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

Syllabus for
Master of Science (M. Sc.) in
Biotechnology Programme
Semester III and IV

Under Choice Based Credit System (CBCS)

To be implemented from the Academic Year
2024 - 2025

Revised Scheme of Examination Faculty of Science (Post-graduate Programme) Choice Based Credit System (CBCS) Scheme of Examination

Name of Programme	**Master of Science in 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 with 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 % (40 Marks)

Sr.No.	**Particulars**	**4 credit subjects** **Marks**	**2 credit subjects** **Marks**
01	One Class Test / Online Examination [Duration: 40 Minutes] [Duration: 20 Minutes]/ Powerpoint presentation to be conducted in the given semester	20	10
02	One Assignment to be conducted in the given semester	10	05
03	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
	Total	40	20

B) Semester End Examination: 60% of 100 (60 Marks) or 60% of 50 (30 Marks)

Duration: The examination shall be of 2 hours' duration. (1 hour for 30 marks)
Question Paper Pattern
1. There shall be five questions each of 12 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.

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	O(Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+(Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+(Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C(Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P(Pass)
Below4.00	Below40	F(Fail)
Ab (Absent)	-	Absent

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

M. Sc. II Biotechnology

(To be implemented from Academic Year 2024-25)

Course Code	Semester III	Credits	Course Code	Semester IV	Credits
	Major Mandatory			Major Mandatory	
PSBT301	Applied Virology and Microbiology	4	PSBT401	Nanobiotechnology	4
PSBT302	Environmental Biotechnology	4	PSBT402	Molecular Enzymology and Enzyme Technology	4
PSBT303	Scientific Writing	2	PSBT403	Nanobiotechnology Practical PSBT401	2
PSBT304	Applied Virology and Microbiology Practical PSBT301	2	PSBT404	Molecular Enzymology and Enzyme Technology Practical PSBT402	2
PSBT305	Environmental Biotechnology Practical PSBT302	2			
	Major Elective (Any One)			Major Elective (Any One)	
PSBT306	Biologics and Regulatory Affairs	4	PSBT405	OMICS and Systems Biology	4
OR			OR		
PSBT307	Drug Discovery and Clinical Studies	4	PSBT406	Food Biotechnology	2
			PSBT407	Food Biotechnology Practical PSBT406	2
PSBT308	Research Project	4	PSBT408	Research Project	6
Total Credits		22	Total Credits		22

SMART Criteria for Course Outcomes:

1. Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.
2. Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.
3. Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.
4. Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.
5. 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 III	Credits
	Major: Mandatory	
PSBT301	Applied Virology and Microbiology	4
PSBT302	Environmental Biotechnology	4
PSBT303	Scientific Writing	2
PSBT304	Applied Virology and Microbiology Practical PSBT301	2
PSBT305	Environmental Biotechnology Practical PSBT302	2
	Major: Elective (Any One from below)	
PSBT306	Biologics and Regulatory Affairs	4
OR		
PSBT307	Drug Discovery and Clinical Studies	4
PSBT308	Research Project	4
Total Credits		22

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Applied Virology and Microbiology
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT301
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Gain insights into latest development of diagnostics & therapeutics for such diseases

CO2 – Understand epidemiological principles in prevention, control and management of pandemic disease.

CO3 – Acquire understanding of antimicrobial resistance for management of drug resistance in population.

CO4 – Understand the different aspects of biofilm and their management.

Syllabus:

Unit No.	Modules/Units
1	**Pandemic diseases, pathogenesis, diagnosis and treatment**
	1.1 Introduction to Pandemic diseases and causative agent like H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus. 1.2 Structure of these virus-coat and envelope protein, genome composition Pathogenesis (Mechanism of infection) and Acute Clinical manifestations (Signs and symptoms) of H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus 1.3 Diagnosis, and Treatment for H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus Economic and Social loss due to the Viruses
2	**Epidemiology of infectious diseases**
	1.1 Concept of Host, Reservoir, Source of infection, Carrier, Epidemic, Endemic, Pandemic, Outbreak History, Definition scope, importance of epidemiology 1.2 Epidemiology, Health and Public Health Epidemiological principles in prevention and control of disease 1.3 Measures of disease frequency – Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality 1.4 Epidemiological studies Organizations in disease control and Research – WHO,

	CDC, UNICEF, NACO, ICMR, NARI, NIV and NGOs
3	**Medical Microbiology**
	1.1 Emerging Pathogens / Infections: Diseases caused by Bacteria / parasites/ viruses: Name of causative agent, Name of disease caused, History, Antigenic structure, virulence factors, source of infection, Transmission, Pathogenesis, Clinical manifestations, Laboratory diagnosis, Treatment, Prophylaxis, vaccines, Current research and developments 1.2 Bacteria as emerging pathogens / Diseases caused by bacteria: MOTT, Legionella, Conditions caused by *Helicobacter pylori* 1.3 Viruses as emerging pathogens / Diseases caused by viruses: HIV (AIDS), Chikungunya, Dengue 1.4 Parasites as emerging pathogens / Diseases caused by parasites: Malaria, *Entamoeba histolytica* (Amoebic dysentery)
4	**Biofilms and Antimicrobial activity**
	1.1 Structure of Biofilm – Extracellular polymeric substances, Biofilm architecture. Stages in formation of Biofilm. Microbial interactions in Biofilms (Quorum sensing), Need for formation of Biofilms by microorganisms 1.2 Microorganisms commonly associated with biofilms on indwelling medical devices 1.3 Response of biofilms to host defence mechanisms and antimicrobial agents and recent advances in biofilm management. 1.4 Conventional methods of drug susceptibility testing: Kirby-Bauer disc diffusion, Stoke's method, E test 1.5 Advanced methods- Macro and Micro broth dilution methods, Time kill curves, serum killing curves, checker-board assays. 1.6 Detection of drug resistance in *Staphylococci*, *Streptococci*, *Enterococci*. 1.7 Automated methods of sensitivity testing. 1.8 Concept of CLSI standards

Learning Resources Recommended:

1. Microbiology An introduction 10th edition Gerald Tortora, Burdell Funke, Christine Case, Pearson Education Inc. Publication 2010

2. Basic Epidemiology R. Bonita, Bealglehole, T. Kjellstrom, 2nd Edition, 2006, WHO

3. Principles of Epidemiology in Public Health Practice, Third edition, US Department of Health & Human Services, CDC, 2012

4. Martin Rusnák, Viera Rusnáková, Georges Kamtoh, RELATIONS BETWEEN EPIDEMIOLOGY AND PUBLIC HEALTH, 2018 https://www.researchgate.net/publication/323964710

5. Evaluation and use of Epidemiological evidence for environmental health risk assessment guideline document World Health Organization 2000 eur/00/5020369

6. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10th ed Universities Press; Tenth edition, 2017

7. Koneman's Colour Atlas & Textbook of Diagnostic microbiology, 7th edition, 2017, Lippincott, Williams & Wilkins.

8. Mackie & McCartney Medical Microbiology, J. G. Collee, J. P.Duguid, A. G. Fraser, B. P. Marmion, Thirteenth edition, Churchill Liviingston

9. Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12th ed, Moshby

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Pandemic diseases, pathogenesis, diagnosis and treatment	Student Centric and Blended	15
2	Epidemiology of infectious diseases	Student Centric and Blended	15
3	Medical Microbiology	Student Centric and Blended	15
4	Biofilms and Antimicrobial activity	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60

Questions to be set: 05

Duration: 02 Hrs.

