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Faculty of Science

SHREE RAMKRISHNA INSTITUTE OF COMPUTER EDUCATION AND APPLIED SCIENCES, SURAT

M.Sc. Industrial Microbiology

Syllabus

(Effective from 2021)

M.T.B Collge Campus, B/h P.T.Science College, Opp. Chowpati,
Athwalines, Surat-395001 Gujarat, India
Contact: 7228018498, 728018499. Email: info@srki.ac.in

M.Sc. Industrial Microbiology	
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A. About M.Sc. Industrial Microbiology Programme

The M.Sc. Industrial Microbiology programme offered by Sarvajanik University is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars, assignments and field trips. Three categories of courses are being offered in this programme: Core courses, Skill enhancement courses and Elective course. A separate research-based course that leads to a dissertation is also one of the Core Courses offer in the final semester. The student presents his/ her research orally at the end of the semester, and this is coupled to a *viva-voce*. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently. Thirty percent of the total marks for each course will be awarded through Internal Assessment. Particular emphasis is laid on the practical aspects of the field. Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively.

B. Programme Objective

- Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice.
- By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student.
- The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

C. Eligibility

- A candidate must have passed Bachelor's degree in Microbiology / Medical Technology/Biotechnology/Environmental Science / Industrial Microbiology /Bioscience / General Science/ Life-Science / Botany/Plant Science/Zoology/Animal Science/ Biology /Agriculture/Fisheries/Forestry /others.

- The candidate who has passed equivalent exam from other subjects or boards need to avail eligibility certificate for this programme from the Board of Equivalence (BoE) of the Sarvajanik University.

D. M.Sc. Industrial Microbiology Course Structure

Sem	Course Type	Course Code	Paper Title	Hours/Week		Credit
				Th	Pr	
1	Core course	DSC-1	Principles of Industrial Microbiology	4	4	4+2
		DSC-2	Fermentation Technology	4	4	4+2
	SEC	SEC-1	Molecular biology & Genetic Engineering	4	4	4+2
	Elective	DSE-1		4	4	4+2
2	Core course	DSC-3	Microbial Physiology & Metabolism	4	4	4+2
		DSC-4	Principles of Biochemical Engineering & Bioseparation	4	4	4+2
	SEC	SEC-2	Instrumentation and analytical techniques	4	4	4+2
	Elective	DSE-2		4	4	4+2
3	Core course	DSC-5	Microbial products	4	4	4+2
		DSC-6	Enzyme & Immuno Technology	4	4	4+2
	SEC	SEC-3	cGMP & Quality Assurance	4	4	4+2
	Elective	DSE-3		4	4	4+2
4	Core course	DSC-7	Dissertation	32		16
		DSC-8	Seminar Presentation			4
		DSC-9	Review of published research paper/Article			4
					Total Credit	96
Note: DSC – Discipline Specific Core, DSE - – Discipline Specific Elective, SEC - Skill Enhancement Course						

Semester	DSE (Any one to be opt)
1	1. Food Chemistry 2. Energy and Environment 3. Laboratory safety and management 4. Bioethics & Biosafety
2	1. Forensic Chemistry & Toxicology 2. Bioinformatics & Other “OMICS” 3. IPR 4. Biostatistics.
3	1. Forensic biology and DNA typing 2. Research Methodology 3. Bio-entrepreneurship 4. Application of Green Chemistry

E. Evaluation Scheme

M.Sc. Industrial Microbiology					
Evaluation	**Criteria**	**Theory**	**Practical**	**Dissertation**	**Seminar/ Review of published research paper**
Internal	Continuous & Comprehensive Evaluation (CCE)	40	60	140	60
	Attendance	10	10	10	10
	Assignment	20	----	----	----
	Internal Practical Test and Viva – Voce /	----	70	----	----
	Internal assessment	----	----	50	30
External	External Evaluation	30	60	100	50
	Total	100	200	300	150

F. Syllabus

Semester 3

Microbial Products

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Industrial Microbiology Sem-III	**Type:** DSC-5
Subject: Microbial Products	
Credit: 4+2	**Total learning hours:** 60

Course description:
This course covers the principles of various processes associated with the production and recovery of different microbial derived products and bio-products. It will enable to discuss the significance of microbial roles in industry as well introduce to the real-world applications include enzymes, antibiotics, hormones, amino acids and many more.

