Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: MASTER OF SCIENCE

Course: M.Sc. - Microbiology

Semesters: III & IV

Choice Based Credit System (CBCS) with effect from the Academic year 2022-23

A.C. No: 13

Agenda No: 3(xiv)

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of M.Sc. Microbiology, the learners should be enriched with knowledge and be able to-

PSO1: Have an in-depth understanding of microbiology and allied fields.
PSO2: Keep abreast of the emerging trends in various biosciences.
PSO3: Have a multidisciplinary and innovative approach in finding solutions to problems faced by society.
PSO4: Maintain high standards of professional and ethical values.
PSO5: Develop an entrepreneurial mindset so as to be job creators.
PSO6: Become responsible world citizens who will be enthusiastic lifelong learners.

PREAMBLE:

The grant of autonomy to Mithibai College has proved to be a boon to the growth of the institution. The teaching learning process has geared towards becoming more learner centric and there is a conscious shift to constructivist learning techniques.

The post-graduate syllabus in Microbiology aims at creating self-motivated, disciplined and determined learners who will not only be assets to the available human resource but also be a value addition to the research and innovation programmes of the country.

The syllabus has been revised taking into account the fact that there is a perceptible shift among learners to be job providers rather than job seekers. The syllabus focuses on areas that are most relevant with the above view in mind.

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. centres and if the research project demands, in conjunction with relevant industries/ research institutes.

In order to enable students to develop employable skills concurrently with an understanding of theoretical concepts and practical techniques required in R&D, quality control, and regulatory functions in pharmaceuticals, food industry, and environmental sciences, papers on Pharmaceutical and Food Microbiology, Applied Microbiology, Environmental Microbiology and Sustainable Development have been included in the revised syllabus. The papers on Microbial Genetics, Advanced Immunology and Advanced Virology will ensure that the learners are kept abreast with the latest innovations in a fast-changing world. One of the unique features of this post-graduate syllabus is the introduction, for the first time in the Microbiology syllabus of the University of Mumbai, a paper on Entrepreneurship Development, wherein learners will not only be exposed to the what and whereof of the field but will also be required to present these learnings in the form of a formal business proposal that will be evaluated.

The courses are as follows:

Semester III: PSMAMB305: Advanced Immunology
PSMAMB306: Microbial Genetics
PSMAMB307: Applied Microbiology
PSMAMB308: Emerging Trends in Biosciences
Semester IV: PSMAMB405: Pharmaceutical and Food Microbiology
PSMAMB409: Advances in Epidemiology and Public Health
PSMAMB410: Environmental Microbiology and Industrial Microbiology
PSMAMB408: Entrepreneurship Management

I profusely thank all the committee members for their effort in drafting the syllabus.

N.B.-

i. The duration of each theory lecture will be of 60 minutes. A course consists of 4 modules. For each module, the total number of hours allotted are 15. The total number of lecture hours for each course will thus be 60. For the theory component, the value of one credit is equal to 15 learning hours.
ii. There will be one practical per batch for each course. The duration of each practical will be of 4 hours, i.e., of 240 minutes. For the practical component, the value of one credit is equal to 30 learning hours.
iii. Thus, in a week, a student will study 16 hours of theory and 16 hours of practical. This structure is outlined below-

Course name	Course code	Number of hours/ week	Total number of hours	Number of credits
Advanced Immunology	PSMAMB305	4	4 X 15= 60	4
Microbial Genetics	PSMAMB306	4	4 X 15= 60	4
Applied Microbiology	PSMAMB307	4	4 X 15= 60	4
Emerging Trends in Biosciences	PSMAMB308	4	4 X 15= 60	4
Microbiology Practical I	PSMAMBP31	2	4 X 15= 60	2
Microbiology Practical II	PSMAMBP32	2	4 X 15= 60	2
Microbiology Practical III	PSMAMBP33	2	4 X 15= 60	2
Microbiology Practical IV	PSMAMBP34	2	4 X 15= 60	2
Pharmaceutical and Food Microbiology	PSMAMB405	4	4 X 15= 60	4
Advances in Epidemiology and Public Health	PSMAMB409	4	4 X 15= 60	4
Environmental Microbiology and Industrial Microbiology	PSMAMB410	4	4 X 15= 60	4
Entrepreneurship Management	PSMAMB408	4	4 X 15= 60	4
Microbiology Practical I	PSMAMBP41	2	4 X 15= 60	2
Microbiology Practical II	PSMAMBP42	2	4 X 15= 60	2
Microbiology Practical III	PSMAMBP43	2	4 X 15= 60	2
Microbiology Practical IV	PSMAMBP44	2	4 X 15= 60	2

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Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Presentation of a scientific paper	15 marks
Component 2 (CA-2)	Assignment based on the presentation	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of the examination will be two and half hours.

Question Number	Description	Marks	Total Marks
1	Question I will be based on module I, question 2 on module II, question 3 on module III and question 4 on module IV. Each question will be subdivided into two sub questions, "A" and "B". Sub question "A" will have eight questions (of 10 marks each) out of which any four will be attempted. Total marks allotted to sub question "A" will be 10 marks. Sub question "B" will be compulsory for 5 marks without internal choice	A (10 × 1) = 10 marks B = 5 marks	60
2		A (10 × 1) = 10 marks B = 5 marks	
3		A (10 × 1) = 10 marks B = 5 marks	
4		A (10 × 1) = 10 marks B = 5 marks	
5	It will have questions from all four modules of the course. It will have 4 questions (of 5 marks each), one from each module out of which any 3 will be attempted	3 × 5 = 15 marks	15
		Total Marks	**75**

Dr. Geeta Narayan
HOD

Dr. Meenakshi Vaidya
Approved by Vice –Principal

Dr. Krutika Desai
Approved by Principal

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Program: M.Sc.				**Semester: III**	
Course: ADVANCED IMMUNOLOGY				**Course Code: PSMAMB305**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

This course will provide exploration of the fields of immunology. It encompasses the evolution of the immune system and immune response to various infectious agents such as bacteria, viruses, fungi and parasites.

It will also enable the students to understand the immunologic mechanisms of hypersensitivity and immunodeficiency diseases.

