

# **HSNC University Mumbai**

(2020-2021)

Ordinances and Regulations

With Respect to

Choice Based Credit System

(CBCS)

For the Programmes Under

## **The Faculty of Science and Technology**

For the Course

### **Microbiology**

**Curriculum – Second Year Postgraduate Programmes**

**Semester-III and Semester -IV**

2021-2022

## **1. Course Objectives:**

### **Semester III**

#### **PS-SMB-301: Food, Pharmaceutical and Cosmetic Microbiology**

To understand the process of fermentation in various types of food products and familiarize with the different fermented foods of indigenous origin and their health benefits.

- Understand concepts of prebiotics and probiotics
- To study the advanced methods of food preservation.
- Understand the criteria that can be used to assess the quality of food and improve shelf-life of the food.
- To understand the basics of cosmetic microbiology and sample the products for analysis
- Understand the criteria of microbiological evaluation for quality control and toxicological studies
- To study the use of preservatives and its efficacy testing in cosmetics
- To provide an insight into the research and development carried out in drug discovery
- To study the techniques for molecular modelling and drug designing
- To provide knowledge about Clinical Trial Designs
- To know the importance of Preclinical studies and various procedure used in clinical trials

#### **PS-SMB-302: Environmental Microbiology**

- To understand the physiology, biochemistry and applications of extremophiles.
- To analyze microbial communities using nonculture-based techniques.
- To learn physiological measurement and newer molecular approaches for complete analysis of an environmental sample.
- To examine different types of microbial activity measurements in both pure culture and environmental samples.
- To measure microbial activity using radiolabeled tracer molecules.
- To understand Geo-microbiology with respect to biocorrosion and bioleaching
- Describe the structure, formation, development, and composition of bacterial and fungal biofilms.
- Assess the interaction of biofilms and impact on plants.
- Propose strategies for biofilm management and eradication.
- Comprehend the impact of the environment on biofilms.
- Explain how biofilms affect health and materials.

#### **PS-SMB-303: Advances In Biotechnology- I**

- To understand techniques involved in enzyme purification and protein engineering
- To understand the concept of Enzyme immobilization
- Understand synthesis and properties of nanostructures and their applications.
- Know the concept, applications, techniques involved in Medical Biotechnology

- To understand the bioremediation process and its feasibility and learn the various methods of bioremediation.
- Know about various Concepts in Applied Biotechnology

### **PS-SMB-304: Research Methodology & Biostatistics**

- To know how to identify a research problem
- Understand basics of research design and design a research study from its commencement to its conclusion and reporting.
- To be familiar with the different aspects of scientific communication.
- Understand concepts of quantitative and qualitative data collection and the process of analysing the data.
- To learn to carry out statistical test of a hypothesis.
- Understand the criteria that can be used to select an appropriate statistical test in a research problem and present statistically validated conclusions.

## **Semester IV**

### **PS-SMB-401: Advances in Biotechnology- II**

- Know the concept and techniques in animal tissue culture.
- Understand generation and applications of transgenic animals.
- Understand advanced technologies involved in plant biotechnology.
- Understand applications of transgenic plants.
- Know the concept and techniques in Agricultural Biotechnology.
- Understand Concept and applications in Fungal and Algal Biotechnology

### **PS-SMB-402: Environmental & Natural Resource Management & Safety Standards**

- Understand the importance of natural resource management
- Be able to reflect their role as global citizens, consumers and environment protectors
- To understand biohazard and biosafety standards In laboratories and industries
- To study the methods of disposal of solid waste.
- To understand the types of hazardous waste and its management
- To give an insight into the diverse application of microorganisms in marine environment
- To study the modern methods and techniques for understanding diversity of marine microbes.
- To study the causes of marine pollution, the damage to the environment, to the health of all organisms.
- To study the impact of Biofouling on marine environment.

### **PS-SMB-403: Biotechnological Advancement and Entrepreneurship**

- To know types of scanning probe microscope and its applications
- Understand basics of various types of fluorescence microscopes.
- To be familiar with the various biophysical techniques used in cell biology.
- To learn to interpret chromatographic data and understand high end chromatographic techniques.
- Understand the principle underlying molecular diagnostics and Biosensors for analysing biological samples.
- To create awareness on IPR issues and need for knowledge in patents
- To understand the bioethical guidelines of biomedical research
- To become familiarize with the ethical practices in microbiology
- To enable the students to develop an Entrepreneurial mindset.
- To enhance innovative ability and personality.
- To develop Entrepreneurial skills that will allow identification and creation of Business Opportunities.

**MSc Part II Semester III - Units – Topics – Teaching Hours**

<b>S. N 0.</b>	<b>Subject Code</b>	<b>Subject Unit Title</b>	<b>Hour s/Lec tures</b>	<b>Total No. of hours/le ctures</b>	<b>Cre dit</b>	<b>Total Marks</b>
<b>1</b>	<b>PS-SMB-301 Food, Pharmaceutical and Cosmetic Microbiology</b>	1 Food Microbiology	15	60 L	4	100 (60+40)
		2 Cosmetic Microbiology	15			
		3 Drug discovery	15			
		4 Clinical trials	15			
<b>2</b>	<b>PS-SMB-302  Environmental Microbiology</b>	1 Microbial Diversity	15	60 L	4	100 (60+40)
		2 Extremophiles	15			
		3 Measurement of Microbial activity in Environmental sample and pure culture	15			
		4 Biofilms	15			
<b>3</b>	<b>PS-SMB-303 Advances In Biotechnology-I</b>	1 Enzyme Purification, Immobilization and Protein Engineering	15	60 L	4	100 (60+40)
		2 Medical Biotechnology	15			
		3 Nanobiotechnology	15			
		4 Applied Biotechnology	15			
<b>4</b>	<b>PS-SMB-304 Research Methodology &amp; Biostatistics</b>	1 Research Methodology I	15	60 L	4	100 (60+40)
		2 Research Methodology II	15			
		3 Biostatistics	15			
		4 Scientific Communication	15			
<b>5</b>	<b>PS-SMB-1P1</b>	1 Practicals based on PS-SMB -301	4	60x2=120 lectures per batch	4	100 (80+10 +10)
<b>6</b>	<b>PS-SMB-1P2</b>	2 Practicals based on PS-SMB -302	4			
<b>7</b>	<b>PS-SMB-1P3</b>	1 Practicals based on PS-SMB -303	4	60x2= 120 lectures per batch	4	100 (80+10 +10)
<b>8</b>	<b>PS-SMB-1P34</b>	2 Practicals based on PS-SMB -304 (Minor Project)	4			
<b>TOTAL</b>					<b>24</b>	<b>600</b>

