



St. Xavier's College – Autonomous Mumbai

M.Sc. Syllabus For 3rd Semester Courses in **Microbiology** (June 2015 onwards)

Contents:

Theory Syllabus for Courses:

MS.MIC.3.01 - RESEARCH METHODOLOGY AND BIOSTATS

MS.MIC.3.02 - TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS

MS.MIC.3.03 - ADVANCES IN BIOTECHNOLOGY - 1

Practical Syllabus for Courses:

MS.MIC.3.PR EXTERNAL PROJECT

M.Sc. II

Course: MS.MIC.3.01

Title: RESEARCH METHODOLOGY AND BIOSTATS

LEARNING OBJECTIVES

Understand the overall process of designing a research study from its inception to its report.

Number of lectures: 60

UNIT 1: RESEARCH FUNDAMENTALS AND TERMINOLOGY 15 LECTURES

LEARNING OBJECTIVES

1. To know how to identify a research problem
 2. Understand importance of educational research
 3. Understand basics of research design
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1. Meaning and Objective of research 5L

- Features of a good research study
- Scientific method

2. Study designs and variations 10L

- Basic, applied, historical, exploratory, experimental, ex-post-facto
- Case study, diagnostic research
- Crossover design, case control design, cohort study design, multifactorial design

UNIT 2: DEFINING A RESEARCH PROBLEM AND DATA COLLECTION 15 LECTURES

LEARNING OBJECTIVES

Understand concepts of quantitative and qualitative data collection

1. Hypothesis, theory and scientific law 2L

- Difference between hypothesis, theory and scientific law
- Formulation of hypothesis

2. Methods and techniques of data collection 13L

- Types of data
- Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study)
- Methods of secondary data collection (internal/ external), schedule method

- Use of computers in data collection- Literature survey using web, handling search engines

UNIT 3: DATA ANALYSIS AND REPORT WRITING **15 LECTURES**

LEARNING OBJECTIVES

1. Understand how to analyze data
 2. Be able to distinguish between the writing structure used for a quantitative study and one used for a qualitative study.
 3. Know the different conventions for scholarly/ report writing
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1. Experimental data collection and data processing **5L**

- Processing operations, problems in processing
- Elements of analysis in data processing
- Software for data processing

2. Report writing and presentation **10L**

- Types of research reports, guidelines for writing a report, report format, appendices
- Miscellaneous information
- Poster and oral presentations (use of software)
- Project proposal

UNIT 4: BIostatISTICS **15 LECTURES**

LEARNING OBJECTIVES

1. Understand how to conduct a statistical test of a hypothesis.
 2. Know the criteria that can be used to select an appropriate statistical test to answer a research question or hypothesis.
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1. Sampling, Sampling Distributions & Sampling Errors **2L**

- Simple random sampling, systematic sampling, stratified random sampling, cluster sampling
- Non random sampling
- Sampling Errors

2. Correlation & Regression **3L**

- Types of Correlation
- Degree of Correlation

- Linear Regression Analysis
- Regression Lines & Regression Equations

3. Chi Square Test **2L**

- Test of Independence
- Test of Homogeneity

4. Test of Significance **3L**

- Null Hypothesis, Alternate Hypothesis, Type I & Type II errors
- Level of Significance, one tailed & two tailed test
- Concept of Standard error

5. Comparison of means of 2 samples **2L**

- t test
- z test

6. Comparison of means of 3 or more samples **3L**

- 1-way ANOVA
- 2-way ANOVA

CIA: Problem Solving- Biostatistics, Literature Survey

References:-

Units 1, 2, 3:

1. Research Methodology - Methods and Techniques, Kothari, C.R., 2004 (2011), New Delhi, Wishwa prakashan.
2. Research Methodology, (2nd.ed.), Bhattacharya, D.K., 2006, New Delhi, Excel Books.
3. Research methods in biosciences, Holmes D., 2006, Oxford university press
4. Research Methodology: A Handbook, Misra R.P., 1989, New Delhi, Concept Publishing Company
5. Introduction to biostats and research methodology, Sunder Rao P. S. S., 4th edition, 2006, Prentice-Hall Pvt. Ltd.
6. <http://www.cebm.net/wp-content/uploads/2014/06/CEBM-study-design-april-2013.pdf>
7. <http://www.cebm.net/study-designs/>

