John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the
UNIVERSITY OF MUMBAI

Syllabus for M.Sc. Part 2

Program: M.Sc.

Program Code: WPSMIC

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

Based on the National Education Policy 2020

PROGRAM OUTLINE 2024-2025

YEAR	SEM	COURSE CODE		COURSE TITLE	CREDITS
MSc Part 2	III	WPSMICMT631	Mandatory 1	MOLECULAR BIOLOGY AND POPULATION GENETICS	4
		WPSMICMT632	Mandatory 2	EPIDEMIOLOGY OF MICROBIAL DISEASES, ADVANCES IN MEDICAL MICROBIOLOGY & IMMUNOLOGY	4
		WPSMICMT633	Mandatory 3	ADVANCED VIROLOGY	4
		WPSMICMP634	Mandatory 4 Practical	TECHNIQUES IN IMMUNOLOGY AND MOLECULAR BIOLOGY	2
		WPSMICET631 WPSMICEP632	Elective 1 Theory 1 Practical	BIOSTATISTICS AND BIOINFORMATICS	4=2+2
		WPSMICRP631	Research Project	RESEARCH PROJECT	4
	IV	WPSMICMT641	Mandatory 1	APPLIED MICROBIOLOGY	4
		WPSMICMT642	Mandatory 2	ADVANCES IN BIOTECHNOLOGY	4
		WPSMICMT643	Mandatory 3	IPR, BIOETHICS AND NANOBIOTECHNOLOGY	4
		WPSMICET641 WPSMICEP642	Elective 1 Theory 1 Practical	ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT	4=2+2 Case study
		WPSMICRP641	Research Project	DISSERTATION	6

PROGRAMME SPECIFIC OUTCOME (PSOs)

The Microbiology Post graduates students will be able to:

1. Acquire and comprehend advanced knowledge of molecular biology and bioinformatics, epidemiology of microbial diseases, advances in medical microbiology & immunology, advanced virology, biostatistics and population genetics, applied microbiology, advances in biotechnology, IPR, bioethics and nanotechnology, environmental management, safety standards & sustainable development.
2. Develop various communication skills including presentation to express ideas
3. Find solutions to current issues based on conceptual knowledge, investigations, evaluation, scientific analysis and justification using evidence-based approach.
4. Apply several Basic and Advanced Microbiology tools, such as bioinformatics and statistical techniques in designing new scientific objectives and execute short term projects.
5. Inculcate ethical and moral values, communicate and discuss scientific outputs by publishing well structured articles and papers in peer reviewed journals.
6. Create social awareness about the environment and learn methods for maintaining its sustainability or betterment of the future.

PREAMBLE:

With the grant of Autonomy from the academic year 2022-23 and introduction of Choice Based Credit System (CBCS), the existing syllabus of M.Sc. Microbiology is restructured to comply with the requirement of NEP 2020 pattern for its implementation from 2024-25. The earlier revision of the syllabus took care of inculcating the various important disciplines of Microbiology, however there was need to introduce skill enhancement course, provide hands-on training and emphasize the role of research methodology, critical thinking, problem solving, evidence based decision, their significance in interdisciplinary areas and industries keeping in line the current syllabus has been designed to meet all these requirements

The postgraduates students of Microbiology will be well equipped with the understanding about the various fields of microbiology and allied areas, which will allow them to build upon their existing knowledge and pursue higher studies in Microbiology, at the same time the syllabus will help prepare the learners for competitive exams required to qualify for pursuing careers in this field. The Syllabus was drafted after several rounds of discussions with professionals from educational institutes, research and industry as well as a few past and present students. It covers the areas of Molecular biology and Bioinformatics, Epidemiology Of Microbial Diseases, Advances in Medical Microbiology & Immunology, Advanced virology, Biostatistics and Population genetics, Applied microbiology, Advances in biotechnology, IPR, Bioethics and Nanotechnology, Environmental Management, Safety Standards & Sustainable Development.

PROGRAM: M.Sc.	**SEMESTER: III (Mandatory 1: Theory)**		
Course: MOLECULAR BIOLOGY AND POPULATION GENETICS	**Course Code: WPSMICMT631**		
Teaching Scheme			**Evaluation Scheme**
Lectures (Hours per week)	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
4	**4**	**40**	**60**

Learning Objectives:
The course 'MOLECULAR BIOLOGY AND POPULATION GENETICS' will enable the learner:

LO1: To impart knowledge about selected concepts and techniques related to molecular biology.
LO2: To explain the mechanisms of natural selection and its impact on allele frequencies.
LO3:To comprehend the concept of a gene pool and gene frequency within a population.
LO4: To develop understanding of the advanced mechanism related to regulation and control of gene expression.
LO5: To apply the Hardy-Weinberg equation to calculate genotype and allele frequencies in a population.

Course Outcomes:
At the end of the course, the students will be able to:

CO1: Explain regulation of genes in prokaryotes and eukaryotes.
CO2: Comprehend the principles of advanced techniques used in the field of molecular biology.
CO3: Describe natural selection's impact on gene frequency change.
CO5: Analyze migration, genetic drift, and their effects on genetic diversity.
CO6: Solve problems related to population genetics.

DETAILED SYLLABUS

Course Code: WPSMICMT631	**Subunit**	**Course/ Unit Title: MOLECULAR BIOLOGY AND POPULATION GENETICS**	**Credits/ Lectures 4**
1		**Regulation of gene expression**	**15 lectures**
	1.1	**Control of gene expression in prokaryotes** 1.1.1 Riboswitches 1.1.2 CRISPR and CAS system 1.1.3 The Gal operon of *E.coli* 1.1.4 The ara operon of *E.coli* 1.1.5 Iron regulation in *E. coli* 1.1.6 Regulation of Sporulation in *Bacillus subtilis*	
	1.2	**Control of gene expression in eukaryotes** 1.2.1 DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation. 1.2.2 Regulation through transcriptional activators, Coactivators & repressors, enhancers and insulators 1.2.3 Regulation through RNA processing & degradation 12.4 Regulation through RNA interference	
2		**Essential concepts and techniques of Molecular tools for studying genes**	**15 lectures**
	2.1	**Labeled tracers** (Explain each with suitable example) 2.1.1 Autoradiography 2.1.2 Phosphorimaging 2.1.3 Liquid scintillation counting 2.1.4 Nonradioactive tracers	
	2.2	In situ hybridization: Locating genes in chromosomes Chromosome painting	
	2.3	**DNA sequencing and physical mapping** 2.3.1 The Sanger Chain-Termination Sequencing method 2.3.2 Automated DNA sequencing 2.3.3 High-throughput Sequencing 2.3.4 Restriction Mapping	
3		**Essential concepts and techniques of Molecular tools for studying gene expression**	**15 lectures**
	3.1	**Mapping and quantifying transcripts**	