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination, PA-Project Assessment, AT- Attendance

### Part-3 Detailed Scheme Theory

**Curriculum Topics along with Self-Learning topics** - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

#### **Course Code: PS-SMB-301 (Food, Pharmaceutical and Cosmetic Microbiology)**

Unit	Topic	Credits	Lectures
1	<b>Food microbiology</b>	01	15
	1.1 Starter culture of bacteria, yeast & mold used in food fermentation [1L]  1.2 Fermented Foods [5L] 1.2.1 General methods of fermented food production and fermented foods of Indian Origin 1.2.2 Fermented cereals 1.2.3 Fermented vegetables 1.2.4 Production of microbial flavouring compounds  1.3 Prebiotic & Probiotic [3L] 1.3.1 Probiotics 1.3.2 Screening of Potential Probiotics 1.3.3 Industrial Aspects of Probiotic Production 1.3.4 Prebiotics  1.4 Food Preservation & Food safety [4L] 1.4.1 Advanced methods of food preservation 1.4.2 Advanced methods of detection of microorganisms in food  1.5 Controlling quality of food [2L] Control at Source, Codes of Good Manufacturing Practice, The Hazard Analysis and Critical Control Point (HACCP) Concept Quality Systems: BS 5750 and ISO 9000 Series Risk Analysis		
2	<b>Cosmetic Microbiology</b>	01	15
	2.1 History of Cosmetic Microbiology, Preservation of cosmetics [3L]  2.2 Antimicrobial preservative efficacy & microbial content testing [3L]  2.3 Microbiology Laboratory methods in support of sterility Assurance System [2L]		

	<p>2.4 Bioburden testing &amp; Environmental monitoring [2L]</p> <p>2.5 Sampling: Principles and Practice [2L]</p> <p>2.6 Global regulations &amp; toxicological aspects [3L]</p>		
3	<b>Drug Discovery</b>	01	15
	<p>3.1 Drug discovery [4L]</p> <p>3.1.1 Steps involved in drug discovery</p> <p>3.1.2 Production and characterization</p> <p>3.1.3 Preclinical studies and Validation studies</p> <p>3.2 Computer-aided drug designing and docking [7L]</p> <p>3.2.1 General Principles of CADD</p> <p>3.2.2 Types of drug designing</p> <p>3.2.3 Ligand-based molecular interactions</p> <p>3.2.4 Structure-based Drug designing</p> <p>3.2.5 Examples of Ligand and structure-based drug designing</p> <p>3.2.6 Applications and importance of CADD</p> <p>3.3 Principles of pharmacokinetics and pharmacodynamics [4L]</p> <p>3.3.1 Intestinal absorption</p> <p>3.3.2 Metabolic stability</p> <p>3.3.3 Drug-drug interactions</p> <p>3.3.4 Plasma protein binding assays</p> <p>3.3.5 Metabolite profile studies</p>		
4	<b>Clinical trials</b>	01	15
	<p>4.1 Introduction to clinical trials [3L]</p> <p>4.2 Types of clinical trials – single blinding, double blinding, open access, randomised trials with examples [5L]</p> <p>4.3 Interventional study [1L]</p> <p>4.4 Ethics committee and its members – Institution ethics/independent ethics [4L]</p> <p>4.5 Cross over designs [2L]</p>		

**Self-Learning topics (Unit wise)**

<b>Unit</b>	<b>Topics</b>
1	Fermented Foods
1	Advanced methods of food preservation
3	Drug discovery
4	Introduction to clinical trials Ethics committee

**Online Resources****Online module: Fermented Foods (Unit 1)**

[https://onlinecourses.nptel.ac.in/noc20\\_ag02/preview](https://onlinecourses.nptel.ac.in/noc20_ag02/preview)

[https://onlinecourses.nptel.ac.in/noc19\\_ag05/preview](https://onlinecourses.nptel.ac.in/noc19_ag05/preview)

