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UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part - II
Program: M.Sc.
Course : Microbiology(PSMB)
[Semester - III & IV]

(Credit Based Semester and Grading System with effect from the academic year 2013–2014)

PROGRAMME: M.Sc.

COURSE: MICROBIOLOGY (PSMB)

Semester-III & Semester-IV

PREAMBLE

With the introduction of credit based semester and grading system and continuous evaluation Consisting of components of Internal Assessment and External Assessment by the esteemed University, the syllabus in Microbiology was revised for M.Sc. Semester -I & II to be implemented with effect from 2012-13, after approval by the concerned authorities of the University. Eight sub-committees were formed to revise the syllabus of M.Sc. I (semester I & II) and M.Sc. II (semester III & IV), with Dr. D.B. Thakare as the convener, BOS members as co-conveners and Head/ senior teachers from affiliated colleges as members of these sub-committees.

Suitably revised draft syllabus for M.Sc. II semester III & IV in the subject of Microbiology, to be implemented from 2013-2014, has been approved by the concerned authorities of the University.

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 at their own P.G. centers and if the research project demands, in conjunction with relevant industries/ research institutes.

Accordingly a paper on Research Methodology & Biomolecular analysis has been introduced in the revised syllabus.

In order to enable students to develop employable skills concurrently with an understanding of theoretical foundations and practical techniques required in R & D, quality control, regulatory function in pharmaceuticals, food industry, environmental sciences, papers on Pharmaceutical Microbiology, Food Microbiology, Advances in Biotechnology, Applied & Environmental Microbiology and Applied & Environmental monitoring and management have been included in the revised syllabus.

As mentioned in the syllabus, all the 16 courses of theory & practicals are compulsory to M.Sc. Microbiology (By Papers) students.(Semester I, II, III, IV)

However, in case of M.Sc. Microbiology (Partly by Papers & Partly by Research) degree students, courses PSMB -301 and PSMB- 401 (Tools and Techniques : Research Methodology and Biomolecular Analysis) are compulsory. They can opt for any two courses as per the following combinations which is related to the research topic of the student:-

1. PSMB -101 and PSMB- 201: Cell Biology and Virology
2. PSMB -102 and PSMB- 202: Microbial Genetics
3. PSMB -103 and PSMB- 203: Microbial Biochemistry
4. PSMB -104 and PSMB- 204: Medical Microbiology and Immunology
5. PSMB -302 and PSMB- 402: Food and Pharmaceutical Microbiology
6. PSMB -303 and PSMB- 403: Advances in Biotechnology
7. PSMB -304 and PSMB- 404: Applied and Environmental Microbiology, Applied and Environmental Monitoring & Management

M.Sc. Part - II Microbiology Syllabus

[Semester - III & IV]

Revised for Credit Based and Grading System

To be implemented from the Academic year 2013-2014

SEMESTER III

Theory :

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSMB301 **Tools and Techniques :** **Research Methodology**	I	Research Fundamentals And Terminology	**4**	**01**
	II	Defining Research problem and Data Collection		**01**
	III	Sampling And Sampling Distributions		**01**
	IV	Data Analysis And Report Writing		**01**
PSMB302 **Food Microbiology**	I	Microbes In Food	**4**	01
	II	Uses Of Microbes In Food		01
	III	Control Of Microbes In Food		01

	IV	Microbial Detection And Food Safety		01
PSMB303 Advances In Biotechnology	I	Plant And Agricultural Biotechnology	**4**	**01**
	II	Animal Biotechnology		**01**
	III	Nano Biotechnology		**01**
	IV	Medical Biotechnology		**01**
MB304 Applied and Environmental Microbiology	I	Microbial Diversity	**4**	**01**
	II	Techniques In Microbial Ecology		**01**
	III	Soil, Marine & Agricultural Microbiology		**01**
	IV	Advanced Food & Water Microbiology		**01**

Practicals :

PSMB3P1	Literature Survey And Research Project Proposal	**2**	**04**
PSMB3P2	Food Microbiology	**2**	**04**
PSMB3P3	Advances In Biotechnology	**2**	**04**

PSMB3P4	Applied And Environmental Microbiology	**2**	**04**

SEMESTER IV

Theory :

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSMB401 Tools and Techniques: Biomolecular Analysis	I	Spectroscopic Techniques	**4**	01
	II	Chromatographic Techniques		01
	III	Molecular Biology Techniques		01
	IV	Nanotechnology Techniques		01
PSMB402 Pharmaceutical Microbiology	I	Principles And Applications Of GMP In Pharmaceuticals And Cosmetics	**4**	01
	II	Quality Management And Regulatory Aspects		01
	III	Analytical Aspects For Pharmaceutical And Cosmetic Products		01
	IV	Drug Discovery		01
PSMB403 Advances in Biotechnology	I	Pharmaceutical Biotechnology	**4**	01
	II	IPR and ethics in Biotechnology		01
	III	Marine Biotechnology		01

	IV	Advances in Molecular Biotechnology		01
PSMB404 Applied and Environmental Monitoring & Management	I	Bioremediation, Biodegradation & Waste disposal	**4**	**01**
	II	Biofilm Management		**01**
	III	Environmental Pollution & Monitoring		**01**
	IV	Environmental & Natural Resources Management and safety standards		**01**

Practicals :

PSMB4P1	Dissertation based on Research Project and Poster Presentation.	**2**	**04**
PSMB4P2	Pharmaceutical Microbiology	**2**	**04**
PSMB4P3	Advances in Biotechnology	**2**	**04**
PSMB4-P4	Applied and Environmental Monitoring & Management	**2**	**04**

Each Theory and Practical period shall be of one hour duration.