Student learning outcome:

- Students will be benefited by understanding of the concept of industrial production of various biomolecules from microbiological perspective
- Students understanding will enriched about the immunotherapeutic & its modern trends in microbiology
- Students will be conceptualized for traditional as well novel microbial products

Unit-1: Industrial Production of Aminoacids **(Duration: 06 Hrs)**

1.1 Glutamate
1.2 L aspartic acid
1.3 L Tryptophan
1.4 L Lysine

Unit-2: Industrial Production of Organic acids **(Duration: 06 Hrs)**

2.1 Citric acid
2.2 Acetic Acid
2.3 Lactic acid
2.4 Kojic acid and Itaconic acid

Unit-3: Industrial Production of Enzymes **(Duration: 08 Hrs)**

3.1 Tyrosine Phenol lyase
3.2 Amylase
3.3 Glucose Isomerases
3.4 Proteases
3.5 Penecillin Acylase

Unit-4: Industrial Production of Biopolymers **(Duration: 08 Hrs)**

4.1 PHA
4.2 Pullulan
4.3 Dextran
4.4 Xanthan

Unit-5: Health Care Products **(Duration: 08 Hrs)**

5.1 Penicillin
5.2 Erythropoietin
5.3 Ergot alkaloids
5.4 Bacterial Vaccines
5.5 Recombinant therapeutic peptides and proteins

Unit-6: Industrial solvents and alcoholic Beverages **(Duration: 08 Hrs)**

6.1 Ethanol fermentation
6.2 Acetone/Butanol fermentation
6.3 Wine & Beer Production
6.4 Cidar Production

Unit-7: Novel Microbial Products **(Duration: 08 Hrs)**

7.1 Microbial Insecticides
7.2 Rhizobium Biofertilizers
7.3 Single Cell protein
7.4 Food grade Pigments
7.5 Manufacture of Biodiesel
7.6 Mushroom Cultivation

Unit-8: Fermented Foods **(Duration: 08 Hrs)**

8.1 Fermented food from Wheat: Bread
8.2 Fermented food from milk: Cheese, Yoghurt & Probiotic
8.3 Fermented food from vegetables: Sauerkaur, Pickles
8.4 Fermented food from legumes and Oil Seeds

Reference Book:

- Flickinger, M. & Drew, S.(1999), Encyclopedia of Bioprocess Technology, (Volumes 1 - 5): ISBN 0-471-13822-3.
- Nduka Okafor (2007), Modern Industrial Microbiology and Biotechnology, Science publishers, ISBN: 978-1-57808-513-2
- S Lee & Y T Shah (2013), Biofuels and Bioenergy: Processes and Technologies, CRC Press: ISBN 9781138569416
- Waites M J et al, (20020), Industrial MicrobiologyLAn Introduction, Black well publishing: ISBN: 978-0-632-05307-0

- Wulf Crueger et al, (2005), A text Book of Industrial Microbiology, 2nd ed, Panima Publishing Cooperation: ISBN: 81-86535-27-6

Further Reading:

- A.L. Demain et al (1989), Novel Microbial Products for Medicine and Agriculture, Elsevier Science Ltd. ISBN: 978-0444810663
- Alexander N. Glazer & Hiroshi Nikaido (2008), Microbial Biotechnology, Cambridge University Press. ISBN: 978-0521729673

List of Practical

1) Microbial production of Penicillin
2) Comparison of Ethanol production using pure carbohydrate and agro industrial waste.
3) Production of fungal amylase by solid state fermentation and its partial purification.

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Enzyme & Immuno Technology

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Industrial Microbiology Sem-III	**Type:** DSC-6
Subject: Enzyme & Immuno Technology	
Credit: 4+2	**Total learning hours:** 60

Course description:
The objective of this paper is to provide detailed knowledge of techniques used in enzyme and immunological research Laboratory and industries. Understanding biotechniques is essential to strengthen the knowledge of the candidate desired to work in the field of clinical and enzyme industry. This course provides basic understanding various immunological techniques like antigen-antibody interactions and cellular assays and technologies that are used for diagnosis and treatment of these diseases as well as cancer.

Student learning outcome: After successful completion of the course student will be able to understand

- Detailed concepts of enzymology and enzyme technology and about production and synthesis of industrially important biological substance.
- Commercial production of enzymes, enzyme engineering, design and construction of novel enzymes and its application in various field.
- Techniques of immunological diagnosis and In situ nucleic acid hybridization.
- Evaluate and assess current and evolving concepts in immunological developments including Enzyme technology, immunotechnology and immunotherapy.
- Students will be able to explain various immunotechniques for the detection of molecules in living cells. They will learn detection and measurements of different types of radioisotopes as well as electrophysiological methods

Unit-1: Introduction to Enzyme Technology and Basics of Enzymes (Duration:08 Hrs)

1.1 Introduction to Enzyme Technology, Goals and Potential of Biotechnological Production Processes

1.2 History of Enzyme Technology, Biotechnological Processes, Advantages and limitation of Enzyme-Based Production Processes, New or Improved Enzyme Processes

1.3 Enzyme Classification, synthesis, structure, function and mechanisms, Specificity, equilibrium-controlled reactions, Kinetics of Enzyme-Catalyzed Reactions