All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 3	Unit III A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 4	Unit IV A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Environmental Biotechnology
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT302
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Acquire understanding of the various concepts related to air pollution and air pollution monitoring.

CO2 – Gain insights into the various concepts related to soil pollution and solid waste management.

CO3 – Impart the knowledge of water pollution and different strategies of waste water treatment.

CO4 – Gain insights into the biodiversity concepts, data management and environmental monitoring.

Syllabus:

Unit No.	Modules/Units
1	**Air**
	1.1 Air pollution and air Quality Monitoring, Sampling, Source Apportionment. 1.2 Air Pollution Management in Urban Settlement and Rural Areas, Integrated Air Pollution Management, Green Belt, Biofilters/ Bioscrubber. Catalytic Systems. Green Technology. 1.3 Ozone Layer Depletion Atmospheric Brown Cloud, Impact on Flora and Fauna Impact on Crop Yield. 1.4 Concept of carbon credit, footprint.
2	**Soil**
	1.1 Causes of soil salinity; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Bioleaching of metals, bioaugmentation and biomagnification for soil remediation. 1.2 Phytostabilization – Contaminant removal, Soil cover, Rhizosphere modification. 1.3 Geotextile capping solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; solid waste management

	1.4 Disposal of organic and medical waste; Recovery and recycling of metallic waste 1.5 Disposal of plastic waste and hazardous wastes
3	**Water**
	1.1 Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms. 1.2 Marine pollution - Major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, microplastics) 1.3 Biological indicators (Marine microbes, algae and crustaceans) and accumulators 1.4 Biotechnological application of hazardous waste management of water; Use of microbial systems, Phytoremediation strategies in constructed wetlands, Designing constructed wetlands, Substrate, Hydraulic loading rate, Hydraulic retention time, selection of plant species, Surface area of wetland, Mechanisms to remove pollutants from constructed wetlands
4	**Biodiversity and Environment Monitoring**
	1.1 Introducing biodiversity informatics, Global patterns of distribution of biodiversity, biomes, Composition and distribution of biodiversity in India, 1.2 Taxonomic Database Working Group (TDWG) standards, compatibility and interoperability, taxonomically intelligent systems 1.3 Global biodiversity information system - Overview of the UNEP/GEF biodiversity data management project (BDM) 1.4 Biosensors in Environmental Monitoring – Working and its application for monitoring environment pollutants, 1.5 Application of protein biomarkers; Biosensors and biochips. 1.6 IOT for water quality monitoring – General working, Application, water Parameters

Learning Resources Recommended:

1. Chandrappa, R., & Kulshrestha, U. C. (2015). Sustainable air pollution management: theory and practice. Springer.

2. Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press

3. Singh, R. L. (Ed.). (2017). Principles and applications of environmental biotechnology for a sustainable future. Springer Singapore.

4. Enger, E. D., Smith, B. F., & Bockarie, A. T. (2000). Environmental science: A study of interrelationships (p. 434). Boston, MA: McGraw-Hill.

5. Rittmann, B. E., & McCarty, P. L. (2012). Environmental biotechnology: principles and applications. Tata McGraw-Hill Education.

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Air	Student Centric and Blended	15
2	Soil	Student Centric and Blended	15
3	Water	Student Centric and Blended	15
4	Biodiversity and Environment Monitoring	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60
Questions to be set: 05
Duration: 02 Hrs.
All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 3	Unit III A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks)	12 Marks

	B) Long Answer Question (Any one out of two) (08 Marks)	
Q. 4	Unit IV A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Scientific Writing
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT303
No. of Credits	2
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Think critically, organize and analyze scientific data; understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

CO2 – Develop advanced scientific writing skills to write research articles, reviews, thesis and proposals and to make oral, poster or power point presentations.

Syllabus:

Unit No.	Modules/Units
1	**Basic scientific writing and plagiarism**
	1.1 Introduction to scientific writing. 1.2 Basic scientific writing skills: style and language, spelling, grammar, syntax, jargon and sentence structure. Elements of a scientific paper: abstract, introduction, materials & methods, results, discussion, references and drafting titles. 1.3 Scientific writing process: thinking, planning, rough draft, revision of content. 1.4 Processing data & application of statistics, displaying data: text, table, graph and defining terms and abbreviations. 1.5 Statistical analysis and tools for experimental data. 1.6 Referencing software: Mendeley, Endnote. 1.7 Plagiarism: Definition, Common types of plagiarism, Intentional and Unintentional plagiarism, Detection of plagiarism by antiplagiarism tools (Turnitin, Duplichecker, Viper, Copyleaks), Penalties for plagiarism, avoiding plagiarism.
2	**Advanced scientific writing**

	1.1 Guidelines for Medical writing. 1.2 Scientific writing skills: Writing a research paper for biomedical journal, Writing science research papers and articles, writing a research proposal, writing a research report, writing popular reports, writing thesis and dissertation, writing clinical study reports. 1.3 Presentation skills: Oral presentation, Poster Preparation and presentation, Powerpoint presentations. Research ethics, scientific misconduct.

Learning Resources Recommended:

1. Thomas, C George. (2019). Research Methodology and Scientific Writing 2nd edition.

2. Kumar, Ranjeet. (2011). Research methodology: a step-by-step guide for beginners 3rd edition.

3. Jennifer Peat, Elizabeth Elliott, Louise Baur, and Victoria Keena. (2002). Scientific Writing (BMJ Books).

4. J.R. Mathews & R.W.Mathews (2008) Successful Scientific Writing, 3rd Ed. Cambridge University Press.

5. https://www.ema.europa.eu/en/documents/scientific-guideline/ich-e-3-structure-content-clinical-study-reports-step-5_en.pdf

6. https://www.emwa.org/documents/about_us/EMWAguidelines.pdf

7. https://www.otago.ac.nz/hedc/otago615367.pdf

8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3510958/

9. http://medind.nic.in/iad/t02/i1/iadt02i1p21.pdf

10. https://intranet.birmingham.ac.uk/as/registry/policy/conduct/plagiarism/interactive-course.aspx

11. https://www.bowdoin.edu/dean-of-students/judicial-board/academic-honesty-and-plagiarism/common-types-of-plagiarism.html

12. https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism?wssl=1

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Basic scientific writing and plagiarism	Student Centric and Blended	15
2	Advanced scientific writing	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination to be conducted in the given semester [Duration: 20 Minutes]	10
02	One Assignment to be conducted in the given semester	05
03	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: 10 Duration: 20 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 30

Question Paper Pattern

Maximum Marks: 30

Questions to be set: 02

Duration: 01 Hr.

All Questions are Compulsory Carrying 15 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Long Answer Question (Any one out of two) (08 Marks) B) Long Answer Question (Any one out of two) (07 Marks)	15 Marks
Q. 2	Unit II A) Long Answer Question (Any one out of two) (08 Marks) B) Long Answer Question (Any one out of two) (07 Marks)	15 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Biologics and Regulatory Affairs
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT306
No. of Credits	04
Nature	Theory
Type	Major: Elective

Course Outcomes:

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

CO1 – Be familiar with the basic concepts and significance of Biologics/Biosimilar in addition to having knowledge about its therapeutic applications.

CO2 – Be knowledgeable in the steps involved in the production of Biologics/Biosimilars.

CO3 – Aware of the protocols/techniques required for characterization of the Biosimilar relative to the Reference Biologic.

CO4 – Acquaint with the regulatory aspects of approval of Biologics and Biosimilars.

