AC/II(23-24).2.RPS9

S.P.Mandali's

Ramnarain Ruia Autonomous College

Syllabus for MSc Part II

Program: MSc Microbiology

Program Code: RPSMIC

(As per the guidelines of National Education Policy 2020-Academic year 2023-24)

(Choice based Credit System)

GRADUATE ATTRIBUTES

In the post graduate courses, S.P.Mandali's Ramnarain Ruia Autonomous College is committed to impart conceptual and procedural knowledge in specific subject areas that would build diverse creative abilities in the learner. The College also thrives to make its Science post graduates research/ job ready as well as adaptable to revolutionary changes happening in this era of Industry 4.0.

GA	**A student completing Master's Degree in Science program will be able to:**
GA1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
GA5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.

GA7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

PO	Description **A student completing Master's Degree in Science program in the subject of Microbiology will be able to:**
PO 1	Recall the basic concepts of gene expression and regulation, exemplify cytoplasmic inheritance and transposons. Analyse the genetics underlying cancer and cell cycle. Solve problems based on allelic and genotypic frequencies
PO 2	Apply the principles of thermodynamics to understand stability of biological molecules, execute experiments for their detection and estimation in samples. Summarize the metabolism of one and two carbon compounds by microorganisms
PO 3	Attribute pathogenesis of diseases to virulence mechanisms, outline the pathogenesis, transmission and treatment of emerging bacterial and viral infections. Recognize the role of microbiome in the overall physiology of humans.
PO 4	Acquire skills to work in a clinical laboratory. Execute antibiotic susceptibility assays and evaluate efficacy in context of antibiotic resistance. Also, implement diagnostic tests for infectious diseases. Recall aspects in epidemiological study designs and public health surveillance and detect agents that could be associated with bioterrorism.
PO 5	Formulate a hypothesis, design a research project, execute the experiments including appropriate calibrations and controls, implement appropriate methods for data collection and analyse data with appropriate statistical tools.
PO 6	Recall the structure and functions of cell membrane and cytoskeleton as well as the concept of protein trafficking and transport. Compare various transport mechanisms, and analyse the significance of cell to cell

	communication. Explain the process of development and organogenesis in higher animals and correlate it to genes with specific reference to Drosophila.
PO 7	Execute extraction, purification and analysis of various biomolecules. Compare the mechanisms of enzyme catalysis of different classes of enzymes and solve problems on enzyme kinetics. Recall different cell signalling mechanisms. Outline the biochemistry of degradation of various xenobiotics by microorganisms
PO 8	Recall methods used to study microbial ecology and execute analysis of samples from varied environments. Extrapolate potential of extremophilic proteins to industrial applications, attribute problems like biofouling and biocorrosion to microbial activity. Recall the role of microbes in soil and demonstrate their role in plant growth. Outline, appreciate and apply the principles of solid and hazardous waste management and appreciate various regulations enacted with respect to biosafety.
PO 9	Access appropriate biological databases and apply various bioinformatics tools for varied analysis, recall concepts of synthetic biology and systems biology. Extrapolate understanding of contemporary tools in Molecular Biotechnology for DNA sequencing, mutagenesis and protein expression studies. Execute experiments for preparation of nanoparticles and their analysis
PO 10	Understand and evaluate the significance of viral genetics in representative bacterial viruses and apply it in rDNA technology. Recall and extrapolate the types of animal and plant viruses, describe their mechanisms of infections, control and treatment. Explain and give an overview of emerging & re-emerging viral infections responsible for causing pandemics. Outline the mechanism of tumorigenesis by oncogenic viruses.

PO 11	Recall detailed mechanisms of innate and adaptive immunity, and emphasize the molecular interactions that help distinction of self from non self in immune mechanisms. Outline the mechanisms of immune tolerance and exemplify reasons for autoimmune diseases as well as cancer. Apply principles of immunoassays for execution of diagnosis of disorders and diseases. Summarize and illustrate concepts in immunotherapy. Extrapolate basics of vaccine development to combat emerging infections
PO 12	Understand and implement different concepts in microbial approaches to quality control and management in industries. Check food and water samples for microbiological quality as per prescribed standards and maintain records. Recall concepts and monitor processes in food industry, bottled water manufacturing units and monitor processes and products of pharmaceutical industry with emphasis on BIS regulations, regulatory frameworks, GMP and HACCP, GLP, ISO standards and validation.
PO 13	Recall and explain the principle and working of techniques like spectroscopy, chromatography, hyphenated techniques, PCR based assays, microarrays, electrophoresis, X ray diffraction and SPR and compare all the different types included under each technique. Understand and extrapolate these concepts to analyse biological samples for biomolecular composition and/or structure.
PO 14	Understand, explain and Apply concepts in bioinformatics, proteomics, high throughput screening and pharmacogenomics for discovering new drugs
PO 15	Recall and apply various concepts in modern Biotechnology like gene therapy, stem cell technology, 16SrRNA sequencing in fields like diagnostics, therapeutics and genetic counselling. Summarize and

	evaluate the biotechnological potential of fungi and algae for production of commercial products like pharmaceutics, pigments, enzymes, biofuels etc. and in processes like bioremediation and wastewater treatment. Summarize and interpret the laws for IPR, biodiversity conservation and recall the perspectives of bioethics. Implement patent searches and outline prerequisites and steps in patentability.
PO 16	Categorize biofuels and outline fermentation technologies for their manufacture. Exemplify enzymes with industrial potential and recall and explore technologies like immobilization for their application in industrial products. Explain techniques in protein engineering for increasing activity and specificity.
PO 17	Outline work plans and execute tasks independently and to completion. Coordinate and cooperate with team members for execution of experiments. Maintain records, make reports and interpret them for making summaries. Communicate information accurately and effectively. Follow ethical practices at workplace, take initiative, exhibit competency and imbibe other professional skills.
PO 18	Apply theoretical concepts effectively and think innovatively to translate ideas to research projects and projects to products. Understand the significance of microbiology as a science that has transdisciplinary relevance and immense potential to improve quality of life for all humankind.

