



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

**Syllabus for
M. Sc. Biotechnology Programme
Semester III and IV**

**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)	<p>At the end of the Programme, Learner will be able</p> <ol style="list-style-type: none"> 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	<p>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.</p>

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.

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) in the Internal Assessment and 40% marks in Semester End Examination (i. e. 24 out of 60) 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)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

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.

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Applied Virology and Microbiology
Course Code	PSBT 301
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 – Students will understand epidemiological principles in prevention, control and management of pandemic disease. They will acquire understanding of antimicrobial resistance for management of drug resistance in population.

CO2 - Students will understand the different aspects of biofilm and their management. They will also get insights into latest development of diagnostics & therapeutics for such diseases.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Pandemic diseases, pathogenesis, diagnosis and treatment	Introduction to Pandemic diseases and causative agent like H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus. Structure of these viruse-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 Diagnosis, and Treatment for H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus Economic and Social loss due to t Viruses	15
II	Epidemiology of infectious diseases	Concept of Host, Reservoir, Source of infection, Carrier, Epidemic, Endemic, Pandemic, Outbreak History, Definition scope, importance of epidemiology	15

		Epidemiology, Health & Public Health Epidemiological principles in prevention & control of disease Measures of disease frequency – Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality Epidemiological studies Organizations in disease control & Research – WHO, CDC, UNICEF, NACO, ICMR, NARI, NIV & NGOs	
III	Medical Microbiology	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 Bacteria as emerging pathogens / Diseases caused by bacteria: MOTT, Legionella, Conditions caused by <i>Helicobacter pylori</i> Viruses as emerging pathogens / Diseases caused by viruses : HIV (AIDS), Chikungunya, Dengue, Parasites as emerging pathogens / Diseases caused by parasites : Malaria , <i>Entamoeba histolytica</i> (Amoebic dysentery)	15
IV	Biofilms and Antimicrobial activity	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 Microorganisms commonly associated with biofilms on indwelling medical devices Response of biofilms to host defense mechanisms & antimicrobial agents	15

		<p>Recent advances in biofilm management.</p> <p>Conventional methods of drug susceptibility testing (Kirby-Bauer disc diffusion, Stoke's method, E test)</p> <p>Advanced methods- Macro & Micro broth dilution methods, Time kill curves, serum killing curves, checker-board assays. Detection of drug resistance in Staphylococci, Streptococci, Enterococci.</p> <p>Automated methods of sensitivity testing. Concept of CLSI standards</p>	
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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, Beaglehole, 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 Kamto, 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 Livingstone
9. Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12th ed, Moshby

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Assignment/ Powerpoint presentation/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Environmental Biotechnology
Course Code	PSBT 302
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - At the end of the course, students will be able to understand various concepts of environmental biotechnology, latest development in the area and use of microbiological, molecular and analytical methods in environmental biotechnology.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Air	Air pollution & air Quality Monitoring, Sampling, Source Apportionment. Air Pollution Management in Urban Settlement & Rural Areas, Integrated Air Pollution Management, Green Belt. Biofilters/ Bioscrubber. Catalytic Systems. Green Technology. Ozone Layer Depletion Atmospheric Brown Cloud, Impact on Flora and Fauna Impact on Crop Yield, concept of carbon credit, footprint.	15
II	Soil	Causes of soil salinity; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Bioleaching of metals, bioaugmentation & biomagnification for soil remediation. Phytostabilization – Contaminant removal, Soil cover, Rhizosphere modification, Geotextile capping	15

		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, Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes.	
III	Water	Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms. Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, microplastics); Biological indicators (Marine microbes, algae and crustaceans) and accumulators: 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, The selection of plant species, Surface area of wetland, Mechanisms to remove pollutants from constructed wetlands	15
IV	Biodiversity and Environmental Monitoring	Introducing biodiversity informatics, Global patterns of distribution of biodiversity, biomes, Composition and distribution of biodiversity in India, Taxonomic Database Working Group (TDWG) standards, compatibility and interoperability, taxonomically intelligent systems, Global biodiversity information system-Overview of the UNEP/GEF biodiversity data management project (BDM), Biosensors in Environmental Monitoring –	15

		Working & its application for monitoring environment pollutants, Application of protein biomarkers; Biosensors and biochips. IOT for water quality monitoring – General working, Application, water Parameters	
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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.

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Assignment/ Powerpoint presentation/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Biologics and Regulatory Affairs
Course Code	PSBT 303
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - At the end of the course, the learner will be: Familiar with the basic concepts and significance of Biologics/Biosimilar in addition to having knowledge about its therapeutic applications.