**Online module: Advanced methods of food preservation (Unit 1)**

<https://nptel.ac.in/courses/126/105/126105011/>

**Online module: Drug development process (Unit 3)**

<https://nptel.ac.in/courses/127/106/127106137/>

**Online module: Clinical trials (Unit 4)**

<https://nptel.ac.in/courses/127/106/127106137/>



**Course Code:PS-SMB-302 (Environmental Microbiology)**

<b>Unit</b>	<b>Topic</b>	<b>Credits</b>	<b>Lectures</b>
1	<b>Microbial Diversity</b>	01	15
	1.1 Microbial Communities[1L] 1.2 Microbial Diversity in Natural Systems (Soil and Ocean environment) [1L] 1.3 Environmental Factors that Impact Microbial Diversity[1L] 1.4 Functional Diversity and the Resilience of Bacterial Communities [1L] 1.5 Microbial Diversity and Natural Products [1L] 1.6 Obtaining Microbial Nucleic Acids from the Environment [1L] 1.7 Nucleic acid-based methods of analysis [2L] 1.8 Gene Probes and Probing [3L] 1.8.1 Colony Hybridization or Lifts 1.8.2 FISH 1.8.3 Phyloarray 1.9 Reporter Genes [1L] 1.10 Overview of Bioinformatics Tools for Microbial Diversity Analysis [1L] 1.11 Identification of Uncultivated Organisms [2L]		
2	<b>Extremophiles</b>	01	15
	2.1 Physiology, Biochemistry and Applications of [6L] 2.1.1 Thermophiles 2.1.2 Psychrophiles 2.1.3 Piezophiles 2.1.4 Radiation resistant organisms 2.2 Physiology, Biochemistry and Applications of [6L] 2.2.1 Acidophiles 2.2.2 Alkaliphiles 2.2.3 Halophiles 2.3 Geo Microbiology- Bio corrosion and Bioleaching [3L]		

3	<b>Measurement of Microbial activity in Environmental sample and pure culture</b>	01	15
	<p>3.1 Choosing the Appropriate Activity Measurement for Environmental Samples[1L]</p> <p>3.2 Carbon Respiration [7L]</p> <p>3.2.1 Measurement of Respiratory Gases, CO<sub>2</sub> and O<sub>2</sub>, in Laboratory and Field Studies</p> <p>3.2.2 The Application of Respiration Measurements in Environmental Microbiology</p> <p>3.2.3 Tracer Studies to Determine Heterotrophic Potential</p> <p>3.2.4 Anaerobic Respiration as an Indicator of Microbial Activity</p> <p>3.3 Incorporation of Radiolabelled Tracers into Cellular Macromolecules[8L]</p> <p>3.3.1 Incorporation of Thymidine into DNA</p> <p>3.3.2 Incorporation of Leucine into Protein</p> <p>3.3.3 Adenylate Energy Charge</p> <p>3.3.4 Enzyme Assays</p> <p>3.3.5 Dehydrogenase Assay</p> <p>3.3.6 Stable Isotope Probing</p>		
4	<b>Biofilms</b>	01	15
	<p>4.1 Structure and properties of biofilms. [1L]</p> <p>4.2 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. [3L]</p> <p>4.3 Study of Quorum Sensing: Cell-Cell Communication amongst bacteria, and its similarity with <i>M. xanthus</i> Fruiting Body Development. [2L]</p> <p>4.4 Multispecies biofilms: Clinical Relevance. [1L]</p> <p>4.5 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). [2L]</p> <p>4.6 Biofilm eradication: Methods and commonly used biocides such as surfactants, enzymes, triclosan, chlorhexidine,</p>		

	<p>quaternary ammonium compounds. [1L]</p> <p>4.7 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 (e.g., dental plaque). [1L]</p> <p>4.8 Disadvantages of biofilm management strategies development of resistant strains-cross resistance induction. [1L]</p> <p>4.9 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. [2L]</p> <p>4.10 Fungal biofilms. [1L]</p>			
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#### Self-Learning topics (Unit wise)

Unit	Topics
1	Data analysis, Culture based and culture independent tools
1	Bioinformatics Tools,
3	Isotope labelling
4	Formation of biofilm: Maturation of the Biofilm & Quorum sensing

Online Resources
<p><b>Online module:</b> Techniques in Environmental Microbiology (Unit7-1,2 lecture)  <a href="https://nptel.ac.in/courses/105/107/105107173/">https://nptel.ac.in/courses/105/107/105107173/</a> (Unit-1)</p> <p><b>Online module:</b> Bioinformatic tools used in Applied Environmental Microbiology  Unit12(1-5 lectures) <a href="https://nptel.ac.in/courses/105/107/105107173/">https://nptel.ac.in/courses/105/107/105107173/</a> (Unit-1)</p> <p><b>Online module:</b> Quantitative Proteomics: Stable Isotope Labeling by Amino Acids (Mod  24,Lec 24) <a href="https://www.youtube.com/watch?v=Vr25UzsucpY">https://www.youtube.com/watch?v=Vr25UzsucpY</a> (Unit-3)</p> <p><b>Online module :</b> Biofilms (Lec 10-11) <a href="https://nptel.ac.in/courses/102/106/102106057/">https://nptel.ac.in/courses/102/106/102106057/</a> (Unit  4)</p>

**Course Code:PS-SMB-303 (Advances in Biotechnology-I)**

<b>Unit</b>	<b>Topic</b>	<b>Credits</b>	<b>Lectures</b>
1	<b>Enzyme Purification, Immobilization and Protein Engineering</b>	01	15
	<p>1.1 Enzyme Extraction and Purification [7L]            1.1.1 General methods of extraction            1.1.2 Purification methods and determination of purity (based on Solubility, Molecular weight, Charge): pH, Salting out, solvent precipitation, molecular exclusion chromatography, PAGE, SDS-PAGE, western blotting, Ion exchange, chromatography, isoelectric focussing, 2-D gel electrophoresis, Affinity chromatography, Dye ligand chromatography</p> <p>1.2 Immobilization techniques [3L]            1.2.1 Whole cell and enzyme immobilization, Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries.            1.2.2 Kinetics of immobilized enzymes</p> <p>1.3 Protein engineering [5L]            1.3.1 Adding disulphide bonds            1.3.2 Changing asparagine to other amino acids            1.3.3 Reducing the number of free sulphhydryl residues            1.3.4 Increasing enzymatic activity, modifying metal cofactor requirement            1.3.5 Decreasing protease sensitivity            1.3.6 Modifying protein specificity            1.3.7 Increasing enzyme stability and specificity</p>		
2	<b>Medical Biotechnology</b>	01	15
	<p>2.1 Genetic Testing of diseases and disorders- Sickle Cell Anaemia, Cystic Fibrosis, Prenatal diagnosis; Genetic Counselling [3L]</p> <p>2.2 Use of monoclonal antibodies in diagnostics: RA, Blood grouping [1L]</p> <p>2.3 Protein therapeutics: Hormones, cytokines, Monoclonal antibodies, regenerative medicines, molecular diagnostics, NAS as therapeutic agents, Vaccines [4L]</p> <p>2.4 Advanced techniques in Molecular biotechnology implications in medical diagnostics and gene therapy- vectors, gene targeting and tissue-specific expression, Anti- sense Technology, Cre-lox system and CRISPR-Cas9 for gene modification [6L]</p>		