M.Sc. (Semester -III)Microbiology Syllabus

Revised for Credit Based and Grading System

To be implemented from the Academic year 2013-2014

Semester -III Detail Syllabus

PSMB301: Tools and Techniques: Research Methodology (60L)

Course Code	Title	Credits
PSMB301	**Tools and Techniques : Research Methodology (60L)**	**04**
	Unit I Research Fundamentals and Terminology (15L)	01
	1.1 Meaning and Objective of research, features of a good research study, scientific method, (05L)	
	1.2 Study designs and variations: basic, applied, historical, exploratory, experimental, ex-post-facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design (10L)	
	Unit II Defining Research problem and data Collection (15L)	01
	2.1 Hypothesis, theory and scientific law: development, structure, conditions, sources, formulation, explanation of hypothesis; structure, identification, elements, classification, functions of theory; scientific laws and principles (05L)	
	2.2 Methods and techniques of data collection: types of data, methods of primary data collection(observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study , methods), methods of secondary data collection(internal/ external),	

	schedule method **(10L)**	
	Unit III Sampling and sampling distributions (15L)	01
	3.1 Sampling frame, importance of probability sampling, simple random sampling, systematic sampling, stratified random sampling, cluster sampling, problems due to unintended sampling, ecological and statistical population in the laboratory, (10L)	
	3.2 Variables: nominal, ordinal, discontinuous, continuous, derived (05)	
	Unit IV Data analysis and report writing (15L)	01
	4.1 Experimental data collection and data processing: Processing operations, problems in processing, elements of analysis in data processing, software for data processing, (05L)	
	4.2 Report writing and presentation: types of research reports, guidelines for writing a report, report format, appendices, Miscellaneous information, poster and oral presentations (10L)	

Practical: PSMB3P1

PSMB3P1	**Tools and Techniques: Research Methodology (60L)** **Unit I :** Literature survey (15L) **Unit II :** Literature survey (15L) **Unit III** : Writing Research Project Proposal (15L) **Unit IV** : Writing Research Project Proposal (15L)	**02**

References: PSMB301 (Semester III)

1. Kothari, C.R.,1985, *Research Methodology- Methods and Techniques,* New Delhi, Wiley Eastern Limited.
2. Das, S.K. , 1986, *An Introduction to Research*, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, *Research Methodology: A Handbook*, New Delhi, Concept Publishing Company
4. Kumar, R., 2005, *Research Methodology-A Step-by-Step Guide for* for Beginners,(2nd.ed.),Singapore, Pearson Education.
5. Bhattachraya, D.K., 2006, *Research Methodology*,(2nd.ed.),New Delhi, Excel Books.
6. Panneerselvam R.,2012, *Research Methodology*, New Delhi, PHI Learning Pvt. Ltd.
7. Khan, Irfan Ali, 2008, *Fundamentals of Biostatistics*, Ukaaz Publications
8. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
9. Katz J.M., 2009, *Form Research to Manuscript: A guide to scientific writing*, USA, Springer Science
10. Saravanavel, P. 1990. Research methodology. Allahabad, Kitab Mahal

PSMB302: Food Microbiology

Course Code	Title	Credits
PSMB302	**Food Microbiology (60L)**	**04**
Unit I: Microbes in foods (15L) 1.1 Importance of microbes in food 1.2 Sources of microbes in food 1.3 Normal microbiological quality of food 1.4 Factors influencing microbial growth in food		**01**
Unit II: Uses of microbes in food (15L) 2.1 Microbial stress response in food 2.2 Starter cultures 2.3 Microbiology of fermented foods General method of production 2.3.a. Cheese – Swiss and Blue cheese 2.3.b.Fermented meat product – Sausage 2.3.c.Fermented vegetable products – Pickles, soy product , Sauerkraut 2.3.d.Bread and Idli		**01**

Unit : III Control of microbes in food (15L) 3.1 Control of access 3.2 Control by physical removal, heat, low temperature, reduced a_w, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation 3.3 Novel emerging techniques of food preservation 3.4 Control by combination of methods (Hurdle concept) .	**01**
Unit : IV Microbial Detection and Food Safety (15L) 4.1Conventional Methods. 4.1.a. Methods used, Sampling for microbial analysis 4.1.b.Quantitative microbial enumeration in food 4.1.c.Qualitative methods of microbial detection 4.1.d.Bacterial Toxins 4.1.e.Rapid methods 4.1.f.Biosensors 4.2 Controlling the Microbiological Quality of food. 4.2.a. Quality and Criteria 4.2.b.Sampling Schemes 4.2.c.QC using microbiological control 4.2.d.Control at source 4.2.e.Codes of GMP	**01**

4.2.f.HACCP 4.2.g.Laboratory Accreditation	

Practicals : PSMB3P2:

PSMB3P2	**Food Microbiology (60L)** 1.Microbiological study of fermented foods (Idli batter and sauerkraut) 2.Microbiological load in carrot and apple juice, salad, mayonese. 3.Quality Assessment and Analysis of food i) Milk (Raw, Packed) ii) Ice-cream iii)Yoghurt 4. Report to be written in journal on Novel detection methods for food borne pathogens/ toxins.	**02**

References:PSMB302 (Semester III)

References: Unit I

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. Srilakshami B (2010) Food Science. 5th Ed. New Age International Publishers.
3. James Jay , M Loessner and D Golden (2005) Modern Food Microbiology 7th Ed.
4. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
5. J Maud Kordylas (1991) Processing and Preservation of tropical and subtropical foods. ELBS Macmillan.

References: Unit II

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. Gerald Reed (2004) Prescott and Dunn's Industrial Microbiology 4th Ed. CBS Publishers.
3. J Maud Kordylas (1991) Processing and Preservation of tropical and subtropical foods. ELBS Macmillan.

