**MSc Biotechnology Course Structure**

**Semester III**

| Course code | Title | Theory /Practical | Marks | Credits | No. of Lectures /week |
|---|---|---|---|---|---|
| **PSBT 301** | Applied Virology and microbiology | Theory | 100 | 4 | 1 |
| **PSBT 302** | Environmental Biotechnology | Theory | 100 | 4 | 1 |
| **PSBT 303** | Biologics and Regulatory Affairs | Theory | 100 | 4 | 1 |
| **PSBT 304** | Molecular Enzymology and Enzyme Technology | Theory | 100 | 4 | 1 |
| **PSBTP301** | Practical I | Practical | 50 | 2 | 4 |
| **PSBTP302** | Practical II | Practical | 50 | 2 | 4 |
| **PSBTP303** | Practical III | Practical | 50 | 2 | 4 |
| **PSBTP304** | Practical IV | Practical | 50 | 2 | 4 |
| | **TOTAL** | | **600** | **24** | |

**MSc Biotechnology Course Structure**

**Semester IV**

| Course code | Title | Theory /Practical | Marks | Credits | No. of Lectures/ week |
|---|---|---|---|---|---|
| **PSBT 401** | Nanobiotechnology | Theory | 100 | 4 | 1 |
| **PSBT 402** | OMICS & Systems Biology | Theory | 100 | 4 | 1 |
| **PSBT 403** | Drug Discovery & Clinical Study | Theory | 100 | 4 | 1 |
| **PSBT 404** | Scientific Writing & Food Biotechnology | Theory | 100 | 4 | 1 |
| **PSBTP401** | Practical I | Practical | 50 | 2 | 4 |
| **PSBTP402** | Practical II | Practical | 50 | 2 | 4 |
| **PSBTP403 & PSBTP404** | Practical III & IV | Practical | 100 | 4 | 8 |
| | **TOTAL** | | **600** | **24** | |

**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.

**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. Semester III- Theory -Internal assessment (40%) -40 marks**

| Sr No | Evaluation type | Marks |
|---|---|---|
| 1. | Assignments that can include article writing, report writing, preparation of a review, on any topic selected from each paper<br>OR<br>PowerPoint presentation on a topic from the syllabus or related to the syllabus<br>*Note: The student can submit only 2 assignments and give 2 PowerPoint presentations per semester. Respective college/department can decide the allocation.* | 30 |
| 2. | **a.** Active participation in routine class instructional deliveries | 05 |
| | **b** Overall conduct as a responsible student, w.r.t manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc. | 05 |
| | Total Marks | 40 |

**Semester IV- Theory -Internal assessment (40%) -40 marks**

| Sr. No | Evaluation type | Marks |
|---|---|---|
| 1. | **For PAPER 1 & 2**<br>Assignments that can include article writing, report writing, preparation of a review, on any topic selected from each paper<br>OR<br>PowerPoint presentation on a topic from the syllabus or related to the syllabus<br>*Note: The student can submit only 1 assignment and give 1 PowerPoint presentations per semester. Respective college/department can decide the allocation*<br>**FOR PAPER 3:**<br>The students have to present a clinical case/trial study report. | 30 |
| 2. | **a.** Active participation in routine class instructional deliveries | 05 |
| | **b** Overall conduct as a responsible student, w.r.t manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc. | 05 |
| | Total Marks | 40 |

| Sr. No | Evaluation type | Marks |
|---|---|---|
| 3. | **FOR PAPER 4:**<br>The internal assessment will comprise of the following:<br>a. Online course:<br>The student is expected to complete at least one online course relevant for the subject from any of the appropriate reputed online platforms.<br>A proof of successful completion of the online course must be provided for the award of marks. | 20 |
| | b. Research Proposal:<br>The student is expected to submit a research proposal relevant to the subject. | 20 |
| | Total Marks | 40 |

**B. Theory -External examination -60%**

**Semester End Theory Assessment- 60 marks**

- The duration of this exam will be of 2.5 hours (150 minutes)
- The theory question paper will have 5 questions each of 12 marks.
- For each unit, there will be one question and the fifth will be based on all the four units.
- The fifth question will have 6 sub-questions out of which the student has to attempt any 3.
- All questions shall be compulsory with internal choice within the questions such that each question will be set of 24 marks with options.

