of equipment's such as bioreactor, and procedures involved in manufacturing of industrially important products like pharmaceuticals, nutraceuticals, alcohol, enzymes, antibiotics, acids, polymers, *etc.*, using biologicals.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will come to know the basics of bioprocess/ fermentation technology; cultivation, preservation and maintenance of industrially important microorganisms; and various processes of sterilization.	R	1,5,6	1,5,6
2	Will impart knowledge about design and different types of bioreactors and various parameters regulating the bioprocess.	Ap	1,6,7,9,10	1,4,6
3	Students will be able to understand different steps of downstream processing; aspects of effluent treatment; and various procedures of microbial cell immobilization.	C	1,2,4,8, 9,10	1,6
4	Students will gain an idea about production processes of various commercials like alcohol, acids, antibiotics, single cell proteins, *etc.*, and elementary knowledge of food technology.	C	1,3,5,7,8, 9,10	1,2,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Introduction to Bioprocess Engineering & its applications. 2. Kinetics of microbial growth and death 3. Isolation, screening, preservation and maintenance of industrially important microorganisms. 4. Nutrients and media for industrial fermentation 5. Air and media Sterilization- physical & chemical processes of sterilization.	15	1
II	1. Types of fermentation processes; Bioreactors- types; design and components; analysis of batch, fed–batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial population, specialized reactors (pulsed, fluidized, photo bioreactors). 2. Measurement and control of bioprocess parameters- inoculum size and age, pH, temperature, foaming, agitation, aeration, etc.	15	2
III	1. Downstream processing: introduction, removal of microbial cells and solid materials, foam reparation, precipitation, filtration, centrifugation, cell disruption- physical and chemical methods, liquid–liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment: TDS, BOD, COD; treatment and disposal of effluents. 2. Immobilization technique; types of immobilizations; materials used for immobilization, whole cell Immobilization, and their industrial applications.	15	3
IV	1. Industrial production of chemicals: Alcohol (ethanol), Acids (citric, acetic and gluconic), solvents (glycerol, acetone-butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid), Single cell protein. Use of microbes in mineral beneficiation and oil recovery. 2. Introduction to food technology: elementary idea of canning and packaging, sterilization and pasteurization of food products, technology of typical food/ food products like bread, cheese, and idli: food preservation.	15	4

Books Recommended:

1. Michael J. Waites (2016) Industrial Microbiology: an introduction 7th Edition; Wiley-Blackwell.
2. Stanbury P. F., & Whitaker A. (2016). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Baily J.E. &Ollis D.F. (2017) Biochemical Engineering fundamentals. 2nd Edition. McGraw-Hill.
4. Shuler M.L.&Kargi F. (2017) Bioprocess Engineering: Basic concepts. 2nd Edition. Prentice Hall, Engelwood Cliffs.
5. Wulf Crueger& Anneliese Crueger (2017) Crueger's Biotechnology: A Textbook of Industrial Microbiology.3rd Edition.Medtech Publication.
6. CasidaL.E.J.R. (2019) Industrial Microbiology. New Age International Publisher.
7. El-Mansi E. M. T., Bryce C. F. A., Arnold L. Demain, Allman A.R. (2019) Fermentation Microbiology and Biotechnology. Boca Raton: Taylor & Francis.
8. Satayanarayan U (2020) Biotechnology. 1st Edition. Books and Allied (P) Ltd. Kolkata.
9. Vanitha N., InithaC. &Lebanon Ebency (2020) A Textbook on Industrial MicrobiologyRyan Publishers.
10. Patel A.H. (2022) Industrial Microbiology. Laxmi Publication.

CO-PSO Mapping for the course:

PO	Pos											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	-	-	-	1	2	-	-	-	-	-	2	-	-	-	2	3
CO2	3	-	-	-	-	3	3	-	-	2	-	1	-	-	1	-	2
CO3	2	1	-	2	-	-	-	2	2	2	-	1	-	-	-	-	3
CO4	2	-	3	-	1	-	1	1	2	2	-	1	1	-	2	-	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-III

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**III**
Course Code	Course Title		Course Type
LSBTMS304	**Environmental Biotechnology**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This course integrates environmental sciences and biotechnology, focusing on applying biotechnological methods for mitigation of pollution particularly in solid waste management and industrial waste bioremediation. The course emphasises the societal benefits of utilizing plant- and microbe-based bioremediation processes.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will gain knowledge about environmental pollution issues and different types of pollutants. They will also know about different limitations, and approaches to cure the problem of pollution.	U	1,3,4,6,9,10,11	1,3,5,6
2	Students will understand water pollution and know the sources of pollution. They will gain knowledge of waste water treatment processesand different techniques of treatment of water pollution.	Ap	1,2,3,4,6,9,10,11	1,3,5,6
3	Students will imbibe idea of waste water treatment techniques applied in different industries. They also gain knowledge of xenobiotic compounds and pesticides. Will understand how chemicals are affecting the environment and know their management techniques.	Ap	1,3,4,6,9,10,11	1,3,5,6

4	Students will acquire knowledge of solid waste management and different bio-fertilizer making processes. They also learn about different laws of environment for control and prevention of pollution. Students will learn about different biotech agencies which are working for pollution management.	An	1,2,3,4,5,6,7,8,9,10,11	1,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Environment: Basic concepts and issues. 2. Environmental Pollution: Types of pollution, Methods for the measurement of pollution; Methodology of environmental management – the problem solving approach, its limitations. 3. Air pollution and its control through Biotechnology	15	1
II	1. Water pollution and its control: Water as a scarce natural resource, sources of water pollution, Need for water management, Measurement of water pollution, waste water collection, waste water treatment – physical, chemical and biological treatment processes 2. Microbiology of waste water treatments, aerobic process: Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. 3. Anaerobic process: Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors.	15	2
III	1. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries; Bioremediation 2. Xenobiotics in Environment – Ecological considerations, oil pollution, surfactants, pesticides. 3. Biopesticides in integrated pest management.	15	3
IV	1. Solid wastes: Sources and management (composting, vermiculture and methane production). 2. Global Environmental Problems: Ozone depletion, UV – B, green house – effect and acid rain, their impact and biotechnological approaches for management. 3. Role of National organization in Biotechnology. 4. Acts and rules for environment managements and pollution control in India.	15	4