	2.5 Synthetic Biology: Concept and Applications [1L]		
3	<b>Nanobiotechnology</b>	01	15
	<p>3.1 Basics of Nanotechnology - Types of nanomaterials - Properties of nanomaterials [1L]</p> <p>3.2 Fundamentals of Bio – nanotechnology [5L]  3.2.1 nanomotors of biological systems- ATP synthase: a nanoturbine  3.2.2 Flagellar motors in bacteria-Linear molecular motors</p> <p>3.3 Biosynthesis of nanomaterials biosystems as nano factories [3L]  3.3.1 Bacteria as machinery for synthesis of nano metals - gold, silver, Zinc, cadmium, platinum  3.3.2 Fungi and Actinomycetes as fabricators of nano metals  3.3.3 Plants as nano engineers - Algae as nanotechnologists</p> <p>3.4 Applications of nanotechnology – Nanomedicine, nano bio - devices, nano implants, applications in agriculture, food and cosmetics [3L]</p> <p>3.5 Nanoparticulate carrier systems, Micro and Nanofluidics [3L]</p>		
4	<b>Applied Biotechnology</b>	01	15
	<p>4.1 Bioremediation [6L]  4.1.1 Introduction to Bioremediation strategies for synthetic compounds, petrochemicals, inorganic waste.  4.1.2 Bioremediation of metals &amp; gaseous ex situ. Environment modification for bioremediation  4.1.3 Approaches to bioremediation: Microbial seeding &amp; bioengineering using rDNA technology</p> <p>4.2 Biosensors [1L]</p> <p>4.3 Bioleaching and Enhanced oil recovery [2L]</p> <p>4.4 Biofuels [1L]</p> <p>4.5 Biopolymers, microbial concrete [1L]</p> <p>4.6 Bio surfactants [1L]</p> <p>4.7 Sustainable development [3L]</p>		

	4.7.1 Definition, goals and Principles 4.7.2 Environmental management and innovation strategies for sustainable development		
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#### Self-Learning topics (Unit wise)

Unit	Topics
1	General Methods of Enzyme Extraction
2	Gene Therapy
3	Applications of Nanotechnology
4	Sustainable development

#### Online Resources

**Online module:** General Methods of Enzyme Extraction

[https://www.swayamprabha.gov.in/index.php/module\\_details](https://www.swayamprabha.gov.in/index.php/module_details) (Unit 1)

<https://www.youtube.com/watch?v=CfLNWNUv1Uo>

**Online module:** Gene Therapy

<https://nptel.ac.in/courses/102/103/102103041/> (Unit 2)

**Online module:** Applications of nanotechnology

<https://nptel.ac.in/courses/102/107/102107058/> (Unit 3)

**Online module:** Sustainable Development

[https://www.youtube.com/watch?v=uPo9\\_cecNuI](https://www.youtube.com/watch?v=uPo9_cecNuI)

<https://www.youtube.com/watch?v=A9PGRnkLubE> (Unit 4)

**Course Code:PS-SMB-304 (Research Methodology & Biostatistics)**

<b>Unit</b>	<b>Topic</b>	<b>Credits</b>	<b>Lectures</b>
1	<b>Research Methodology-I</b>	01	15
	<p>1.1. Foundations of Research [3L] Objectives of Research, Motivations in Research, types of Research, Research Approaches, Significance of Research, Variables-nominal, ordinal, discontinuous, continuous, derived</p> <p>1.2. Research Design [8L] Concept and Importance in Research – Features of a good research design -Basic, applied, historical, exploratory, experimental, Case study, diagnostic research, Crossover design, case control design, cohort study design, multifactorial design.</p> <p>1.3. Problem Identification &amp; Formulation [4L] Research Question, Formulation of hypothesis, Hypothesis Testing-Null Hypothesis &amp; Alternative Hypothesis, Level of significance, p value.</p>		
2	<b>Research Methodology-II</b>	01	15
	<p>2.1. Qualitative and Quantitative Research [2L]</p> <p>2.2. Data Collection [7L] 2.2.1. Types of data, Selection of appropriate method for data collection 2.2.2. Collection of Primary Data - observation, experimentations, questionnaires, interviews, case study, pilot study 2.2.3. Collection of Secondary Data - internal, external, schedule method, Use of computers in data collection 2.2.4. Graphical representation of Data</p> <p>2.3. Sampling and Sampling Errors [6L] 2.3.1. Concepts of Population, Sample Size, Characteristics of a good sample. 2.3.2. Types of samplings - Random Sampling-Simple random sampling, systematic sampling, stratified random sampling, cluster sampling 2.3.3. Non random sampling 2.3.4. Sampling Errors</p>		

