

**RAYAT SHIKSHAN SANSTHA'S
KARMAVEER BHURAO PATIL COLLEGE, VASHI
NAVI MUMBAI
[AUTONOMOUS COLLEGE]**

DEPARTMENT OF MICROBIOLOGY

Program: M. Sc. Microbiology

Course: M.Sc. Part II

Choice Based Credit and Grading System

2019-20

A.C.-09/12/2020
Item No.-5.4



Rayat Shikshan Sanstha's

KARMAVEER BHURAO PATIL COLLEGE VASHI

(AUTONOMOUS COLLEGE)

Sector-15- A, Vashi, Navi Mumbai - 400 703

Syllabus for M.Sc. Microbiology

Program: M.Sc. Microbiology [Part II]

Course: M.Sc. Microbiology[PGMB]

**(Choice Based Credit, Grading and Semester System
with effect from the academic year 2019-2020)**

Preamble

Masters of Science (M.Sc.) in Microbiology is a post graduate programme of Department of Microbiology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Autonomous College]

The credit based semester and grading system and continuous evaluation consisting of components of Internal Assessment and External Assessment followed by the esteemed University of Mumbai, have been maintained while the syllabus for Microbiology was revised for M.Sc. Semester -III& IV to be implemented with effect from 2019-20. The proposed changes in the syllabus and introduction of new concepts passed several rounds of discussion before being presented to the members of Board of Studies for Microbiology, with Dr. S.S. Nayak as the Chairperson.

Suitably revised draft syllabus for M.Sc. II Semester III & IV in the subject of Microbiology, to be implemented from 2019-2020, has been approved by the concerned authorities of the BOS, Academic Council and Governing Body of Karmaveer Bhaurao Patil College, Vashi.

In order to assist students in developing research skills in general and in specific area of their interest/ specialization in particular, research proposal & research project component has been retained in the revised syllabus. This component will provide students with an opportunity to conduct independent research in the subject of Microbiology.

Accordingly a paper on “Research Methodology “has been retained in Semester III. A paper on “Analytical techniques and introduction to ‘omics”” has been introduced in Semester IV to empower students with the know-how of sophisticated analytical techniques and instrumentation.

In order to enhance employability of students in various allied areas, curricula focusing on understanding of theoretical foundations and practical techniques required in R & D, quality control, regulatory function in pharmaceuticals, food industry, environmental sciences, have been included in the revised syllabus. Thus, Semester III and IV cover papers on Food and Pharmaceutical Microbiology, Microbial Biotechnology, Industrial Microbiology.

A dynamic paper on “Recent Advances in Microbiology “will keep students abreast with current topics trending in the subject of Microbiology and the continually evolving world of knowledge.

Objectives of the Course:

- To introduce the application-based research in Microbiology
- To inculcate sense of scientific responsibilities and social and environment awareness
- To enrich students’ knowledge and train them in the applied microbial sciences
- To help students build-up a progressive and successful career

Program Outcome: Master of Science

PO-1	Disciplinary Knowledge and Skills: Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio-analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	Communication and Presentation Skills: Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	Creativity and Critical Judgement: Facilitate solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	Analytical Reasoning and Problem Solving: Build a critical and analytical attitude in handling the problems and situations.
PO-5	Sense of Inquiry: Curiously raise relevant questions based on highly developed ideas, scientific theories and their applications including research.
PO-6	Use of Digital Technologies: Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	Research Skills: Construct, collect, investigate, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	Application of Knowledge: Develop a scientific outlook to create consciousness against the social myths and blind faith.
PO-9	Moral and Ethical Reasoning: Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	Leadership and Teamwork: Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.
PO-11	Environment and Sustainability: Create social awareness about environment and develop sustainability for betterment of future.
PO-12	Lifelong Learning: Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Programme Specific Outcomes (PSOs):

At the end of the two year programme the student will understand and be able to-

PSO1. Explain different branches of Microbiology such as Bacteriology, Virology, Immunology and Medical.

PSO2. Explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food and Dairy Microbiology, Pharmaceutical Microbiology. Food Licensing and Certification and Quality assurance and Quality control, Biostatistics, Bioinformatics, Public health etc.

PSO3. Design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics.

