



# St. Xavier's College – Autonomous Mumbai

## M.Sc. Syllabus For 3<sup>rd</sup> Semester Courses in **Microbiology** (June 2019 onwards)

Contents:

Theory Syllabus for Courses:

**SMIC0901 - MEDICAL AND PHARMACEUTICAL MICROBIOLOGY**

**SMIC0902 - TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS**

**SMIC0903 - BIOPROCESS TECHNOLOGY**

Practical Syllabus for Courses:

**SMIC9PR      EXTERNAL PROJECT**

**M.Sc II**

**Course: SMIC0901**

**Title: MEDICAL AND PHARMACEUTICAL MICROBIOLOGY**

**LEARNING OBJECTIVES:**

1. Study significant emerging/reemerging infections and the microbial pathogens involved
2. Learn basic principles of Epidemiology
3. Gain an understanding of clinical research and modern diagnostics

**Number of lectures: 60**

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**UNIT 1: EMERGING/RE-EMERGING INFECTIONS**

**15 LECTURES**

**LEARNING OBJECTIVES:**

Study some significant bacterial pathogens and their associated emerging/ re-emerging infections with special emphasis on advances in diagnostics, prophylactic measures, therapeutics and epidemiology

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- 1. Study of significant emerging/re-emerging infections-** with emphasis on advances in diagnostics, therapeutics and epidemiology **15L**
- MDR and XDR Tuberculosis
  - MRSA
  - VRE (Vancomycin Resistant Enterococci)
  - Leptospirosis
  - Hepatitis infections
  - Swine flu
  - Dengue
  - Chikungunya
  - Amoebiasis
  - *Candida auris*
  - Japanese encephalitis

**UNIT 2: EPIDEMIOLOGY OF INFECTIOUS DISEASES**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Learn the history of epidemiology of infectious diseases
2. Get an overview of the principles of epidemiology
3. Know the measurements of risk
4. Understand the significance of public health surveillance and the methods used

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**1. Historical aspects-definition**

**1L**

**2. Descriptive Epidemiology-aims and uses** **2L**

**3. Epidemiological principles** **4L**

- Herd immunity
- Carrier status
- Co-evolution of host-parasite
- Control of epidemics
  - i. Methods directed against reservoir
  - ii. Methods directed against transmission
  - iii. Pathogen eradication

**4. Measures of risks:** **4L**

- Frequency measures
- Morbidity frequency measures
- Mortality frequency measures
- Natality(birth) measures
- Measures of association
- Measures of public health impact

**6. Public health surveillance:** **4L**

- Purpose and characteristics
- Identifying health problems for surveillance
- Collecting data for surveillance
- Analyzing and interpreting data
- Disseminating data and interpretation
- Evaluating and improving surveillance

**UNIT 3: DRUG DISCOVERY**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand modern methods of drug discovery.
2. Understand concepts of Pharmacokinetics and Pharmacodynamics.

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**1. Drug Discovery Tools** **7L**

- Pharmacokinetics and Pharmacodynamics, Natural products for lead identification, High Throughput Screening, Combinatorial Chemistry
- Concept of Pharmacognosy

**2. Modern Methods of Drug Discovery** **6L**

- Cheminformatics, in silico-modelling, Molecular Modeling, Structure Prediction, Rational Drug Designing, Drug Development, Proteomics, protein 3D structures in the drug discovery process, microbial genome mining

### **3. Clinical trial**

**2L**

- History, phases and need

## **UNIT 4: PRINCIPLES OF GMP AND QUALITY PRACTICES IN PHARMACEUTICAL AND COSMETIC INDUSTRY**

**15 LECTURES**

### **LEARNING OBJECTIVES**

1. Understand GMP and its significance
2. Understand concepts of QA and validation in pharmaceutical and cosmetic products.

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#### **1. Principles of GMP, QC, QA, ISO**

**3L**

- Importance of data integrity in pharmaceutical industry

#### **2. QC and GCLP for Pharmaceuticals**

**7L**

- Assurance of quality and sanitary practices in the manufacture of sterile products and non-sterile products
- Pharmacopeia test methods and Rapid test methods
- Validation: concepts, principles, analytical methods and applications.

