Title of the Course: S.Y B. Sc. (Industrial Microbiology)

CBCS pattern (2019)

Introduction

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. Previous year we have revised F.Y.B.Sc. (Industrial Microbiology) course and introduced the CBCS pattern. This year we have proposed this revised syllabus for S.Y.B.Sc. The primary objective of the new syllabus is to provide students more opportunities of experiential learning along with classroom learning. Industrial Microbiology being vocational course it is important to blend the theoretical knowledge with practical knowledge. Second year forms the base for the final year and in this syllabus we have not only tried to consolidate the basics learned in First year but also introduced the students to state of the art technologies currently used in industry.

New syllabus and credit distribution

Semester	Paper Code	Paper	Paper title	credits	Lectures/Week Th .	Tut	Pr.	Evaluation CA	UE	Total
III	**Voc-IND-IMB 211**	**I**	Bio-reactors –Design & Operation	**2**	**2**			**15**	**35**	**50**
	Voc-IND-IMB 212	**II**	Screening & Process Optimization	**2**	**2**			**15**	**35**	**50**
	Voc-IND-IMB 213	**III**	Practicals based on 211 and 212				**4**	**15**	**35**	**50**
IV	**Voc-IND-IMB 221**	**I**	Microbial Fermentations & Down-stream processing	**2**	**2**			**15**	**35**	**50**
	Voc-IND-IMB 222	**II**	Quality Assurance in Industrial Product	**2**	**2**			**15**	**35**	**50**
	Voc-IND-IMB 223	**III**	Practicals based on 221 and 222				**4**	**15**	**35**	**50**

Equivalence to previous syllabus

Old course (2014 semester pattern) 48 min/L			New course (2020 Semester pattern) 48 min/L		
Paper Code	**Paper**	**Paper title**	**Paper Code**	**Paper**	**Paper title**
VOC-IND-MIC – 211	I	Bioreactors: Design and Operation (48 L, 50 marks)	Voc-IND-IMB 211	I	Bioreactors:Design& Operation (2 credit, 36 L)
VOC-IND-MIC – 212	II	Screening and Process Optimization (48 L, 50 marks)	Voc-IND-IMB 212	II	Screening & Process Optimization (2 credit, 36 L)
			Voc-IND-IMB 213	III	Practicals based on 211 and 212 50 marks
VOC-IND-MIC – 221	I	Fermentation Processes and Downstream Processing (48 L, 50 marks)	Voc-IND-IMB 221	I	Microbial Fermentations & Downstream Processing (2 credit, 36 L)
VOC-IND-MIC – 222	II	Quality Assurance Tests for fermentation products (48 L, 50 marks)	Voc-IND-IMB 222	II	Quality Assurance in Industrial Product (2 credit, 36 L)
		Annual Practicals 100 marks	Voc-IND-IMB 223	III	Practicals based on 221 and 222 50 marks

S.Y.B.Sc. Semester III
Bio-reactors – Design & Operation (Voc-IND-IMB-211)

Bioreactor Design course has two objectives:

- To provide the basic principles of reactor design
- To provide knowledge about different types of state-of the art bioreactors used

1. Fundamentals of Bioreactors and Overview of fermentation processes 1) Design of of CSTR, Batch fermenter, Continuous fermenter, fed batch fermenter a) Stirred tank fermenter b) Tubular fermenter c) Fluidized bed fermenter d) Hollow fibre reactors e) Bioreactors on Chip- Microfluidics f) Single use Bioreactors g) Stem cell and Recombinant protein reactors 9L 2) Parts of Bioreactors a) Body construction and temperature control b) Aeration and agitation: Aerator (sparger), Agitation (Impellers, baffles) c) Achievement and maintenance of aspectic conditions d) Sterilization of fermenter, air supply and exhaust gas e) Monitoring and control of various parameters- probes 6L *Student activity: Construction of Bioreactor prototypes*	**1C**
2. Maintenance and Operation of Bioreactors 1) Fermenter design- Assembly and testing, Repairs and maintenance, Troubleshooting 3L 2) Utilities required for fermentor maintenance a) Boilers b) Compressors c) Cooling towers d) Refrigeration and air conditioning e) Chilling plants f) Waste Water treatment plants 9L 3) Data acquisition and analysis- On-line, off-line and derived variables. 3L *Student activity- Product based layout of Industry, Guest lectures by Industry experts*	**1C**