Credit structure for MSC

Semester	Mandatory	Elective	RM	OJT/FP	RP/ Internship	Credits
1	14	4	4	0	0	22
2	14	4	0	4 FP	0	22
3	12	4	0	0	6 RP	22
4	8	4	0		10 OJT	22
Total CREDITS	**48**	**16**	**4**	**4**	**16**	**88**

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc I	I	RPSMICO501 (Core Course)	GENETICS-I	03
		RPSMICPO501	Practical based on Genetics- I	01
		RPSMICO502 (Core Course)	BIOCHEMISTRY	03
		RPSMICPO502	Practical based on Biochemistry	01
		RPSMICO503 (Core Course)	MEDICAL MICROBIOLOGY	03
		RPSMICPO503	Practical based on Medical Microbiology	01
		RPSMICO504	GENETICS-II	02
		RPSMICRMO505	RESEARCH METHODOLOGY	04
		Student should select anyone of the following Course		
		RPSMICO506 (Discipline Specific Course)	CLINICAL MICROBIOLOGY EPIDEMIOLOGY	03
		RPSBCHO506 (Discipline Specific Course)	PLANT BIOCHEMISTRY	
		RPSBTKO506 (Discipline Specific Course)	CLINICAL DATA MANAGEMENT	
		RPSMICPO506/ RPSBCHPO506/ RPSBTKPO506	Practical based on Clinical Microbiology and Epidemiology	01
			Total Credits	22
MSc I	II	RPSMICE511 (Core Course)	CELL BIOLOGY	03
		RPSMICPE511	Practical based on Cell biology	01

		RPSMICE512 (Core Course)	**MICROBIAL BIOCHEMISTRY**	**03**
		RPSMICPE512	**Practical based on Microbial Biochemistry**	**01**
		RPSMICE513 (Core Course)	**ENVIRONMENTAL MICROBIOLOGY**	**03**
		RPSMICPE513	**Practical based on Environmental Microbiology**	**01**
		RPSMICE514	**BIOINSTRUMENTATION**	**02**
		RPSMICE515	**Field Project**	**04**
		Student should select anyone of the following Course		
		RPSMICE516 (Discipline Specific Course)	**MICROBIAL APPROACHES TO QUALITY MANAGEMENT**	**03**
		RPSBCHE516 (Discipline Specific Course)	**NUTRACEUTICALS AND FUNCTIONAL FOODS**	
		RPSBTKE516 (Discipline Specific Course)	**NANOTECHNOLOGY**	
		RPSMICPE516/ RPSBCHE516/ RPSBTKE516	**Practical based on Microbial Approaches to Quality Management**	**01**
			Total Credits	**22**
MSc II	**III**	**RPSMICO601 (Core Course)**	**IMMUNOLOGY**	**03**
		RPSMICPO601	**Practical based on Immunology**	**01**
		RPSMICO602 (Core Course)	**FUNGAL, ALGAL BIOTECHNOLOGY AND BIOINFORMATICS**	**03**
		RPSMICPO602	**Practical based on Fungal, Algal Biotechnology and Bioinformatics**	**01**
		RPSMICO603 (Core Course)	**BACTERIAL BIOTECHNOLOGY**	**03**
		RPSMICPO603	**Practical based on Bacterial Biotechnology**	**01**

		Student should select anyone of the following Course		
		RPSEMICO604 (Discipline Specific Course)	**CLINICAL MICROBIOLOGY EPIDEMIOLOGY**	**03**
		RPSEBCHO604 (Discipline Specific Course)	**PLANT BIOCHEMISTRY**	
		RPSEBTKO604 (Discipline Specific Course)	**CLINICAL DATA MANAGEMENT**	
		RPSEMICPO604/ RPSEBCHPO604/ RPSEBTKPO604	**Practical based on Clinical Microbiology and Epidemiology**	**01**
		RPSRPMIC605	**RESEARCH PROJECT**	**06**
			Total Credits	**22**
MSc II	**IV**	**RPSMICE611 (Core Course)**	**VIROLOGY**	**03**
		RPSMICE612 (Core Course)	**EMERGING AREAS IN BIOLOGY**	**03**
		RPSMICPE611	**Practical based on Virology**	**01**
		RPSMICPE612	**Practical based emerging areas in Biology**	**01**
		Student should select anyone of the following Course		
		RPSEMICE613 (Discipline Specific Course)	**ADVANCES IN BIOTECHNOLOGY**	**03**
		RPSEBCHE613 (Discipline Specific Course)	**NUTRACEUTICALS AND FUNCTIONAL FOODS**	
		RPSEBTKE613 (Discipline Specific Course)	**NANOTECHNOLOGY**	
		RPSEMICPE613/ RPSEBCHPE613/ RPSEBTKPE613	**Practical based on ADVANCES IN BIOTECHNOLOGY/ NUTRACEUTICALS AND**	**01**

			FUNCTIONAL FOODS/ NANOTECHNOLOGY	
		RPSINTMICE614	**INTERNSHIP**	**10**
			Total Credits	**22**

Course Code: RPSMICO601(Core Course)

Course Title: Immunology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Explain the defence mechanisms in the human body against various infectious agents
CO 2	Recall the key players of innate and adaptive immune response
CO 3	Compare the T cell dependent and T cell independent immune responses
CO 4	Integrate the understanding of immune tolerance to distinguish between autoimmune and Immunity Mediated Inflammatory Disease
CO 5	Distinguish between immune tolerance and immune therapy and extend its application to treatment of Cancer

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMICO601 (Core Course)		**IMMUNOLOGY**	**03/45**
I		**Defense against infectious agents**	**15**
		a) Viral infections b) Bacterial infections c) Fungal infections d) Parasitic and worm infections e) Emerging and re-emerging infections	**4** **4** **2** **3** **2**
II		**Mechanisms of Innate immunity and Acquired Immunity**	**15**
	2.1	**Innate Immunity**	**7**
		a) Inflammation i) Role of cytokines and chemokines in leucocyte recruitment ii) Inflammatory mediators b) Phagocytosis i) Role of PAMP's ii) Soluble pattern recognition molecules iii) TLR's and CLR's c) Evasion of Innate immune mechanisms	
	2.2	**Acquired Immunity**	**8**
		a) Molecular basis of diversity of immunoglobulin molecules i) Mechanism of VDJ recombination ii) Other mechanisms of generation of antibody diversity b) Introduction to Mechanisms of T dependent and independent responses	
III		**Immune tolerance and Autoimmunity**	**15**
	3.1	**Establishment of immune tolerance**	**6**
		a) Central Tolerance, Peripheral Tolerance, Regulatory T cells b) B cell tolerance	
	3.2	**Autoimmunity and Immune Linked Inflammatory diseases**	**7**
		a) Autoimmunity i. Spectrum of autoimmune diseases ii. Genetic factors for autoimmunity	

		iii. Induction of autoimmunity iv. Treatment of autoimmune diseases b) Introduction to Immune mediated inflammatory diseases (IMID) i. Definition and examples	
	3.3	**Cancer Immunology**	**2**
		a) Tumor antigens b) Anti-Tumor Immune responses	

