Janardan Bhagat Shikshan Prasarak Sanstha's

# CHANGU KANA THAKUR
# ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL
# (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

## Affiliated to University of Mumbai with an autonomous Status

## Revised Syllabus of

## Program: M.Sc. Biotechnology

## M.Sc. Part-II
## (Semester III & IV)
## Choice Based Credit & Grading System (60:40)

## (To be implemented from Academic Year 2020-2021)

# Preamble:

Master of Science (M.Sc.) Programme in Biotechnology is a P.G. Programme of Department of Biotechnology, Changu Kana Thakur Arts, Commerce & Science College, New Panvel, affiliated to University of Mumbai with an Autonomous status. Biotechnology is technology based on biology. Biotechnology harnesses cellular and bio-molecular processes to develop technologies and products that help to improve our lives and the health. Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, cleaner energy, and have safer, cleaner, and more efficient industrial manufacturing processes.

The Choice Based Credit and Grading System (CBCGS) to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The proposed credit-based curriculum and grading system will even add much more to the existing interdisciplinary nature of biotechnology.

Under the 'autonomy' we have made an attempt to design Master's in Biotechnology course syllabus to cater to the needs of credit based- semester and grading system. The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards current need of modern research and industrial sectors.

The present M.Sc. Biotechnology Second Year (Semester III and IV) syllabus is based on the remodeled M.Sc. Biotechnology Curriculum, May 2017, Department of Biotechnology, Ministry of Science and Technology, Government of India and revised syllabus of University of Mumbai. Syllabus is robust and well-designed to enable students to pursue high quality research or increase employability of the students. Online course component has been introduced in the curriculum in keeping with the digital initiatives of MHRD to provide good quality self-learning content through MOOCs under SWAYAM and allied platforms. It is hoped that the revised syllabus shall serve its objective of promoting outcome-based learning to meet the changing needs of the biotechnology sector.

# M.Sc. Biotechnology Course Structure

## Semester III

| Course code PSBT | Title | Theory /Practical | Marks | Credits | Nos of Lectures / week |
|---|---|---|---|---|---|
| **PBT3AVM** | Applied Virology and Microbiology | Theory | 100 | 4 | 4 |
| **PBT3EBT** | Environmental Biotechnology | Theory | 100 | 4 | 4 |
| **PBT3BRA** | Biologics and Regulatory Affairs | Theory | 100 | 4 | 4 |
| **PBT3MET** | Molecular Enzymology and Enzyme Technology | Theory | 100 | 4 | 4 |
| **PBT3PR1** | Practical- I (Paper-I &IV) | Practical | 100 | 4 | 8 |
| **PBT3PR2** | Practical –II (Paper-II &III) | Practical | 100 | 4 | 8 |
| | | **TOTAL** | **600** | **24** | **32** |

## Semester IV

| Course code PSBT | Title | Theory /Practical | Marks | Credits | Nos of Lectures / week |
|---|---|---|---|---|---|
| **PBT4NBT** | Nanobiotechnology | Theory | 100 | 4 | 4 |
| **PBT4OSB** | OMICS & Systems Biology | Theory | 100 | 4 | 4 |
| **PBT4DDC** | Drug Discovery & Clinical Study | Theory | 100 | 4 | 4 |
| **PBT4SWF** | Scientific Writing & Food Biotechnology | Theory | 100 | 4 | 4 |
| **PBT4PR1** | Practical- I (Paper-I &II) | Practical | 100 | 4 | 8 |
| **PBT4PR2** | Practical –II (Paper-III &IV) | Practical | 100 | 4 | 8 |
| | | **TOTAL** | **600** | **24** | **32** |

**Teaching pattern:** One (01) Credit would be of thirty-forty (30-40) learning hours; of this, more than fifty per cent of the time will be spent on classroom instructions including practical as prescribed by the University. Rest of the time would be invested for assignments, projects, journal writing, case studies, library work, industrial visits, attending seminars/workshops, preparations for examinations etc. would be considered as notional hours. The present syllabus considers (60L as classroom teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be for 60 min. The names of the reference books provided in the syllabus are for guidance purpose only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

**Eligibility:** As per University of Mumbai Rules

**Scheme of Examinations:** (a) Internal assessment of 40 marks per course per semester should be conducted. (b) External assessment of 60 marks per course per semester at the end of every semester (c) Practical examination of 200 marks should be conducted at the end of every semester.