Syllabus:

Unit No.	Modules/Units
1	**Introduction to Biologics and Biosimilars**
	1.1 Definition: Drugs, Small molecules, Large molecules/Biologics 1.2 Categories of Biologics: protein-based hormones, enzymes, monoclonal antibodies, vaccines, blood products, and gene/ cellular therapies. 1.3 Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars. 1.4 USFDA Approved Small Molecules and USFDA Approved Generics USFDA Approved Biologics and USFDA Approved Biosimilars Indian Regulatory Scenario in relation to Small Molecules and Biologics 1.5 Therapeutic uses of some of the Biologics/Biosimilars Acceptable quality differences between approved Biosimilar and innovator's product
2	**Production of Biologics and Biosimilars**
	1.1 Reference Biologic and its significance, Choice of expression system/s and stability of cell lines 1.2 Development of upstream and downstream processes and scale up to manufacturing, Major factors contributing to the maintenance of product quality: raw materials and manufacturing conditions, virus filtration, mycoplasma removal, ultrafiltration

	1.3 Example: Production of Monoclonal antibody, downstream processing of monoclonal antibody 1.4 Introduction to the concept of Biobetters Vs Biosimilars
3	**Characterization of Biologics and Biosimilars**
	1.1 Appearance, particulates, pH, osmolality, particle size, Molecular Weight, Protein Sequence and/or amino acid composition Glycosylation, Sialylation, Phosphorylation, Acetylation, and Myristoylation, if any Sulfhydryl groups(s) and di-sulphide bridges. 1.2 Size and Purity on HPLC/ MALDI Isoform pattern. 1.3 Gel electrophoresis (IEF, SDS-PAGE and Native PAGE), Western blot, Fluorescence spectrum, FTIR spectrum and NMR spectrum Bioassays, characterization using Monoclonal Antibody as an example
4	**Quality assurance and regulatory affairs of Biologics and Biosimilars**
	1.1 Introduction to Regulatory Affairs and approvals of Biosimilars, Products approved under the FD&C. 1.2 PHS/BCPI Act 2009: Innovator Biologics Approval, Biosimilar Pathway, Totality of Evidence, Information required to demonstrate biosimilarity, Interchangeability, Product Switching, Product Naming 1.3 Global regulatory framework

Learning Resources Recommended:

1. Biosimilars: Regulatory, Clinical and Biopharmaceutical Development, Editors: Hiten J. Gutka • Harry Yang • Shefali Kakar, AAPS Advances in the Pharmaceutical, Sciences Series, Volume 34.

2. https://www.fda.gov/drugs/drug-approvals-and-databases/approved-drug-products-therapeutic-equivalence-evaluations-orange-book.

3. https://www.fda.gov/drugs/therapeutic-biologics-applications-bla/purple-book-lists-licensed-biological-products-reference-product-exclusivity-and-biosimilarity.

4. http://nib.gov.in/ NIB-DBT2016.pdf.

5. Biosimilars of Monoclonal Antibodies, A Practical Guide to Manufacturing, Preclinical, and Clinical Development. Edited by Cheng Liu, Ph.D.,K. John Morrow, Jr., Ph.D., Copyright c 2017 by John Wiley & Sons, Inc. All rights reserved. Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

6. Introduction to Biologic and Biosimilar Product Development and Analysis, Karen M. Nagel, AAPS Introductions in the Pharmaceutical Sciences, Editor-in-Chief: Robin M. Zavod, Midwestern University, Downers Grove, IL, USA.

7. Regulatory Requirements of 'Similar Biologics' for Marketing Authorization in India. Review Article. Sharmila et al., International Journal of Drug Regualtory Affairs; 2017, 5(1), 20-24.

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Introduction to Biologics and Biosimilars	Student Centric and Blended	15
2	Production of Biologics and Biosimilars	Student Centric and Blended	15
3	Characterization of Biologics and Biosimilars	Student Centric and Blended	15
4	Quality assurance and regulatory affairs of Biologics and Biosimilars	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60

Questions to be set: 05

Duration: 02 Hrs.

All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I B) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II B) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks

Q. 3	Unit III B) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 4	Unit IV B) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Drug Discovery and Clinical Studies
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT307
No. of Credits	04
Nature	Theory
Type	Major: Elective

Course Outcomes:

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

CO1 – Learn about clinical research informatics in drug discovery and design pathway using some in silico tools.

CO2 – Understand the clinical trial design set up and gain information on rules-regulation and responsibilities in clinical studies.

CO3 – Gain insights into the various concepts, scope and purpose of pharmacovigilance.

CO4 – Impart the knowledge of data management in clinical research.

Syllabus:

Unit No.	Modules/Units
1	**Clinical research informatics in drug discovery**
	1.1 Introduction to the drug discovery and development: Source of drugs, structural effects on drug action, Drugs derived from natural products, General principles of pharmacology, Drug development and testing process 1.2 Approaches to new drug discovery: Computer-aided drug design**,** Identification of novel drug candidates and drug targets**,** Construction the signalling network of a drug using integer linear programming**,** Identification for druggable targets of a disease
2	**Clinical trial design and Indian regulations**
	1.1 Clinical Trial Design: Basic framework of clinical trial**,** Randomized clinical trials and different phases**,** Adaptive randomization methods**,** Seamless design**,** Internal pilot design**,** Design selection factors 1.2 Regulations: The national regulatory body**,** Key documents in clinical research**,** Regulatory requirements for the conduct of clinical trials in India 1.3 The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial Data: Participants in clinical trials**,** Investigators, Research institutions and universities**,** Journals and Professional societies

3	**Pharmacovigilance**
	1.1 Scope and purposes of pharmacovigilance: Adverse Drug Reactions (ADR), ADR classification, Nature and mechanism of ADR, Concept of safety, Phases and types of DATA 1.2 The process of Pharmacovigilance: Signal detection, evaluation and investigation, Communication 1.3 Methods of evaluating effectiveness of action International regulatory collaboration: WHO, CIOMS, ICH, ISoP, ISPE
4	**Clinical data science**
	1.1 Data management in clinical research: An overview, Data Sources and Data Types, Standards in Healthcare Data, 1.2 Research Data Stewardship for Healthcare Professionals, Preparing Data for Prediction Model Development, Prediction Modelling Methodology 1.3 Clinical Decision Support System

Learning resources Recommended:

1. Fundamentals of Clinical Data Science, Pieter Kubben, Michel Dumonier, Andre Dekker, ISBN 978-3-319-99712-4 ISBN 978-3-319-99713-1 (eBook).
2. Experimental designs for small randomized clinical trials: an algorithm for choice, Orphanet J. Rare Dis. 2013; 8: 48, Catherine Cornu et. al.
3. Molecular docking studies, Chapter 5, Shodhganga
4. Basic and clinical pharmacology, 2017, Fourteenth Edition, Section I, Chapter I, Bertram G. Katzung, Editor, ISSN 0891 – 2033.
5. An introduction to Pharmacovigilance, second edition, Patrick Waller and Mira Harrison – Woolrych.

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Clinical research informatics in drug discovery	Student Centric and Blended	15
2	Clinical trial design and Indian regulations	Student Centric and Blended	15
3	Pharmacovigilance	Student Centric and Blended	15
4	Clinical data science	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60

Questions to be set: 05

Duration: 02 Hrs.

