R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

Syllabus for
M. Sc. Biotechnology Programme
Semester I and II

Under Choice Based Credit System (CBCS)
To be implemented from the Academic Year
2023 - 2024

Name of Programme	**M. Sc. Biotechnology**
Level	PG
No. of Semesters	04
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	At the end of the Programme, Learner will be able 1. To identify, formulate, review research literature, analyze and design experiments and identify the solutions for complex problems using modern tools. 2. To apply the knowledge of basic biotechnology to solve complex problems in society. 3. To design experiments to investigate the problems in varied fields of Biotechnology and allied areas. 4. To understand and interpret data and derive unique solutions to existing and emerging issue. 5. To apply reasoning informed by contextual knowledge to assess societal, health, safety and the consequent responsibilities relevant to the professional biotechnology practices. 6. To recognize the need and have the ability to engage in independent and lifelong learning in technological change. 7. To function effectively as an individual and as a member or leader in diverse teams and in inter- and multi-disciplinary areas. 8. To empower with a knowledge base in processes and applications that would impact and influence existing prototypes of green, blue, red and white Biotechnology. 9. To be skilled and equipped with contemporary knowledge in Biotechnology and would be eligible for jobs in varied industrial sectors.
Relevance of PSOs to the local, regional, national, and global developmental needs	Biotechnology is important at Global, National, Regional and local level. The significance of Biotechnology identified at all these levels and it is relevant to everyday life. The curriculum design of M. Sc. Biotechnology programme helps in understanding various concepts in detail. This programme includes new emerging technologies and their applications. This also involves the actual working and mechanism required in industries. The application part is taken care of so that the learner shall be able to connect the phenomena around him with the curriculum. This programme also imparts the research values among the learners. The hard and softs skills acquired during the completion of this programme shall make him employable.

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40 % marks in the first part and by conducting the Semester End Examinations of 60 % marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (For 4 Credits - 40 Marks; For 2 Credits – 20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30/ 15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10/ 05
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 30/ 15 Duration: 60 Minutes/ 30 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (For 4 Credits - 60 Marks; For 2 Credits – 30 Marks)

Duration: The examination shall be of 2 hours'/ 1 hour duration. Question Paper Pattern 1. All questions shall be compulsory with internal options. 2. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

C) Practical Examination: 50 Marks

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i. e. 16 out of 40 or 8 out of 20) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60 or 12 out of 30) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Master of Science (M.Sc.) in Biotechnology Programme
Under Choice Based Credit System (CBCS)
Course Structure

M.Sc. I Biotechnology

(To be implemented from Academic Year 2023-24)

Course Code	Semester I	Credits	Course Code	Semester II	Credits
	Major Mandatory			Major Mandatory	
PSBT101	Biochemistry	4	PSBT201	Bioinformatics and Biostatistics	4
PSBT102	Bioprocess Engineering and Technology	4	PSBT202	Plant and Animal Biotechnology	4
PSBT103	Basics in IPR and Patents	2	PSBT203	Patenting in Biotechnology and Bioethics	2
PSBT104	Biochemistry Practical PSBT101	2	PSBT204	Bioinformatics and Biostatistics Practical PSBT201	2
PSBT105	Bioprocess Engineering and Technology Practical PSBT102	2	PSBT205	Plant and Animal Biotechnology Practical PSBT202	2
	Major Electives (Any One)			Major Electives (Any One)	
PSBT106	Immunology	2	PSBT206	Bio Entrepreneurship	3
PSBT107	Immunology Practical PSBT106	2	PSBT207	Bio Entrepreneurship Practical PSBT206	1
OR			OR		
PSBT108	Molecular Diagnostics	2	PSBT208	Bioanalytical and Biophysical Techniques	4
PSBT109	Molecular Diagnostics Practical PSBT108	2			
PSBT110	Research Methodology	4	PSBT209	On Job Training/ Field Project	4
Total Credits		22	Total Credits		22

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

Course Code	Semester I	Credits
	Major: Mandatory	
PSBT101	Biochemistry	4
PSBT102	Bioprocess Engineering and Technology	4
PSBT103	Basics in IPR and Patents	2
PSBT104	Biochemistry Practicals	2
PSBT105	Bioprocess Engineering and Technology Practicals	2
	Major: Elective (Any One from below)	
PSBT106	Immunology	2
PSBT107	Immunology Practical PSBT106	2
OR		
PSBT108	Molecular Diagnostics	2
PSBT109	Molecular Diagnostics Practical PSBT108	2
PSBT110	Research Methodology	4
Total Credits		22

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Biochemistry
Course Code	PSBT101
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	4
Nature	Theory
Type	Major: Mandatory

Biochemistry

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Glycobiology and Membrane Biochemistry	15
2	Protein Transport and Membrane Trafficking	15
3	Biochemistry of nucleic acids	15
4	Bioenergetics and regulation of metabolism	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of glycobiology and membrane biochemistry.
CO2 – To provide the insight of protein transport and membrane trafficking.
CO3 – To gain the knowledge of nucleic acids biochemistry.
CO4 – To have a firm foundation in bioenergetics and regulation of metabolism.

Curriculum:

Sr. No.	Units
1	Glycobiology and Membrane Biochemistry (15 Lectures)
	Glycosylation of Biomolecules - Synthesis N-linked, O-linked, and GPI linked glycoproteins and role of glycosylation. Lipid aggregates: micelles, bilayers, and liposomes- structure, types, preparation, characterization, and therapeutic applications of liposomes. Composition and Architecture of membrane: structural lipids in membranes, membrane bound proteins - structure, properties, and function. Membrane Dynamics: lipid movements, flippase, FRAP, Lipid raft, Membrane fusion. Solubilization of the membrane by using different detergents.
2	Protein Transport and Membrane Trafficking (15 Lectures)
	Translocation of Secretory Proteins across the ER Membrane, Insertion, Protein Modifications, Folding, and Quality Control in the ER, Protein sorting and export from Golgi Apparatus. Sorting of Proteins to Mitochondria and Chloroplasts. Molecular Mechanisms of Vesicular Traffic, early and later Stages of the Secretory Pathway, Receptor-Mediated

	Endocytosis. Protein degradation: Ubiquitin- proteasome pathway and lysosomal proteolysis.
3	Biochemistry of nucleic acids (15 Lectures)
	Forces stabilizing nucleic acid structures, triple helix. Super helix topology- linking number, Twist and writhing number, measurement of supercoiling and Topoisomerases. Nucleic acid binding protein – Leucine Zipper, Zinc fingers, OB fold, Beta Barrel, Helix-turn-helix, Helix-loop-helix. Biosynthesis of nucleic acids and inborn errors of nucleic acid Metabolism **Methodologies for detection:** Protein –Protein and DNA –Protein interactions: Gel retardation assay, DNA footprinting, Yeast 2 Hybrid Method advantages and limitations, yeast split-hybrid and reverse two-hybrid systems, Co-Immunoprecipitation (Co-IP) and Far-Western Blot Analysis.
4	Bioenergetics and regulation of metabolism (15 Lectures)
	Biosynthesis of Amino acids; phenylalanine, tyrosine, threonine, and methionine. Bioenergetics- coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism. Integration of central metabolism; entry/ exit of various biomolecules from central pathways, principles of metabolic regulation. Strategies of energy Metabolism: organ specialization- Brain, Muscle, Adipose Tissue, Liver, Kidney. Metabolic Homeostasis: Regulation of Appetite, Energy Expenditure and Body Weight.