**A) Internal Assessment: 40 %** **40 Marks**

<table>
<tr><th>Sr. No.</th><th colspan="2">Particular</th><th>Marks</th></tr>
<tr><td>01</td><td colspan="2">One periodical class test / online examination to be conducted in the given semester</td><td>20 Marks</td></tr>
<tr><td rowspan="3">02</td><td colspan="2">One case study (clinical case/trial study report for paper III) /review / project with presentation based on curriculum to be assessed by the teacher concerned</td><td rowspan="3">15 Marks</td></tr>
<tr><td>Presentation</td><td>10 Marks</td></tr>
<tr><td>Written Document</td><td>05 Marks</td></tr>
<tr><td>03</td><td colspan="2">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</td><td>05 Marks</td></tr>
</table>

| | Semester -IV | |
|---|---|---|
| | a. **FOR PAPER 4:** The internal assessment will comprise of the following:<br>Online course: The student is expected to complete at least one online course relevant for the subject from any of the appropriate reputed online platforms. A proof of successful completion of the online course must be provided for the award of marks. /TEST | 20 Marks |
| | b. Research Proposal: The student is expected to submit a research proposal relevant to the subject | 20 Marks |

**Question Paper Pattern**
**(Periodical Class Test for the Courses at Under Graduate Programs)**

Maximum Marks: 20 Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

| Question No. | Particular | Marks |
|---|---|---|
| Q-1 | Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each) | 10 Marks |
| Q-2 | Answer in Brief (Attempt any Two of the Three)<br>(5 Marks each) | 10 Marks |

**B) Semester End Examination: 60 % 60 Marks Duration: $2\frac{1}{2}$ hours**

**Question Paper Pattern**

| Theory question paper pattern |
|---|
| 1. There shall be five questions each of 12 marks.<br>2. All questions shall be compulsory with internal options.<br>3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit. |

**Passing Standard:**

The learners shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners 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 grade D in each project wherever applicable to pass a particular

**Practical Examination Evaluation scheme (50 marks per paper)**

| SL. No. | Questions | MARKS |
|---|---|---|
| **1.** | Practical Question 1 | **25** |
| **2.** | Practical Question 2 | **15** |
| **3.** | Journal | **05** |
| **4.** | Viva Voce | **05** |
| **OR** | | |
| **1.** | Practical Question | **40** |
| **2.** | Journal | **05** |
| **3.** | Viva Voce | **05** |
| | Semester IV- Project Dissertation | **100** |

- 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 technique.
- Thesis on the same to be evaluated by the guide alternatively by an internal examiner for 50M based on the student's performance, written matter and experimentation.
- A certificate must be appended with the thesis. The external examiner will assess for 50M as a Presentation during practical exams. Marks allotted by Internal examiner would be scaled down if required as per university guidelines

The practical examinations at a center would be evaluated by one external examiner assigned by the University and one internal examiner assigned by the college/department.

# Semester-III

## M.Sc. Biotechnology
## Semester –III
## Paper-I Applied Virology & Microbiology (PBT3AVM)

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|---|---|---|---|
| **Course Objectives:** | • Students will be exposed to pandemic diseases, significance of epidemiology in studying various diseases and societal & economic issues related to such diseases.<br>• Students will also learn details about emerging viral, bacterial, parasitic pathogens. Students will learn advanced, automated methods for determining antimicrobial susceptibility, drug resistance and various aspects of biofilms | | |
| **Course Outcomes:** | • 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.<br>• 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. | | |
| **Units** | **Topics** | **Credit** | **Lectures** |
| **Unit-I**<br>**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.<br>• Structure of these virus-coat and envelope protein, genome composition.<br>• Pathogenesis (Mechanism of infection) and Acute Clinical manifestations (Signs and symptoms) of H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus.<br>• Diagnosis, and Treatment for H1N1, MERS, SARS, Swine flu, COVID-19, Nipah virus, Ebola virus.<br>• Economic and Social loss due to t Viruses. | **4** | **15** |

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|---|---|---|---|
| **Unit- II**<br>**Epidemiology of Infectious Diseases** | • Concept of Host, Reservoir, Source of infection, Carrier, Epidemic, Endemic, Pandemic, Outbreak<br>• History, Definition scope, importance of epidemiology<br>• Epidemiology, Health & Public Health<br>• Epidemiological principles in prevention & control of disease<br>• Measures of disease frequency – Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality<br>• Epidemiological studies Organizations in disease control & Research – WHO, CDC, UNICEF, NACO, ICMR, NARI, NIV & NGOs | | **15** |
| **Unit- III**<br>**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<br>• Bacteria as emerging pathogens / Diseases caused by bacteria: MOTT, Legionella, Conditions caused by *Helicobacter pylori*<br>• Viruses as emerging pathogens / Diseases caused by viruses: HIV (AIDS), Chikungunya, Dengue,<br>• Parasites as emerging pathogens / Diseases caused by parasites: Malaria, *Entamoeba histolytica* (Amoebic dysentery) | | **15** |
| **Unit- IV**<br>**Biofilms**<br>**&**<br>**Antimicrobial Activity** | • Structure of Biofilm – Extracellular polymeric substances, Biofilm architecture.<br>• Stages in formation of Biofilm.<br>• Microbial interactions in Biofilms (Quorum sensing) Need for formation of Biofilms by microorganisms.<br>• Microorganisms commonly associated with biofilms on indwelling medical devices | | **15** |