1.4 End Points of Enzyme Processes, Enzyme-Catalyzed Processes, Stability, Denaturation, and Renaturation of Enzymes, Better Enzymes by Natural Evolution

Unit-2: Enzyme Discovery **(Duration:07 Hrs)**

2.1 Enzyme Discovery and Strategies for Protein Engineering
2.2 Computational Design of Enzymes
2.3 Cells Designed by Metabolic Engineering as Biocatalysts for Multienzyme Biotransformations
2.4 Driving forces for biocatalyst development and Novel microbial enzymes

Unit-3: Industrial Enzymes in Food Applications **(Duration: 07 Hrs)**

3.1 Biocatalysts in Baking process
3.2 Enzymes in Fruit Juice Production and Fruit Processing
3.3 Biocatalysts in Brewing industries
3.4 Application of enzymes in Dairy sector

Unit-4: Industrial Enzymes in Non-food Applications **(Duration: 08 Hrs)**

4.1 Application of enzymes in Household Detergents and Automatic Dishwashing
4.2 Biocatalysts in Grain Wet-Milling
4.3 Role of Enzymes in Animal Feeds
4.4 Enzymes in Textile Production

Unit-5: Basics of Immunological reaction and techniques **(Duration: 07 Hrs)**

5.1 Basic Immunological Procedures: Basic Immunological Procedures, Antibody Generation
5.2 Precipitation Reactions: antigen–antibody binding, precipitation curve and measurement of precipitation, passive immunodiffusion technique, electrophoretic techniques
5.3 Agglutination: Steps in agglutination, types of agglutination reactions, antiglobulin-mediated agglutination, instrumentation-Particle-counting immunoassay
5.4 Microscopic Visualization of Cells and Subcellular Structures, Immunofluorescence-Based Imaging Techniques

Unit-6: Molecular based Techniques **(Duration: 08 Hrs)**

6.1 Labeled Immunoassays: Characteristics of Labeled Assays, Radioimmunoassay, Enzyme Immunoassay, Fluorescent Immunoassay, Chemiluminescent Immunoassays
6.2 Molecular Diagnostic Techniques: Hybridization Techniques, FISH, MFISH, GISH
6.3 Amplification techniques: Target Amplification, Probe Amplification, Signal Amplification, Limitation of amplification methods, Future of Molecular Diagnostic Techniques
6.4 Flow Cytometry and Magnetic Activated Cell Sorting, Laboratory Automation and Validation, Cell Cycle Analysis, Assays of Cell Death

Unit-7: Advanced Techniques for Cancer Immunology **(Duration: 07 Hrs)**

7.1 Array-Based Copy Number Analysis: Array comparative genomic hybridization (aCGH), Whole genome sampling and amplification (WGSA)
7.2 Next-Generation DNA Sequencing: Sequencing by synthesis (Illumina), Electrochemical sequencing, Long read sequencing

7.3 Cancer Immunology: Immunity to Cancers
7.4 Immunotherapy: Cytokine-, antibody-, and cell-mediated immunotherapy

Unit-8: Immunotherapy **(Duration: 08 Hrs)**

8.1 Immunomodulating Pharmaceuticals
8.2 Prevention and Therapy of Immunological Diseases: Protein Kinase Antagonists in Therapy of Immunological and Inflammatory Diseases
8.3 Biological Modifers of Inflammatory Diseases: Immunomodulatory Cytokines, Inhibitors of Inflammatory Cytokines
8.4 Immunotherapy of Allergic Disease

Reference Book:

- Klaus Buchholz, Volker Kasche and Uwe T. Bornscheuer (2012). Biocatalysts and enzyme technology. By. Wiley-Blackwell, ISBN: 978-3-527-32989-2.
- Aehle, W. (Ed.). (2007). Enzymes in industry: production and applications. John Wiley & Sons. ISBN: 978-3-527-31689-2
- Rich, R. R., Fleisher, T. A., Shearer, W. T., Schroeder Jr, H. W., Frew, A. J., & Weyand, C. M. (2012). Clinical Immunology: Principles and Practice. Elsevier Health Sciences. ISBN: 978-0-7020-6896-6
- Lydyard, P., Whelan, A., & Fanger, M. (2011). BIOS Instant notes in immunology. Taylor & Francis. 978-0-415-60753-7
- Stevens, C. D., & Miller, L. E. (2016). Clinical Immunology and Serology: A Laboratory Perspetive. FA Davis. ISBN: 9780803658561
- Male, J. Brostoff, D. Roth, I. Roitt (2012). Immunology 8th Ed. elsevier, ISBN: 978-0-323-08058-3.
- Owen, J. A., & Punt, J., Stranford. *SA, Patricia P. Jones.* (2013). Kuby Immunology. *7th ed.,* W H Freeman & Co. 978-14641-3784-6
- William H. Scouten, New Biocatalysts: Essential Tools for a Sustainable 21st Century Chemical Industry, Gene Petersen.