		3.1.1 S1 mapping 3.1.2 Primer extension 3.1.3 Run-off transcription and G-less cassette transcription	
	3.2	**Measuring transcription rates in vivo** 3.2.1 Nuclear run-on transcription 3.2.2 Reporter gene transcription 3.2.3 Measuring protein accumulation in vivo	
	3.3	**Assaying DNA –protein interactions** 3.3.1 Filter binding 3.3.2 Gel mobility shift 3.3.3 DNase Footprinting 3.3.4 DMS footprinting and other footprinting methods 3.3.5 Chromatin immunoprecipitation (ChIP)	
	3.4	**Assaying protein-protein interactions**	
	3.5	**Finding RNA sequences that interact with other molecules** 3.5.1 SELEX 3.5.2 Functional SELEX	
	3.6	**Knockouts and Transgenics**	
4		**Population genetics**	**15 lectures**
	4.1	4.1.1 Populations, Gene pool, Gene frequency 4.1.2 Hardy-Weinberg Law 4.1.3 Concepts and rate of change in gene frequency through natural selection 4.1.4 Migration and random genetic drift 4.1.5 Adaptive radiation 4.1.6 Isolating mechanisms 4.1.7 Speciation 4.1.8 Allopatricity and Sympatricity 4.1.9 Convergent evolution; Sexual selection and Coevolution. 4.1.10 Problems based on Population Genetics	

References:

1. Weaver R. F. (2012) Molecular Biology, 5th edition, McGraw-Hill.
2. Benjamin Pierce. (2004) Genetics- A Conceptual Approach, 3rd edition , W H Freeman
3. Watson, Baker, Bell, Gann, Levine, Losick. (2007) Molecular Biology of the Gene,7th edition, Pearson Education
4. Jocelyn E. Krebs , Elliott S. Goldstein, Stephen T. Kilpatrick, (2017) Lewin's Genes XII, Jones and Bartlett.
5. Hamilton, M. B. (2021) Population genetics. Wiley-Blackwell.
6. Hartl, D. L., & Clark, A. G. (1989) Principles of population genetics. Sinauer.

<table>
<tr><td colspan="2">PROGRAM: M.Sc.</td><td colspan="3">SEMESTER: III (Mandatory 2: Theory)</td></tr>
<tr><td colspan="2">Course:
EPIDEMIOLOGY OF MICROBIAL DISEASES, ADVANCES IN MEDICAL MICROBIOLOGY & IMMUNOLOGY</td><td colspan="3">Course Code: WPSMICMT632</td></tr>
<tr><td colspan="3">Teaching Scheme</td><td colspan="2">Evaluation Scheme</td></tr>
<tr><td>Lectures
(Hours per week)</td><td>Credit</td><td>Continuous Internal Assessment (CIA) (40%)</td><td colspan="2">Semester End Examination
(60%)</td></tr>
<tr><td>4</td><td>4</td><td>40</td><td colspan="2">60</td></tr>
<tr><td colspan="5">Learning Objectives:
The course on ‘EPIDEMIOLOGY OF MICROBIAL DISEASES, ADVANCES IN MEDICAL MICROBIOLOGY & IMMUNOLOGY’ will enable the learners:
LO1: To acquire the knowledge of the advanced diagnostic techniques used in clinical microbiology.
LO2: To comprehend the newer strategies of Vaccine preparation and its role in control of infectious diseases.
LO3: To understand about emerging and re-emerging infectious diseases.
LO4: To summarize the conceptual understanding of Immune disorders, transplantation, transfusion and tumor Immunology.
LO4: To review the potential and future developments of medical biotechnology and synthetic biology and their likely technological, and socio-economic impact on medical science.</td></tr>
<tr><td colspan="5">Course Outcomes:
At the end of the course, the students will be able to:
CO1: Describe the role of various factors contributing to the emergence of new infectious diseases and the spread of these diseases.
CO2: State the importance of various methods of genetic testing of diseases and uses of gene therapy for cancer.
CO3: Discuss the discrimination in various fields based on social and genetic aspects of an individual.
CO4: Explain the concept of tissue engineering and synthetic biology.
CO5: Correlate the causes, principles , examples, control and treatment of immunodeficiency disorders, hypersensitivity reactions, autoimmune diseases and cancer.
CO6: Apply the immunological concepts to organs and tissue transplantation, and blood transfusion.
CO7: Analyze newer strategies for Vaccine preparation for controlling infectious diseases.</td></tr>
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DETAILED SYLLABUS

Course Code: WPSMICMT 632	Subunit	Course/ Unit Title: EPIDEMIOLOGY OF MICROBIAL DISEASES, ADVANCES IN MEDICAL MICROBIOLOGY & IMMUNOLOGY	Credits/ Lectures 4
1		**Emerging and Re-emerging infections**	**15 lectures**
	1.1	The role of infectious diseases in the world today	
	1.2	The links between infectious diseases, poverty and civil unrest	
	1.3	Factors contributing to the emergence of new infectious diseases and the spread and evolution of older diseases environment, ecology and climate change contributing to novel infections	
	1.4	Prevention of emerging/ re-emerging infectious diseases	
	1.5	Strategies and response capacities in India for combating emerging infections, One health and planetary health concept.	
	1.6	**Epidemiology of following pathogen:** 1.6.1 COVID-19, SARS 1.6.2 Dengue 1.6.3 Chikungunya 1.6.4 Malaria 1.6.5 Hepatitis C- bloodborne 1.6.6 Chandipura Virus 1.6.7 Neglected tropical diseases- Leishmaniasis, Helminthiasis, Nematodes 1.6.8 Mucormycosis and *Candida auris* 1.6.9 The emerging importance of infectious diseases in the immunocompromised patients (with suitable example)	
	1.7	**The emerging threat of bioweapons in reference to plague and anthrax**	
2		**Medical biotechnology**	**15 lectures**
	2.1	Genetic Testing of diseases and disorders, Immunogenetics; Karyotyping	

