



**Maharashtra Education Society's  
Abasaheb Garware College, Pune  
(Autonomous)**

(Affiliated to Savitribai Phule Pune University, Pune)

Syllabus

**Three Year B.Sc. Degree Program in  
Industrial Microbiology**

**(Faculty of Science & Technology)**

**S. Y. B. Sc. (Industrial Microbiology)**

**Choice Based Credit System Syllabus**

**To be implemented from Academic Year 2023-2024**

**Titles of courses in S. Y. B. Sc. Industrial Microbiology**

<b>Semester</b>	<b>Paper Code</b>	<b>Paper</b>	<b>Paper Title</b>
III	USIMR- 231	I	Bioreactor: Design and Operation
	USIMR -232	I	Screening and process optimization
	USIMRP-233	III	Practical based on USIMR-231 and USIMR-232
IV	USIMR- 241	I	Fermentation Processes and Downstream processing
	USIMR- 242	II	Quality assurance test for fermentation products
	USIMRP-243	III	Practical based on USIMR-241 and USIMR-242

**S.Y.B.Sc Industrial Microbiology Course Structure**

<b>Subject /Paper Code</b>	<b>Subject/Paper Title</b>	<b>Subject type (theory/practical/other)</b>	<b>Credits Allotted</b>	<b>Type Optional/ compulsory</b>	<b>Medium Description (English/Hindi/Marathi)</b>	<b>FY/SY/TY BA/BSc MA/MSc part1/part2 Mlib/Blib</b>	<b>Semester (I/II/III/IV/V/VI)</b>	<b>Lectures allotted</b>
USIMR- 231	Bioreactor: Design and Operation	Theory	2	Compulsory	English	SYBSc	III	36
USIMR -232	Screening and process optimization	Theory	2	Compulsory	English	SYBSc	III	36
USIMRP-233	Practical based on USIMR-231 and USIMR-232	Practical	2	Compulsory	English	SYBSc	III	78
USIMR- 241	Fermentation Processes and Downstream processing	Theory	2	Compulsory	English	SYBSc	IV	36
USIMR- 242	Quality assurance test for fermentation products	Theory	2	Compulsory	English	SYBSc	IV	36
USIMRP-243	Practical based on USIMR-241 and USIMR-242	Practical	2	Compulsory	English	SYBSc	IV	78

**Evaluation:**

Semester	Paper code	Paper	Paper title	Credits	Lectures/week		Evaluation		
					Th	Pr	In	Ex	T
III	USIMR-231	1	Bioreactor: Design and Operation	2	3		15	35	50
	USIMR-232	2	Screening and Process Optimization	2	3		15	35	50
	USIMRP-233	3	Practical course based on paper 1 and paper 2	2		4	15	35	50
IV	USIMR-241	1	Microbial fermentation and downstream processing	2	3		15	35	50
	USIMR-242	2	Quality assurance in Industrial Product	2	3		15	35	50
	USIMRP-243	3	Practical course based on paper 1 and paper 2	2		4	15	35	50

**SEMESTER-III****Course code and title: USIMR-231: Bioreactor: Design and Operation****Lectures: 36 (Credits- 2) (18Lectures/credit)****Course Outcomes:**

1. To provide the basic knowledge of bioreactor design.
2. To provide information about different types of state-of the art bioreactors used for fermentation.
3. To appreciate and understand differences in design and operation of different types of bioreactors along with their use in Industry