References: Unit III

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. N Shakuntala Manay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International

References: Unit IV

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
2. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
3. N Shakuntala Manay and Shadaksharaswamy M (1985) Foods Facts and Principles. New Age International.
4. Harrigan W F and McCance M F (1976) Laboratory methods in food and dairy microbiology. Academic Press.
5. Aylward F (2001) Food Technology Processing and Laboratory Control. Agrobios (India)

PSMB303 : Advances in Biotechnology

Course Code	Title	Credits
PSMB303	**Advances in Biotechnology (60L)**	**04**
	Unit I Plant and Agricultural Biotechnology (15L)	
	1.1 Plant Tissue Culture for crop improvement--Initiation and maintenance of Callus and Suspension culture, Direct and Indirect Organogenesis, Micropropagation, Artificial seeds, Anther culture and dihaploids, Protoplast isolation culture and fusion, Production of haploids, Somaclonal variations, Germplasm conservation, Somatic hybrids, Cybrids.	01
	1.2 Production of secondary metabolites from plant cell cultures, Technology of plant cell culture for production of chemicals, Bioreactor systems and models for mass cultivation of plant cells.	
	1.3 Plant Transformation Technology – Agrobacterium mediated gene transfer,	

Agrobacterium based vectors, viral vectors, Direct gene transfer methods, chemical methods, electroporation, microinjection, particle bombardment, Molecular breeding, plant selectable markers, Reporter genes, Positive selection, Selectable marker elimination, Trangene silencing, Strategies to avoid trangene silencing. 1.4 Plant Genetic Engineering for Productivity and Performance— a) Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt toxin, Disease Resistance, Virus resistance b) Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature. c) By manipulation of—Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency d) For Quality Improvement-Protein, Lipids, carbohydrates, vitamins and minerals. e) Biosafety concerns of transgenic plants 1.5 Plants as bioreactors.	
UNIT II Animal Biotechnology (15L) 2.1 Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines 2.2 Scale up, Cryopreservation, Culture Collections 2.3 Risks and Safety, Bioethics. 2.4 Stem Cell Technology, Cloning techniques Applications. 2.5 Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish 2.6 Applications: Transgenic mice: i) Retroviral method ii) DNA microinjection method iii) Engineered Embryonic Stem cell method	01
Unit III Nanobiotechnology (15L) 3.1 Nanoscale systems,nanoparticles,nanowires,thin films and multilayers; Properties of nanomaterials.	01

3.2 Synthesis of nanostuctures - physical, chemical and biological,micobiological methods - a. Biomolecules as nanostructures. b. Nanoparticular carrier systems, Micro and Nanofluidics. c. Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging,Nanomedicine and Cancer diagnostics and treatment.	
Unit IV - Medical Biotechnology (15L) 4.1 Genetic Testing of diseases and disorders, Cancer genetics., Immunogenetics; pre-natal diagnosis-chorionic villus sampling, amniocentesis, Pre-implantation diagnosis., Genetic counselling. 4.2 Gene therapy-concept, vectors, gene targeting and tissue-specific expression, Anti-sense Technology 4.3 Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics 4.4 Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination 4.5 Tissue Engineering, Methods of Synthesis, Biomolecular Engineering	01

Practicals: PSMB3P3

PSMB3P3	**Advances in Biotechnology (60 L)** 1. Terminology, Laboratory design of Animal tissue culture laboratory 2. Preparation of complete medium, Sterilization and sterility checking. 3. Chick embryo fibroblast culture, viable staining 4. Lymphocyte culture, viable staining and heamocytometer count.	**02**

	5. Preparation of Nanosilver By Wet reduction Method(Chemical),using Neem Extact(plants) & Bacteria(Microbiological) 6. Characterisation of Nanosilver by UV spectrometry and microscopic methods 7. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods. 8. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria	

References: Unit I :PSMB303 (Semester III)

1. Plant Biotechnology: The genetic manipulation of plants,2005,A.Slater ,N.Scott & M.Fowler, Oxford Univ Press, Oxford.
2. Introduction to Plant Biotechnology(3rd Edtn), H.S. Chawla
3. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2nd Edtn,Academic Press,2000
4. H.K.Das(ed),Textbook of Biotechnology,Wiley India,2004
5. J.H.Hammond, P.Mcgarvey, and V.Yusibov(eds), Plant Biotechnolgy,Springer Verlag,Heidelberg,2000
6. B.B.Buchanan, W.Gruissen and R.L.Jones(eds), Biochemistry and Molecular Biology of Plants,American Society of Plant Biology,Rockville,USA,2000.
7. Plant Biotechnology and Agriculture:Prospects for the 21st Century, Arie altman ,Paul Michael Hasegawa,

8. Plant Biotechnology and Genetics:Principles, Techniques & Applications, Stewart, C.Neal,June 2008,John Wiley &Sons

References: Unit II

1. Animal Cell Culture by Ian Freshney
2. Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press
3. Animal Cell Culture Sudha Gangal
4. Principles of biotechnology and applications-Glick and Pasternack

References: Unit III

1. Nanobiotechnology by David Goodsell. John Wiley
2. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology by Nalwa HS 2005. American scientific publishers
3. Nanobiotechnology by Niemeyer CM & Mirkin CA 2005 .Wiley Interscience

References: Unit IV

1. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)
2. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
3. Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, Oxford University Press, India (2010)

PSMB304: APPLIED AND ENVIRONMENTAL MICROBIOLOGY

Course Code	Title		Credits
PSMB304	APPLIED AND ENVIRONMENTAL MICROBIOLOGY	(60L)	04
Unit : I	Microbial Diversity	(15L)	01