Further Reading:

- Brahmachari, G. (2016). Biotechnology of microbial enzymes: production, biocatalysis and Industrial applications. Academic Press. ISBN: 9780128037461
- Ray, R. C., & Rosell, C. M. (Eds.). (2017). Microbial enzyme technology in food applications. CRC Press. ISBN: 9781315351414
- Janeway, C. et al. (2004) Immunobiology 6 Ed. Garland Science. ASIN: B00BTM716E
- Lichtman, A. & Abbas, A. (2003) Cellular and Molecular Immunology 5Ed.Saunders. ISBN-13: 978-0721600086
- Paul, W. (1999) Fundamental Immunology 4Ed. Lippincott Williams & Wilkins. ISBN-13: 978-0781714129

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List of Practical

1) Determination of cellulase activity on CMC as substrate.
2) Determination of *Km* and *Vmax* of amylase/ Cellulase enzyme.
3) Immobilization of amylase /cellulase and determine its activity yield.
4) Ouchterlony: Double diffusion Technique.

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cGMP & Quality Assurance

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Industrial Microbiology Sem-III	**Type:** SEC-3
Subject: cGMP & Quality Assurance	
Credit: 4+2	**Total learning hours:** 60

Course description:
This course gives insight of quality control & good manufacturing practice in pharmaceutical industries. It includes risk assessment & microbiological auditing along with quality control & quality assurance in sterile product preparation. Also introduce with the fundamentals of clean room technology.

Student learning outcome:

- Students will introduce with cGMP and international regulation
- Student learn key aspects of microbial spoilage & preservation of pharmaceutical products
- Students will learn about quality control & quality assurance in sterile product
- Students will acquaint with the methodologies of microbiological assay.
- Students will be introduce with the fundamentals of clean room technology.

Unit-1: cGMP & Regulation (Duration: 07 Hrs)

1.1 Definition: Quality, Manufacture, Quality assurance (QA), Good manufacturing practice (GMP), Quality control (QC), In - process control, Validation.
1.2 Manufacture of sterile product: Design of premises & Aseptic areas
1.3 Good manufacturing practice
1.4 FD&C Act, Federal Register & Code of Federal Regulation (CFR)
1.5 What is cGMP
1.6 Importance of CGMP
1.7 Key aspects of GMP compliance
1.8 Ten rules of GMP
1.9 Risk management
1.10 The role and development of pharmacopoeias
1.11 Indian GMP regulation

Unit-2: Risk assessment and microbiological auditing (Duration: 07 Hrs)

2.1 The nature of risk
2.2 The need for microbiological risk assessment
2.3 Microbial contamination transfer
2.4 Identification of sources and routes of contamination
2.5 Risk assessments for general cleanroom areas

2.6 Risk scoring systems
2.7 Microbiological auditing

Unit-3: Microbial spoilage & Preservation of Pharmaceutical Products
(Duration: 08 Hrs)

3.1 Pharmaceutical ingredients susceptible to microbial attack
3.2 Factors affecting microbial spoilage of pharmaceutical products
3.3 Preservation of pharmaceutical product by antimicrobial agents
3.4 Factors affecting the availability of preservatives
3.5 Preservative efficacy testing

Unit-4: Quality control of pharmaceutical water (Duration: 07 Hrs)

4.1 Types of water used in pharmaceutical process
4.2 Microbiological sampling & testing of pharmaceutical water
4.3 Action & Alert limits
4.4 Objectionable microorganisms in water
4.5 Rapid microbiological methods

Unit-5: Quality control and quality assurance of sterile products (Duration: 08 Hrs)

5.1 Types of sterile products
5.2 Pharmacopeia and microbiological tests
5.3 Microbiological examination of nonsterile products
5.4 Test for specified organisms
5.5 Specification limits
5.6 Bioburden determination

Unit-6: Sterilization & sterility assurance (Duration: 08 Hrs)

6.1 Sterility
6.2 Sterility assurance and sterility assurance level
6.3 Sterility testing
6.4 Endotoxin & pyrogen testing
6.5 Parametric release
6.6 Factors affecting sterilization effectiveness
6.7 Validation and in-process monitoring of sterilization procedures

Unit-7: Clean room technology (Duration: 08 Hrs)

7.1 Importance of clean room
7.2 Different types of clean room
7.3 Classification of clean room
7.4 Sources of Contamination in Clean room

7.5 Layout of Clean room
7.6 Air handling in clean room

Unit-8: Microbiological assays **(Duration: 08 Hrs)**

8.1 Principle
8.2 Methodologies
8.3 Types of microbiological assays
8.4 Assay of antibiotics, vitamins & aminoacids

Reference Book:

- Sandle, T. (2015). Pharmaceutical microbiology: essentials for quality assurance and quality control. Woodhead Publishing. ISBN 9780081000229
- Ashutosh Kar, (2008) Pharmaceutical microbiology, New Age International (P) Ltd., Publishers, New Delhi . ISBN No 9788122422009
- Hugo and Russells, (2007), Pharmaceutical Microbiology 8th Edi., Blackwell Publishing.ISBN 978-9332541306
- Walsh G., (2007), Pharmaceurcal Biotechnolog- Concepts and Applications, Wiley. ISBN: 978-0-470-01244-4.
- Current Good Manufacturing Practice (CGMP) Regulations. Retrieved from https://www.fda.gov/drugs/pharmaceutical-quality-resources/current-good-manufacturing-practice-cgmp-regulations
- Denyer, S. P. and Baird, R. M., (2008), Guide to microbiological control in pharmaceuticals and medical devices. 2nd Edition, CRC Press, Boca Raton, ISBN: 9781444330632
- Gupta, Antima. (2019). Chapter1 Clean Room Technology. Retrieved from https://www.researchgate.net/publication/337561543_Chapter1_Clean_Room_Technology

Further Reading:

- Gad, S. C., (2007), Handbook of Pharmaceutical Biotechnology. Wiley-Interscience, New Jersey, ISBN: 978-0-470-25958-0.

List of Practical

1) Sterility testing of pharmaceutical products by direct inoculation & membrane filtration methods as per Indian Pharmacopoeia (IP).
2) Microbiological assay of amino acid/ vitamin.
3) Perform preservative efficacy test

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Forensic Biology and DNA Typing

Name of faculty: Science	**Department:** Biotechnology
Program: M.Sc. Sem-III	**Type:** DSE-3
Subject: Forensic Biology and DNA Typing	
Credit: 04	**Total learning hours: 60**

Course description:

The course provides the basic knowledge about Forensic Science and its applications. Specifically, this course covers biological and molecular aspects and information used for forensic studies and to solve the crimes. The techniques used for identification and characterization of culprits or victims through diverse biological evidences are included in this course.

Student learning outcome:

On completion of course students will be able to:

- Learn the basics of forensic biology.
- Understand the collection, identification and applications of various biological evidence for solving crimes.
- Learn basic biology of DNA and its principles.
- Apply the techniques for DNA typing for forensics.

Unit-1: Basics of Forensics: (4 h)

1.1. Introduction to Forensics and its branches
1.2. Forensic biology: A subdiscipline of Forensics
1.3. History of Forensic Biology
1.4. Laboratory Services: Forensics

Unit-2: Biological Sources as Forensic Indicators: (8 h)

2.1. The Decay process of Biological Sources
2.2. Body fluids and waste products
2.2.1. Blood and Cells; Blood Typing (bloodstain pattern analysis)
2.2.2. Saliva and Semen
2.2.3. Faeces, urine and vomitus
2.3. Hair
2.4. Bone
2.5. Wounds

Unit-3: Crime Scene Investigation and Analysis of Biological Evidence: (8 h)

3.1. Protection and documentation of crime scene
3.2. Recognition and collection of biological evidence
3.3. Packaging and transportation of biological evidence
3.4. Identification and characterization of biological evidence
3.5. Crime scene reconstruction and reporting results

Unit-4: Organisms in Forensics: (9 h)

4.1. Microbes (Bacteria, Viruses, Protist And Fungi)
4.2. Plants
4.2.1. Wood and illegal trade in protected plants
4.2.2. Pollen and spores
4.2.3. Fruit, seeds and leaves
4.2.4. Secondary metabolites as drugs and poison
4.3. Invertebrates (forensic indicators and forensic information obtained-calculating death time)
4.4. Vertebrates
4.5. Collection of plant and animal material for forensic studies

Unit-5: Basics of DNA Biology: (6 h)

5.1. Basic DNA principles and structure of DNA
5.2. Chromosome, genes
5.3. DNA Polymorphisms
5.4. DNA Markers
5.5. Designating chromosomal locations

Unit-6: DNA typing: (8 h)

6.1. Introduction to DNA analysis
6.2. Historical methods for DNA typing
6.3. Sources for DNA
6.4. Sampling, collection, storage and transportation of DNA evidence
6.5. Dealing with Degraded DNA, Low copy Number DNA and Mixture of DNA samples

Unit-7: Techniques for DNA typing: (10 h)

7.1. Extraction of DNA
7.2. Quantitation and analysis of DNA evidence
7.3. Amplification of DNA
7.4. Separation and detection of DNA
7.5. STR markers and genotyping (general STR and Y-chromosome)
7.6. SNPs and other polymorphisms
7.7. VNTRs profiling

Unit-8: Applications of DNA Typing in Forensics: (7 h)