CO2 - Knowledgeable in the steps involved in the production of Biologics/Biosimilars. Aware of the protocols/techniques required for characterization of the Biosimilar relative to the Reference Biologic Acquainted with the regulatory aspects of approval of a Biosimilars.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Introduction to Biologics and Biosimilars	<p>Definition: Drugs, Small molecules, Large molecules/Biologics</p> <p>Categories of Biologics: protein-based hormones, enzymes, monoclonal antibodies, vaccines, blood products, and gene/ cellular therapies. Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars.</p> <p>USFDA Approved Small Molecules and USFDA Approved Generics</p> <p>USFDA Approved Biologics and USFDA Approved Biosimilars</p> <p>Indian Regulatory Scenario in relation to Small Molecules and Biologics</p> <p>Therapeutic uses of some of the Biologics/Biosimilars Acceptable quality differences between</p>	15

		approved Biosimilar and innovator's product	
II	Production of Biologics and Biosimilars	Reference Biologic and its significance, Choice of expression system/s and stability of cell lines 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 Example: Production of Monoclonal antibody, downstream processing of Mab Introduction to the concept of Biobetters Vs Biosimilars	15
III	Characterization of Biologics and Biosimilars	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. Size and Purity on HPLC/ MALDI Isoform pattern. 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	15
IV	Quality assurance and regulatory affairs of Biologics and Biosimilars	Introduction to Regulatory Affairs and approvals of Biosimilars, Products approved under the FD&C .PHS/BCPI Act 2009: Innovator Biologics Approval, Biosimilar Pathway, Totality of Evidence, Information required to demonstrate biosimilarity, Interchangeability, Product Switching, Product Naming Global regulatory framework	15

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 Regulatory Affairs; 2017, 5(1), 20-24.

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Assignment/ Powerpoint presentation/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Molecular Enzymology and Enzyme Technology
Course Code	PSBT 304
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - Enzyme deficiencies and use of enzymes as therapeutics.

At the end of the course the student will be 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 - The need for and methods for enzyme engineering to enhance its activity or half - life. The significance of enzymes as diagnostic tools, in therapy, industrial application and as biosensors; and the outcome of enzyme deficiencies.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Basic concepts	Brief history and introduction; chemical nature and properties of enzymes; how enzymes work mechanism of action; catalytic power and specificity of enzymes; types of catalysis; active site ; transition state and evidence for enzyme transition state complementarity; 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.	15

II	Techniques of enzyme purification and studies/enzyme engineering	<p>Based on molecular size (Dialysis/ ultrafiltration, density gradient centrifugation, size exclusion chromatography); based on solubility of proteins (Isoelectric precipitation, salting out); based on electric charge (Ion exchange chromatography, Electrophoresis capillary electrophoresis, 2D electrophoresis); based on adsorption properties (Adsorption and Affinity chromatography). Other techniques: Immobilized metal ion affinity chromatography, Hydrophobic interaction chromatography, Reversed phase chromatography and Chromatofocusing.</p> <p>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.</p>	15
III	Industrial and medical application of enzymes	<p>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.</p> <p>Biosensors – Introduction, instrumentation, Types and examples. 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.</p>	15

IV	Enzyme deficiencies/diagnostic enzymes/therapeutics	Disorders of amino acid metabolism- Phenylketonuria, Alkaptonuria, Homocystinuria. Disorders of carbohydrate metabolism – Galactosemia, Hereditary fructose intolerance, Hereditary lactose intolerance. Disorder of lipid metabolism - Gaucher disease, Fabry disease. Disorders of purine and pyrimidine metabolism- HGPRT deficiency, Adenosine deaminase deficiency, Orotic aciduria. Enzymes in diagnosis of diseases- Liver disorders, Cancer, Cardiac disorders. Role of Other enzymes- Lysozyme, Butyrylcholinesterase and Lipases. Therapeutic uses of enzymes - enzymes in replacement therapy, enzymes in cancer treatment, enzymes for fibrinolysis, enzymes used for various treatments and enzyme gene therapy.	15
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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](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.

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Assignment/ Powerpoint presentation/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical I
Course Code	PSBTP301
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	02
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to applied virology and microbiology.

Curriculum:

Title	Learning Points	No. of Lectures
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 & Micro broth dilution method 7. Study of microbial biofilm formation on various surfaces & Biofilm visualization by staining	60
Demonstration Practicals	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, Beaglehole, 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.