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

| | | |
|---|---|---|
| 1. | Practical Question 1 | 25 |
| 2. | Practical Question 2 | 15 |
| 3. | Journal | 5 |
| 4. | Viva Voce | 5 |
| OR | | |
| 1. | Practical Question | 40 |
| 2. | Journal | 5 |
| 3. | Viva Voce | 5 |
| | | |
| | Semester IV- Project Dissertation | 100 Marks |
| | 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.<br>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.<br>A certificate must be appended with the thesis.<br>The external examiner will assess for 50M as a Presentation during practical exams.<br>Marks allotted by Internal examiner would be scaled down if required as per university guidelines. | |

**A certified copy of the journal is essential to appear for the practical examination.**

Note:

- In case of any changes in the above-mentioned evaluation scheme, the chairperson of examinations would provide the necessary details and the format.
- 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.

## M.Sc. BIOTECHNOLOGY

## SEMESTER- III

| PSBT301- Applied Virology & Microbiology | | | | |
|---|---|---|---|---|
| **Course Objectives** | Students will be exposed to pandemic diseases, significance of epidemiology in studying various diseases and societal & economic issues related to such diseases**.** 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. 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. | | | |
| **Course Code** | **Unit** | **Unit Details** | **Credits** | **Lectures** |
| **PSBT302** | I<br><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 viruse-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 | 1 | 15 |
| | II<br><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 –<br>Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality<br>Epidemiological studies<br>Organizations in disease control & Research – WHO, CDC, UNICEF, NACO, ICMR, NARI, NIV & NGOs | 1 | 15 |

| | | | | |
|---|---|---|---|---|
| | | | | |
| | III<br><br>Medical Microbiology | Emerging Pathogens / Infections : Diseases caused by Bacteria / parasites/ viruses<br>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 :<br>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) | 1 | 15 |
| | IV<br><br>Biofilms & Antimicrobial Activity | Structure of Biofilm – Extracellular polymeric substances, Biofilm architecture. Stages in formation of Biofilm. Microbial interactions in Biofilms (Quorum sensing)<br>Need for formation of Biofilms by microorganisms<br>Microorganisms commonly associated with biofilms on indwelling medical devices<br>Response of biofilms to host defense mechanisms & antimicrobial agents<br>Recent advances in biofilm management.<br><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, checker-board assays.<br>Detection of drug resistance in Staphylococci, Streptococci, Enterococci.<br>Automated methods of sensitivity testing.<br>Concept of CLSI standards | 1 | 15 |

**PSBTP-301 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
8. Demonstration of minimum biofilm inhibition concentration of antibiotics/disinfectants.

**References**


| | |
|---|---|
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| 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 |

| PSBT302-Environmental Biotechnology | | | | |
|---|---|---|---|---|
| **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. | | |
| **Course Code** | **Unit** | **Unit Details** | **Credits** | **Lectures** |
| **PSBT 302** | I<br>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. | 1 | **15** |
| | II<br>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 & biomagnifcation for soil remediation. 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; solid waste management, Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes. | 1 | 15 |
| | III<br>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 | 1 | 15 |

| | | | | |
|---|---|---|---|---|
| | | wetland, Mechanisms to remove pollutants from constructed wetlands | | |
| | 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), 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 | 1 | 15 |

**PSBTP 302-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.

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|---|
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| PSBT303- Biologics & Regulatory Affairs | | | | |
|---|---|---|---|---|
| **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<br>Knowledgeable in the steps involved in the production of Biologics/Biosimilars<br>Aware of the protocols/techniques required for characterization of the Biosimilar relative to the Reference Biologic<br>Acquainted with the regulatory aspects of approval of a Biosimilars. | | |
| **Course Code** | **Unit** | **Paper 3: Biologics & Regulatory Affairs** | **Credits** | **Lectures** |
| **PSBT 303** | **Unit 1**<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<br>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<br>Acceptable quality differences between approved Biosimilar and innovator's product | 1 | 15 |

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|---|---|---|---|---|
| | **Unit 2**<br><br>**Production of Biologics and Biosimilars** | Reference Biologic and its significance,<br>Choice of expression system/s and stability of cell lines<br>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<br>Introduction to the concept of Biobetters vs Biosimilars | 1 | 15 |
| | **Unit 3 Characterization of Biologics and Biosimilars** | Appearance, particulates, pH, osmolality, particle size<br>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<br>Fluorescence spectrum<br>FTIR spectrum and NMR spectrum<br>Bioassays, characterization using Monoclonal Antibody as an example | 1 | 15 |
| | **Unit 4 Quality assurance & 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<br>Global regulatory framework | 1 | 15 |

**PSBT303- 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) 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


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

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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.