8.1. Sex chromosome haplotyping and gender identification

8.2. Mitochondrial DNA profiling (Tzar Nicholas II case)
8.3. Parentage identification
8.4. Disaster victim identification
8.5. Wildlife Crime and Forensics

References:

- Li R.,(2015) Forensic Biology (2nd Edition), CRC Press ISBN:978-1-4398-8972-5
- Butler J., (2010) Fundamentals of Forensic DNA Typing, Elsevier ISBN:9780123749994
- Gunn A., (2006) Essential Forensic Biology, John Wiley & Sons Ltd.ISBN:978-0470758038
- Jamieson A. & Bader S., (2016) A Guide to Forensic DNA Profiling, John Wiley & Sons Ltd.ISBN:978-1118751527

Practical:

1. Extraction and characterization (spectrophotometric and gel electrophoresis) of DNA from hair/nail clipping. Or To study DNA extraction through InstaDNA card.
2. Demonstration of Crime scene investigation. Or To identify unknown remains through mitochondrial DNA study (Demonstration and theoretical case study)
3. To study diatoms for identification of location, time of year and habitat of crime involving drowning.
4. To identify blood stain through presumptive tests (Hydrogen Peroxide test/Kastle-Meyer Test).

Reference for Practical:

1. Walker P. & Wood E., (2010) Facts on File Science Experiments Forensic Science Experiments, Infobase Publishing ISBN:978-0816078042

Research Methodology

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Microbiology Sem-III	**Type:** DSE-3
Subject: Research Methodology	
Credit: 04	**Total learning hours:** 60

Course description:
The learning objective of the paper will enrich the students with basic principle of research methodology which help the students to learn essential steps involved in research methodology like Review of literature, Construction of hypothesis, Data collection, Report writing and Research publication.

Student learning outcome:

- Student will learn about objective and types of research.
- Student will understand important steps involved in research
- Student will learn about writing a research proposal and report and how to do citation

Unit-1: Introduction to research methodology **(Duration: 07 Hrs)**

1.1 Definition of Research
1.2 Objectives of research
1.3 Types of research.
1.4 The research process

Unit-2: Important steps of research **(Duration: 08 Hrs)**

3.1 Reviewing the literature
3.2 Formulating a research problem
3.3 Identifying variables: What is variables?, Types of variablesConstructing hypothesis
3.4 Types of measurement scale
3.5 Data collection

Unit-3: Constructing Hypothesis **(Duration: 07 Hrs)**

3.1 Defination of Hypothesis
3.2 The function of Hypothesis
3.3 Testing of a hypothesis
3.4 Characteristics of hypothesis
3.5 Types of hypothesis

Unit-4: Research design **(Duration: 07 Hrs)**

4.1Need for a research design
4.2 Important concept relating to research design

4.3 Basic principles of experimental designs
4.4 Important experimental designs

Unit-5: Data collection & preparation process (Duration: 08 Hrs)

5.1 Collection of primary data
5.2 Collection of secondary data
5.3 Selection of appropriate method for data collection
5.4 Data preparation process

Unit-6: Literature citation (Duration: 08 Hrs)

5.5 Different systems of citing references
5.6 Citation in text
5.7 Placement of reference section
5.8 Format of reference section

Unit-7: Research Report – Tables & Figures (Duration: 07 Hrs)

6.1 Introduction and placement of tables
6.2 Format of table
6.3 Introduction and placement of figures
6.4 Numbering & caption of figures
6.5 Preparation of statistical diagrams, photographs & microphotograps

Unit-8: Writing a Research proposal & report (Duration: 08 Hrs)

5.1 Contents of research proposal
5.2 Components of research report
5.3 Research report - Formatting & typing
5.4 Plagiarism

Reference Book:

- Gurumani N. (2011) Research Methodology For Biological Sciences, MJP Publishers, Chennai (ISBN: 978-81-8094-016-0)
- Kumar, R. (2005). *A Step-by-step Guide for Beginners*. Sage Publications. (ISBN: 9788132106487)
- Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International. (ISBN: 978-81-224-2488-1)

Further Reading:

- Singh, Y. K. (2015) Fundamental of Research Methodology and Statistic New Age International (P) Ltd., Publishers - New Delhi (ISBN: 978-81-224-2418-8)

List of Practical

1) Searching of scientific journals & resources
2) Preparation of graphs and tables to present the scientific data
3) Online grammar checking in scientific writing
4) References management by online tools
5) Plagiarisms checking

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Bioentrepreneurship

Name of Faculty: Science	**Department:** Biotechnology
Program: M.Sc. Sem-III	**Type:** DSE-3
Subject: Bioentrepreneurship	
Credit: 04	**Total Learning Hours:** 60
Course Description: This course introduces students to basic concepts of Bio- Entrepreneurship. It will also inculcate the importance, need & applications of these areas. This course will prepare the students for becoming an entrepreneur.	
Student Learning Outcome: After completion of the course, students will be: 1)Student will be able to appreciate the importance of Bio-Entrepreneurship 2)Student will be able to exposed to different concepts needed for practical execution when they work as Entrepreneur 3) Student will gain skills useful for becoming an entrepreneur	