	2.2	Advanced techniques in Molecular biotechnology implications in medical diagnostics and gene therapy	
	2.3	Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics	
	2.4	Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination	
	2.5	Tissue Engineering- overview, Biomolecular Engineering	
	2.6	**Introduction to Clinical Research** 2.6.1 What is a clinical trial, history, phases and need? 2.6.2 Good Clinical practice Guidelines 2.6.3 Ethical aspects of Clinical Research 2.6.4 Patenting biotechnology	
	2.7	**Synthetic biology-** 2.7.1 What is synthetic biology? 2.7.2 Relevant aspects of biological systems 2.7.3 The emergence of synthetic biology 2.7.4 Additional tools in synthetic biology	
3		**Immune disorders: Immunodeficiency, Immune Tolerance & Autoimmune disease**	**15 lectures**
	3.1	**Immunodeficiency** 3.1.1 Deficiencies of pattern recognition- Receptor signaling 3.1.2 Phagocytic cell defects 3.1.3 Complement system deficiencies 3.1.4 Cytokine and cytokine receptor deficiencies 3.1.5 Primary B-cell deficiency 3.1.6 Primary T- cell deficiency 3.1.7 Severe combined immunodeficiency 3.1.8 Diagnosis and treatment of primary immunodeficiency	
	3.2	**Immune Tolerance** 3.2.1 Major mechanisms for achieving tolerance 3.2.2 Central Tolerance 3.2.3 Peripheral Tolerance 3.2.4 Tolerance induction 3.2.5 Immunoprivileged sites-The brain, the eyes	

	3.3	**Autoimmune diseases** 3.3.1 Causes 3.3.2 Mechanisms 3.3.3 Pathogenic effects of autoantibody 3.3.4 Pathogenic effects of complexes with auto antigens 3.3.5 T-cell mediated hypersensitivity as a Pathogenic factor in autoimmune disease	
4		**Applied Immunology**	**15 lectures**
	4.1	**Vaccines** 4.1.1 Vaccination: Overview-Advantages, limitations current vaccines 4.1.2 Newer approaches to vaccine development 4.1.3 Herpes Simplex Virus, Cholera, Severe Acute Respiratory Syndrome, Human Papillomavirus 4.1.4 Peptide Vaccines: Malaria, Cancer, Autoimmune Disease, Allergy 4.1.5 Human Immunodeficiency Virus, Cancer 4.1.6 DNA vaccines: Delivery and Immune Mechanisms of Action, Advantages and Disadvantages, Improved Efficacy and Immunogenicity 4.1.7 Overview of mRNA vaccine 4.1.8 Attenuated Vaccines- Poliovirus, Influenza Virus, Dengue Virus 4.1.9 Vector Vaccines: Vaccines Directed against Viruses, Vaccines Directed against Bacteria, Bacteria as Antigen Delivery Systems 4.1.10 Systems Biology and Evaluation of Vaccines.	
	4.2	**Transplantation and Transfusion Immunology** 4.2.1 Types of Graft 4.2.2 Types of graft rejection 4.2.3 Mechanisms of graft rejection 4.2.4 Matching the donor and recipient 4.2.5 Immunosuppression 4.2.6 The fetus as an allograft 4.2.7 Blood transfusion - Blood grouping and cross matching - Transfusion reactions - Criteria for selection and rejection of Blood Donor	
	4.3	**Tumor Immunology** 4.3.1 Cell- intrinsic and extrinsic mechanisms of tumor suppression 4.3.2 Role of inflammation in the enhancement of tumor initiation, promotion and progression 4.3.3 Tumor antigens and their classes 4.3.4 Approaches to cancer immunotherapy - 4.3.5 Passive immunotherapy with monoclonal antibodies Unmasking of the latent T- cell responses - Antigen independent cytokine therapy. 4.3.6 Self-Study: Conventional Cancer Therapy	

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1. A brief guide to emerging infectious diseases and zoonoses. WHO.
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3. Friis, Robert H_Sellers, Thomas A, 2014, Epidemiology for Public Health Practice-Jones and Bartlett Learning.
4. Lisa A. Beltz, 2011, Emerging Infectious Diseases: A Guide to Diseases, Causative Agents, and Surveillance John Wiley & Sons.
5. Principles of Epidemiology in Public Health Practice-Third Edition.
6. An Introduction to Applied Epidemiology and Biostatistics, 2012. –Centers for Disease Control and Prevention (CDC).
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14. Bernard R. Glick, Cheryl L. Patten, Terry L. Delovitch, 2014, Medical Biotechnology ASM Press, Washington DC.
15. Kanai Mukherjee and Swarajit Ghosh, 2010, Medical Laboratory Technology, Vol 1, TataMcGraw Hill Education Private Limited
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Additional references

1. Wong D, Nielsen T.B., Bonomo R.A., Pantapalangkoor P., Luna B., Spellberg B. Clinical and Pathophysiological Overview of Acinetobacter Infections: a Century of Challenges. Clin Microbiol Rev. 2017;30(1):409-447. doi:10.1128/CMR.00058-16.
2. Nett JE (2019) Candida auris: An emerging pathogen "incognito"? PLoSPathog 15(4): e1007638. https://doi.org/10.1371/journal.
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5. Abdad M.Y., Abou Abdallah R., Fournier P.E., Stenos J, Vasoo S. 2018. A concise review of the epidemiology and diagnostics of rickettsiases: Rickettsia and Orientia spp. J Clin Microbiol56:e01728-17. https://doi.org/10.1128/JCM.01728-17. 7.
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PROGRAM:M.Sc.	**SEMESTER: III (Mandatory 3: Theory)**		
Course: **ADVANCED VIROLOGY**	**Course Code: WPSMICMT633**		
Teaching Scheme			**Evaluation Scheme**
Lectures **(Hours per week)**	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
4	**4**	**40**	**60**

Learning Objectives:

The course on 'ADVANCED VIROLOGY' will enable the learners:

LO1: To understand structure, genetic material, and replication strategies of various viruses.

LO2: To summarize the mechanisms of viral pathogenesis, viral diagnostics, prevention and treatment of viral infection.

Course Outcomes:

At the end of the course, the students will be able:

CO1: Enlist the re-emerging viruses and understand the strategies to prevent their transmission.

CO2: Describe the life cycle of different types of viruses.

CO3: Comprehend the diseases caused by plant, animal and human viruses

CO4: Justify the various aspects of human viral diseases and newer emerging viral infections.

DETAILED SYLLABUS

Course Code: WPSMICMT633	**Sub unit**	**Course/ Unit Title: ADVANCED VIROLOGY**	**Credits/ Lectures 4**
1		**Microbial Phages**	**15 lectures**
	1.1	**Bacteriophages:** General properties of phages, properties of phage-infected Bacterial cultures, Specificity of Phage Infection **(Revision)**	
	1.2	***E.coli* Phage T7:** Organization of the T7 genes, Growth Cycle, Regulation of transcription of T7 phage	
	1.3	***E.coli* Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle.**	
	1.4	**Overview of mycoviruses, algal viruses, protozoal viruses**	
	1.5	**Phage-Plasmids Spread Antibiotic Resistance Genes through Infection and Lysogenic Conversion**	
2		**Plant Viruses**	**15 lectures**
	2.1	**Plant viruses:** Morphology, Transmission of plant viruses, symptoms of plant diseases caused by viruses,	
	2.2	Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids, TMV, Citrus Tristeza Virus (CTV): Viral structure, Genome, Host range, Transmission, Symptom and Control.	
	2.3	Diagnosis of viral infections in plants	
3		**Viruses Related to human health I** study wrt structure, antigenic variation, cultivation, pathogenesis, clinical features, lab diagnosis, epidemiology, emerging /reemerging infection and prophylactic measures	**15 lectures**
	3.1	**Orthomyxoviruses:** Influenza virus. **Paramyxoviruses**: Mumps virus, Measles Virus, Respiratory syncytial virus.	
	3.2	**Rhabdoviruses**: Rabies virus **Pox virus:** Variola and Vaccinia virus.	
	3.3	**Herpes Virus:** Varicella Zoster virus, Herpes Zoster Epstein-Barr virus, Cytomegalovirus.	

