

# **University of Pune**

**Three Year B. Sc. Degree Course in  
INDUSTRIAL MICROBIOLOGY (VOCATIONAL)**

**S.Y.B.SC. INDUSTRIAL MICROBIOLOGY**

**Syllabus**

**(To be implemented from Academic Year 2014-15)**

Submitted by:

**Dr. B. D. Bhole**  
Chairman,

Industrial Microbiology (Vocational) Syllabus Sub-Committee

**January 15, 2014**

## Preamble:

The 3-year B.Sc. Vocational Course in Industrial Microbiology is conducted as a part of the University of Pune approved course in B.Sc. 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 “Industrial Microbiology” is being coordinated and conducted by the Department of Microbiology at the concerned centres.

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, and in certain cases, Biotechnology at the undergraduate level.

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.

In keeping with the purpose of introducing vocational courses in the affiliated colleges of the University of Pune, and as given in the previous statements of intent by the Board of Studies, the vocational courses are expected to be:

1. Specialized in the sense of being **non-conventional**.
2. They are expected to be **multi-faculty** as well as **multidisciplinary**.
3. The concerned Board of Studies is supposed to keep a **holistic view** and **integrated approach**.
4. The courses are **expected to be different** also because they are incorporated into conventional disciplines.
5. The courses are expected to **establish a linkage with main stream disciplines, market and industry**.

## Introduction:

There is a continual demand for microbiologists in the work force – education, industry and research. Career opportunities for the graduate students are available in manufacturing industry and research institutes at technical level. This course focuses on training students on how microbiological techniques are carried out in industrial practices. Though the fundamentals of microbiological practices remains the same in theory and industrial practice, there are several facets of even simple microbiological practices that are exclusive to industry. For example, validation of procedures and processes are an integral part of industrial production. This is not taught in practicals at the B.Sc. level. Also, some practices in industry, though simple and sometimes monotonous, need to be standardized. Such standardization procedures are also not extensively taught at the B.Sc. level.

The proposed syllabus lays more stress on practicals as compared to theory. This course will concentrate on experimental practice, and theoretical aspects will be oriented to explain and discuss the experimental practices. This approach justifies the term 'vocational'.

The teaching centre at the college will develop trained manpower for industry, such that employability immediately after B.Sc. is possible.

Trained and competent teachers with experience in industry would be ideal to teach the subject. Besides such teachers, persons from industry could contribute to the course.

### **Objectives to be achieved:**

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

### **Eligibility**

#### **1. First Year B.Sc.:**

- a. 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. OR
- b. Three Years Diploma in Pharmacy Course of Board of Technical Education conducted by Government of Maharashtra or its equivalent. OR
- c. Higher Secondary School Certificate (10+2) Examination with English and vocational subject of + 2 level (MCVC) - Medical Lab. Technician (Subject Code = P1/P2/P3). The students should have appeared for Biology as one of their subjects.

#### **2. Second Year B.Sc.:**

The students should pass in all subjects at the F.Y.B.Sc. level or at least keep terms (ATKT) of First Year of B. Sc. with Microbiology and Industrial Microbiology as two of the subjects at the F.Y.B.Sc. level. In addition to the above qualification, students who have passed the Diploma course in Pharmacy are eligible however such cases should be approved by equivalence committee of Faculty of Science of the University of Pune.

#### **3. Third Year B. Sc.:**

The student should compulsorily clear all First Year B. Sc. Microbiology and Industrial Microbiology courses and satisfactorily keep terms (at least ATKT) of Second Year of B. Sc. with Microbiology and Industrial Microbiology as two of their subjects. Students who may have passed in all subjects at the S.Y.B.Sc. level, but have not cleared all the courses at F.Y.B.Sc. level are not eligible to be admitted to the T.Y.B.Sc. class.

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

Reservation and relaxation will be as per the State Government rules.