3	<b>Biostatistics</b>	01	15
	<p>3.1. Overview of Descriptive Statistics [2L] Standard Normal distribution, Measures of central Tendency (Mean, median, Mode), Measures of dispersion (range, mean deviation, standard deviation)</p> <p>3.2. Correlation &amp; Regression analysis [3L] Types of Correlation, Degree of Correlation, Linear Regression Analysis Regression Lines &amp; Regression Equations</p> <p>3.3. Chi Square test [1L]</p> <p>3.4. Level of Significance, one tailed &amp; two tailed test Concept of Standard error [1L]</p> <p>3.5. Comparison of means [4L] 3.5.1. Parametric tests - F-test (Testing equality of variance), For 2 samples - t test, z test. For 3 or more samples -ANOVA, Post Hoc tests. 3.5.2. Non-Parametric tests [3L] Wilcoxon, and Mann-Whitney test, Kruskal-Wallis.</p> <p>3.6. Use of statistical softwares (SPSS, Jamovi) [1L]</p>		
4	<b>Scientific Communication</b>	01	15
	<p>4.1. Report writing and presentations [5L] Types of research reports, guidelines for writing a report, report format, appendices, poster and oral presentations.</p> <p>4.2. Writing a research/review article [5L] Layout of a Research Paper, writing a review, Bibliography and referencing, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism</p> <p>4.3. Use of tools /techniques for Research [5L] Referencing methods and tools - reference Management Softwares (e.g.Mendeley), Softwares for paper formatting, Software for detection of Plagiarism.</p>		



### Self-Learning topics (Unit wise)

Unit	Topics
1	Research Methodology - Survey Research - (Ch-26 State Open Universities programs [IGNOU])
3	Introduction to biostatistics - Testing of hypothesis - Type I and II error (lecture 34) [NPTEL]
4	Introduction To Professional Scientific Communication- Scientific hypothesis and abstract writing [NPTEL]

### Online Resources

**Online module:** Research Methodology-I

<https://www.youtube.com/embed/U043zAgjGUI> (Unit 1)

**Online module:** Biostatistics

<https://nptel.ac.in/courses/102/101/102101056/>

<https://www.youtube.com/watch?v=g9SJfZ-iqcI> (Unit 3)

**Online module:** Scientific Communication

<https://nptel.ac.in/courses/102/104/102104061/#>

<https://www.youtube.com/watch?v=y1sxuhTO-54> (Unit 4)

## Part 4: Detailed scheme Practicals

### Course Code:PS-SMB-3P1

1	Isolation & Characterization of organisms with probiotic potential from food samples.
2	Effect of several prebiotic agents on growth of probiotic cultures
3	Preparation of fermented pickle and Microbiological analysis
4	Preservative efficacy test as per ISO 11930
5	Bio burden test
6	Quality control of microbial content of cosmetics as per IS 14648:2011 wrt to heterotrophic count, presence of <i>Pseudomonas</i> sps, <i>Staphylococci</i> sps & <i>P.acne</i>
7	Assignment: Report on a completed clinical trial (Reference: <a href="https://clinicaltrials.gov/ct2/home">https://clinicaltrials.gov/ct2/home</a> )

### Course Code:PS-SMB-3P2

1	Case study/Review/Report: Bioinformatics Tools used for Microbial Diversity Analysis
2	Isolation and characterization of thermophiles and thermotolerant organisms from hot spring water samples.
3	Screening of Halophilic bacteria from salt pans and identification of an isolate by conventional biochemical as well as by VITEK systems
4	Extraction of membrane lipids of halophilic archaea and its detection by TLC
5	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 environments).
6	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
7	Extraction of DNA from soil and checking its purity using agarose electrophoresis and UV 260/280 ratio

**Course Code:PS-SMB-3P3**

1	Isolation and purification of protease
2	Removal of blood stains by using proteases/detergents.
3	Residual starch degradation by amylase
4	Visit to a Genetic testing Laboratory
5	Restriction Fragment Length Polymorphism for diagnosis of genetic disease (Demonstration)
6	Diagnosis of Rheumatoid Arthritis
7	Preparation and characterization of Silver Nanoparticles
8	Survival Curve and antibacterial activity of nano silver particles
9	Study of nano silver coated gauze / textiles for antimicrobial effect on different bacteria.
10	Isolation of biopolymer producing bacteria and quantify the biopolymer produced

**Course Code:PS-SMB-3P4**

1	Writing Research Project Proposal
2	Short survey - result and interpretation using statistical software
3	Writing review article

### MSc Part II Semester IV- Units – Topics – Teaching Hours

S. N	Subject Code	Subject Unit Title	Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	<b>PS-SMB -401</b>  <b>Advances in Biotechnology-II</b>	1 Plant Biotechnology	15	60 L	4	100  (60+40)
		2 Agricultural Biotechnology	15			
		3 Animal Biotechnology	15			
		4 Algal and Fungal Biotechnology	15			
2	<b>PS-SMB -402</b>  <b>Environmental &amp; Natural Resource Management &amp; Safety Standards</b>	1 Environmental and Natural Resource Management and safety standards	15	60 L	4	100  (60+40)
		2 Solid and Hazardous Waste Management	15			
		3 Marine resource Management	15			
		4 Biohazards and Biosafety	15			
3	<b>PS-SMB -403</b>  <b>Biotechnological Advancement and Entrepreneurship</b>	1 Bioinformatics	15	60 L	4	100  (60+40)
		2 IPR and Bioethics	15			
		3 Instrumentation	15			
		4 Entrepreneurship	15			
4	<b>PS-SMB -404</b>	Internship and Project			4	100  (60+40)
5	<b>PS-SMB -4P1</b>	1 Practicals based on PS-SMB -401	4	60 x2= 120 lectures per batch	2	100  (80+10 +10)
	<b>PS-SMB -4P2</b>	2 Practicals based on PS-SMB -402	4			
6	<b>PS-SMB -4P3</b>	1 Practicals based on PS-SMB -403 Major project	4	60 x2= 120 lectures per batch	2	
	<b>PS-SMB -4P4</b>	2 Project Report and presentation Major project	4			
<b>TOTAL</b>					24	600