	3.4	**Miscellaneous viruses:** Human Papillomavirus, Rubella virus, Slow virus disease- Prion disease Creutzfeldt Jakob, Kuru, Ebola Virus, SARS coronavirus	
4		**Virology in relation to Human health II** Study wrt structure, antigenic variation, cultivation, pathogenesis, clinical features, lab diagnosis, epidemiology, emerging/reemerging infection and prophylactic measures	**15 lectures**
	4.1	**Picornavirus:** Enterovirus e.g. Poliovirus.	
	4.2	**Arboviruses:** Flaviviridae eg. Yellow fever and Dengue virus	
	4.3	**Oncogenic DNA Viruses :**Polyoma, Papilloma virus and oncolytic Adenovirus	
	4.4	**Other Positive-Strand RNA Viruses** : Calicivirus - Norovirus,Togavirus-Chikungunya virus and Astroviruses	

References:

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2. S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, Lynn W. Enquist, 2015, Principles of Virology, 2nd Edition. ASM Press.
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13. https://doi.org/10.1086/343812
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<table>
<tr><td colspan="2">PROGRAM: M.Sc.</td><td colspan="2">SEMESTER: III (Mandatory 4: Practical)</td></tr>
<tr><td colspan="2">Course:
TECHNIQUES IN IMMUNOLOGY AND MOLECULAR BIOLOGY</td><td colspan="2">Course Code: WPSMICMP634</td></tr>
<tr><td colspan="2">Teaching Scheme</td><td colspan="2">Evaluation Scheme</td></tr>
<tr><td>Practicals
(Hours per week)</td><td>Credit</td><td>Continuous Internal Assessment (CIA) (40%)</td><td>Semester End Examination (60%)</td></tr>
<tr><td>4</td><td>2</td><td>20</td><td>30</td></tr>
<tr><td colspan="4">Learning Objectives:
The Practical course ‘TECHNIQUES IN IMMUNOLOGY AND MOLECULAR BIOLOGY’ will enable the learner:
LO1: To learn the clinical significance of laboratory tests in the diagnosis and management of various diseases.
LO2: To understand the concepts and applications of molecular tools and techniques.
LO3: To comprehend advanced molecular biology techniques.
LO4: To apply the theoretical knowledge while performing the immunoassays.</td></tr>
<tr><td colspan="4">Course Outcomes:
At the end of the practical course, the students will be able to:
CO1: Apply molecular techniques for genetic analysis, including mutagenesis and mutant isolation methods.
CO2: Evaluate genotoxicity using the Ames test and interpret its results effectively.
CO3: Perform molecular biology tools and techniques for nucleic acid analysis, including hybridization, blotting, and mapping.
CO4: Demonstrate comprehensive knowledge of laboratory tests used in clinical diagnosis.</td></tr>
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DETAILED SYLLABUS

Course Code: WPSMICMP 634	Experiment no.	Course/ Unit Title: TECHNIQUES IN IMMUNOLOGY AND MOLECULAR BIOLOGY	Credits 2
		Practicals	
	1.	Detection of Bombay blood group using commercial preparation of anti-H Lectin.	
	2.	Rheumatoid factor test for laboratory diagnosis of Rheumatoid arthritis	
	3.	Detection of serum lysozyme activity	
	4.	Detection of serum- Myeloperoxidase activity	
	5.	RIST and RAST	
	6.	Detection of hormones by ELISA technique	
	7.	Effect of physical mutagen (UV) on *E.coli* to check alterations in characteristics such as carbohydrate utilization (β galactosidase assay), growth factors	
	8.	Effect of chemical mutagen (Acridine orange) on *E.coli* to check alterations in characteristics such as carbohydrate utilization, growth factors	
	9.	Isolation of mutants by Replica plate technique	
	10.	Ames test	
	11.	Southern hybridization technique [Demonstration]	
	12.	Northern Blotting technique [Demonstration]	
	13.	Restriction mapping	
	14.	Western blot- (Demonstration)	

PROGRAM: M.Sc.	**SEMESTER: III (Elective: Theory+Practical)**		
Course: BIOSTATISTICS AND BIOINFORMATICS	**Course Code: WPSMICET631/ WPSMICEP632**		
Teaching Scheme			**Evaluation Scheme**
Lectures (Hours per week)	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
2T+2P	**(2+2=4)**	**40**	**60**

Learning Objectives:

The elective course 'BIOSTATISTICS AND BIOINFORMATICS' will help the learner:

LO1: To understand the concept of testing a single population mean using the Wilcoxon Signed-Rank test.

LO2: To use the concept of testing for equality of medians using the Mann-Whitney Test.

LO3: To understand the various databases and alignments softwares for construction of phylogenetic tree.

LO4: To comprehend the application of bioinformatics in various fields of sciences.

Course Outcomes:

At the end of the course, the students will be able to :

CO1: List the different non parametric tests.

CO2: Describe the Wilcoxon Signed-Rank test for single population mean, difference between correlated population means, and difference between two independent population means.

CO3: Apply the Mann-Whitney Test for comparing medians of independent samples.

CO4: Apply bioinformatics in different fields.

CO4: Design the phylogenetic tree from the unknown nucleotide sequences.

DETAILED SYLLABUS

Course Code: WPSMICE T6 31	Sub unit	Course/ Unit Title: BIOSTATISTICS AND BIOINFORMATICS	Credits 4= 2Th + 2Prac
		Theory	**2**
1		**Biostatistics: Non parametric**	**15 lectures**
	1.1	Introduction to Non-parametric tests: 1.1.1 The Wilcoxon Signed-Rank test for location 1.1.1.1 Testing single population mean 1.1.1.2 Testing difference between correlated (match pair) population means 1.1.1.3 Testing difference between two independent population means 1.1.2 The Mann-Whitney Test (Mann- Whitney-Wilcoxon test -for equality of medians) 1.1.3 The Kolmogorov-Smirnov Goodness- of -Fit Test 1.1.4 The Kruskal-Wallis One-Way Analysis of Variance by Ranks 1.1.5 The Friedman Two-Way Analysis of Variance by Ranks	
2		**Bioinformatics**	**15 lectures**
	2.1	**Introduction and Revision of T.Y.B.Sc topics to give an overview of bioinformatics** **2.1.1 Biological databases-** Nucleic acid sequence databases- Genbank/ EMBL/ DDBJ Protein sequence databases- (UniProtKB), Derived databases (Prosite, BLOCKS, Pfam/Prodom) Structural databases (PDB, NDB) and Enzyme databases **2.1.2 Alignment:** Pairwise BLAST, FASTA Multiple sequence alignment: PRAS, CLUSTAL omega **2.1.3 Phylogenetic analysis and Tree construction** Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction.	