Students of M.Sc. Microbiology have had an introductory course on Immunology in T.Y.B.Sc. The present course incorporates efforts to understand how the immune system has evolved in higher animals, immunologic mechanisms of diseases and transplantation immunology.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Summarize the evolutionary and developmental changes of the immune system.
CO2: Describe how our immune system responds to the presence of various types of infectious agents
CO3: Outline various mechanisms of regulatory cell death.
CO4: Learn details of specific immunologic mechanisms that are triggered during disease.
CO5: Summarize about transplantation and rejection.
CO6: Review development of tumours.
CO7: Explain various aspects of immunodeficiencies.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Evolution, ontogeny and phylogeny of the immune system**	**15**
2	**Immune response to infectious agents and regulatory aspects of the immune system**	**15**
3	**Immunologic mechanisms in disease: Part I**	**15**
4	**Immunologic mechanisms in disease: Part II**	**15**
	Total	**60**
PRACTICALS		**120**

Detailed Syllabus:			
Module	**Topic and Description**	**No. of hours**	**No. of Credits**
Module 1	**EVOLUTION, ONTOGENY AND PHYLOGENY OF THE IMMUNE SYSTEM**	**15**	**01**
	General Principles of Immune System Evolution	1	
	Major Gene Families Involved in Immunity	2	
	Immunity in Plants and Invertebrates	2	
	Defence Families: Recognition and Effector	2	
	Proteolytic and Signalling Cascades	2	
	T-cell ontogeny and T-cell tolerance (Central and Peripheral)	3	
	B-cell ontogeny and B-cell tolerance (Central and Peripheral	3	
Module 2	**IMMUNE RESPONSE TO INFECTIOUS AGENTS AND REGULATORY ASPECTS OF THE IMMUNE SYSTEM**	**15**	**01**
	IMMUNE RESPONSE TO INFECTIOUS AGENTS	7	
	General Features of lmmune Responses to Microbes	2	
	Immunity to Extracellular Bacteria	1	
	lmmunity to Intracellular Bacteria	1	
	lmmunity to Fungi	1	
	lmmunity to Viruses	1	
	lmmunity to Parasites	1	
	REGULATORY ASPECTS OF THE IMMUNE SYSTEM	8	
	Programmed Cell Death	2	
	Neural Immune Interactions	2	
	Effects of immune factors on the CNS	2	
	CNS regulation of the immune system	2	
Module 3	**IMMUNOLOGIC MECHANISMS IN DISEASE: PART I**	**15**	**01**
	HYPERSENSITIVITY	6	
	Causes and types of hypersensitivity reactions	2	
	Anaphylaxis	1	
	Antibody-dependent cytotoxic reactions	1	
	Immune complex-mediated reactions	1	
	Delayed type hypersensitivity	1	
	AUTOIMMUNITY	7	
	General principles	2	
	Systemic autoimmune diseases	5	
	General principles	2	
	SLE	1	
	Arthritis	1	
	Vasculitis	1	
	Organ specific autoimmune diseases	2	

Module 4	**IMMUNOLOGIC MECHANISMS IN DISEASE: PART II** TRANSPLANTATION IMMUNOLOGY Immune responses to allografts Effector mechanisms of allograft rejection Prevention and treatment of allograft rejection Xenogeneic transplantation Blood transfusion Bone marrow transplantation TUMOUR IMMUNOLOGY General Features of Tumour lmmunity Tumour Antigens Immune Responses to Tumours Evasion of lmmune Responses by Tumours lmmunotherapy for Tumours The Role of the lmmune System in Promoting Tumour Growth IMMUNODEFICIENCIES General features of immunodeficiency disease Congenital (Primary) immunodeficiencies Acquired (Secondary) immunodeficiencies	**15** 5 1 1 1 1 1 1 7 1 1 1 1 1 1 1 3 1 1 1	**01**
	Total	**60**	**04**

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Program: M.Sc.				**Semester: III**	
Course: MICROBIOLOGY PRACTICAL I				**Course Code: PSMAMBP31**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	1. ELISA of cytokines. 2. Isolation of PBMC and their culturing. 3. Study of protein profile of PBMC lys Cate. 4. Radial immunodiffusion technique. 5. Ouchterlony's immunoprecipitation method *6.* Kit-based methods of detection.		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READING:

Essential Reading

1. Paul William- Fundamental Immunology, Sixth Edition, Lippincott, Williams and Wilkins
2. Abbas Abul, Lichtman Andrew and Pillai Shiv, Cellular and Molecular Immunology, Sixth Edition, Saunders

Supplementary Reading

1. Jenni Punt; Sharon Stranford; Patricia Jones; Judy Owen- Kuby Immunology, Eighth Edition.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt– Essential Immunology, Thirteenth Edition
3. Any other reference sources as recommended by the course instructor.

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Program: M.Sc.				**Semester: III**	
Course: MICROBIAL GENETICS				**Course Code: PSMAMB 306**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

Microbial Genetics is a course for post graduate students, with both the conceptual and practical tools for generating and understanding biological genetic information. The course involves an understanding of gene transfer in bacteria and bacteriophages, as well as a detailed account of extrachromosomal genetic elements, mutation and DNA repair. It gives an overview of the branches of genetics and model. Additionally, the learner will be exposed to population genetics and various "omics" techniques such as proteomics, transcriptomics, metabolomics, genomics and metagenomics.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Comprehensively assess the molecular mechanisms of gene transfer in different groups of bacteria.
CO2: Describe the methods of genetic mapping in eukaryotes.
CO3: Explain the concepts related to transposable elements in eukaryotes.
CO4: Recall the principles of Mendelian genetics and describe its applications.
CO5: Know various aspects of chromosome mutations.
CO6: Learn about the genetic basis of cancer.
CO7: Describe the nucleic acid components within cytoplasm, chloroplast and give examples of extra nuclear inheritance.
CO8: Explain chromosomal rearrangements and the effects they have on gene expression.
CO9: Describe various concepts related to population genetics.
CO10: Calculate alleleic and genotypic frequencies, understand how genetic variation may be measured.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Gene transfer and genetic analysis in bacteria and bacteriophages**	**15**
2	**Transposable genetic elements, genetic basis of cancer**	**15**
3	**Cytoplasmic Inheritance & Chromosomal Rearrangements**	**15**
4	**Population Genetics and Omics**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**GENE TRANSFER AND GENETIC ANALYSIS IN BACTERIA AND BACTERIOPHAGES**	**15**	**01**
	Bacterial genome, horizontal gene transfer	1	
	Transformation		
	Development of Competence in Gram positive bacteria and Gram-negative bacteria,		
	Transformation systems based on Type II secretion system	1	
	Competence based on type IV secretion systems.	1	
	Natural competence, regulation of natural competence	1	
	Regulation of competence in *Bacillus subtilis*- Competence pheromones, *S. pneumoniae*		
	Role of natural transformation- Nutrition, repair, recombination, Importance of natural	1	
	transformation for forward and reverse genetics	1	
	Artificially induced competence- Calcium ion induction, transformation by plasmids,		
	transfection by phage DNA, transformation of cells with chromosomal genes,	1	
	Electroporation	1	
	Transformation in *H. influenzae*		
	Overview, Classification of self-transmissible plasmids	1	
	Mechanism of DNA transfer during		
	Conjugation in Gram negative bacteria	1	
	Chromosome transfer by plasmids- Formation of Hfr strains, transfer & mobilization of chromosomal DNA by integrated plasmids,		
	prime factors	1	
	Transfer system of gram-positive bacteria- Plasmid pheromones	1	
	Transduction: generalised and specialised transduction	1	
	Genetic mapping in eukaryotes		
	Coupling and repulsion, recombination frequency, linkage maps based on two factor and three factor crosses.	1	