REFERENCES:

a) Oven, Punt, Stranford, Kuby "Immunology", 7th Ed W.H. Freeman, 2013

b) Male, Brostoff, Roth, Roitt, "Immunology", 8th Ed, Elsevier, 2013

c) Sulabha Pathak, Urmi Palan, "Immunology: Essential and Fundamental", 3rd Ed, Anshan Ltd, 2011

d) Roitt, Delves, Roitt's , "Essential Immunology", 10th Ed Blackwell Science, 2001

e) Delves, Martin, Burton, Roitt, Roitt's "Essential Immunology", 13th Ed, Wiley Blackwell, 2011

f) Krupa Naran, Trishana Nundalall, "Principles of Immunotherapy: Implications for Treatment Strategies in Cancer and Infectious Diseases", *Frontiers in Microbiology,* 2018, Volume:9, Article 3158

g) Laura Walker, Dennis Burton, "Passive Immunotherapy of Viral Infections: 'Super-antibodies' enter the fray", *Nature Reviews Immunology,* 2018, Volume 18.

h) Annabel Kuek, Brian L Hazleman, Andrew J K Ostor, "Immune-mediated inflammatory diseases (IMIDs) and biologic therapy: a medical revolution", *Postgrad Med J*, 2007;83:251–260. doi: 10.1136/pgmj.2006.052688

i) Caroline L. Sokol and Andrew D. Luster, "The Chemokine System in Innate Immunity", *Cold spring Harbour Perspectives in Biology*, 2019.

j) Taro Kawai and Shizuo Akira, "Toll-like Receptors and Their Crosstalk with Other Innate Receptors in Infection and Immunity", *Immunity,* 2011

k) Shirly Frizinsky, *et al.,* "The innate immune perspective of autoimmune and autoinflammatory conditions", *Rheumatology*, 2019;58:vi1vi8

PRACTICAL: RPSMICPO601 (Core Course) (30 Contact Hrs)

a) Phagocytosis & Phagocytic index
b) Collection of human blood & separation of mononuclear cells by Ficoll Hypaque density gradient centrifugation,
c) Counting of viable cells by trypan blue
d) Rocket immunoelectrophoresis
e) SRID
f) Demonstration of Flow cytometry

Course Code: RPSMICO602 (Core Course)

Course Title: Fungal, Algal Biotechnology and Bioinformatics

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Evaluate the commercialization potential of fungal strains & understand the current trends in fungal biotechnology.
CO 2	Interpret the potential of microalgae in producing biofuels & biofertilizers.
CO 3	Understand the basic principles of Bioinformatics
CO 4	Analyse the sequence data using Bioinformatics tools
CO 5	Summarize the types and uses of various bioinformatics tools

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMICO 602 (Core Course)		**FUNGAL, ALGAL BIOTECHNOLOGY AND BIOINFORMATICS**	**03/45**
I		**Fungal Biotechnology**	**15**
	1.1	**Introduction Fungal world**	**05**
		a) An overview of Fungi and fungal activities b) Fungal growth and Fungal nutrition c) Fungal Genetics	
	1.2	**Applications of Fungal Biotechnology**	**10**
		a) Fungal bioremediation b) Fungal Biocatalysts in the textile industry and waste water treatment c) Fungal Pigments d) Myconanotechnology e) Fungal Antitumor agents and Recombinant Peptides	
II		**Algal Biotechnology**	**15**
	2.1	**The microalgal cell**	**04**
		a) Introduction b) Structural and Morphological features of Microalgae c) Ultrastructure and cell division d) Cell growth and development e) Microalgal systematics	
	2.2	**Basic culturing techniques**	**07**
		a) Isolation of Microalgae b) Screening of Microalgae for bioactive molecules c) Measurement of Growth Parameters d) Modes of culture e) Introduction to Photobioreactors and their types	
	2.3	**Applications of Algal Biotechnology**	**04**
		a) Microalgae as platforms for Recombinant proteins b) Algae as a source of Biofuel c) Algae as biofertilizer for rice	
III		**Bioinformatics**	**15**
	3.1	**Introduction to Bioinformatics**	**02**

		a) What Is Bioinformatics? b) Goal c) Scope d) Applications e) Limitations f) New Themes	
	3.2	**Introduction to Biological Databases**	**03**
		a) What Is a Database? b) Types of Databases c) Biological Databases d) Pitfalls of Biological Databases e) Information Retrieval from Biological Databases	
	3.3	**Pairwise Sequence Alignment**	**04**
		a) Evolutionary Basis b) Sequence Homology versus Sequence Similarity c) Sequence Similarity versus Sequence Identity d) Methods e) Scoring Matrices f) Statistical Significance of Sequence Alignment	
	3.4	**Database Similarity Searching**	**03**
		a) Unique Requirements of Database Searching b) Heuristic Database Searching c) Basic Local Alignment Search Tool (BLAST) d) FASTA e) Comparison of FASTA and BLAST f) Database Searching with the Smith–Waterman Method	
	3.5	**Multiple Sequence Alignment**	**03**
		a) Scoring Function b) Exhaustive Algorithms c) Heuristic Algorithms d) Practical Issues	

REFERENCES:

a) Jim Deacon, “Fungal Biology”, 4th Ed, Blackwell Publishing, 2006
b) Tulasi Satyanarayana and Sunil K. Deshmukh, “Developments in Fungal Biology and Applied Mycology”, Springer, 2017
c) Dinabandhu Sahoo, “The Algae World”, Volume 26, Springer, 2015.
d) Robert Andersen, “Algal culturing Techniques”, Elsevier Academic Press, 2005
e) Yuan Kun Lee, Microbial Biotechnology: Principles & Applications, 2nd edition, 2006, World Scientific Publishing Company.
f) Jin Xiong Ëssential Bioinformatics” Cambridge University Press, 2006
g) Henrik Christensen, “Introduction to Bioinformatics in Microbiology”, Springer International Publishing, 2018
h) Arthur Lesk, “Introduction to Bioinformatics”, Oxford University Press, 2013

PRACTICAL: RPSMICPO602 (30 CONTACT HRS.)

a) Growth curve of *Aspergillus spp* and *Candida spp* in complex and defined medium
b) Biosorption of textile dyes using fungal biomass
c) Silver Nanoparticles synthesis using fungal biomass
d) Extraction of pigment from fungi *Talaromyces verruculosus*
e) Cultivation of cyanobacteria
f) Growth curve of Spirulina
g) Extraction of oil from algae
h) Exploration of DNA and protein databases
i) Pair-wise and multiple alignment of DNA and Amino acid sequences
j) Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained
k) Visiting & exploring various databases mentioned in syllabus
l) Using BLAST and FASTA for sequence analysis
m) Six frame translation of given nucleotide sequence
n) Restriction analysis of given nucleotide sequence
o) Pair-wise alignment and multiple alignment of a given protein sequences
p) Protein structure visualisation using Protein Data Bank

Course Code: RPSMICO603 (Core Course)

Course Title: Bacterial Biotechnology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand various factors that affect the synthesis of amino acid production by microorganisms
CO 2	Illustrate various processes of amino acid fermentation
CO 3	Analyse the process of antibiotic synthesis and industrial production
CO 4	Classify and categorise various microbial polysaccharides and understand its applications
CO 5	Interpret various aspects of prebiotics and probiotics
CO 6	Define and understand the process and importance of bioremediation

