



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

(Savitribai Phule Pune University)

**Three Year B.Sc. Degree Program in Microbiology (with Industrial Microbiology)
(Faculty of Science and Technology)**

**Syllabi under Autonomy
F.Y.B. Sc. (Industrial Microbiology)**

**Choice Based Credit System Syllabus
To be implemented from Academic Year 2022-2023**

Title of the Course: B.Sc. Microbiology (with Industrial Microbiology) (B.Sc. Degree will be awarded for Microbiology)

Preamble

The 3-year B.Sc. Course in Microbiology is conducted alongside Industrial Microbiology. **Industrial Microbiology is offered as one of the subjects among the four subjects at the F.Y.B.Sc. level and among the three subjects at S.Y.B.Sc. level. At the T.Y.B.Sc. level, there are two theory courses and one practical course to be offered along with four theory courses and two practical courses of T.Y.B.Sc. Microbiology.**

The course of Industrial Microbiology gives student an impression of the application of Microbiology in fermentation industry. Students also learn different subjects like Cell culture technology, Bioinformatics, Stem cell technology, Entrepreneurship in the three-year course. This will enrich students with knowledge of different aspects of Microbiology which will prove crucial and indispensable for them to make right career choices. Career opportunities for the graduate students are available in industry and research equally.

It is therefore to be understood that this syllabus will only operate when it is offered to students who have the basic knowledge of Microbiology. It is therefore necessary that the syllabus of B.Sc. Microbiology is simultaneously considered, and that the course in Industrial Microbiology is an add-on information and practice, along with concomitant studies in Microbiology.

Program outcome:

1. To promote the possibility of entrepreneurship/ self-employment after B.Sc.
2. To bridge up the gap between knowledge based conventional education and market demands and to provide an alternative to those pursuing higher education.
3. To introduce the concepts of experimental design in Industrial Microbiology.
4. To inculcate sense of job responsibilities, while maintaining social and environment awareness.
5. To help students' build-up a progressive and successful career in industries with a biotechnological perspective.

Eligibility

First Year B.Sc.:

Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Mathematics, Geography, Geology, etc.

Admissions will be given as per the selection procedure / policies adopted by the college keeping in accordance with conditions laid down by the Savitribai Phule Pune University.

Reservation and relaxation will be as per the Government rules.

Structure of the Course: Microbiology (with Industrial Microbiology)

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
1	I	Compulsory	USIMR- 111	Introduction to Industrial Microbiology and Microorganisms	Theory	2	36
		Compulsory	USIMR-112	Introduction to Industrial Process and Economics	Theory	2	36
		Compulsory	USIMRP-113	Practical Course based on theory paper USIMR- 111 and USIMR- 112	Practical	1.5	14
	II	Compulsory	USIMR-121	Quantitative Industrial Microbiology	Theory	2	36
		Compulsory	USIMR-122	Industrial Bioprocesses and Microbial Products	Theory	2	36
		Compulsory	USIMRP-123	Practical Course based on paper USIMR-121 and USIMR-122	Practical	1.5	14
2	III	Compulsory	USIMR-231	Bioreactors: Design and Operation	Theory	2	36
		Compulsory	USIMR-232	Screening and Process Optimization	Theory	2	36
		Compulsory	USIMRP-233	Practical based on paper USIMR- 231 and USIMR-232	Practical	2	12
		Compulsory	USLG-231	Language	Theory	2	36
		Compulsory	AACC-231	Environmental Science	Theory	2	36
	IV	Compulsory	USIMR-241	Fermentation Processes and Downstream processing	Theory	2	36
		Compulsory	USIMR-242	Quality Assurance Tests for fermentation products	Theory	2	36

