

S. P. Mandali's
Ramnarin Ruia Autonomous College
(Affiliated to University of Mumbai)



Syllabus for MSc Part I

Program: MSc (Microbiology)

Program Code: RPSMIC

(Credit Based Semester and Grading
System for academic year 2020–2021)

PROGRAM OUTCOMES

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.

PO	PO Description
PO 1	<p>A student completing Master's Degree in Science program will be able to:</p> <p>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.</p>
PO 2	<p>Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.</p>
PO 3	<p>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.</p>
PO 4	<p>Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.</p>
PO 5	<p>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.</p>
PO 6	<p>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</p>

	issues and understand its scientific significance and global relevance.
PO 7	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.
PO 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM SPECIFIC OUTCOMES

PSO	Description
	A student completing Master's Degree in Science program in the subject of Microbiology will be able to:
PSO 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
PSO 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
PSO 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. Execute antibiotic susceptibility assays and evaluate efficacy in context of antibiotic resistance. Also, implement diagnostic tests for infectious diseases
PSO 4	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. Abstract and paraphrase scientific information, extrapolate it and present it creatively in the appropriate scientific language for verbal and non-verbal communication, using ICT tools.
PSO 5	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.

PSO 6	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
PSO 7	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.
PSO 8	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
PSO 9	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.
PSO 10	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
PSO 11	Understand and illustrate different concepts in food microbiology like- fermentations, preservation, microbial analysis and quality control. Check food and water samples for microbiological quality as per prescribed standards and maintain records. Recall concepts and monitor processes in food industry and bottled water manufacturing units with emphasis on BIS regulations, regulatory frameworks, GMP and HACCP.
PSO 12	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.
PSO 13	Understand, explain and monitor processes in pharmaceutical industry with respect to regulatory aspects, QA, QC, GLP, ISO standards and validation. Check microbial quality of bulk and finished pharmaceutical products, judge their quality and maintain records. Apply concepts in bioinformatics, proteomics, high throughput screening and pharmacogenomics for discovering new drugs
PSO 14	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 pharmaceuticals, 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.

PSO 15	Recall aspects in epidemiological study designs and public health surveillance and detect agents that could be associated with bioterrorism. 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.
PSO 16	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.
PSO 17	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.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc I	I	RPSMIC 101	MICROBIAL GENETICS	04
		RPSMIC 1P1	Practicals based on Microbial Genetics	02
		RPSMIC 102	MICROBIAL BIOCHEMISTRY	04
		RPSMIC 1P2	Practicals based on Microbial Biochemistry	02
		RPSMIC 103	MEDICAL AND CLINICAL MICROBIOLOGY	04
		RPSMIC 1P3	Practicals based on Medical And Clinical Microbiology	02
		RPSMIC 104	RESEARCH METHODOLOGY	04
		RPSMIC 1P4	Practicals based on Research Methodology	02
	II	RPSMIC 201	CELL BIOLOGY	04
		RPSMIC 2P1	Practicals based on Cell Biology	02
		RPSMIC 202	MICROBIAL BIOCHEMISTRY II	04
		RPSMIC 2P2	Practicals based on Microbial Biochemistry II	02
		RPSMIC 203	ENVIRONMENTAL MICROBIOLOGY	04
		RPSMIC 2P3	Practicals based on Environmental Microbiology	02
		RPSMIC	EMERGING AREAS IN	04

		204	BIOLOGY	
		RPSMIC 2P4	Practicals based on Emerging Areas In Biology	02
MSc II	III	RPSMIC 301	VIROLOGY	04
		RPSMIC 3P1	Practicals based on Virology	02
		RPSMIC 302	IMMUNOLOGY	04
		RPSMIC 3P2	Practicals based on Immunology	02
		RPSMIC 303	FOOD AND WATER MICROBIOLOGY	04
		RPSMIC 3P3	Practicals based on Food And Water Microbiology	02
		RPSMIC 304	TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS	04
		RPSMIC 3P4	Practicals based on Tools And Techniques: Biomolecular Analysis	02
	IV	RPSMIC 401	PHARMACEUTICAL AND COSMETIC MICROBIOLOGY	04
		RPSMIC 4P1	Practicals based on Pharmaceutical And Cosmetic Microbiology	02
		RPSMIC 402	ADVANCES IN BIOTECHNOLOGY	04
		RPSMIC 4P2	Practicals based on Advances In Biotechnology	02
		RPSMIC 403	EMERGING AREAS IN BIOLOGY II	04
		RPSMIC 4P3	Practicals based on Emerging Areas In Biology II	02
		RPSMIC 404	INTERNSHIP	04
RPSMIC 4P4		Practicals based on Internship	02	

Course Code: RPSMIC 101
Course Title: Microbial Genetics
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the basic genetic mechanisms like transcription and translation mechanisms, post translational modifications, levels of gene expression
CO 2	Compare and contrast between prokaryotic and eukaryotic transcription and demonstrate an in depth understanding of gene regulation
CO 3	Implement the knowledge about oncogenes and cancer genetics in research
CO 4	Structure the medical and evolutionary relation of transposition
CO 5	Critique the best model organism for genetic studies
CO 6	Outline the factors leading to changes in genetic structure in a population
CO 7	To apply Hardy-Weinberg's Law and evaluate problems based on genotypic and allelic frequencies
CO 8	Outlining the significance of cytoplasmic inheritance, giving emphasis to the evolutionary relationship of inheritance