Books Recommended:

1. Kumar H.D. (2003) Modern Concepts of Biotechnology. 3rd Reprint Edition, Vikas Publishing House. Pvt. Ltd.
2. Alan Scragg (2005) Environmental Biotechnology. 1st Edition. Oxford University Press.
3. Hans-Joachim Jördening, & Josef Winter (2005) Environmental biotechnology: concepts and applications. Wiley-VCH.
4. Indu Shekhar Thakur (2006) Environmental Biotechnology: Basic Concepts and Applications. 1st Edition. I. K. International Pvt. Ltd.
5. Debnath M. (2011) Tools and Techniques in Biotechnology.Pointer Publication.
6. Gareth G. Evans & Judy Furlong (2011) Environmental Biotechnology: Theory and Application. 2nd Edition. John Wiley and Sons.
7. Chatterjee A.K. (2011) Introduction to Environmental Biotechnology. 3rd Edition. Prentice Hall of India Pvt. Ltd. New Delhi.
8. Manoj Tiwari, KapilKhulbe& Archana Tiwari (2013) Environmental Studies.Revised Edition. I. K. International Publishing House Pvt. Ltd.
9. Singh B.D. (2020) Biotechnology: Expanding Horizons. Latest Edition. Kalyani Publishers.
10. Ritmann B. & McCarty P.L. (2020) Environmental Biotechnology: Principle & Applications. 2nd Edition. McGraw Hill Science.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	-	3	2	-	3	-	-	3	3	3	3	-	3	-	3	3
CO2	2	3	3	3	-	3	-	-	3	2	3	3	-	3	-	3	3
CO3	3	-	3	2	-	3	-	-	3	3	3	3	-	3	-	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3	3	-	3	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-III

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**III**
Course Code	Course Title		Course Type
LSBTMS305	**Lab Course 5 (Based on Papers LSBTMS301&302)**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**-**	**-**	**8**

Maximum Marks	CIA	EA
100	**25**	**75**

Learning Objective (LO):

By this course, student will develop hands-on skills, and a complete understanding of recombinant technology and immunological techniques, which will fostertheir ability to apply these methods in research and diagnostics.Will also understand the principles, applications, and significance of biotechnology procedureswhich will prepare them for advanced studies or careers in biotechnology, genetics, and related fields.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	These practical provide understanding of techniques related to nucleic acid extraction, quantification, and analysis.	An	1,2,3,6,7,10,11	3,5,6
2	Students will acquire practical skills in restriction digestion, ligation, isolate plasmid DNA from *E. coli*, and execute DNA amplification through PCR.	An	1,2,3,6,7,10,11	3,5,6
3	Students will acquire skills in clinical hematology and biochemistry.	An	1,2,3,6,7,10,11	3,5,6
4	This skill set will equip learners with the practical experience necessary for advanced studies and applications in immunology and related fields.	An	1,2,3,6,7,10,11	3,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Extraction of DNA from *E. coli.* 2. Estimation of bacterial DNA by Spectrophotometer methods. 3. Separation of bacterial genomic DNA by agarose gel electrophoresis. 4. Hot phenol method for extraction of total RNA from *E. coli.* 5. Estimation of cellular RNA by spectrophotometer method.	5	1
II	1. Restriction digestion of DNA with restriction enzymes. 2. Ligation of DNA. 3. Isolation of plasmid DNA from *E. coli.* 4. DNA amplification by PCR.	5	2
III	1. Blood group determination by slide agglutination reaction. 2. Enumeration of WBC in blood sample. 3. Preparation of a blood smear and differential blood count. 4. To separate serum from the given blood sample. 5. To determine albumin:globulin ratio in given serum sample. 6. Estimation of serum protein by Folin Lowry method. 7. Isolation of immunoglobulin. 8. Separation of serum protein by SDS-PAGE.	5	3
IV	1. Detection of class specific antibody by double diffusion method. 2. Observe Ag-Ab interaction by immunoelectrophoresis. 3. Observe Ag-Ab interaction by counter current immunoelectrophoresis. 4. Study of agglutination reaction 5. Study of ELISA technique. 6. Immuno diffusion test.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	3	2	-	-	3	3	-	-	3	3	-	-	3	-	3	3
CO2	3	3	2	-	-	3	3	-	-	3	3	-	-	3	-	3	3
CO3	3	3	2	-	-	3	3	-	-	3	3	-	-	3	-	3	3
CO4	3	3	2	-	-	3	3	-	-	3.	3	-	-	3	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-III