#### **3. Cosmetic microbiology- testing methods and reservation**

**5L**

- Antimicrobial preservation efficacy and microbial content testing
- Validation method for cosmetics
- Preservation strategy - Global regulatory and toxicological aspects
- Evaluation of antimicrobial mechanism

### **CIA: Assignment, Test**

#### **References:-**

##### **Unit 1**

1. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004 vol. 24 no. 3.
2. Koneman's color Atlas & Textbook of Diagnostic Microbiology, Winn, C. W., Allen, D. S., Janda, M. W., Koneman, W. E., Schreckenberger, C. P., Procop, W. G. and Woods, L. G., 6th edition, 2005, Lippincott Williams & Wilkins.
3. Textbook of Microbiology, Ananthanarayan & Paniker, 9<sup>th</sup> edition, 2013, University press

##### **Unit 2**

1. Basic lab methods in medical bacteriology, WHO Geneva.

2. Epidemiology for Public Health Practice- Friis, H. R., & Sellers, A. T., 4<sup>th</sup> edition, 2009, Jones & Bartlett publishers.
3. Handbook of Epidemiology- Ahrens, W., Pigeot, I., 2005 Springer- Verlag Berlin Herdelberg.
4. Infectious disease surveillance, Nikuchia, N., 2005, Blackwell Publishing.
5. Medical Laboratory Technology, Godkar, P. & Godkar, D., 2<sup>nd</sup> edition, 2006, Bhalani Publishing House.
6. Park's Textbook of Preventive and Social Medicine, Park, K., 16th edition, 2000, M/S Banarsidas Bhanot
7. Principles of epidemiology in public health practices 3<sup>rd</sup> edition  
[www.cdc.gov/training/products/ss1000](http://www.cdc.gov/training/products/ss1000)

**Unit 3:**

1. Foye's Principles of Medicinal Chemistry, Lemke T. L. and Williams D. A., 6<sup>th</sup> Ed, 2008, Wolter Luwer, Lippincott Williams and Wilkins. N Delhi.
2. Modern Methods of drug discovery, Hillisch A. and Hilgenfeld R., 2009, Springer International Edition
3. Principles of Medicinal Chemistry, Kadam S. S., Mahadik K. R. and Bothara K. G., 2009, Vol II, Nirali Prakashan Pune
4. Principles of pharmacology: the pathophysiologic basis of drug therapy by Golan D. E., 2<sup>nd</sup> Edition, 2007, Lippincott Williams and Wilkins

**Unit 4:**

1. Cosmetic Microbiology a practical approach, Geis P. A., Taylor and Francis, 2<sup>nd</sup> Ed, 2006, CRC Press
2. Guidelines on cGMP and quality of Pharmaceutical products, Iyer S., 2003, D K Publishers Mumbai.
3. Hugo and Russell's Pharmaceutical Microbiology, Denyer S. P., Hodges N. A., Gorman S. P. And Gilmore B., 8<sup>th</sup> Edition, 2011, Blackwell Publishing.
4. Quality Assurance in Microbiology, Bhatia R. and Ichhapujani R. L. 1995, CBS publishers and distributors
5. Quality in the manufacture of medicines and other healthcare products, Sharp John, 2000, Pharmaceutical Press.
6. USPs

**M. Sc. II**

**Course: SMIC0902**

**Title: TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS**

**LEARNING OBJECTIVES**

Understand principles and applications of bioanalytical techniques

**Number of lectures: 60**

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**UNIT 1: TOOLS AND TECHNIQUES: MICROSCOPY, X-RAY DIFFRACTION AND CD/ORD** **15 LECTURES**

**LEARNING OBJECTIVES**

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

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**1. Advanced microscopic techniques: principles and applications** **7L**

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)