Module 2	**TRANSPOSABLE GENETIC ELEMENTS, GENETIC BASIS OF CANCER** Transposable Elements in Eukaryotes Ac and Ds Elements in Maize P Elements and Hybrid Dysgenesis in Drosophila Mariner, an Ancient and Widespread Transposon Mendelian Genetics and its Extension Mendelian Genetics with respect to the phenotypic and genotypic ratios of monohybrid, dihybrid and trihybrid Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis (recessive epistasis, dominant epistasis, duplicate recessive and duplicate dominant epistasis) Penetrance and expressivity Pedigree Analysis Chromosome mutations- Deletion, duplication, inversion, translocation, Aneuploidy and polyploidy Genetic basis of cancer Cancer and the Cell Cycle, check points in cell cycle Genetics Basis for Cancer, Oncogenes Tumor-Inducing Retroviruses and Viral Oncogenes Cellular Homologs of Viral Oncogenes: The Proto-Oncogenes Mutant Cellular Oncogenes and Cancer Chromosome Rearrangement and Cancer Tumor Suppressor Genes Inherited Cancers and Knudson's Two-Hit Hypothesis Cellular Roles of Tumor Suppressor Proteins Genetic Pathways to Cancer Epigenetics & cancer	**15** 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	**01**
Module 3	**CYTOPLASMIC INHERITANCE & CHROMOSOMAL REARRANGEMENTS** Cytoplasmic Inheritance (Organellar Genetics) mt-DNA Mitochondrial genome structure, Maps of mt DNA	**15** 1 1	**01**

	Ancestral and derived mitochondrial genome Mitochondrial DNA of Human, yeast and flowering plants Endosymbiotic theory Mitochondrial DNA replication, transcription & translation Codon usage in Mitochondria Damage to Mitochondrial DNA and aging. Evolution of Mitochondrial DNA mt DNA analysis for study of evolutionary relationships Chloroplast DNA. Gene structure and organization, Map of chloroplast DNA General features of replication, transcription and translation of cpDNA Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA Examples of extra nuclear inheritance. Leaf Variegation, Poky mutant of Neurospora, Yeast petite mutant, Human genetic diseases Chromosomal Rearrangements and effects on gene expression Amplification and deletion of genes Inversions that alter gene expression Transpositions that alter gene Expression antigenic variation in Trypansomes Mating type switching in yeast Phase variation in *Salmonella*	1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Module 4	**POPULATION GENETICS AND OMICS** Population genetics Population and gene pool Genotypic and Allelic frequencies Calculation of Genotypic frequencies and Allelic frequencies for autosomal and X linked loci Problems –calculation of alleleic and genotypic frequencies Hardy-Weinberg Law, genotypic frequencies at HWE, Implications of the H-W Law,	**15** 2	**01**

	H-W proportions for multiple alleles, X-linked alleles Changes in the genetic structure of populations: Mutation, Migration and gene flow, Genetic drift, Natural selection Simple problems based on the natural forces Measuring genetic variation: RFLP, DNA sequencing Protein electrophoresis Transcriptomics Transcriptomics in functional genomics Transcriptomics in Human cancer hazard assessment Microarray databases (GEO, Array express etc.), data-file formats, Tools for Transcriptomics and Transcriptome Analysis, Proteomic Introduction -basics Techniques- 2-D, mass spectrometry Advancement in technique Metagenomics Metabolomics Metabolic profiling and fingerprinting, Metabolic pathway analysis and metabolic networks, Single Cell Metabolomics Metabotype Concept Evolution and phylogeny of metabolic pathways	2 2 3 2 2 2	
	Total	**60**	**04**

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Program: M.Sc.				**Semester: III**	
Course: MICROBIOLOGY PRACTICAL II				**Course Code: PSMAMBP32**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	1. Conjugation in bacteria 2. Transformation in bacteria 3. Genetic mapping- sums		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READING:

Essential Reading

1. Trun Trempy - Fundamental Bacterial Genetics, 1st edition, 2004, Blackwell Publishing
2. Benjamin Pierce, Genetics: A Conceptual Approach, 4th edition, 2008, W. H. Freeman & Co
3. Snustad & Simmons, Principles of Genetics, 6th edition, 2012, John Wiley & Sons Inc
4. Klug & Cummins, Concepts of genetics - Pearson Hall
5. Arther Lesk, Introduction to Genomics, 2nd edition Oxford University Press
6. Ute Roessner Metabolomics, InTech, Publisher
7. Larry Snyder and Wendy Champness, Molecular Genetics of bacteria, 3rd Edition by (ASM press)

Supplementary Reading

1. Russell, P.J.- iGenetics- A Molecular Approach, 3rd edition, 2010, Pearson International edition
2. Watson, Baker, Bell, Gann, Levine, Losick Molecular Biology of the Gene, 7th edition, 2007, Pearson Education
3. Lewin, B, Genes X I, 2014, Jones and Bartlett Learning
4. Lewin, B., Genes /XII, 2018, Jones and Bartlett Learning
5. Burton E. Tropp, Molecular biology –Genes to proteins 3rd ed. by (Jones & Bartlett publishers)
6. Any other reference sources as recommended by the course instructor.