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| **PSBT304- Molecular Enzymology and Enzyme Technology** | |
|---|---|
| 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. |

| | |
|---|---|
| | 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.<br><br>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. The significance of enzymes as diagnostic tools, in therapy, industrial application and as biosensors; and the outcome of enzyme deficiencies. |

| **Course code** | **Unit** | **Molecular Enzymology and Enzyme Technology** | **Credits** | **Lectures** |
|---|---|---|---|---|
| PSBT304 | I<br>**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. | 4 | 15 |
| | II<br>**Techniques of Enzyme purification and studies/enzyme engineering** | 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 | | 15 |

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|---|---|---|---|---|
| | | Chromatofocusing.<br><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. | | |
| | III<br><br>**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><br>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. | | 15 |
| | IV<br>**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.<br><br>Enzymes in diagnosis of diseases- Liver disorders, Cancer, Cardiac disorders. Role of Other enzymes- Lysozyme, Butyrylcholinesterase and Lipases.<br><br>Therapeutic uses of enzymes - enzymes in replacement therapy, | | 15 |

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|---|---|---|---|---|
| | | enzymes in cancer treatment, enzymes for fibrinolysis, enzymes used for various treatments and enzyme gene therapy. | | |

**PSBTP 304-PRACTICALS**

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

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11. http://web.sungshin.ac.kr/~spark/class/enzchem/EnzChem_ch02.pdf Chapter 2 - purification of enzymes
12. https://www.labome.com/method/Protein-Purification.html
13. http://www1.lsbu.ac.uk/water/enztech/index.html Chapter 6 Enzyme preparation and use

14. https://docplayer.net/20937505- Protein-purification-nison-sattayasai-khon-kaen-university-thailand-1-introduction-2-extraction-of-protein.html
15. http://www.processdevelopmentforum.com/ppts/posters/ Protein_purification_methods-_overview,_29155460.pdf
16. https://www.researchgate.net/publication/281102215_ How_to_purify_proteins.
17. Fundamentals of Enzyme Engineering, Young Je Yoo, Yan Feng, Yong-Hwan Kim, Camila Flor J. Yagonia, : Springer Netherlands 2017.

## M.Sc. BIOTECHNOLOGY

## SEMESTER- IV

| PSBT401- Nanobiotechnology | | | | |
|---|---|---|---|---|
| **Course Objectives** | The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the synthesis and applications of nanomaterials in the field of medicine. 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. | | | |
| **Course Code** | **UNIT** | **Unit Details** | **Credits** | **Lectures** |
| **PSBT401** | 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. | 1 | 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 | 1 | 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 | 1 | 15 |
| | IV | Applications of Nanomaterials. | 1 | 15 |

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| | Applications of nanotechnology and Nanotoxicology | 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 | | |

**PSBTP 401-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

**References:**


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
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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)

| PSBT 402-OMICS AND SYSTEMS BIOLOGY | |
|---|---|
| **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<br>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 modellling systems , databases ,computational tools used in systems biology<br>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 .<br>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.<br>Understand the application of data mining in genomics , proteomics and development of tools in bioinformatics.<br>Have the knowledge of applications of systems biology in development of personalized medicine, drug development. |

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| **Course Code** | **UNIT** | **OMICS AND SYSTEMS BIOLOGY** | **credits** | **lectures (hours)** |
| **PSBT 402** | I<br><br>OMICS- the OMICS technology , a broad outlook | Tools of Omics. Introduction to Epigenomics<br>Human genome project- goals, conclusions and application. 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 | 1 | 15 |
| | II<br><br>Transcriptomics, Lipidomics And Metabolomics | Introduction to Transcriptomics, Lipidomics And Metabolomics, Glycomics, Pharmacogenomics<br>Techniques used in Lipidomics- Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI.<br>Technique used in Metabolomics- Mass Spectroscopy, Electrophoresis, chromatography- 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, personalised medicine, infectious diseases) | 1 | 15 |
| | III<br><br>Introduction to systems biology | Systems biology towards systems level understanding of biological systemsSystems structure, systems dynamics,systems design and control, systems project<br>Models and Modelling systems in systems biology What is a model? Key properties of models,Basic of computational models, networks, data integration, standards, and model organism<br>Perturbation of biological systemsand ‘Omics’ as Quantitative high throughput experimental tools for systems biology<br>Standards and formats for systems biologyComputational Databases and software | 1 | 15 |