**3. Circular Dichroism (CD) and Optical rotator Dispersion (ORD)** **4L**

**UNIT 2: TOOLS AND TECHNIQUES: SPECTROSCOPY** **15 LECTURES**

**LEARNING OBJECTIVES**

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

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**1. Infrared spectroscopy** **2L**

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

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

- 3. Atomic Absorption Spectroscopy** **2L**
- Principles, Instrumentation, operation, calibration, accuracy and applications
- 4. NMR spectroscopy** **5L**
- Basic Principles of NMR, Chemical shift, Intensity, Line width
  - Theory and application
- 5. Mass spectroscopy** **4L**
- Instrumentation
  - Various detection systems including MALDI-TOF

**UNIT 3: TOOLS AND TECHNIQUES: CHROMATOGRAPHY** **15 LECTURES**

**LEARNING OBJECTIVES**

Understand principles, working and applications of different chromatographic techniques

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- 1. Gas Chromatography** **5L**
- Principles, Instrumentation, operation, calibration, accuracy and applications
- 2. High Performance Liquid Chromatography** **7L**
- Principles, Instrumentation, operation, calibration, accuracy and applications
- 3. Supercritical Liquid Chromatography** **3L**
- Properties of SFE/SFC, Instrumentation, operation, advantages and applications

**UNIT 4: OTHER ANALYTICAL TECHNIQUES** **15 LECTURES**

**LEARNING OBJECTIVES**

Understand different methods and principles used in analytical techniques.

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- 1. Centrifugation** **4L**
- Overview of preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications
- 2. Radioisotopic techniques** **6L**
- 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. Electrophoretic techniques and application** **3L**

**4. Hybridization techniques/Microarray** **2L**

**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. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
3. Handbook of Physics in Medicine and Biology, edited by Robert Splinter, 2010, CRC Press
4. 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. Atomic absorption and plasma spectroscopy, Dean J.R., 1997 (2008), Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
2. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
3. [http://faculty.sdmiramar.edu/fgarces/labmatters/instruments/aa/AAS\\_Theory/AASTheory.htm](http://faculty.sdmiramar.edu/fgarces/labmatters/instruments/aa/AAS_Theory/AASTheory.htm)
4. [http://www.brynmawr.edu/chemistry/Chem/mnerzsto/The\\_Basics\\_Nuclear\\_Magnetic\\_Resonance%20\\_Spectroscopy\\_2.htm](http://www.brynmawr.edu/chemistry/Chem/mnerzsto/The_Basics_Nuclear_Magnetic_Resonance%20_Spectroscopy_2.htm)
5. Mass spectroscopy, Barker J., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
6. NMR spectroscopy, Williams D.A.R., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
7. Principles of Instrumental Analysis, 5th Ed. Skoog D. A., Holler F.A., Crouch S.R., Holler and Nieman, Australia

**Unit 3:**

1. Basic Gas Chromatography, McNair H. M. and Miller J. M., 2009, Wiley International
2. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House



3. Gas Chromatography, Fowles I. A., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
4. HPLC, Lindsay S., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)

**Unit 4:**

1. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
2. Centrifugation: a practical approach, edited by D. Rickwood, 1984, Oxford
3. Molecular cloning: A laboratory Manual, Sambrook J., Fritsch, Maniatis T, 2<sup>nd</sup> edition, 1989, Cold Spring Harbor Laboratory Press
4. Wilson and Walker's Principles and techniques of biochemistry and molecular biology, Hofmann A., Clokie S., 2018, 8<sup>th</sup> Ed., Cambridge University Press, UK

**M.Sc II**

**Course: SMIC0903**

**Title: BIOPROCESS TECHNOLOGY**

**LEARNING OBJECTIVES**

1. Understand the basic principles and applications of bioprocess technology
2. Understand the concepts of bioprocess technology including fermentation kinetics and process design and apply them to microbial bioprocesses
3. Understand the concept of IPR, bioethics and entrepreneurship

**Number of lectures: 60**

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**UNIT 1: BIOPROCESS TECHNOLOGY  
LECTURES**