PROBLEMS SOLVING ON BIOSTATISTICS AND PRACTICALS ON BIOINFORMATICS		
Sr.no	**Course Code: WPSMICEP632**	**Credits: 2 credit**
1.	**Case study based problem solving on biostatistics.** 1.1 Wilcoxon Signed-Rank test 1.2 Mann-Whitney-Wilcoxon test -for equality of medians 1.3 Kolmogorov-Smirnov Goodness- of -Fit Test 1.4 Kruskal-Wallis One-Way Analysis of Variance by Ranks 1.5 The Friedman Two-Way Analysis of Variance by Ranks	
2.	**Computational techniques of bioinformatics** 2.1 Visiting & exploring various databases mentioned in syllabus 2.2 Using BLAST and FASTA for sequence analysis 2.3 Fish out homologs for given specific sequences (by teacher) - decide sequence of some relevance to their syllabus and related to some biological problem e.g. 29 evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology) 2.4 Six frame translation of given nucleotide sequence 2.5 Restriction analysis of given nucleotide sequence 2.6 Pairwise alignment and multiple alignment of a given protein sequences 2.7 Construction of phylogenetic tree	

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PROGRAM: M.Sc.	**SEMESTER: III (Research Project)**		
Course: **RESEARCH PROJECT**	**Course Code: WPSMICRP631**		
Teaching Scheme			**Evaluation Scheme**
Total Hours in the semester	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
120 hours (8 hrs per week)	**4**	**40**	**60**

Learning Objectives:

LO1: To develop a scientific temperament.
LO2: To understand and identify a problem.
LO3: To design a hypothesis.
LO4: To acquaint learners with a literature survey and review writing.
LO5: To design the research model and execute it methodically.
LO6: To analyze the data obtained and validate the same.
LO7: To draw conclusions from the obtained data.
LO8: To publish the research work in a reputed journal.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Think critically and identify the problem .
CO2: Imbibe the culture of working ethically and inculcate laboratory skills independently.
CO3: Write a mini review.
CO4: Work confidently as an independent researcher
CO5: Analyze their data collected and relate them to the research problem.
CO5: Present the data and become effective communicators.

Continuous Internal Assessment (CIA) (40%)	**Semester End Examination (60%)**
Periodic presentation on wet lab work (2 presentations in a month)	Proposal submission, Presentation and Viva based on completion of Phase I work (Screening and identification) **Based on this grades will be awarded**

MODALITY OF ASSESSMENT

Course	Mandatory 1	Mandatory 2	Mandatory 3	Mandatory 4	Elective	Research Project
	Theory	Theory	Theory	Practical	Theory +Practicals	
Name	MOLECULAR BIOLOGY & POPULATION GENETICS	EPIDEMIOLOGY OF MICROBIAL DISEASES, ADVANCES IN MEDICAL MICROBIOLOGY & IMMUNOLOGY	ADVANCED VIROLOGY	TECHNIQUES IN IMMUNOLOGY AND MOLECULAR BIOLOGY	BIOSTATISTICS AND BIOINFORMATICS	RESEARCH PROJECT
Code	WPSMICMT631	WPSMICMT632	WPSMICMT633	WPSMICMP634	WPSMICET631 WPSMICEP632	WPSMIC RP631
Credit	4	4	4	2	4	4
CIA	40	40	40	20	40	40
Sem end	60	60	60	30	60	60
Total	100	100	100	50	100	**100**

Theory Examination Pattern: (For 100 marks Mandatory papers)

A. Internal Assessment- 40% (2 or 3 Continuous Assessments may be conducted)

Sr. No.	Evaluation Type	Marks
1.	Class test	15
2.	Assignment/ Case study/presentation	25
	Total	**40**

B. External Examination- 60%

Semester End Theory Examination:

1. Duration – This examinations shall be of two hours duration
2. Theory question paper pattern: For Core course

a. There shall be 04 questions each of 12 marks one on each unit and 01 mixed bag

question of 12 marks on all four units

b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options		Questions based on
Q.1)	Any 2 out of 3	12	**Unit 1**
Q.2)	Any 2 out of 3	12	**Unit 2**
Q.3)	Any 2 out of 3	12	**Unit 3**
Q.4)	Any 2 out of 3	12	**Unit 4**
Q.5) a)	Any 4 out of 5	04	**All four units**
Q.5) b)	Any 4 out of 5	04	**All four units**
Q.5) c)	Any 2 out of 3	04	**All four units**
TOTAL		**60**	

Examination Pattern for Elective: 100 marks paper

Theory: 50 marks

a. Internal Assessment: 20 marks (Two assessments)

Sr. No	Evaluation Type	Marks
1.	Written Exam	10
2.	Presentation	10
	Total	**20**

b. Sem End Examination: 30 marks

1. Duration – This examinations shall be of **One hour**
2. Theory question paper pattern:

a. There shall be 02 questions each of 12 marks ,one on each unit and 01 mixed bag question of 06 marks based on the two units

b. All questions shall be compulsory with internal choice within the questions.

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	**Unit 1**
Q.2)	Any 2 out of 3	12	**Unit 2**
Q.3)	Any 3 out of 4	06	**both units**
TOTAL		30	

PRACTICAL BOOK/JOURNAL :

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Practical: 50 marks

a. Internal Assessment: 20 marks (Two Assessments)

Sr. No	Evaluation Type	Marks
1.	Planning and execution of an experiment.	10
2.	Case study/presentation	10
	Total	**20**

b. Sem End Examination: 30 marks

Sr. No	Evaluation Type	Marks
1.	Laboratory work	20
2.	Viva	05
3.	Quiz	05
	Total	**30**

PROGRAM: M.Sc.	**SEMESTER: IV(Mandatory 1: Theory)**		
Course: **APPLIED MICROBIOLOGY**	**Course Code: WPSMICMT641**		
Teaching Scheme			**Evaluation Scheme**
Lectures (Hours per week)	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
4	**4**	**40**	**60**

Learning Objectives:
The course will enable the learners:
LO1: To learn about the microbial biomolecules in the field of diagnostics.
LO2: To study the applications of various enzymes and biomolecules in the food industry, cosmetics, diagnostics.
LO3: To understand the production of novel microbial products.
LO4: To foster an interest for entrepreneurship among students.