PSO4. Execute Research Project incorporating techniques of Basic and Advanced Microbiology under supervision and Hands on training (Internship)

PSO5. Take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Scheme of examination for Each Semester:

Theory: Continuous Internal Evaluation: 40 Marks-

Based on one specified Unit of each paper

(Common Test-20 Marks & 20 Marks for-Assignment, Poster, Presentation, Participation in workshops/ seminar, Group discussion, societal awareness activity etc.)

Semester End Examination: 60 Marks will be as follows –

- The question paper will be Unitized (based on the remaining three Units) and Subjective.
- Each theory paper shall be of two hours duration.
- All questions are compulsory and will have internal options.

Practical: Practical will be of 100 marks in each Semester.

Detailed Marking Scheme:

Semester		Particulars (NEW)	Marks	Credit/s
III	Theory	P-I	100	4
		P-II	100	4
		P-III	100	4
		P-IV Elective	100	4
	Other activity	Review Article	100	5
		Research proposal	100	4
		Total	600	25

Semester		Particulars (NEW)	Marks	Credit/s
IV	Theory	P-I	100	4
		P-II	100	4
		P-III Elective	100	4
	Practical	Practical/OJT	100	5
	Other activity	Research Project	200	8
			Total	600

Note:

- On the job training will be from May through July.
- Students will resume the college in first week of August.

Research project will commence in Semester III and extend up-to Semester IV. Marks for project are allotted in Semester IV

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 To be implemented from the Academic Year 2019- 20

SEMESTER III

Theory:

Course Code	Unit	Topic Headings	Credits	NH / Week
PGMB301 Research Methodology	I	Fundamentals of Research Methodology	1	4
	II	Data Collection	1	
	III	Data Analysis and Reporting	1	
	IV	Biostatistics	1	
PGMB302 Food and Pharmaceutical Microbiology	I	Uses of Microbes in Food	1	4
	II	Microbial Detection and Food Safety	1	
	III	Quality Management and GMP in Pharmaceutical and Cosmetic Industry	1	
	IV	Analytical Methods for Pharmaceutical and Cosmetic Products	1	
PGMB303 Microbial Biotechnology	I	Marine Biotechnology	1	4
	II	Nano Biotechnology	1	
	III	Industrial Microbial Technology	1	
	IV	Bioenergy and Bioplastics	1	

Practical:

Paper	Title
PGMBP302	Food and Pharmaceutical Microbiology
PGMBP303	Microbial Biotechnology

SEMESTER IV

Theory:

Course Code	Unit	Topic Headings	Credits	NH / Week
PGMB401 Analytical techniques and introduction to 'omics'	I	Hyphenated techniques	1	4
	II	Nanotechnology Techniques	1	
	III	Molecular Biology Techniques	1	
	IV	Introduction to 'Omics'	1	
PGMB402 Industrial Microbiology	I	Introduction to Industrial Microbiology	1	4
	II	Biosynthesis of Industrial Microbial Products	1	
	III	Microbial Products	1	
	IV	Biosafety and Industrial Waste Treatment	1	

Practical:

Paper	Title
PGMBP401	Analytical Techniques And Introduction To 'Omics'
PGMBP402	Industrial Microbiology

Detailed syllabus

PGMB 301: Research Methodology

CO1: Understand the fundamental concepts of Research Methodology[2]*

CO2: Justify the problem undertaken as research project [5]*

CO3: Understand characteristics of a good sample design and implement for his/her research problem[6]*

CO4: Compare the role of different variables in research [4]*

CO5: Discuss steps involved in processing data [2]*

CO6: Apply biostatistics to his/her research and increase its credibility [3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER III Paper I		
Course Code	Title	Credits
PGMB301	RESEARCH METHODOLOGY	04 Credits (60 lectures)
Unit-I	<p>Fundamentals of Research Methodology (15 L)</p> <p>1.1 Introduction to Research Methodology (02 L)</p> <ul style="list-style-type: none"> • Meaning and objectives of research • Terminology • Features of a good research study • Ethics in research <p>1.2 Study designs: basic, applied, historical, exploratory, experimental, ex-post-facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design (08 L)</p> <p>1.3 Hypothesis (05 L)</p> <ul style="list-style-type: none"> • Meaning, significance and characteristics of hypothesis • Basic concepts concerning testing of hypotheses • Hypothesis development • Steps in formulation of hypothesis • Statistical hypothesis testing – type 1, type 2 error, levels of significance 	15 Lectures