Learning Resources recommended:

1. Stryer, L. (2015). *Biochemistry*. (8th edition) New York: Freeman.
2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th edition). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th edition). Hoboken, NJ: J. Wiley & Sons.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
5. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
6. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014).
7. *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
8. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
9. Laouini et.al. Preparation, Characterization and Applications of Liposomes: State of the Art. journal of Colloid Science and Biotechnology Vol. 1, 147–168, 2012
10. Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 30 Duration: 60 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours' duration. Question Paper Pattern 1. There shall be four questions each of 15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Bioprocess engineering and technology
Course Code	PSBT102
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	4
Nature	Theory
Type	Major: Mandatory

Bioprocess Engineering and Technology

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Basic principles of biochemical engineering	15
2	Production of proteins from recombinant microorganisms	15
3	Applications of enzyme technology in food processing	15
4	Applications of microbial technology	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of basic principles of biochemical engineering.
CO2 – To provide the insight of production of proteins from recombinant.
CO3 – To gain the knowledge of applications of enzyme technology in food processing.
CO4 – To have a firm foundation in applications of microbial technology.

Curriculum:

Sr. No.	Units
1	Basic principles of biochemical engineering (15 Lectures)
	Sources of Microorganisms Used in Biotechnology- Literature search and culture collection supply, Isolation de novo of organisms producing metabolites of economic importance. Strain Improvement- Selection from naturally occurring variants, Manipulation of the genome of industrial organisms in strain improvement Bioreactor design and analysis. Media formulation and optimization methods; sterilization of bioreactors aeration and agitation in bioreactors KLa value (factors affecting and methods of determination).
2	Production of proteins from recombinant microorganisms (15 Lectures)
	Principles of Microbial Growth: Batch Fermentation, Fed-Batch Fermentation, Continuous Fermentation Maximizing the Efficiency of the Fermentation Process High-Density Cell Cultures, Increasing Plasmid Stability, Quiescent *E. coli* Cells, Protein Secretion and Reducing Acetate Bioreactors: Typical Large-Scale Fermentation Systems

	Two-Stage Fermentation in Tandem Airlift Reactors, Two-Stage Fermentation in a Single Stirred-Tank Reactor, Batch versus Fed-Batch Fermentation, Harvesting Microbial Cells, Disrupting Microbial Cells, Downstream Processing, Protein Solubilization, Large-Scale Production of plasmid DNA
3	Applications of enzyme technology in food processing (15 Lectures)
	Introduction and scope 1. Enzymes sourced from animals and plants used in food manufacturing technology 2. Enzyme usage in food applications. Mechanism of enzyme function and reactions in food processes 1. Starch-processing and related carbohydrates. 2. Lipases for production of food components: interesterified fat 3. Enzymes in protein modification: hydrolyzed protein 4. Enzymes in bread making - flavor, texture and keeping quality 5. Enzymes in dairy product manufacture 6. Enzymes in fruit and vegetable processing and juice extraction 7. Enzymes in fish and meat processing 8. Beer Production using Immobilized Cell Technology
4	Applications of microbial technology (15 Lectures)
	1. Microbial biomass production: mushrooms, SCP 2. Fermented foods from: meat and fish, bread, Vegetables (sauerkraut, cucumber), Legumes and Oil, Seeds soya bean fermentations 3. Beverages: a) Stimulant Beverages -coffee, cocoa and tea fermentations b) Alcoholic beverages - Cider production 4. Food additives and supplements: a) Lipids, Nucleosides, nucleotides and related compounds- Vitamins b) Natural food preservatives- bacteriocins from lactic acid bacteria – production and applications e. g. Nisin c) Microbial production of colours and flavours. d) Polyhydric alcohols: low-calorie sweetener particularly useful for sweetening food products for diabetics e) Microbial exopolysaccharides - Xanthan gum 5. Process Food wastes - for bioconversion to useful products (Compost, biofuels, biomass cheap source of raw material in fermentation etc.)

Learning Resources recommended:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
6. Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition
7. Michael Waites and Morgan, Rockney and Highton -Industrial microbiology: An Introduction

8. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
9. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, (2007)

Evaluation Pattern:

A) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 30 Duration: 60 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours' duration. Question Paper Pattern 1. There shall be four questions each of 15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Basics in IPR and Patents
Course Code	PSBT103
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Theory
Type	Major: Mandatory

Basics in IPR and Patents

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Introduction to IPR	15
2	Basics of Patents	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of the introduction of IPR.
CO2 – To provide the insight of basics of patents.

Curriculum:

Sr. No.	Units
1	Introduction to IPR (15 Lectures)
	World Intellectual Property Organization (WIPO) – Functions of WIPO – Membership – GATT Agreement – Paris Convention – TRIPS agreement. Types of IP: patents, trademarks, trade secrets, copyright & related rights, industrial design, geographical indications, Biodiversity importance and legislation, plant variety protection and farmers rights act, traditional knowledge.
2	Basics of Patents (15 Lectures)
	Eligibility criteria, concept of novelty, concept of inventive step; Patenting systems- Indian Patent Act and amendments, Process of Patenting, Types of patent applications, Patent Agent, Patent Search, Rights of the patent holder, Assignment and licensing of patents and patent Infringement, case studies.

Learning Resources Recommended:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Karen F. Greif, Jon F. Merz - Current Controversies in the Biological Sciences_ Case Studies of Policy Challenges from New Technologies (Basic Bioethics)-The MIT Press (2007)

3. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights
4. Issues in Biotechnology- Academic Press (2017)
5. David Castle - The Role of Intellectual Property Rights in Biotechnology Innovation (2011)
6. Goel, D., & Parashar, S. (2013). IPR, Biosafety and Bioethics. Pearson Education India.
7. Singh, S. S. (2004). The Law of Intellectual Property Rights. Deep and Deep Publications, New Delhi, 96.
8. Talwar Shabana; Intellectual Property Rights in WTO and Developing Countries, Edition 2010, Serials Publications, New Delhi.

Evaluation Pattern:

A) Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 15 Duration: 30 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (30 Marks)

Duration: The examination shall be of 1 hour duration. Question Paper Pattern 1. There shall be three questions. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Immunology
Course Code	PSBT106
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Theory
Type	Major: Elective

Immunology

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Vaccinology	15
2	Antigen – antibody interactions	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To gain the knowledge of vaccinology.
CO2 – To have a firm foundation in antigen – antibody interactions.