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| | | tools in systems biology.<br>Biological networks: metabolic networks, gene regulatory networks, PPI networks, genetic interaction (GI) networks, and signaling networks | 1 | |
| | IV<br><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<br>Machine learning –Symbolic and statistical approaches.<br>Text mining, and Pattern evaluation.<br>Data mining in scientific applicationsApplication of systems biology : 1. Systems biology to systems medicine.<br>2. Application of systems biology in drug discovery and development<br>3. Systems biology and synthetic biology | | 15 |

**PSBTP 402-PRACTICALS :**

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)

**REFERENCES-**


| Sr no | Title of the book | Author | Publisher |
|---|---|---|---|
| 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 |

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|---|---|---|---|
| | genomics, *third edition* | | publications |
| 5. | Concepts and techniques in genomics and proteomics- | Nachimuthu Saraswathy And Ponnusamy Ramalingam. | Biohealthcare publishing (oxford) limited |
| 6. | Intrduction to proteomics- *tools for the new biology- by* | Daniel C. Liebler, | Humana press totowa, nj |
| 7. | Introduction to proteomics principles and applications | By Nawinmishra | John wiley & sons, inc., publication |
| 8. | Multi-omics approaches to disease | Hasin et.,Al; | Genome biology (2017) |
| 9. | The new science of metagenomics | Committee On Metagenomics: Challenges And Functional Applications, National Research Council, Board On Life Sciences | The national academies press. www.nap.edu |
| 10. | Human molecular genetics 4th edition | Tom Strachan And Andrew Read | Garland science |
| 11. | Systems biology a textbook, second edition | Edda Klipp, Wolfram Liebermeister, Christoph Wierling Axel Kowald | Wiley-vch publication |
| 12. | Lipidomics-technologies and applications (2012) | Dr. Kim Ekroos | Wiley wch publications |
| 13. | Topics in current genetics-metabolomics-a powerful tool in systems biology | Jens Nielsen · Michael C. Jewett (Eds) | Springer publications |
| 14. | Foundations of systems biology. First edition | Hiraokikitano(2001) | MIT press, Cambridge |
| 15. | Systems biology | Karthik Raman and Nagasuma Chandra, | Resonance February 2010 |
| 16. | A new approach to decoding life: systems biology | Trey Ideker | Article *in* annual review of genomics and human genetics · february 2001 |
| 17. | systems biology and synthetic biology (2009) | Pengcheng Fu, Sven Panke | Wiley publication |
| 18. | Analysis of biological networks (2008) | Bjorn .Junker, Falk Schreiber | Wiley Interscience |
| 19. | Knowledge discovery and data mining in biological databases | Vladimir Brus I C | The knowledge engineering review, vol. 14:3, 1999 |
| 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 |

<table>
<tr><th colspan="5">PSBT 403- Drug Discovery and Clinical Studies</th></tr>
<tr><td>Course Objectives:</td><td colspan="4">The objective of this course is to have a firm foundation in Drug Discovery and Clinical Studies. To provide students knowledge about Clinical Trial Design and Indian Regulations, Pharmacovigilance and Clinical Data Science.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="4">By the end of the course the student will:<br>Able to learn about drug discovery-design pathway using some in-silico tools.<br>Able to understand the clinical trial design set up as well as they will gain information on rules-regulation and responsibilities in clinical studies.</td></tr>
<tr><th>Course Code</th><th>Unit</th><th>Drug Discovery and Clinical Studies</th><th>Credit</th><th>Lectures</th></tr>
<tr><td rowspan="2">PSBT403</td><td>I<br><br>Clinical Research Informatics in Drug Discovery</td><td>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><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</td><td>1</td><td>15</td></tr>
<tr><td>II<br><br>Clinical Trial Design And Indian Regulations</td><td>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<br><br>Regulations<br>• The national regulatory body<br>• Key documents in clinical research<br>• Regulatory requirements for the conduct of clinical trials in India<br><br>The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial Data<br>• Participants in clinical trials,</td><td>1</td><td>15</td></tr>
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| | | • Investigators,<br>• Research institutions and universities<br>• Journals and Professional societies | | |
| | **III**<br><br>**Pharmacovigilance** | • 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><br>**The process of Pharmacovigilance**<br>• Signal detection, evaluation and investigation,<br>• Communication<br><br>**Methods of evaluating effectiveness of action**<br><br>**International regulatory collaboration**<br>• WHO, CIOMS, ICH, ISoP, ISPE | 1 | 15 |
| | **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 | 1 | 15 |