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 Edite by Carl-Fredrik Mandenius

S.Y.B.Sc. Semester III
Screening and Process Optimization (Voc-IND-IMB-212)

The objectives of this paper are-

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

1. Screening of Industrially Important Microorganisms 1) Microbial Diversity: i. Expanse of microbial diversity ii. Introduction to diversity indices- Shannon and Simpson's indices iii. Concept of un-culturable bacteria 5L 2) Screening: i. Primary screening ii. Secondary Screening iii. Targeted Screening- Concept of metagenomics, function based targeted screening, sequence based targeted screening 10L	**1C**
2. Process Optimization and Scale-up 1) Strain improvement and Maintenance of industrially important microorganisms Concept and need of strain improvement, feedback inhibition and repression, types of feedback control (concerted, cumulative, co-operative, sequential, isoenzymes), modification of cell permeability, use of auxotrophs for primary metabolite production, isolation of analogue resistant mutants and revertants. i) Inoculum development a) Inoculum build-up b) Media formulation- Details of fermentation media ii. Media Optimization – Plackett- Burman design, factorial design, RSM, biological mimicry, one factor at a time (OFAT) iii. Media sterilization- Processes of Sterilization, decimal reduction time, del factor. Numericals for DRT and Del factor. 9L 2) Process optimization a) Process parameters and their importance – temperature, pH, O-R potential, aeration, agitation, foam, pressure, dissolved oxygen; exhaust gas analysis (N_2, CO, CO_2, O_2), etc. b) Monitoring and control of media components – C, N, product, product, cell mass, precursors, by-products, etc. 3L 3) Scale-up of Fermentation a) Objectives of scale-up b) Levels of fermentation- Pilot scale, Lab scale c) Parameters to be scaled-up fermenter design, media, sterilization of media, scale up window, scale up time temperature regime etc. 3L *Student activity- Numericals on DRT and DST*	**1C**

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

S.Y.B.Sc. Semester IV
Microbial Fermentations and Down Streaming Processing
(Voc-IND-IMB-221)

This paper has two objectives:

- To provide in depth knowledge of production processes
- To make students aware of importance of downstream processing process along with upstream processes

1. Industrial production of Microbial products a) Pharmaceuticals (Penicillin and Vitamin B_{12}) b) Organic acid (Acetic acid) c) Amino acid (Glutamic acid) d) Enzyme (Amylase) e) Solvents (Ethanol) f) Fuels (Methane) g) Milk product (cheese) h) Bioinoculants (Symbiotic & non-symbiotic fixers, Phosphate solubilizers) i) Single cell protein- yeast Structure of molecule, production flowchart including upstream and downstream processes, time course, critical parameters affecting process 15 L *Student activity- Market survey of products*	**1C**
2. Downstream processing of above fermentation products a) Pre-treatment (cell disruption, flocculation) b) Solid liquid separation (filtration, sedimentation, centrifugation) c) Concentration (membranes, salt and solvent precipitation, evaporation, liquid extraction and distillation) d) Purification (Precipitation, Details of all types of chromatography, adsorption and elution) e) Formulation (drying, extrusion, granulation and tabletting) f) Introduction to Matrix Assisted Liquid Desorption Ionisation (MALDI), Gas Chromatography -Mass Spectrometry, Liquid Chromatography-Mass Spectrometry X- ray Diffraction (XRD), Fourier Transform Infra Red - characterisation techniques, Principle and applications in characterisation of products. 15L Visit to Central Instrumentation facility.	**1C**

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) Peppler, H.J. (Ed), 1979, microbial Technology, Vols I and II, A. P.