<b>Credit</b>	<b>Sr. No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	1	<ul style="list-style-type: none"> <li>• Construction and parts of bioreactor</li> <li>• Importance of different probes used in fermentation and working of sensors used for monitoring fermentation process(pH, temperature, dissolved oxygen, foam, pressure, exhaust gas analysis)</li> <li>• Data acquisition and analysis – online, in-line and off-line sensors</li> </ul>	1 8  1
	2	<ul style="list-style-type: none"> <li>• Bioreactor- types, characteristic and application of each type               <ol style="list-style-type: none"> <li>a) Stirred tank fermenter</li> <li>b) Tubular fermenter</li> <li>c) Fluidized bed fermenter</li> <li>d) Hollow fibre reactors</li> <li>e) Bioreactors on Chip- Microfluidics</li> <li>f) Single use Bioreactors</li> </ol> </li> <li>• Achievement of aseptic conditions in and during fermentation process, Sterilization of fermenter</li> </ul>	6       2
2	1	<ul style="list-style-type: none"> <li>• Utilities required for fermenter maintenance               <ol style="list-style-type: none"> <li>a) Boilers</li> <li>b) Compressors</li> <li>c) Cooling towers</li> <li>d) Refrigeration and air conditioning</li> <li>e) Chilling plants</li> </ol> </li> </ul>	3
	2	<ul style="list-style-type: none"> <li>• Wastewater treatment plant (In detail process- Pre-treatment, Primary, Secondary and Tertiary treatment)</li> </ul>	15

## Suggested references:

- 1) Stanbury,P.F. and Whitaker,A. , Principles of fermentation technology

- 2) Patel, A.H., Industrial Microbiology, New Delhi.
- 3) McNeil, B. and Harvey, L.M. (Eds.) Fermentation, A Practical Approach. IRL Press, Oxford.
- 4) Aiba, S., Humphrey, A.L. and Milles, N.F. (1973). Biochemical Engineering (2nd edition), Academic Press, New York
- 5) Bioreactors - Design Operation and Novel Applications WILEY-CH Edited by Carl-Fredrik Mandenius

**SEMESTER-III****Course code and title: USIMR-232: Screening and Process Optimization****Lectures: 36 (Credits- 2) (18 lectures/credit)****Course Outcomes:**

1. To introduce students to concept of microbial diversity indices and concept of non-culturable bacteria
2. To make student understand the importance of scale up studies in taking product from bench to bed.
3. To understand concept and applicability of scale up.

Credit	Sr. No.	Topic	No. of Lectures
1	1	<ul style="list-style-type: none"> <li>• Screening of industrially important microorganisms, (purpose and importance)</li> <li>• Primary and secondary screening</li> <li>• Concept of targeted screening- concept of metagenomics</li> <li>• Concept of high throughput screening</li> </ul>	2 4 3 3
	2	<ul style="list-style-type: none"> <li>• Microbial diversity in ecosystem</li> <li>• Introduction to Diversity indices – Shannon and Simpsons index</li> <li>• Concept of VBNC</li> </ul>	2 2 2
2	1	<ul style="list-style-type: none"> <li>• Concept and need of Strain improvement</li> <li>• Feedback inhibition and repression</li> <li>• Types of feedback control (concerted, cumulative, co-operative, sequential, isoenzymes)</li> <li>• Concept of auxotrophs, analogue resistant mutants and revertants</li> </ul>	2 1 3 3
	2	<ul style="list-style-type: none"> <li>• Scale up (Window model)</li> <li>• Inoculum development and inoculum build up</li> <li>• Media optimization (OFAT, Plackett Burman design, Factorial design, RSM)</li> <li>• Media sterilization- Processes of Sterilization, decimal reduction time, del factor.</li> <li>• Numerical on DRT and Del factor</li> </ul>	1 5 3

**Suggested references:**

- 1) Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
- 2) Aiba, Shuichi, 1973, Biochemical Engineering, 2nd Ed. Academic Press
- 3) Stanbury, P.F. and Whitaker, A., Principles of Fermentation Technology, Parga.Press.
- 4) Patel, A.H. , Industrial Microbiology.