All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I C) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II C) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 3	Unit III C) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 4	Unit IV C) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Applied Virology and Microbiology Practical PSBT301
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT304
No. of Credits	02
Nature	Practical
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Impart knowledge and hands on experience of the various practicals related to applied virology and microbiology.

Syllabus:

I	**Regular Practicals**
	1. Viral Titering – Plaque Assay, Tissue Culture Infectious Dose (TCID), Chicken Embryo Infectious Dose (CEID) 2. Immunoassays: For detection of the virus antigens by ELISA / RIA 3. Detection techniques for COVID like RT- PCR and various RAPID tests 4. Diagnosis of dengue (kit method) 5. Diagnosis of Chikungunya (kit method) 6. Antibiotics susceptibility testing by broth Macro dilution method and Micro broth dilution method 7. Study of microbial biofilm formation on various surfaces and Biofilm visualization by staining
II	**Demonstration Practical**
	Demonstration of minimum biofilm inhibition concentration of antibiotics/ disinfectants.

Learning resources Recommended:

1. Microbiology An introduction 10th edition Gerald Tortora, Burdell Funke, Christine Case, pearson Education Inc. Publication 2010

2. Basic Epidemiology R. Bonita, Bealglehole, T. Kjellstrom, 2nd Edition, 2006, WHO

3. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10th ed Universities Press; Tenth edition, 2017

4. Koneman's Colour Atlas & Textbook of Diagnostic microbiology, 7th edition, 2017, Lippincott, Williams & Wilkins.

Teaching plan:

Title	Teaching methods	No. of Lectures
Regular Practicals	Hands on performance, Demonstration, Videos, Assignment, Visit	60
Demonstration Practicals		

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Method	Marks
Journal	05
Viva	05
Identification	05
Active class participation and Attendance	05

B. Semester End Examination: Maximum Marks: 30

Question No.	Type of Experiment	Marks
Q. 1	Major	20
Q. 2	Minor	10

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Environmental Biotechnology Practical PSBT302
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT305
No. of Credits	02
Nature	Practical
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Impart knowledge and hands on experience of the various practicals related to environmental Biotechnology.

Syllabus:

I	Regular Practicals
	1. Soil and water quality assessment (Temperature, pH, salinity, water holding capacity of soil, etc.) 2. Study of metal tolerance of microorganisms isolated from soil/water 3. Soil ecosystem analysis/ analysis of microorganisms of soil 4. Analysis of compost 5. Detection of heavy metals concentration in soil/ water 6. Study and comparison of different air samplers 7. Growth curve of metal tolerant organism isolated from soil/ water. 8. Biological Oxygen Demand (BOD) 9. Chemical Oxygen Demand (COD)

Learning resources Recommended:

1. Chandrappa, R., & Kulshrestha, U. C. (2015). Sustainable air pollution management: theory and practice. Springer.

2. Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press

3. Singh, R. L. (Ed.). (2017). Principles and applications of environmental biotechnology for a sustainable future. Springer Singapore.

4. Enger, E. D., Smith, B. F., & Bockarie, A. T. (2000). Environmental science: A study of interrelationships (p. 434). Boston, MA: McGraw-Hill.

5. Rittmann, B. E., & McCarty, P. L. (2012). Environmental biotechnology: principles and applications. Tata McGraw-Hill Education.

Teaching plan:

Title	Teaching methods	No. of Lectures
Regular Practicals	Hands on performance, Demonstration, Videos, Assignment, Visit	60

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Method	Marks
Journal	05
Viva	05
Identification	05
Active class participation and Attendance	05

B. Semester End Examination: Maximum Marks: 30

Question No.	Type of Experiment	Marks
Q. 1	Major	20
Q. 2	Minor	10

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester III with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Research Project
Class	M.Sc. II Biotechnology
Semester	III
Course Code	PSBT308
No. of Credits	04
Nature	Practical
Type	Research Project

Inclusion of project work 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 project work is to inculcate the element of research work challenging the potential of learner as regards to his/her eager to enquire and ability to interpret particular aspect of the study in his/her own words. It is expected that the guiding teacher should undertake the counselling sessions and make the awareness among the learners about the methodology of formulation, preparation and evaluation pattern of the project work.

Marks: 60 (Research Project); 40 (Project Viva): Total 100 Credits: 4

Course Outcomes:

1. Identify the research problem and formulate objectives.
2. Choose appropriate methodology with proper tools and techniques.
3. Analyze and interpret the data collected from different sources.
4. Make decision or find out conclusions on the basis of data analysis.
5. Recall and list key research paradigms and methodologies in the subject.
6. Explain the principles of statistical analysis and their application in subject of research.
7. Develop new methods which can be practically implemented.

Guidelines for preparation of Project Work

1. Research Project can be undertaken on any Major subject or Interdisciplinary subject.
2. Research Project can be based on primary data or secondary data.
3. The Research Project should be prepared under the guidance of the Project Guide.
4. The Research Project shall contain at least five chapters as follows:
   Chapter I: Introduction and Research Methodology
   Chapter II: Literature Review
   Chapter III: Profile of Study Area
   Chapter IV: Data Analysis, Interpretation and Presentation
   Chapter V: Conclusions and Future Prospects

5. Project Work will be done by the student individually. Project Work, which is interdisciplinary in nature, can be done by group of students with the prior permission of their respective Head of Departments.
6. The Research Project shall consist of 80 to 100 Pages.
7. Two Copies of typed Research Projects should be submitted through the concerned college as per the schedule provided by the college.
8. All P.G. Teachers under the Faculty of Science are eligible to work as Project Guide.
9. The Responsibility of guiding the projects will be shared by all P. G. Teachers in proportion.
10. Project viva shall be conducted by the panel of examiners.

For this purpose, the following points may be kept in mind while assessing the project reports:

a. The panel of experts should try to verify that the candidate has done the project on his own and also identify his/her insight in the research problem concerned. The quality of the work should be evaluated on the basis of novelty, use of research methodology, contribution to the society or business and developing critical thinking, analytical thinking and decision-making skills of students.

b. Research Project report will be examined by the Internal Examiner, who will allot 60 marks for the same.

c. Panel of Viva-Voce examination will consist of Internal and External examiners. The evaluation of Viva Voce for 40 marks will be made collectively by Internal and External Examiners.

d. The viva voce examination shall be conducted as per schedule of the College.

Structure to be followed to maintain the uniformity in formulation and presentation of Project Work

(Model Structure of the Project Work)

Chapter I: Introduction and Research Methodology

In this chapter Selection and relevance of the problem, historical background of the problem, brief profile of the study area, definition/s of related aspects, characteristics, different concepts pertaining to the problem etc. can be incorporated by the learner.

This chapter also Research Methodology which will include Objectives, Hypothesis, Scope of the study, limitations of the study, significance of the study, Selection of the problem, Sample size, Data collection, Tabulation of data, Techniques and tools to be used, etc. can be incorporated by the learner.

Chapter II: Literature Review

This chapter will provide information about studies done on the respective issue. This would specify how the study undertaken is relevant and contribute for value addition in information/ knowledge/ application of study area which ultimately helps the learner to undertake further study on same issue.

Chapter III: Profile of Study Area

This chapter describe the information about the study area. It includes the Background part and Overall information about the Research area.

Chapter IV: Data Analysis, Interpretation and Presentation

This chapter is the core part of the study. The analysis pertaining to collected data will be done by the learner. The application of selected tools or techniques will be used to arrive at findings. In this, table of information's, presentation of graphs etc. can be provided with interpretation by the learner.