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**III**
Course Code	Course Title		Course Type
LSBTMS306	**Lab Course 6 (Based on Papers LSBTMS303&304)**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	-	-	**8**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This course aims to provide hands on proficiency for execution of experiments and handling of glassware, and related instruments utilized during study of bioprocess/ fermentation technology, and environmental biotechnology.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Will learn different techniques of microbial isolation; and formation of various fermentation products	B	1,2,4,8,10,11	1,4,5,6
2	Will gain knowledge of microbial growth and kinetics of enzymes produced through bioprocess technology; along with production of bioethanol and several other commercial products.	B	1,2,3,4,6,7,8,10,11	1,4,5,6
3	Will learn determining different physico-chemical pollutants of water and several other samples.	B	1,2,3,4,7,10,11	1,3,5,6
4	Come to know about analytical procedures, and different biological and chemical contaminants of water bodies.	B	1,2,3,4,7,10,11	1,3,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; U-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	5. Isolation and identification of microorganisms from industrial waste water. 6. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism (Bacteria and Fungi). 7. To study the production of citric acid by *Aspergillus niger* and also qualitative and quantitative test.	5	1
II	4. To study the bacterial growth curve. 5. To study the fungal growth curve. 6. Determine enzyme kinetics in respect to substrate concentration. 7. Production of Bio-ethanol from different wastes and its qualitative analysis.	5	2
III	1. To determine total suspended solids (TSS) of water. 2. To determine total dissolved solids (TDS) of water. 3. Determination of dissolved oxygen (DO) of water. 4. Determination of chemical oxygen demand (COD) of water.	5	3
IV	1. Determination of biochemical oxygen demand (BOD) of water. 2. To screen antagonism between *Trichoderma* sp. and *Aspergillus* sp. 3. Determination of effect of fungicide on growth of fungi. 4. To determine the Most Probable number (MPN) of a given water sample.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	-	3	-	-	-	2	-	2	3	3	-	-	2	3	3
CO2	3	2	3	2	-	2	2	1	-	2	3	2	-	-	2	2	3
CO3	2	3	2	2	-	-	3	-	-	3	?	2	-	3	-	2	2
CO4	3	2	2	3	-	-	2	-	-	2	3	2	-	3	-	3	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS401	**IPR, Biosafety, Bioethics and Nanobiotechnology**		**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

Students will acquire detailed idea about IPR, biosafety and bioethics. They will also know different aspects of nanotechnology such as principles, synthesis procedures, and their applications in various avenues, including health care practices, along with idea about thin films and biosensing devices.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Proposed paper will impart basic understanding and awareness towards importance of IPR and various ways of its protection. It will also instill a desire among the students for innovation and entrepreneurial practices.	U	2,6,9,10	4,5,6
2	This course will make the students aware of biosafety guidelines and bioethical issues. Also, will get idea about environmental risk and its protection aspects.	Ap	1,2,7,9	5,6
3	Will acquire in depth knowledge regarding principles, applications and several other aspects of nanotechnology and nanomaterials.	C	1,2,8,9,10	5,6
4	Students will be able to know about biosensors and thin films along with applications of nanomaterials in the health care system.	C	1,2,8,9,10	5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

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Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. IPR: Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, plagiarism, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D. Intellectual property laws of India. 2. Entrepreneurship in bio-business: Introduction and scope in Bio-entrepreneurship, Types of bio-industries; Strategy and operations of bio-sector firms; Entrepreneurship development program of public and private agencies (MSME, DBT, BIRAC, Make in India).	15	1
II	1. Biosafety: introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of pathogenic microorganisms; definition of GMOs; principles of environmental risk assessment and, food and feed safety assessment. 2. Bioethics: cloning and stem cell research; human, plants, microbes and animal experimentation; animal rights/ welfare; Agriculture biotechnology: Genetically engineered food; Protection of environment and biodiversity: biopiracy.	15	2
III	1. Nanobiotechnology: Introduction to Nanobiotechnology: Concepts, historical perspective; Different formats of nanomaterials and applications. 2. Cellular Nanostructures; Nanopores; Bimolecular motors; Synthesis and characterization of different nanomaterials.	15	3
IV	1. Nanoparticles for diagnostics and treatments; concepts of smart stimuli responsive nanoparticles, implications in cancer therapy. 2. Nanodevices for biosensor development, nanomaterials in pollution control. 3. Thin films: synthesis and applications.	15	4

Books Recommended:

1. Rita Khare (2016) Concepts in Nano Biotechnology. Anmol Publications Pvt. Ltd.
2. National IPR Policy (2016) Government of India Ministry of Commerce and Industry Department of Industrial Policy & Promotion (https://cipam.gov.in)
3. Ganguli P. (2017) Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Publication.
4. Desai V. (2018) The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Publication House.

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5. OnettiA., &Zucchella A. (2018) Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
6. Handbook for Food Safety Officials Genetically Modified Foods: Safety Assessment and Regulations (2019) Ministry of Environment, Forest and Climate Change (MoEFCC) and Biotech Consortium India Limited, New Delhi under the UNEP/GEF supported Phase II Capacity Building Project on Biosafety.
7. Jordan J. F. (2021). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
8. Vandana Shiva (2021) Biopiracy: The Plunder of Nature and Knowledge. Natraj Publishers.
9. Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, EzebuiroNwagboChristpeace, Charles OluwaseunAdetunji, Abdulrazak B. Ibrahim & Benjamin Ewa Ubi (2022) Biosafety and Bioethics in Biotechnology Policy, Advocacy, and Capacity Building. CRC Press Taylor and Francis Group.
10. Russell Franco D'Souza, Vedprakash Mishra & Mary Mathew Textbook of Bioethics, Medical Ethics and Health Law (2023) Paras Medical Books Pvt. Ltd.