### **Standard of Passing**

- i. In order to pass in the First Year Theory Examination, the candidate has to obtain at least 40 marks out of 100 in each Theory Course. (Minimum 32 marks must be obtained in the University Theory Examination).
- ii. In order to pass in the Second Year and Third Year Theory Examinations, the candidate has to obtain at least 20 marks out of 50 in each course of each semester. (Minimum 16 marks must be obtained in the University Theory Examination).
- iii. In order to pass in Practical Examination, the candidate has to obtain at least 40 marks out of 100 in each course. (Minimum 32 marks must be obtained in the University Examination).

### **Award of Class**

The class will be awarded to the student on the aggregate marks obtained during the Second and Third year in the Principle subject only. The award of the class shall be as follows:

1	Aggregate 70% and above	First Class with Distinction
2	Aggregate 60% and more but less than 70%	First Class
3	Aggregate 55% and more but less than 60%	Higher Second Class
4	Aggregate 50% and more but less than 55%	Second Class
5	Aggregate 40% and more but less than 50%	Pass Class
6	Below 40%	Fail

### **ATKT Rules**

While progressing from F. Y. B. Sc. to S. Y. B. Sc. Class, the student has to pass in at least 8 courses (out of total 12).

While going from S. Y. B. Sc. to T. Y. B. Sc., at least 12 courses (out of 20) should be cleared. The student will not be able to progress from S.Y.B.Sc. to T.Y.B.Sc. unless all his / her F. Y. B. Sc. courses are cleared.

### **Equivalence of Previous Syllabus**

No equivalence required at S. Y. B. Sc. level, the course titles are same as previous syllabus.

## **External Students**

There shall be no external students.

## **University Terms**

Dates for commencement and conclusion for the First and Second Terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 80 percent attendance at theory and practical course and satisfactory performance during the term.

**Medium of Instruction:** The medium of instruction for the course shall be English.

## **Course Structure:**

**Duration:** The duration of B.Sc. (Industrial Microbiology) Degree Program shall be three years.

The syllabus has been structured to progressively inform and discuss the concepts and working areas of the fermentation / biotechnology industry. The training for skill sets required to perform the tasks in the industry has been concomitantly developed through the three-year course.

In the **First Year of undergraduate studies**, students will be given information about the spectrum of microorganisms used for production of useful metabolites and enzymes (catalysts). A typical layout of the industry, equipment and operations, and regulations governing the organisms and products are presented to the student. This information lays the foundation for detailed study of each facet in the progressive years. In the practical exercises, students will learn the basic techniques of microbiological procedures in the industrial context.

In the **Second Year of undergraduate studies**, methods of screening of microorganisms and media, details of operations and designs of bioreactors, processes for production of industrially important metabolites and procedures of quality assurance will be studied. The focus of these topics is to reveal to the students the different strategies used for designing and directing the metabolism of a production strain to overproduce the metabolite, and recover it. The practical exercises use examples to explain the procedures described in the theory courses.

In the **Third Year of undergraduate studies**, the students of Industrial Microbiology share four theory courses (per semester) and one practical course with Third Year Microbiology undergraduate students. The four theory courses they share are Medical Microbiology, Microbial Physiology, Microbial (prokaryotic and eukaryotic) Genetics and Immunology. The practical courses they share are 'Biochemistry and Molecular Biology' (Practical Course II) and 'Diagnostic Microbiology and Immunology' (Practical Course III) as per the existing version of the T.Y.B.Sc. Microbiology syllabus.

The courses for T.Y.B.Sc. Industrial Microbiology are structured to describe, explain and perform experiments related to Pollution Control Methods, Animal and Plant Tissue Culture, Validation of processes and methods and areas of Process Management and Economics.