Chapter V: Conclusions and Future Prospects

In this chapter of project work, findings of work will be covered and future prospects will be enlisted to validate the objectives and hypotheses.

Note: If required more chapters of data analysis can be added.

Bibliography

Appendix

Course Code	Semester IV	Credits
	Major: Mandatory	
PSBT401	Nanobiotechnology	4
PSBT402	Molecular Enzymology and Enzyme Technology	4
PSBT403	Nanobiotechnology Practical PSBT401	2
PSBT404	Molecular Enzymology and Enzyme Technology Practical PSBT402	2
	Major: Elective	
PSBT405	OMICS and Systems Biology	4
OR		
PSBT406	Food Biotechnology	2
PSBT407	Food Biotechnology Practical PSBT406	2
PSBT408	Research Project	6
Total Credits		22

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Nanobiotechnology
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT401
No. of Credits	4
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Impart the knowledge of a general and broad introduction to multidisciplinary field of nanotechnology.

CO2 – Be familiarize with the synthesis of nanomaterials.

CO3 – Understand the basic science behind the properties of nanomaterials and the principles behind advanced experimental techniques for studying nanomaterials.

CO4 – Understand the different aspects and applications of nanomaterials.

Syllabus:

Unit No.	Modules / Units
1	**Introduction to nanotechnology and nanomaterials**
	1.1 Introduction: Nanotechnology, Nature's biological pathway, Examples of nanomaterials and nanostructures found in nature. 1.2 Nanometer-scale materials: Nanometer-Scale Metals Nano Metal Oxides, Nanopolymers, Quantum Dots, Carbon nanostructures. 1.3 Nanorobotiocs devices of nature ATP synthase, the kinesin, myosin, dynein, flagella modulated motion.
2	**Synthesis of nanomaterials**
	1.1 Synthesis of nanometer-scale materials - Top down and bottom up approaches. 1.2 Self-Assembly of nanoparticles and its mechanism. 1.3 Bio-directed synthesis and assembly of nanomaterials. 1.4 Synthesis and Assembly of Nanoparticles and Nanostructures Using Bio-Derived Templates
3	**Nanotechnology in drug delivery**
	1.1 Biological Barriers to Nanocarrier - Mediated Delivery of Therapeutic and Imaging Agents, Nano-Sized Carriers for Drug Delivery, nano enabled drug delivery system, nanorobotics in medicine 1.2 Nanomedicine: biopharmaceutics, implantable materials, implantable chemicals,

	surgical aids
4	**Applications of nanotechnology and Nanotoxicology**
	1.1 Applications of Nanomaterials. 1.2 Nanotoxicology: Unique Properties, Toxicity of Nanomaterials, Factors Responsible for the Nanomaterial Toxicity, Routes of Exposure, Mechanisms of Nanoparticle Toxicity 1.3 In Vitro Testing Methods for Nanomaterials 1.4 Ecotoxicity Analyses of Nanomaterials

Learning Resources Recommended:

1. Poinern, Gerrard Eddy Jai. A laboratory course in nanoscience and nanotechnology. CRC Press, 2014.

2. Guozhong, Cao. Nanostructures and nanomaterials: synthesis, properties and applications. World scientific, 2004.

3. Sulabha K. Kulkarni (auth.) - Nanotechnology_ Principles and Practices-Springer International Publishing (2015)

4. Crookes-Goodson, W. J., Slocik, J. M., & Naik, R. R. (2008). Bio-directed synthesis and assembly of nanomaterials. Chemical Society Reviews, 37(11), 2403-2412

5. Chad A. Mirkin, Christof M. Niemeyer - Nanobiotechnology II_ More Concepts and Applications-Wiley-VCH (2007)

6. Christof M. Niemeyer, Chad A. Mirkin (Editors) - Nanobiotechnology_ Concepts, Applications and Perspectives-Wiley-VCH (2004)

7. Chad A. Mirkin, Christof M. Niemeyer - Nanobiotechnology II_ More Concepts and Applications-Wiley-VCH (2007)

8. Oded Shoseyov, Ilan Levy NanoBioTechnology_ BioInspired Devices and Materials of the Future (2008, Humana Press)

9. Textbook of Nanoscience and Nanotechnology by B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday

10. Arun Kumar - Nanomedicine in drug delivery-CRC Press _ Taylor & Francis (2013).

11. Yuliang Zhao, Zhiyong Zhang, and Weiyue Feng - Toxicology of Nanomaterials-Wiley-VCH (2016)

12. Diwan, Parag, and Ashish Bharadwaj, eds. The Nanoscope: Encyclopedia of Nanoscience and Nanotechnology. Pentagon Press, 2005. (Vol 1-6)

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Introduction to nanotechnology and nanomaterials	Student Centric and Blended	15
2	Synthesis of nanomaterials	Student Centric and Blended	15
3	Nanotechnology in drug delivery	Student Centric and Blended	15
4	Applications of nanotechnology and Nanotoxicology	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60
Questions to be set: 05
Duration: 02 Hrs.
All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks

Q. 3	Unit III A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 4	Unit IV A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Molecular Enzymology and Enzyme Technology
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT402
No. of Credits	4
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Aware of the enzyme kinetics, the catalytic power of an enzyme, changes in the active site, and the importance of the transition state. The importance of obtaining enzymes in their pure form and the ways it can be achieved.

CO2 – Get insights into the need for and methods for enzyme engineering to enhance its activity or half - life.

CO3 – Impart the knowledge of the industrial and medical applications of enzymes.

CO4 – Aware of the significance of enzymes as diagnostic tools, in therapy, industrial application and as biosensors; and the outcome of enzyme deficiencies.

Syllabus:

Unit No.	Modules / Units
1	**Basic concepts**
	1.1 Brief history and introduction; chemical nature and properties of enzymes 1.2 How enzymes work, mechanism of action 1.3 Catalytic power and specificity of enzymes; types of catalysis; 1.4 Active site; transition state and evidence for enzyme transition state complementarity 1.5 Enzyme kinetics – factors affecting enzyme activity; enzyme inhibition; enzyme specificity; regulatory enzymes, regulation of enzyme activity; allosteric enzymes and their kinetic properties; units of enzymes; non protein enzymes; coenzymes and cofactors; isoenzymes; enzyme pattern in diseases.
2	**Techniques of enzyme purification and studies/enzyme engineering**
	1.1 Based on molecular size: Dialysis/ ultrafiltration, density gradient centrifugation, size exclusion chromatography 1.2 Based on solubility of proteins: Isoelectric precipitation, salting out 1.3 Based on electric charge: Ion exchange chromatography, Electrophoresis capillary electrophoresis, 2D electrophoresis 1.4 Based on adsorption properties: Adsorption and Affinity chromatography