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Program: M.Sc.				**Semester: III**	
Course: APPLIED MICROBIOLOGY				**Course Code: PSMAMB 307**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

The Applied Microbiology course is designed to explore various applications of microorganisms. The learner will be able to appreciate the contribution of microbes to Bioenergy production, Biofilm formation and Bioremediation. In addition, Bioprocess technology (microbial fermentation kinetics) and techniques for enzyme purification have been detailed.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Explain the importance of bioenergy and how it can be produced using various sources.
CO2: Describe the structure, formation, development, and composition of bacterial and fungal biofilms.
CO3: Assess the interaction of biofilms and impact on plants.
CO4: Propose strategies for biofilm management and eradication.
CO5: Assess the impact of the environment on biofilms.
CO6: Explain how biofilms affect health and materials.
CO7: Design the process of setting up an industrial fermentation process including the designing and scaling up of bioreactors.
CO8: Produce and purify enzymes on a large scale, evaluate their purity and immobilize them for reuse.
CO9: Describe various bioremediation processes; evaluate the needs and limitations of the process, suggest remedial measures for certain specific types of contaminated environments.
CO10: Propose and devise sewage and sludge disposal methods.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Bioenergy Production**	**15**
2	**Biofilm Management**	**15**
3	**Bioprocess and Enzyme Technology**	**15**
4	**Bioremediation**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**BIOENERGY PRODUCTION**	**15**	**01**
	Bioethanol – Production from various substrates	3	
	Biogas technology – production and applications	3	
	Biodiesel – Properties and production	3	
	Biohydrogen – Production methods including production through genetic engineering	3	
Module 2	**BIOFILM MANAGEMENT**	**15**	**01**
	Structure and properties of biofilms	1	
	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	1 1 1	
	Study of Quorum Sensing: Cell-Cell Communication amongst bacteria, and its similarity with *M. xanthus* Fruiting Body Development.	2 1	
	Multispecies biofilms: Clinical Relevance	1	
	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,)	1	
	Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine, quarternary ammonium compounds.	1	
	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)	1	
	Disadvantages of biofilm management strategies-development of resistant strains-cross resistance induction	1	
	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	2	
	Fungal biofilms	**1**	

Module 3	**BIOPROCESS AND ENZYME TECHNOLOGY** Bioprocess technology Microbiology of Industrial Fermentation Fermentation kinetics Design, development and scale up of bioreactors and photobioreactors ENZYME TECHNOLOGY: Large scale production of enzymes Precipitation methods, concentration of enzyme by ultrafiltration, purification by chromatographic methods(all) Calculation of enzyme purity Stabilization of enzyme using additives Introduction to enzyme engineering and tools for enzyme engineering Immobilization methods and kinetics of enzyme immobilization	**15** 6 2 2 2 9 1 1 2 1 2 2	**01**
Module 4	**BIOREMEDIATION** Engineering and bioremediation process its needs and limitations. Bioremediation in Soil of BTEX hydrocarbons. Petroleum contamination, Polycyclic aromatic compounds, Nitroaromatic compounds, PCB, Chlorinated Phenols, Chlorinated aliphatic compounds. Molecular technique in Bioremediation. Sewage & Sludge treatment and disposal methods.	**15** 3 4 8	**01**
	Total	**60**	

		No. of hours	No. of Credits
PRACTICALS		**60**	**02**
	1. Bioethanol production 2. Large scale production of alkaline phosphatase and protease and purification. 3. Biofilm visualization by staining a slide immersed in different environments such as soil, water, saliva-compositional and structural variations in biofilms from different environments. 4. Academic visit to effluent treatment plant and fermentation industry		

SUGGESTED READING:

Essential Reading

1. E. M..T.,El Mansi- Fermentation Microbiology and Biotechnology (2007) CRC press
2. N Gray, M Calvin, SC Bhatia - Enzyme Biotechnology (2010) CBS publishers and distributors.
3. Nicholas Price and Lewis Stevens – Fundamentals of Enzymology; Cell and Molecular Biology of Catalytic Proteins; 3rd edition; 1999; Oxford University Press
4. Ronald L Crawford and Don L Crawford- Bioremediation: Principles and Applications; 1996; Cambridge University Press

Supplemetary Reading

1. Ronald M. Atlas and Richard Bartha- Microbial Ecology – Fundamentals and Applications (4th edition), Pearson Education
2. M. H. Fulekar- Environmental Biotechnology by, CRC Press (Taylor & Francis group), Science Publishers
3. S. N. Mukhopadhyay- Process Biotechnology Fundamentals (3rd edition, 2010); Viva Books
4. Allan Scragg- Environmental Biotechnology, 2nd Edition; 22005; Oxford University Press

Supplementary Articles

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 aeruginosaWCS365 proceeds via multiple, convergent signaling pathways: a genetic analysis. Mol. Microbiol. 28:449–61
3. O'Toole, G., Kaplan, H. B. and Kolter, R., 2000. Biofilm formation as microbial development. Annu. Rev. Microbiol. 2000. 54:49–79
4. Luanne Hall-Stoodley, J. William Costerton & Paul Stoodley- Bacterial biofilms: from the Natural environment to infectious diseases. Nature Reviews Microbiology 2, 95-108
5. Morris, C. E. and Monier, J. M. 2003.The ecological significance of biofilm formation by plant-associated bacteria. Annu. Rev. Phytopathol.41:429–53
6. Any other reference sources as recommended by the course instructor.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: III**	
Course: EMERGING TRENDS IN BIOSCIENCES				**Course Code: PSMAMB 308**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

The course, Emerging Trends in Biosciences will expose the learner to the current trends in Biosciences, encompassing the various areas of Biotechnology- an application of Biosciences. It includes- Plant, animal and agricultural biotechnology and the recently emerging Nanobiotechnology. The learners will be introduced to cutting edge areas of artificial intelligence, machine learning and microfluidics.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Outline various animal cell culture techniques.
CO2: Evaluate the risks and safety issues related to animal biotechnology.
CO3: Appraise the importance of bioethics.
CO4: Explain cloning techniques and their applications.
CO5: Describe various nanoscale systems, their properties & their characterization; explain various methods for their synthesis and characterisation and applications.
CO6: Appraise the benefits and dangers of use of nanoparticles.
CO7: Explain about microfluidics and nanofluidics.
CO8: Elaborate upon the application of artificial intelligence and machine learning in the field of microbiology.
CO9: Describe CRISPR Cas technique for gene editing.
CO10: Illustrate how various plant tissue culture techniques may be carried out for crop improvement.
CO11: Describe how plants may be used as bioreactors.
CO12: Summarize how plant genetic engineering may be carried out. Propose measures for improvement of plant quality.
CO13: Argue for or against development and use of transgenic plants.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Animal Biotechnology**	**15**
2	**Nanobiotechnology**	**15**
3	**Modern Approaches in Biological Studies**	**15**
4	**Plant and Agricultural Biotechnology**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**ANIMAL BIOTECHNOLOGY** Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines Scale up, Cryopreservation, Culture Collections Risks and Safety, Bioethics. Stem Cell Technology, Cloning techniques and Applications. Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish Applications: Transgenic mice: i) Retroviral method ii) DNA microinjection method iii) Engineered Embryonic Stem cell method	**15** 2 2 2 2 2 2 3	**01**
Module 2	**NANOBIOTECHNOLOGY** Nanoscale systems, nanoparticles, nanowires, thin films and multilayers; Properties of nanomaterials, Characterization of nanoparticles Synthesis of nanostuctures - physical, chemical and biological, microbiological methods Biomolecules as nanostructures. Nanoparticulate carrier systems, Micro and Nanofluidics Applications: Biosensors, drug and gene delivery systems, nano imaging, Nanomedicine and Cancer diagnostics and treatment Health and Environmental hazards of nanoparticles	**15**	**01**
Module 3	**MODERN APPROACHES IN BIOLOGICAL STUDIES** Artificial intelligence and machine learning in microbiology Artificial intelligence and machine learning. Applications of machine learning in microbiology Clinical applications Drug and vaccine discovery Epidemiology Microbial ecology and microbiomes Microbial classification Other applications Targeted genome editing using Crispr Cas9 systems Microfluidics Principle of microfluidics and Chip technologies	**15** 6 1 1 1 1 1 1 3 6	**01**