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 101		MICROBIAL GENETICS	4/60
I		Gene expression and its regulation	15
	1.1	Gene expression	05
		a) Revision of prokaryote transcription and translation b) Transcription process in eukaryotes c) Pre-mRNA processing and Small RNA molecules <ol style="list-style-type: none"> i. Structure of mRNA ii. Post transcriptional processing of pre-mRNA <ol style="list-style-type: none"> 1. Addition of 5"cap 2. Addition of Poly(A)tail 3. RNA splicing 4. RNA editing ii. Small RNA molecules <ol style="list-style-type: none"> 1. RNA interference 2. Types 3. Processing 4. Function of micro RNAs d) mRNA surveillance e) Post translational modification of Proteins	
	1.2.	Regulation of gene expression	09
		a) Control of gene expression in prokaryotes <ol style="list-style-type: none"> i. Levels of gene regulation ii. DNA binding proteins iii. Antisense RNA molecules iv. Riboswitches v. Operon (Revision with examples) b) Control of gene expression in eukaryotes <ol style="list-style-type: none"> i. Regulation through modification of gene structure <ol style="list-style-type: none"> 1. DNase I hypersensitivity 2. histone modifications 3. chromatin remodelling 4. DNA methylation. ii. Regulation through regulatory molecules <ol style="list-style-type: none"> 1. Transcriptional activators 2. Co-activators 3. Repressors 4. Enhancers 5. Insulators iii. Regulation through RNA processing & 	 03 06

		degradation iv. Regulation through RNA interference	
	1.3	Chromosomal Rearrangements and effects on gene expression	01
		a) Amplification and deletion of genes b) Inversions that alter gene expression c) Phase variation in <i>Salmonella</i>	
II		Cytoplasmic Inheritance (Organelar Genetics)	15
	2.1	Mitochondrial Inheritance	06
		a) Mitochondrial genome structure b) Ancestral and derived mitochondrial genome c) Mitochondrial DNA of Human, yeast and flowering plants d) Endosymbiotic theory e) Mitochondrial DNA replication, transcription & translation f) Codon usage in Mitochondria g) Damage to Mitochondrial DNA and aging. h) Evolution of mitochondrial DNA i) Mt DNA analysis for study of evolutionary relationships	
	2.2	Chloroplast DNA (cp DNA)	05
		a) Gene structure and organization b) General features of replication, transcription and translation of cp DNA c) Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA d) cp DNA maps	
	2.3	Examples of extranuclear inheritance	05
		a) Leaf Variegation b) Poky mutant of Neurospora c) Yeast petite mutant, d) Human genetic diseases	
III		Transposable genetic elements and population genetics	15
	3.1	Transposable genetic elements	08
		a) Revision of prokaryotic transposable elements b) Transposable Elements in Eukaryotes i. Ac and Ds Elements in Maize ii. P Elements and Hybrid Dysgenesis in Drosophila iii. Retro-transposons Retrovirus like Elements Retroposons iv. Transposable elements in Humans c) The Genetic and Evolutionary Significance of Transposable Elements d) Transposons and Genome Organization	

		Transposons and Mutation e) Transpositions that alter gene Expression i. Antigenic variation in Trypanosomes ii. Mating type switching in yeast	
	3.2	Population genetics	07
		a) Population and gene pool i. Genotypic and Allelic frequencies ii. Calculation of Genotypic frequencies and Allelic frequencies for autosomal and X linked loci iii. Problems –calculation of allelic and genotypic frequencies iv. Hardy-Weinberg Law, genotypic frequencies at HWE, Implications of the H-W Law v. H-W proportions for multiple alleles, vi. X-linked alleles vii. Testing for H-W proportions and problems viii. Genetic ill effects of in-breeding b) Changes in the genetic structure of populations: i. Mutation ii. Migration and gene flow iii. Genetic drift iv. Natural selection and Simple problems based on the natural forces	
IV		Model organisms and Genetic basis of cancer	15
	4.1	Model organisms	07
		a) Characteristics of an ideal model organism b) Elaborating each model organism i. <i>E. coli</i> ii. Yeast iii. <i>C. elegans</i> iv. <i>A. thaliana</i> v. <i>Mus musculus</i>	
	4.2	Genetic basis of cancer	08
		a) Forms of Cancer, cancer and the Cell Cycle b) Genetics Basis for Cancer c) Oncogenes d) Tumor-Inducing Retroviruses and Viral Oncogenes e) Cellular Homologs of Viral Oncogenes: The Proto-Oncogenes Mutant Cellular Oncogenes and Cancer f) Chromosome Rearrangement and Cancer g) Tumor Suppressor Genes h) Inherited Cancers and Knudson's Two-Hit Hypothesis Cellular Roles of Tumor Suppressor Proteins Genetic Pathways to Cancer	

References:

- a) Watson, Baker, Bell, Gann, Levine, Losick, "Molecular Biology of the Gene", 5th Ed, Pearson Education (LPE)
- b) Russell, P.J., "iGenetics- A Molecular Approach", 3rd Ed, Pearson International Edition
- c) Snustad & Simmons, "Principals of Genetics", 3rd Ed, John Wiley & Sons Inc
- d) Pierce, B.A, "Genetics- A Conceptual Approach", 2nd Ed, W.H. Freeman & Co
- e) Gray Micheal *et al*, "The origin and early evolution of Mitochondria", *Genome Biology*, 2001, 2(6)
- f) Gray Micheal, "The origin and evolution of Mitochondrial DNA", *Annual Reviews in Cell Biology*, 1989, 25-50
- g) Howe Christopher J *et al*, "Evolution of the chloroplast genome", *The Royal Society*, 2003, 358, 99-107
- h) Kelchner, S. A., "The Evolution of Non-Coding Chloroplast DNA and Its Application in Plant Systematics", 2000, *Annals of the Missouri Botanical Garden*, 87(4), 482.
- i) Ladoukakis Emmanuel *et al* "Evolution and inheritance of animal mitochondrial DNA: rules and exceptions", *Journal of Biological Research*, 2017, 24:2.
- j) Wallace Douglas C., "Mitochondrial DNA in evolution and disease", *Nature*, 2016, 535(7613), 498–500.

Practicals: RPSMIC1P1 (60 Contact Hrs)

- a. β galactosidase assay
- b. Isolation of genomic DNA from yeast
- c. Demonstration of Mating type switching in yeast
- d. Isolation of mitochondria DNA & chloroplast DNA
- e. Problems on population genetics
- f. Transformation of yeast
- g. Tetrad analysis of yeast
- h. Artificial transformation of bacteria
- i. Bacterial conjugation
- j. Study of transduction

Course Code: RPSMIC 102
Course Title: Microbial Biochemistry-I
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the basics of biochemical calculations like SI units and expression of concentration
CO 2	Illustrate various biochemical processes with the help of thermodynamic principles
CO 3	Remember the basics of amino acids and peptides and understand further details about secondary structure of polypeptide chain.
CO 4	Differentiate between various polysaccharides like glycoproteins and proteoglyans
CO 5	Organize various events in evolution of metabolic pathway
CO 6	Explain the method of transport of four major biomolecules into the cell
CO 7	Execute various chemical methods to characterize the biomolecules

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 102		MICROBIAL BIOCHEMISTRY I	4/60
I		Biochemical Calculations and Thermodynamics	15
	1.1	Biochemical Calculations	09
		a) SI Units Relevant to Biochemistry <ol style="list-style-type: none"> i. Prefixes for Multiples and Fractions of Units ii. Relative molecular mass (Mr) iii. Stoichiometry b) Various units of expressing and inter-converting concentration of solutions <ol style="list-style-type: none"> i. Molarity ii. Moles iii. Normality iv. Osmolarity v. Molality vi. Mole fraction vii. Density viii. Specific gravity c) Bronsted Concept of conjugate acid–conjugate base pairs <ol style="list-style-type: none"> i. Ionization of solutions ii. pH iii. Titration curves iv. Buffers: preparation, action and their use in Biology d) Henderson-Hasselbalch equation <ol style="list-style-type: none"> i. Buffer capacity ii. Polyprotic acids iii. Amphoteric salts iv. Ionic strengths (problem solving under all heads)	
	1.2	Thermodynamics	06
		a) Energy Transformations b) First and second law of thermodynamics <ol style="list-style-type: none"> i. Statement and Introduction ii. Enthalpy, examples from biochemistry and energy conservation in living organisms iii. Entropy of universe iv. Protein denaturation c) Gibbs Free Energy-Applications <ol style="list-style-type: none"> i. Introduction 	

		<ul style="list-style-type: none"> ii. Photosynthesis, glycolysis, and the citric acid cycle iii. Oxidative phosphorylation and ATP hydrolysis iv. Enzyme–substrate interaction v. Protein solubility vi. Protein stability 	
II		Biomolecules	15
	2.1	Amino acids and Proteins	04
		<ul style="list-style-type: none"> a) Amino Acids and Peptides (Revision) <ul style="list-style-type: none"> i. Properties of α-Amino Acids ii. Acidic and Basic Side Chains iii. The Peptide Unit iv. Polypeptides b) The Architecture of Folded Proteins <ul style="list-style-type: none"> i. Conformations of Polypeptide Chains ii. The Extended Chain β Structures iii. Helices iv. Turns and Bends, Domains, Subunits, and Interfaces v. Packing of Side Chains c) Dynamic Properties of Proteins <ul style="list-style-type: none"> i. Packing of Side Chain Motion of Backbone and Side Chains ii. Conformational Changes iii. Denaturation and Refolding iv. Effects of pH and Solvent v. Irreversible Damage to Proteins 	
	2.2	Sugars, Polysaccharides and glycoproteins	03
		Structures and Properties of Simple Sugars <ul style="list-style-type: none"> a) Glycosides, Oligosaccharides, Glycosylamines, and Glycation b) Polysaccharides (Glycans) c) Glycoproteins and Proteoglycans 	
	2.3	Lipids	03
		<ul style="list-style-type: none"> a) Lipid Structures <ul style="list-style-type: none"> i. Fatty Acids, Fatty Alcohols, and Hydrocarbons ii. Acylglycerols, Ether Lipids, and Waxes iii. Phospholipids iv. Glycolipids v. Sphingolipids vi. Sterols and Other Isoprenoid Lipids b) Membranes-The Structure of Membranes 	
	2.4	Evolution of Metabolic pathway	05
		<ul style="list-style-type: none"> a) The primordial metabolism b) The role of duplication and fusion of DNA sequences in the evolution of metabolic pathways in the early cells 	