- 5) Comprehensive Biotechnology Vol I, II, III
- 6) Methods of studying soil microbial diversity. Jennifer Kirk et al, (2004). Journal of Microbiological Methods 58, 169 – 188.
- 7) Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews 2, 141
- 8) Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, Science, 276, 734740. 9



**SEMESTER-III****Course code and title: USIMRP-233 Practical course based on USIMR-231 and USIMR-232****(Credits- 2)**

Practical course aims at experimental learning. The objective of this course is to give students hands on training of techniques used in industries for fermented product synthesis, characterisation and quality assessment.

Practical based on Paper-I: Bio-reactors –Design & Operation and Paper-II: Screening and Process Optimization

**Course Outcomes:**

- To provide students the basic understanding of different approaches towards screening of microorganism for industrial purposes.**
- To make students familiarize with different strategies of media and process optimization in industrial fermentations.**

<b>Sr. No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	Determination of Total Dissolved Solids, Total Suspended Solids	1
2	Primary screening for enzyme production (Protease/Invertase)	1
3	Optimization of parameters for amylase production using One Factor at a Time (OFAT) at flask level	2
4	Process optimization by demonstration -Factorial design/Plackett Burman using design software	1
5	Estimation of Invertase enzyme activity by immobilisation of Yeast	2
6	Single cell protein Biomass production at flask level (Yeast and Spirulina)	2
7	Determination of Decimal reduction time – D value	1
8	Scale-up of a process from flask level to laboratory fermenter level for the production of any acid/alcohol/metabolite	2

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- Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi.
- Aiba, Shuichi, 1973, Biochemical Engineering, 2nd Ed. Academic Press.
- Stanbury, P.F. and Whitaker, A., Principles of Fermentation Technology, Pergamon Press.
- Patel, A.H., Industrial Microbiology.
- Comprehensive Biotechnology Vol I, II, III
- Methods of studying soil microbial diversity. Jennifer Kirk et al, (2004). Journal of Microbiological Methods 58, 169 – 188.

6. Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. *Nature Reviews* 2, 141
7. Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, *Science*, 276.
8. McNeil, B. and Harvey, L.M. (Eds.) *Fermentation, A Practical Approach*. IRL Press, Oxford.
9. *Bioreactors - Design Operation and Novel Applications* WILEY-CH Edited by Carl-Fredrik Mandenius

**SEMESTER-IV****Course code and title: USIMR-241: Microbial Fermentations and Downstream Processing****Lectures: 36 (Credits- 2) (18 lectures/credits)****Course Outcomes:**

- 1. To provide in depth knowledge of different types of production processes for various products along with the downstream processes**
- 2. To make students aware of techniques required for characterization of industrial products.**

<b>Credit</b>	<b>Sr. No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	1	<ul style="list-style-type: none"> <li>• Fermentation process of various products</li> <li>a) Pharmaceuticals (Penicillin and Vitamin B12)</li> <li>b) Organic acid (Acetic acid)</li> <li>c) Amino acid (Glutamic acid)</li> <li>d) Enzyme (Amylase)</li> <li>e) Solvents (Ethanol)</li> <li>f) Fuels (Methane)</li> <li>g) Milk product (cheese)</li> <li>h) Bioinoculants (Symbiotic &amp; non-symbiotic fixers, Phosphate solubilizers)</li> <li>i) Single cell protein- yeast</li> </ul> <p>Structure of molecule, production flowchart including upstream and downstream processes, time course, critical parameters affecting process</p>	18
2	1	<ul style="list-style-type: none"> <li>• Downstream processing with respect to above products</li> <li>a) Pre-treatment (cell disruption, flocculation)</li> <li>b) Solid liquid separation (filtration, sedimentation, centrifugation)</li> <li>c) Concentration (membranes, salt and solvent precipitation, evaporation, liquid extraction and dialysis)</li> <li>d) Purification (Precipitation, Chromatography- Gel permeation, Affinity, Ion exchange (detail process), adsorption and elution)</li> <li>e) Formulation (drying, extrusion, granulation and tableting)</li> <li>f) Packaging (types and techniques, labelling)</li> </ul>	14
	2	<ul style="list-style-type: none"> <li>• Characterisation of product- MALDI, XRD, FTIR, GC-MS (Introduction, concept and application of individual technique)</li> </ul>	4