	Application in biological sciences, advantages and limitations		
Module 4	**PLANT AND AGRICULTURAL BIOTECHNOLOGY** 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. 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. 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 transgene silencing. Plant Genetic Engineering for Productivity and Performance— Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt toxin, Disease Resistance, Virus resistance Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature. By manipulation of—Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency For Quality Improvement-Protein, Lipids, carbohydrates, vitamins and minerals. Biosafety concerns of transgenic plants Plants as bioreactors.	**15** 3 1 4 2 2 1 1 1	**01**
	Total	**60**	**04**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: III**	
Course: MICROBIOLOGY PRACTICAL IV				**Course Code: PSMAMBP34**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	1. Preparation of nanoparticles and characterization 2. Determination of antioxidant property of nanoparticles (using ascorbic acid as standard) 3. Determination of antibacterial activity of nanoparticles 4. Plant tissue culture –callus initiation		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READING:

Essential Reading

1. Ian Freshney- Animal Cell Culture
2. Niemeyer CM & Mirkin CA - Nanobiotechnology: Concepts, Applications and Prospectives; 2004; Wiley Interscience
3. Yubing Xie- The Nanobiotechnology Handbook (2016), CRC press
4. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)
5. Judith Pongracz, Mary Keen- Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
6. Pratibha Nallari & V. Venugopal Rao- Medical Biotechnology, Oxford University Press, India (2010)
7. Baldwin, Bayer, Dickinson, Ellis, Freemont, Kiney Polliz, Stan- Synthetic biology, a primer Rev. ed (2016); Imperial College Press
8. A. Slater, N. Scott & M. Fowler- Plant Biotechnology: The genetic manipulation of plants, 2005, , Oxford Univ Press.
9. H.S. Chawla- Introduction to Plant Biotechnology (3rd Edtn)
10. Ariealtman, Paul Michael Hasegawa- Plant Biotechnology and Agriculture: Prospects for the 21st Century

Supplementary Reading

1. Sudha Gangal- Animal Cell Culture
2. Bernard R. Glick and Jack G. Pasternack- Molecular Biotechnology: Principles and Applications of Recombinant DNA; 2002; American Society for Microbiology
3. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2nd Edn, Academic Press,2000
4. H.K. Das (ed), Textbook of Biotechnology, Wiley India, 2004
5. J.M. Davis Ed.- Basic Cell Culture. 2nd.Ed, Oxford press
6. J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer Verlag, Heidelberg, 2000
7. B.B. Buchanan, W. Gruissen and R.L. Jones (eds), Biochemistry and Molecular Biology of Plants, American Society of Plant Biology, Rockville, USA, 2000.
8. Stewart, C. Neal- Plant Biotechnology and Genetics: Principles, Techniques & Applications, June 2008, John Wiley &Sons
9. Dixit Chandra, K Kaushik Ajeet (Eds) Microfluidics for Biologists.
10. The use of CRISPR CAS 9, ZFN and TALENS John n. Abelson and Melvin I. Simon , Anna Marie Pyle (eds) (2014) Methods in Enzymology Elsevier Inc.
11. Takashi Yamamoto, Editor; 2015; Targeted Genome Editing Using Site-Specific Nucleases ZFNs, TALENs, and the CRISPR/Cas9 System Springer; Japan.

Supplementary Articles

1. N. Peiffer-Smadja S. Delliere, C. Rodriguez, G. Birgand, F.-X. Lescure, S. Fourati,E. Rupp (2020) Machine learning in the clinical microbiology laboratory: has the time come for routine practice? Clinical Microbiology and Infection 26 ,1300-1309 –Review.
2. Qu K, Guo F, Liu X, Lin Y andZou Q (2019) Application of Machine Learning in Microbiology Front. Microbiol., 10,827 - Review
3. A. Egli1, J. Schrenzel, G. Greub (2020) Digital microbiology Clinical Microbiology and Infection, 26 , 1324-1331- Review
4. Any other reference sources as recommended by the course instructor.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: PHARMACEUTICAL AND FOOD MICROBIOLOGY				**Course Code: PSMAMB405**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