		<ul style="list-style-type: none"> c) Hypotheses on the origin and evolution of metabolic pathways d) The reconstruction of the origin and evolution of metabolic pathways 	
III		One and two Carbon metabolism	15
	3.1	Metabolism of one carbon compounds	07
		<ul style="list-style-type: none"> a) Methylotrophs <ul style="list-style-type: none"> i. Oxidation of methane, methanol, methylamines ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens b) Methanogenesis <ul style="list-style-type: none"> i. Methanogenesis form H_2, CO_2, CH_3OH, $HCOOH$, methylamines ii. Energy coupling and biosynthesis in methanogenic bacteria c) Acetogens: autotrophic pathway of acetate synthesis and CO_2 fixation, d) Carboxidotrophs: Biochemistry of chemolithoautotrophic metabolism e) Cyanogens and cynotrophs <ul style="list-style-type: none"> i. Cynogenesis ii. Cyanide degradation 	
	3.2	Metabolism of two- carbon compounds	08
		<ul style="list-style-type: none"> a) Acetate <ul style="list-style-type: none"> i. TCA ii. Glyoxylate cycle iii. Modified citric acid cycle iv. Carbon monoxide dehydrogenase pathway and disproportionation to methane b) Ethanol- acetic acid bacteria c) Glyoxylate and glycollate <ul style="list-style-type: none"> i. Dicarboxylic acid cycle ii. Glycerate pathway iii. Beta hydroxyaspartate pathway d) Oxalate- as carbon and energy source e) Highlight about sign of 1C/2C utilization 	
IV		Transport of Biomolecules	15
	4.1	Transport of sugars	03
		<ul style="list-style-type: none"> a) Transport of D-Glucose and D-Fructose into <i>E. coli</i> cell. b) Glucose transporters of erythrocytes, various glucose transporters present in humans (GLUT1- GLUT12) 	
	4.2	Transport of amino acids	03
		Amino acid transporter families for various amino acids	

	4.3	Transport of Fatty acid	03
		a) Mobilization of triacylglycerols stored in adipose tissue b) Fatty acid entry into mitochondria via the acyl-carnitine/carnitine transporter	
	4.4	Transport of proteins	06
		a) Protein transport: extracellular protein secretion, drug export system b) Folding of periplasmic proteins, translocation of folded proteins	

References:

- Segel. R, "Biochemical calculations", 3rd edition John Wiley and Sons, 1995
- Mathew, Van Holde and Ahern, "Biochemistry" 3rd edition, Pearson Education
- Zubay, G., Wm.C., "Principles of Biochemistry", 4th edition, Brown Publishers, 1998
- Lehninger A.L., Cox and Nelson, "Principles of Biochemistry", 4th Edition, CBS Publishers and Distributors Pvt. Ltd. 1994
- G N Cohen, "Microbial Biochemistry", 2nd Edition, Springer, 2011
- Donald Haynie, "Biological Thermodynamics", 2nd Edition, Cambridge University Press, 2008
- David E. Metzler, "Biochemistry: The Chemical reactions of living cell", 2nd Edition Vol. 1 & 2 Elsevier Academic Press
- David White, "The Physiology and Biochemistry of Prokaryotes", 3rd Edition Oxford University Press 2007
- John Gareth Morris, A biologist's Physical Chemistry, 2nd Edition, Wiley
- Fani, R., & Fondi, M. "Origin and evolution of metabolic pathways" *Physics of Life Reviews*, 2009, 6(1), 23–52. doi:10.1016/j.pprev.2008.12.003

Practicals: RPSMIC1P2 (60 Contact Hrs)

- Preparation of buffers
- Determination of pK and PI value for an amino acid
- Extraction of total lipids
- Identification of fatty acids and other lipids by TLC
- Determination of degree of unsaturation of fats and oils
- Estimation of total sugars by phenol-sulphuric acid method
- Determination of molar absorption coefficient(ϵ) of l-tyrosine
- Determination of the isoelectric point of the given protein
- Estimation of polyphenols /tannins by Folin-Denis method
- Enrichment, isolation and identification of *Methylobacterium*
- Diffusion studies of molecules across RBCs
- Diffusion studies of molecules across yeasts cells

Course Code: RPSMIC 103
Course Title: Medical and Clinical Microbiology
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Elaborate on pathogenesis, mode of transmission, epidemiology and therefore modes of prophylaxis of some current and emerging diseases
CO 2	Understand nature of regulation of expression of pathogenicity, evasion of host defense
CO 3	Recognise and appreciate the importance of biofilms in different environments
CO 4	Identify and classify the nature and methods of eradication of biofilms, especially those on implants and medical devices
CO 5	Apply appropriate methodologies to tackle the threat of antibiotic resistance
CO 6	Perform and analyze all kinds of clinical microbiological tests associated with antibiotic susceptibility testing
CO 7	Analysing and hypothesizing the effects of gut microbiome on different aspects of human physiology