1.1 Microbial ecology: concepts, niche, habitat, ecosystem. 1.2 Introduction to microbial diversity: Types of microorganisms- bacteria, Archaebacteria, Eucarya interactions between microorganisms , ecological succession 1.3 Extremophiles: Habitat, effect of extreme conditions on cellular components- membrane structure, nucleic acids and proteins, adaptation mechanism in microorganisms in diverse environments 1.4 Study of Thermophiles, Psychrophiles, halophiles, Piezophiles, Acidophiles, Alkaliphiles, Xerophiles, Radiation resistant organisms, Methanogens. 1.5 Biotechnological Applications of extreme proteins from the above groups 1.6 Geomicrobiology: Biofouling, biocorrosion, bioleaching.		
UNIT : II Techniques in Microbial Ecology	**(15L)**	**01**
2.1 Environmental sample collection and processing.: Soils and Sediment, Water, Air, Detection of Micro organisms on fomites 2.2 Cultural Methods:Cultural methods for isolation & enumeration of Bacteria 2.3 Physiological Methods:Measuring microbial activity in pure culture;Carbon respiration, Stable isotope probing, Use of radioisotopes as tracers Adenylate energy charge, Enzyme assays, 2.4 Functional genomics &proteomics based approach 2.5 Immunological methods: Immunoassays. 2.6 Nucleic acid based methods of analysis:Obtaining Nucleic acids from Environment, Use of Gene probes, PCR, 2.7 Recombinant DNA Techniques, RFLP, Denaturing /Temperature gradient, Plasmid analysis, Reporter genes. Rep PCR fingerprinting and microbial diversity 2.8 Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment: culturable and unculturable bacterial analysis.		
Unit III : Soil, Marine & Agricultural Microbiology	**(15L)**	**01**

3.1 Soil Microbiology: The litho ecosphere: Soil formation, Properties (physical and chemical) Soil communities. Link to microbial interactions. Soil sampling for surface, subsurface soils .Processing and storage of samples. 3.2 Marine microbiology: Marine and estuarine habitats. Characterization and stratification of the oceans Vertical and horizontal zones of marine habitats Marine microbes characteristics, distribution, composition & activity. 3.3 Agricultural microbiology: Factors affecting microbial load of soils. Relationship between plants and microbes rhizosphere, phyllosphere. Beneficial uses of microorganisms for plant growth and development, Interactions with aerial plant structures. 3.4 Microbial contribution to animal nutrition Special reference to Rumen flora 3.5 Biogeochemical cycles for Carbon Nitrogen and Oxygen. Degradation of recalcitrant polymers and xenobiotics eg cellulose, lignin .lignocellulose. Combating Greenhouse effect using microbes. Concept of Carbon credits		
UNIT IV: Advanced Food & Water Microbiology	**(15L)**	**01**
4.1Sampling, sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi ,pathogenic bacteria(Enteropathogenic Ecoli, Vibrio ,Salmonellae) and viruses (Hepatitis A , Norwalk) in meat/fish products as per BIS/ISO/APHA standards 4.2 Use of biosensors,and enzymatic/ thermal techniques for food analysis 4.3 Food additives and ingredients :Food additives-definitions, classification and functions, (Preservatives, antioxidants, colors, emulsifiers, sequesterants,		

natural and microbial flavors) 4.4 Toxicological evaluation of food additives. 4.5 Applications of fibres from food sources, microbial fructooligosaccharides. 4.6 Nutraceuticals and health foods: Introduction to nutraceuticals: definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals .Microbes and production of nutraceuticals like lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols.Formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues. 4.7Drinking water risk assessment & its safety: Bottled water–legislation:Types of bottled water.BIS Regulations regarding the production of bottled waters wrt final quality of the product.Potential chemical and microbiological hazards in the bottles depending on the type of water, the type of bottle and the bottling procedure.The application of HACCP in the bottling plants: Water Quality attained from point of use water purifier units , Types of water purifiers.: Microbiological specifications and methods used certify water purifiers International standards regulating quality of water purifiers .		
Practicals PSMB3P4	**60L**	**02**
1. . Enrichment & isolation of thermophiles from hotsprings/compost heaps & extraction of thermophillic enzymes & determination of its specific activity. 2. Estimation of anti oxidants and anti nutritional factors (tannin/phytic acid) by spectrometric method . 3. Microbiological analysis of fish samples wrt sample processing for recovery and detection of Enteropathogenic *Ecoli, Vibrio ,Salmonellae* as per BIS/ISO/APHA standards and computation of measure of uncertainity 4. Assessment of point of use water purifiers (Zero B) for removal of bacteria.		

5. Soil analysis- nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content.
6. Enrichment and isolation of cellulose, lignin & xylanase degraders from mangrove soil

References :PSMB 304 (Semester III)

Unit - I Microbial Diversity

1. Brock Biology of microorganisms12th ed Madigan,Martinko,Dunlap,Clara,Pearson Intl Ed
2. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and Applications.
3. AddisonWesley Longman, Inc.
4. Microbial Diversity- Current Perspective and Potential Application--Johri and Satyanarayana
5. Methods in Microbiology Vol 35- Extremophiles (2006) Edited by Fred Rainey, Aharon Oren (Academic press)

UNIT - II Techniques in Microbial Ecology

1. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. AddisonWesley Longman, Inc.
2. R.MMaier,I.L.Pepper and C.P.Gerba 2010,Environmental Microbiology Academic Press
3. Rastogi & Sani,Microbes and Microbial Technology, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment, \\
4. A K Bej and M H Mahbubani,Applications of the polymerase chain reaction in environmental .Microbiology.*Genome Res.* 1992 1: 151-159
5. The Metagenomics of soil by *Rolf Daniel*,470/June2005/vol3,

ww.nature.com/reviews

6. Metagenomics: DNA sequencing of environmental samples,Susannah Green Tringe and Edward M. Rubin,806/November2005/Volume6
7. www.nature.com/reviews/genetics

Unit - III : Soil, Marine & Agricultural Microbiology

1. Marine Microbiology: Ecology and Applications. Colin Munn. Garland publishing. ISBN: 0815365179
2. Environmental Microbiology. Alan H. Varnam. Manson Publishing. 2000.
3. Agricultural Microbiology. G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj. PHI Learning Pvt. Ltd., 2004
4. Microbes and Microbial Technology: Agricultural and Environmental Applications. Iqbal Ahmad, Farah Ahmad, John Pichtel. Springer, 2011.