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMICO603 (Core Course)		**BACTERIAL BIOTECHNOLOGY**	**03/45**
	I	**Synthesis of Commercial Products from Micro-organisms-I**	**15**
	1.1	**Synthesis of Primary Metabolite- Amino acids**	**07**
		a) Microbial strains employed in Amino acids production i. Direct production of Amino acids from Carbon sources ii. Precursor addition method iii. Enzymatic methods b) Process control in Animo acid fermentation i. Maintenance of pure culture conditions ii. Automatic control of Amino acid fermentation iii. Agitation Aeration effectiveness	
	1.2	**Synthesis of Secondary Metabolite- Antibiotics**	**04**
		a) Synthesis of Streptomycin i. Introduction ii. Chemical structure iii. Production iv. Harvest and Recovery v. Vitamin B as by product b) Development of Newer Amino glycosides	
	1.3	**Synthesis of Microbial Polysaccharides**	**04**
		a) Nature of Microbial Polysaccharide b) Mechanisms of Synthesis c) Bacterial Polysaccharides- Azotobacteraceae d) Fungal Polysaccharides- Pullulans e) Yeast Polysaccharide- Phosphomannan f) Commercial polysaccharides- Xanthan Gum i. Composition ii. Production iii. Industrial Applications	
	II	**Synthesis of Commercial Products from Micro-organisms-II**	**15**
	2.1	**Probiotics and Prebiotics**	**10**
		a) Isolation, Identification and Characterization of Probiotics b) Identification and Enumeration of Probiotics	

		c) Industrial Aspects of Probiotics d) Introduction to Prebiotics	
	2.2	**Microbial fructo-oligosaccharides (FOS)**	**02**
		a) Introduction b) Fermentation of FOS by Gut Microbiota c) Beneficial Effects of FOS and Mechanisms	
	2.3	**Microbial Insecticides**	**03**
		a) Insecticidal toxin of *B. thuringiensis* i. Mode of action and Use ii. Toxin Gene Isolation b) Engineering of *B. thuringiensis* Toxin Genes i. Synthesis during vegetative growth	
III		**Microbial Degradation and Bioremediation**	**15**
	3.1	**Degradation of complex polymers**	**03**
		a) Cellulose b) Lignin c) Lignocellulose	
	3.2	**Microbial Transformations**	**02**
		a) Mercury Transformations i. Microbial Redox Cycle for Mercury ii. Mercury Resistance	
	3.3	**Mineral Recovery and Acid Mine Drainage**	**03**
		a) Mining with Microorganisms i. The Leaching Process ii. Metal Recovery iii. Other Microbial Leaching Processes: Uranium and Gold Acid Mine Drainage	
	3.4	**Microbially Influenced Corrosion of Metals**	**02**
		a) Metal Corrosion by Sulfate-Reducing Bacteria b) Mechanisms of Metal Corrosion	
	3.5	**Bioremediation**	**05**
		a) Bioremediation of Uranium-Contaminated Environments i. Bioremediation of Uranium ii. Bacterial Transformations of Uranium a) Bioremediation of Organic Pollutants: Hydrocarbons i. Petroleum and Hydrocarbon Bioremediation ii. Degradation of Stored Hydrocarbons b) Bioremediation of Organic Pollutants: Pesticides and Plastics i. Pesticide Catabolism ii. Dechlorination Plastics	

REFERENCES:

a) Madigan, M., Martinko, J., Stahl, D., Clark, D. P. (2011). Brock Biology of Microorganisms. (n.p.): Pearson Education.
b) Casida, L. E. (1968). Industrial Microbiology. United Kingdom: Wiley.
c) Microbial Technology: Microbial Processes. (2012). United Kingdom: Elsevier Science.
d) Advances in Probiotic Technology. (2015). United States: CRC Press.

PRACTICAL: RPSMICPO603 (30 CONTACT HRS.)

a) Production and purification L-glutamate from *Corynebacterium glutamicum*
b) Production and purification of Streptomycin from *Streptomycetes griseus*
c) Bioassay of Streptomycin
d) Production and isolation of bacterial polysaccharide
e) Isolation of Xanthan gum from Xanthomonas campestris
f) Isolation and characterization of Lactic acid bacteria as candidate for Probiotic
g) Effect of Fructooligosaccharides (FOS) on the growth of Lactic acid bacteria
h) Larvicidal activity of *Bacillus thuringiensis*
i) Enrichment and isolation of cellulose, lignin degraders from soil sample
j) Bacterial degradation of petroleum hydrocarbon
k) Bacterial degradation of pesticides

Modality of Assessment for Core Courses

RPSMICO601, RPSMICO602, RPSMICO603:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	10
2	Class test	20
	Total	**30**

B) External Examination- 60%- 45 Marks per paper

1. Duration- These examinations shall be of **two hours**.
2. Theory question paper pattern-

a. There shall be **three** questions each of **15** marks. On each unit there shall be one question.

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

Paper pattern:

Question	Options	Marks	Questions based on
Q.1) a)	Any 2 out of 3	10	Unit 1
Q.1) b)	Any 5 out of 7	5	Unit 1
Q.2) a)	Any 2 out of 3	10	Unit 2
Q.2) b)	Any 5 out of 7	5	Unit 2
Q.3) a)	Any 2 out of 3	10	Unit 3
Q.3) b)	Any 5 out of 7	5	Unit 3

II) Practical Examination Pattern

	RPSMICO601	**RPSMICO602**	**RPSMICO603**
Viva and Quiz	05	05	05
Laboratory work	20	20	20
Total	**25**	**25**	**25**