	1.5 Other techniques: Immobilized metal ion affinity chromatography, hydrophobic interaction chromatography, Reversed phase chromatography and Chromatofocusing. 1.6 Enzyme engineering – Introduction, Objectives, Principles, Examples and Steps involved in enzymes engineering. Random mutagenesis and molecular breeding of DNA. Recent advances in rational approaches for Enzyme engineering. Applications of enzyme engineering.
3	**Industrial and medical application of enzymes**
	1.1 Textile Industry, Detergent Industry, Pulp and Paper Industry, Animal Feed Industry: Enzyme Technology for Detoxification of Mycotoxins in Animal Feed, Phytases for Feed Applications and Leather Industry. Enzyme Applications for Human and Animal Nutrition. 1.2 Biosensors – Introduction, instrumentation, Types and examples. 1.3 Enzymes based sensors as diagnostic tools - Biosensors for Blood Glucose, Biosensors for Urea in Blood and Urine, Biosensors for Uric Acid, Biosensors for Arginine, Biosensors for Asparagine, Biosensors for Creatinine, Biosensors for Cholesterol, Allosteric enzyme-based biosensors.
4	**Enzyme deficiencies/diagnostic enzymes/therapeutics**
	1.1 Disorders of amino acid metabolism - Phenylketonuria, Alkaptonuria, Homocystinuria. 1.2 Disorders of carbohydrate metabolism – Galactosemia, Hereditary fructose intolerance, hereditary lactose intolerance. 1.3 Disorder of lipid metabolism - Gaucher disease, Fabry disease. 1.4 Disorders of purine and pyrimidine metabolism- HGPRT deficiency, Adenosine deaminase deficiency, Orotic aciduria. 1.5 Enzymes in diagnosis of diseases- Liver disorders, Cancer, Cardiac disorders. 1.6 Role of Other enzymes- Lysozyme, Butyryl cholinesterase and Lipases. 1.7 Therapeutic uses of enzymes - enzymes in replacement therapy, enzymes in cancer treatment, enzymes for fibrinolysis, enzymes used for various treatments and enzyme gene therapy.

Learning Resources Recommended:

1. Lehninger Principles of Biochemistry (4th Ed. Nelson, D., and Cox, M.; W.H. Freeman and Company, New York, 2005.

2. Satyanarayan and Chakrapani, Biochemistry. New Delhi, Elsevier Health Sciences APAC, 2013.

3. Berg JM, Tymoczko JL, Stryer L (2002): Biochemistry, 5th ed., Freeman WH and Co., New York.

4. https://shodhganga.inflibnet.ac.in/ bitstream/10603/100595/7/07_chapter%201.pdf General Introduction to enzymes.

5. https://iopscience.iop.org/book/978-0-7503-1302-5/chapter/bk978-0-7503-1302-5ch1 Introduction to enzymes and their applications.

6. Biochemistry by Lehninger, 2nd Ed, Kalyani publication 2008.

7. Understanding enzymes (3rd edition). Edited by Trevor Palmer, Ellis Horwood, Chichester, 1991.

8. Protein purification principles, High Resolution Methods, and Applications, 3rd Edition, Jan-Christer Janson, John Wiley & Sons, Inc., Hoboken, New Jersey.

9. https://www.biotecharticles.com/ Applications-Article/Methods-of-Purification-of-Enzymes-583.html

10. https://www.creative-enzymes.com/service/enzyme-purification_307.html Enzyme purification.

Teaching plan:

Unit No.	Unit Title	Teaching methods	No. of Lectures
1	Basic concepts	Student Centric and Blended	15
2	Techniques of enzyme purification and studies/enzyme engineering	Student Centric and Blended	15
3	Industrial and medical application of enzymes	Student Centric and Blended	15
4	Enzyme deficiencies/diagnostic enzymes/therapeutics	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60

Questions to be set: 05

Duration: 02 Hrs.

All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 3	Unit III A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 4	Unit IV A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	OMICS and Systems Biology
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT405
No. of Credits	04
Nature	Theory
Type	Major: Elective

Course Outcomes:

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

CO1 – Aware of the concepts and strategies of the emerging fields of OMICS.

CO2 – Understand, compare and contrast the techniques involved and applications of Genomics, Proteomics, Transcriptomics, Lipidomics and Metabolomics.

CO3 – Impart the knowledge of the structure and dynamics of a system as a whole and apply the different approaches to study systems biology by top down and bottom up approach.

CO4 – Gain insights into the concepts of knowledge discovery process and data mining methods; applications of systems biology.

Syllabus:

Unit No.	Modules / Units
1	**OMICS – the OMICS technology, a broad outlook**
	1.1 Tools of Omics. 1.2 Introduction to Epigenomics Human genome project - goals, conclusions and application. 1.3 Structural and functional proteomics protein - protein interaction and identification of interactions by various methods. 1.4 Application of Proteomics and Genomics in human diseases, screening, testing and treatment of diseases. 1.5 Metagenomics: concept, strategies, and applications in environmental biotechnology, agriculture and health
2	**Transcriptomics, Lipidomics and Metabolomics**
	1.1 Introduction to Transcriptomics, Lipidomics And Metabolomics, Glycomics, Pharmacogenomics 1.2 Techniques used in Lipidomics - Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI. 1.3 Technique used in Metabolomics - Mass Spectroscopy, Electrophoresis and chromatography - GC, LC and NMR.

	1.4 Technique used in Transcriptomics- next generation sequencing, northern blotting, DDRTPCR, microarrays, gel free assays like biolayer interference, SPR. 1.5 Applications of transcriptomics metabolomics and lipidomics in human diseases – screening, testing and treatment of diseases.(in clinical applications, personalised medicine, infectious diseases)
3	**Introduction to systems biology**
	1.1 Systems biology towards systems level understanding of biological systems, Systems structure, systems dynamics, systems design and control, systems project Models and Modelling systems in systems biology 1.2 What is a model? Key properties of models, Basic of computational models, networks, data integration, standards, and model organism Perturbation of biological systems and 'Omics' as Quantitative high throughput experimental tools for systems biology 1.3 Standards and formats for systems biology Computational Databases and software tools in systems biology. Biological networks: metabolic networks, gene regulatory networks, PPI networks, genetic interaction (GI) networks and signalling networks
4	**Data mining and applications of systems biology**
	1.1 Introduction to Knowledge of discovery in databases (KDD), What is knowledge, need for KDD, KDD process outline, concept and goals. 1.2 Data mining methods: Statistics – classification, correlation, association analysis, regression, and clustering; Machine learning –Symbolic and statistical approaches. 1.3 Text mining, and Pattern evaluation. 1.4 Data mining in scientific applications 1.5 Applications of systems biology: 1. Systems biology to systems medicine. 2. Application of systems biology in drug discovery and development 3. Systems biology and synthetic biology

Learning Resources Recommended:

1. Bioinformatics and functional genomics (2003), Jonathan Pevsner, John Wiley and sons Publications

2. Omic technologies: genomics, transcriptomics, proteomics and metabolomics, Richard P. Horgan and Louise C. Kenny, Scientific advisory committee (sac), the obstetrician and gynecologist.

3. Systems Biology a textbook, second edition, Edda Klipp, Wolfram Liebermeister, Christoph Wierling A Axel Kowald, Wiley wch publications

4. Analysis of biological networks (2008), Bjorn Junker, Falk Schreiber, Wiley Interscience

5. Introduction to biological networks, Alpan Ravaland, Animesh Ray, CRC Press (2013).

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	OMICS – the OMICS technology, a broad outlook	Student Centric and Blended	15
2	Transcriptomics, Lipidomics and Metabolomics	Student Centric and Blended	15
3	Introduction to systems biology	Student Centric and Blended	15
4	Data mining and applications of systems biology	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination [Duration: 40 Minutes]/ Powerpoint Presentation to be conducted in the given semester	20
02	One Assignment to be conducted in the given semester	10
03	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: 20 Duration: 40 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 60

Question Paper Pattern

Maximum Marks: 60

Questions to be set: 05

Duration: 02 Hrs.