Unit 4:

1. Fundamentals of Biostatistics, Khan, Irfan Ali, 2008, Ukaaz Publications
2. Methods in Biostatistics, Mahajan B. K., 7th edition, 2010, JPB publishers.
3. Fundamentals of Biostatistics, Rosner B.A., 2011, Cengage Learning
4. Statistical methods, Gupta S.P, S. Chand Publications, Delhi
5. Biostatistics The Bare Essentials, Norman G.R., Streiner D.L., 3rd edition, 2008, B. C.

Decker Inc

6. An introduction to biostatistics, Gurumani N., 2004, MJP Publishers
7. Statistics for biologists, Campbell R.C., 1974, Cambridge university press

M.Sc II

Course: MS.MIC.3.02

Title: TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS

LEARNING OBJECTIVES

Understand principles and applications of bioanalytical techniques

Comment [P1]: Aligned, removed number

Number of lectures: 60

UNIT 1: MICROSCOPIC TECHNIQUES AND X-RAY DIFFRACTION 15 LECTURES

LEARNING OBJECTIVES

Understand the principles, methods and applications of Microscopic techniques and X-ray diffraction

1. Advanced microscopic techniques: principles and applications 11L

- Scanning Probe Microscopes - scanning tunneling microscope (STM), magnetic force microscope (MFM), scanning near field microscope (SNOM)
- Electron Microscopy

2. Diffraction techniques 4L

- X-ray diffraction (XRD)

UNIT 2: SPECTROSCOPIC TECHNIQUES 15 LECTURES

LEARNING OBJECTIVES

Understand principles, working and applications of different spectroscopic and electrophoretic techniques

1. UV-visible spectroscopy 2L

- Beer- Lambert's Law, Instrumentation, operation, calibration, accuracy and applications

2. Infra red spectroscopy 4L

- Principles, Instrumentation, operation, calibration, accuracy and applications

3. Electron Spin Resonance (ESR) Spectrometer: principle and application 2L

4. Atomic Absorption Spectroscopy 3L

- Principles, Instrumentation, operation, calibration, accuracy and applications

- 5. Circular Dichroism (CD) and Optical rotator Dispersion (ORD) 4L**
- Theory and application

UNIT 3: CHROMATOGRAPHIC & ELECTROPHORETIC TECHNIQUES 15 LECTURES

LEARNING OBJECTIVES

Understand principles, working and applications of different chromatographic techniques

- 1. Gas Chromatography 5L**
- Principles, Instrumentation, operation, calibration, accuracy and applications
- 2. High Performance Liquid Chromatography 5L**
- Principles, Instrumentation, operation, calibration, accuracy and applications
- 3. Supercritical Liquid Chromatography 2L**
- Properties of SFE/SFC, Instrumentation, operation, advantages and applications
- 4. Electrophoretic techniques 3L**

UNIT 4: OTHER ANALYTICAL TECHNIQUES 15 LECTURES

LEARNING OBJECTIVES

Understand different methods and principles used in analytical techniques.

- 1. Centrifugation 3L**
- Overview of preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications
- 2. Radioisotopic techniques 5L**
- Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications.
 - Dosimetry.
- 3. Mass spectroscopy 5L**
- Instrumentation
 - Various detection systems including MALDI-TOF

4. NMR spectroscopy

2L

- Basic Principles of NMR, Chemical shift, Intensity, Line width

CIA: Assignment, Test

References: -

Unit 1:

1. Bioimaging: current concepts in light and electron microscopy, Chandler D.E. and Roberson R.W. 2009, Singapore, Jones and Bartlett Publishers
2. Handbook of Physics in Medicine and Biology, edited by Robert Splinter, 2010, CRC Press
3. Principles of Physical Biochemistry 2nd Edition, van Holde, E. Kersal, W.C. Johnson, H. P. Shing, 2006, New Jersey, Pearson Prentice Hall

Unit 2:

1. Fundamentals of Molecular Spectroscopy, 4th Ed., Banwell, C.N. and McCash, E.M., 2012, New Delhi, Tata McGraw Hill Education Pvt. Ltd.
2. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
3. Introduction to Instrumental Analysis, Braun R., New York, McGraw Hill Book Company
4. Principles of Instrumental Analysis, 5th Ed. Skoog, Holler and Nieman, Australia, Thomson Brock/Cole
5. Biophysics (2nd Ed.) Pattabhi V. and Gantham N. 2002, Springer
6. Atomic absorption and plasma spectroscopy, Dean J.R., 1997 (2008), Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
7. http://faculty.sdmiramar.edu/fgarces/labmatters/instruments/aa/AAS_Theory/AAS_Theory.htm

Unit 3:

1. Gas Chromatography, Fowles I. A., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
2. HPLC, Lindsay S., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
3. Basic Gas Chromatography, McNair H. M. and Miller J. M., 2009, Wiley International
4. Electrophoresis, Melvin M., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
5. Molecular cloning: A laboratory Manual, Sambrook J., Fritsch, Maniatis T, 2nd edition, 1989, Cold Spring Harbor Laboratory Pr

Unit 4:

1. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
2. NMR spectroscopy, Williams D. A .R., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
3. Mass spectroscopy, Barker J., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
4. Centrifugation : a practical approach, edited by D. Rickwood, 1984, Oxford
5. http://www.brynmawr.edu/chemistry/Chem/mnerzsto/The_Basics_Nuclear_Magnetic_Resonance%20_Spectroscopy_2.htm

M.Sc. II

Course: MS. MIC.3.03

Title: ADVANCES IN BIOTECHNOLOGY-I

LEARNING OBJECTIVES

Understand applications of Biotechnology

Number of lectures: 60

UNIT 1: PLANT AND AGRICULTURAL BIOTECHNOLOGY 15 LECTURES

LEARNING OBJECTIVES

1. Understand advanced technologies involved in plant biotechnology.
 2. Understand applications of transgenic plants.
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1. Plant Transformation Technology 7L

- *Agrobacterium* mediated gene transfer, *Agrobacterium* based vectors, viral vectors
- Direct gene transfer methods, chemical methods, electroporation, microinjection, particle bombardment, Molecular breeding, plant selectable markers, Reporter genes, Positive selection, Selectable marker elimination
- Transgene silencing, Strategies to avoid transgene silencing

2. Plant Genetic Engineering for Productivity and Performance 6L

- Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, *Bt* toxin, Disease Resistance, Virus resistance
- Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature.
- Manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency
- Quality Improvement-Protein, Lipids, carbohydrates, vitamins and minerals.
- Biosafety concerns of transgenic plants

3. Plants as bioreactors 2L

UNIT 2: MARINE BIOTECHNOLOGY 15 LECTURES

LEARNING OBJECTIVES

1. Know marine microbes and their applications
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1. Marine environments and biodiversity 2L

- Extreme environmental conditions

- Marine life forms - Marine bacteria, marine archaea
- Environmental research in marine environment

2. Biofouling, Bioremediation and Biodeterioration in marine environment and the role of microorganisms in these processes **3L**

3. Methods in Marine Microbiology – **2L**

- Detection of microorganisms and microbial activity, Metabolic diversity, Marine Genomics and Marine Proteomics

4. Marine bioprospecting **1L**

- Isolation of Marine Natural Products

5. Diversity of marine derived compounds **7L**

- Alkaloid, Terpenoids and steroides, nucleoside, aminoacids, peptides, depsipeptide, polyketide, Macrolide
- Marine Enzymes- protease, lipase, chitinase, glucanase
- Marine biominerals; Biomineralized structures
- Biocomposites
- Biopolymers - polysaccharides, chitin, marine collagens
- Biomimetic materials, new class of pharmaceuticals, industrial products and processes
- Vaccines, diagnostics and analytical reagents
- Bioactive compounds
- Biomaterials

UNIT 3: FERMENTATION PROCESSES IN BIOTECHNOLOGY **15 LECTURES**

LEARNING OBJECTIVES

Understand concepts of microbial fermentation and downstream processing

1. Bioreactor **7L**

- Basic configuration, features, measurement and control of bioprocess parameters
- Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa.
- Agitation
- Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases
- Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation,

yield of biomass, product, calculation for productivity, substrate utilization kinetic

2. Upstream processing **2L**

- Media formulation and modification
- Inoculum development and storage of cultures
- Scaling up of process from shake flask to industrial fermentation.