**PSBTP 403-PRACTICALS:**

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 **Multi**ple Alignment of Protein **Bind**ing Sites (MultiBind) tool and analysis using RasMol/Jmol
4. Computational protein-ligand docking using AutoDock (DEMO)

**REFERENCES**


| Sr No | Title | Author | Print Details |
|---|---|---|---|
| 1 | Introduction to Basics of Pharmacology and Toxicology, Volume 1: General and Molecular Pharmacology: Principles of Drug Action, Chapter 3 | Gerard Marshall Raj Ramasamy Raveendran, Editors | ISBN 978-981-32-9778-4 ISBN 978-981-32-9779-1 (eBook) https:oi.org/10.1007/978-981-32-9779-1 |
| 2 | Basic & Clinical Pharmacology, 2017, Fourteenth Edition, Section I, Chapter 1. | Bertram G. Katzung, Editor | ISBN 978-1-259-64115-2 MHID 1-259-64115-5 ISSN 0891-2033 |
| 3 | Software based approaches for drug designing and development: A systematic review on commonly used software and its applications, Bulletin of Faculty of Pharmacy, Cairo University 55 (2017) 203–210 | Prasad G. Jamkhande, Mahavir H. Ghante, Balaji R. Ajgunde | http://dx.doi.org/10.1016/j.bfopcu.2017.10.001 |
| 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 |
| 5 | Molecular docking studies, Chapter 5, Shodhganga | | |
| | | | |
| 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 |
| 7 | Experimental designs for small randomised clinical trials: an algorithm for choice, | Catherine Cornu et. al., | doi: 10.1186/1750-1172-8-48 PMCID: PMC3635911 PMID: 23531234 |

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|---|---|---|---|
| | Orphanet J Rare Dis. 2013; 8: 48. | | |
| 8 | Regulatory requirements for clinical trials in India: What academicians need to know, Indian J Anaesth 2017;61:192-9 | Nithya J Gogtay, Renju Ravi, Urmila M Thatte | DOI: 10.4103/ija.IJA_143_17 |
| 9 | Regulatory environment for clinical research: Recent past and expected future, Perspect Clin Res 2017;8:11-6. | Bhave A, Menon S | DOI: 10.4103/2229-3485.198551 |
| 10 | National Academy Press, Committee on Strategies for Responsible Sharing of Clinical Trial Data; (Chapter 3, The Roles and Responsibilities of Stakeholders in the Sharing of Clinical Trial) Data, Board on Health Sciences Policy; Institute of Medicine. Washington (DC): National Academies Press (US); 2015 Apr 20. | The National Academies Press | International Standard Book Number-13: 978-0-309-31629-3 |
| | | | |
| 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<br>PMCID: PMC3326906<br>PMID: 22529469 |
| 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)<br>https://doi.org/10.1007/978-3-319-99713-1 |

| PSBT 404-Scientific Writing and Food Biotechnology | |
|---|---|
| **Course Objectives:** | The objective of this course is:<br>• 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:** | On completion of the course students will be able to:<br>• 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 powerpoint presentations.<br>Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism. |

| course code | | Scientific Writing and Food Biotechnology | credits | lectures |
|---|---|---|---|---|
| **PSBT 404** | **Unit I: 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<br>Displaying data: text, table, graph and defining terms and abbreviations.<br>Statistical analysis and tools for experimental data.<br>Referencing software: Mendeley, Endnote.<br>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. | **1** | **15** |
| | **Unit II: Advanced Scientific Writing** | Guidelines for Medical writing.<br>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.<br>Presentation skills: Oral presentation, Poster Preparation & presentation, Powerpoint presentations.<br>Research ethics, Scientific misconduct. | **1** | **15** |
| | **Unit III: 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 | **1** | **15** |

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|---|---|---|---|---|
| | | processing (animal and sea food), food packaging | | |
| | **Unit 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<br>Nutraceuitcals in management of health and disease<br>Development of designer foods for specific chronic diseases<br>Nutraceutical adjuvants | **1** | **15** |

**PSBT 404-Practicals**

**A) Practical: Scientific writing**

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. 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.

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/

**B) Practical: (Food Technology - Nutraceuticals)**

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

**References:**


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
13. https://holyfamily.libguides.com/c.php?g=610218&p=4236572
14. https://plagiarismdetector.net
15. https://www.duplichecker.com