Journal

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

DSE (Discipline Specific Elective)
Students have to select any one of the following courses
Course Code: RPSEMICO604
Course Title: Clinical Microbiology and Epidemiology
Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Apply appropriate methodologies to tackle the threat of antibiotic resistance
CO 2	Perform and analyse all kinds of clinical microbiological tests associated with antibiotic susceptibility testing
CO 3	Demonstrate a basic understanding of epidemiological strategies, study designs and evaluate the data for its statistical relevance.
CO 4	Discuss and understand the strategies to detect & monitor biological agents used for bioterrorism & exemplify the significance of biosecurity.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSEMICO604 (Discipline Specific Elective)		**CLINICAL MICROBIOLOGY AND EPIDEMIOLOGY**	**03/45**
I		**Clinical Microbiology- General principles**	**15**
	1.1	**General Principles of Clinical Microbiology**	**5**
		a) Laboratory Safety and Preventing the Spread of Disease b) Design of the Clinical Microbiology Laboratory c) Quality in the Clinical Microbiology Laboratory d) Legal and Ethical Issues	
	1.2	**Clinical microbiology- Processes and Recent trends**	**10**
		a) Phases of the diagnostic cycle b) Overview of Specimen Collection and Processing c) Specimen management and workup- Overview of classical and modern bacterial Identification Methods and Strategies d) Decontamination, Disinfection, and Sterilization during surgeries e) Automation and HTS in diagnosis f) Point of care diagnostics	
II		**Clinical Microbiology- Antibiotic resistance and Antibiotic susceptibility testing**	**15**
	2.1	a) Antibiotic resistance in microbes	**07**
		a) Antimicrobial resistance- General principles b) Mechanisms of antibiotic resistance in bacteria and fungi - overview c) Transfer of antibiotic resistance d) Maintaining antibiotic resistance through Selective Pressure e) Methods for detection of resistance f) Antimicrobial stewardship, surveillance of antimicrobial consumption, and its consequences	
	2.2	b) Antibiotic susceptibility testing	**08**
		a) General considerations- selection, Indications, b) Pharmacokinetic and pharmacodynamics Principles, Clinical relevance of antibiotic	

		sensitivity tests, Serum killing curves c) Susceptibility Test Methods: Dilution and Disk Diffusion Methods- standardization, QC, Procedures and interpretation d) Antimicrobial Susceptibility Testing Systems e) Special methods- Bactericidal tests, Testing antibiotic combinations	
III		**Epidemiology**	**15**
	3.1	**Introduction to Epidemiology**	**07**
		a) Historical aspects-definition b) Descriptive Epidemiology-aims and uses c) Recent Applications of Epidemiology d) Introduction e) Observational Versus Experimental approaches in Epidemiology f) Overview of study designs used in Epidemiology g) Ecologic Studies h) Cross-Sectional studies i) Case-Control studies	
	3.2	**Public health surveillance**	**04**
		a) Purpose and characteristics b) Identifying health problems for surveillance c) Collecting data for surveillance d) Analysing and interpreting data e) Disseminating data and interpretation f) Evaluating and improving surveillance	
	3.3	**Healthcare-associated infections**	**04**
		a) Surveillance for HAIs b) Major types of HAIs c) The need for integrated infection control programs	

REFERENCES:

a) Patricia M. Tille, Bailey and Scott's Diagnostic Microbiology, 13th ed, 2014, Mosby Inc

b) Dawey et al., Antimicrobial Chemotherapy, 7th ed. 2014, Oxford Univ Press

c) Ed by Jorgensen et al., Manual of Clinical Microbiology, 11th ed., 2015, ASM Press Volume 1 and 2

d) Lieseke, Zeibig, Essentials of Medical Laboratory Practice, 2012, F.A. davis Co.

e) Brenda Wilson, Abigail Salyers et al, "Bacterial Pathogenesis- A molecular approach", 3rd ed, ASM press, 2011

f) J. Vandepitte, J. Verhaegen et al, "Basic laboratory procedures in clinical bacteriology", 2nd ed, WHO, Geneva, 2003

g) Gary Procop, Elmer Koneman et al, “Koneman's Color Atlas and Textbook of Diagnostic Microbiology”, 7th Edition, Wolters Kluwer, 2017
h) Principles of epidemiology in public health practices 3rd Ed. (www.cdc.gov/training/products/ss1000)
i) Kenrad E. Nelson, Infectious Disease Epidemiology – Theory and Practice, 3rd ed.

PRACTICAL: RPSEMICPO604 (Discipline Specific Elective) (30 CONTACT HRS)

a) QC of laboratory media
b) QC of laboratory reagents
c) Antimicrobial susceptibility testing- disc method according to CLSI guidelines
d) QA of Antibiotic Susceptibility Test- disc method
e) Antibiotic Susceptibility Test – microdilution methods according to CLSI guidelines
f) Checkerboard assay
g) E-test
h) Octa-disc method for AST

Modality of Assessment for Discipline Specific Elective RPSEMICO604:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	10
2	Class test	20
	Total	**30**

B) External Examination- 60%- 45 Marks per paper

3. Duration- These examinations shall be of **two hours**.
4. Theory question paper pattern-
    c. There shall be **three** questions each of **15** marks. On each unit there shall be one question.
    d. All questions shall be compulsory with internal choice within the questions.

Paper pattern:

Question	Options	Marks	Questions based on
Q.1) a)	Any 2 out of 3	10	Unit 1
Q.1) b)	Any 5 out of 7	5	Unit 1
Q.2) a)	Any 2 out of 3	10	Unit 2
Q.2) b)	Any 5 out of 7	5	Unit 2
Q.3) a)	Any 2 out of 3	10	Unit 3
Q.3) b)	Any 5 out of 7	5	Unit 3

II) Practical Examination Pattern

	RPSEMICPO604
Viva and Quiz	05
Laboratory work	20
Total	**25**

Journal

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department; failing which the student will not be allowed to appear for the practical examination.

Course Code: RPSRPMICO605
Course Title: Research Project
Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand various aspects of research projects like literature survey, planning of experiments, recording and analysing data.
CO 2	Interpret the results of the experiments conducted in research project
CO 3	Apply the theoretical background of the subject to the research problem
CO 4	Analyse the data acquired during the research project
CO 5	Predict the possible outcomes of the results obtained in the project

a) DETAILED SYLLABUS

Course Code	Course/ Unit Title	Credits
RPSRPMICO605	**RESEARCH PROJECT**	**06**
	Research Project on a selected topic	

Modality of Assessment for Research Project:

Research Project Marking Pattern

Criteria	Marks
Proposal Writing and Lab work	75
Thesis and Poster presentation	75
Total	**150**

Research project work

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

Overall Examination and Marks Distribution Pattern

Semester III

Course	RPSMIC O601			RPSMIC O602			RPSMIC O603			RPSRPMICO605 Research Project					RPSEMIC O604			Grand total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Proposal Writing	Thesis	Poster and Viva Voce	Lab work	Total	Internal	External	Total	
Theory	30	45	75	30	45	75	30	45	75	-	-	-	-	-	30	45	75	300
Practical	-	25	25	-	25	25	-	25	25	-	-	-	-	-	-	25	25	100
Research Work	-	-	-	-	-	-	-	-	-	25	50	25	50	150	-	-	-	550

SEMESTER 4
Course Code: RPSMICE611 (Core Course)
Course Title: Virology
Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand and compare the types of bacterial viruses, their structure, mode of replication and their characteristic features
CO 2	Summarize and infer the significance of viral genetics to map the genes and decode the ways to construct and use phage vectors in rDNA technology
CO 3	Recall the types of plant viruses, their general mechanisms of infections, steps in inducing the infection, diagnosis & control of plant viral infections
CO 4	Demonstrate an in depth understanding of the types and structure of animal viruses, their pathogenesis and attribute it to the mode of transmission, diagnosis, control & therapy of different animal viral infections
CO 5	Differentiate between the mechanisms of pathogenesis of plant and animal viruses
CO 6	Illustrate and exemplify the types and mechanisms of oncolytic viruses and their tumorigenic characteristics.
CO 7	Integrate knowledge on the novel emerging & re-emerging viral infections to attribute to pandemics
CO 8	Apply molecular biology techniques& bioinformatics tools to diagnose & control viral infections