CO-PSO Mapping for the course:

PO	Pos											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	-	2	-	-	-	1	-	-	2	2	-	-	-	-	3	2	3
CO2	2	1	-	-	-	-	2	-	2	-	-	-	-	-	-	2	2
CO3	1	1	-	-	-	-	-	3	3	2	-	-	-	-	-	1	3
CO4	1	1	-	-	-	-	-	3	3	2	-	-	-	-	-	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS402	**Advanced Techniques in Biotechnology**		**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This course aims to provide an understanding of the principles of advanced instruments and techniques employed in the biotechnology. It integrates theoretical knowledge with practical applications for the discovery of new drugs, pharmaceuticals, and bio-actives.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PO No.	PSO No.
1	Will gain knowledge of different techniques followed for separation, purification and identification of molecules; and disease diagnosis techniques.	An	1,3,4,7,8,9,10,11	1,2,3,5,6
2	Will know about microbial world, their nature, structure, size and their characteristics; and gain idea of DNA amplifications.	B	1,2,3,4,7,8,9,10,11	1,2,4,5,6
3	Acquire knowledge of quantification techniques and structural analysis of different macromolecules like proteins, DNA, *etc.*	C	1,2,3,4,8,9,10,11	1,2,3,4,5,6
4	Imbibe comprehensive knowledge of gene identification and analysis of hereditary diseases; DNA sequencing; and blotting techniques.	C	1,2,3,4,6,8,9,10,11	1,2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Principles and application of: Centrifugation, Chromatography (Paper, Thin layer, column, gas and liquid chromatography, LCMS), Electrophoresis-principle and types, Agarose gel electrophoresis, SDS PAGE, etc. 2. RIA and autoradiography in biology, ELISA: its types and application.	15	1
II	1. Principle and application of PCR, Thermocycler-types and application. 2. Microscopy: Light and compound microscopes, Confocal microscopy, Scanning & Transmission Electron microscopy, Inverted microscopy, Phase Contrast and fluorescence microscopy.	15	2
III	1. Principles and application of: Colorimetry, Spectrophotometry, Fluorescence spectrophotometry. 2. Molecular structure determination using NMR and X-ray diffraction. 3. Principles and application of DNA micro array	15	3
IV	1. Principles and application of Cytophotometry 2. Flow cytometry: Cell sorting and separation, Determination of cell cycle stages. 3. Blotting techniques: Southern, Northern, and Western Blotting. 4. DNA sequencer	15	4

Books Recommended:

1. Anthony J.F. Griffiths, William M. Gelbart, Richard C. Lewontin& Jeffrey H. Miller; (1999) Modern Genetic Analysis. W. H. Freeman Publication.
2. Serdyuk, I. N., Zaccai, N. R., &Zaccai, G. (2007) Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press.
3. David, L. Nelson & Michael, M. Cox Lehniger (2008) Principal of Biochemistry. 5th Edition. W.H. Freeman and Company, New York.
4. Upadhya&Upadhya (2009) Biophysical Chemistry. Mumbai: Himalaya Pub. House.
5. Debnath M. (2011) Tools and Techniques in Biotechnology. Pointer Publication.
6. Campbell, I. D. (2012) Biophysical Techniques. Oxford: Oxford University Press.
7. Ralf Pörtner (2013) Animal Cell Biotechnology: Methods and Protocols. Humana Press.
8. Rajagopal Vadivambal&Digvir S. Jayas (2015) Bio-Imaging: Principles, Techniques, and Applications. CRC Press.
9. Alberto Diaspro, Marc A. M. &Zandvoort J. (2016) Super-Resolution Imaging in Biomedicine. Taylor and Francis Group.
10. Wilson K. & Walker J. (2018) Principle and Techniques of Biotechnology and Molecular Biotechnology. Cambridge University Press.

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	-	2	3	-	-	3	3	2	2	2	2	2	3	-	2	3
CO2	3	3	2	2	-	-	2	3	2	3	2	2	3	-	2	2	3
CO3	3	2	3	3	-	-	-	3	2	3	3	2	2	3	3	3	3
CO4	3	2	2	2	-	3	-	3	2	3	3	2	3	3	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS403	**Animal Biotechnology**		**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This paper will impart comprehensive knowledge about the basic principles and techniques of animal tissue culture. Students will learn cell viability, cytotoxicity, cell cloning, scale-up process, and cell transformation; able to understand culture and maintenance of stem cell, induced pluripotent stem cells, basic ethics of animal cell culture, transgenic animals, vaccine development and tissue engineering.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Aimed to provide an in-depth understanding of animal cell culture and its techniques.	U	1,2,3,5,7,8,9,10,11	1,3,6
2	Will learn checking and screening cell viability, cytotoxicity and cell death parameters; understand scale-up process, including basic methods of cell cloning and transformation.	An	1,2,3,4,5,6,9,10,11	1,3,5,6
3	Understand basic biology of stem cells, their properties and applications; learn cell culture-based vaccines and somatic cell genetics; gain knowledge about animal biotechnology related research guidelines including IAEC.	AP	1,2,3,4,5,7,9,10,11	1,2,3,4,5,6
4	Imbibe concepts of transgenic animals; tissue engineering and its applications; acquire information of cell-based vaccines and their toxicity mechanisms.	An	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Animal cell: Structure and organization 2. Equipment's and materials for animal cell culture 3. Animal Cell culture: Primary and established cell line cultures. 4. Constituents of culture media and their application 5. Basic techniques of mammalian cell culture in vitro; disaggregating of tissue and primary culture; maintenance of cell culture; cell separation	15	1
II	1. Biology and characterization of the cultured cells, measuring parameters of growth 2. Scaling - up of animal cell culture. 3. Cell synchronization: Cell growth stages 4. Cell cloning: Basic techniques for cell cloning 5. Cell transformation: Characteristics of transformed cells	15	2
III	1. Stem cell cultures, embryonic stem cells and their applications. 2. Cell culture based vaccines: General introduction, Vaccines for Malaria and AIDS 3. Ethical issues in animal biotechnology: animal usage, CPCSEA and IAEC guidelines, Management aspects of biotechnology and genetic engineering 4. Somatic cell genetics	15	3
IV	1. Transgenic animals: Mice, Sheep, Birds and Fish 2. Apoptosis. 3. Tissue engineering: Elementary idea of tissue engineering, Artificial skin, artificial cartilage 4. Application of animal cell culture in viral based vaccine development and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture and pharmaceutical proteins.	15	4

Books Recommended:

1. Ramadass P. (2017) Animal Biotechnology: Recent Concepts and Developments. MJP Publishers.
2. Sarah Lombard Callisto (2018) Animal Biotechnology. Reference Publication.
3. Amanda Capes-Davis (2020) Freshney's Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications. 8th Edition. Wiley -Blackwell.
4. Anthony Atala, Joseph P. Vacanti, Robert Langer and Robert Lanza (2020) Principles of Tissue Engineering. Elsevier Science.
5. Ashish S. Verma &Anchal Singh (2020) Animal Biotechnology: Models in Discovery and Translation. 2nd Edition. Academic Press.
6. Lucio Costa & Michael Aschner (2020) Cell Culture Techniques. Springer New York. Marques Starks (2020) Immunology and Animal Biotechnology. ED-Tech Press.
7. Wei-Shou Hu (2020) Cell Culture Bioprocess Engineering. 2nd Edition. CRC Press.

8. Freshney R.I. (2021) Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications. 8th Edition. Wiley Blackwell.
9. Shalini Mani, Manisha Singh &Anil Kumar (2023) Animal Cell Culture, Springer Nature.

CO-PSO Mapping for the course:

PO / CO	POs											PSO					
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	2	-	3	-	1	2	2	2	2	2	-	2	-	-	3
CO2	3	3	2	2	1	3	-	-	3	3	2	1	-	2	-	2	3
CO3	3	2	1	2	3	-	2	-	3	3	2	2	1	2	2	2	3
CO4	3	2	2	2	1	3	1	3	2	2	-	2	1	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS404	**Genomics & Proteomics**		**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**3**	**1**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This will empower students to gain insights of fundamental structural and functional aspects of genomes and proteomes with a particular emphasis on their integrated applications in the field of agriculture and medicine, including drug discovery, vaccine development, cancer therapy, *etc.*

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will have a strong foundation of concepts of genomics; and its applications in biological research, agriculture, and medicine.	B	1,2,3,4,5,6,7,8,9,10,11	2,3,4,5,6
2	Gain comprehensive knowledge of genomics in the field of medicine, agriculture, and evolutionary biology; and its possible contribution in shaping future of scientific research and healthcare.	B	1,2,3,4,5,6,7,8,9,10,11	2,3,4,5,6
3	Will gain detailed idea of proteomics including methodologies used in proteomic analysis; and different facets and types of proteomics.	B	1,2,3,4,5,6,7,8,9,10,11	2,3,4,5,6
4	Come to know tools and techniques followed for protein structure analysis and interaction studies; databases; global analyses for various applications in science and medicine.	B	1,2,3,4,5,6,7,8,9,10,11	2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember;**U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	1. Genomics – General introduction, Types of genomics, Structural genomics, Functional genomics, Comparative genomics, Genome sequencing, Genome mapping, Future of genomics 2. Plant Genomics 3. Genomics in medicine: Gene medicine, Disease models, The impact of genomics on medicine	15	1
II	1. Human genome project, Methods of gene sequencing: - Random shotgun sequencing, EST. Whole genome shotgun sequencing, Genome prediction and gene counting, Single nucleotide polymorphisms (SNPs) 2. Comparative Genomics: Sequence comparison, Comparative genomics in bacteria, Comparative genomics in Eukaryotes & organelles	15	2
III	1. Proteomics – General concept, Gene and Protein, Types of proteomics, Structural proteomics and Functional proteomics 2. Methods of study the protein, Protein arrays, protein chips, System biology, Practical application of proteomics	15	3
IV	1. Future of proteomics, Analysis of protein structure, 2. Protein-Protein interactions, Protein database, Global analysis of protein, Expression analysis and characterization of protein	15	4

Books Recommended:

1. Sandor Suhai (2007) Genomics and Proteomics (Functional and Computational Aspects). Springer-Nature.
2. Gupta P.K. (2010) Biotechnology and Genomics. Rastogi publication
3. Saraswathy N. & Ramalingam P. (2011) Concept and Techniques in Proteomics. Elsevier.
4. Primose S. B. & Twyman R.M. (2013) Principles of Gene Manipulation and Genomics. 7th Edition. Blackwell Publishing.
5. Gyorgy Marko-Varga (2014) Genomics for Clinical Discovery and Development (Translational Bioinformatics). Springer-Nature.
6. Thangadure D. (2015) Genomics and Proteomics Principles and Technologies and Applications. Springer link
7. Charles Malkoff (2017) Bioinformatics, Proteomics and Genomics. Callisto Reference.
8. Miguel Rudolph (2019) Genomics and Proteomics: Computational and Functional Aspects.Syrawood Publishing House
9. Brown T. A. (2020) Gene Cloning and DNA Analysis. 8th Edition. Wiley-Blackwell.
10. Rakeeb Ahmed Mir, Sheikh Mansoor Shafi& Sajad MajeerZargar (2023) Principles of Genomics and Proteomics. Elsevier Sciences

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	1	2	3	2	1	1	1	1	1	1	2	-	1	1	2	2	2
CO2	2	2	3	2	1	1	2	3	1	2	2	-	1	1	2	2	2
CO3	2	2	3	2	1	1	1	2	1	2	2	-	1	1	2	2	2
CO4	2	2	3	2	1	1	2	2	1	2	2	-	1	1	2	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS405	**Lab Course 7 (Based on Papers LSBTMS401&402)**		**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	-	-	**8**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This course aims to provide practical proficiency for the execution of experimental protocols and handling of glassware and different instruments utilized in nano-biotechnology, and tools and techniques of biotechnology.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	Students will learn synthesizing nanoparticles and their characterization procedures; antimicrobial activity; and plagiarism and its detection techniques.	B	1,2,4,7,8,9,10,11	1,2,3,4,5,6
2	Students will know safety guidelines of laboratories and experiments; gain knowledge of bioethics.	B	1,2,3,4,7,8,9,10,11	1,2,3,4,5,6
3	Students will be acquainted with working of different instruments regularly used for separation and purification of various macromolecules.	B	1,2,3,4,7,10,11	1,2,3,4,5,6
4	Students will be able to handle different analytical instruments for detection and quantification of various macromolecules.	B	1,2,3,4,7,10,11	1,2,3,4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