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| | Response of biofilms to host defense mechanisms & antimicrobial agents<br>• Recent advances in biofilm management.<br>• Conventional methods of drug susceptibility testing (Kirby-Bauer disc diffusion, Stoke's method, E test)<br>• Advanced methods- Macro & Micro broth dilution methods, Time kill curves, serum killing curves and checker-board assays.<br>• Detection of drug resistance in Staphylococci, Streptococci, Enterococci. Automated methods of sensitivity testing. Concept of CLSI standards. | | |

## References:


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|---|---|
| **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, 10thedUniversities 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 |

## M.Sc. Biotechnology
## Semester –III
## Paper-II - Environmental Biotechnology (PBT3EBT)

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| **Course Objectives** | • This course aims to introduce learners to latest concepts in environmental biotechnology, various types of pollutions, monitoring, latest mitigation strategies and management of the same. Health hazards of pollution and waste, solid waste management, biodiversity concepts and data management and environmental monitoring. | | |
| **Course Outcomes** | • 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. | | |
| **Units** | **Topics** | **Credit** | **Lectures** |
| **Unit -I**<br>**Air pollution and Management** | • Air pollution & air Quality Monitoring, Sampling, and Source Apportionment.<br>• Air Pollution Management in Urban Settlement & Rural Areas, Integrated Air Pollution Management, Green Belt. Bio scrubber. Catalytic Systems. Green Technology.<br>• Ozone Layer Depletion Atmospheric Brown Cloud Impact on Flora and Fauna Impact on Crop Yield, concept of carbon credit, footprint. | **4** | **15** |
| **Unit -II**<br>**Soil pollution And Solid waste Management** | • Causes of soil salinity; Chemical and metallic pollution of agricultural soil; Mining and soil pollution.<br>• Bioleaching of metals, bioaugmentation & biomagnifcation for soil remediation.<br>• Phytostabilization - Contaminant removal, Soil cover, Rhizosphere modification, 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; | | **15** |

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| | • Solid waste management, Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes. | | |
| **Unit -III Water Pollution and Management** | • Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms.<br>• Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, microplastics);<br>• 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** |
| **Unit- IV Biodiversity & Environment 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 interoperatability, taxonomically intelligent systems, Global biodiversity information system-Overview of the UNEP/GEF biodiversity data management project (BDM)<br>• Biosensors in Environmental Monitoring – Working & its application for monitoring environment pollutants, Application of protein biomarkers; Biosensors and biochips. IOT for water quality monitoring – General working, Application, water Parameters. | | **15** |

## References:


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| 2. | Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press |
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| 15. | Gareth M. Evams et al., (2003) Environmental Biotechnology: Therory & Applications, Wiley. |
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| 21. | Rastogi, S. C., Rastogi, S. C., Mendriratta, N., & Rastogi, P. (2006). *Bioinformatics: Concepts, Skills & Applications*. CBS Publishers & Distributors Pvt. Limited. |
| 22. | Sensen, C. W. (2005). *Handbook of genome research: genomics, proteomics, metabolomics, bioinformatics, ethics and legal issues; Vol. 1 und 2*. Wiley-VCH Verlag GmbH & Co. KGaA. |

## M.Sc. Biotechnology
## Semester –III
## Paper-III- Biologics and Regulatory Affairs (PBT3BRA)

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| **Course Objectives:** | • To introduce learner to the basic concept of Biologics and Biosimilars, and its therapeutic uses<br>• To expose learner to the methodologies/steps involved in the production of Biologics/Biosimilars.<br>• To educate learner with the nuances of characterization of Biosimilars with emphasis on Reference Biologic.<br>• To familiarize learner with the regulatory aspects of approval of a Biologic/Biosimilar. | | |
| **Course Outcomes** | At the end of the course, the learner will be:<br>• Familiar with the basic concepts and significance of Biologics/Biosimilar in addition to having knowledge about its therapeutic applications Knowledgeable in the steps involved in the production of Biologics/Biosimilars<br>• Aware of the protocols/techniques required for characterization of the Biosimilars relative to the Reference Biologic<br>• Acquainted with the regulatory aspects of approval of a Biosimilars. | | |
| **Unit** | **Topics** | **Credits** | **Lectures** |
| **Unit- I**<br><br>**Introduction to Biologics and Biosimilars** | • Definition: Drugs, Small molecules, Large molecules/Biologics; Categories of Biologics: protein-based hormones, enzymes, monoclonal antibodies, vaccines, blood products, and gene/ cellular therapies.<br>• Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars.<br>• USFDA Approved Small Molecules and USFDA Approved Generics USFDA Approved Biologics and USFDA Approved Biosimilars.<br>• Indian Regulatory Scenario in relation to Small Molecules and Biologics.<br>• Therapeutic uses of some of the Biologics/Biosimilars Acceptable quality differences between approved Biosimilar and innovator's product. | **4** | **15** |