DETAILED SYLLABUS

Course Code	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 103		MEDICAL AND CLINICAL MICROBIOLOGY	04/ 60
I		Study of Infections – I	15
		Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment: MOTT (mycobacteria other than TB), MDR and XDR TB, Legionellosis, Emerging infections like- Rickettsial infections and <i>C.auris</i> , Conditions caused by <i>Helicobacter pylori</i> , VRE (Vancomycin Resistant enterococci), Listeriosis, Leptospirosis	
II		Study of Infections- II and introduction to microbiome	15
	2.1	Detailed Study of following infections	06
		including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment Chikungunya, Dengue, Hepatitis non-A, Swine flu	
	2.2	Microbiome studies	09
		a) Stomach, small and large intestinal microbiome b) Function of the Human Gut Microbiota c) Gut Microbiota in health and disease d) Gut-brain axis	
III		Virulence regulation and strategies to evade defense	15
	3.1	Revision of Virulence mechanisms in pathogens	02
	3.2	Mechanisms of virulence regulation	04
		a) Types of regulation b) Quorum Sensing	
	3.3	Measuring Virulence	03
	3.4	Bacterial strategies for evading or surviving host defense systems	06
		a) Biofilms- Structure, development, biofilms on implants and prosthetic devices, Biofilm eradication b) Colonization of host surfaces c) Evading host responses	

IV		Clinical Microbiology- Antibiotic resistance and Antibiotic susceptibility testing	15
	4.1	Antibiotic resistance in microbes	07
		a) Mechanisms of antibiotic resistance b) Transfer of antibiotic resistance c) Maintaining antibiotic resistance through Selective Pressure	
	4.2	Antibiotic susceptibility testing	08
		a) Tests that predict the effectiveness of therapy <ol style="list-style-type: none"> i. Antibiotic Susceptibility Testing Methods- Indications, standardization, QC, Procedures and interpretation ii. Detection of resistance- Beta lactamase and ESBL iii. Antibiograms b) Tests that monitor the effectiveness of therapy <ol style="list-style-type: none"> i. Molecular detection ii. MBC iii. Serum killing curves iv. Testing antibiotic combinations v. Time kill curves c) Test of therapeutic efficacy and avoidance of toxicity	

References:

- a) Ananthnarayan & Paniker, "Textbook of Microbiology", 8th edition, University press 2009
- b) Richard Goering, Hazel Dockerell *et al*, "Mim's Medical Microbiology, 5th ed, Saunders, Elsevier, 2013
- c) David Greenwood *et al*, "Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control", 17th Edition, Churchill Livingstone/Elsevier, 2012
- d) Julian R. Marchesi, "The Human Microbiota and Microbiome, Advances in Molecular and Cellular Microbiology", CABI press, 2014
- e) Brenda Wilson, Abigail Salyers *et al*, "Bacterial Pathogenesis- A molecular approach", 3rd ed, ASM press, 2011
- f) Jana Jass, Sussane Surma *et al*, "Medical Biofilms. Detection Prevention and Control", Wiley, 2003
- g) Kendra Rumbaugh, Iqbal Ahmed, "Antibiofilm agents-From Diagnosis to treatment and Prevention", Springer Series on Biofilms Vol 8, Springer, 2014
- h) J. Vandepitte, J. Verhaegen *et al*, "Basic laboratory procedures in clinical bacteriology", 2nd ed, WHO, Geneva, 2003

- i) Gary Procop, Elmer Koneman *et al*, "Koneman's Color Atlas and Textbook of Diagnostic Microbiology", 7th Edition, Wolters Kluwer, 2017
- j) Indira Kudva, Nancy Cornick *et al*, "Virulence Mechanisms of Bacterial Pathogens", 5th ed, ASM Press, 2016
- k) A brief guide to emerging infectious diseases and zoonoses. WHO.
- l) Nett JE, "Candida auris: An emerging pathogen "incognito", *PLoS Pathog*, 2019, 15(4): e1007638. <https://doi.org/10.1371/journal>.
- m) Spivak ES, Hanson KE, "Candida auris: an emerging fungal pathogen", *J Clin Microbiol*, 2018, 56:e01588-17.
- n) Abdad MY, Abou Abdallah R, Fournier P-E, Stenos J, Vasoo S, "A concise review of the epidemiology and diagnostics of rickettsioses: Rickettsia and Orienti spp", *J Clin Microbiol*, 2018, 56: e01728-17. <https://doi.org/10.1128/JCM.01728-17>.
- o) Narendra Rathi And Akanksha Rathi, "Rickettsial Infections: Indian Perspective", *Indian Pediatrics*, 2010, Volume 47.
- p) Haake, D. A., & Levett, P. N., "Leptospirosis in Humans", *Leptospira and Leptospirosis*, 2014, 65–97. doi:10.1007/978-3-662-45059-8_5.