All Questions are Compulsory Carrying 12 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 2	Unit II A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks

Q. 3	Unit III A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 4	Unit IV A) Objective Questions (Any four out of six) (04 Marks) (Multiple choice / True or False / Fill in the blanks) B) Long Answer Question (Any one out of two) (08 Marks)	12 Marks
Q. 5	All Units Write Short Notes. (Any three out of four)	12 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Food Biotechnology
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT406
No. of Credits	2
Nature	Theory
Type	Major: Elective

Course Outcomes:

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

CO1 – Impart the knowledge of nutraceuticals and functional foods.

CO2 – Gain insights into Food Biotechnology in management of health and disease.

Syllabus:

Unit No.	Modules / Units
1	**Food Biotechnology – Nutraceuticals**
	1.1 Nutraceuticals and functional foods: Definition, characteristic features and classification 1.2 Phyto nutraceuticals, Prebiotics and Probiotics, Sources (with examples e.g. microbes, plants, algae, animals), blue biotechnology, food security, food preservation, Chemopreservation; Food processing (animal and sea food), food packaging
2	**Food Biotechnology in management of health and disease**
	1.1 Applications of nutraceuticals in human health and nutrition - health effects of commonly used nutraceuticals and functional foods (case studies) 1.2 Safety and Regulatory guidelines 1.3 Nutraceuticals in management of health and disease 1.4 Development of designer foods for specific chronic diseases 1.5 Nutraceutical adjuvants

Learning Resources recommended:

1. Handbook of Nutraceuticals and Functional Foods, Edited by Robert E. C. Wildman, Robert Wildman, Taylor.
2. Handbook of Probiotics and Prebiotics, Second Edition, Editor(s): Yuan Kun Lee Seppo Salminen.
3. Blue Biotechnology: Production and Use of marine molecules Stephane La Barre (Editor), Stephen S. Bates (Editor).
4. Handbook of food processing – food preservation (PDFDrive).pdf
5. https://agrimoon.com/wp-content/uploads/Food-Packaging-Technology.pdf

6. Lipi Das, Eshani Bhaumik, Utpal Raychaudhuri and Runu Chakraborty, Role of nutraceuticals in human health, Food Sci.Technol (March-April 2012) 49(2):173-183 DOI 10.1007/s13197-011-0269-4.

Teaching plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
1	Food Biotechnology – Nutraceuticals	Student Centric and Blended	15
2	Food Biotechnology in management of health and disease	Student Centric and Blended	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Sr. No.	Particulars	Marks
01	One Class Test / Online Examination to be conducted in the given semester [Duration: 20 Minutes]	10
02	One Assignment to be conducted in the given semester	05
03	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: 10 Duration: 20 Minutes Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Mark each)/ short notes (5 Marks each)		

B. Semester End Examination: Maximum Marks: 30

Question Paper Pattern

Maximum Marks: 30
Questions to be set: 02
Duration: 01 Hr.
All Questions are Compulsory Carrying 15 Marks each.

Question No.	Particular	Marks
Q. 1	Unit I A) Long Answer Question (Any one out of two) (08 Marks) B) Long Answer Question (Any one out of two) (07 Marks)	15 Marks
Q. 2	Unit II A) Long Answer Question (Any one out of two) (08 Marks) B) Long Answer Question (Any one out of two) (07 Marks)	15 Marks

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Nanobiotechnology Practical PSBT401
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT403
No. of Credits	2
Nature	Practical
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Impart knowledge and hands on experience of the various practicals related to nanobiotechnology.

Syllabus:

I	Regular Practicals
	1. Biosynthesis and characterization of eco-friendly silver nanoparticles by using plant/leaf extracts/green tea 2. Synthesis and characterization of zinc sulfide nanoparticles by A reverse micelle method 3. Synthesis and characterization of Fluorescent Carbon Nanoparticles from Candle Soot and its separation of using the Thin-Layer Chromatographic Method 4. Synthesis of alginate beads and investigation of citric acid release from a nanoshell coating of polymer 5. Antimicrobial activity testing of Nanoparticles/nanocomposites

Learning Resources Recommended:

1. Poinern, Gerrard Eddy Jai. A laboratory course in nanoscience and nanotechnology. CRC Press, 2014.
2. Guozhong, Cao. Nanostructures and nanomaterials: synthesis, properties and applications. World scientific, 2004.
3. Sulabha K. Kulkarni (auth.) - Nanotechnology_ Principles and Practices-Springer International Publishing (2015)
4. Textbook of Nanoscience and Nanotechnology by B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday

Teaching plan:

Title	Teaching methods	No. of Lectures
Regular Practicals	Hands on performance, Demonstration, Videos, Assignment, Visit	60

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Method	Marks
Journal	05
Viva	05
Identification	05
Active class participation and Attendance	05

B. Semester End Examination: Maximum Marks: 30

Question No.	Type of Experiment	Marks
Q. 1	Major	20
Q. 2	Minor	10

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Molecular Enzymology and Enzyme Technology Practical PSBT402
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT404
No. of Credits	2
Nature	Practical
Type	Major: Mandatory

Course Outcomes:

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

CO1 – Impart knowledge and hands on experience of the various practicals related to molecular enzymology and enzyme technology.

Syllabus:

I	**Regular Practicals**
	1. Microbial Enzyme production: a. Partial purification using ammonium sulphate precipitation. b. Dialysis of the salt-precipitated protein. c. Assessing the enzyme activity and the protein content. 2. Effect of inhibitors/ chemicals on enzyme activity. 3. Extraction of enzymes from plant sources. 4. Measurement of Enzymatic Activity by Using a Colorimetric Assay. 5. Purification of Acid Phosphatase from Wheat Germ. 6. Enzyme Immunoassays. a. Methods for Enzyme Immunoassays. b. Non-competitive Solid-phase Enzyme Immunoassay. c. Competitive, Solid-phase Enzyme Immunoassay. 7. Determining of Alkaline Phosphatase (ALP) Concentration in Blood Plasma. 8. Measuring Lactase Enzymatic Activity. 9. Screening of new microbial strains for production of enzymes and perform its activity staining (zymogram). 10. To determine Specific activity of α Amylase from different sources.

Learning Resources Recommended:

1. Satyanarayan and Chakrapani, Biochemistry. New Delhi, Elsevier Health Sciences APAC, 2013.

2. https://shodhganga.inflibnet.ac.in/ bitstream/10603/100595/7/07_chapter%201.pdf General Introduction to enzymes.

3. Understanding enzymes (3rd edition). Edited by Trevor Palmer, Ellis Horwood, Chichester, 1991.

4. Protein purification principles, High Resolution Methods, and Applications, 3rd Edition, Jan-Christer Janson, John Wiley & Sons, Inc., Hoboken, New Jersey.

5. https://www.biotecharticles.com/ Applications-Article/Methods-of-Purification-of-Enzymes-583.html

6. Enzyme purification.

https://www.creative-enzymes.com/service/enzyme-purification_307.html

Teaching plan:

Title	Teaching methods	No. of Lectures
Regular Practicals	Hands on performance, Demonstration, Videos, Assignment, Visit	60

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Method	Marks
Journal	05
Viva	05
Identification	05
Active class participation and Attendance	05

B. Semester End Examination: Maximum Marks: 30

Question No.	Type of Experiment	Marks
Q. 1	Major	20
Q. 2	Minor	10

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Food Biotechnology Practical PSBT406
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT407
No. of Credits	2
Nature	Practical
Type	Major: Elective

Course Outcomes:

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

CO1 – Impart knowledge and hands on experience of the various practicals related to Food Biotechnology.