Unit-II	<p>Data Collection</p> <p>2.1 Experimental data collection (05 L)</p> <ul style="list-style-type: none"> • Types of data • Methods of primary data collection (observation, experimentation, questionnaire, schedules, interviewing, case, pilot study) • Methods of secondary data collection (internal, external) • Selection of appropriate method for data collection <p>2.2 Sampling (06 L)</p> <ul style="list-style-type: none"> • Terminology • Need for sampling • Types of Sampling (probability sampling and non-probability sampling) <p>2.3 Variables(04 L)</p> <ul style="list-style-type: none"> • Dependent • Independent • Intervening • Moderator • Control variables • Extraneous variables 	15 Lectures
Unit-III	<p>Data Analysis and Reporting (15)</p> <p>3.1 Data processing and processing operations(08 L)</p> <ul style="list-style-type: none"> • Problems in processing • Elements of analysis in data processing • Software for data processing e.g. SPSS & SAS <p>3.2 Scientific writing and publishing (07 L)</p>	15 Lectures

Unit-IV	<p>Biostatistics (15 L)</p> <ul style="list-style-type: none"> • Terminologies and definitions • Tests of significance: <ul style="list-style-type: none"> i. Parametric tests: <ul style="list-style-type: none"> ○ Z-test ○ t-Test (Single mean, paired and unpaired) ○ Chi- Square test ○ Q-Test, F- Test ○ ANOVA and ANOCOVA ii. Non-Parametric tests: <ul style="list-style-type: none"> ○ Sign Tests ○ Fisher-Irwin Test ○ McNemer Test ○ Wilcoxon Matched-pairs Test (or Signed Rank Test) ○ Rank Sum Tests ○ Spearman's Rank Correlation ○ Kendall's Coefficient of Concordance 	
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Practical (PGMBP301)

- **Tutorials**

References:

1. Research Methodology: C.R. Kothari Second edition
2. Patent: Jeffrey G. Sheldon, How to Write a Patent Application, Third Edition, Practising Law Institute, 2016
3. http://linguistics.byu.edu/faculty/henrichsenl/ResearchMethods/RM_2_14.html

PGMB 302 : Food and Pharmaceutical Microbiology

CO1: Signify importance of microorganisms in food and to discuss its role [2]*

CO 2: Justify various mechanisms involved in microbial stress response in food. [5]*

CO 3: Compare and contrast conventional and rapid methods for detecting microbial contamination in food. [4]*

CO 4: Apply seven principles of HACCP in food industry. [4]*

CO 5: Perform Sterility testing of sterile pharmaceutical product. [3]*

CO 6: Compare and contrast between GMP and cGMP. [4]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER III Paper II		
Course Code	Title	Credits
PGMB302	FOOD AND PHARMACEUTICAL MICROBIOLOGY	04 Credits (60 lectures)
Unit-I	<p>Uses Of Microbes In Food (15L)</p> <p>Importance of microbes in food (01L)</p> <p>Normal microbiological quality of different foods (02L)</p> <p>Raw and ready-to-eat meat products</p> <p>Raw and pasteurized milk</p> <p>Shell egg and liquid egg</p> <p>Fish and shellfish</p> <p>Vegetables, fruit and nuts</p> <p>Cereal, starches, and gums</p> <p>Canned foods</p> <p>Sugars and confectioneries</p> <p>Soft drinks, fruit and vegetable drinks, juices and bottled water</p> <p>Mayonnaise and salad dressings</p> <p>Spices and condiments</p> <p>1.3 Microbial stress response in food and its significance (02L)</p> <ul style="list-style-type: none"> • Microbial growth characteristics • Stress adaptation • Sub lethal stress and injury. • Viable-but-non-culturable 	15 Lectures

1.4 Starter cultures (01L)

- Lactic starter culture
- Yeast and molds starter culture
- Other Starter Cultures