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Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Synthesize different types of Nanoparticles. 2. Biophysical characterization of synthesized nanoparticle through UV-Vis Spectrophotometer. 3. Determine antimicrobial activity of nanoparticle. 4. Detection of plagiarism following different online plagiarism-tools.	5	1
II	1. Write-down guidelines for GMO. 2. Find and list-out bio-safety rules for food & beverage. 3. Write down IPRs of a researcher. 4. Find and list-out different bio-safety rules to be followed in the laboratories. 5. Find and list-out different bio-safety rules to be considered during management of biohazard materials.	5	2
III	1. Separate molecules following centrifugation. 2. Separate amino acids using paper chromatography. 3. Separate plant pigments through thin layer chromatography.	5	3
IV	1. Determine concentration of different macromolecules using spectrophotometer. 2. Separate different macromolecules through electrophoresis. 3. Perform ELISA, PCR, Southern blotting, etc.	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	2	-	2	-	-	3	2	3	2	2	3	2	2	3	2	2
CO2	3	2	3	2	-	-	2	2	3	3	2	2	3	3	2	2	2
CO3	2	2	3	3	-	-	3	-	-	3	3	2	2	2	3	2	3
CO4	3	3	2	3	-	-	2	-	-	2	2	2	3	3	2	3	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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14/5/24 Keshav Jagpal 14/5/24

Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS406	**Lab Course 8 (Based on Papers LSBTMS403&404)**		**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	**-**	**-**	**8**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

This course will provide an understanding of biomedical research and enable students to excel in IVF, vaccine production, and animal cell line maintenance. Additionally, it will help the students to anticipate possible applications of genomics and proteomics in 'genoeconomics' that will provide insights into individual differences across the taxonomical levels.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PO No.	PSO No.
1	Students will understand importance of disaggregation in cell isolation, tissue analysis and DNA extraction.	B	1,3,5,7,10,11	4,5
2	Enzymatic disaggregation of tissue; primary culture of animal cells, subculturing; and viability assessment will be learned.	B	1,3,5,7,10,11	4,5
3	Acquire a deeper understanding of genomics; tools and techniques of sequence analysis; databases; and functional elements of genomes.	B	1,2,3,4,5,7,10,11	2,4,5
4	Facilitate in-depth knowledge of several experimental aspects of genomics, proteomics, and molecular biology; sequence similarity analysis; and sequence search tools.	B	1,2,3,4,5,7,10,11	2,4,5

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

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Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	1. Extraction, estimation and separation of DNA from blood 2. Extraction, estimation and separation of DNA from spleen 3. Extraction, estimation and separation of DNA from muscle tissue 4. To perform mechanical disaggregation of soft tissues of chick, for recovery of cells.	5	1
II	1. To perform enzymatic disaggregation of tissue, for recovery of cells. 2. To perform primary animal cell culture and subculture. 3. Determine viability of cultured cells.	5	2
III	1. Find out and study the sequence similarity by BLAST & FASTA. 2. To study the genome map from NCBI resource. 3. To study the basic functionality of genome by genome browser. 4. Study the whole genome of Hepatitis B virus and Human Mitochondrial Genome using genome databases of Gene Bank. 5. Study the single nucleotide polymorphism (SNP) of human genome using SNP databases of NCBI (Example: MTHFR gene)	5	3
IV	1. Study the Sequence comparison in bacterial genome using Gene Bank (16S Ribosomal DNA sequence of *Rickettsia* sp.) 2. To study the Multiple Alignment Sequence by using CLUSTAL OMEGA tools. 3. To determine the sequence of database of RNA families by using Rfam. 4. To retrieve the protein sequence by Swiss Prot database 5. Study the Protein protein and Protein nucleotide interaction using Gene Bank databases (Example : Human 40S ribosome)	5	4

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	1	-	2	-	1	-	1	-	-	2	2	-	-	-	2	3	-
CO2	2	-	2	-	1	-	1	-	-	2	2	-	-	-	2	3	-
CO3	1	2	2	2	1	-	2	-	-	2	2	-	3	-	2	3	-
CO4	1	2	2	2	1	-	2	-	-	2	2	-	3	-	2	3	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Semester-IV

Program	Subject	Year	Semester
M. Sc.	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS407			**DCEC-2**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	**-**	**-**	**60 h in total**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO): Students will be able to apply theoretical knowledge to practical settings through hands-on experience gained during the internship period. Will develop professional skills and competencies relevant to the field through real-world application and reflection during the internship.

CO No.	Expected Course Outcomes	Cognitive Levels	PO No.	PSO No.
1	Able to utilize academic principles in real-world scenarios by actively engaging in hands-on learning throughout the internship. Will be capable of crafting a thorough internship report detailing insights and growth achieved during the internship journey. Will gain professional aptitudes and expertise pertinent to the field through practical implementation and thoughtful contemplation throughout the internship.	An	1,2,3,4,7,9,10,11	5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	Students will be able to carry out their Internship (LSBTMS407#) either in this School itself or in any the other Schools of the University Campus or in industries, depending upon their choice. However, those who will be interested to carry out their internship in the School itself, have to pay an Internship Fee of Rs 2000.00 only. Total duration of the Internship will be of 60 hours. After completion of the Internship, a detailed report, dully signed by the Supervisor and forwarded by the Head of the Institution has to be submitted by each of the student in the Office of the School.	60 h in total	1

CO-PSO Mapping for the course:

PO / CO	POs											PSO					
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	3	3	3	-	-	3	-	3	3	3	-	-	-	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**II**	**IV**
Course Code	Course Title		Course Type
LSBTMS408	**Project Work*/Internship#**		**DCEC - 3**
Credit	Hours Per Week (L-T-P)		
	L	T	P
24	**-**	**-**	**26**
Maximum Marks	CIA		EA
600	**425**		**175**

*1. Any student of the IV Semester will have an option to opt for Project Work and a theory paper (taught through online mode only) (DCEC-2) in lieu of the four theory papers and two lab courses (DCEC-3).