UNIT -IV: Advanced Food & Water Microbiology

1. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities.
2. Kirk RS & Sawyer R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Longman Scientific & Technical.
3. Leo ML. 2004. Handbook of Food Analysis. 2nd Ed. Vols. I-III.
4. Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.
5. Macleod AJ. 1973. Instrumental Methods of Food Analysis. Elek Sci.Marcel Dekker
6. Nielsen S. (Eds.). 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett.

Suggested Readings for Food additives

1. Branen AL, Davidson PM & Salminen S. 2001. Food Additives. 2nd Ed. Marcel Dekker.
2. Gerorge AB. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
3. Madhavi DL, Deshpande SS & Salunkhe DK. 1996. Food Antioxidants: Technological, Toxicological and Health Perspective. Marcel Dekker.
4. Stephen AM. (Ed.). 2006. Food Polysaccharides and Their Applications. Marcel Dekker.

Suggested Readings for Neutraceuticals

1. Brigelius Flohé, J & Joost *HG. 2006.* Nutritional Genomics: Impact on Health and Disease. Wiley VCH.
2. Gibson GR & William CM. 2000. Functional Foods - Concept to Product.
3. Losso JN. 2007. Angi-angiogenic Functional and Medicinal Foods. CRC Press.
4. Manson P.2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press.
5. Shi J. (Ed.). 2006. Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC Press.

Course Code	Title	Credits

M.Sc. (Semester -IV)Microbiology Syllabus

Revised for Credit Based and Grading System

To be implemented from the Academic year 2013-2014

Semester- IV :Detail Syllabus

PSMB401	Tools and Techniques : Biomolecular Analysis (60L)	04
	Unit I Spectroscopic Techniques (15L)	01
	1.1 UV-visible spectroscopy: Beer- Lambert's Law, Instrumentation, operation, calibration, accuracy and applications (05L)	
	1.2 IR: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)	
	1.3 Atomic Absorption Spectroscopy: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)	
	Unit II Chromatographic Techniques (15L)	01
	2.1 Gas Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)	
	2.2 High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications (05L)	
	2.3 Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications (05L)	
	Unit III Molecular Biology Techniques (15L)	01
	3.1 Variations/ Modifications of PCR: Hot- Start PCR, Multiplex PCR, Nested PCR, RT-PCR, Broad Range PCR, arbitrarily primed PCR, Quantitative PCR, Real time PCR (05L)	
	3.2 Hybridization array technology: applications of microarrays in microbiology, Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays) (05L)	
	3.3 FISH with other techniques: (confocal laser scanning microscopy, microautoradiography, flow cytometry, immunofluorescence,microsensors, peptide, nucleic acids) (05L)	
	Unit IV Nanotechnology Techniques (15L)	01

4.1 Microscopy: i. Scanning Probe Microscopes - scanning tunneling microscope(STM), atomic force microscope(AFM), magnetic force microscope(MFM), scanning near field microscope(SNOM), ii. Electron Microscopy: SEM, TEM (10L) 4.2 Diffraction Techniques: X-ray diffraction (XRD) (02L) 4.3 Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies(XPS)/Auger electron spectroscopy (03L)	

PSMB401: Tools and Techniques : Biomolecular Analysis

Practicals : PSMB4P1

PSMBP1	**Tools and Techniques: Biomolecular Analysis (60L)** **<u>Unit I</u> :** Research project experimental work (15L) **<u>Unit II</u>:**Research project experimental work (15L) **<u>Unit III</u>** : Research project experimental work (15L) **<u>Unit IV</u> :** Research project experimental work (15L)	**02**

References: PSMB401(Semester IV)

1. Persing, H.D. et al. 2004, *Molecular Microbiology: Diagnostic principles and practice,* Washington D.C., ASM press.
2. Chandler D.E. and Roberson R.W. 2009, *Bioimaging: current concepts in light and electron microscopy,* Singapore, Jones and Bartlett Publishers
3. Muralidharan V.S. and Subramania A. 2010, *Nanoscience and Technology*, New Delhi Ane Books Pvt Ltd.
4. Viswanathan B. 2010, *NanoMaterials,* New Delhi, Narosa Publishing House.
5. Pattabhi V. and Gantham N. 2002, *Biophysics* (2nd Ed.) Springer.
6. Narayana P. 2008, *Essentials of Biophysics,* New Age International Pvt Ltd Publishers
7. Sharon, Madhuri and Maheshwar, 2012, Bio-Nanotechnology: concepts and applications. New Delhi, Ane books Pvt Ltd.
8. Scott R. P.W. 2012,*Principles and Practice of Chromatography (Chrom-Ed Book Series)* , Reese-Scott Partnership
9. McNair H. M. and Miller J. M., 2009, *Basic Gas Chromatography* , Wiley International
10. Kulkarni Sulabha, 2011, *Nantotechnology: Principles and Practices*, New Delhi, Capital Publishing Company.
11. Chattopadhyay K.K. and Banerjee A.N. , 2012, *Introduction to Nanoscience and Nanotechnology*, New Delhi, PHI Learning Pvt. Ltd.
12. Miller J. M. , 2009, *Chromatography: Concepts and Contrasts,* USA, John Wiley and Sons, Inc.
13. Banwell, C.N. and McCash, E.M., 2012, *Fundamentals of Molecular Spectroscopy,* 4th Ed., New Delhi, Tata McGraw Hill Education Pvt. Ltd.
14. Upadhyay, Upadhyay and Nath, 2012, *Biophysical Chemistry: Principles and Techniques*, Mumbai, Himalaya Publishing House
15. Braithwaite A. and Smith F.J., 2001, *Chromatographic Methods*, 5th Ed. , London, Kluwer Academic Publishers
16. *Analytical Chemistry by Open Learning Series*, 2008, New York, John Wiley and Sons.
17. Braun R. , Introduction to Instrumental Analysis, New York, McGarw Hill Book Company
18. Skoog, Holler and Nieman, Principles of Instrumental Analysis, 5th Ed. Australia, Thomson Brock/Cole