Curriculum:

Sr. No.	Units
1	Vaccinology (15 Lectures)
	Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.
2	Antigen – antibody interactions (15 Lectures)
	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Learning Resources recommended:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Immunology. New York: W.H. Freeman.
2. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
3. An introduction to Immunology C V Rao Narosa Publishing house
4. Immunology essential and fundamental, Second edition S Pathak & U P Parveen Publishing House
5. Text Book of Medical Biochemistry, Praful Godkar. Bahalani Publishers
6. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
7. Immunology, fifth Ed Goldsby, T J. Kindt, Osborne, Janis Kuby Freeman and company.
8. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd
9. Practical immunology, Frank Hay, 4th Edition, Blackwell Science Medical Microbiology, Anantharayan.

Evaluation Pattern:

A) Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 15 Duration: 30 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (30 Marks)

Duration: The examination shall be of 1 hour duration. Question Paper Pattern 1. There shall be three questions. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Molecular Diagnostics
Course Code	PSBT108
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Theory
Type	Major: Elective

Molecular Diagnostics

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Diagnostics Microbiology	15
2	Functional Genomics and Proteomics	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of diagnostic microbiology.
CO2 – To have a firm foundation in functional genomics and proteomics.

Curriculum:

Sr. No.	Units
1	Diagnostics Microbiology (15 Lectures)
	Techniques: Molecular amplification techniques ● Target amplification systems ● Probe amplification systems ● Signal amplification PCR in molecular diagnostics; viral and bacterial detection; Quantitation of organisms – internal controls, external standards, calibrators, absolute and relative quantification; Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing Detection and identity of microbial diseases Direct detection and identification of pathogenic organisms/ viruses e.g. TB and HIV Clinical utility of molecular diagnostics tests (NAAT) for Hepatitis and AIDS. Molecular identification of fungal pathogens; Pharmacogenetics.
2	Functional Genomics and Proteomics (15 Lectures)
	Genomics: Gene expression by SAGE and Functional Microarrays- Construction of microarrays – genomics and genomic arrays, cDNA arrays and oligo arrays and Proteomics its applications, NGS platforms, high and low read sequences Proteomics: Separation and Identification of Proteins 2D-PAGE, isoelectric focusing, Edmand reaction Protein tryptic digestion and peptide mass fingerprinting mass spectrometry, MALDI-TOF.

	Protein Expression Profiling: Protein Microarrays/ Protein chips: Types and applications, Gel-based quantitative proteomics: DIGE 15 (Difference in Gel Electrophoresis) Clinical and biomedical applications of proteomics, Introduction to metabolomics, lipidomics, metagenomics and systems biology.

Learning Resources recommended:

1. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure,Dynamics, Function. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). Physical Biology of the Cell. New York: Garland Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
4. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi: 10.1016/j. cell.2015.12.041.
5. Ledford, H. (2016). The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a.
6. Molecular Imaging Theranostics, 4(4), 386-398. doi:10.7150/thno.8006 Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
7. Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 5th ed. 2008
8. Molecular Microbiology Diagnostic Principles and practice third edition, David H. Persing and Fred C. Tenover Copyright _ 2016 by ASM Press
9. Methods in Molecular Biology, Vol. 204: Molecular Cytogenetics: Protocols and Applications, Edited by: Y. S. Fan © Humana Press Inc., Totowa, NJ 2001
10. Genome 3 TA Brown Molecular Biotechnology – Principles and applications of recombinant technology, Glick 4th edition 2010
11. Human Molecular Genetics. Tom Strachan and Andrew Read, 2004, 3rd Edition, Garland
12. Introduction to human molecular genetics. Jack Pasternak, 2005, 2nd Edition, Wiley publication.

Evaluation Pattern:

A) Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05

Question Paper Pattern for Periodical Class Test/ Online Examination
Maximum Marks: 15
Duration: 30 Minutes
Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)

B) Semester End Examination: 60 % (30 Marks)

Duration: The examination shall be of 1 hour duration.
Question Paper Pattern
1. There shall be three questions.
2. All questions shall be compulsory with internal options.
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Biochemistry Practical PSBT101
Course Code	PSBT104
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Practical
Type	Major: Mandatory

Biochemistry Practical PSBT101

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to Biochemistry.

Curriculum: (60 Lectures)

Regular Practicals
1. To prepare Acetate and Phosphate buffers using the Henderson-Hasselbalch equation. 2. Protein purification by ammonium sulphate fractionation, dialysis and separation using PAGE - CBB/silver staining, Glycoprotein staining. 3. To determine an unknown protein concentration using Biuret, Folin Lowry and Bradford method. 4. Isolation of genomic DNA from plant/animal source. 5. Isolation of cholesterol and lecithin from egg yolks. 6. Paper chromatography of Amino acids and detection using Ninhydrin.

Learning Resources Recommended:

1. Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication.
3. Biochemical Methods, Sadasivam and Manikam (3rd Ed, 2008) New age international publishers, 2008.
4. An Introduction to Practical Biochemistry (3rd Edition), David T Plummer, Tata McGraw Hill Publishing Company Limited, 1992.

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Bioprocess engineering and Technology Practical PSBT102
Course Code	PSBT105
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Practical
Type	Major: Mandatory

Bioprocess Engineering and Technology Practical
PSBT102

Course Outcomes:

At the end of the Course, the Learner will be able to
CO1 – To impart knowledge and hands on experience of the various practicals related to bioprocess engineering and technology.

Curriculum: (60 Lectures)

Regular Practicals
1. Microbial pigment/metabolite: a. Production – Factors affecting – pH, temperature, nutrients, static/ shaker conditions, submerged/surface. b. Extraction – soluble and insoluble pigments - organic solvent extraction and purification. 2. Immobilize an organism / enzyme and detect the conversion of substrate to product. 3. Methods for measurement of cell mass: a. Direct physical measurement of dry weight, wet weight, or volume of cells after centrifugation. b. Indirect measurement. c. Turbidity measurements employ instruments to determine the amount of light scattered by cell suspension.
Demonstration Practicals
1. Demonstration of media optimization by Placket Burman test. 2. Demonstration of Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates.
Visit
Quality Assurance in a Biotechnology/food/beverage industry – Field visit and report.
Report Writing
Method validation for any biochemical test (Accuracy, Limit of Detection, Limit of Quantitation, Specificity, Linearity and range, Ruggedness and Robustness) – Report writing.

Learning Resources Recommended:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.

4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
6. Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition
7. Michael Waites and Morgan, Rockney and Highton -Industrial microbiology: An Introduction
8. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
9. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield, (2007)

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Immunology Practical PSBT106
Course Code	PSBT107
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Practical
Type	Major: Elective

Immunology Practical PSBT106

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to Immunology.