**L:** Lecture: **Tutorials** **P:** Practical **Ct-Core Theory, Cp-Core Practical, SLE-** Self learning evaluation **CT-Commutative Test, SEE-** Semester End Examination , **PA-Project Assessment, AT-** Attendance

## Part 6: Detail Scheme Theory

### Semester – IV      Units – Topics – Teaching Hours

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective Unit

#### Course Code:PS-SMB-401(Advances in Biotechnology- II)

Unit	Topic	Credits	Lectures
<b>1</b>	<b>Plant Biotechnology</b>	01	15
	1.1 Applications of Genetically engineered plants [7L] 1.1.1. Resistance to biotic and abiotic stress: Insect resistance: Increasing expression of the <i>B.thuringiensis</i> protoxin, other strategies for protecting plants against insects, Virus resistance, Herbicide resistance, fungus and bacterium resistance, Oxidative stress, Salt and drought stress, Fruit ripening and Flower wilting 1.1.2 Improvement in plant quality and proteins. 1.1.3 Modification of plant nutritional content, Modification of plant taste and appearance 1.1.4 Plants as bioreactors, edible vaccines  1.2 Genetic engineering of Plants [8L] 1.2.1 Plant transformation with T DNA 1.2.2 Physical methods of transferring genes to plants 1.2.3 Plant genes cloning by using transposable elements, Use of reporter genes in transformed plant cells, Use of virus vectors for whole plants,  1.2.4 Manipulation of gene expression in plants: Gene targeting, Facilitating protein purification: Oleosins, Rhizosecretion, Glycosylation		
<b>2</b>	<b>Agricultural Biotechnology</b>	01	15
	2.1 Introduction to Bioaugmentation and		

	<p>Biostimulation [1L]</p> <p>2.2 Bio -intensive Nutrient Management, Use of Biofertilizers: Rhizobium, blue green algae, phosphate solubilizers, Mycorrhiza [2L]</p> <p>2.3 Organic Farming and scope of organic farming in India [1L]</p> <p>2.4 Biological control of Pests: Biological Control agent and its mechanism [2L]</p> <p>2.5 Induced systemic resistance in Biocontrol of Plant diseases [3L]</p> <p>2.5.1 Induction of systemic resistance by Pseudomonas, Bacillus, Tricoderma, Fungi and others</p> <p>2.5.2 Mechanism of Induced systemic resistance</p> <p>2.6 Microbial control strategies: Postharvest diseases of Fruits, Vegetables, Roots and Tubers [6L]</p> <p>2.6.1 Mode of action of biocontrol agents</p> <p>2.6.2 Extensive of use of biocontrol agents</p> <p>2.6.3 Enhancing biocontrol efficacy of Microbial Antagonist</p> <p>2.6.4 Biotechnological Approach</p>		
<b>3</b>	<b>Animal Biotechnology</b>	<b>01</b>	<b>15</b>
	<p>3.1. Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines [1L]</p> <p>3.2. Scale up, Cryopreservation, Culture Collections [2L]</p> <p>3.3. Risks and Safety, Bioethics [1L]</p> <p>3.4. Stem Cell Technology, Cloning techniques and Applications [2L]</p> <p>3.5. Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish [3L]</p> <p>3.6. Applications: Transgenic mice: [5L]</p> <p>3.6.1 Retroviral method</p> <p>3.6.2 DNA microinjection method</p> <p>3.6.3 Engineered Embryonic Stem cell method</p> <p>3. 7 Tissue Engineering, Methods of Synthesis,</p>		

	Biomolecular Engineering[2L]		
<b>4</b>	<b>Algal and Fungal Biotechnology</b>	01	15
	<p>4.1 Algal Biotechnology</p> <p>4.1.1 Culture techniques and media for growth of fresh water algae: Measurement of algal growth in culture - lag phase, log phase, stationary phase and death phase using biomass, chlorophyll content, Measurement of algal pigments. [3L]</p> <p>4.1.2 Culturing microalgae in Photobioreactors, Fermentor and Outdoor ponds: Variation in design, culture conditions, scale up, economics, advantages and disadvantages [3L]</p> <p>4.1.3 Applications of Algal Biotechnology: Food Supplements and fertilizers, Bioactive compounds and cosmetics, Biofuel, high value commercial products, Bioplastics [2L]</p> <p>4.2 Fungal Technology</p> <p>4.2.1 Introduction to Fungal Technology[1L]</p> <p>4.2.2 Fungal Pigments and Mycotoxins [2L]</p> <p>4.2.3Fungal siderophores – structure, function and applications [2L]</p> <p>4.2.4 Fungal Lipid production- Oleaginous fungi, Lipid production from lignocelluloses and crude glycerol [2L]</p>		

**Self-Learning topics (Unit wise)**

<b>Unit</b>	<b>Topics</b>
1	Plant Transformation by T DNA
2	Biological Control of pest
3	Tissue Engineering
4	Applications of Algal Biotechnology

**Online Resources**

**Online module:** Plant Transformation by T DNA  
<https://www.youtube.com/watch?v=xbHK44TglR0> (Unit 1)

**Online module:** Biological Control of pest  
<https://nptel.ac.in/courses/102/103/102103074/>  
<https://www.youtube.com/watch?v=3oGrVSTJa8I> (Unit 2)