3. Downstream processing **2L**

- Biomass separation by centrifugation, filtration, flocculation and other methods
- Cell disintegration: Physical, chemical and enzymatic methods
- Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis, drying and crystallization

4. Microbial Fermentations **4L**

- Metabolic pathways and metabolic control mechanisms, industrial production of citric acid, enzymes (e.g. proteases), acetone- butanol, amino acids (e.g. lysine)

UNIT 4: ADVANCES IN BIOPROCESSES

15 LECTURES

LEARNING OBJECTIVES

Know the advance methods of microbial bioprocesses.

1. Modern trends in microbial production **4L**

- Bioplastics (PHB, PHA), Bioinsectices (Entomopathogenic e.g. *Bacillus thuringensis*, Antifungal e.g. *Trichoderma spp*, Antibacterial e.g. *Pantoea agglomerans*, phages), Biopolymer (dextran, alginate, xanthan, pullulan), Biofertilizers (nitrogen fixer Azotobacter, Phosphate solubilizing microorganisms), Single Cell Protein

2. Microbial production of therapeutic compounds **4L**

- Rifamycin, Biotransformation of steroids, Riboflavin fermentation and Interferon

3. Biofuels **3L**

- Biogas production (biomethanation)
- Production of bioethanol from sugar, molasses, starch and cellulosic materials
- Ethanol recovery
- Microbial production of hydrogen gas, biodiesel from hydrocarbons.

4. Immobilization techniques **2L**

- Whole cell and enzyme immobilization
- Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries.

5. Microbial strain improvement

2L

- Screening and isolation of microorganisms
- Use of genetic manipulation for strain improvement
- Problems associated with strain improvement
- improvement of characters other than products

CIA: Assignment, Test

References:-

Unit 1:

1. Molecular Biotechnology, Principles and Applications of recombinant DNA, Glick and Paternak, 4th edition, 2009, ASM Press
2. Plant Biotechnology: The genetic manipulation of plants, 2005, A. Slater, N. Scott & M. Fowler, Oxford Univ Press, Oxford.
3. Introduction to Plant Biotechnology, H.S. Chawla, 3rd Ed, 2002, Oxford and IBH publishers
4. H. K. Das, Textbook of Biotechnology, 2004, Wiley India

Unit 2:

1. Marine Biotechnology: Volume 1, Attway D. H. & Zabosky O. R., Plenum Press, (1993).
2. Marine microbiology: bioactive compounds and biotechnological applications edited by Se-Kwon K., 2013, Wiley-VCH Verlag GmbH & Co.

Unit 3:

1. Fermentation Technology Vol. 1 Upstream Fermentation Technology, Modi H. A., Pointer Publisher, Jaipur India (2014)
2. Fermentation Technology Vol. 2 Downstream Fermentation Technology, Modi H. A., Pointer Publisher, Jaipur India (2014)
3. Microbial Technology Volume 1 and 2, Peppler H. J. and Perlman D., Academic Press New York (1970)
4. Principles of Fermentation Technology, Stanbury P.F., Whitaker W. & Hall S. J., Aditya Books (P) Ltd., New Delhi, 1997.
5. Fermentation Microbiology and Biotechnology, El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
6. Industrial Microbiology, Casida L.E. Jr, 1994 (reprint), Wiley Eastern Limited.

Unit 4:

1. Fermentation Technology Vol. 1 Upstream Fermentation Technology, Modi H. A., Pointer Publisher, Jaipur India (2014)
2. Biotechnology, A textbook of industrial Microbiology, Creuger and Creuger, Sinaeur associates.
3. Industrial Microbiology, Casida L.E. Jr, 1994 (reprint), Wiley Eastern Limited.

SEMESTER 3:

PRACTICALS: EXTERNAL PROJECT (THREE TO FOUR MONTHS)

CIA

3.01: Biostatistics-Problem solving

3.02: Project Proposal

3.03: Rough Draft of Dissertation

3.04: Oral Presentation