2. The project work has to be carried out in any of the recognized national laboratories, UGC-recognized Government universities, teaching departments of the PRSU, Government colleges recognized as research centres by the RDC, Biotechnology of PRSU, reputed private institutions namely TIFR, Mumbai, Reliance Life Sciences Pvt. Ltd., Nashik, Thapar Institute, Patiyala, Reddys Laboratory, Hyderabad, Novazyme, Pune, Lupin India, Mumbai, Sisco Research Laboratory, Mumbai, HiMedia Laboratories Pvt. Ltd., Mumbai, Shanta Biotech, Hyderabad, Verda Biotech, Mumbai, Pariyar Chemicals Ltd., Mumbai, Nicholas Piramal Laboratory, Mumbai, Aragen Life Sciences, Hyderabad, Biocon Research Ltd., Bengaluru, Sun Pharma, Mumbai, Panacia Biotech, Mumbai, Cadilla, Mumbai, ITC, Bengaluru, Chambal Biofertilizer & Chemicals, Kota, and any other Publicly Traded Companies. However, any student of School of Studies in Biotechnology willing to carry out his/ her project in the School itself has to pay Rs 30,000.00 only (Rupees Thirty Thousand Only) in addition to the course fee (normal fee or payment seat fee, mentioned in the admission brochure) as Project Fee, without which he/ she will not be permitted to do so in any of the circumstances. No relaxation from payment of the Project Fee will be granted, in any of the circumstances, to any students belonging to any of the categories, domicile, locality, economic status (BPL, APL, *etc.*), gender, *etc.*

3. The valuation of all the projects will be carried out by the external examiner and Head of the School of Studies in Biotechnology or its nominee at the School of Studies in Biotechnology. However; answer books of the online paper Methodology, Philosophy and Ethics of Research will be evaluated at the departmental level and its marks will be sent to the University Administration.

Learning Objective (LO):

It will impart skills to plan and conduct investigational work independently, provide practical knowledge, thoughtful and reasonable thinking attitude, scientific and logical way of interpretation, and report writing skill. Make the students capable of writing and carrying out research projects with their own.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PONo.	PSO No.
1	A dissertation in the field of Biotechnology will represent a significant milestone in the academic and professional development of the candidate. It will not only showcase the depth of their knowledge and research skills but will also contribute in their collective understanding of this dynamic and rapidly evolving field.	C	1,2,3,4,5,6,7,8,9,10,11	4,5,6
2	The structured format of the report will ensure that the research has been effectively communicated to a wide audience, including peers, educators, and potential collaborators.	C	1,2,3,4,5,6,7,8,9,10,11	4,5,6
3	The seminar of the dissertation will display the incredible efforts of student and will serve as a catalyst for advancing knowledge and collaboration in the field of biotechnology.	C	1,2,3,4,5,6,7,8,9,10,11	4,5,6
4	The *viva-voce* examination will give an opportunity to the student to defend themselves, discuss their findings, and demonstrate knowledge.	C	1,2,3,4,5,6,7,8,9,10,11	4,5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create; **R**-Remember; **U**-Understanding

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Detailed Syllabus:

Unit No.	Topics	No. of Practical classes (1= 3h)	CO No.
I	**Dissertation:** The project work should be related to the field of Biotechnology. The project report should include a declaration by the candidate, a certificate by the supervisor, an acknowledgement and a title along with the following points: 1. Introduction 2. Review of Literature 3. Materials and Methods 4. Results & Discussion 5. Conclusions 6. References	900	1
II	**Seminar** based on project	-	2
III	*Viva-voce* of the project	-	3

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	3	3	3	3	3	3	3	3	3	3	3	-	-	-	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	-	-	-	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	-	-	-	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	-	-	-	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Semester-IV

Program	Subject	Year	Semester
MSc	**Biotechnology**	**2**	**IV**
Course Code	Course Title		Course Type
LSBTMS409	**Methodology, Philosophy and Ethics of Research**		**DCEC - 3**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	**2**	**-**	**-**
Maximum Marks	CIA		EA
100	**25**		**75**

Learning Objective (LO):

It will make them aware regrading different aspects of research such as planning and execution of research, formulation of research objectives, research design, interpretation and presentation of data, scientific writing, research ethics, scientific misconduct, citation, plagiarism, and report writing.

Course Outcomes (COs):

CO No.	Expected Course Outcomes	Cognitive Levels	PO No.	PSO No.
1	Will make them efficient in planning and execution of research activity, and formulate objectives of the work with their own.	Ap	1,2,3,6,7,8,10,11	5,6
2	Will be able to decide research design and, collect, represent and interpret obtained data.	Ap	1,2,3,6,7,8,10,11	5,6
3	Will imbibe idea about research ethics and scientific misconduct.	Ap	1,2,3,6,7,8,9,10,11	5,6
4	Will come to know about citations, plagiarism, research integrity, H-index, I_{10}-index, *etc.*	E	1,2,3,6,7,8, 9,10,11	5,6

Cognitive Level: **An**-Analyze; **Ap**-Apply; **B**-Evaluate; **C**-Create;**R**-Remember;**U**-Understanding