Course Outcomes:
At the end of the course, the students will be able to :
CO1: Comprehend the role of microorganisms in bioremediation.
CO2: Demonstrate the various different applications of Microbiology in various industries.
CO3: Evaluate the significance and applications of biomolecules in diagnostics.
CO4: Apply the knowledge of microbiology in developing novel microbial products.
CO5: Discuss the role of microbiology in pollution control and remediation.

DETAILED SYLLABUS

Course Code: WPSMICMT641	**Subunit**	**Course/ Unit Title: APPLIED MICROBIOLOGY**	**Credits/ Lectures 4**
1		**Applications of Microbiology in bioremediation & pollution control**	**15 lectures**
	1.1	Introduction to Bioremediation strategies for synthetic compounds, petrochemicals, inorganic waste.	
	1.2	Bioremediation strategies and techniques in situ and testing its efficacy and side effects	
	1.3	Bioremediation of metals & gaseous ex-situ. Environment modification for bioremediation	
	1.4	Approaches to bioremediation: Microbial seeding & bioengineering using rDNA technology	
	1.5	Bioremediation of various ecosystems-Soil, aquifers, marine, air	
2		**Applications of enzymes**	**15 lectures**
	2.1	Enzymes as an analytical tool for the assessment of food quality, safety, and monitoring food processing.	
	2.2	Applications of enzymes in food: Baking, fruit juice production, processing, brewing, and dairy. Applications of nonfood enzymes in detergents, laundry, Textiles, medical, therapy, and chemical industries.	
	2.3	New industrial enzyme applications: Cosmetics, enzymes for preservation. Hard surface cleaning, oil field application, wastewater treatment, pH shift	
3		**DNA based approaches to diseases diagnosis and microbial biomolecules-as therapeutics**	**15 Lectures**
	3.1	Protein therapeutics: Hormones, cytokines, monoclonal antibodies, regenerative medicines, molecular diagnostics, NAS as therapeutic agents, Vaccines	

	3.2	Hybridization Probes , Allele-Specific Hybridization Oligonucleotide Ligation Assay , Padlock Probes, Allele-Specific PCR,TaqMan PCR, Real-Time PCR To Detect Infectious Disease, Detection of Multiple Disease-Associated Mutations Using Microarrays, Detection of Epigenetic Markers, Detection of RNA Signatures of Antibiotic Resistance in Human Pathogens and Detection of miRNA Signatures of Cancers.	
4		**Novel uses of microorganisms and microbial products**	**15 lectures**
	4.1	Biosensors, microbial concrete, Bioleaching, Enhanced oil recovery, Biofuels	
	4.2	Biotech of the marine environment, microbial contribution of climate change	
	4.3	Biopolymers, Bio surfactants	

References:

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PROGRAM: M.Sc.	**SEMESTER: IV (Mandatory 2: Theory)**		
Course: **ADVANCES IN BIOTECHNOLOGY**	**Course Code: WPSMICMT642**		
Teaching Scheme			**Evaluation Scheme**
Lectures (Hours per week)	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
4	**4**	**40**	**60**

Learning Objectives:
The course will enable the learners:
LO1:To gain a broad background of mycology and study its use and importance in production of products of industrial importance
LO2: To understand algal biotechnology and learn cultivation of algae.
LO3: To acquaint with the concept and scope of Organic Farming.
LO4: To apply the concepts of Bioaugmentation, Biostimulation and Biocontrol in the field of Agriculture.

Course Outcomes:
At the end of the course, the students will be able to:
CO1: Discuss the scope of Organic farming.
CO2: Relate the basic knowledge of mycology with its application in various industries.
CO3: Demonstrate the importance of Vermicomposting and Biofertilizers in agriculture.
CO4: Evaluate the need for the use of biocontrol agents in the field of agriculture. Apply
CO5: Apply knowledge of algal cultivation in biotechnology.

DETAILED SYLLABUS

Course Code: WPSMICMT 642	Subunit	Course/ Unit Title: ADVANCES IN BIOTECHNOLOGY	Credits/ Lectures 4
1		**Algal Biotechnology**	**15 lectures**
	1.1	Culture techniques and media for growth of freshwater algae: 1.1.1 Measurement of algal growth in culture 1.12 lag phase, log phase, stationary phase and death phase using biomass, chlorophyll content, 1.1.3 Measurement of algal pigments	
	1.2	Culturing microalgae in Photobioreactors, Fermentor and Outdoor ponds: Variation in design, culture conditions, scale up, economics, advantages and disadvantages	
	1.3	Applications of Algal Biotechnology: 1.3.1 Food Supplements and fertilizers. 1.3.2 Bioactive compounds and cosmetics 1.3.3 Biofuel 1.3.4 High value commercial products 1.4.4 Bioplastics.	
2		**Fungal technology**	**15 lectures**
	2.1	**Mycology (Overview)**	
	2.2	**Fungal Pigments and Mycotoxins** 2.2.1 Genetic basis of pigment production 2.2.2 Factors affecting pigment production 2.2.3 Fermentation for pigment synthesis 2.2.4 Mycotoxins and their replacement 2.2.5 Relevance of pigments in various fields	
	2.3	**Fungal siderophores, Lipid and Metabolite production** 2.3.1 Siderophores 2.3.2 Oleaginous fungi 2.3.3 Lipid production from lignocelluloses and crude glycerol 2.3.4 Production of specific chemicals and fuels derived from lipid metabolism 2.3.4 Enzymes - Xylanase, Laccase, Galactosidase, Inulinase, Catalase 2.3.5 Engineering of fungal biomolecules	

3		**Bioaugmentation and Biostimulation in Agriculture**	**15 Lectures**
	3.1	Introduction	
	3.2	Vermicomposting	
	3.3	Bio-intensive Nutrient Management, Use of biofertilizers: Rhizobium, blue green algae, phosphate solubilizers, Mycorrhiza.	
	3.4	Organic Farming and scope of organic farming in India	
4		**Biocontrol in Agriculture**	**15 Lectures**
	4.1	Induced systemic resistance in Biocontrol of Plant diseases: a) Induction of systemic resistance by Pseudomonas, Bacillus, Trichoderma, Fungi and others. b) Mechanism of Induced systemic resistance	
	4.2	Microbial control strategies: 4.3.1 Postharvest diseases of Fruits, Vegetables, Roots and Tubers 4.3.2 Mode of action of biocontrol agents 4.3.3 Extensive of use of biocontrol agents 4.3.4 Enhancing biocontrol efficacy of Microbial Antagonist 4.3.5 Biotechnological Approach	

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PROGRAM: M.Sc.	**SEMESTER: IV (Mandatory 3: Theory)**		
Course: **IPR, BIOETHICS AND NANOBIOTECHNOLOGY**	**Course Code: WPSMICMT643**		
Teaching Scheme			**Evaluation Scheme**
Lectures **(Hours per week)**	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
4	**4**	**20**	**30**

Learning Objectives:
The course 'IPR, BIOETHICS AND NANOBIOTECHNOLOGY' will enable the learners:
LO1: To understand the need of IPR and patents in biotechnology research.
LO2: To explain the significance of patents using case studies.
LO3: To acquire knowledge about biodiversity law.
LO4: To develop an ethical approach to scientific research.
LO5: To learn the fundamentals and applications of nanobiotechnology.