Practicals: RPSMIC1P3 (60 Contact Hrs)

- a) Diagnosis for HIV - Trispot/ ELISA for AIDS (Demonstration)
- b) Mono - Spot Test for diagnosis of Chikungunya (Demonstration expt.)
- c) Diagnosis of leptospirosis – Kit method (Demonstration)
- d) Diagnosis for *Helicobacter pylori* HPSA (*Helicobacter pylori*) (Demonstration expt.) (kit method)
- e) Study of Quorum Sensing in *C.violaecium*
- f) Study of Quorum sensing inhibitors
- g) Detection of Biofilm formation on different surfaces
- h) Determination of Minimum Biofilm Inhibition Concentration of an antibiotic
- i) Study of biofilms in flow systems
- j) Antibiotic Susceptibility Test – microdilution methods according to CLSI guidelines
- k) Checkerboard assay
- l) E-test

Course Code: RPSMIC 104
Course Title: Research Methodology
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Summarize the basics of research methodology
CO 2	Execute the experiments including appropriate calibrations and controls, with a carefully written record of the outcomes
CO 3	Implement different methods of data collection and process the collected data by conventional and modern methods.
CO 4	Hypothesize a solution to a research problem
CO 5	Design a research project
CO 6	Distinguish between laws, theory, postulates, and research types
CO 7	Carrying out statistical analysis of the result
CO 8	Selecting correct mode of scientific communication and quality literature

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 104		RESEARCH METHODOLOGY	4/60
I		Research Fundamentals and Terminology	15
	1.1	Philosophy of natural science	02
		a) Traditional philosophy of science b) Scientific explanation and modes of inference c) Scientific rationality d) Theory testing	
	1.2	Introduction to research	02
		a) Definition of research b) Scientific research c) General characters of research d) Objectives of research e) Classification and types of research	
	1.3	Research methodology	03
		a) Types of research methods b) Research methods verses methodology c) Research and scientific method d) Research process e) Criteria of good research	
	1.4	Strategies and analysis	04
		a) Research conditions b) Importance of controls c) Experimental protocol and experimental routine	
	1.4	Research problem	01
		a) Selection of a research problem b) Necessity of defining a research problem c) Technique involved in defining a research problem	
	1.5	Study designs	03
II		Preparation for research project and data collection methods	15
	2.1	Literature search	02
		a) Concept of Information literacy b) Method: Systematic literature search c) Literature Search Technique d) Methodology filters e) Concept of Quality of literature f) Impact factor	

	2.2	Personal reference database	02
		<ul style="list-style-type: none"> a) Introduction to principal bibliographic databases b) Importance of being scientifically update c) Medical and scientific internet search engines d) Reference management softwares e) Significance of cite when you write f) Bibliographic format: output styles 	
	2.3	Hypothesis and testing of hypothesis	04
		<ul style="list-style-type: none"> a) Meaning, nature of hypothesis, b) Functions of hypothesis, c) Importance of hypothesis, d) Kinds of hypothesis, e) Characteristics of good hypothesis, f) Formulation of hypothesis 	
	2.4	Methods and techniques of data collection	03
		<ul style="list-style-type: none"> a) Types of data b) methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study, methods) c) methods of secondary data collection (internal/external), schedule method 	
	2.4	Experimental data processing	04
		<ul style="list-style-type: none"> a) Processing operations b) Problems in processing c) Elements of analysis in data processing d) Software for data processing 	
III		Sampling, Sampling distribution and Statistics	15
	3.1	Sampling	05
		<ul style="list-style-type: none"> a) Sampling frame b) Importance of probability sampling c) Types of sampling <ul style="list-style-type: none"> i. Simple random sampling ii. Systematic sampling iii. Stratified random sampling iv. Cluster sampling d) Problems due to unintended sampling e) Ecological and statistical population in the laboratory 	
	3.2	Variables	01
		<ul style="list-style-type: none"> a) Types of Variables <ul style="list-style-type: none"> i. Ordinal ii. Discontinuous iii. Continuous iv. Derived 	
	3.3	Statistical methods	09
		Statistical methods	

		<ul style="list-style-type: none"> a. Effect measure, Comparing two proportions, Measures of association in 2 x 2 tables, Normal distribution, Comparison of means, Non-parametric methods, Regression analysis b. hypothesis testing and confidence interval <ul style="list-style-type: none"> i. Null and alternate hypothesis ii. Type-I & Type-II errors iii. Level of significance, iv. Power of test v. p value c. Parametric tests <ul style="list-style-type: none"> i. Large sample Tests <ul style="list-style-type: none"> a. Testing significance of single population mean b. Testing significance of two population mean ii. Small sample Tests <ul style="list-style-type: none"> a. Testing significance of single population mean b. Testing difference between two independent normal population mean c. Testing difference between two correlated normal population mean d. Testing significance of correlation coefficient iii. χ^2 test <ul style="list-style-type: none"> a. Testing single population variance b. Testing Goodness of fit c. Testing association between two attributes iv. F-test- Testing equality of variance <ul style="list-style-type: none"> a. ANOVA- one-way classification, two-way classification 	
IV		Scientific writing and Communication	15
	4.1	Report writing	03
		<ul style="list-style-type: none"> a) Types of research reports b) Guidelines for writing a report c) Report format d) Appendices e) Miscellaneous information 	
	4.2	Scientific communication	05
		<ul style="list-style-type: none"> a) Types of scientific documents <ul style="list-style-type: none"> i. Journal articles ii. Books iii. Thesis iv. Conference v. Project reports b) Components of a research paper 	

		c) Publication process d) Copy right transfer and co-authorship e) Open access	
	4.3	How to write grant application	02
	4.4	Communication skills	02
		a) Importance of communication b) The process of communication c) Verbal and nonverbal communication d) Comparison of general, Business and scientific communication	
	4.5	Modes of communication	03
		a) Communication by presentations i. Structure and types of presentation ii. PowerPoint presentation iii. Handling PowerPoint iv. Slide organisation and Content management v. Body language, gestures and voice modulation b) Communication by Email c) Poster presentations d) Oral presentations i. Preparing for a lecture ii. Delivering a lecture	