1.5 Fermented food Products(06L)

Microbiology of fermented foods

General Method of Production

Raw Materials

Microorganisms Used

Fermentation Process

Natural Fermentation

Back Slopping

Controlled Fermentation

Fermented Meat Products

Microbiology of Semidry Sausages

Fermented Vegetable Products

Microbiology of Sauerkraut, Pickles and Soy product

Fermented Dairy Products

i. Microbiology of Blue Cheese

ii. Kefir

iii. Koumis

1.6 Nutraceuticals

1.7 Probiotics and prebiotics

1.8 Control of microbes in food (06L)

Control of access

Control by physical removal, heat, low temperature,

reduced aw, low pH and organic acids,

modified atmosphere, antimicrobial preservatives,

irradiation

Novel emerging techniques of food preservation

- Control by combination of methods (Hurdle concept)

Unit-II	<p>Microbial Detection and Food Safety (15L)</p> <p>2.1 Conventional Methods (08L)</p> <ul style="list-style-type: none"> • Methods used, Sampling for microbial analysis • Quantitative microbial enumeration in food • Qualitative methods of microbial detection • Detection of Bacterial Toxins • Rapid methods • Use of Biosensors <p>2.2 Controlling the Microbiological Quality of food (07L)</p> <ul style="list-style-type: none"> • Quality and Criteria • Sampling Schemes • QC using microbiological control • Control at source • Codes of GMP • HACCP • Laboratory Accreditation 	15 Lectures
Unit-III	<p>Quality Management And GMP In Pharmaceutical And Cosmetic Industry (15L)</p> <p>3.1 Definitions and terminologies (01L)</p> <p>3.2 QA, QC, GMP and c GMP (03L)(Comparison and Differences)</p> <p>3.3 Premises and contamination control, location, design, structure, layout, services and cleaning (02L)</p> <p>3.4 Personnel management, training, hygiene and health (01L)</p> <p>3.5 Water for pharmaceutical use (01L)</p> <p>3.6 Air conditioning system (HVAC) (01L)</p> <p>3.7 Documentation (01L)</p> <p>3.8 Validation (02L)</p> <p>3.9 Quality control and GCLP (02L)</p> <p>3.10 Sanitary practices in cosmetic manufacturing (01L)</p>	15 Lectures

Unit-IV	Analytical Aspects Of Pharmaceutical And Cosmetic Products (15L) 4.1 Microbial test methods and general requirements 4.2 Sterility test 4.3 Microbial limit test 4.4 LAL test 4.5 Testing of water for pharmaceutical use 4.6 Antimicrobial preservation efficacy and microbial content testing 4.7 Evaluation of antimicrobial mechanism 4.8 Cosmetics microbiology- testing methods and preservation 4.9 Allergen screening testing for cosmetics 4.10 R & D aspects of pharmaceutical industry 4.11 Industrial safety	
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Practical(PGMBP302):

1. Microbiological study of fermented foods (idli batter and sauerkraut)
2. Microbiological load in carrot and apple juice, salad, mayonnaise.
3. Quality Assessment and Analysis of food
 - 3.1 Dairy Product
 - i) Milk (Raw, Packed)
 - ii) Ice-cream
 - iii) Yoghurt
 - 3.2 Sea food/ Meat and Meat product
 - 3.3 Spices
4. Study of effect of preservatives on food
5. Farm to fork: identifying the sources of cross contamination, mitigation strategies
6. Sterility testing of sterile pharmaceutical product and reporting (as per Pharmacopeia)
7. Microbial load in cosmetic product
8. Efficacy testing of preservatives like parabens
9. Efficacy of preservation and shelf life study
10. Preparation of cosmetic product and its preservation study
11. Sterility testing of laminar airflow bench top
12. Report to be written in journal on Novel detection methods for food borne pathogens/ toxins
13. Report on LAL and other tests for QC

References:

Unit 1

1. Fundamental Food Microbiology, 5th Ed., Bibek R. and Bhunia A., 2014, CRC Press
2. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
3. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing
4. Fundamentals of food microbiology, Fields M., 1979, AVI Publishing.