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| **Unit- II**<br><br>**Production of Biologics and Biosimilar s** | • 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.<br>• Major factors contributing to the maintenance of product quality: raw materials and manufacturing conditions, virus filtration, mycoplasma removal, ultrafiltration.<br>• Example: Production of Monoclonal antibody, downstream processing of Mab Introduction to the concept of Biobetters vs Biosimilars. | | **15** |
| **Unit- III**<br><br>**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.<br>• 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** |
| **Unit- IV**<br><br>**Quality Assurance**<br><br>**&**<br><br>**Regulatory Affairs of Biologics and Biosimilars** | • Introduction to Regulatory Affairs and approvals of Biosimilars, Products approved under the FD&C.<br>• PHS/BCPI Act 2009: Innovator Biologics Approval, Biosimilar Pathway, Totality of Evidence, Information required to demonstrate biosimilarity, Inter changeability, Product Switching, Product Naming Global regulatory framework. | | **15** |

## References:


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| 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. | International Journal of Drug Regulatory Affairs; 2017, 5(1), 20-24. |
| 8. | Introduction to Biosimilars and Regulatory Requirements. Fact Sheet 3. International Federation of Pharmaceutical Manufacturers & Association (Geneva) & International Alliance of Patients Organization (UK). |

# M.Sc. Biotechnology
# Semester –III
## Paper-IV-Molecular Enzymology and Enzyme Technology (PBT3MET)

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| **Course Objectives** | • To get familiarity with the basic concepts of enzymes like enzyme kinetics, catalytic power of enzymes, active site and transition sate, regulatory and allosteric enzymes, on protein enzymes.<br>• Techniques of enzyme purification and its importance. Need for enzyme engineering and its benefits and applications.<br>• Role of enzymes as a diagnostic tool and for industrial applications. Use of enzymes as Biosensors. | | |
| **Course Outcomes** | • 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. The need for and methods for enzyme engineering to enhance its activity or half-life.<br>• The significance of enzymes as diagnostic tools, in therapy, industrial application and as biosensors; and the outcome of enzyme deficiencies. | | |
| **Unit** | **Topics** | **Credits** | **Lectures** |
| **Unit-I Basic concepts of Enzymology** | • Brief history and introduction; chemical nature and properties of enzymes;<br>• **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;<br>• **Regulatory enzymes**, regulation of enzyme activity; **allosteric enzymes** and their kinetic properties; units of enzymes; non protein enzymes. | **4** | **15** |
| **Unit-II Techniques of Enzyme Purification and Studies /Enzyme Engineering** | Purification and Characterization:<br>• Based on molecular size (Dialysis/ ultrafiltration, density gradient centrifugation, size exclusion chromatography);<br>• based on solubility of proteins (Isoelectric precipitation, salting out); Based on electric charge | | **15** |

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| | (Ion exchange chromatography, Electrophoresis-capillary electrophoresis, 2D electrophoresis);<br>• Based on adsorption properties (Adsorption and Affinity chromatography).<br>• Other techniques: Immobilized metal ion affinity chromatography, Hydrophobic interaction chromatography, Reversed-phase chromate-graphy and Chromato-focusing.<br>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. | | |
| **Unit-III Industrial & Medical Application Of Enzymes** | • 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.<br>• Biosensors – Introduction, instrumentation, Types and examples.<br>• 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. | | **15** |
| **Unit-IV Enzyme Deficiencies/ Diagnostic Enzymes/ Therapeutics** | • Disorders of amino acid metabolism-Phenylketonuria, Alkaptonuria, Homocystinuria.<br>• Disorders of carbohydrate metabolism – Galactosemia, Hereditary fructose intolerance, hereditary lactose intolerance.<br>• Disorder of lipid metabolism - Gaucher disease, Fabry disease.<br>• Enzymes in diagnosis of diseases- Liver disorders, Cancer, Cardiac disorders.<br>• Role of Other enzymes- Lysozyme, Butyryl choline esterase and Lipases. | | **15** |