Evaluation Pattern

	No. of Experiments	Duration	Total Marks	CIE	Total
Practical I	4 experiments of 1.5 hrs duration	6 hrs	60 M (01 Paper) (2 Major Experiments, 2 Minor Experiments)	40 M (20 M for Journal, 10 M for Viva, 10 M for overall performance)	100
Practical I examination marks will be converted into 50 marks.					

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical II
Course Code	PSBTP302
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	02
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to environmental Biotechnology.

Curriculum:

Title	Learning Points	No of Lectures
Regular Practicals	1. Soil and water quality assessment (temp, 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.	60

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.

Evaluation Pattern

	No. of Experiments	Duration	Total Marks	CIE	Total
Practical II	4 experiments of 1.5 hrs duration	6 hrs	60 M (01 Paper) (2 Major Experiments, 2 Minor Experiments)	40 M (20 M for Journal, 10 M for Viva, 10 M for overall performance)	100
Practical II examination marks will be converted into 50 marks.					

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical III
Course Code	PSBTP303
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	02
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to biologics and regulatory affairs.

Curriculum:

Title	Learning Points	No. of Lectures
Regular Practicals	1) Electrophoresis {PAGE (native, SDS, reducing, non-reducing)} to characterize the protein with regard to its molecular weight, structure/subunits/SS bonds etc., or for detection of impurities in the product 2) Concentration of protein with Folin Lowry 3) HPLC /FTIR/NMR spectrum based theory questions may be asked for interpretation	60
Demonstration Practicals	Western blot/dot blot for purity of product demonstration/ dummy sandwich preparation of semi-dry or wet western blot sandwich.	
Visit	Visit to a facility manufacturing Biosimilar	

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](http://nib.gov.in/NIB-DBT2016.pdf).

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

Evaluation Pattern

	No. of Experiments	Duration	Total Marks	CIE	Total
Practical III	4 experiments of 1.5 hrs duration	6 hrs	60 M (01 Paper) (2 Major Experiments, 2 Minor Experiments)	40 M (20 M for Journal, 10 M for Viva, 10 M for overall performance)	100
Practical III examination marks will be converted into 50 marks.					

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical IV
Course Code	PSBTP304
Class	M. Sc. II Biotechnology
Semester	III
No. of Credits	02
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to molecular enzymology and enzyme technology.

Curriculum:

Title	Learning Points	No. of Lectures
Regular Practicals	<ol style="list-style-type: none"> 1. Microbial Enzyme production: <ol style="list-style-type: none"> 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. <ol style="list-style-type: none"> 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. 	60

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

Evaluation Pattern

	No. of Experiments	Duration	Total Marks	CIE	Total
Practical IV	4 experiments of 1.5 hrs duration	6 hrs	60 M (01 Paper) (2 Major Experiments, 2 Minor Experiments)	40 M (20 M for Journal, 10 M for Viva, 10 M for overall performance)	100
Practical IV examination marks will be converted into 50 marks.					

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Nanobiotechnology
Course Code	PSBT 401
Class	M. Sc. II Biotechnology
Semester	IV
No of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - Students should be able to understand the basic science behind the properties of nanomaterials and the principles behind advanced experimental techniques for studying nanomaterials.

CO2 - Also understand the different aspects and applications of nanomaterials.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Introduction to nanotechnology and nanomaterials	Introduction: Nanotechnology, Nature's biological pathway, Examples of nanomaterials and nanostructures found in nature. Nanometer-scale materials: Nanometer-Scale Metals Nano Metal Oxides, Nanopolymers, Quantum Dots, Carbon nanostructures. Nanorobotiocs devices of nature ATP synthase, the kinesin, myosin, dynein, flagella modulated motion.	15
II	Synthesis of nanomaterials	Synthesis of nanometer-scale materials- Top down and Bottom up approaches. Self-Assembly of nanoparticles and its mechanism. Bio-directed synthesis and assembly of nanomaterials Synthesis and Assembly of Nanoparticles and Nanostructures Using Bio-Derived Templates	15

III	Nanotechnology in drug delivery	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, Nanomedicine: biopharmaceutics, implantable materials, implantable chemicals, surgical aids	15
IV	Applications of nanotechnology and Nanotoxicology	Applications of Nanomaterials. Nanotoxicology: Unique Properties, Toxicity of Nanomaterials, Factors Responsible for the Nanomaterial Toxicity, Routes of Exposure, Mechanisms of Nanoparticle Toxicity, In Vitro Testing Methods for Nanomaterials, Ecotoxicity Analyses of Nanomaterials	15

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)

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Assignment/ Powerpoint presentation/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	OMICS and Systems Biology
Course Code	PSBT 402
Class	M. Sc. II Biotechnology
Semester	IV
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - At the end of the course learners will be able to understand how the data is generated by OMICS technologies to contribute to different databases.