Unit 2:

1. Fundamental Food Microbiology, 5th Ed., Bibek Ray and ArunBhunia, 2014, CRC Press
2. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed RSC Publishing, 2008
3. Laboratory methods in food and dairy microbiology, Harrigan W. F. and McCance M. F., Academic Press,1976.
4. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
5. Lab Manual 14, FSSAI, Manual of methods of analysis of foods Microbiological testing, 2012, Food safety and standards authority of India, Ministry of health and family welfare, Government of India
6. Microbiological safety of processed foods: Proceedings of symposium sponsored by Hindustan Lever research foundation, ed. Crowther J.S., Marthi B., 1998, Oxford and IBH publishing company Pvt. Ltd.
7. www.fwwqi.gov.in
8. codexindia.nic.in
9. www.codexalimentarius.org WHO, FAO

Unit 3:

1. Quality in the manufacture of medicines and other healthcare products, Sharp J., 2000, Pharmaceutical Press.
2. Guidelines on cGMP and quality of Pharmaceutical products, Iyer S., 2003, D K Publishers Mumbai.
3. Cosmetic Microbiology a practical approach, Geis P. A., Taylor and Francis,,2nd Ed, 2006, CRC Press
4. Quality Assurance in Microbiology, Bhatia R. and Ichhapujani R. L. 1995, CBS publishers and distributors.

Unit 4:

1. Cosmetic Microbiology a practical approach, Geis P. A., Taylor and Francis,,2nd Ed, 2006, CRC Press
2. Quality in the manufacture of medicines and other healthcare products, Sharp John, 2000, Pharmaceutical Press.
3. Pharmaceutical Manufacturing Handbook Regulations and Quality
4. Shayne Cox Gad, A John Wiley & Sons, Inc., Publication

PGMB 303: Microbial Biotechnology

CO1: Isolation methods for detection of microorganisms and microbial activity, Metabolic diversity[3]*

CO2: Schematically explain degradation of pollutants[4]

CO3: Comprehensive information of Sample preparation, cell extraction and cell recovery [3]*

CO4: Describe methods involved in bioenergy generation[2]*

CO5: Prepare silver nanoparticles[3]*

CO6: Produce PHB from marine bacterial species[3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER III Paper III		
Course Code	Title	Credits
PGMB303	MICROBIAL BIOTECHNOLOGY	04 Credits (60 lectures)
Unit-I	Marine Biotechnology (15L) 1.1 Marine microbes and their products <ul style="list-style-type: none">• Marine Environmental conditions• Marine Life forms: Bacteria, Archea, Algae, Protozoa• Methods in Marine Microbiology-Detection of microorganisms and microbial activity, Metabolic diversity• Role of microorganisms in ocean processes• Biofouling and bio deterioration• Degradation of pollutants, Bioremediation• Research in marine environment 1.2 Diversity of marine derived compounds <ul style="list-style-type: none">• Alkaloid, Terpenoids and steroids,• Nucleoside• Amino acids, peptides, depsipeptide, polyketide, macrolide• Marine enzymes- protease, lipase, chitinase, glucanase• Marine biominerals and Biomineralized structures• Biocomposites• Biopolymers-Polysaccharides, chitin, marine	15 Lectures

	<p>collagens</p> <p>1.3 Bioactive compounds and biomaterials in Marine Environment</p> <ul style="list-style-type: none"> • Products from marine microbes, Biomimetic materials, New class of pharmaceuticals • Industrial products: vaccines, diagnostics and analytical reagents 	
Unit-II	<p>Nano Biotechnology (15L)</p> <p>2.1 Nanoscale systems, nanoparticles, nanowires, thin films and multilayers, Properties of nanomaterials</p> <p>2.2 Synthesis of nanostructures: physical, chemical, and biological, microbiological methods</p> <p>2.3 Biomolecules and nanostructures</p> <p>2.4 Nanoparticulate carrier systems</p> <p>2.5 Micro and nanofluidics</p> <p>2.6 Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and cancer diagnostics and treatment</p>	15 Lectures
Unit-III	<p>Bioprospecting (15L)</p> <p>3.1 Introduction to Bioprospecting</p> <p>3.2 Sampling: Sample sites and sampling procedure (Terrestrial and aquatic)</p> <p>3.3 Sample preparation (Physical and Chemical Dispersion)</p> <p>3.4 Cell Extraction (Immunomagnetic Capture- Selective and Non-selective Cell Recovery), Recovery of cells</p> <p>3.5 Capture of genes from environmental samples</p> <p>3.6 Detection of functional activity in environmental samples</p> <p>3.7 Degradative capacities of microorganisms in:</p> <ol style="list-style-type: none"> Distillary industries Petroleum industries. Leather tanning industries. Pharmaceutical industries 	15 Lectures