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| | • Therapeutic uses of enzymes - enzymes in replacement therapy enzymes in cancer treatment, enzymes for fibrinolysis, enzymes used for various treatments and enzyme gene therapy.<br>• Iso-enzymes; enzyme pattern in diseases. | | |

**References**:


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|---|---|
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# M.Sc. Biotechnology
# Semester –III
## PRACTICAL- I (PBT3PR1) 4 Credits

## Paper-I

| | |
|---|---|
| 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 |
| 8. | Demonstration of minimum biofilm inhibition concentration of antibiotics/disinfectants |

## Paper-II

| | |
|---|---|
| 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. |

# M.Sc. Biotechnology
# Semester –III
## PRACTICAL- I (PBT3PR2) 4 Credits

## Paper-III

| | |
|---|---|
| 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. | Western blot/dot blot for purity of product demonstration/ dummy sandwich preparation of semi-dry or wet western blot sandwich. |
| 4. | HPLC /FTIR/NMR spectrum based theory questions may be asked for interpretation |
| 5. | Visit to a facility manufacturing Biosimilar |

## Paper-IV

| | |
|---|---|
| 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 any 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. |

# Semester-IV

# M.Sc. Biotechnology
## Semester –IV
## Nanobiotechnology (PBT4NBT)

| | | | |
|---|---|---|---|
| **Course Objectives** | • The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology.<br>• It will familiarize students with the synthesis and applications of nanomaterials in the field of medicine.<br>• The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life. | | |
| **Course Outcomes** | • Students should be able to understand the basic science behind the properties of nanomaterials and the principles behind advanced experimental techniques for studying nanomaterials. Also understand the different aspects and applications of nanomaterials. | | |
| **Unit** | **Topic** | **Credits** | **Lectures** |
| **Unit -I Introduction to Nanotechnology and Nanomaterials** | • Introduction: Nanotechnology, Nature's biological pathway, Examples of nanomaterials and nanostructures found in nature.<br>• Nanometer-scale materials: Nanometer-Scale Metals Nano Metal Oxides, Nanopolymers, Quantum Dots, Carbon nanostructures.<br>• Nanorobotiocs devices of nature ATP synthase, the kinesin, myosin, dynein, flagella modulated motion. | **4** | **15** |
| **Unit -II Synthesis of Nanomaterials** | • Synthesis of nanometer-scale materials- Top down and Bottom up approaches.<br>• Self-Assembly of nanoparticles and its mechanism.<br>• Bio-directed synthesis and assembly of nanomaterials Synthesis and Assembly of Nanoparticles and Nanostructures Using Bio-Derived Templates | | |
| **Unit -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,<br>• Nanomedicine: biopharmaceutics, implantable materials, implantable chemicals, surgical aids. | | |

| | | | |
|---|---|---|---|
| **Unit –IV Applications of nanotechnology and Nanotoxicology** | • Applications of Nanomaterials.<br>• Nanotoxicology: Unique Properties, Toxicity of Nanomaterials, Factors Responsible for the Nanomaterial Toxicity, Routes of Exposure, Mechanisms of Nanoparticle Toxicity,<br>• In Vitro Testing Methods for Nanomaterials, Ecotoxicity Analyses of Nanomaterials | | |

**References:**


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|---|---|
| 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. |
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| 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) |

## M.Sc. Biotechnology
## Semester –IV
## OMICS & Systems Biology (PBT4OSB)

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|---|---|
| **Course objective:** | • Bring awareness of the emerging fields of OMICS and Systems Biology, biological systems as a whole and how parts of a systems interact with each other To introduce the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics.<br>• To describe the key features of human genome project<br>• To understand the applications of the different OMICS technology to screening, testing and treatment of human diseases.<br>• Perturbation of biological systems to study various responses in the biological systems using high throughput techniques.<br>• Introduction to the modeling systems, databases, computational tools used in systems biology Data mining: The unit aims at introducing the concept of knowledge discovery process, data mining methods and various scientific application of data mining. The unit also explores application of systems biology in different field of health care. |
| **Course outcome:** | **At the end of the course learners will be able to**<br>• Understand how the data is generated by OMICS technologies to contribute to different databases.<br>• Understand, compare and contrast the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics.<br>• Will be able to apply the different technologies of OMICS to the screening, testing and treatment of human diseases.<br>• 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.<br>• 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. |