Unit 1 Introduction to Entrepreneurship (08 Hours)

1.1 Definitions & Concepts -Entrepreneur, Entrepreneurship, MSMEs, Enterprise & Startups

1.2 Process of Entrepreneurship

1.3 Competencies & Skills/ Qualities of an Entrepreneur

1.4 Types of Entrepreneurs & Enterprise

1.5 Advantages & Disadvantages of Entrepreneurship

Unit 2 Biotechnology Entrepreneurship (09 Hours)

2.1 Concept of Biotechnology Entrepreneurship

2.2 Significance of the Biotechnology Entrepreneur

2.3 Biotechnology entrepreneurship versus general entrepreneurship

2.4 Essential biotechnology entrepreneurial characteristics

2.5 Backgrounds of biotechnology entrepreneurs

2.6 Fuel, Feed and Heal the world through Biotechnology Entrepreneurship: Industrial and Environmental Biotechnology, Food and Agricultural Biotechnology, Health Biotechnology.

Unit 3 Financial Management & Financial Statements (09 hours)

3.1 Approaches to managing capital & cost of capital

3.2 Working capital & cash flow planning

3.3 Financial Planning & Budgets

3.4 Statement showing financial position

3.5 Measuring & reporting financial performance

3.6 Accounting conventions & concepts

Unit 4 Project Management (07 hours)

4.1 Project: Concept & Classification

4.2 Project Formulation

4.3 Project Reporting

4.4 Project Appraisal

Unit 5 Entrepreneurial Planning & HRM (06hours)

5.1 Basic legal forms of organizations

5.2 Company formation,ownership structure & securities

5.3 Human resource & business strategies

5.4 Workforce Planning

5.5 HRM Functions

Unit 6 Case studies of Biotech Entrepreneurs (06 Hours)

6.1 Shantha Biotech: Unleashing Biotechnology in India.

6.2 Aravind Eye Hospital: Making a Dent in Global Blindness.

6.3 Centocor: Diagnostics Company on Monoclonal Antibodies.

6.4 Suguna Poultry Farm Ltd: Hard work, No compromise, No excuse.

6.5 The Surat Transformation: Urban Renewal.

Unit 7 Introduction to IPR (06 Hours)

7.1 History & Definition of IPR

7.2 Forms/ Types of IPR

7.3 Traditional Knowledge, Commercial Exploitation & Protection

7.4 Protection of Biotechnological Inventions

Unit 8 Introduction to Patent (09 Hours)

8.1 Introduction & Types of Patent

8.2 Requirements for Patenting

8.3 Procedure of Patent Application

8.4 Various types of patent applications in India

8.5 Patent Search

References:

- Bioentrepreneurship Development: A Resource Book Prepared by Biotech Consortium India Limited (BCIL), New Delhi Compiled by: Ms. Shreya Sanghvi Malik, Deputy Manager Dr. Shiv Kant Shukla, Deputy General Manage
- Biotechnology Entrepreneurship (2014) Craig Shimasaki, Academic Press, USA.
- Dynamics of Entrepreneurial Development and Management (2005) Vasant Desai, Himalaya Publishing House.
- Making Breakthrough Innovation Happen: How Eleven Indians Pulled of the Impossible (2009) Porus Mushi, HarperCollins Publishers India.
- The CII Entrepreneur Hand Book: Practical Advice for Starting a New Business (2010) Sushila Ravindranath, Westland Ltd.
- The Game Changers: 20 extraordinary success stories of Entrepreneurs (2013) Y. Modi, R. Kumar & A. Kothari, Random House Publishers India Pvt. Ltd.
- Bioethics & Biosafety by M K Sateesh ,I K International Pub. Ltd
- Biotechnology Expanding Horizons by B D Singh, Kalyani Pub.

Application of Green Chemistry

Name of faculty: Science	**Department:** Chemistry
Program: M.Sc. Sem-III	**Type:** DSE-3
Subject: Application of Green Chemistry	
Credit: 04(T) + 02 (P)	**Total learning hours:** 60

Course description: Students shall be able to understand:

- A functional concept of the field of green chemistry.
- The 12 principles of green chemistry.
- Several real-world examples where organizations used green chemistry to improve the sustainability performance of their products.

How the practice of green chemistry enhances competitiveness, innovation and faster time to market.

Student learning outcome:

At the end of the course students will be able to...understand about

- Green Chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.
- This course will present the fundamentals of the 12 principles of green chemistry, and explore relevant examples of their practical use in commercial applications.
- To understand the environmental consequences of chemical manufacturing and illustrate how these may be minimized.