Curriculum: (60 Lectures)

Regular Practicals
1. Preparation and sterility testing of heat killed vaccines. 2. To perform Dot blot technique. 3. Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF). 4. Separation of lymphocytes on Ficoll Histopaque and viability count. 5. Study of precipitation reactions - Ouchterlony and Mancini methods. 6. Widal test - Qualitative and Quantitative. 7. RPR (Rapid Plasma Reagin) - Kit based 8. Determination of ESR.
Demonstration Practical
Demonstration of Western blotting.

Learning Resources Recommended:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Immunology. New York: W.H. Freeman.
2. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
3. An introduction to Immunology C V Rao Narosa Publishing house
4. Immunology essential and fundamental, Second edition S Pathak & U P Parveen Publishing House
5. Text Book of Medical Biochemistry, Praful Godkar. Bahalani Publishers
6. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
7. Immunology, fifth Ed Goldsby, T J. Kindt, Osborne, Janis Kuby Freeman and company.
8. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd
9. Practical immunology, Frank Hay, 4th Edition, Blackwell Science
10. Medical Microbiology, Anantharayan.

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Molecular Diagnostics Practical PSBT108
Course Code	PSBT109
Class	M. Sc. I Biotechnology
Semester	I
No. of Credits	2
Nature	Practical
Type	Major: Elective

Molecular Diagnostics Practical PSBT108

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to molecular diagnostics.

Curriculum: (60 Lectures)

Regular Practicals
1. Sample collection, storage and processing in molecular diagnostic labs. 2. Photo album of chromosomal abnormalities in normal and disease condition numerical detected by using different probes – centromeric, locus specific, telomeric Structural - Translocations and fusion genes, Detection of inversions and interstitial deletions by SKY, CGH for a disease or cancer. 3. Separation of human serum / plasma proteins / egg white using Native PAGE.
Demonstration Practicals
1. Antimicrobial sensitivity test and demonstration of drug resistance. 2. Identification of microorganisms using biochemical testing (performing) and 16S rDNA sequencing (demonstration). 3. Demonstration/ video of 2D PAGE. 4. Demonstration of Affinity chromatography.
Visit
Visit to molecular diagnostic lab/ cytogenetic lab: Report.

Learning Resources Recommended:

1. Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication.
3. Biochemical Methods, Sadasivam and Manikam (3rd Ed, 2008) New age international publishers, 2008.
4. An Introduction to Practical Biochemistry (3rd Edition), David T Plummer, Tata McGraw Hill Publishing Company Limited, 1992

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Revised Syllabus of Courses of Master of Sciences (M.Sc.) in Biotechnology Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Research Methodology
Course Code	PSBT110
Class	M.Sc. I Biotechnology
Semester	I
No. of Credits	4
Nature	Theory
Type	Research Methodology
Relevance with Employability/ Entrepreneurship/ Skill development	Learner will gain the knowledge of Research Methodology in biotechnological application. Further, the learner will be benefited in the form of increase in his/her research aptitude, analytical and decision-making skills. Acquisition of the knowledge in the field of research will increase the chances of employability and will offer better prospects in the corporate sector.

Research Methodology

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Fundamentals of Research Methods	15
2	Research Design and Measurement Concepts and Literature Searching	15
3	Documentation, scientific writing and Academic Integrity	15
4	Hypothesis Testing and Communication Skills in Research	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to -

1. Demonstrate an understanding of the features and importance of research in business, different types of research, the formulation of research problems, research design and the significance of literature review.

2. Apply the knowledge of data collection methods, including primary and secondary data collection techniques, questionnaire designing and factors influencing the choice of data collection methods.

3. Analyze data processing techniques, including editing, coding, classification, tabulation, and graphic presentation, as well as perform statistical analysis.

4. Evaluate different testing methods for hypotheses, including non-parametric tests (ANOVA, factor analysis, path analysis), considering their applicability and significance in research.

5. Create well-structured research reports, following the essentials of research report writing, proper referencing and citation methods and adhering to ethical norms and practices in research.

Curriculum:

Sr. No.	Units
1	Fundamentals of Research Methods (15 Lectures)
	Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of results and discussion.
2	Research Design and Measurement Concepts and Literature Searching (15 Lectures)
	Selecting and defining a research problem, Need for research design, Features of a good research design, Different research designs, Scales of measurements, Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. Digital: Web sources, E-journals, Journal access, Citation Index, Impact factor, H-index, E-consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, Scopus.
3	Documentation, scientific writing and Academic Integrity (15 Lectures)
	Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style, publications of scientific work, Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues, Ethics in research, and case studies.
4	Hypothesis Testing and Communication Skills in Research (15 Lectures)
	Hypothesis: Meaning, nature, functions, importance, kinds of hypothesis; Characteristics of a good hypothesis. Hypothesis Testing: Null and alternate hypothesis, Type I and Type II errors, level of significance, power of test, p-value. Communication Skills: Important communication through English, The process of communication and factors that influence communication, sender, receiver, channel, code, topic, message, context, feedback, noise, filters and barriers; Verbal and non-verbal communication; comparison of general communication and business communication. Presentation Skills: Structure and types of presentation, oral powerpoint – Handling powerpoint slides, organization, content, body language, gesture and voice modulation.

Learning Resources recommended:

Main References:

1. Kothari C.R., "Research Methodology, Methods and Techniques" (Second revised edition, New Age International Publication, 2004).

2. Saravanavel P., "Research Methodology" (Kitab Mahal, Sixteenth edition, 2007).

3. Ranjit Kumar, "Research Methodology, a step-by-step guide for beginners" (Pearson education Australia, Second edition 2005).

4. Mark Saunders, Philip Lewis, Adrain Thornhiu, "Research Methods for Business Students" (Pearson Education ltd, Seventh edition, 2016)

Additional References:

1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press, 1976.
3. The Craft of Scientific Writing by Michael Alley, (Springer).
4. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005
5. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
6. How to write and publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
7. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
8. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.
9. Standard /Reputed Journal authors' instructions.
10. Web resources: www.sciencedirect.com for journal references,
11. www.aip.org and www.aps.org for reference styles.
12. Web resources: www.nature.com, www.sciencemag.org,
13. www.springer.com, www.pnas.org, www.tandf.co.uk,
14. www.opticsinfobase.org for research updates.