References:

- a) Kothari, C.R, "Research Methodology- Methods and Techniques", New Delhi, Wiley Eastern Limited. 1985
- b) Das, S.K, "An Introduction to Research", Kolkata, Mukherjee and Company Pvt. Ltd. 1986
- c) Rosner B.A., "Fundamentals of Biostatistics", Cengage Learning, 2011
- d) Katz J.M., "From Research to Manuscript: A guide to scientific writing" , USA, Springer Science, 2009
- e) Petter Laake, Haakon Breien Benestad and Bjorn Reino Olsen, "Research methodology in the medical and biological sciences" 1st Ed, Academic Press, 2007
- f) Pradip Kumar Sahu, "Research Methodology: A guide for Researchers in Agricultural Science", Social Science and other related fields, Springer, 2006
- g) Ranjit Kumar, "Research Methodology- A step-by-step Guide for beginners", 3rd Ed, Sage publications, 2005
- h) Daniel WW, "Biostatistics: A foundation for analysis in health sciences", 10th Edn, Cross CL., Wiley. 2013

Practicals: RPSMIC1P4 (60 Contact Hrs)

- a) Writing the Literature review on research topic that the students wishes to take for dissertation
- b) Problem solving on Biostatistics (manually and using software)
- c) Abstract writing or summary for a research paper
- d) Conduct a Lecture
- e) Data analysis using Software

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation/ Assignment	15
2	One class test (Multiple choice questions/ objectives)	20
3	Active participation in routine class instructional deliveries	05

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

1. Duration- These examinations shall be of **two hours and thirty minutes**.
2. Theory question paper pattern-
 - a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.
 - b. All questions shall be compulsory with internal choice within the questions.

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

II) Practical Examination Pattern

	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	-
Viva	05	05	05	-
Quiz	05	05	05	25
Laboratory work	35	35	35	-
Literature Review	-	-	-	25
Total	50	50	50	50

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.

Overall Examination and Marks Distribution Pattern

Semester I

Course	101			102			103			104			Grand total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

Course Code: RPSMIC201

Course Title: Cell Biology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Interpret the structure and analyze the function of cell membrane & Cytoskeleton.
CO 2	Discuss the concept of compartmentalization of cell and understand the process of membrane transport and protein trafficking.
CO 3	Interpret the phases of Cell cycle & discuss the apoptotic mechanisms.
CO 4	Exemplify cell communication strategies in plants & animals.
CO 5	Recall the basics of developmental biology and deconstruct the process of meiosis, embryonic cleavage, gastrulation & morphogenesis
CO 6	Justify the genetic basis of development in model organisms
CO 7	Analyze the entire genetically predisposed process of development in Drosophila.
CO 8	Execute & implement the techniques used to study cell structure & its components.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 201		CELL BIOLOGY	4/60
I		Cell structure and cytoskeleton	15
	1.1	Techniques to study cell and cellular structure.	02
	1.2	Cell membrane structure	03
		<ul style="list-style-type: none"> a) Lipid bilayer b) Membrane proteins c) Spectrins d) Glycophorin e) Multi pass membrane protein f) Bacteriorhodopsin 	
	1.3	Cytoskeleton	05
		<ul style="list-style-type: none"> a) Cytoskeletal filaments b) Microtubules c) Actin regulation d) Molecular motors e) Cell behaviour 	
	1.4	Cell Junctions and cell adhesion	05
		<ul style="list-style-type: none"> a) Anchoring b) Adherence junctions c) Desmosomes d) Gap junctions e) Cell-cell adhesion f) Cadherins 	
II		Membrane Transport and Compartmentalization	15
	2.1	Membrane Transport (Revision)	05
		<ul style="list-style-type: none"> a) Principles of membrane transport <ul style="list-style-type: none"> i. Ion channels ii. electrical properties of membranes b) Types of diffusion <ul style="list-style-type: none"> i. Passive Diffusion, and Facilitated Diffusion, ii. Ion channels – Ligand gated and voltage gated channels, c) Active transport – ion pumps (e.g.: Na⁺-K⁺ pump) 	
	2.2	Intracellular Compartments and protein sorting	07
		<ul style="list-style-type: none"> a) Compartmentalization of cells b) Transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum c) Transport of proteins into mitochondria and chloroplasts 	