Unit-IV	<p>Bioenergy and Bioplastics</p> <p>4.1 Biomass- A renewable source of energy</p> <p>4.2 Biomass conversion</p> <ul style="list-style-type: none"> • Non biological process • Biological process <p>4.3 Bioenergy</p> <ul style="list-style-type: none"> • Biomethanation • Hydrogen- a new fuel • Biofuel • Biodiesel <p>4.4 Bioplastics</p> <ul style="list-style-type: none"> • Preparation • Properties • Practical applications • Production economics <p>4.5 Microbial Composting</p>	
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Practical (PGMBP303)

1. Preparation of silver nanoparticles
2. Characterization of silver nanoparticles
3. Survival curve and antibacterial activity of nanosilver particles
4. Study of nanosilver coated gauze/ textile for antimicrobial effect on different bacteria
5. Production of PHB from marine bacterial species
6. Production of Biodiesel from Microalgae
7. Development of Biogas plant model in laboratory

References:

1. RSK Barners& R.N Huges : Introduction to Marine Ecology, Blackwell
2. David H.Attway& Oskar R.Zabosky: Marine Biotechnology: Volume 1,2,3, Plenum Press, (1993).
3. P.J.Scheuer: Marine. Natural Products, Volume 1 & 2 (1978). Volume (1980-81) Academic Press.
4. O.Kinne: Marine Ecology, Vol.V.Ocean Management 3&4, John Wiley & Sons, (1984).
5. Rita Colwell (Ed.): Biotechnology in Marine Sciences, Academic Press, (1981).
6. R.R.Colwell (ed), Biotechnology of Marine Science, (1982).
7. R.R.Colwellet. al (eds) Biotechnology of Marine polysaccharides, (1985). David H.Attway& Oskar R.Zabosky: Marine Biotechnology, Volume 1,2,3, plenum press (1993).
8. P.J.Scheuer: Marine Natural Products, Volume 1&2 (1978) Volume (1980, 81), Academic Press
9. Nanobiotechnology by David Goodsell.John Wiley

10. Handbook of nanostructured biomaterials and their application in Nanobiotechnology by Nalwa HS 2005. American scientific publishers.
11. Nanobiotechnology by Niemeyer CM and Mirkin CA 2005. Wiley Interscience.
12. Industrial Biotechnology- Problems and Remedies By InduShekhar Thakur
13. Environmental Biotechnology- Basic Concepts and Applications By InduShekhar Thakur
14. A text book of Biotechnology by R.C. Dubey
15. Microbial Biotechnology – Fundamentals of Applied Microbiology, Second Edition by Alexander Glazer, Hiroshi Nikaido
16. Manual of Industrial Microbiology and Biotechnology, Second Edition by Arnold L. Demain and Julian E. Davies

Semester IV

PGMB401 Analytical techniques and introduction to ‘omics’

CO1: Exhibit chromatography techniques with mass spectrometry with for mass analysis[3]*

CO2: Compare and Contrast X-ray and UV photoelectron spectroscopies[4]*

CO3: Illustrate Auger electron spectroscopy[4]*

CO4: Summarize Hybridization microarray technologies [2]*

CO5: Exhibit the molecular biology techniques for proteomics, genomics, transcriptomics, metabolomics and pharmacogenomics [3]*

CO6: Set up a PCR[6]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER IV Paper I		
Course Code	Title	Credits
PGMB401	ANALYTICAL TECHNIQUES AND INTRODUCTION TO ‘OMICS’	04 Credits (60 lectures)
Unit-I	Unit I: Hyphenated techniques (15 L) 1.1 GC-MS 1.2 GC-FTIR 1.3 LC-MS 1.4 LC-IR 1.5 LC-NMR 1.6 CE-MS	15 Lectures
Unit-II	Nanotechnology Techniques (15L) 2.1 Microscopy(10L) Scanning tunnelling microscope (STM) Atomic force microscope(AFM) Magnetic force microscope(MFM) Scanning near field microscope (SNOM) Scanning Electron Microscope Transmission Electron Microscope 2.2 Diffraction Techniques: X-ray diffraction (XRD) (02L) 2.3 Photoluminescence Spectroscopy <ul style="list-style-type: none"> • X-ray and UV photoelectron spectroscopies(XPS) Auger electron spectroscopy(03L) 	15 Lectures