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

Question Paper Pattern for Periodical Class Test/ Online Examination
Maximum Marks: 30
Duration: 60 Minutes
Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours' duration.
Question Paper Pattern
1. There shall be four questions each of 15 marks.
2. All questions shall be compulsory with internal options.
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

No. of Courses	Semester II	Credits
	Major: Mandatory	
PSBT201	Bioinformatics and Biostatistics	4
PSBT202	Plant and Animal Biotechnology	4
PSBT203	Patenting in Biotechnology and Bioethics	2
PSBT204	Bioinformatics and Biostatistics Practical PSBT201	2
PSBT205	Plant and Animal Biotechnology Practical PSBT202	2
	Major Electives (Any One)	
PSBT206	Bio Entrepreneurship	3
PSBT207	Bio Entrepreneurship Practical PSBT206	1
	OR	
PSBT208	Bioanalytical and Biophysical Techniques	4
PSBT209	On Job Training/ Field Project	4
	Total Credits	22

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Bioinformatics and Biostatistics
Course Code	PSBT201
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	4
Nature	Theory
Type	Major: Mandatory

Bioinformatics and Biostatistics

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Basics of Bioinformatics and DNA sequence analysis	15
2	Multiple sequence alignments and protein modelling	15
3	Biostatistics	15
4	Biostatistics	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of basics of Bioinformatics and DNA sequence analysis.
CO2 – To provide the insight of multiple sequence alignments and protein modelling.
CO3 – To gain the knowledge of the various concepts of Biostatistics.

Curriculum:

Sr. No.	Units
1	Basics of Bioinformatics and DNA sequence analysis (15 Lectures)
	Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Biological XML DTD's; databases and search tools: biological background for sequence analysis, NCBI - publicly available tools; resources at EBI; DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases, pairwise alignment techniques: BLAST and FASTA, motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing
2	Multiple sequence alignments and protein modelling (15 Lectures)
	Multiple sequence alignment: CLUSTALW and CLUSTALX for multiple sequence alignment, submitting DNA protein sequence to databases: where and how to submit, SEQUIN; submitting aligned sets of sequences, updating submitted sequences; methods of phylogenetic analysis.

	Protein modelling: Protein structure and classification databases; Protein structure visualization; Protein structure analysis: Secondary, (Chou Fasman algorithm, GOR algorithm, Tertiary (Homology modelling, Threading, Ab initio)
3	Biostatistics (15 Lectures)
	Introduction and scope of statistics in biological studies and basic concepts. Collection of data, by different sampling methods: Simple random sampling, stratified random sampling and systematic sampling and non - random sampling. Measures of central tendency; Mean, Median and Mode. Measures of Dispersion: Variance/ standard deviation, coefficient of variation and standard error. Confidence limits for mean and proportion. Probability and Basic concepts: Normal and binomial distribution. Correlation and regression analysis for a bivariate data: Scatter diagram
4	Biostatistics (15 Lectures)
	Test of Hypothesis: Null hypothesis, alternate hypothesis, test statistics, Type I and Type II errors, level of significance and critical region. Z test: for a single sample, two samples, t-test a single sample, two samples and testing the significance of the correlation. Coefficient: t paired test, Chi-square (x2 test): As a goodness of fit and in 2x2 contingency test

Learning Resources recommended:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.

2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.

4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.

5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

7. S. P. Gupta, Statistical Methods, (45th Revised Edition), Publisher SCHAND

8. William G. Cochran, Sampling Techniques (3th Edition), Wiley and sons

9. Boris V. Gnedenko, Theory of Probability (6th Edition), CRC Press, 13-May-1998

10. Oscar Kempthorne, Klaus Hinkelmann, Design and Analysis of Experiments, Volume1: Introduction to Experimental Design, 2nd Edition, ISBN: 978-0-471-72756-9 December 2007

11. Acheson Johnston Duncan, Quality Control and Industrial Statistics (5th Edition), Irwin; 5 edition January 1, 1986

12. BK Mahajan, Methods in Biostatistics (7th Edition), Published December 1st 2008 by JP Medical Ltd

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 30 Duration: 60 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours' duration. Question Paper Pattern 1. There shall be four questions each of 15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Plant and Animal Biotechnology
Course Code	PSBT202
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	4
Nature	Theory
Type	Major: Mandatory

Plant and Animal Biotechnology

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Plant tissue culture	15
2	Plant genetic manipulations	15
3	Animal cell culture and Animal reproductive Biotechnology	15
4	Molecular mapping and marker assisted selection	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of plant tissue culture.
CO2 – To provide the insight of plant genetic manipulations.
CO3 – To gain the knowledge of animal cell culture and animal reproductive Biotechnology.
CO4 – To have a firm foundation in molecular mapping and marker assisted selection.

Curriculum:

Sr. No.	Units
1	Plant tissue culture (15 Lectures)
	Historical perspective; totipotency; culture and organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media culture preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production.
2	Plant genetic manipulations (15 Lectures)
	Genetic engineering: Agrobacterium-plant interaction; Genetic virulence; Ti and Ri plasmids; opines and their manipulations significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate

	and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming -concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.
3	Animal cell culture and Animal reproductive Biotechnology (15 Lectures)
	Brief history of animal cell culture; ATC media: serum, serum free and plant based serum alternatives and chemically defined media. Application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Novel strategies and advancement in mammalian cell line development, large scale production of animal cells, advances in tissue engineering, use of genetic engineering tools for therapy. Animal reproductive biotechnology: structure of sperms reproductive and ovum; cryopreservation of sperms and ova of biotechnology livestock; artificial insemination; super ovulation, and embryo recovery and in vitro fertilization; culture of Vaccinology embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species
4	Molecular mapping and marker assisted selection (15 Lectures)
	Molecular markers - hybridization and PCR based mapping and markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; marker DNA fingerprinting-principles and applications; assisted introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.

Learning Resources recommended:

1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43, Chichester, West Sussex; Ames, Iowa: Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).
3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
8. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.

9. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Human a Press.
10. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
11. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
12. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: n Introduction to Genetic Engineering. Oxford: Oxford University Press.
13. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants, Wiley 2002.

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 30 Duration: 60 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours' duration. Question Paper Pattern 1. There shall be four questions each of 15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Patenting in Biotechnology and Bioethics
Course Code	PSBT203
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	2
Nature	Theory
Type	Major: Mandatory

Patenting in Biotechnology and Bioethics

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Patenting	15
2	Bioethics	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of patenting.
CO2 – To provide the insight of bioethics.

Curriculum:

Sr. No.	Units
1	Patenting (15 Lectures)
	Patentability of Statutory Provisions Regarding Biotechnological; Biotechnology Inventions Under the Current Patent Act 1970 (as Inventions Amended 2005). Interpreting TRIPS in the Light of Biotechnology, Territorial Nature of Patents: From Territorial to Global Patent Regime, Inventions, Feasibility of a Uniform Global Patent, System, Merits and Demerits of Uniform Patent Law, Relevance of the Existing International Patent, Tentative Harmonization Efforts, Implications of Setting up a Uniform World Patent System.
2	Bioethics (15 Lectures)
	Introduction, bioethics in health care- euthanasia, Bioethics artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, organ transplantation. Ethics of clinical research, Bioethics in research – cloning and stem cell research, Human and animal experimentation, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Bioterrorism.