CO2 - Understand, compare and contrast the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics; Will be able to apply the different technologies of OMICS to the screening, testing and treatment of human diseases. Understand the structure and dynamics of a systems as a whole. Apply the different approaches to study systems biology by top down and bottom up approach.

CO3 - Introduction to concepts of knowledge discovery process and data mining methods. Understand the application of data mining in genomics, proteomics and development of tools in bioinformatics. Have the knowledge of applications of systems biology in development of personalized medicine, drug development.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	OMICS – the OMICS technology, a broad outlook	Tools of Omics. Introduction to Epigenomics Human genome project- goals, conclusions and application. Structural and functional proteomics protein - protein interaction and identification of interactions by various methods. Application of Proteomics and Genomics in human diseases, screening, testing and treatment of diseases. Metagenomics: concept, strategies, and applications in environmental	15

		biotechnology, agriculture and health	
II	Transcriptomics, Lipidomics and Metabolomics	<p>Introduction to Transcriptomics, Lipidomics And Metabolomics, Glycomics, Pharmacogenomics</p> <p>Techniques used in Lipidomics- Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI. Technique used in Metabolomics- Mass Spectroscopy, Electrophoresis, chromatography- GC, LC & NMR. Technique used in Transcriptomics- next generation sequencing, northern blotting, DDRTPCR, microarrays, gel free assays like biolayer interference, SPR.</p> <p>Applications of transcriptomics metabolomics and lipidomics in human diseases –screening, testing and treatment of diseases.(in clinical applications, personalised medicine, infectious diseases)</p>	15
III	Introduction to systems biology	<p>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</p> <p>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</p> <p>Standards and formats for systems biology Computational Databases and software tools in systems biology. Biological networks: metabolic networks, gene regulatory networks, PPI networks, genetic</p>	15

		interaction (GI) networks, and signalling networks	
IV	Data mining and application of systems biology	<p>Introduction to Knowledge of discovery in databases (KDD) What is knowledge, need for KDD, KDD process outline, concept and goals.</p> <p>Data Mining methods: Statistics – classification, correlation, association analysis, regression, and clustering; Machine learning – Symbolic and statistical approaches. Text mining, and Pattern evaluation.</p> <p>Data mining in scientific applications</p> <p>Application of systems biology: 1. Systems biology to systems medicine.</p> <p>2. Application of systems biology in drug discovery and development</p> <p>3. Systems biology and synthetic biology</p>	15

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 gynaecologist.
3. Systems Biology a textbook, second edition, Edda Klipp, Wolfram Liebermeister, Christoph Wierling 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).

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Assignment/ Powerpoint presentation/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Drug Discovery and Clinical Study
Course Code	PSBT 403
Class	M. Sc. II Biotechnology
Semester	IV
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

By the end of the course the student will:

CO1 - Able to learn about drug discovery-design pathway using some in-silico tools.

CO2 - Able to understand the clinical trial design set up as well as they will gain information on rules-regulation and responsibilities in clinical studies.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Clinical research informatics in drug discovery	Introduction to the drug discovery & development <ul style="list-style-type: none"> • Source of drugs • Structural effects on drug action • Drugs derived from natural products • General principles of pharmacology • Drug development and testing process Approaches to new drug discovery <ul style="list-style-type: none"> • 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 	15
II	Clinical trial design and Indian regulations	Clinical Trial Design <ul style="list-style-type: none"> • Basic framework of clinical trial 	15

		<ul style="list-style-type: none"> • Randomized clinical trials and different phases • Adaptive randomization methods • Seamless design • Internal pilot design • Design selection factors <p>Regulations</p> <ul style="list-style-type: none"> • The national regulatory body • Key documents in clinical research • Regulatory requirements for the conduct of clinical trials in India <p>The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial Data</p> <ul style="list-style-type: none"> • Participants in clinical trials • Investigators, • Research institutions and universities • Journals and Professional societies 	
III	Pharmacovigilance	<p>Scope and purposes of pharmacovigilance</p> <ul style="list-style-type: none"> • Adverse Drug Reactions (ADR) • ADR classification • Nature and mechanism of ADR • Concept of safety • Phases and types of DATA <p>The process of Pharmacovigilance</p> <ul style="list-style-type: none"> • Signal detection, evaluation and investigation, • Communication <p>Methods of evaluating effectiveness of action International regulatory collaboration</p> <ul style="list-style-type: none"> • WHO, CIOMS, ICH, ISoP, ISPE 	15
IV	Clinical data science	<p>Data management in clinical research: An overview</p> <ul style="list-style-type: none"> • Data Sources and Data Types • Standards in Healthcare Data • Research Data Stewardship for Healthcare Professionals 	15