<p>Unit-III</p>	<p>Molecular Biology Techniques (Principle, Instrumentation, Applications) (15L)</p> <p>1.1 Modifications of PCR(05L)</p> <ul style="list-style-type: none"> • Hot- Start PCR • Multiplex PCR • Nested PCR • RT-PCR • Broad Range PCR • Arbitrarily primed PCR • Quantitative PCR • Real time PCR <p>1.2 Hybridization array technology(05L)</p> <ul style="list-style-type: none"> • Applications of microarrays in Microbiology • Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays) <p>1.3 Other techniques (05L)</p> <ul style="list-style-type: none"> • Immunofluorescence • FISH • Confocal laser scanning microscopy • Micro autoradiography • Flow cytometry • Micro sensors 	<p>15 Lectures</p>
<p>Unit-IV</p>	<p>Introduction To ‘Omics’ And Advanced Techniques (15L)</p> <p>4.1 Proteomics (04L)</p> <p>4.2 Introduction to transcriptome(02L)</p> <p>4.3 Metabolomics (03L)</p> <p>4.4 Pharmacogenomics (02L)</p> <p>4.5 Next Generation Sequencing- illumina NGS (02L)</p> <p>4.6 Pyro-sequencing (01L)</p> <p>4.7 Whole genome shotgun sequencing (01L)</p>	

Practical (PGMBP401):

1. Visit to SAIF/ SASMIRA/ Other Institutes
2. Workshop on Instrumentation
3. Workshop on Proteomics
4. Primer design
5. PCR
6. Cloning
- 7.

References:

1. Patent: Jeffrey G. Sheldon, How to Write a Patent Application, Third Edition, Practising Law Institute, 2016.
2. www.amrita.edu
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3658024/>
4. <https://www.ijarnd.com/manuscripts/v2i4/V2I4-1168.pdf>

PGMB 402 : Industrial Microbiology

CO1: Understand organizational set up in Industrial Microbiology[2]*

CO2: Illustrate Strain Improvement of industrial microorganisms[3]*

CO3: Isolation of mutants viz.auxotrophic mutants, induced mutants, resistant mutants and reverting mutants[3]*

CO4:Diagrammatically and schematically fermentation plant, downstream processing [4]*

CO5: Produce Antibiotic [3]*

CO6: Isolate and Study bioleaching by Microorganisms[3]*

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

SEMESTER IV Paper II		
Course Code	Title	Credits
PGMB402	INDUSTRIAL MICROBIOLOGY	04 Credits (60 lectures)
Unit-I	Unit I: 1.1 Introduction to Industrial microbiology 1.2 Organizational set up in Industrial Microbiology 1.3 Process Design Criteria for <ul style="list-style-type: none"> • Low Value High Volume • High Value Low Volume 1.4 Physio-chemical Basis of Bioseparation- electrostatic charges, biological activity, polarity, size or mass 1.5 Strain Improvement of industrial microorganisms <ul style="list-style-type: none"> • Selection of induced mutants Selection of mutants with altered permeability • Isolation of mutants not producing Feed Back Inhibitors or Feed Back repressors (All methods – Only one example) • Use of auxotrophs for production of primary metabolites (Example aspartate family) • Isolation of mutants that do not recognize the presence of inhibitors & repressors with example(Gradient plate –Lysine) • Isolation of auxotrophic mutants example- (Penicillin Davies technique &Minaturized 	15 Lectures

	<p>technique)</p> <ul style="list-style-type: none"> • Isolation of induced mutants for secondary metabolites • Isolation of resistant mutants • Isolation of reverting mutants • Use of recombinant system for strain improvement • Strain improvement of industrially important microorganisms based on resistance to toxic metabolites and abiotic stress <p>1.6 Fermentation Economics</p>	
Unit-II	<p>Biosynthesis of industrially important microbial products (15L)</p> <p>2.1 The nature of Metabolic Pathways</p> <p>2.2 Industrial Microbiological Products as Primary and Secondary Metabolites</p> <p>2.3 Trophophase- idiophase relationships in the production of secondary metabolites</p> <p>2.4 Role of Secondary Metabolites in the Physiology of organisms producing them</p> <p>2.5 Pathways for the synthesis of Primary and Secondary Metabolites of Industrial Importance-</p> <ul style="list-style-type: none"> • Catabolism of Carbohydrates • Catabolism of Hydrocarbons <p>2.6 Carbon Pathways for the formation of some Industrial Products Derived from Primary Metabolism</p> <ul style="list-style-type: none"> • Catabolic Products • Anabolic Products <p>2.7 Carbon Pathways for the Formation of Some Products of Microbial Secondary Metabolism of Industrial Importance</p>	15 Lectures
Unit-III	<p>Microbial Products (15L)</p> <p>3.1 Single Cell Protein Production</p> <p>3.2 Vaccine Production</p> <p>3.3 Biofertilizer Production</p> <p>3.4 Microbial insecticide production</p> <p>3.5 Ergot Alkaloides</p> <p>3.6 Production of antibiotic- Cephalosporin and research for new antibiotic</p> <p>3.7 Production of Microbial anti-tumour agent</p> <p>3.8 Mining Microbiology</p>	15 Lectures