PSMB402 : Pharmaceutical Microbiology

Course Code	Title	Credits
PSMB402	**Pharmaceutical Microbiology (60L)**	**04**
Unit I: Principles and applications of GMP in pharmaceuticals and cosmetics (15L) 1.1 Principles – Applications and Definitions 1.2 The concept of Quality 1.3 The regulatory factors 1.4 QC, QA and GMP 1.5 Quality assurance beyond GMP 1.6 ISO 1.7 Sanitary practices in cosmetic manufacturing		**01**
Unit II Quality management and regulatory aspects (15L) 2.1 Premises and contamination control, location, design, structure, layout, services and cleaning. 2.2 Personnel management, training, Hygiene and health. 2.3Documentation 2.4 Quality control and GCLP 2.5 Sterile and other products. 2.6 Global regulatory and toxicological aspects of cosmetic preservation		**01**
		01

Unit III Analytical aspects for pharmaceutical and cosmetic Products (15L) 3.1 Quality control and GCLP 3.2 Sterile and other products. 3.3 Validation 3.4 Cosmetics microbiology- testing methods and preservation 3.4.a Antimicrobial preservation efficacy and microbial content testing 3.4.b Validation method for cosmetics 3.4.c Preservation strategy 3.4.d Evaluation of antimicrobial mechanism	
Unit : IV Drug Discovery (15L) 4.1 Modern Methods of Drug Discovery 4.2 Proteomics 4.3 Bioinformatics 4.4 High throughput screening technology 4.5 Natural products for lead identification 4.6 The role of protein 3D structures in the drug discovery process.	01

Practicals : PSMB4P2

PSMB4P2	**Pharmaceutical Microbiology (60L)** 1.Sterility testing and reporting (as per Pharmacopia) 2. Microbial load in cosmetic product 3. Efficacy testing of preservatives like parabens 4. Efficacy of preservation and shelf life study. 5. Preparation of cosmetic product and its preservation study 6. Report on LAL and other tests for QC	**02**

ReferencesPSMB402 (Semester IV)

References: Unit I:

1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
2. Iyer S. (2003) Guidelines on cGMP and quality of Pharmaceutical products. D K Publishers Mumbai.
3. Philip A , Taylor and Francis (2006) Cosmetic Microbiology a practical approach.2nd Ed.

References: Unit II:

1. Denyer S p, Hodges N A and Gorman S P (2005) Hugo and Russell's Pharmaceutical Microbiology. Blackwell Publishing.
2. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology. 4th Ed. CRC Press.
3. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
4. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors.

References: Unit :III :

1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
2. Philip A , Taylor and Francis (2006) Cosmetic Microbiology a practical approach.2nd Ed.

References : Unit IV :

1. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition.
2. Kadam s s, Mahadik K R and Bothara K G (2009). Principles of medicinal Chemistry. Vol II Nirali Prakashan Pune.
3. Lemke T L and Williams D A (2008) Foye's Principles of

Medicinal Chemistry. 6th Ed. Wolter Luwer, Lippincott Williams and Wilkins. N Delhi.

PSMB403: Advances in Biotechnology

Course Code	Title	Credits
PSMB403	**Advances in Biotechnology (60L)**	**04**
	Unit I - Pharmaceutical Biotechnology (15L) 1.1 Biologics, Biopharmaceuticals, 1.2 Protein structure stability, folding, structure prediction, Post translation modifications, Protein Therapeutics – Upstream and Downstream processing, Cytokines, Interferon production, Interleukins production, Therpeutic hormones – Insulin, Human Growth Hormone, Recombinant blood products, Therapeutic Enzymes 1.3 Newer Vaccines, Vaccine Designing Approaches 1.4 Drug Discovery Tools, Combinatorial Chemistry, High Throughput Screening, Chemiinformatics, In silico Modelling, Molecular Modeling, Structure Prediction, Rational Drug Designing, Drug Development, Concept of Pharmacognosy, Pharmacokinetics and Pharmacodynamics	01
	Unit II IPR and Ethics in Biotechnology (15L) **2.1 Biotechnology and Intellectual Property Rights (9 L) lectures** 2.1a. Intellectual Property Rights (IPR) and Protection (IPP) 2.1 b. Biotechnology and IPR-Rationale of Patent in Research and Scientific Innovations , Biotechnological Patents 2.1c. Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement. 2.1d. Patent Specifications and Basic Component of License Agreement, In IP System 2.1e. Categories of Biotechnological Patents-Patenting in New Era of Genomics, Proteomics and Microbiology, Examples of Patents granted by USPTO, Concerns over Biotechnology Patents.	01

2.1f. .Patenting in Biotechnology-European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non Patentable IP and Patentable IP in Indian Patent Act **2.2 Biotechnology and Bioethics (6 L)** 2.2.a) Biotechnology and Bioethics 2.2.b) Bioethics and cross-cultural bioethics.- Autonomy, Rights, Beneficience, Do No Harm, Justice,Confidentiality, Animal Rights, Environmental ethics, Decision-Making 2.2.c) Perceptions of Ethical Biotechnology.-'Moral' is not the same as Ethical, Mixed Perception of Benefit & Risk, Reasoning behind Acceptance or Rejection of Genetic Manipulation,Concerns about Consuming products of GMOs. 2.2.d) Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse 2.2.e) Future 'Bioethical Conflicts' in Biotechnology. - Changing perception of Nature, Human Genetic Engineering 2.2.f) Bioethics vs Business: A Conflict?- IPP, Global Issues of Technology Transfer, Safety vs Costs, Is New Technology Better 2.2.g) Resolution of Conflicts- Who can be trusted?, Public Education, Sufficient Regulations 2.2.h) Ethical limits of Biotechnology.-Absolute or Relative, Timeless or Transient 2.2.i)Criteria to Assess whether Biotech Research is Ethical.	
Unit III - Marine Biotechnology (15L) 3.1 Extreme environmental conditions, Marine life forms, Biomimetic materials, new	01