The course includes new developments in pharmaceutical industry with respect to drug discovery and development. It also emphasizes the importance of quality assurance in industry. In addition, use of microbes in food preparation as well as the control of undesired organisms has been highlighted.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Summarize the modern methods of drug discovery.
CO2: Explain the high throughput screening technologies.
CO3: Describe the role of protein 3D structures in the drug discovery process.
CO4: Define terms related to and describe the processes involved in quality control, QA and GMP.
CO5: Propose testing, preserving and validation method for cosmetics.
CO6: Review various fermented foods.
CO7: Examine whether conditions are stressful for microbes in foods.
CO8: Plan microbial food analysis tests.
CO9: Design strategies to control microbes in foods.
CO10: Establish food safety while adhering to prescribed guidelines.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Drug Discovery and Development**	**15**
2	**Quality Assurance and Validation in the Pharmaceutical Industry**	**15**
3	**Microbes in Foods: Uses and Detection**	**15**
4	**Microbes in Foods: Control and Safety**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**DRUG DISCOVERY AND DEVELOPMENT** Modern methods of drug discovery Proteomics Bioinformatics High throughput screening technologies Natural products for lead identification The role of protein 3D structures in the drug discovery process	**15** 3 2 2 2 2 4	**01**
Module 2	**QUALITY ASSURANCE AND VALIDATION IN THE PHARMACEUTICAL INDUSTRY** The concept of quality, definitions and applications QC, QA and GMP Cosmetics microbiology- testing methods and preservation Antimicrobial preservation efficacy and microbial content testing Validation method for cosmetics Preservation strategy Evaluation of antimicrobial mechanism	**15** 2 2 2 2 2 2 3	**01**
Module 3	**MICROBES IN FOODS: USES AND DETECTION** Fermented foods: Starter cultures, Blue cheese, Sausage, Sauerkraut, Bread, Idli, Pickle Microbial stress response- Effect of pH, temperature and water activity Conventional Methods for microbial detection: Sampling methods, qualitative & quantitative methods, rapid methods, biosensors & bacterial toxins. Use of GMO to produce vegan products, Dairy alternatives Microbes as food- Microbial protein, SCP and mycelial protein	**15** 2 2 3 4 2 2	**01**
Module 4	**MICROBES IN FOODS: CONTROL AND SAFETY** Control: of access, by physical removal, heat, low temperature, reduced Aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives & irradiation, combination of methods (Intrinsic & Extrinsic factors, Hurdle concept), Novel emerging techniques of food preservation. Food Safety: Controlling the Microbiological Quality of food, Quality and Criteria, Sampling Schemes, QC using microbiological control, Control at source, Codes of GMP, HACCP, Laboratory Accreditation.	**15** 8 7	**01**
	Total	**60**	**04**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: MICROBIOLOGY PRACTICAL I				**Course Code: PSMAMBP41**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	1. Sterility testing of pharmaceutical products (any 3 as per the instructions of the practical instructor) 2. Microbial study of Idli batter, sauerkraut 3. Microbial analysis of two food products 4. Observation in industry with Quality assurance, Quality Control or GLP department		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READINGS:

Essential Reading

1. Hillisch A. and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International ed
2. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press
3. Kadam S. S. Mahadik, K. R. and Bothara K. G. (2009) Principles of Medicinal Chemistry. Vol II Nirali Prakashan, Pune
4. Lernke T L and Williams D A (2008) Foye's Principles of Medicinal Chemistry, 6th ed. Wolter Luwer, Lippincott Williiams and Wilkins N. Delhi
5. J Maud Kordylas (1991) Processing and Preservation on tropical and subtropical foods. ELBS Macmillan.
6. N Shakuntala Manay and Shadaksharawamy M (1985) Foods Facts and Principles. New Age International
7. Aylward FV (2001) Food Technology Processing and Laboratory Control. Agrobios (India)

Supplementary Reading

1. Gerald Reed (2004) Prescott and Dunn's Industrial Microbiology 4thed CBS publishers
2. Philip A. Geis (2006) Cosmetic Microbiology: a practical approach, 2nd ed.
3. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology 4thed CRC Press
4. Adams M.R. and Moss M.O. (2008) Food Microbiology 3rded RSC publishing.
5. Harrigan W.F. and McCance M.F. (1976) Laboratory methods in food and dairy microbiology. Academic Press.
6. Iyer S. (2003) Guidelines on cGMP and quality of pharmaceutical products. D.K. Publisher Mumbai
7. Any other reference sources as recommended by the course instructor.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: ADVANCES IN EPIDEMIOLOGY AND PUBLIC HEALTH				**Course Code: PSMAMB 409**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**Semester End Examinations (SEE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

The course will provide the learner with in depth knowledge about the advances in epidemiology and public health including design principles, evaluation of public health data etc. thus equipping them for a career in public health. It will also sensitize the learner to social and ethical aspects of biotechnology and equip them with knowledge about intellectual properties.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Develop insight into the various study design principles of epidemiology.
CO2: Critically evaluate articles related to public health.
CO3: Interpret the results of studies in clinical epidemiology or public health.
CO4: Classify different types of intellectual properties
CO5: Debate on social and ethical aspects of biotechnology
CO6: Apply the knowledge of biotechnological advances for disease treatment.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Epidemiology-I**	**15**
2	**Epidemiology-II**	**15**
3	**Role of Biotechnology in Society**	**15**
4	**Biotechnology and Intellectual Property Rights**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**EPIDEMIOLOGY- I**	**15**	**01**
	Introduction to epidemiology; The epidemiological concept of population;	2	
	Variation in disease-by time, place, and person; role of error, bias and confounding	2	
	Cause and effect: The epidemiological approach	1	
	The concept of risk and measures of disease frequency:	2	
	Incidence and prevalence	1	
	Sources of public health data	1	
	Descriptive epidemiology	1	
	Study design	5	
Module 2	**EPIDEMIOLOGY- II**	**15**	**01**
	The Epidemiological Approach to Causation	2	
	Communicable diseases: epidemiology, surveillance and response	3	
	Clinical epidemiology	3	
	Environmental and occupational epidemiology	3	
	Epidemiology, health policy and planning	2	
	Theoretical, ethical, contextual, practical, and critical foundations for future epidemiology	2	
Module 3	**ROLE OF BIOTECHNOLOGY IN SOCIETY**	**15**	**01**
	Social aspects of biotechnology	3	
	Bioterrorism	1	
	GMOs in the environment	2	
	Biosafety guidelines	2	
	Biotechnology in Medicine: Monoclonal antibodies Interferons, Growth factors and stem cell therapy and Artificial tissue	7	
Module 4	**BIOTECHNOLOGY AND INTELLECTUAL PROPERTY RIGHTS**	**15**	**01**
	Intellectual Property Rights (IPR) and Protection (IPP) Biotechnology and IPR-Rationale of Patent in Research and Scientific	3	
	Innovations, Biotechnological Patents	1	
	Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement.	1	
	Patent Specifications and Basic Component of License Agreement, In IP System	1	

	Categories of Biotechnological Patents-Patenting in New Era of Genomics, Proteomics and Microbiology, Examples of Patents granted by USPTO, Concerns over Biotechnology Patents. Patenting in Biotechnology-European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non Patentable IP and Patentable IP in Indian Patent Act **BIOTECHNOLOGY AND BIOETHICS** Biotechnology and Bioethics Bioethics and cross-cultural bioethic- Autonomy, Rights, Beneficience, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making 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. Past and Present 'Bioethical Conflicts' in Biotechnology-Interference with Nature, Fear of Unknown, Regulatory Concerns, Human Misuse Future 'Bioethical Conflicts' in Biotechnology. - Changing perception of Nature, Human Genetic Engineering Bioethics vs Business: A Conflict?- IPP, Global Issues of Technology Transfer, Safety vs Costs, Is New Technology Better Resolution of Conflicts- Who can be trusted?, Public Education, Sufficient Regulations Ethical limits of Biotechnology.-Absolute or Relative, Timeless or Transient Criteria to Assess whether Biotech Research is Ethical.	1 1 1 2 1 1 1 1	
	Total	**60**	**04**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: MICROBIOLOGY PRACTICAL II				**Course Code: PSMAMBP42**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	Project work PSMAMB 409, PSMAMB 410- 100 mks total		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READINGS:

Essential Reading

1. B. D. Singh. Biotechnology. Kalyani Publishers.
2. S. N. Jogdand. Advances in Biotechnology. 2005. 5th Edition.
3. S. B. Primrose. Modern Biotechnology. 1989. Blackwell Scientific Publ.
4. S. N Jogdand. Gene Biotechnology. 2008, Himalaya Pub. House.
5. Raj S. Bhopal (2002) Concepts of Epidemiology. Oxford University Press.
6. Susan Carr, Nigel Unwin and Tanja Pless-Mulloli (2007) An Introduction to Public Health and Epidemiology, 2nd edition. McGraw Hill Open University Press.
7. Jogdand, S. N. Medical Biotechnology, 2008. Himalaya Pub. House (Ebrary)

Supplementary Reading

1. Primrose and others. Principles of Gene manipulation. 6th edition. 2004 Blackwell Science.
2. Aschengrau A., Seage, G.R. (2020) Essentials of Epidemiology in Public Health. 4th edition, Jones & Bartlett Learning
3. Bonita R., Beaglehole R., Kjellstrom T. (2006) Basic Epidemiology, 2nd edition. WHO Press.
4. Bernard R. Glick and Jack J. Pasternak (2002). Molecular Biotechnology: Principles and Applications of recombinant DNA. 4th Edition. American Society for Microbiology.
5. Aluizio Borem Fabricio R. Santos and David E. Bowen. Understanding Biotechnology. 2004 Pearson Education.
6. James Watson and Others. Recombinant DNA. 2001. Scientific American Books.
7. Purohit, S. S. Biotechnology – Fundamentals and applications. 4th edition, 2005. Agrobios (India).
8. Any other reference sources as recommended by the course instructor.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: ENVIRONMENTAL MICROBIOLOGY AND INDUSTRIAL MICROBIOLOGY				**Course Code: PSMAMB 410**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

The course is designed to give insight into the role of microorganisms in various ecosystems. It also includes modern methods and techniques used for the detection of various microbes from the environment. In addition, it will acquaint the learner about advances in bioprocess technology.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Describe types of microorganisms in soil and marine habitats and their interaction with plants.
CO2: Explain various techniques that can be used for isolation and study of microorganisms.
CO3: Apply newer approaches for screening various microbial metabolites.
CO4: Design the process for production of heterologous protein on large scale.
CO5: Design the process for microbial products in relation to sustainable development.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Soil and Marine Microbiology**	**15**
2	**Techniques in Environmental Microbiology**	**15**
3	**Bioprocess Technology**	**15**
4	**Advances in Bioprocess Technology**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**SOIL AND MARINE MICROBIOLOGY** SOIL MICROBIOLOGY Factors affecting microbial load of soils. Soil aggregate microbial communities The rhizosphere and phyllosphere. Plant microbe interactions - benefits and detrimental effects. MARINE MICROBIOLOGY Marine habitats and environment -an overview Types of microbes in the marine environment Study of marine microbes from mangrove ecosystem Methods of studying /cultivation of marine microbes+C68 Applications of marine microbes	**15** 1 2 2 1 2 2 2 3 2	**01**
Module 2	**TECHNIQUES IN ENVIRONMENTAL MICROBIOLOGY** Environmental sample collection and processing.: Soils and Sediment, Water, Air, Detection of Microorganisms on fomites Cultural Methods: Cultural methods for isolation & enumeration of bacteria Physiological Methods: Measuring microbial activity in pure culture; Carbon respiration, Stable isotope probing, Use of radioisotopes as tracers Adenylate energy charge, Enzyme assays Functional genomics & proteomics-based approach Immunological methods: Immunoassays Nucleic acid-based methods of analysis: Obtaining Nucleic acids from Environment, Use of Gene probes, PCR Recombinant DNA Techniques, RFLP, Denaturing /Temperature gradient, Plasmid analysis, Reporter genes. Rep PCR fingerprinting and microbial diversity Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment: culturable and unculturable bacterial analysis	**15**	**01**
Module 3	**BIOPROCESS TECHNOLOGY** Newer approaches for screening microbial metabolites The production of Heterologous Proteins Heterologous protein production by bacteria, yeast and mammalian cell culture	**15** **05** **10**	**01**

Module 4	**ADVANCES IN BIOPROCESS TECHNOLOGY** **Recent approaches in microbial production** Bioplastics, Biopesticides, Biopolymer, Single Cell Protein Biofertilizers Symbiotic: *Bradyrhizobium*, *Rhizobium*, *Frankia* Nonsymbiotic: Azospirillum, Azotobacter, Mycorhiza, MHB, Novel combination of microbes as Biofertilizer, plant growth promoting bacteria, phosphate solubilizer) **Microbial Fuel Cells**	**15** 4 2 6 3	**01**
	Total	**60**	**04**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: MICROBIOLOGY PRACTICAL III				**Course Code: PSMAMBP43**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	Project work - 100 mks total		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READINGS:

Essential Reading

1. Regina L. Wilpiszeski, Jayde A. Aufrecht, Scott T. Retterer, Matthew B. Sullivan, David E. Graham, Eric M. Pierce, Olivier D. Zablocki, Anthony V. Palumbo, Dwayne A. Elias, Volker Müller, Editor- Soil Aggregate Microbial Communities: Towards Understanding Microbiome Interactions at Biologically Relevant Scales, Applied and Environmental Microbiology, 85: e00324-19 - PHI Learning Pvt. Ltd., 2004
2. Colin B. Munn -Marine Microbiology: Ecology & Applications-, 3rd edition, CRC Press.
3. S. K. Agarwal- Resource ecology, Himanshu Publication