Unit-IV	Biosafety And Industrial Waste Treatment 4.1 Biosafety <ul style="list-style-type: none"> • Risk assessment- recombinant microorganisms and animal cell • Containment levels • Risk management- spill management, building and facilities • Process equipment-fermentation plant, downstream processing • Other systems- personal protective equipment, personal training, medical surveillance, biowaste 4.2 Treatment of waste in Industries: <ul style="list-style-type: none"> • Paper and Pulp Industry • Tanning Industry • Distillery Industry • Dye Industry • Petroleum Industry • Antibiotic Industry • Dairy Industry 	
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Practical (PGMBP402):

1. Antibiotic production
2. Production and detection of amino acid(TLC)
3. Production and formulation of Biofertilizer
4. Detection of Alkaloides
5. Production of TAB Vaccine
6. Isolation and Study of bioleaching Microorganisms

References:

UNIT- I: Bioremediation, biodegradation & waste disposal

1. Principles and Applications by Ronald L
2. Crawford and Don L Crawford
3. Biotechnology: B.D.Singh
4. A textbook of Biotechnology: R.C.Dubey
5. Environmental Biotechnology by Allan Scragg, 2nd Ed.

UNIT- II: Biofilm management

1. Davies DG, Parsek MR, Pearson J. P. Iglewski BH, Costerton JW, Greenberg EP. 1998. The involvement of cell-to cell signals in the development of a bacterial biofilm. Science 280 (5361):295–98

2. O'Toole GA, Kolter R. 1998. The initiation of biofilm formation in *Pseudomonas aeruginosa* WCS365 proceeds via multiple, convergent signalling pathways: a genetic analysis. *Mol. Microbiol.* 28:449–61
3. Morris, C. E. and Monier, J. M. 2003. The ecological significance of biofilm formation by plant-associated bacteria. *Annu. Rev. Phytopathol.* 41:429–53
4. O'Toole, G., Kaplan, H. B. and Kolter, R., 2000. Biofilm formation as microbial development. *Annu. Rev. Microbiol.* 2000. 54:49–79
5. Bacterial biofilms: from the Natural environment to infectious diseases. *Nature Reviews Microbiology* 2, 95-108 (February 2004)

UNIT - III Pollution control and monitoring

1. Environmental microbiology. P. D. Sharma. Alpha Science International 2005 ed.
2. Wastewater engineering: Treatment and reuse. Metcalf and Eddy, Tata McGraw Hill Publishing Co. Ltd. 4th Ed.
3. A textbook of environmental pollution and control. S S. Dara
4. Environmental chemistry A. K. De
5. Environmental pollution control engineering. C. S. Rao. New Age International Publishers.
6. APHA 1998. Standard Methods for the examination of water and wastewater, 20th Ed.
7. Biotechnology of Odour and Air pollution Control. Springer
8. Water and Wastewater analysis Volume 1. Handbook of methods in environmental studies. S. K. Maiti. ABD Publishers 2004
9. Soil analysis Volume 2. Handbook of methods in environmental studies. S. K. Maiti. ABD Publishers 2004
10. Environmental chemistry B. K. Sharma

UNIT - IV

1. Environmental & natural resources management and safety standards
2. Resource ecology. S. K. Agarwal
3. Environmental management. H. V. Jadhav, VipulPrakashan, 2002
4. Environmental management. R.K. Jain and others
5. Modern trends in ecology and environment. R. S. Ambasht