		Compulsory	USIMRP-243	Practical based on paper USIMR-241 and USIMR-242	Practical	2	12
		Compulsory	USLG-241	Language	Theory	2	36
		Compulsory	AACC-241	Environmental Science	Theory	2	36
3	V	DSEC-Compulsory	USMR- 351	Medical Microbiology- I	Same as B.Sc. Microbiology	2	36
		DSEC-Compulsory	USMR- 352	Immunology- I		2	36
		DSEC-Compulsory	USMR- 353	Enzymology		2	36
		DSEC-Compulsory	USMR- 354	Genetics		2	36
		DSEC-Compulsory	USIMR-355	Applications of Microbial systems	Theory	2	36
		DSEC-Compulsory	USIMR-356	Cell Culture Technology	Theory	2	36
		DSEC-Compulsory	USMRP- 357	Practical Course I	Same as B.Sc. Microbiology	2	12
		DSEC-Compulsory	USMRP- 358	Practical Course II		2	12
		DSEC-Compulsory	USIMRP- 359	Practical Course III	Practical	2	12
		SEC-Compulsory	USIMRSEC-3510	Plant Tissue Culture	Theory/practical	2	36
		SEC-Compulsory	USMRSEC-3511	Dairy Microbiology	Same as B.Sc. Microbiology	2	36
	VI	DSEC-Compulsory	USMR- 361	Medical Microbiology- II	Same as B.Sc. Microbiology	2	36
		DSEC-Compulsory	USMR- 362	Immunology- II		2	36
		DSEC-Compulsory	USMR- 363	Metabolism		2	36
		DSEC-Compulsory	USMR-364	Molecular Biology		2	36
		DSEC-Compulsory	USIMR-365	Bioentrepreneurship and IPR	Theory	2	36
		DSEC-Compulsory	USIMR-366	Recombinant DNA technology	Theory	2	36
		DSEC-Compulsory	USMRP- 367	Practical Course I	Same as B.Sc. Microbiology	2	12
		DSEC-Compulsory	USMRP- 368	Practical Course II		2	12
		DSEC-Compulsory	USIMRP- 369	Practical Course III	Practical	2	12
		SEC-Compulsory	USIMRSEC-3610	Introduction to Bioinformatics	Theory/practical	2	36
		SEC-Compulsory	USMRSEC-3611	Nanobiotechnology	Same as B.Sc. Microbiology	2	36

SEMESTER-I**Course code and title: USIMR-111: Introduction to Industrial Microbiology and Microorganisms****Lectures: 36 (Credits- 2)****Course Outcomes:**

1. Students will understand the meaning and scope of Industrial Microbiology.
2. To allow students to appreciate and apply basic knowledge of Microbiology for its use in fermentation science.
3. Students will learn different processes involved in fermentation along with different microorganisms involved in large scale production of fermented products.
4. Students will realise inter-disciplinary nature of Industrial Microbiology.
5. Students will understand Good Manufacturing Practices, GILSP and IPR.

Sr. No.	Topic	No. of Lectures
Credit One	Scope of Industrial Microbiology: <i>(Discussion should address atypical nature of Industrial microbiology to that with Chemical/any other industry, emphasis on functioning of fermentation industry by quoting examples of product and microbes)</i>	1
	• Definition and use of the term 'fermentation'	
	• History (An Art from the Past, a Skill for the Future)	1
	• Multidisciplinary nature	
	• A Typical Bioprocess: introduction, advantages and limitations. From Inoculum development to final product	4
	• Upstream processing (USP) and downstream processing (DSP), unit downstream processing	2
	• Organizational set-up in an industrial microbiology establishment	1
	• Process flow diagrams	1
	• Types of fermentations: Aseptic and non-aseptic fermentations	2
	• Fermentation types according to the organization of the biological system: Suspended and support culture	2
	Design of fermenter Emphasis on the basic parts, operation and utilities of the fermenter	3
	• GMP, GILSP, SOP, Validation	1
	Activity Based Learning methodology	

Credit Two	Industrial Microorganisms:	
	• Taxonomic diversity of industrially useful bacteria and Fungi (<i>Discussion on groups, their general feature and taxonomic position and uses</i>)	3
	• Important characteristics of microbes used in Industrial Microbiology	2
	• Industrial fermentation products and their producer microorganisms	2
	• Isolation of suitable producer microorganisms from the environment (Discuss approach for isolation)	3
	• Concept and examples of Microorganisms classified as Generally Regarded As Safe (GRAS)	2
	• Preservation of industrially important microorganisms	2
	• Culture Collections of industrially important microorganisms	1
	Introduction to Patents and Intellectual Property Rights (Trademarks, Trade secret, Copyrights, Patents, GI, Design)	3

Reference Books

1. Modern Industrial Microbiology and Biotechnology (2007) by Nduka Okafor. Published by Science Publishers, Enfield, NH, USA
2. Practical Fermentation Technology Edited by Brian McNeil and Linda M. Harvey 2008 John Wiley & Sons, Ltd. ISBN: 978-0-470-01434-9
3. Industrial Microbiology: An Introduction (2001); Michael J. Waites, Neil L. Morgan, John S. Rockey & Gary Higton
4. Bioprocess Engineering Principles by Pauline M. Doran (1995), Elsevier Science & Technology Books, ISBN: 0122208552
5. Basic Biotechnology 2nd Ed. (2001); Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
6. Bioreaction Engineering Principles 3rd Ed. (2011); John Villadsen, Jens Nielsen, Gunnar Lide'n, Springer
7. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.