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMICE611 (Core course)		**VIROLOGY**	**03/45**
I		**Viral Genetics & Bacterial Viruses**	**15**
	1.1	**Viral genetics**	**04**
		a) Mapping the Bacteriophage genome. b) Phage phenotypes c) Genetic recombination in phages d) Genetic fine structure mapping e) Deletion mapping f) Genes within genes: Bacteriophage ΦX174 g) Constructing phage vectors-phage display vectors, suicide vectors, combining phage vectors and transposons	
	1.2	**Bacteriophages**	**02**
		General properties of phages, properties of phage infected Bacterial cultures, Specificity of Phage Infection	
	1.3	***E.coli* Phage T4**	**02**
		Properties of T4 DNA, Genetic organization, the T4 growth cycle, Replication of T4 DNA	
	1.4	***E.coli* PhageT7 and Lambda**	**03**
		Organization of the T7 genes, Growth Cycle, Regulation of transcription of T7phage.	
	1.5	***E.coli* Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle.**	**04**
II		**Plant Viruses**	**15**
	2.1	**Plant viruses: General features & infection process**	**04**
		a) Morphology b) Modes of Transmission c) General life cycle d) Symptoms of infection	

	2.2	**Virus-plant interactions: steps in induction of disease**	**04**
	2.3	**Plant satellite viruses and satellite Nucleic acids**	**02**
	2.4	**Citrus Tristeza Virus (CTV): Viral structure, Genome, Host range, Transmission, Symptoms and Control.**	**03**
	2.5	**Diagnosis and control of viral infections in plants**	**02**
III		**Animal Viruses**	**15**
		Study of Structure, replication, life cycle, pathogenesis, transmission, clinical features- Signs & symptoms, diagnosis and control of following viral infections:	
	3.1	**Rabies**	**02**
	3.2	**Polio**	**03**
	3.3	**Hepatitis**	**04**
	3.4	**Pox virus, Vaccinia Virus, Orthopox virus, Variola Virus**	**03**
	3.5	**HSV and Varicella Zoster**	**02**
	3.6	**Epstein Barr & Cytomegalovirus**	**01**

REFERENCES:

a) Luria, General Virology, 3rd Edition, John Wiley & Sons, 1978
b) Edward Birge, Bacterial and Bacteriophage Genetics, 5th edition, Springer Publications, 2006
c) Flint, Enquist, Racaniello & Skalka, Principles of Virology– Vol I and II, 3rd Edition, ASM, 2008
d) Teri Shors, Understanding Viruses, 3rd Edition, Jones and Bartlett pub, 2016.
e) Roger Hull, Matthew's Plant Virology, 4th edition, Academic Press, 2001.
f) Edward K Wagner, Basic Virology, 3rd Edition, Blackwell Publishing house, 2008.

PRACTICAL: RPSMICPE611 (30 CONTACT HRS)

a) Enrichment of coliphages & phage assay.
b) One step growth curve.
c) Induction of lytic cycle.
d) Demonstration of Chick embryo inoculation.
e) Case Studies on emerging viral infections.
f) Visit to Enterovirus Centre
g) Demonstration of viral cultivation using cell lines

Course Code: RPSMICE612 (Core Course)
Course Title: Emerging areas in Biology
Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Identify & implement potential solutions for energy needs by evaluating existing & novel biomass to energy technologies
CO 2	Explain and recall the alternative sources for exhaustible fuels in the form of variety of biofuels.
CO 3	Critique the current and emerging trends of enzyme technology & discuss the applications of enzymes.
CO 4	Understand & execute methods for production, purification, characterization & immobilization of enzymes.
CO 5	Apply the understanding of immunological techniques for analysis of immune responses
CO 6	Critically evaluate the newer methods of vaccine developments

DETAILED SYLLABUS

Course Code	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSMICE612 (Core Course)		**EMERGING AREAS IN BIOLOGY**	**04/60**
I		**Bioenergy and Bioconversions**	**15**
	1.1	Classification of biofuels: a) Conventional and Advanced Biofuels 1st generation biofuels- sugar and starch-based ethanol, conventional biodiesel, biogas b) 2nd generation biofuels – cellulosic ethanol, advanced biodiesel, biooils and biobutanol c) 3rd generation biofuels- Biohydrogen and algal based fuels. d) 4th generation biofuels e) Syngas/ Biogas production f) Types of feedstocks g) Process types and digestors used	**09**
	1.2	**Microbial fuel cells**	**03**
	1.3	a) Bioconversion of Lignocelluloses into food and feed rich in protein b) Bioconversion of industrial cellulosic pulp materials to protein-enriched food and feeds	**03**
II		**Enzyme Technology**	**15**
	2.1	**Different types enzymes, production and enzymatic analysis and assay methods**	**08**
		a) Amylases b) Cellulases c) Lipases d) Laccases e) Proteases	
	2.2	**Enzyme immobilization- Need, methods, Carriers and applications**	**05**
	2.3	**Therapeutic enzymes**	**02**
III		**Techniques in Immunology, Immunotherapy and Vaccines**	**15**
	3.1	**Techniques in Immunology**	**8**
		a) Cellular Techniques i. Flow Cytometry ii. Fluorescence-activated cell sorting (FACS)	

		iii. Immunohistochemistry b) Methodologies for developing therapeutic antibodies- Humanization of mAbs and Human antibody-producing mice	
	3.2	**Immunotherapy**	**4**
		a) Cancer Immunotherapy b) Using cytokines and Mab's for Immunotherapy c) Plantibodies	
	3.3	**Vaccines**	**3**
		a) Newer approaches to vaccine development b) Malarial vaccine	

REFERENCES:

a) Biofuels Production, Ed by Vikash Babu, Ashish Thapliyal & Girijesh Kumar Patel, 2014, Scrivener Publishing LLC. Co-published by John Wiley & Sons, Inc.