class of pharmaceuticals, industrial products and processes, vaccines, diagnostics and analytical reagents, Environmental research in marine environment, Methods in Marine Microbiology – Detection of microorganisms and microbial activity, Metabolic diversity, Extreme Environment conditions, Marine bacteria, marine archaea, Biofouling and biodetrioration, Degradation of pollutants, Bioremediation, Role of microorganisms in ocean processes, Marine Genomics and Proteomics. 3.2 Marine bioprospecting – Isolation of Marine Natural Products 3.3 Diversity of marine derived compounds - Alkaloid, Terpenoids and steroides, nucleoside, aminoacids, peptides, depsipeptide, polyketide, Macrolide; Marine Enzymes- protease, lipase, chitinase, glucanase; Marine biominerals; Biominerelized structures; Biocomposites; Biopolymers - polysaccharides, chitin, marine collagens. 3.4 Bioactive Compounds And Biomaterials From Marine Environment.	
<u>Unit IV: Advances in Molecular Biotechnology</u> **(15L)** 4.1 Chemical synthesis and sequencing of DNA: Phosphoramidite method, Uses of synthesized oligonucleotides, Dideoxynucleotide method for sequencing of DNA, Automated DNA sequencing, Using Phage M13 as a sequencing vector	01

4.2 Manipulation of Gene Expression in Procaryotes: Gene expression from strong and regulatable promoters, Fusion proteins, unidirectional tandem gene arrays, Increasing protein stability, protein folding, DNA integration into host chromosome,

4.3 Heterologous protein production production in eukaryotic cells:Expression systems like Saccharomyces cerevisiae, Pichia pastoris, Baculovirus-Insect cell, mammalian cell

4.4 Directed Mutagenesis: Oligonucleotide directed mutagenesis with M13, Oligonucleotide directed mutagenesis with plasmid DNA, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primer, Random mutagenesis with nucleotide analogues, Error-prone PCR, DNA shuffling, Mutant proteins with unusual amino acids

4.5 Protein Engineering: Adding disulfide bonds, Changing aspargine to other amino acids, Reducing the number of free sulfhydryl residues, Increasing enzymatic activity, Modifying metal cofactor requirement, Decreasing protease sensitivity, Modifying protein specificity, Increasing enzyme stability and specificity, altering multiple properties

4.6 Synthetic Biology: Introduction, types, mechanisms, applications in industry

Practical: PSMB4P3 Advances in Biotechnology (60L)

PSMB4P3	**i.Assignments on IPR-Case studies on different patents granted** **ii.Report on International Bioethics survey on specific concerned issues.** **iii. Research Project experimental work**	**02**

ReferencesPSMB403 (SemesterIV)

References: Unit I :

1. Gary Walsh, Pharmaceutical Biotechnology – Concepts and Applications (E-Book), John Wiley & Sons Ltd. (2007)
2. Jogdand S. N., Biopharmaceuticals, Himalaya Publishing House, Mumbai (2006)
3. K. Sambamurthi, Pharmaceutical Biotechnology, New Age International (2006)
4. Daan J. A. Crommelin, Robert D. Sindelar and Bernd Meibohm Pharmaceutical Biotechnology: Fundamentals and Applications, informa healthcare, (Oct 30, 2007)

References: Unit II: 2.1:

1. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights , Aravind Kumar, Govind Das, Narosa
2. A textbook of Biotechnology, R.C.Dubey ,S.Chand.

References: Unit II: 2.2:

1. Biotechnology,Second Completely Revised Edition-Volume 12-Legal,Economic and **Ethical** Dimensions.Volume Editor-D.Brauer(A multi-Volume Comprehensive Treatise),H.J.Rehm and G.Reed, A.Puhler ,P Stadler
2. Ethics in Biotechnology-An Executive Guide ,Chris MacDonald &Rahul.K. Dhanda
3. www.BiotechEthics.ca

References:Unit: III :

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.Colwell et. 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

References: Unit IV

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA
   Bernard R. Glick, Jack J. Pasternak, 4/e (2010), ASM Press
2. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology
   edited by Michael Wink, (2006)Wiley VCH
3. Molecular biotechnology: principles and practices
   Channarayappa, (2006), Universities Press
4. Synthetic Biology

PSMB404: Applied and Environmental Monitoring & Management

Course Code	Title		Credits
PSMB404	**Applied and Environmental Monitoring & Management**	**(60L)**	**04**
UNIT I: Bioremediation, biodegradation &Waste disposal		**(15L)**	**01**
1.1 Engineering and bioremediation process its needs and limitations. 1.2 Bioremediation in Soil of BTEX hydrocarbons. 1.3 Petroleum contamination, Polycyclic aromatic compounds, 1.4 Nitroaromatic compounds, PCB, Chlorinated Phenols, Chlorinated aliphatic compounds. Molecular technique in Bioremediation. 1.5 Sewage & Sludge treatment and disposal methods.			