## Suggested references:

- 1) Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
- 2) Stanbury, P.F. and Whittaker, A., Principles of Fermentation Technology.
- 3) Prescott, S.C. and Dunn, C.G., 1983, Industrial Microbiology, Reed G. (Ed.). AVI Tech books.
- 4) Pepler, H.J. (Ed), 1979, microbial Technology, Vols I and II, A. P

**SEMESTER-IV**

**Course code and title: USIMR-242: Quality Assurance Tests for Fermentation Products**  
**Lectures:36 (Credits- 2) (18 lectures/credit)**

**Course Outcomes:**

- 1. To introduce students to the concepts of Quality assurance and Quality maintenance**
- 2. To train students in industry important skills such preparation of MSDS, monographs**

<b>Credit</b>	<b>Sr. No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	1	<ul style="list-style-type: none"> <li>• Introduction to pharmacopeia IP, USP, BP.</li> <li>• Introduction to various standards: ISO, FDA, ISI, FPO, AGMARK, FSSAI</li> <li>• WHO guidelines for pharmaceutical</li> </ul>	4 3 2
	2	<ul style="list-style-type: none"> <li>• Quality assurance and quality control for products (Antibiotics, vitamins, SCP)</li> </ul> With respect to <ul style="list-style-type: none"> <li>• Sterility testing</li> <li>• Pyrogen testing</li> <li>• Carcinogenicity testing</li> <li>• Toxicity testing</li> <li>• Allergen testing</li> <li>• Bioassays</li> <li>• Shelf-life</li> </ul>	9
2	1	Organic acids, amino acids, solvents, milk products, bioinoculants, fuels with respect to <ul style="list-style-type: none"> <li>• Sterility testing</li> <li>• Pyrogen testing</li> <li>• Carcinogenicity testing</li> <li>• Toxicity testing</li> <li>• Allergen testing</li> <li>• Bioassays</li> <li>• Shelf-life</li> </ul>	18

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- 1) Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
- 2) Stanbury, P.F. and Whittaker, A., Principles of Fermentation Technology.
- 3) Prescott, S.C. and Dunn, C.G., 1983, Industrial Microbiology, Reed G. (Ed.). AVI Tech books.
- 4) Pepler, H.J. (Ed), 1979, microbial Technology, Vols I and II, A. P
- 5) Indian Pharmacopoeia
- 6) British Pharmacopoeia
- 7) United States Pharmacopoeia

**SEMESTER-IV**

**Course code and title: USIMRP-243: Practical course based on USIMR-241 and USIMR-242**

**Lectures: (Credits- 2)**

**Course Outcomes:**

- 1. To help students understand the significance of quality assurance and the principles of its testing methods in industries.**
- 2. To demonstrate lab scale production and their downstream processing techniques commonly employed in industries.**

<b>Sr. No.</b>	<b>Topic</b>	<b>No. of Lectures</b>
1	Handling of Indian Pharmacopoeia	1
2	Preparation of Material Safety Data Sheet (MSDS)	1
3	Downstream processing of product by filtration/centrifugation	1
5	Vitamin B12 bioassay	1.5
6	Antibiotic assay	1.5
7	Recovery of amylase using salting-out method and quantification of enzyme activity	2
8	Microbiological assays of fermentation products - MIC and MBC	2
9	Sterility testing of injectables	1
10	Bio-burden estimation of any commercial food product	1

**Suggested references:**

- 1) Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
- 2) Stanbury, P.F. and Whittaker, A., Principles of Fermentation Technology.
- 3) Prescott, S.C. and Dunn, C.G., 1983, Industrial Microbiology, Reed G. (Ed.). AVI Tech books.
- 4) Pepler, H.J. (Ed), 1979, microbial Technology, Vols I and II, A. P
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