**Online module:** Tissue Engineering  
<https://nptel.ac.in/courses/102/106/102106081/>  
<https://www.youtube.com/watch?v=bgRjFW5agvA> (Unit 3)

**Online module:** Applications of Algal Biotechnology  
[https://onlinecourses.nptel.ac.in/noc19\\_bt20/preview](https://onlinecourses.nptel.ac.in/noc19_bt20/preview) (Unit 4)



**Course Code: PS-SMB-402 (Environmental & Natural Resource Management  
& Safety Standards)**

<b>Unit</b>	<b>Topic</b>	<b>Credits</b>	<b>Lectures</b>
1	<b>Natural Resources and Environmental Impact Assessment and Audit</b>	01	15
	<p>1.1 Natural resources: [4L]            1.1.1 Renewable/ non-renewable. Land, water, forest, minerals, energy, food.            1.1.2 Associated problems and management practices.</p> <p>1.2 Environmental Impact Assessment and Sustainable Development [7L]            1.2.1 Environmental impact assessment in India            1.2.2 Elements of an Environmental Impact Assessment report            1.2.3 Project Description            1.2.4 Baseline Data Analysis            1.2.5 Anticipated Impacts and Mitigation Measures            1.2.6 Environmental Monitoring Program            1.2.7 Risk Analysis and Disaster Management Plan            1.2.8 Environmental Management Plan (EMP)</p> <p>1.3 Environmental Audit [5L]            1.3.1 Definition &amp; principle element of an environmental audit            1.3.2 Components of auditing            1.3.3 Audit process            1.3.4 Environmental audit report            1.3.5 Waste audit.</p>		

2	<b>Solid and Hazardous Waste Management</b>	01	15
	<p>2.1 Solid waste Management [05L]  2.1.1 Introduction  2.1.2 Solid Waste and Its Composition  2.1.3 Typical Issues in Solid Waste Management  2.1.4 Methods of Waste Disposal  2.1.5 Green Productivity of Solid Waste</p> <p>2.2 Hazardous Waste Management [07L]  2.2.1. Definition  2.2.2. Commonly Used Terms in Hazardous Waste Management  2.2.3. Effect On Health  2.2.4. Sampling And Analysis of Hazardous Waste  2.2.5. Treatment, Storage, And Disposal Facilities  2.2.6. Creation Of Treatment, Storage, And Disposal Facilities  2.2.7. Design Of Landfill  2.2.8. Operation  2.2.9. Post-Monitoring  2.2.10. Safety And Occupational Hygiene</p> <p>2.3 Biomedical and electronic waste management, recovery of precious metals from electronic waste resources. [03L]</p>		
3	<b>Marine Resource Management</b>	01	15
	<p>3.1 Diversity of microbes in the marine environment [2L]</p> <p>3.2 Tools to study marine microbial diversity: flow cytometry, molecular approaches - metagenomics and community fingerprinting [3L]</p> <p>3.3 Marine Biofouling and Biodeterioration [2L]</p> <p>3.4 Marine Pollution- sewage, oil and chemical pollution [2L]</p> <p>3.5 Applications of marine microbes in : [6L]  Enzymes, polymers, Microalgal culture, pharmaceutical and biomedical products, food industry, biomimetics, nanotechnology and bioelectronics.</p>		

4	<b>Biohazards and Biosafety</b>	01	15
	<p>4.1 Biohazards: [7L]</p> <p>4.1.1 Introduction</p> <p>4.1.2 Levels of biohazards,</p> <p>4.1.3 Risk assessment in Industries and Laboratories, proper cleaning procedures</p> <p>4.2 Biosafety: [8L]</p> <p>4.2.1 Historical background and introduction need of biosafety levels,</p> <p>4.2.2 Biosafety guidelines for GMOs and LMOs.</p> <p>4.2.3 Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs.</p> <p>4.2.4 Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS).</p> <p>4.2.5 Biosafety in laboratories (Microbiological, Biomedical).</p>		

### Self-Learning topics (Unit wise)

Unit	Topics
1	Non renewable Energy sources
2	Electronic waste management
2	Biomedical waste management
3	Marine pollution (plastic and oil spills)
4	Risk assessment in industries

### Online Resources

**Online module:** Week 1(lecture 1-5),Week-3(lecture 11-15)

<https://nptel.ac.in/courses/105/105/105105169/> (Unit2)

**Online module:** Biomedical Waste Management

<https://dth.ac.in/medical/courses/Microbiology/block-9/3/index.php> (Unit2)

**Online module:** Oil spills (lecture4) <https://nptel.ac.in/courses/114/106/114106042/>

Impact of Plastic Pollution on Marine Life Week -5 (21-25)

<https://nptel.ac.in/courses/105/105/105105184/> (Unit3)

**Online module:** Conventional Sources of Energy: Lec3

<https://nptel.ac.in/courses/121/106/121106014/> (Unit-1)

**Online module:** Safety reviews and Risk assessment I & II : (Lec 39-40)

<https://nptel.ac.in/courses/103/107/103107156/> (Unit-4)