Unit 1 Application of green chemistry in daily life (06 Hours)

1.1 Green Dry cleaning of clothes, Green Bleaching Agents, green detergents, green dyes
1.2 Eco Friendly paints & Waxes
1.3 Putting out Fires in a green way
1.4 Turning turbid water clear in a Green way
1.5 Biodegradable plastics
1.6 Computer chips
1.7 Green drugs
1.8 Solar cell, Solar water heater
1.9 Green building and construction Materials
1.10 Bleaching of paper
1.11 Reusable water Bottle
1.12 Bio Material & Green fuel
1.13 Anti foulants and other green chemicals

Unit 2 Application of green chemistry in pharmaceutical Industry. (12Hours)

2.1 Green Pharmacy: Principle
2.2 Green Catalyst & Biocatalyst used in pharmaceutical industry.
2.3 Green Solvents and it's categories:
Water, Ionic liquids & Supercritical CO_2, Other Green Solvents
2.4 Solvent free processes,

2.5 Green processes in Pharmaceutical development
2.6 Minimum Pharmacy Waste
2.7 Design pharmaceutical products for degradation
2.8 Green Resources for Drug development through Ethan botany
2.9 Eco friendly Medicinal plants & Ayurvedic preparation

Unit 3 Application of Green chemistry in Agriculture. (10Hours)

3.1 Natural product in plant protection:
3.2 Development of green chemicals for the Agriculture-Minimum Risk Pesticides
3.3 Eco friendly Pesticides & Insecticides
3.4 Renewable Feedstock from Agriculture (Biomass)
3.5 A new Role of Neem Tree in greening the Environment
3.6 Vesicular Arbuscular Mycorrhizae in green chemistry.

Unit 4 Application of Green chemistry in Industry (12Hours)

4.1 Food and flavour Industry
4.2 Paper and pulp Industry
4.3 Polymer Industry
4.4 Textile Industry
4.5 Paint Industry: Water Based paints, High solids Paints, low TiO_2 paint
4.6 Tannery Industry
4.7 Rubber Industry

Unit 5 Application of Green chemistry for achieving sustainable development (06 Hours)

5.1 Green chemistry skills
5.2 Environmentally Friendly Technologies
5.3 Renewable feedstock and raw materials,
5.4 Oleochemistry, photochemistry, bio catalysis & biotransformation, sequestration of CO_2, waste biomass as chemical feed stock,
5.5 Biodegradation of biomass to biogas & biodiesels

Unit 6 Application of Green chemistry in analytical chemistry (04Hours)

6.1 Green analytical chemistry
6.2 Electrophoresis
6.3 Micronization in separation Methods
6.4 Greener solvent for separation

Unit 7 Eco friendly technologies for clean world (06Hours)

7.1 Waste: production, problems & prevention
7.2 Environmentally Benign Technologies using green chemistry
7.3 Application of non conventional energy sources
7.4 Microwave induced & Ultrasound assisted green synthesis

Unit 8 Other Applications Of Green Chemistry **(04 Hours)**

8.1 Chemicals from glucose:

8.2 Polysaccharide Polymers

8.3 Application of green chemistry in organic synthesis

8.4 Greener nanoscience

References:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, 2005, Anamalaya Publishers.
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, 1988, University Press.
3. A.S. Matlack: Introduction to Green Chemistry, 2001, Marcel Dekker.
4. M.C. Cann & M.E. Connely: Real-World Cases in Green Chemistry, 2000, American Chemical Society, Washington.
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, 2002, American Chemical Society, Washington.

Laboratory Practical

1. Determination of Organic Carbon in soil sample.
2. Determination of Nitrogen in soil sample.
3. Determination of Phosphorous in soil sample.
4. Determination of BOD in industrial wastewater sample.
5. Determination of NOx in Air sample.
6. Determination of SOx in Air sample.
7. Nitration of Salysilic Acid using $Ca(NO_3)_2$ and Acetic Acid.
8. Bromination of Acetanilide using $KBrO_3$ and $(NH_4)_2Ce(NO_3)_6$.
9. Preparation of Schiff Base by Microwave Technique.
10. Determination of Blood Sugar by Folin-Wu method.
11. Determination of Blood Urea by DAM method.
12. Determination of % Purity of Brass Alloy (Copper and Zinc).

References:

1. Standard Methods for Examination of Water & Wastewater, Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Official Methods of Analysis, Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
3. Analytical Techniques in Agriculture, Biotechnology and Environmental Engineering, A. Nag, 1st Edition, 2006, Prentice Hall of India Pvt. Ltd.
4. Laboratory Manual on Engineering Chemistry, S.K. Bhasin and Sudha Rani, 3rd Edition, Reprint 2011, Dhanpat Rai Publishing Company (P) Ltd.