		<ul style="list-style-type: none"> • Preparing Data for Prediction Model Development • Prediction Modelling Methodology • Clinical Decision Support System 	
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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.

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Powerpoint presentation of a clinical case/trial study report/ Class Test	30
Active participation in routine class instructional deliveries	05
Overall performance	05

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Scientific Writing and Food Biotechnology
Course Code	PSBT 404
Class	M. Sc. II Biotechnology
Semester	IV
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

On completion of the course students will be able to:

CO1 - Think critically, organize and analyze scientific data.

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

CO3 - Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	Basic scientific writing and plagiarism	<p>Introduction to scientific writing.</p> <p>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.</p> <p>Scientific writing process: thinking, planning, rough draft, revision of content.</p> <p>Processing data & application of statistics, Displaying data: text, table, graph and defining terms and abbreviations.</p> <p>Statistical analysis and tools for experimental data.</p> <p>Referencing software: Mendeley, Endnote.</p>	15

		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.	
II	Advanced scientific writing	Guidelines for Medical writing. 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. Presentation skills: Oral presentation, Poster Preparation & presentation, Powerpoint presentations. Research ethics, Scientific misconduct.	15
III	Food Biotechnology – Nutraceuticals	Nutraceuticals and functional foods Definition, characteristic features, and classification, phytonutraceuticals, 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	15
IV	Food Biotechnology in management of health and disease	Applications of nutraceuticals in human health and nutrition- health effects of commonly used nutraceuticals and functional foods (case studies), Safety and Regulatory guidelines Nutraceuticals in management of health and disease Development of designer foods for specific chronic diseases Nutraceutical adjuvants	15

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>

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Online Course	20
Research Proposal	20

B. Semester End Evaluation (Paper Pattern)

Question No.	Unit	Marks
1	I	Unit I questions 12 M
2	II	Unit II questions 12 M
3	III	Unit III questions 12 M
4	IV	Unit IV questions 12 M
5	All Units	Short notes (03 out of 04) 12 M

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical I
Course Code	PSBTP401
Class	M. Sc. II Biotechnology
Semester	IV
No. of Credits	02
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to nanobiotechnology.

Curriculum:

Title	Learning Points	No. of Lectures
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	60

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

Evaluation Pattern

	No. of Experiments	Duration	Total Marks	CIE	Total
Practical I	4 experiments of 1.5 hrs duration	6 hrs	60 M (01 Paper) (2 Major Experiments, 2 Minor Experiments)	40 M (20 M for Journal, 10 M for Viva, 10 M for overall performance)	100
Practical I examination marks will be converted into 50 marks.					

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical II
Course Code	PSBTP402
Class	M. Sc. II Biotechnology
Semester	IV
No of Credits	02
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to OMICS and systems biology.

Curriculum:

Title	Learning Points	No. of Lectures
Regular Practicals	1. Gel electrophoresis of lipids (lipoproteins extracted from various sources) to separate and identify the lipid fraction	60
Demonstration Practicals	1. Detection assay for gene expression using micro array and qRT –PCR (demonstration) 2. Identification of protein using analytical technique Mass spectroscopy (demonstration)	
Report Writing	1. Preparation of report based on - Databases and data repositories used in systems Biology	

Learning Resources recommended:

1. Bioinformatics and functional genomics (2003), Jonathan Pevsner, John Wiley and sons Publications
2. Systems Biology a textbook, second edition, Edda Klipp, Wolfram Liebermeister, Christoph Wierling Axel Kowald, Wiley wch publications
3. Analysis of biological networks (2008), Bjorn Junker, Falk Schreiber, Wiley Interscience
4. Introduction to biological networks, Alpan Ravaland, Animesh Ray, CRC Press (2013).