Learning Resources recommended:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
2. Karen F. Greif, Jon F. Merz - Current Controversies in the Biological Sciences_ Case Studies of Policy Challenges from New Technologies (Basic Bioethics)-The MIT Press (2007)
3. V. Sreekrishna - Bioethics and Biosafety in Biotechnology-to New Age International Pvt Ltd. Publishers (2007)
4. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights
5. Issues in Biotechnology- Academic Press (2017)
6. Kshitij Kumar Singh (auth.) - Biotechnology and Intellectual Property Rights_ Legal and Social Implications-Springer India (2015)
7. Talwar Shabana; Intellectual Property Rights in WTO and Developing Countries, Edition 2010, Serials Publications, New Delhi.

Evaluation Pattern:

A) Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 15 Duration: 30 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (30 Marks)

Duration: The examination shall be of 1 hour duration. Question Paper Pattern 1. There shall be three questions. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Bio Entrepreneurship
Course Code	PSBT206
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	3
Nature	Theory
Type	Major: Elective

Bio Entrepreneurship

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Innovation and Entrepreneurship	15
2	Business strategies	15
3	Finance and Accounting	15
	Total	**45**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To gain the knowledge of innovation and entrepreneurship.
CO2 – To have a firm foundation in business strategies.
CO3 – To provide the insight of finance and accounting.

Curriculum:

Sr. No.	Units
1	Innovation and Entrepreneurship (15 Lectures)
	Innovation and entrepreneurship in bio-business Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms; Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging biofirms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.
2	Business strategies (15 Lectures)
	Bio markets: business strategy and marketing Negotiating the road from lab to the market (strategies and processes of negotiation with financers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

3	Finance and Accounting	(15 Lectures)
	Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.	

Learning Resources recommended:

1. Adams, D. J., & Sparrow, J. C. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences Scion
2. Shimasaki, C. D. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies Academic Press Latest Edition
3. Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge Routledge Latest Edition
4. Jordan, J. F. Innovation, Commercialization, and Start-Ups in Life Sciences CRC Press Latest Edition.

Evaluation Pattern:

A) Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 15 Duration: 30 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (30 Marks)

Duration: The examination shall be of 1 hour duration. Question Paper Pattern 1. There shall be three questions. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Bioanalytical and Biophysical Techniques
Course Code	PSBT208
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	4
Nature	Theory
Type	Major: Elective

Bioanalytical and Biophysical Techniques

Units at a Glance

Sr. No.	Units	No. of Lectures
1	Microscopic Techniques	15
2	Chromatography	15
3	HPTLC Principles and Instrumentation	15
4	Spectroscopy	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart the knowledge of microscopic techniques.
CO2 – To provide the insight of chromatography.
CO3 – To gain the knowledge of HPTLC principles and instrumentation.
CO4 – To have a firm foundation in spectroscopy.

Curriculum:

Sr. No.	Units
1	Microscopic Techniques (15 Lectures)
	Confocal microscopy, Scanning Probe microscope, AFM, cryotomy scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy, single cell imaging. Environmental SEM and its advantages, Immunoelectron microscopy.
2	Chromatography (15 Lectures)
	HPLC and GC: Specialized columns & detectors in HPLC, Ultra Performance Liquid Chromatography (UPLC), Fast protein liquid chromatography (FPLC), 2D-HPLC and preparative HPLC, Universal and specific Detectors in GC (FID, TCD, ECD, FPD and NPD), Derivatization for GC and Applications.
3	HPTLC Principles and Instrumentation (15 Lectures)

	HPTLC vs TLC, Densitometry & quantitation in HPTLC, HPTLC in fingerprinting & QC, Troubleshooting, Applications of HPTLC, Method Development and validation, Preparative HPTLC
4	Spectroscopy (15 Lectures)
	Introduction and principle of: fluorescence spectroscopy, Light scattering spectroscopy, Luminometry, circular dichroism, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction, X ray crystallography and NMR, Molecular analysis using light scattering, IR, Atomic absorption Spectroscopy.

Learning Resources recommended:

1. Douglas A. Skoog, Principles of Instrumental Analysis, Saunders College Publishing
2. Chung Chow Chan, Y. C. Lee, Analytical Method Validation and Instrumental Performance Verification, Wiley Interscience o Raymond P. W. Scott,
3. Chromatographic Detectors Design Function Function and Operation, Marcel Dekker Inc
4. D. J. David, Gas Chromatographic Detectors, John Wiley & Sons
5. G. Subramanian, Preparative and Process Scale Liquid Chromatography, Ellis Horwood
6. W. M. A. Niessen, Liquid Chromatography Mass Spectrometry 2nd Ed., Marcel Dekker Inc.
7. Dr. P. D. Sethi, HPTLC High Performance Thin Layer Chromatography

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Online Examination/ Assignments/ Powerpoint presentation to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Question Paper Pattern for Periodical Class Test/ Online Examination Maximum Marks: 30 Duration: 60 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each)/ Long answer questions (6 Marks each)/ short notes (5 Marks each)		

B) Semester End Examination: 60 % (60 Marks)

Duration: The examination shall be of 2 hours' duration. Question Paper Pattern 1. There shall be four questions each of 15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Bioinformatics and Biostatistics Practical PSBT201
Course Code	PSBT204
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	2
Nature	Practical
Type	Major: Mandatory

Bioinformatics and Biostatistics Practical PSBT201

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to Bioinformatics and Biostatistics.

Curriculum: (60 Lectures)

Regular Practicals
1. Using NCBI and Uniprot web resources. 2. Introduction and use of various genome databases. 3. Sequence information resources: Using NCBI, EMBL, GenBank, Entrez, Swissprot/ TrEMBL, UniProt. 4. Similarity searches using tools like BLAST and interpretation of results. 5. Multiple sequence alignment using ClustalW. 6. Phylogenetic analysis of protein and nucleotide sequences. 7. Homology modeling. 8. Use of various primer designing and restriction site prediction tools. 9. Use of different protein structure prediction databases (PDB, SCOP, CATH). 10. Measures of central tendency: Mean, median and mode for grouped and ungrouped data. 11. Measures of dispersion: Standard deviation for grouped and ungrouped data: standard value for the mean and proportion. 12. Confidence limits for the mean and proportion. 13. Probability: Normal distribution and Binomial distribution use of normal tables. 14. Correlation and Regression: Estimation of correlation coefficient, to fit regression equations from bivariate data. 15. Test of hypothesis: a) Z-test b) t-test c) x2 test
Demonstration Practical
Use of gene prediction methods (GRAIL, Genscan, Glimmer).