**Course Code:PS-SMB-403 (Biotechnological Advancement and Entrepreneurship)**

Unit	Topic	Credits	Lectures
1	<b>Bioinformatics</b>	01	15
	<p>1.1 Sequence alignment – [8L]            1.1.1 Pairwise alignment- NEEDLEMAN and Wunch algorithm, Smith Waterman, Scoring Matrices            1.1.2 Multiple alignment – CLUSTAL, PRAS; BLAST, FASTA, Homology, phylogeny and evolutionary trees, Phylogenetic Tree Construction Methods</p> <p>1.2 Genome Information Resources: DNA Sequence Databases Specialized Genomic Resources. [2L]</p> <p>1.3 Protein Databases based on Composition, Motifs and Patterns. Protein Structure Visualization Software [3L]</p> <p>1.4 Pharmacogenomics [2L]</p>		
2	<b>IPR and Bioethics</b>	01	15
	<p>2.1 IPR and its different types [8L]            2.1.1 Patents - Requirements for Patentability, Novelty, subject matter, invention, industrial applicability            2.1.2 Implications of patents in biotechnology Chakraborty case, corn genetically engineered with an insecticide            2.1.3 Case studies- basmati rice, turmeric and neem</p> <p>2.2 Bioethics [7L]            2.2.1 Ethical issues and perspectives in the discipline of Microbiology            2.2.2 Ethics perspectives from India            2.2.3 Bioethics, bioweapons and the microbiologist            2.2.4 Ethical guidelines for biomedical research on human subjects            2.2.5 Public Perception of biotechnology: Genetic engineering- safety, social, moral and ethical considerations</p>		

3	<b>Instrumentation</b>	01	15
	<p>3.1 Advanced Microscopy [5L]</p> <p>3.1.1 Cryo-electron microscopy, Scanning tunnelling microscope (STM), magnetic force microscope (MFM), Scanning near field microscope (SNOM)</p> <p>3.1.2 Advanced Fluorescence Microscopy techniques: Fluorescence Lifetime imaging microscopy (FLIM), Fluorescence Correlation Spectroscopy (FCS)</p> <p>3.2 Biophysical Techniques [4L]:</p> <p>3.2.1 NMR and FTIR spectroscopy</p> <p>3.2.2 Electrophysiology Patch Clamp and Voltage – Clamp techniques for measuring membrane potential.</p> <p>3.2.3 Geiger-Mueller Counter, Scintillation Counters</p> <p>3.3 Current chromatographic techniques: HPTLC, Supercritical Fluid chromatography and Hyphenated techniques [3L]</p> <p>3.4 Molecular Diagnostic techniques [2L]</p> <p>3.5 Biosensors and Ion selective electrodes [1L]</p>		
4	<b>Entrepreneurship</b>	01	15
	<p>4.1 Concept of Entrepreneur [1L]</p> <p>4.2 Essentials of a Successful Entrepreneur [1L]</p> <p>4.3 Role of Government and Financial Institutions in Entrepreneurship Development [1L]</p> <p>4.4 Preparing a Business Plan [2L]</p> <p>4.5. Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property and marketing the new venture [2L]</p> <p>4.6 Financing the New Venture: Importance of new venture financing, types of ownership securities,</p>		

	<p>venture capital, types of debt securities, determining ideal debt-equity mix, financial institutions and banks [3L]</p> <p>4.7 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. [3L]</p> <p>4.8 Marketing Plan for an Entrepreneur[2L]</p>		
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### Self-Learning topics (Unit wise)

Unit	Topics
1	Pairwise sequence alignment and scoring matrices
2	Overview of bioethical issues
3	Advanced Fluorescence Microscopy techniques
3	NMR spectroscopy
3	Geiger-Mueller Counter, Scintillation Counters
4	Marketing Plan for an Entrepreneur

### Online Resources

**Online module:** <https://nptel.ac.in/courses/102/106/102106065/> Week 3 (lectures 14-20)

**Online module: Overview of bioethical issues (Unit 2)**

<https://nptel.ac.in/courses/109/106/109106092/>

**Online module: NMR spectroscopy (Unit 2)**

<https://nptel.ac.in/courses/104/108/104108078/>

**Online module: Advanced Fluorescence Microscopy techniques (Unit 2)**

<https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-cy14/>

**Online module: Geiger-Mueller Counter, Scintillation Counters (Unit 2)**

nptelhrd <https://www.youtube.com/watch?v=ww5xpqv0yHs>

**Online module: Marketing Plan for start-up Week-3 (lectures 11-15)**

<https://nptel.ac.in/courses/127/105/127105007/> (Unit4)

**Course Code: PS-SMB-404 Internship and projects (4 CREDITS)**



## Part 7: Detailed scheme Practicals

### Course Code: PS-SMB- 4P1

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 and hemocytometer count
5	Preparation of growth culture medium for fresh water algae and study its diversity with respect to its type count and morphology.
6	Counting algal cells in cultures with the Light Microscope.
7	Isolation, inoculation and growth of microalgae
8	Plant tissue culture –callus initiation

### Course Code: PS-SMB-4P2

1	Isolation and identification of pigment producing bacteria from marine environment and extraction of pigments through solvent extraction procedure.
2	Enrichment and isolation of Agarase producing bacteria.
3	Problems/ Assignment on Biohazards and biosafety or Case study : EIA report of a polluted ecosystem
4	Assignment on Waste Management/Handling
5	Study tour/ academic visit to any large-scale industry (environmental health and safety aspects) Food/ Pharma/chemical, environmental consultancy, research centres

**Course Code: PS-SMB-4P3**

1.	Use of NCBI BLAST Tool.
2.	Pairwise and Multiple Sequence Alignment and Phylogeny using Bioedit
3.	Classification of Proteins using CATH/SCOP.
4.	Visualization PDB Molecules using SPDBV
5	Molecular modeling and drug designing using Arguslab
6.	Case study on IPR
7.	Virtual lab exercise to understand the instrumentation, experimentation and interpretation of data obtained using HPTLC, FTIR, STM, and NMR
8.	Assignment/case studies on preparing business plan/marketing strategies

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