b) Introduction to Biofuels, David M. Mousdale, 2010, CRC Press Taylor & Francis Group

c) Biofuels, Alternative Feedstocks and Conversion Processes, Ed by Ashok Pandey, Christian Larroche, Steven Cricke, Claude-Gilles Dussap, Edgard Gnansounou, 2011, Academic Press

d) Cui, H., Wang, L., & Yu, Y. (2015). Production and Characterization of Alkaline Protease from a High Yielding and Moderately Halophilic Strain of SD11 Marine Bacteria. Journal of Chemistry, 2015, e798304. https://doi.org/10.1155/2015/798304

e) Gopinath, S. C. B., Anbu, P., Arshad, M. K. M., Lakshmipriya, T., Voon, C. H., Hashim, U., & Chinni, S. V. (2017). Biotechnological Processes in Microbial Amylase Production. BioMed Research International, 2017, e1272193. https://doi.org/10.1155/2017/1272193

f) Javed, S., Azeem, F., Hussain, S., Rasul, I., Siddique, M. H., Riaz, M., Afzal, M., Kouser, A., & Nadeem, H. (2018). Bacterial lipases: A review on purification and characterization. Progress in Biophysics and Molecular Biology, 132, 23–34. https://doi.org/10.1016/j.pbiomolbio.2017.07.014

g) Microbial Laccases and their Applications: A Review. (n.d.). https://doi.org/10.3923/ajbkr.2011.98.124

h) Sadhu, S., & Maiti, T. K. (2013). Cellulase Production by Bacteria: A Review. Microbiology Research Journal International, 235–258 Bernard R.

i) Industrial Biocatalysis, (2015) Edited by Peter Grunwald, Pan Standard Publishing, CRC Press Taylor & Francis Group

j) Ruei-Min Lu, Yu-Chyi Hwang *etal*, "Development of therapeutic antibodies for the treatment of diseases", *Journal of Biomedical Science,* 2020, 27:1

k) Gueven Edgue, Richard M Twyman, *et al.*, "Antibodies from plants for Bionanomaterials", *WIREs Nanomedicine and Nanobiotechnology*, 2017, Volume 9

l) Krupa Naran, Trishana Nundalall, "Principles of Immunotherapy: Implications for Treatment Strategies in Cancer and Infectious Diseases", *Frontiers in Microbiology,* 2018, Volume:9, Article 3158
m) Oven, Punt, Stranford, Kuby "Immunology", 7th Ed W.H. Freeman, 2013
n) Male, Brostoff, Roth, Roitt, "Immunology", 8th Ed, Elsevier, 2013
o) Sulabha Pathak, Urmi Palan, "Immunology: Essential and Fundamental", 3rd Ed, Anshan Ltd, 2011
p) Roitt, Delves, Roitt's , "Essential Immunology", 10th Ed Blackwell Science, 2001
q) Delves, Martin, Burton, Roitt, Roitt's "Essential Immunology", 13th Ed, Wiley Blackwell, 2011
r) Ruei-Min Lu, Yu-Chyi Hwang *etal*, "Development of therapeutic antibodies for the treatment of diseases", *Journal of Biomedical Science,* 2020, 27:1
s) Gueven Edgue, Richard M Twyman, *et al.*, "Antibodies from plants for Bionanomaterials", *WIREs Nanomedicine and Nanobiotechnology*, 2017, Volume 9

PRACTICAL: RPSMICE612 (30 CONTACT HRS)

a) Qualitative detection of Amylase, Cellulase, Lipase, Laccase and Protease from bacteria.
b) Enzyme assay of Amylase, Cellulase, Lipase, Protease
c) Immobilization of Amylase, Cellulase, Lipase, Protease
d) Visit to Enzyme manufacturing and Vaccine production industry

Modality of Assessment for Core Courses

RPSMICE611, RPSMICE612:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	10
2	Class test	20
	Total	**30**

B) External Examination- 60%- 45 Marks per paper

1. Duration- These examinations shall be of **two hours**.
2. Theory question paper pattern-
3. There shall be **three** questions each of **15** marks. On each unit there shall be one question.

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

Paper pattern:

Question	Options	Marks	Questions based on
Q.1) a)	Any 2 out of 3	10	Unit 1
Q.1) b)	Any 5 out of 7	5	Unit 1
Q.2) a)	Any 2 out of 3	10	Unit 2
Q.2) b)	Any 5 out of 7	5	Unit 2
Q.3) a)	Any 2 out of 3	10	Unit 3
Q.3) b)	Any 5 out of 7	5	Unit 3

II) Practical Examination Pattern

	RPSMICE611	**RPSMICE612**
Viva and Quiz	05	05
Laboratory work	20	20
Total	**25**	**25**

Journal

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

(Discipline Specific Elective)
Student will have to select anyone of the course

Course Code: RPSEMICE613

Course Title: Advances in Biotechnology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Identify & implement potential solutions for energy needs by evaluating existing & novel biomass to energy technologies
CO 2	Explain and recall the alternative sources for exhaustible fuels in the form of variety of biofuels.
CO 3	Discuss & recall the principles & procedure of protein engineering techniques.
CO 4	Compare different methods of quantifying transcription of DNA
CO 5	Understand different types of IPR and its importance in the field of biotechnology
CO 6	Appreciate the importance of bioethics related acts in the biology research

DETAILED SYLLABUS

Course Code	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSEMICE613		**ADVANCES IN BIOTECHNOLOGY**	**03/45**
I		**Contemporary tools in Molecular Biotechnology I**	**15**
	1.1	**DNA Sequencing and Physical mapping**	**04**
		a) Dideoxynucleoside method for sequencing of DNA b) Automated DNA sequencing c) High-throughput Sequencing d) Restriction Mapping reference	
	1.2	**Heterologous protein production in eukaryotic cells**	**06**
		a) *Saccharomyces cerevisiae* *b) Pichia pastoris*	
	1.3	**Directed Mutagenesis**	**05**
		a) Oligonucleotide directed mutagenesis with plasmid DNA b) PCR amplified oligonucleotide directed mutagenesis c) Random mutagenesis with degenerate oligonucleotide primer	
II		**Contemporary tools in Molecular Biotechnology II**	**15**
	2.1	**Mapping and quantifying transcriptions**	**02**
		a) Northern Blotting b) S1 mapping c) Primer extension reference	
	2.2	**Measuring transcription rates in vivo**	**02**
		a) Nuclear Run-on b) Reverse transcription-PCR	
	2.3	**Assaying DNA–protein, protein-protein interactions**	**04**
		a) Filter binding and Gel mobility shift assays b) Chromatin immuno-precipitation (ChIP)	
	2.4	**Genome Editing with CRISPR/Cas9**	**05**
		a) Brief history & Components of CRISPR b) Advantages over TALENs or ZFNs c) Target Specificity of CRISPR/Cas9	
III		**IPR and Bioethics Traditional Knowledge & Biodiversity conservation.**	**15**
	3.1	**Types of IPR & the Need of IPR in Biotechnology**	**02**
		a) What is IPR?	