Learning Resources Recommended:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
7. S. P. Gupta, Statistical Methods, (45th Revised Edition), Publisher SCHAND
8. William G. Cochran, Sampling Techniques (3th Edition), Wiley and sons
9. Boris V. Gnedenko, Theory of Probability (6th Edition), CRC Press, 13-May-1998

10. Oscar Kempthorne, Klaus Hinkelmann, Design and Analysis of Experiments, Volume1: Introduction to Experimental Design, 2nd Edition, ISBN: 978-0-471-72756-9 December 2007
11. Acheson Johnston Duncan, Quality Control and Industrial Statistics (5th Edition), Irwin; 5 edition January 1, 1986
12. BK Mahajan, Methods in Biostatistics (7th Edition), Published December 1st 2008 by JP Medical Ltd

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Plant and Animal Biotechnology Practical PSBT202
Course Code	PSBT205
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	2
Nature	Practical
Type	Major: Mandatory

Plant and Animal Biotechnology Practical PSBT202

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to plant and animal Biotechnology.

Curriculum: (60 Lectures)

Regular Practicals
Plant tissue culture - 1. Prepare culture media with various supplements for plant tissue culture. 2. Prepare explants from suitable plants for inoculation under aseptic conditions. 3. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG. 4. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species. 5. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometric methods. Animal cell culture - 6. Count cells of an animal tissue and check their viability. 7. Prepare culture media with various supplements for plant and animal tissue culture. 8. Prepare single cell suspension from spleen and thymus. 9. Isolate DNA from animal tissue by SDS method. 10. Attempt animal cell fusion using PEG.

Learning Resources Recommended:

1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43, Chichester, West Sussex;Ames, Iowa: Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).
3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics.Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
8. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.
9. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: HumanaPress.
10. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
11. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
12. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: n Introduction to Genetic Engineering. Oxford: Oxford University Press.
13. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants, Wiley 2002.

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Journal	10
02	Viva	05
03	Overall performance	05

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Practical Question 1	15
02	Practical Question 2	15

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Bio Entrepreneurship Practical PSBT206
Course Code	PSBT207
Class	M. Sc. I Biotechnology
Semester	II
No. of Credits	1
Nature	Practical
Type	Major: Elective

Bio Entrepreneurship Practical PSBT206

Course Outcomes:

At the end of the Course, the Learner will be able to -
CO1 – To impart knowledge and hands on experience of the various practicals related to bio entrepreneurship.

Curriculum: (30 Lectures)

Case Study
Case study - Successful Entrepreneurship in Biotechnology/Pharma industry – Presentation.
Project and Report Writing
Project submission on startup ideas and validation, presentation and report writing.
MOOC
Any MOOC related to Biotechnology.

Learning Resources Recommended:

1. Coursera
2. Swayam https://swayam.gov.in
3. NPTEL https://nptel.ac.in/noc/
4. Udemy

Evaluation Pattern:

a) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	MOOC Report	10
02	Case Study Report	10

b) Semester End Examination: 60 % (30 Marks)

Sr. No.	Particulars	Marks
01	Project Work	10
02	Project Report	10
03	Project Presentation	10

Revised Syllabus of Courses of Master of Science (M.Sc.) in Biotechnology Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	On Job Training/ Field Project
Course Code	PSBT209
Class	M.Sc. I Biotechnology
Semester	II
No. of Credits	4
Nature	Practical
Type	On Job Training/ Field Project
Relevance with Employability/ Entrepreneurship/ Skill development	The learners will be able to think critically, organize ana analyze scientific data; to develop advanced scientific writing skills to write research articles, reviews, thesis and proposals and to make oral, poster or Powerpoint presentations; to understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

Guidelines and Evaluation pattern for On Job Training/ Field Project (100 Marks)

Introduction:

Inclusion of On Job Training/ Field Project in the course curriculum of the M.Sc. in Biotechnology programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of On Job Training/ Field Project is to inculcate ability to interpret particular aspect of the study in his/ her own words.

Guidelines for On Job Training

On-the-Job Training/Field Project: Students will be required to undertake a designated project or tasks in an organization or industry relevant to their field of study. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study.

Course Objectives:

By the end of the course, students should be able to -

1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance his/her skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities.

Course Duration:

Minimum 20 days / 120 hours of On Job Training with an Organization/ NGO/ Charitable Organization/ Private firm.

- The theme of the internship should be based on any study area of the Major course.
- Project Report should be of minimum 50 pages.
- Experience Certificate is Mandatory.

Report Structure:

The students will be required to submit a comprehensive report at the end of the On-the-Job Training/Field Project. A project report has to be brief in content and must include the following aspects:

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution and the period of training.

b) Certificate of Completion:

A certificate issued by the organization or supervisor confirming the successful completion of the training.

c) Declaration:

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) Acknowledgment:

Recognizing individuals or organizations that provided support, guidance or resources during the training.

e) Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f) **Executive Summary:**

A bird's eye view of your entire presentation has to be precisely offered under this Category.

g) **Introduction on the Company:**

A Concise representation of company/ organization defining its scope, products/services, etc.

h) **Your Role in the Organization during the On Job Training:**

The key aspects handled, the department under which you were deployed and brief Summary report duly acknowledged by the reporting head.

i) **Challenges**:

The challenges confronted while churning out theoretical knowledge into practical world.

j) **Conclusion:**

A brief overview of your experience and suggestions to bridge the gap between theory and practice.

Course Outcomes:

1. Apply theoretical knowledge and concepts acquired during the academic program to real-world work scenarios.
2. Develop practical skills and competencies necessary for successful professional engagement.
3. Demonstrate effective problem-solving, decision-making and critical thinking abilities in a work environment.
4. Adapt to and navigate organizational dynamics and work culture in the chosen industry/ institute.

5. Prepare a comprehensive report documenting the training/project experience, findings and recommendations.

Guidelines for Field Project

The Field Project for Master of Science in Biotechnology is designed to provide students with hands-on learning experiences in understanding different methods and techniques. The project aims to expose students to development-related issues in both rural and urban settings. It offers opportunities for students to observe and study actual field situations related to Biotechnology and programmes that guide the development process. Additionally, students will explore innovative practices to address complex problems in the society.

Course Objectives:
By the end of the course, students should be able to -
1. Think critically, organize and analyze scientific data.
2. Develop advanced scientific writing skills to write research articles, reviews, thesis and proposals and to make oral, poster or Powerpoint presentations.
3. Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

Course Duration: One Semester Minimum 20 days / 120 hours of field project work.

Course Outline:

1. **Introduction to Field Project (10 Hours)**
   Understanding the significance of field-based learning in societal development. Identifying the objectives and expected outcomes of the field project.
   Selecting suitable rural and urban settings for the project.

2. **Field Visits and Observations (30 Hours)**
   Organizing field visits to selected rural and urban areas. Observing and documenting the societal conditions, challenges and opportunities in the community.
   Engaging with local stakeholders and understanding their perspectives.

3. **Research and Data Collection (20 Hours)**
   Designing research methodologies and data collection tools. Collecting primary and secondary data related to development issues. Analyzing and interpreting the data to identify key challenges and potential solutions.