SEMESTER-I

Course code and title: USIMR-112 : Introduction to Industrial Process and Economics
Lectures: 36 (Credits-2)

Course Outcomes:

1. Students learn the functioning of biotechnological company.
2. Student will have an over-view on infrastructure and management of biotechnological company.
3. Students learn design and optimization of fermentation process.
4. Students learn concept and strategy behind strain improvement and its importance.
5. Students understand concept of process economics.

Serial No.	Topic	No. of Lectures
Credit One	Entrepreneurial overview of Biotechnology companies <i>(It is expected to discuss configuration and functioning of biotechnology companies with special emphasis on the factors that contribute to the success and failure of the companies.)</i>	
	• Concept of a biotechnology company	1
	• Applications of biotechnology companies (Food, Agriculture, Medicine etc.)	2
	• Scientific creativity	1
	• Market need	1
	• The basic components of the companies (Infrastructure, Manpower, Hierarchical structure for overall management)	2
	• How are the facilities integrated?	2
	• Strategy to establish and run the company	2
	• Competitive advantages	1
	• Success	1
	• Business plan	1
	• Investment in biotechnology	2
	• Management	1
	• Government policies for start-ups	1
	• Career avenues – Guest Lecture	

Credit II	I Designing Biotech Processes for commercial success	
	a. Concept of an industrial strain	2
	b. Ideal characteristics of an industrial strain	2
	c. Strain Design and Selection	2
	d. Strain Improvement through various strategies	2
	II Criteria for Design and Optimization of a Fermentation Process	2
	III Process economics	
	a. Cost estimates	1
	b. Process design optimization	2
	c. Design exercise - activity	2
	d. Capital costs estimates	1
	e. Operating costs estimates, The costs case – to build or not to build	2

Recommended books:

1. Modern Industrial Microbiology and Biotechnology (2007) by Nduka Okafor. Published by Science Publishers, Enfield, NH, USA
2. Practical Fermentation Technology Edited by Brian McNeil and Linda M. Harvey 2008 John Wiley & Sons, Ltd. ISBN: 978-0-470-01434-9
3. Industrial Microbiology: An Introduction (2001); Michael J. Waites, Neil L. Morgan, John S. Rockey & Gary Higton
4. Bioprocess Engineering Principles by Pauline M. Doran (1995), Elsevier Science & Technology Books, ISBN: 0122208552
5. Basic Biotechnology 2nd Ed. (2001); Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
6. Bioreaction Engineering Principles 3rd Ed. (2011); John Villadsen, Jens Nielsen, Gunnar Lide'n, Springer
7. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.
8. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
9. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
10. Batch Fermentation Modeling: Monitoring, and Control. Authors: Ali Cinar; Satish J. Parulekar; Cenk Undey

SEMESTER I**Course code and title: USIMRP-113: Practical Course based on theory paper USIMR -111 and USIMR -112****Practicals: 14 (Credits- 1.5)****Course Outcomes:**

1. Students will get accustomed to Good Laboratory Practices followed in Microbiology laboratory.
2. Students will understand parts and functioning of Bioreactor.
3. Students will understand and practice the use of microscope efficiently.
4. Students will understand concept, importance and technique involved in isolation of microorganisms.
5. Overall the student will get trained in basic practices of Microbiology.

Semester I		
Expt. No.	Topics	No. of Practicals
1	Good Laboratory Practices in Industrial Microbiology laboratory	1
2	Study of Bioreactor and its essential parts	1
3	Necessity and procedure of writing SOPs for instruments and equipment's used in Industry	2
4	Microscopic observation of industrially important microorganisms using Light Microscopy	2
5	Introduction to isolation of microorganisms, techniques and importance Characterization of microorganisms	2
6	Enrichment culture technique – any one type of extremophilic bacteria	1
7	Culturing and Characterization of microorganisms used in Dairy industry	2
8	Culturing and Characterization of microorganisms used in Agro-industry	1
9	Culturing and Characterization of yeast used in Bakery/distillery/winery	1
10	Culturing and Characterization of fungi used in pharmaceutical industry	1

Recommended Books:

1. Basic Biotechnology 2nd Ed. (2001); Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Bioreaction Engineering Principles 3rd Ed. (2011); John Villadsen, Jens Nielsen, Gunnar