\*\*\*\*\*

### F. Y. B. Sc. Industrial Microbiology

Paper	Course Title	Marks	Lectures
Paper - I	Microorganisms and Systems for Fermentation Processes	100	Three Hours/Week per Paper (Total 36/Paper per Term)
Paper - II	Industrial Processes and Products	100	
Practical Course	Practical Course	100	*Four Hours / Week (Total 96 – Term I & II)
<b>*Practical to be conducted as two hours each day on two consecutive days / Batch</b>			

#### Examination Pattern

Theory paper:	University Examination – 80 marks (at the end 2 <sup>nd</sup> term)
	Internal Examination – 20 marks
Practical course:	University Examination – 80 marks (at the end of 2 <sup>nd</sup> term)
	Internal Examination – 20 marks

**Theory examination** will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks. The pattern of question papers shall be:

Question 1	8 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus
Question 2 and 3	4 out of 6 – short answer type questions; answerable in 6 – 8 lines
Question 4	2 out of 4 – long answer type questions; answerable in 12 – 16 lines
Question 5	1 out of 2 – essay / long answer type question; answerable in 25 – 30 lines

**Internal examination:** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks each term. The written test shall comprise of objective type questions – Multiple Types Questions, True / False, Definitions, Tricky computational problems with minimum calculations. There shall be 20 questions, each question of 0.5 marks.

**Practical Examination:** Practical examination shall be conducted by the respective college at the end of the academic year. Practical examination will be of minimum 4 hours duration, carried over on two subsequent days. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce and minimum three experiments. Certified journal is compulsory to appear for practical examination. There shall be two experts and two examiners per batch for the practical examination.

**Setting question papers:** Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

## S. Y. B. Sc. Microbiology

	Paper	Course Title	Marks	Lectures
<b>Semester I</b>	VOC-IND-MIC – 211	Bioreactors: Design and Operation	50	Four Hours/Week per Paper (Total 48/Paper per Semester)
	VOC-IND-MIC – 212	Screening and Process Optimization	50	
<b>Semester II</b>	VOC-IND-MIC – 221	Fermentation Processes and Downstream Processing	50	
	VOC-IND-MIC – 222	Quality Assurance Tests for fermentation products	50	
<b>Semester I &amp; II</b>	Practical Course	Practical Course	100	*Four Hours / Week (Total 96 – Semester I & II)
<b>*Practical to be conducted as two hours each day on two consecutive days / Batch</b>				

### Examination Pattern

- Theory paper: University Examination – 40 marks (at the end of each semester)  
Internal Examination – 10 marks
- Practical course: University Examination – 80 marks (at the end of 2<sup>nd</sup> semester)  
Internal Examination – 20 marks

**Theory examination** will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks. The pattern of question papers shall be:

- Question 1            10 sub-questions, each of 1 marks; objective type and based on entire syllabus
- Question 2 and 3    2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
- Question 4            1 out of 2 – long answer type questions; answerable in 20 – 25 lines

**Internal examination:** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks each semester. The written test shall comprise of objective type questions – Multiple Types Questions, True / False, Definitions, Tricky computational problems with minimum calculations. Different sets of question papers may be given in the same class-room. There shall be 20 questions to be answered in 40 minutes, each question of 1mark.

**Practical Examination:** Practical examination will be of minimum 4 hours duration, carried over on two subsequent days. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce and minimum three experiments. Certified journal is compulsory for appearing for practical examination. There shall be two experts and two examiners per batch for the practical examination. One of the examiners will be external.

**Setting question papers:** Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.





## T. Y. B. Sc. Microbiology

### Theory Papers

	Paper	Paper Title	Marks	Lectures
<b>Semester III</b>	MB 331	Medical Microbiology – I	50	Four Hours/Week per Paper (Total 48/Paper per Semester)
	MB 332	Genetics & Molecular Biology - I	50	
	MB 333	Enzymology	50	
	MB 334	Immunology –I	50	
	VOC-IND-MIC – 335	Pollution Control Technology	50	
	VOC-IND-MIC – 336	Animal and Plant Tissue Culture	50	
<b>Semester IV</b>	MB 341	Medical Microbiology - II	50	
	MB 342	Genetics & Molecular Biology – II	50	
	MB 343	Metabolism	50	
	MB 344	Immunology –II	50	
	VOC-IND-MIC – 345	Molecular Biology and Recombinant DNA Technology	50	
	VOC-IND-MIC – 346	Microbial Process Management & Economics	50	