4. **Understanding Policies and Programmes (20 Hours)**
   Exploring government policies and programmes related to societal development. Studying the role of various organizations in implementing development initiatives.

5. **Identifying Innovative Solutions (20 Hours)**
   Brainstorming and ideating innovative practices to address identified societal problems. Developing action plans for implementing proposed solutions.

6. **Preparing Project Report and Presentations (20 Hours)**
   Preparing a detailed project report as per the format and making presentations for the same. Developing Report writing and presentation skills among the learner.

Rubrics for Field Project Report Evaluation:

1. **Content (40 Marks):**

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Introduction and Objectives	Clear and well-defined	Clearly stated	Adequately stated	Vaguely stated	Not stated or unclear
Literature Review	Comprehensive and relevant	Relevant and adequate	Limited relevance	Inadequate or missing	Not included
Field Visits and Observations	Thorough and detailed	Adequate information	Limited data collection	Incomplete or lacking detail	No field observations made
Data Analysis	In-depth analysis	Analyzed effectively	Some analysis performed	Superficial or incomplete	No data analysis conducted
Understanding of Policies and Programmes	Strong understanding	Adequate understanding	Limited understanding	Inadequate or inaccurate	No understanding displayed
Identified Socio-Economic Problems	Comprehensive and clear	Clearly identified	Some problems identified	Inadequate or vague	No problems identified
Conclusion	Concise and conclusive	Clear and summarized	Somewhat conclusive	Unclear or missing	No conclusion provided
Recommendations	Well-developed and feasible	Feasible and relevant	Partially feasible	Infeasible or lacking detail	No recommendations given

2. Presentation (20 Marks):

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Structure and Organization	Well-structured and logical	Clear organization	Adequate organization	Lacks structure	Disorganized and unclear
Language and Clarity	Clear, concise, and fluent	Fluent language	Some clarity issues	Difficult to understand	Incoherent and unclear
Visual Presentation	Professional and engaging	Neat and presentable	Some visual aids used	Minimal use of visuals	No visuals used
Grammar and Spelling	No errors in grammar/spelling	Minor errors	Some errors	Frequent errors	Numerous errors

3. Research Methodology (10 Marks):

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Appropriate Method Selection	Highly appropriate	Mostly appropriate	Adequate method choice	Inappropriate methods	No clear method used
Data Collection and Analysis	Thorough data collection	Adequate data analysis	Limited analysis	Incomplete or weak analysis	No data analysis done

4. Creativity and Innovation (20 Marks):

Criteria	Excellent (10)	Good (8)	Satisfactory (6)	Needs Improvement (4)	Unsatisfactory (2)
Innovation in Problem Solving	Highly innovative	Innovative solutions	Some creativity shown	Lacks creativity	No innovative solutions

5. Overall Impression (10 Marks):

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Overall Quality	Exceptional quality	High quality	Acceptable quality	Below acceptable	Poor quality
Contribution and Learning	Outstanding contribution	Significant contribution	Some contribution	Limited or no learning	No contribution or learning

Conclusion:

The Field Project for Master of Science in Biotechnology provides students with invaluable experiences in understanding societal contexts and development-related issues. Through field visits, research and innovative thinking, students gain practical insights into addressing complex challenges and contributing to the societal development of communities. The rubrics for evaluation ensure a comprehensive assessment of students' learning and contributions during the project.

a) **Title Page:**

   Mentioning the title of the report, name of the student, program, institution and the period of training/project.

b) **Certificate of Completion:**

   A certificate issued by the organization or guide confirming the successful completion of the project.

c) Declaration:

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) Acknowledgment:

Recognizing individuals or organizations that provided support, guidance or resources during the project.

e) Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f) Executive Summary:

A bird's eye view of your entire presentation has to be precisely offered under this Category. A brief overview of the project, its objectives, and key findings should be mentioned.

g) Introduction:

Background information about the field project and its significance. Objectives and scope of the project.

h) Literature Review:

Overview of relevant literature and studies related to the chosen field and development issues.

i) Methodology:

Description of the research methods used for data collection, such as interviews, surveys, or observations. Explanation of the data analysis techniques employed.

j) Field Visits and Observations:

Detailed accounts of the field visits including locations, dates and observations made during the visits. Photographs or visual aids to support the observations.

k) Data Analysis:

Presentation and interpretation of the data collected during the field visits. Charts, graphs, or tables to illustrate the findings.

i) Understanding Policies and Programmes:

Explanation of relevant government policies and programmes related to the identified development issues. Assessment of how these policies will be implemented in the field context.

ii) Identified Societal Problems:

Detailed description of the complex societal problems observed in the community. Analysis of the root causes and implications of these problems.

l) Innovative Solutions:

Presentation of innovative practices proposed to address the identified problems. Description of the action plans to implement these solutions.

m) Conclusion & Recommendations:

Summary of the key findings and outcomes of the field project. Reflections on the overall experience and learning during the project. Specific recommendations for policymakers, organizations, or stakeholders to address the identified issues.

n) References & Appendices:

List of all sources cited in the project report. Additional supporting materials, such as interview transcripts, survey questionnaires, or field visit notes can be attached as appendices.

The project report based on 'On Job Training/ Field Project' shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman
- Font size: 12-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work
- Paper Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report shall be bounded.

Format

1st page (Main Page)

Title of the problem of the Project

A Project Submitted

to

R. P. Gogate college of Arts & Science and

R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

under

University of Mumbai

for partial completion of the degree

of

Master in Science

in special Group Biotechnology

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

R. P. Gogate college of Arts & Science and

R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Near District Court

Month and Year

On separate page

Index

Chapter No.	Title of the Chapter	Page No.
01		
02		
03		
04		
05		

On separate page

Declaration by learner

I the undersigned Miss/Mr. _____
[Name of the learner] here by, declare that work embodied in this project work titled _____ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher] _____ is a result of my own research work and has not been previously submitted to any other University for any other Degree/ Diploma to this or any other University.
Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.
I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by
Name and signature of the Guiding Teacher

On separate page

Acknowledgment

(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

I would like to acknowledge the following as being idealistic channels and fresh dimensions in the completion of this project.

I thank the **R. P. Gogate college of Arts & Science and R. V. Jogalekar College of Commerce, Ratnagiri (Autonomous) & University of Mumbai** for giving me opportunity to do this project.

I would like to thank my Principal, _____for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our Head _____, for his moral support and guidance.

I would also like to express my sincere gratitude towards my project guide _____ whose guidance and care made the project successful.

I would like to thank my College Library, for having provided various reference books and magazines related to my project.

Lastly, I would like to thank each and every person who directly or indirectly helped me in the completion of the project especially my Parents and Peers who supported me throughout my project.

(Rashmi A. Bhave)
The Chairperson, BoS