S.Y.B.Sc. Semester IV
Quality Assurance in Industrial Product (Voc-IND-IMB-222)

This course has two objectives:

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

1. Introduction to Pharmacopoeias and standards 1) Introduction to various pharmacopoeias: IP, BP, USP 2) Introduction to various standards: ISO, URO, ISI, FDA, FPO, AGMARK, etc. 3) Introduction to pharmaceutical GMP and CGMP (WHO) 15 L	**1C**
2. Quality Assurance Quality assurance of products explained in paper I a) Pharmaceuticals (Penicillin and Vitamin B12) b) Organic acid (Acetic acid) c) Amino acid (Glutamic acid) d) Enzyme (Amylase) e) Solvents (Ethanol) f) Fuels (Methane) g) Milk product (cheese) h) Bioinoculants (Symbiotic & non-symbiotic fixers, Phosphate solubilizers) i) Single cell protein- yeast j) Health care products (Tooth pastes, creams and lotions) k) Cosmetics, Packaged products (Dairy and Food products and Mineral waters with respect to: a) Sterility testing b) Pyrogen testing c) Carcinogenicity testing d) Toxicity testing e) Allergen testing f) Bioassays g) Shelf life 15 L *Suggested Student activity – Monograph preparation.*	**1C**

References:

1) Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi

2) I. P. / B. P. / U. S. P.

SEMESTER III
S.Y.B.Sc. Industrial Microbiology Practical Course

Practical course aims at experiential 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.

Any 11 practicals have to be conducted as per syllabus and considering availability of resources at the center.

SEM III 4 credit course (4h 20 min sessions per week)

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

Practical Title	Number of sessions
1) Design of laboratory fermenter	1P
2) Screening for Enzyme producers (amylase /protease)	1P
3) Screening for Organic acid producers (acetic acid/lactic acid)	1P
4) Screening for Antibiotic producers	1P
5) Optimization of parameters for Amylase production using one factor at a time (OFAT) design.	2P
6) Demonstration of Factorial design using Design software	1P
7) Demonstration of PlackettBurman design for exopolysaccharide production	1P
8) Optimization of Amlyase production at flask level	2P
9) Immobilization of enzyme, enyzme activity- Invertase	2P
10) Demonstration of Single cell protein Biomass production (Yeast/Spirulina)	2P
11) Determination of Decimal reduction time – D value	1P
12) Scale-up of a process from flask level to laboratory fermenter level for the production of lactic acid	2P

SEM IV 4 credit course (4h 20 min sessions per week)

Practicals on Paper IV-Downstream processing and Paper-II: Quality Assurance in Industrial Products

Practical Title	Number of sessions
1) Laboratory scale production of Ethanol/ Saurkraut/Kefir/Cheese (Demonstration)	2P
2) Downstream processing of the product (filtration/centrifugation) (Demonstration)	1P
3) Paper chromatography of fermentation broth for presence of sugars	1P
4) Paper chromatography of fermentation broth for presence of amino acids	1P
4) Lyophilisation and revival of industrially important strains (Demonstration)	1P
5) Total viable count of Yeast Biomass by live dead staining method	1P
6) Detection of adulteration in food	1P
7) Microbiological assays of fermentation products - MIC MBC	2P
8) Sterility testing of injectables	1P
9) Preparation of MSDS	1P
10) Handling of Indian Pharmacopeia based on generated queries (ointments\bandages gauze \prebiotics\probiotics) DW, DMSO, Vitamin Antibiotic Probiotic capsule material gelatine, heart stents, suppositories, aspirin, paracetamol and microbial enzyme (activity based)	2P
11) Bio-burden estimation of commercial food product	1P
12) Visit to Industry / research institute/ testing laboratory and Report preparation	1P