Syllabus:

I	**Regular Practicals**
	1. Estimation of total sugars from food products (dairy, fruit juices, bakery). 2. Determination of acid value of natural fats and oils. 3. Determination of iodine number of fats and oils. 4. Study of nutraceuticals important plants like Zinziber, Curcuma, Aloe vera, Asparagus, *Ocimum*, etc. 5. Estimation of antioxidant property of phytochemical by DPPH. 6. Qualitative tests for tannins, phenols, isoflavones, alkaloids using TLC. 7. Estimate Cholesterol contents in given sample by Zak's methods. 8. Estimation of bio-burden by viable counts. 9. Estimation of gluten from food sample. 10. To study nutritional components (protein, carbohydrate, secondary metabolites, lipids, vitamin C) of following: Bee honey, Mushrooms, Lentils, Soya, Dairy product, Amla, Papaya, Spinach.
II	**Demonstration Practicals**
	1. Estimation of vitamin B by HPLC. 2. Estimation of food preservatives/additives (Parabens) from food sample by HPLC.

Learning Resources Recommended:

1. Handbook of Nutraceuticals and Functional Foods, Edited by Robert E. C. Wildman, Robert Wildman, Taylor.
2. Handbook of Probiotics and Prebiotics, Second Edition, Editor(s): Yuan Kun Lee Seppo Salminen.
3. Blue Biotechnology: Production and Use of marine molecules Stephane La Barre (Editor), Stephen S. Bates (Editor).
4. Handbook of food processing – food preservation (PDFDrive).pdf
5. https://agrimoon.com/wp-content/uploads/Food-Packaging-Technology.pdf
6. Lipi Das, Eshani Bhaumik, Utpal Raychaudhuri and Runu Chakraborty, Role of nutraceuticals in human health, Food Sci.Technol (March-April 2012) 49(2):173-183 DOI 10.1007/s13197-011-0269-4.

Teaching plan:

Title	Teaching methods	No. of Lectures
Regular Practicals	Hands on performance, Demonstration, Videos, Assignment, Visit	60
Demonstration Practicals		

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 20

Method	Marks
Journal	05
Viva	05
Identification	05
Active class participation and Attendance	05

B. Semester End Examination: Maximum Marks: 30

Question No.	Type of Experiment	Marks
Q. 1	Major	20
Q. 2	Minor	10

Syllabus for Master of Science (M.Sc.) in Biotechnology Programme at Semester IV with Effect from the Academic Year 2024-2025

Nomenclature of the Course	Research Project
Class	M.Sc. II Biotechnology
Semester	IV
Course Code	PSBT408
No. of Credits	6
Nature	Practical
Type	Research Project

Inclusion of project work in the course curriculum of the M.Sc. Biotechnology programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of project work is to inculcate the element of research work challenging the potential of learner as regards to his/her eager to enquire and ability to interpret particular aspect of the study in his/her own words. It is expected that the guiding teacher should undertake the counselling sessions and make the awareness among the learners about the methodology of formulation, preparation and evaluation pattern of the project work.

Marks: 90 (Research Project); 60 (Project Viva): Total 150 Credits: 6

Course Outcomes:

1. Identify the research problem and formulate objectives
2. Choose appropriate methodology with proper tools and techniques Advanced Research hypothesis testing methods should be used (e.g. T test, ANOVA, Chi-square, etc.)
3. Analyze and interpret the data collected from different sources.
4. Make decision or find out conclusions on the basis of data analysis
5. Recall and list key research paradigms and methodologies in the subject.
6. Explain the principles of statistical analysis and their application in subject of research.
7. Develop new business models which can be practically Implemented

Guidelines for preparation of Project Work

1. Research Project can be undertaken on any Major subject or Interdisciplinary subject.
2. Research Project can be based on primary data or secondary data.
3. The Research Project should be prepared under the guidance of the Project Guide.
4. The Research Project shall contain at least five chapters as follows:
   Chapter I: Introduction and Research Methodology
   Chapter II: Literature Review
   Chapter III: Profile of Study Area
   Chapter IV: Data Analysis, Interpretation and Hypothesis Testing
   Chapter V: Conclusions and Future Prospects

5. Project Work will be done by the student individually. Project Work, which is interdisciplinary in nature, can be done by group of students with the prior permission of their respective Head of Departments.
6. The Research Project shall consist of 80 to 100 Pages.
7. Two Copies of typed Research Projects should be submitted through the concerned college as per the schedule provided by the college.
8. All P.G. Teachers under the Faculty of Science are eligible to work as Project Guide.
9. The Responsibility of guiding the projects will be shared by all P. G. Teachers in proportion.
10. Project viva shall be conducted by the panel of examiners.

For this purpose, the following points may be kept in mind while assessing the project reports:

a. The panel of experts should try to verify that the candidate has done the project on his own and also identify his/her insight in the research problem concerned. The quality of the work should be evaluated on the basis of novelty, use of research methodology, contribution to the society or business and developing critical thinking, analytical thinking and decision-making skills of students.

b. Research Project report will be examined by the Internal Examiner, who will allot 60 marks for the same.

c. Panel of Viva-Voce examination will consist of Internal and External examiners. The evaluation of Viva Voce for 40 marks will be made collectively by Internal and External Examiners.

d. The viva voce examination shall be conducted as per schedule of the College.

Structure to be followed to maintain the uniformity in formulation and presentation of Project Work

(Model Structure of the Project Work)

Chapter I: Introduction and Research Methodology

In this chapter Selection and relevance of the problem, historical background of the problem, brief profile of the study area, definition/s of related aspects, characteristics, different concepts pertaining to the problem etc can be incorporated by the learner.

This chapter also Research Methodology which will include Objectives, Hypothesis, Scope of the study, limitations of the study, significance of the study, Selection of the problem, Sample size, Data collection, Tabulation of data, Techniques and tools to be used, etc. can be incorporated by the learner.

Chapter II: Literature Review

This chapter will provide information about studies done on the respective issue. This would specify how the study undertaken is relevant and contribute for value addition in information/ knowledge/ application of study area which ultimately helps the learner to undertake further study on same issue.

Chapter III: Profile of Study Area

This chapter describe the information about the study area. It includes the Background part and Overall information about the Research area.

Chapter IV: Data Analysis, Interpretation and Hypothesis Testing

This chapter is the core part of the study. The analysis pertaining to collected dan will be done by the learner. The application of selected tools or techniques will be used to arrive at findings. In this, table of information's, presentation of graphs, etc. can be provided with interpretation by the learner.

Chapter V: Conclusions and Future Prospects

In this chapter of project work, findings of work will be covered and future prospects will be enlisted to validate the objectives and hypotheses.

Note: If required more chapters of data analysis can be added.

Bibliography

Appendix

The bounded Research 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

Format

1st page (Main Page)

Title of the Project
A Project Submitted

To

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

of

Master in Science
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 (Autonomous), Ratnagiri
Advocate N.V. Joshi Road,
Near Ratnagiri District Court, Ratnagiri

Month and Year

On separate page

Index

On separate page

Declaration by learner

I, the undersigned Miss./Mr. _____ [Name of the learner] hereby, 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 or College for any other Degree/ Diploma.

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

Acknowledgement

(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 (Autonomous), Ratnagiri** for giving me opportunity to do this project.

I would like to thank my **Principal, Prof. Dr. M. R. Sakhalkar Sir,** for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our Head of Department, Miss. R. A. Bhave, for her 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)

Chairperson and HoD