Supplemetary Reading

1. Rangaswami G. Bagyaraj D. J.- Agricultural Microbiology, 2nd Edition, January 2009
2. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. Addison Wesley Longman, Inc.
3. R.M. Maier, I.L. Pepper and C.P. Gerba 2010, Environmental Microbiology, Academic Press
4. Iqbal Ahmad, Farah Ahmad, John Pichtel - Microbes and Microbial Technology: Agricultural and Environmental Applications.. Springer, 2011.
5. Joanne Willey, Kathleen Sandman, Dorothy Wood- Prescott's Microbiology, 11th Edition
6. Rastogi & Sani, Microbes and Microbial Technology, 2011, pp 29-57,
7. Gurdeep Rastogi, Rajesh Sani-Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment, February 2011 In book: Microbes and Microbial Technology
8. M. H. Fulekar- Industrial hygiene and safety, I K International Publishing House Pvt. Ltd.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
13. Stanbury P. F., Whitaker A. and HaII S. J. Principles of Fermentation Technology 3rd edition Aditya Books Pvt. Ltd, New Delhi 2016

Supplementary Articles

1. Jacoby et al -The role of soil microorganisms in plant mineral nutrition - current knowledge and future directions; Frontiers in Plant Science; Sep 2017; Vol 8: Marine Microbiology
2. B. Austin- "Biodiversity and biotechnological potential of microorganisms from mangrove ecosystems: a review"
3. Hrudayanath Thatoi, Bikash Chandra Behera, Rashmi Ranjan Mishra, Sushil Kumar Dutta- Biodiversity and biotechnological potential of microorganisms from mangrove ecosystems: A review, March 2012 Annals of Microbiology 63(1)

4. S.N. Baharum, E.K. Beng and M.A.A. Mokhtar, 2010. Marine Microorganisms: Potential Application and Challenges. Journal of Biological Sciences, 10: 555-564.
5. A K Bej and M H Mahbubani, Applications of the polymerase chain reaction in environmental Microbiology. Genome Res. 1992 1: 151-159
6. Rolf Daniel - The Metagenomics of Soil, July 2005, Nature Reviews Microbiology, 3(6):470-8
7. Susannah G Tringe Edward M Rubin- Metagenomics: DNA sequencing of environmental samples, December 2005, Nature Reviews Genetics 6(11):805-14
8. Any other reference sources as recommended by the course instructor.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: ENTREPRENEURSHIP MANAGEMENT				**Course Code: PSMAMB 408**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	-	-	04	25	75

Learning Objectives:

The course highlights the concepts of entrepreneurship and the requirements for the same.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Explain the concepts of marketing.
CO2: Enlist the government agencies facilitating entrepreneurship.
CO3: Design a business plan.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Introduction to Entrepreneurship**	**15**
2	**Development of New Venture**	**15**
3	**Introduction to marketing**	**15**
4	**Entrepreneurship Development and Government**	**15**
	Total	**60**
PRACTICALS		**120**

Module	Topic and Description	No. of Hours	No. of Credits
Module 1	**INTRODUCTION TO ENTREPRENEURSHIP** Meaning and concept of Entrepreneurship, the history of entrepreneurship development in the field of Science, role of entrepreneurship in field of pure sciences, agencies in entrepreneurship management and future of entrepreneurship in the field of pure science. Meaning of entrepreneur, the skills required to be an entrepreneur with respect to Science, the entrepreneurial decision process with respect to Science, role models, mentors and support system with respect to Science. Preparing a Business Plan: Meaning and significance of a business plan, components of a business plan, and feasibility study with respect to science.	**15** 5 5 3	**01**
Module 2	**DEVELOPMENT OF NEW VENTURE** Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property and marketing the new venture Financing the New Venture: Importance of new venture financing, types of ownership securities, venture capital, types of debt securities, determining ideal debt-equity mix, financial institutions and banks Managing Growth in New Venture: Characteristics of high growth new ventures, strategies for growth and building the new venture capital. Harvesting Rewards: Exit strategies for entrepreneurs, bankruptcy, succession and harvesting strategy.	**15** 4 4 7	**01**
Module 3	**INTRODUCTION TO MARKETING** Introduction to Marketing Concept, Evolution of Marketing from Production to Sustainability & Customer Orientation. Marketing Environment, Evaluation of Market Opportunities in Services Sector, Rural area & International market Pillars of Marketing – Market Segmentation, Target Marketing, Positioning & Differentiation, Marketing Mix and Product Decisions – Product Life Cycle, & Brand. Marketing Mix and Product Decisions – Product Life Cycle, & Brand. Pricing Decisions Promotion Decisions – Integrated Marketing Communications. Concept: Advertising, Sales Promotions, Public Relations, Direct Marketing; Communication Tools. Overview of Marketing Strategies: BCG, Ansoff, GE, Shell	**15** 3 2 3 2 2	**01**

	Model, Porter Generic Model, 5 Forces Model, PLC, 7s Model of Marketing, A Little Model, Value Chain Model.	3	
Module 4	**ENTREPRENEURSHIP DEVELOPMENT AND GOVERNMENT** Role of central government and state government in promoting entrepreneurship; Introduction to various incentives, subsidies and grants- Export Oriented units- Fiscal and Tax concessions available Role of following agencies in Entrepreneurship Development- District Industries Centres (DIC), Small industries service institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB) Why do entrepreneurs fail: The FOUR Entrepreneurial pitfalls (Peter Drucker), Women Entrepreneurs: Reasons for low/ no women entrepreneurs? Role, problems and prospects case studies of successful entrepreneurial ventures, failed entrepreneurial ventures and turnaround ventures.	**15** 3 5 7	**01**
	Total	**60**	**04**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Autonomous)

Program: M.Sc.				**Semester: IV**	
Course: MICROBIOLOGY PRACTICAL IV				**Course Code: PSMAMBP44**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credits**	**Continuous Assessment (CA)**	**End Semester Examinations (ESE)**
-	04	-	02		

		No. of hours	**No. of Credits**
PRACTICALS		**60**	**02**
	Project- on Business plan- 50 mks		

Development of scientific temper and interest by exposure through industrial visits and study/educational tour is recommended in each semester.

SUGGESTED READINGS:

Essential Reading

1. Hisrich Peters- Entrepreneurship
2. Brigitte Berger- The culture of entrepreneurship-
3. K. Nagarajan- Project management-
4. Vasant Desai- Dynamics of Entrepreneurship development-
5. Dr. P.C. Shejwalkar- Entrepreneurship development
6. Srinivas Pandit- Thought leaders
7. S.N. Chary - Business Gurus Speak-
8. Gurmit Narula - The entrepreneurial connection

Supplementary Reading

1. Steven Brandt - Entrepreneurship, 3rd Ed.
2. David H. Holt- Entrepreneurship: New venture creation
3. Any other reference sources as recommended by the course instructor.