### Practical Courses

	Course	Course title	Marks	
<b>Semester III &amp; IV</b>	VOC-IND-MIC - 347	Based on Theory Courses: VOC-IND-MIC – 335, 336, 345 and 346.	100	*Four Hours / Week per course (Total 96/Course per Semester)
	MB 348	Practical course – II Biochemistry & Molecular Biology	100	
	MB 349	Practical course – III Diagnostic Microbiology & Immunology	100	
<b>*Practical to be conducted as four hours each day on three consecutive days / Batch</b>				

#### Examination Pattern

Theory paper:	University Examination – 40 marks (at the end of each semester) Internal Examination – 10 marks
Practical course:	University Examination – 80 marks (at the end of 2 <sup>nd</sup> semester) Internal Examination – 20 marks

**Theory examination** will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks. The pattern of question papers shall be:

Question 1	10 sub-questions, each of 1 marks; objective type and based on entire syllabus
Question 2 and 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 4	1 out of 2 – long answer type questions; answerable in 20 – 25 lines

**Internal examination:** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks each semester. The written test shall comprise of objective type questions – Multiple Types Questions, True / False, Definitions, Tricky computational problems with minimum calculations. Different sets of question papers may be given in the same class-room. There shall be 20 questions to be answered in 40 minutes, each question of 1mark.

**Practical Examination:** Practical examination will be of minimum 6 hours duration, carried over on three subsequent days. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce and minimum three experiments per practical course. Certified journals are compulsory for appearing for practical examination. There shall be two experts for each practical course and two examiners per batch; one of the examiners will be external.

**Setting question papers:** Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

### **Qualification of Teachers:**

With minimum postgraduate degree in Microbiology (M. Sc. Microbiology) and qualified as per UGC regulations.

## Course-wise details of the Syllabus

### **S. Y. B. SC. INDUSTRIAL MICROBIOLOGY**

#### **S.Y.B.Sc. Semester I: (Voc-IND-MIC-211) Paper-1: Bioreactors – Designs & Operation**

1. Construction and parts of a typical batch fermenter (CSTR) (05)
2. Aeration and agitation: Aerator (sparger), Agitation (Impellers,baffles) (05)
3. Other types of bioreactors: (05)
  - a. Reactors for immobilized cells
  - b. Tubular reactors
4. Operational modes of fermenters (Batch, Fed-batch, Continuous) (10)
5. Operational parameters in fermentations, their measurement and monitoring; (15)  
Sensors for measuring the parameters
  - a. pH, Oxygen tension, temperature, substrate concentration
  - b. Other critical parameters affecting productivity of the metabolite
  - c. Sterilization (Batch, continuous, SIP); Calculation of Del Factor
  - d. Sterilization of sparged air
6. Time-Course of a fermentation process. (03)
7. Data acquisition and analysis: (05)
  - a) On-line, off-line and in-line.

#### **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

**S.Y.B.Sc. Semester I: (Voc-IND-MIC-212) Paper-2: Screening and Process Optimization**

1. Screening for production strains: (20)
  - a. Primary Screening
  - b. Secondary Screening
  - c. Targeted Screening
  - d. Strain Improvement (including genetic manipulations)
2. Process optimization (28)
  - a. Maintenance of industrially important microorganisms.
  - b. Inoculum build up.
  - c. Medium optimization (Plackett-Burman; other systems; Use of software)
  - d. Scales of fermentation (shake flask – lab fermenter – pilot plant - production level)
  - e. Scale-up
    - i. Objectives of scale-up
    - ii. Levels of fermentation
    - iii. Parameters to be scaled-up fermenter design, media, sterilization of media, etc.