| Unit | Topic | Credit | Lectures |
|---|---|---|---|
| **Unit-I OMICS- The OMICS Technology, A Broad Outlook** | • Tools of Omics-Introduction to Epigenomics Human genome project- goals, conclusions and application.<br>• Structural and functional proteomics- protein- protein interaction and identification of interactions by various methods.<br>• Application of Proteomics and Genomics in human diseases –screening, testing and treatment of diseases.<br>• Metagenomics: concept, strategies, and applications in environmental biotechnology, agriculture and health | **4** | **15** |
| **Unit-II Transcriptomics, Lipidomics and Metabolomics** | • Introduction to Transcriptomics, Lipidomics And Metabolomics, Glycomics,<br>• Pharmacogenomics Techniques used in Lipidomics- Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI.<br>• Technique used in Metabolomics- Mass Spectroscopy, Electrophoresis, chromate-graphy- GC, LC & NMR.<br>• Technique used in Transcriptomics- next generation sequencing, northern blotting, DDRT-PCR, microarrays, gel free assays like biolayer interference, SPR.<br>• Applications of transcriptomics metabolomics and lipidomics in human diseases –screening, testing and treatment of diseases. (in clinical applications, personalized medicine, infectious diseases) | | **15** |
| **Unit-III Introduction to Systems Biology** | • Systems biology towards systems level understanding of biological systems<br>• Systems structure, systems dynamics, systems design and control, systems project Models and Modelling systems in systems biology<br>• What is a model? Key properties of models, Basic of computational models, networks, | | **15** |

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|---|---|---|---|
| | data integration, standards, and model organism<br>• Perturbation of biological systems and 'Omics' as Quantitative high throughput experimental tools for systems biology Standards and formats for systems biology.<br>• Computational Databases and software tools in systems biology.<br>• Biological networks: metabolic networks, gene regulatory networks, PPI networks, genetic interaction (GI) networks, and signaling networks. | | |
| **Unit-IV**<br>**Data mining and Application of Systems Biology** | • Introduction to Knowledge of discovery in databases (KDD) What is knowledge, need for KDD, KDD process outline, concept and goals.<br>• Data Mining methods: Statistics – classification, correlation, association analysis, regression, and clustering Machine learning –Symbolic and statistical approaches.<br>• Text mining, and Pattern evaluation.<br>• Data mining in scientific application<br>• Application 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. | | **15** |

## References


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|---|---|
| 1. | Bioinformatics and functional genomics (2003). Jonathan Pevsner John wiley & sons Publications. |
| 2. | Integration of omics approaches and systems biology for clinical applications. Antonia Vlahou, Harald Mischak, Jerome Zoidakis, Fulvio Magni. Wiley publications. |
| 3. | Omic technologies: genomics, transcriptomics, proteomics and metabolomics. Richard P. Horgan And Louise C. Kenny Scientific advisory committee (sac), the obstetrician and gynaecologist. |
| 4. | Bioinformatics and functional Jonathan Pevsner. Wiley blackwell genomics, *third edition* publications. |

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|---|---|
| 5. | Concepts and techniques in genomics and proteomics- Nachimuthu Saraswathy And Ponnusamy Ramalingam. Biohealthcare publishing (oxford) limited. |
| 6. | Introduction to proteomics-*tools for the new biology- by* Daniel C. Liebler, Humana press totowa, nj. |
| 7. | Introduction to proteomics principles and applications By Nawin Mishra John Wiley & sons, inc., publication. |
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| 10. | Human molecular genetics 4th edition. Tom Strachan and Andrew Read Garland science. |
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| 12. | Topics in current genetics-metabolomics- a powerful tool in systems biology Jens Nielsen · Michael C. Jewett (Eds) Springer publications. |
| 13. | Foundations of systems biology. First edition Hiraokikitano(2001) MIT press, Cambridge |
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| 15. | Systems biology a textbook, second edition Edda Klipp, Wolfram Liebermeister, Christoph Wierling Axel Kowald Wiley-vch publication. |
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| 20. | Computational systems biology Andrieskreite, Roland Eils Elsevier academic press. |
| 21. | introduction To Biological Networks Alpan Ravaland Animesh Ray CRC press (2013). |
| 22. | Advanced systems biology methods in drug discovery and translational biomedicine Jun Zou Biomed research international volume 2013. |