Course Outcomes:
At the end of the course, the students will be able to :
CO1: Reflect on the importance of IPR and apply knowledge of IPR and patents in research.
CO2: Demonstrate a clear understanding of biodiversity laws.
CO3: Analyze the significance of ethics in scientific research.
CO4: Utilize knowledge of nanotechnology for integration in experiments.

DETAILED SYLLABUS

Course Code: WPSMICMT 643	Subunit	Course/ Unit Title:	Credits/ Lectures 4
1		**IPR and Biodiversity Law**	**15 lectures**
	1.1	Need for IPR in Biotechnology	
	1.2	Patents for Biotechnology	
	1.3	Implications of Patents in Biotechnology	
	1.4	Case Studies: 1.4.1 Basmati Rice Issue 1.4.2 Turmeric Patent 1.4.3 Agriculture Neem Patent 1.4.4 Chakraborty case 1.4.5 Bt corn 1.4.6 Bt Brinjal 1.4.7 Golden rice	**15 lectures**
	1.5	Biodiversity law: 1.5.1 Introduction 1.5.2 Development 1.5.3 International and National Biodiversity laws	
2		**Bioethics**	
	2.1	The goals of biotechnology, Challenging characteristics of biotechnology	
	2.2	Bioethics and microbiology Ethical issues and Perspectives in the Discipline of Microbiology Ethics Perspectives from India Bioethics, bioweapons and the microbiologist	**15 Lectures**
	2.3	Ethical guidelines for Biomedical research on Human subjects	
	2.4	Ethics related to vaccination - Effects, Causes and Prevention of infectious diseases through vaccination - Benefits and risks of vaccination - Alternative approaches to vaccination: voluntary, quasi-mandatory and incentivized Schemes, Comparing and assessing vaccination strategies, Children as special cases, Surveillance - HIV, AIDS, COVID as notifiable	

		diseases, - Control of infectious diseases, - Issues raised by quarantine and isolation, - Use of vaccines in control of infectious diseases	
	2.5	Public perception of biotechnology: Genetic engineering– safety, social, moral and ethical considerations	
3		**Nano Biotechnology**	
	3.1	Basics of Nanotechnology 3.1.1 Types of nanomaterials 3.1.2 Properties of nanomaterials	**15 Lectures**
	3.2	Fundamentals of Bio-nanotechnology: 3.2.1 Nanomotors of biological systems 3.2.2 ATPsynthase: a nano turbine 3.2.3 Flagellar motors in bacteria 3.2.4 Linear molecular motors	
4		**Biosynthesis and Applications of Nanoparticles**	**15 Lectures**
	4.1	Biosynthesis of nanomaterials biosystems as nano factories 4.1.1 Bacteria as machinery for synthesis of nano metals-gold, silver, Zinc, cadmium, platinum 4.1.2 Fungi and Actinomycetes as fabricators of nano metals 4.1.3 Plants as nano engineers 4.1.4 Algae as nanotechnologists	
	4.2	DNA and proteins as templates for molecular Nanotechnology and nano electronics	
	4.3	Applications of nanotechnology – 4.3.1 Nanomedicine 4.3.2 Nano bio-devices 4.3.3 Nano implants 4.3.4 Applications in agriculture, food and cosmetics	

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PROGRAM: M.Sc.	**SEMESTER: IV (Elective: Theory + Practical)**		
Course: ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT	**Course Code: WPSMICET641 WPSMICEP642**		
Teaching Scheme			**Evaluation Scheme**
Lectures (Hours per week)	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
2T+2 Case study	**4**	**40**	**60**

Learning Objectives:
The course on 'ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT' is essential for the learner:
LO1: To explain the significance of natural renewable and non-renewable resources.
LO2: To acquaint with the different waste management strategies.
LO3: To gain knowledge about risk of biohazards and the importance of biosafety parameters related to the environment.
LO4: To understand the approaches to a sustainable environment.

Course Outcomes:
At the end of the course, the students will be able to:
CO1: List various types of renewable and non-renewable resources with their significance.
CO2: Describe different principles of waste management.
CO3: Justify the role of different biosafety committees.
CO4: Evaluate the different Indian standards for resource optimization.

DETAILED SYLLABUS

Course Code: WPSMICET641 WPSMICEP642	**Subunit**	**Course/ Unit Title: ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT**	**Credits 4 (2Theory + 2Practical)**
		Theory	**2**
1		**Natural Resource Management And Safety Standards**	**15 lectures**
	1.1	Natural resources: Renewable and non-renewable. Land, water, forest, minerals, energy, food. Associated problems and management practices. Environmental Impact Assessment and Sustainable Development	
	1.2	Solid waste management: Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling.	
	1.3	Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these waste through Common Effluent Treatment Plants.	
	1.4	Biomedical (Visit and report) and electronic waste management, recovery of precious metals from electronic waste resources.(NGOs +Report) Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures.	
	1.5	Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs.	
	1.6	Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)	
2		**Sustainable Development**	**15 lectures**

	2.1	Definition and concepts of sustainable development Sustainable development and the need for strategic response Nature of sustainable development strategies Goals of sustainable development Strategies to achieve sustainable development Green Technology	
	2.2	Resource optimization - 5R principle New sources of energy GHG Emissions - basics Case study of EVs - Lifecycle upto end of life management, Emissions from EVs Wastewater management Extended Producer Responsibility (EPR) in India Origin of ESG, frameworks in ESG - GRI, BRSR, etc. Evolution of ESG in India Why ESG now? - ESG ratings, Examples of bad cases in E, S, G. ESG vs sustainability - Long-term Value creation ISO 9001, 14001, 14064 & 14083, 20400, 26000, 27001, 31000, 45001, 50001 UN SDGs alignment ESG & Climate risk management Current trends in ESG	

References:

1. S. K. Agarwal (1993) Resource Ecology. Himanshu Publications.
2. Om V. Singh Extremophiles (2013). Sustainable Resources and Biotechnological Implications. Wiley Blackwell.
3. R. M. Atlas and R. Bartha (1998). Microbial Ecology - Fundamentals and Applications. AddisonWesley Longman, Inc.
4. R. K. Jain, Sunil S. Rao (2000). Industrial Safety, Health and Environment Management Systems, Khanna Publishers
5. Ambasht, R.S., Ambasht, N.K. (1998). Modern Trends in Ecology and Environment. Backhuys Publishers