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Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Philosophy of research: Definition, nature, scope, and concepts. Research ethics: Definition and moral values in scientific research; scientific honesty and research integrity; scientific misconducts; plagiarism; citations; H-index; and I_{10}-index.	25	1,4
II	Essential steps in research: Identification of research problem; importance of literature collection; formulation of research questions/ objectives; process of research; research design; experimental error and their control mechanisms; collection, representation and interpretation of data; report writing.	25	2,3

CO-PSO Mapping for the course:

PO	POs											PSO					
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
CO1	2	2	2	-	-	2	2	2	-	2	2	-	-	-	-	3	3
CO2	2	2	2	-	-	2	2	2	-	2	2	-	-	-	-	3	3
CO3	2	2	2	-	-	2	2	2	2	2	2	-	-	-	-	3	3
CO4	3	3	3	-	-	3	3	3	3	3	3	-	-	-	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Programme Articulation Matrix:

Program articulation matrix depicts the correlation between all the courses of the programme and Programme Outcomes

Course Code	POs											PSO					
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
LSBTMS101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	-	√	√
LSBTMS102	√	√	√	√	√	√	√	√	-	√	√	√	√	-	-	√	√
LSBTMS103	√	√	√	-	-	√	√	-	-	√	√	√	-	-	-	√	√
LSBTMS104	√	√	√	-	√	-	√	-	-	√	√	√	-	-	-	√	√
LSBTMS105	√	√	√	-	-	-	√	-	-	√	√	√	-	-	-	√	√
LSBTMS106	√	√	√	-	-	-	√	-	-	√	√	√	-	-	-	√	√
LSBTMS201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
LSBTMS202	√	-	-	√	-	-	√	-	-	√	√	-	√	-	-	√	√
LSBTMS203	√	√	√	√	-	-	-	-	√	√	√	√	√	√	√	√	√
LSBTMS204a	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
LSBTMS204b	√	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√
LSBTMS205	√	√	√	-	-	-	√	-	-	√	√	-	√	-	-	√	√
LSBTMS206a	√	√	√	√	√	√	√	√	√	√	√	√	√	-	√	√	√
LSBTMS206b	√	√	√	√	-	-	√	√	√	√	√	√	-	√	√	√	√
LSBTMS301	√	-	√	-	-	-	√	-	√	√	√	-	-	√	√	-	√
LSBTMS302	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
LSBTMS303	√	√	√	√	√	√	√	√	√	√	-	√	√	-	√	√	√
LSBTMS304	√	√	√	√	√	√	√	√	√	√	√	√	-	√	√	√	√
LSBTMS305	√	√	√	-	-	√	√	-	-	√	√	-	-	√	-	√	√
LSBTMS306	√	√	√	√	-	√	√	√	-	√	√	√	-	√	√	√	√
LSBTMS401	√	√	-	-	-	√	√	√	√	√	-	-	-	-	√	√	√
LSBTMS402	√	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√
LSBTMS403	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
LSBTMS404	√	√	√	√	√	√	√	√	√	√	√	-	√	√	√	√	√
LSBTMS405	√	√	√	√	-	-	√	√	√	√	√	√	√	√	√	√	√
LSBTMS406	√	√	√	√	√	-	√	-	-	√	√	-	√	-	√	√	-
LSBTMS407	√	√	√	√	-	-	√	-	√	√	√	-	-	-	-	√	√
LSBTMS408	√	√	√	√	√	√	√	√	√	√	√	-	-	-	√	√	√
LSBTMS409	√	√	√	-	-	√	√	√	√	√	√	-	-	-	-	√	√

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Skill Enhancement/Value Added Course: (Offered to the PG students of School of Studies in Biotechnology only)

Program	Subject	Year	Semester
M. Sc.	**Biotechnology**	**1**	**I**
Course Code	Course Title		Course Type
LSBTVAC101	**Concepts of Traditional Knowledge**		**Value-added**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	**2**	-	-
Maximum Marks	CIA		EA
100	**25**		75

Learning Objective (LO):

This course aims to expand student's comprehension about Indian culture and knowledge system. It encourages thoughtful reflection on Indian philosophies and cultural paradigms. Through exploring diverse intellectual traditions, the objective is to impart significant insights from India's rich heritage across generations.

Detailed Syllabus:

Unit No.	Topics
I	**Foundations of Traditional Knowledge** • Defining & Understanding Indian Traditional Knowledge (ITK) • Characteristics, Scope, and Importance of ITK Systems • Historical Impact of Social Change on ITK • Necessity of Safeguarding Traditional Knowledge • Economic Value of ITK in the Global Marketplace • Role of Government in Promoting and Utilizing ITK
II	**Intellectual Property Rights and Applications of ITK** • Exploring Intellectual Property Rights (IPR) for ITK Protection • Patents and Traditional Knowledge: Compatibility and Challenges • Strategies for Enhancing ITK Protection • Traditional Medicine Systems and their Relevance • The Role of ITK in Sustainable Agriculture and Food Security • Importance of ITK in Environmental Conservation and Biodiversity Management

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Books Recommended:

- Amit Jha. (2024). Traditional Knowledge System in India. Atlantic Publishers Pvt. Ltd., New Delhi
- B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavan R.N. (2022). Introduction to Indian Knowledge System: Concept and applications. Phi learning Pvt. Ltd., New Delhi
- Evana Wright. (2020). Protecting Traditional Knowledge. Edward Elgar Publication, UK.
- Gnanapragasam Lazar, Kamal Misra. (2019). Exploring Indigenous Knowledge System in India. Mittal Publications, India.
- Nirmal Sengupta. (2018). Traditional Knowledge in Modern India. Springer India Pvt. Ltd.
- Basant Kumar Mohantra. (2012). Traditional Knowledge System and Technology in India. Pratibha Prakashan, India