## M.Sc. Biotechnology
## Semester –IV
## Drug Discovery & Clinical Study (PBT4DDC)

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|---|---|---|---|
| **Course Objectives:** | • The objective of this course is to have a firm foundation in Drug Discovery and Clinical Studies.<br>• To provide students' knowledge about Clinical Trial Design and Indian Regulations, Pharmacovigilance and Clinical Data Science. | | |
| **Course Outcomes:** | By the end of the course the student will:<br>• Able to learn about drug discovery-design pathway using some in-silico tools. Able to understand the clinical trial design set up as well as they will gain information on rules-regulation and responsibilities in clinical studies. | | |
| **Unit** | **Topics** | **Credit** | **Lectures** |
| **Unit-I**<br><br>**Clinical Research Informatics in Drug Discovery** | **Introduction to the drug discovery & development**<br>• Source of drugs<br>• Structural effects on drug action<br>• Drugs derived from natural products<br>• General principles of pharmacology<br>• Drug development and testing process<br>**Approaches to new drug discovery**<br>• Computer-aided drug design<br>• Identification of novel drug candidates and drug targets<br>• Construction the signaling network of a drug using integer linear programming<br>• Identification for druggable targets of a disease | **4** | **15** |
| **Unit II**<br><br>**Clinical Trial Design And Indian Regulations** | **Clinical Trial Design**<br>• Basic framework of clinical trial<br>• Randomized clinical trials and different phases<br>• Adaptive randomization methods<br>• Seamless design<br>• Internal pilot design<br>• Design selection factors | | **15** |

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|---|---|---|---|
| | **Regulations**<br>• The national regulatory body<br>• Key documents in clinical research<br>• Regulatory requirements for the conduct of clinical trials in India<br>**The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial Data**<br>• Participants in clinical trials, Investigators,<br>• Research institutions and universities<br>• Journals and Professional societies | | |
| **Unit III**<br>**Pharmaco-vigilance** | **Scope and purposes of pharmacovigilance**<br>• Adverse Drug Reactions (ADR)<br>• ADR classification<br>• Nature and mechanism of ADR<br>• Concept of safety<br>• Phases and types of DATA<br>**The process of Pharmacovigilance**<br>• Signal detection, evaluation and investigation,<br>• Communication<br>**Methods of evaluating effectiveness of action**<br>**International regulatory collaboration**<br>• WHO, CIOMS, ICH, ISoP, ISPE | | **15** |
| **Unit-IV**<br>**Clinical Data Science** | **Data management in clinical research: An overview**<br>• Data Sources and Data Types<br>• Standards in Healthcare Data<br>• Research Data Stewardship for Healthcare Professionals<br>• Preparing Data for Prediction Model Development<br>• Prediction Modeling Methodology<br>• Clinical Decision Support System | | **15** |

## References:


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|---|---|
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|---|---|
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| 4. | Bioinformatics and Drug Discovery, Third Edition, (A Computational Platform and Guide for Acceleration of Novel Medicines and Personalized Medicine, Chapter 10) Richard S. Larson, Tudor I. Oprea https://doi.org/10.1007/978-1-4939-9089-4 |
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| 6. | Clinical Trial Designs, Indian Dermatol Online J. 2019 Mar-Apr; 10(2): 193–201. Brijesh Nair doi: 10.4103/idoj.IDOJ_475_18 PMCID: PMC6434767 PMID: 30984604 |
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| 11. | An Introduction to Pharmacovigilance, Second Edition Patrick Waller and Mira Harrison- Woolrych ISBN 9781119289753 (Adobe PDF) |
| 12. | Data management in clinical research: An overview, Indian J Pharmacol. 2012 Mar-Apr; 44(2): 168–172. Binny Krishnankutty, Shantala Bellary, and Latha S. Moodahadu doi: 10.4103/0253-7613.93842 PMCID: PMC3326906 PMID: 2252946 |
| 13. | Fundamentals of Clinical Data Science Pieter Kubben, Michel Dumontier Andre Dekker ISBN 978-3-319-99712-4 ISBN 978-3-319- 99713-1 (eBook) https://doi.org/10.1007/978-3-319-99713-1 |

## M.Sc. Biotechnology
## Semester –IV
## Scientific Writing & Food Biotechnology (PBT4SWF)

| | | | |
|---|---|---|---|
| **Course Objectives:** | • To develop skills for the processing and analysis of scientific data.<br>• To enable students to present their research results in the format of oral or poster presentations at conferences, to write scientific publications (theses, articles) and to prepare applications for scientific grants (research proposals).<br>• To inculcate good scientific writing practices. | | |
| **Course Outcomes:** | • Think critically, organize and analyze scientific data.<br>• Develop advanced scientific writing skills to write research articles, reviews, thesis, and proposals and to make oral, poster or power point presentations. Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism. | | |
| **Unit** | **Topics** | **Credit** | **Lectures** |
| **Unit-I**<br>**Basic Scientific Writing and Plagiarism** | **Introduction to scientific writing.**<br>• Basic scientific writing skills: style and language, spelling, grammar, syntax, jargon and sentence structure.<br>• Elements of a scientific paper: abstract, introduction, materials & methods, results, discussion, references and drafting titles.<br>• Scientific writing process: thinking, planning, rough draft, revision of content.<br>• Processing data & application of statistics Displaying data: text, table, graph and defining terms and abbreviations.<br>• Statistical analysis and tools for experimental data.<br>• Referencing software: Mendeley, Endnote. Plagiarism: Definition, Common types of plagiarism, Intentional and Unintentional plagiarism, Detection of plagiarism by anti-plagiarism tools (Turnitin, Duplichecker, Viper, Copyleaks), Penalties for plagiarism, Avoiding plagiarism. | **04** | **15** |