Evaluation Pattern

	No. of Experiments	Duration	Total Marks	CIE	Total
Practical II	4 experiments of 1.5 hrs duration	6 hrs	60 M (01 Paper) (2 Major Experiments, 2 Minor Experiments)	40 M (20 M for Journal, 10 M for Viva, 10 M for overall performance)	100
Practical II examination marks will be converted into 50 marks.					

Syllabus for M. Sc. Biotechnology Autonomous from the year 2023-24

Name of the Course	Practical III and Practical IV
Course Code	PSBTP403 and PSBTP404
Class	M. Sc. II Biotechnology
Semester	IV
No. of Credits	04
Nature	Theory/ Practical/ Project/ other (please specify)
Type	Core/ Elective

Course Outcomes:

CO1 - To impart knowledge and hands on experience of the various practicals related to scientific writing.

Curriculum:

Title	Learning Points	No. of Lectures
Regular Practical	<ol style="list-style-type: none"> 1. A finding of a drug-gene interaction or potentially druggable category using The Drug Gene Interaction Database (DGIdb) 2. Recognition of binding patterns common to set of protein structures using ProBiS 3. Recognition of common spatial chemical binding patterns to a Set of Protein Structures using Multiple Alignment of Protein Binding Sites (MultiBind) tool and analysis using RasMol/Jmol 4. Estimation of total sugars from food products (dairy, fruit juices, bakery) 5. Determination of acid value of natural fats and oils. 6. Determination of iodine number of fats and oils. 7. Study of nutraceuticals important plants like Zinziber, Curcuma, Alovera, Asparagus, Ocimum etc. 8. Estimation of antioxidant property of phytochemical by DPPH. 9. Qualitative test for tannins, phenols, isoflavones, alkaloids using TLC. 10. Estimate Cholesterol contents in given sample by Zak's methods. 11. Estimation of bio-burden by viable counts. 12. Estimation of gluten from food sample. 	60

	13.To study nutritional components (protein, carbohydrate, secondary metabolites, lipids, vitamin C) of following: Bee honey, Mushrooms, Lentils, Soya, Dairy product, Amla, Papaya, Spinach.	
Demonstration Practicals	1. Computational protein-ligand docking using AutoDock. 2. Estimation of vitamin B by HPLC. 3. Estimation of food preservatives/additives (Parabens) from food sample by HPLC.	
Online Course	1. Exploration of various learning platforms in online courses listed below : a. Online courses in fundamentals of Neuroscience from Harvard University https://online-learning.harvard.edu/course/fundamentals-neuroscience-part-1-electrical-properties-neuron?delta=0 b. Molecular Biology from MIT https://ocw.mit.edu/courses/biology/7-28-molecular-biology-spring-2005/ c. Introduction to Bioethics from Georgetown https://bioethicsarchive.georgetown.edu/phlx101-02/course.html#units/introduction 2. Complete an online course (Minimum 1 week) on the topic related to the biotechnology. Write a comprehensive report on the studied course contents. a. Swayam https://swayam.gov.in/ b. NPTEL https://nptel.ac.in/noc/ c. MOOC https://www.it.iitb.ac.in/frg/wiki/images/7/7b/Demo-PPT.pdf d. E-learning https://www.bellevuecollege.edu/elearning/start/intro/	
Research Proposal	Write a research proposal on any topic of your interest from the MSc syllabus. For research proposal contents and format refer to NSF guidelines. https://www.nsf.gov/pubs/policydocs/pappg19_1/nsf19_1.pdf For reference work use Mendeley Desktop. https://www.mendeley.com/guides/desktop	

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.
6. Thomas, C George. (2019). Research Methodology and Scientific Writing 2nd edition.
7. Kumar, Ranjeet. (2011). Research methodology: a step-by-step guide for beginners 3rd edition.
8. Jennifer Peat, Elizabeth Elliott, Louise Baur, and Victoria Keena. (2002). Scientific Writing (BMJ Books).
9. <https://www.bowdoin.edu/dean-of-students/judicial-board/academic-honesty-and-plagiarism/common-types-of-plagiarism.html>

Evaluation Pattern

Project Dissertation – 100 M

For semester IV it is mandatory for students to undergo Hands-on Project training in an established research laboratory or college laboratory for 4-6 months; this should involve one or more relevant instrumentation techniques. Thesis on the same to be evaluated by the guide alternatively by an internal examiner for 40 M based on the student's performance, written matter and experimentation. A certificate must be appended with the thesis. Another examiner will assess for 60 M as a Presentation during practical exams.

Sd/-

(Rashmi A. Bhave)
The Chairperson, BoS