Lide'n, Springer

3. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.
4. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
5. Industrial Microbiology by A.H. Patel.
6. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
7. A text book of Industrial Microbiology by WulfCrueger and AnnelieseCrueger, Panimam Publishing Corporation.
8. Industrial Microbiology: An Introduction (2001); Michael J. Waites, Neil L. Morgan, John S. Rockey& Gary Higton.
9. Biology of Industrial microorganisms (1981); Arnold L. Demain.
10. Prescott & Dunn's Industrial microbiology (1987); G. Reed.
11. Modern Industrial Microbiology and Biotechnology (2007); NdukaOkafor.
12. Biotechnology: a text book of industrial microbiology (1990); WulfCrueger, AnnelieseCrueger, Thomas D. Brock.
13. Practical Fermentation Technology. Brian McNeil, Linda Harvey, Wiley.
14. Batch Fermentation Modeling: Monitoring, and Control. Authors: Ali Cinar; Satish J. Parulekar; CenkUndey
15. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.

SEMESTER II**Course code and title: USIMR-121: Quantitative Industrial Microbiology****Lectures: 36 (Credits-2)****Course Outcomes:**

1. Students will learn the importance of calculations in Microbiology.
2. Students will become proficient in understanding Units, dimensions.
3. Students understand the methods of data presentation.
4. Students will learn the concept of modelling of fermentation process.
5. Students will get to know the basics of statistical analysis and understand its importance.

Sr. No.	Topic	No. of Lectures
Credit One	Introduction to Engineering Calculations	
	• Physical Variables, Dimensions and Units (Substantial Variables, Natural Variables, Dimensional Homogeneity in Equations, Equations Without Dimensional Homogeneity)	2
	• Units	1
	• Force and Weight	1
	• Measurement Conventions (Density, Specific Gravity, Specific Volume, Mole, Chemical compositions, Temperature and Pressure)	3
	• Physical and Chemical Property Data	1
	• Stoichiometry	1
	Modeling the Kinetics of Biological Activity in Fermentation Systems <i>(It is expected to emphasize skillful use of mathematics to address problems in fermentation)</i>	
	• Basics of Modeling	1
	• Need of Models	1
	• Cyclic processes of model construction, verification and applications	2
	• The Components of Modeling	2
	• The Control Region (Volume), Variables, Parameters, Equations	3

Credit Two	Presentation and Analysis of Bioprocess Data: <i>(It is expected to deliver the topic using numerical problems and exercises based on fermentation)</i> <ul style="list-style-type: none"> • Errors in data calculation (Significant figures, Absolute and relative uncertainty, types of error) • Standard deviation, Variance calculations • Presentation of experimental data (Tables, graphs and equations) • Use of computer for data presentation and analysis • Data Analysis (Trends, Testing mathematical models, Goodness of fit: Least Square Analysis, Linear and Non-linear models) • Graph paper with logarithmic coordinates (Log-log plots, Semi-log plots) • General procedures for plotting data (Activity) 	<p>3</p> <p>3</p> <p>2</p> <p>3</p> <p>3</p> <p>2</p> <p>2</p>
-------------------	---	--

Recommended books:

1. Basic Biotechnology 3rd Ed. (2001); Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Bioreaction Engineering Principles 3rd Ed. (2011); John Villadsen, Jens Nielsen, Gunnar Liden, Springer
3. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.
4. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
5. Industrial Microbiology by A.H. Patel.
6. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
7. A text book of Industrial Microbiology by Wulf Crueger and Anneliese Crueger, Panimam Publishing Corporation.
8. Industrial Microbiology: An Introduction (2001); Michael J. Waites, Neil L. Morgan, John S. Rockey & Gary Higton.

SEMESTER II**Course code and title: USIMR-122: Industrial Bioprocesses and Microbial Products****Lectures: 36 (Credits-2)****Course Outcomes:**

1. Students will learn various requirements of fermentation process.
2. Students learn manufacturing of different products of fermentation industry.
3. Students realise the uniqueness of every fermentation process.
4. Students understand the scope of fermentation technology.