		b) Types of IPR: Patents, Trade Marks & Service Marks, Design Registration, Trade Secrets, Geographical indications, Protection of New Plant Varieties, Copyright. c) Need & Implications: Technology Transfer, Commercialization, Economic and policy implications d) Global Harmonization: TRIPS Agreement	
	3.2	**Pre-requisites for patentability, the process & its Implications**	**03**
		a) Criteria to be fulfilled for Patentability - new/novel, non-obvious/inventive step, useful/capable of industrial application. b) Steps in patentability: Application to the grant of patent c) Implications of IPR in Biotechnology	
	3.3	**Patentability in Biology: What Can and What Cannot be patented?**	**03**
		a) Indian Scenario of patentability b) Global Scenario of patentability c) Implications in policy making and commercialization due to variables	
	3.4	**Bioethics: Issues & Perspectives in the discipline of Microbiology**	**02**
		a. Ethics involved while working with Microorganisms b. Bioweapons- an Ethical issue c. Bioethics: An Indian perspective	
	3.5	**Ethical guidelines for Biomedical research in Human subjects**	**01**
	3.6	**Safety, ethical, moral implications of Genetic engineering**	**01**
	3.7	**The protection of Traditional Knowledge Bill, 2016**	**01**
	3.8	**Biodiversity Law**	**02**
		a. Need for a biodiversity law b. National Guidelines c. International Guidelines	

REFERENCES:

a) Biofuels Production, Ed by Vikash Babu, Ashish Thapliyal & Girijesh Kumar Patel, 2014, Scrivener Publishing LLC. Co-published by John Wiley & Sons, Inc.

b) Introduction to Biofuels, David M. Mousdale, 2010, CRC Press Taylor & Francis Group

c) Biofuels, Alternative Feedstocks and Conversion Processes, Ed by Ashok Pandey, Christian Larroche, Steven Cricke, Claude-Gilles Dussap, Edgard Gnansounou, 2011, Academic Press

d) Cui, H., Wang, L., & Yu, Y. (2015). Production and Characterization of Alkaline Protease from a High Yielding and Moderately Halophilic Strain of SD11 Marine Bacteria. Journal of Chemistry, 2015, e798304. https://doi.org/10.1155/2015/798304

e) Gopinath, S. C. B., Anbu, P., Arshad, M. K. M., Lakshmipriya, T., Voon, C. H., Hashim, U., & Chinni, S. V. (2017). Biotechnological Processes in Microbial Amylase Production. BioMed Research International, 2017, e1272193. https://doi.org/10.1155/2017/1272193

f) Javed, S., Azeem, F., Hussain, S., Rasul, I., Siddique, M. H., Riaz, M., Afzal, M., Kouser, A., & Nadeem, H. (2018). Bacterial lipases: A review on purification and characterization. Progress in Biophysics and Molecular Biology, 132, 23–34. https://doi.org/10.1016/j.pbiomolbio.2017.07.014

g) Microbial Laccases and their Applications: A Review. (n.d.). https://doi.org/10.3923/ajbkr.2011.98.124

h) Sadhu, S., & Maiti, T. K. (2013). Cellulase Production by Bacteria: A Review. Microbiology Research Journal International, 235–258 Bernard R.

i) Industrial Biocatalysis, (2015) Edited by Peter Grunwald, Pan Standard Publishing, CRC

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k) Glick, Jack J. Pasternak, “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, ASM Press, 2010

l) Michael Wink, “An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology”, Wiley VCH, 2006

m) Robert F. Weaver. “Molecular Biology, 5th edition”, WCB/McGraw-Hill, 2012.

n) Russell, P.J., “iGenetics- A Molecular Approach”, 3rd Ed, Pearson International Edition

o) K. Turksen (ed.), Genome Editing, DOI 10.1007/978-3-319-34148-4_1. Springer International

PRACTICAL: RPSEMICE613 (30 CONTACT HRS)

a) Assignment on Intellectual Property Rights

b) Case study on Bioethics

c) Assignment on molecular biotechnology technique

Modality of Assessment for Discipline Specific Elective RPSEMICE613

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	10
2	Class test	20
	Total	**30**

B) External Examination- 60%- 45 Marks per paper

4. Duration- These examinations shall be of **two hours**.
5. Theory question paper pattern-
    b. There shall be **three** questions each of **15** marks. On each unit there shall be one question.
    c. All questions shall be compulsory with internal choice within the questions.

Paper pattern:

Question	Options	Marks	Questions based on
Q.1) a)	Any 2 out of 3	10	Unit 1
Q.1) b)	Any 5 out of 7	5	Unit 1
Q.2) a)	Any 2 out of 3	10	Unit 2
Q.2) b)	Any 5 out of 7	5	Unit 2
Q.3) a)	Any 2 out of 3	10	Unit 3
Q.3) b)	Any 5 out of 7	5	Unit 3

II) Practical Examination Pattern

	RPSEMICPE613
Viva and Quiz	05
Laboratory work	20
Total	**25**

Journal

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department; failing which the student will not be allowed to appear for the practical examination.

Course Code: RPSINTMICE614

Course Title: Internship

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand how theoretical concepts transpire into application in workplaces like research institutes or industry
CO 2	Comprehend a scientific problem and execute prescribed protocols independently
CO 3	Demonstrate ability to complete tasks on time and record results without fabrication, falsification in prescribed formats
CO 4	Confidently communicate relevant information effectively to supervisors in clear and concise manner, in writing and orally.
CO 5	Capability to work with diverse teams with respect, empathy and understanding
CO 6	Demonstrate competency, integrity and commitment at the workplace

Course Code: RPSINTMICE614

Course Title: Internship

Detailed Syllabus

Course Code	Course/ Unit Title	Credits
RPSINTMICE614	**INTERNSHIP**	**10**
	Internship to research institute/industry	**16 weeks**

Modality of Assessment for Internship

RPSINTMICE614:

Examination Pattern- RPSINTMICE614:

Criteria	**Marks**
Internship evaluation by guide/ mentor	80
Internship report evaluation by internal faculty	50
Internship report evaluation by External Examiner	50
Internship work presentation and viva voce evaluation by External Examiner	70
Total	**250**

Internship Report

1. Candidates are required to present duly certified Internship Report dissertation report based on the topic of Internship
2. The students also have to make a PowerPoint presentation of the work done during Internship for evaluation by the examiner.

Overall Examination and Marks Distribution Pattern

Semester IV

Course	RPSMIC E611			RPSMIC E612			RPSINTMICE614 Internship					RPSEMIC E613			Grand total
	Internal	External	Total	Internal	External	Total	Internship evaluation by guide/ mentor	Internship report evaluation by internal faculty	Internship report evaluation by External Examiner	Internship work presentation and viva voce evaluation by External Examiner	Total	Internal	External	Total	
Theory	30	45	75	30	45	75	-	-	-	-	-	30	45	75	225
Practical	-	25	25	-	25	25	-	-	-	-	-	-	25	25	75
Internship	-	-	-	-	-	-	80	50	50	70	250	-	-	-	550