| | | | |
|---|---|---|---|
| **Unit II**<br>**Advanced Scientific Writing** | **Guidelines for Medical writing.**<br>**Scientific writing skills:**<br>• Writing a research paper for biomedical journal,<br>• Writing science research papers and articles, Writing a research proposal,<br>• Writing a research report, writing popular reports, writing thesis and dissertation, Writing clinical study reports.<br>• Presentation skills: Oral presentation, Poster Preparation & presentation, PowerPoint presentations.<br>• Research ethics, Scientific misconduct. | | **15** |
| **Unit III**<br>**Food Biotechnology-Nutraceuticals** | • Nutraceuticals and functional foods Definition, characteristic features, and classification, phytonutraceuticals,<br>• 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** |
| **Unit-IV**<br>**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<br>• Nutraceuitcals in management of health and disease<br>• Development of designer foods for specific chronic diseases<br>• Nutraceutical adjuvants | | **15** |

## References:


| | |
|---|---|
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| *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). |
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| 6. | htps://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/ |
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| 11. | https://www.bowdoin.edu/dean-of-students/judicial-board/academic-honesty-and-plagiarism/ common-types-of-plagiarism.html |
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| 13. | https://holyfamily.libguides.com/c.php?g=610218&p=4236572 |
| 14. | https://plagiarismdetector.net |
| 15. | https://www.duplichecker.com |

# M.Sc. Biotechnology
# Semester –IV
## PRACTICAL- I (PBT4PR1) 4 Credits
## Paper-I

| | |
|---|---|
| 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 nano shell coating of polymer |
| 5. | Antimicrobial activity testing of Nanoparticles/nanocomposites |

## Paper-II

| | |
|---|---|
| 1. | Gel electrophoresis of lipids (lipoproteins exrtacted from various sources) to separate and identify the lipid fraction |
| 2. | Preparation of report based on -Databases and data repositories used in systems Biology |
| 3. | Detection assay for gene expression using micro array and qRT –PCR (demonstration) |
| 4. | Identification of protein using analytical technique Mass spectroscopy (demonstration) |

# M.Sc. Biotechnology
# Semester –IV
## PRACTICAL- I (PBT4PR2) 4 Credits

## Paper-III

| | |
|---|---|
| 1. | Exploration of various learning platforms in online courses listed below : |
| | Online courses in fundamentals of Neuroscience from Harvard University https://online-learning. harvard.edu/course/fundamentals-neuroscience-part-1-electrical-properties-neuron? delta=0 |
| | Molecular Biology from MIT https://ocw.mit.edu/courses/biology/7-28-molecular-biology-spring- 2005/ |
| | Introduction to Bioethics from Georgetown https://bioethicsarchive.georgetown.edu/phlx101-2/course.html#units/introduction |
| 2. | 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 |
| 3. | Complete an online course (Minimum 1 week) on the topic related to the biotechnology. Write a comprehensive report on the studied course contents. |
| | Swayam https://swayam.gov.in/ |
| | NPTEL https://nptel.ac.in/noc/ |
| | MOOC https://www.it.iitb.ac.in/frg/wiki/images/7/7b/Demo-PPT.pdf |
| | E-learning https://www.bellevuecollege.edu/elearning/start/intro/ |

## Paper-IV

| | |
|---|---|
| 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. | Estimation of vitamin B by HPLC (demonstration) |
| 5. | Study of nutraceuticals important plants like Zinziber, Curcuma, Alovera, Asparagus, Ocimum etc. |
| 6. | Estimation of antioxidant property of phytochemical by DPPH. |
| 7. | Qualitative test for tannins, phenols, isoflavones, alkaloids using TLC. |
| 8. | Estimation of food preservatives/additives (Parabens) from food sample by HPLC (demonstration). |
| 9. | Estimate Cholesterol contents in given sample by Zak's methods |
| 10. | Estimation of bio-burden by viable counts. |
| 11. | Estimation of gluten from food sample. |
| 12. | To study nutritional components (protein, carbohydrate, secondary metabolites, lipids, vitamin C) of following: Bee honey, Mushrooms, Lentils, Soya, Dairy product, Amla, Papaya, Spinach |

## Practical References:


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