Course Code: WPSMICET641 WPSMICEP642	Sr no.	Course/ Unit Title: ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT	Credits 4 (2Theory + 2Practical)
		Practicals (Field study, Survey based study and Visits)	**2**
	1.	Preparation of Compost	
	2.	Contribute 30 hours in Green warrior	
	3.	Hazard waste management (pesticide degradation- Survey based)	
	4.	Explore chemical industries to collect samples of polluting chemicals (Survey). Design practical solutions for bioremediation of pollutants, offering sustainable approaches to environmental cleanup.	
	5.	Survey of chemical industries and designing the practical based on degradation of polluting chemical and offering a bioremediation,	
	6.	Visit a CETP facility to understand wastewater treatment processes and environmental protection measures. Analyze CETP operations and prepare a comprehensive report on wastewater treatment efficiency.	
	7.	Explore biomedical waste management practices, focusing on safe disposal techniques for medical waste.	
	8.	Collaborating with NGOs for electronic waste recycling initiatives and reporting on the process and outcomes.	

PROGRAM: M.Sc.	**SEMESTER: IV (Research Project)**		
Course: RESEARCH PROJECT	**Course Code: WPSMICRP641**		
Teaching Scheme			**Evaluation Scheme**
Hours per week	**Credit**	**Continuous Internal Assessment (CIA) (40%)**	**Semester End Examination (60%)**
20 (4h x 5 days) for a period of 4 weeks	**6**	**80**	**120**

Learning Objectives:
LO1: To develop a scientific temperament.
LO2: To summarize collected data relevant to the project.
LO3: To understand and identify a problem.
LO4: To acquaint learners with literature survey and review writing.
LO5: To design a hypothesis.
LO6: To construct an effective research model.
LO7: To analyze the data obtained.
LO8: To publish the research work in a reputed journal.

Course Outcomes:
At the end of the course, the student will be able to:
CO1: Think critically and identify the problem .
CO2: Imbibe the culture of working ethically and inculcate laboratory skills independently.
CO3: Write a mini review.
CO4: Work confidently as an independent researcher
CO5: Analyze their data collected and relate them to the research problem.
CO6: Demonstrate effective verbal communication skills.

Framework for Thesis will be as follows:

Title: Title of the project work
Abstract: Depicting the rationale, the experiments conducted, significant results and key words (Total not more than 300 words)
Introduction: Background and scope of the research topic, the rationale of the study, and hypotheses
Literature Review: Review of relevant literature (both at National and International level done by other researchers), Identification of gaps and theoretical foundation.
Aims and Objectives: Clearly state the main objective of the study or the research question being addressed.
Methodology: Research design, methods, with details of all techniques to be used during the research
Results: Observations and interpretations of findings.
Discussion: Discussion of the observed results in comparison with existing literature.

Conclusion and Summary: Implications of the research, brief outline of the key findings, its relevance to society and potential impact.
Future Prospects: Limitations, and future research work related to the topic.
References: List of all sources cited in the dissertation, formatted according to the required citation style (e.g., APA, MLA)

Distribution of marks for Research Project:

CIA (40%)	**CIA 1**	Introduction and review writing (on topic of research project)	40 marks
	CIA 2	Periodic presentation (2 presentations)	40 marks
Semester end examination (60%)		Thesis writing (methodology, result, discussion, conclusion)	80 marks
		Presentation	20 marks
		Viva	20 marks
TOTAL			**200 marks**

Students will be awarded grades based on this evaluation pattern.

Course	Mandatory 1	Mandatory 2	Mandatory 3	Elective	Research Project
	Theory	Theory	Theory	Theo+Case study	Research Project
Name	**APPLIED MICROBIOLOGY**	**ADVANCES IN BIOTECHNOLOGY**	**IPR, BIOETHICS AND NANOBIOTECHNOLOGY**	**ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT**	**RESEARCH PROJECT**
Code	**WPSMICMT 641**	**WPSMICMT 642**	**WPSMICMT 643**	**WPSMICET641 / WPSMICEP642**	**WPSMICRP641**
Credit	4	4	4	4	6
CIA	40	40	40	40	60
Sem End	60	60	60	60	90
Total	**100**	**100**	**100**	**100**	**150**

1. Theory Examination Pattern: (For 100 marks Mandatory papers)

A. Internal Assessment- 40% (2 or 3 Continuous Assessments may be conducted)

Sr. No.	Evaluation Type	Marks
1.	Written Objective Examination	15
2.	Assignment/ Case study/presentation	25
	Total	**40**

B. External Examination- 60%

Semester End Theory Examination:

1. Duration – This examination shall be of two hours duration

2. Theory question paper pattern: For Core course

a. There shall be 04 questions each of 12 marks one on each unit and 01 mixed bag question of 12 marks on all four units

b. All questions shall be compulsory with internal choice within the questions.

Theory Paper Pattern:

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	**Unit 1**
Q.2)	Any 2 out of 3	12	**Unit 2**
Q.3)	Any 2 out of 3	12	**Unit 3**
Q.4)	Any 2 out of 3	12	**Unit 4**
Q.5) a)	Any 4 out of 5	04	**All four units**
Q.5) b)	Any 4 out of 5	04	**All four units**
Q.5) c)	Any 2 out of 3	04	**All four units**
TOTAL		**60**	

3. Examination Pattern for Elective: 100 marks paper

Theory: 50 marks

A. Internal Assessment: 20 marks (Two assessments)

Sr. No	Evaluation Type	Marks
1.	Written Exam	10
2.	Presentation	10
	Total	**20**

B. Sem End Examination: 30 marks

1. Duration – This examinations shall be of **One hour**
2. Theory question paper pattern:

a. There shall be 02 questions each of 12 marks ,one on each unit and 01 mixed bag question of 06

marks based on the two units

b. All questions shall be compulsory with internal choice within the questions.

Question	Options		Questions based on
Q.1)	Any 2 out of 3	12	**Unit 1**
Q.2)	Any 2 out of 3	12	**Unit 2**
Q.3)	Any 3 out of 4	06	**both units**
TOTAL		**30**	

4. Practical: 50 marks

a. Internal Assessment: 20 marks (Two Assessments)

Sr. No	Evaluation Type	Marks
1.	Case Study 1	10
2.	Case Study 2	10
	Total	**20**

a. Sem End Examination: 30 marks

Sr. No	Evaluation Type	Marks
1.	Report	10
2.	Research paper Presentation	20
	Total	**30**

PRACTICAL BOOK/REPORT:

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.