**15**

**LEARNING OBJECTIVES**

Understand the general principles of bioprocess technology and upstream process

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**1. General principles of fermentation**

**7L**

- Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa.
- Agitation
- 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 and product, calculation for productivity, substrate utilization kinetics, growth limiting substrate, maintenance energy

**2. Upstream processing**

**3L**

- Media formulation, modification and optimization
- Inoculum development and storage of cultures

**3. Microbial strain improvement**

**3L**

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

**4. Sterilization**

**2L**

- Sterilization of bioreactors, nutrients, air supply, product and effluents

**UNIT 2: FERMENTATION PROCESSES IN BIOTECHNOLOGY** **15**  
**LECTURES**

**LEARNING OBJECTIVES**

Understand concepts of microbial fermentation and downstream processing

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|---|-----------|
| <b>1. Measurement and control of bioprocess parameters</b>  | <b>3L</b> |
| <ul style="list-style-type: none"><li>● Automation for monitoring and Control (online and offline sensors, Biosensors)</li><li>● Use of Computers: Data logging, data analysis, and process control</li></ul>   |           |
| <b>2. Bioreactor</b>  | <b>3L</b> |
| <ul style="list-style-type: none"><li>● Basic configuration and features. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, photobioreactors- their basic construction and types for distribution of gases.</li></ul>   |           |
| <b>3. Downstream processing</b>   | <b>3L</b> |
| <ul style="list-style-type: none"><li>● Biomass separation by centrifugation, filtration, flocculation and other methods.</li><li>● Cell disintegration: Physical, chemical and enzymatic methods.</li><li>● Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods.</li><li>● Concentration by precipitation, ultrafiltration, reverse osmosis, drying and crystallization</li></ul> |           |
| <b>4. Scale-up of Bioprocess</b>  | <b>2L</b> |
| <b>5. Microbial Fermentations</b>   | <b>3L</b> |
| <ul style="list-style-type: none"><li>● Industrial production of citric acid, enzymes (e.g. proteases), acetone- butanol, amino acids (e.g. lysine) by submerged and/or solid state fermentation.</li></ul>   |           |
| <b>6. Effluent treatment</b>  | <b>1L</b> |

**UNIT 3: ADVANCES IN BIOPROCESSES** **15 LECTURES**

**LEARNING OBJECTIVES**

Understand the advanced methods of microbial bioprocesses.

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|---|-----------|
| <b>1. Recent approaches in microbial production</b>   | <b>5L</b> |
| <ul style="list-style-type: none"><li>● Bioplastics, Biopesticides, Biopolymer, Biofertilizers, Single Cell Protein</li></ul> |           |
| <b>2. Biofuels</b>  | <b>3L</b> |

**3. Microbial fuel cell** **2L**

**4. Immobilization techniques** **5L**

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

**UNIT 4: IPR, ETHICS AND ENTERPRENEURSHIP**

**15 LECTURES**

**LEARNING OBJECTIVES:**

1. Understand IPR and its role
2. Understand the concept of bioethics and its relevance
3. Understand the concept of entrepreneurship in biotechnology and obtain a preliminary knowledge of its components

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**1. Biotechnology and Intellectual Property Rights** **7L**

- Intellectual Property Rights (IPR) and Protection (IPP)
- Biotechnology and IPR-Rationale of Patent in Research and Scientific Innovations
- Biotechnological Patents
- Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement.
- Patent Specifications and Basic Component of License Agreement, In IP System
- Categories of Biotechnological Patents-Patenting in New Era of Genomics, Proteomics and Microbiology, Examples of Patents granted by USPTO, Concerns over Biotechnology Patents.
- Patenting in Biotechnology-European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non-Patentable IP and Patentable IP in Indian Patent Act

**2. Biotechnology and Bioethics** **3L**

- Bioethics and cross-cultural bioethics. - Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making
- Perceptions of Ethical Biotechnology, Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about consuming products of GMOs.
- Future 'Bioethical Conflicts' in Biotechnology. - Changing perception of Nature, Human Genetic Engineering