**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, Pergamon Press.
- 4) Patel, A.H. , Industrial Microbiology.
- 5) Comprehensive Biotechnology Vol I, II, III

**S.Y.B.Sc. Semester II: (Voc-IND-MIC-221) Paper-1: Microbial Fermentations and Down Streaming Processing**

1. Typical production processes for antibiotics, vitamins, organic acids, biomass, enzymes, solvents, fermented food, amino acids (one product each). **Suggested products:** Penicillin, Streptomycin, Vitamin B<sub>12</sub>, Acetic acid, Citric acid, Bioinoculants, Baker's Yeast, Amylase, Cheese, Lysine, Glutamic acid. (24)
  - a. Structure of the molecule / product, Applications of the product, Flow-chart and description of production process, Biochemical pathway for overproduction of the metabolites, Time-Course of the process, Critical factors to be regulated in the process for high productivity, Procedures for estimating the quantity of the product as a measure of QC, QA parameters for the product.
2. Unit Processes for recovery of fermentation products (Downstream processing) (24)
  - a. Solids-liquids separation
  - b. Concentration of product
  - c. Purification of product
  - d. Modification of the product (semi-synthetic)
  - e. Formulation of the product (for different preparations)

**References:**

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

**S.Y.B.Sc. Semester II: (Voc-IND-MIC-222) Paper-2: Quality Assurance for Industrial Fermentation Products**

The Quality Assurance tests should be taught for the type products that are described in Paper VOC-IND-MIC 221.

Check references for the tests used for each product with reference to: (48)

1. Pharmacopeia (and its use)
2. Purity
3. Quantitative assay for activity and amount / potency
4. Microbial load / Sterility
5. Shelf-life
6. Undue toxicity
7. Pyrogen

1. Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
2. Pharmacopeias (Indian, British and United States)

## **Paper-8: Practical Course: Based on theory papers and key competency module**

1. Isolation of cultures producing enzyme, antibiotic and organic acid.
2. Using *Aspergillus niger* to produce gluconic acid.
3. Production of enzyme at shake-flask level and scale-up to laboratory fermenter
4. Recovery of amylase using salting-out method.
5. Quantification of enzyme activity (amylase).
6. Immobilization of cells / enzyme and determining immobilization / enzyme activity.
7. Estimation of purity of a product.
8. Estimation Microbial load / Sterility in finished products.
9. Estimation of shelf-life of a product.
10. Microbiological assays: Vitamin and antibiotic (agar-well and turbidimetric methods).
11. Visits to understand:
  - a. Fermentation Process (visit a factory).
  - b. Pyrogen Testing.
  - c. Quality Assurance Protocols.
  - d. Validation of products and processes.
12. Guest lectures and interactions to understand the industrial perspective.

\*\*\*\*\*



---

## **Annexure-II**

Structure/ Pattern of Syllabus must be as follows:

- 1) Title of the Course: Industrial Microbiology (Vocational)
- 2) Introduction: Pattern Semester
- 3) Eligibility: Should have offered Industrial Microbiology (Vocational) at F.Y.B.Sc. and Passed F.Y.B. Sc. As per Pune University Rules
- 4) Examination
  - A) Pattern of examination
    - i) 40:10 (University semester examination of 40 Marks & Internal assessment of 10 Marks) Details as per the syllabus
    - ii) Pattern of the question paper: As per the specimen given
  - B) Standard of Passing : As per Pune University norms
  - C) ATKT Rules : As per Pune University norms
  - D) Award of Class : As per Pune University norms
  - E) External Students : As per Pune University norms
  - F) Setting of Question paper/ Pattern of Question paper: As per Pune University norms
  - G) Verification of Revaluation : As per Pune University norms
- 5) Structure of the Course :
  - i) Optional
  - ii) Medium of instruction : English
- 6) Equivalence subject/ papers & Transitory Provision: Industrial Microbiology (Vocational)
- 7) University terms : As per Pune University Norms
- 8) Subject wise Detail Syllabus : Attached
- 9) Recommended books : Mentioned in syllabus

\*\*\*\*\*