Serial No.	Topic	No. of Lectures
Credit One	I Fermentation media and raw materials	
	• Carbon sources- examples	1
	• Nitrogen sources- examples	1
	• Minerals, Vitamins and growth factors	1
	• Precursors	1
	• Inducers and elicitors	1
	• Inhibitors	1
	• Antifoams	
	Overview of fermentation systems	1
	II Microbial enzymes: Commercial microbial enzyme production	
	a. Detergent enzymes	
	b. Enzymes in cheese production	1
	c. Enzymes in fruit juice production	1
	d. Enzymes in textile manufacture	1
	e. Enzymes used in the treatment of wood pulps	1
	III Fuels- overview of production	
	a. Biodiesel	1
	b. Bio-ethanol	1
	c. Hydrogen	1
	d. Electricity	1
	e. Bio-methane	1

Credit Two	V Food additives and supplements	
	a. Lipids	3
	b. Natural food preservative	2
	c. B-group Vitamins	3
	d. Exopolysaccharides	2
	IV Microbial biomass production	
	a. Overview, importance and application	2
	b. Manufacture of baker's yeast	2
	c. Single cell protein production	2
	d. Mushroom production	2

Recommended books:

9. Basic Biotechnology 3rd Ed. (2001); Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
10. Bioreaction Engineering Principles 3rd Ed. (2011); John Villadsen, Jens Nielsen, Gunnar Lide'n, Springer
11. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.
12. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
13. Industrial Microbiology by A.H. Patel.
14. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
15. A text book of Industrial Microbiology by Wulf Crueger and Anneliese Crueger, Panimam Publishing Corporation.
16. Industrial Microbiology: An Introduction (2001); Michael J. Waites, Neil L. Morgan, John S. Rockey & Gary Higon.
17. Biology of Industrial microorganisms (1981); Arnold L. Demain.
18. Prescott & Dunn's Industrial microbiology (1987); G. Reed.
19. Modern Industrial Microbiology and Biotechnology (2007); NdukaOkafor.
20. Biotechnology: a text book of industrial microbiology (1990); WulfCrueger, AnnelieseCrueger, Thomas D. Brock.
21. Practical Fermentation Technology. Brian McNeil, Linda Harvey, Wiley.
22. Batch Fermentation Modeling: Monitoring, and Control. Authors: Ali Cinar; Satish J. Parulekar; CenkUndey
23. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.

SEMESTER II

Course code and title: USIMRP-123: Practical Course based on theory paper USIMR-I21 and USIMR-122

Number of practicals: 14 (Credits-1.5)

Course Outcomes:

1. Students to learn concept of photo-documentation, record keeping of microorganisms.
2. Students understand the concept and method of estimation of bioburden.
3. Students improve their isolation technique from commercially available fermented products.
4. Students understand fermentation process by performing laboratory scale fermentation of molasses.
5. Improve skill, performance and understanding of student.

Semester II		
Expt. No.	Topics	No. of Practical
1	Photo-documentation of industrially important microorganisms	1
2	Record-keeping for microbial cultures	1
3	Preservation (Lyophilization) of industrially important microorganisms	1
4	Statistics using excel (Activity and Assignment)	2
5	Preparation of bacterial dilutions and comparing with Mac Farland's standard	1
6	Bio-burden estimation of Laminar air flow	1
7	Bio-burden estimation of raw material to be used in fermentation process	2
8	Design and use of typical fermentation process medium using crude raw material such as molasses	2
9	Isolation and enumeration of microorganism from commercially available food products	2
10	Determine activity of pharm/nutraceutical /commercial product	1

Recommended Books:

1. Basic Biotechnology 2nd Ed. (2001); Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Bioreaction Engineering Principles 3rd Ed. (2011); John Villadsen, Jens Nielsen, Gunnar Lide'n, Springer
3. Industrial Microbiology by Casida. LE, New age International (P) Limited,

Publishers.

4. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
5. Industrial Microbiology by A.H. Patel.
6. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
7. A text book of Industrial Microbiology by WulfCrueger and AnnelieseCrueger, Panimam Publishing Corporation.
8. Industrial Microbiology: An Introduction (2001); Michael J. Waites, Neil L. Morgan, John S. Rockey& Gary Higton.
9. Biology of Industrial microorganisms (1981); Arnold L. Demain.
10. Prescott & Dunn's Industrial microbiology (1987); G. Reed.
11. Modern Industrial Microbiology and Biotechnology (2007); NdukaOkafor.
12. Biotechnology: a text book of industrial microbiology (1990); WulfCrueger, AnnelieseCrueger, Thomas D. Brock.
13. Practical Fermentation Technology. Brian McNeil, Linda Harvey, Wiley.
14. Batch Fermentation Modeling: Monitoring, and Control. Authors: Ali Cinar; Satish J. Parulekar; CenkUndey
15. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.