**3. Biosafety** **2L**

- Historical background and introduction
- Need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee
- RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs

- Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)

#### **4. Entrepreneurship in biology**

**3L**

- Introduction
- Case Studies in Entrepreneurship
- Entrepreneurial Skills
- Initiating a Venture
- Planning a Venture
- Financing a Venture

**CIA: Test, Creation of study material or teaching aids** (eg PPT, working model, chart, game etc)

#### **References: -**

##### **Unit 1, 2 and 3:**

1. Biochemical Engineering: A Textbook for Engineers, Chemists and Biologists. Katoh, S., Horiuchi, J. and Fumitake Y. 2<sup>nd</sup> edition, Wiley-VCH Verlag GmbH & Co. KGaA (2015)
2. Bioprocess engineering principles. Doran, P. M., 2<sup>nd</sup> edition, Amsterdam; Boston: Elsevier/Academic Press (2013)
3. Bioprocess Engineering: basic concepts. Shuler, M. L. & Kargi, F. Prentice Hall Publishers, New York (1992)
4. Bioreaction engineering principles. Villadsen, J., Nielsen, J. H., Lidén, G., & Nielsen, J. H., 3rd ed. New York: Springer. (2011)
5. Crueger's Biotechnology: A textbook of industrial microbiology. Crueger, W. & Crueger, A., 3rd ed., Medtech Scientific International Pvt. Ltd. (2017)
6. Fermentation and biochemical engineering handbook: Principles, process design, and equipment. Vogel, H. C., & Todaro, C. L. (Eds.), 2<sup>nd</sup> ed., Westwood, N.J., U.S.A: Noyes Publications. (1997)
7. Microbial Biotechnology: Fundamentals of Applied Microbiology. Glazer A. N. & Nikaido H. W.H. Freeman & Company, New York (1995)
8. Microbial Technology Volume 1 and 2. Peppler H. J. and Perlman D., Academic Press New York (1970)
9. Modern industrial microbiology and biotechnology. Okafor, N., Enfield, (NH): Science Publishers. (2007)
10. Practical fermentation technology. McNeil, B., & Harvey, L. M. Chichester, England; Hoboken, NJ: Wiley (2008)
11. Principles and applications of fermentation technology. Kuila, A., & Sharma, V. (Eds.), Hoboken, New Jersey: Wiley. (2018)
12. Principles of Fermentation Technology. Stanbury P.F., Whitaker W. & Hall S. J., Aditya Books (P) Ltd., New Delhi (1997)

13. Principles of fermentation technology. Stanbury, P. F., Whitaker, A., & Hall, S. J., 3<sup>rd</sup> ed. Amsterdam: Butterworth-Heinemann, an imprint of Elsevier. (2017)
14. Upstream industrial biotechnology. Flickinger, M. C. (Ed.), Hoboken, New Jersey: John Wiley & Sons Inc. (2013)

**Unit 4:**

1. Bioethics and Biosafety in Biotechnology, Sree Krishna V., New Age International (P) Limited. (2017)
2. Bioethics and Biosafety, Sateesh, M. K., I. K. International Publishing House Pvt. Ltd. (2008)
3. IPR, biosafety, and bioethics. Goel, D., & Parashar, S., Dorling Kindersley (India). (2013)
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R. Glick, Jack J. Pasternak, 4<sup>th</sup> ed., ASM Press (2010)

**M.Sc II**

**Course: SMIC09PR**

**Practicals**

**EXTERNAL PROJECT (THREE TO FOUR MONTHS)**

**Evaluation**

CIA		End semester	
Detail	Marks	Detail	Marks
Evaluation of the student by the supervisor of the external project	100	Evaluation of project presentation by internal and external examiner	30
Oral presentation of the external project	20	Evaluation of project thesis by internal and external examiner	120
-	-	Evaluation of project viva by internal and external examiner	30
	120 (total)		180 (Total)