UNIT II: Biofilm management 2.1 Structure and properties of biofilms: 2.2 Formation of biofilm , Regulation of Initial Attachment, Biofilm Formation Proceeds via Multiple Convergent Genetic Pathways, Early Attachment Events, Maturation of the Biofilm , Detachment and Return to the Planktonic Growth Mode 2.3 Study of Quorum Sensing: Cell- Cell Communication amongst bacteria, and its similarity with *M. xanthus* Fruiting Body Development. 2.4 Multispecies biofilms: Clinical Relevance 2.5 Biofilms in plant-associated habitats:In the Phyllosphere (impact on survival and bacterial interactions, interaction of plants with epiphytic biofilms,), In the Rhizosphere (ubiquity and importance for rhizosphere bacteria, impact of rhizosphere biofilms on plant biology,), 2.6 Biofilm erradication :Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quarternary ammonium compounds. 2.7 Use of other biofilm management methods such as probiotic organisms and prebiotics to restore disrupted beneficial biofilms to a “normal state”. Correction of environmental conditions for enhanced bioremediation of biofilms (eg dental plaque) 2.8 Disadvantages of biofilm management strategies-development of resistant strains-cross resistance induction 2.9 Biofilms from different environments,Impact of environment on biofilm development and its composition and implications of each on biofilms in water bodies,biofouling associated microbial biofilms prosthetics associated biofilms,human associated biofilms eg. Gut	**(15L)**	01

UNIT : III Pollution control and monitoring	(15L	01
3.1Introduction to Pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution. Role of government and public in pollution control 3.2 Air pollution: Sources - Organic and inorganic pollutants, particulate matter, photochemical smog, acid rain, ozone depletion, green house effect, global warming, and role of microorganisms in cause and mitigation of global warming, climate change. Control measures of air pollution - dust control equipment, control measures for specific gaseous pollutants Effects of air pollution, assessment & monitoring. (Indoor air pollution, vehicular pollution and control, odour control) 3.3 Water pollution: Sources of water and their contamination, types of pollutants, Effects of water pollution on plants, animals and human beings. Indicator microorganisms. Eutrophication – causes, effects and control measures. 3.4 Wastewater treatment – aerobic and anaerobic. CETP, Water quality criteria and standards for discharge. Assessment & monitoring of water pollution. 3.5 Marine pollution: Sources, effects and coastal management 3.6 Thermal pollution: Sources, effects and control 3.7 Soil Pollution: Chemical composition and classification (hazardous and non hazardous) of soil, sources of soil pollution, effects on plants, animals and human beings, biomagnification, control measures, assessment and monitoring. 3.8 Noise pollution: Sources, impact, measurement and indices, control and abatement 3.9 Radioactive pollution: Sources, effects, prevention and control measures		

UNIT : IV Environmental & natural resources management and safety standards	**(15L)**	**01**
4.1Natural resources: Renewable/ non renewable. Land, water, forest, minerals, energy, food. Associated problems and management practices. Environmental Impact Assessment and Sustainable Development 4.2 Solid waste management: Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling. 4.3Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these waste through Common Effluent Treatment Plants. 4.4 Biomedical and electronic waste management, recovery of precious metals from electronic waste resources. 4.5Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures 4.6Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)		

PRACTICALS: PSMB4P4 (60L)	02
1. Biofilm visualization by staining of a slide immersed in different environments such as soil, water, saliva (to emphasize compositional and structural variations in biofilms from different environment).s 2. Determination of MIC of disinfectant/antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to planktonic cells) quantified using crystal violet assay 3. Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio. 4. Demonstration of Analysis of SO_x, NO_x , heavy metal (As/Cr) pollutants using volumetric/ spectrophotometric methods. 5. Study tour/ academic visit to any large scale industry (environmental health and safety aspects) Food/ Pharma/chemical, environmental consultancy, research centres OR Study tour/ academic visit to Sewage treatment plant/ ETP of any industry / water purification unit/ Pollution Control Board Lab, CETP, landfill, etc. 6. Preparation/ drafting of an EIA report. 7. Case studies: sustainable agricultural practices, coastal zone management, MEOR, management of monuments, air pollution episodes, oil spills.	
References: PSMB404(Semester IV) **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 Edn

UNIT- II: Biofilm management

1. Davies DG, Parsek MR, Pearson JP,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 signaling 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 Environmental & natural resources management and safety standards

1. Resource ecology. S. K. Agarwal
2. Environmental management. H. V. Jadhav, Vipul Prakashan , 2002
3. Environmental management. R.K. Jain and others
4. Modern trends in ecology and environment. R. S. Ambasht
5. Industrial hygiene and safety. M. H. Fulekar

Modality of Assessment :

[I] Theory Examination Pattern:

A] Internal examination for theory (40%):- **40 marks**

Sr. No.	Particulars	Marks.
1.	Active participation in routine Class instructional deliveries	05
2.	Overall conduct as a responsible learner, Communication & leadership qualities in organizing related academic activities.	05
3.	One seminar based on curriculum to be assessed by the teacher of the institution teaching P.G.learners/ publication of a research paper / presentation of a research paper in seminar or conference	30
	(i) Selection of the topic, Introduction,write up, references	15
	(ii) Presentation with the use of ICT	15

B] External examination - 60 %

Semester End Theory Assessment - **60 marks**

i. Duration - These examinations shall be of two and half hours duration.

ii. Theory question paper pattern :-

1. There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units .
2. All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.
3. Questions may be sub divided into sub questions **a, b, c & d only, each carrying six marks OR a, b, c, d, e & f only** each carrying **four** marks and the allocation of marks depends on the weightage of the topic.

[II]Practical Examination Pattern

(A)Internal Examination:-

There will not be any internal examination/ evaluation for practicals.

(B) External (Semester end practical examination) Per course :-

Sr.No.	Particulars	Marks
1.	Laboratory work	40
2.	Journal	05
3.	Viva	05

Semester III:

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department ; failing which the student will not be allowed to appear for the practical examination.

Research proposal: Candidates are required to present duly certified research proposal (as per the BCUD format) with relevant references (minimum 25) and make the power point presentation of the same for the evaluation by the examiner. (The research proposal must be included with literature survey of the selected research topic.)

Semester IV:

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department ; failing which the student will not be allowed to appear for the practical examination.

Research project work: Candidates are required to present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make the poster presentation of the research work for evaluation by the examiner.

Overall Examination and Marks Distribution Pattern

Semester III

Course	PSMB301			PSMB302			PSMB303			PSMB304			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

Semester IV

Course	PSMB401			PSMB402			PSMB403			PSMB404			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200