	2.3	Intracellular vesicular traffic	03
		<ul style="list-style-type: none"> a) Endocytosis b) Exocytosis c) Transport from the ER through the Golgi apparatus 	
III		Cell cycle & Cell communication	15
	3.1	Mechanism of cell division	04
		<ul style="list-style-type: none"> a) M-phase b) Cytokinesis 	
	3.2	Cell cycle and Programmed cell death	03
		<ul style="list-style-type: none"> a) Control system b) Intracellular control of cell cycle events c) Apoptosis d) Extracellular control of cell growth and apoptosis 	
	3.3	Cell communication	03
		<ul style="list-style-type: none"> a) Extracellular signal molecules b) Nitric oxide gas signal c) Classes of cell-surface receptor proteins 	
	3.4	Signalling through enzyme linked cell surface receptors	04
		<ul style="list-style-type: none"> a) Docking sites b) Ras c) MAP kinase d) PI-3kinase e) TGF 	
	3.5	Signalling in plants	01
		<ul style="list-style-type: none"> a) Serine/ Threonine kinases b) Role of ethylene c) Phytochromes 	
IV		Developmental Biology	15
	4.1	The Process of Development in Animals	04
		<ul style="list-style-type: none"> a) Evo-Devo: The Study of Evolution and Development b) Meiosis- Oogenesis, spermatogenesis and fertilization c) The Embryonic Cleavage Divisions and Blastula Formation d) Gastrulation and Morphogenesis 	
	4.2	Genetic Analysis of Development in Model Organisms	01
		<ul style="list-style-type: none"> a) Genetic Analysis of Development Pathways b) Molecular Analysis of Genes Involved in Development 	
	4.3	Maternal Gene Activity in Development	03
		Maternal-Effect Genes	
	4.4	Development of Drosophila	07
		<ul style="list-style-type: none"> a) Determination of the Dorsal-Ventral and Anterior-Posterior Axes in Drosophila Embryos b) Zygotic Gene Activity in Development c) Specification of Cell Types 	

		d) Genes of drosophila i. Drosophila signalling genes ii. gradient of nuclear gene regulatory protein iii. Dpp and Sog setup iv. Neural development	
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References:

- a) Albert, Johnson, Lewis, Raff, Roberts and Walter, "Molecular Biology of The Cell", 5th Ed, Garland Science Publishing, 2008
- b) Lodish, Birk, and Zipursky, "Molecular Cell Biology", Freeman Publishing, 2008
- c) Lipowsky and Sackmann, "The Structure and Dynamics of Cell Membrane", 1st Ed, Elsevier, 1995
- d) Dennis Bray, "Cell Movements: from Molecules to Motility", 2nd Ed, Garland Publications, 2001
- e) Snustad & Simmons, "Principles of Genetics", 3rd Ed, John Wiley & Sons Inc, 2002

Practicals: RPSMIC2P1 (60 Contact Hrs)

- a) Study of cell cytology using Phase contrast Microscopy-Demonstration
- b) Study of Cell structure using Confocal Microscopy- Demonstration
- c) Study of Cell structure using Fluorescence Microscopy- Demonstration
- d) Isolation of Chloroplasts.
- e) Isolation of Mitochondria from the cell.
- f) Cultivation of macrophage cell lines and study of cell viability
- g) Study of Mitosis.
- h) Study of Meiosis
- i) Estimation of NO (Nitric Oxide) produced by Macrophages.
- j) Study of Cell membrane integrity using up take of neutral red.

Course Code: RPSMIC 202
Course Title: Microbial Biochemistry-II
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the basics of biochemical techniques for extraction and purification of biomolecules
CO 2	Compare modes of regulation of enzyme activity at protein level
CO 3	Understand the details of mechanism of enzyme activity for the representative enzyme from each class
CO 4	Attribute various mechanisms to the response to various environmental stimuli
CO 5	Analyze the mechanism of biodegradation of various xenobiotics by microorganisms
CO 6	Check various properties of amylase enzyme in the laboratory

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 202		MICROBIAL BIOCHEMISTRY II	4/60
I		Analytical Biochemistry	15
	1.1	Problems on Determination of	2
		a) Molecular weights b) Purity c) Length and volume of organic compounds	
	1.2	Extraction, purification, application and analysis of proteins, carbohydrates and lipids	2
	1.3	General methods of extraction	3
		a) Salting out b) Use of organic solvents	
	1.4	Purification: Chromatographic techniques	2
	1.5	Mass determination	2
		a) Ultracentrifuge b) GC-MS	
	1.6	Structure determination: X-ray diffraction Location: Confocal spectroscopy	1
	1.7	Methods of analysis of:	3
		a) Proteins, b) Carbohydrates c) Lipids d) Other organic compounds	
II		Enzymology	15
	2.1	Introduction to enzymes	06
		a) Discovery of enzymes b) Enzyme terminology c) Basic aspects of chemical kinetics d) Kinetics of enzyme catalysed reactions e) Enzyme inhibition (reversible and irreversible) f) Specific examples i. Effect of pH on enzyme activity (Fumarase) ii. Enzyme action by X-ray crystallography iii. Nerve gas and its significance iv. HIV enzyme inhibitors and drug design	
	2.2	Enzyme regulation:	05
		a) Phosphofructokinase as allosteric enzyme b) General properties of allosteric enzymes c) Two themes of allosteric regulations d) Regulation by covalent modification e) Regulation by multienzyme complexes and	

		<p>multifunctional enzymes</p> <p>f) specific example- the blood coagulation cascade (problem solving)</p>	
	2.3	Mechanisms of enzyme catalysis	04
		<p>a) Five themes that occur in discussing enzymatic reactions</p> <p>b) Detailed mechanisms of enzyme catalysis for example</p> <p>i. serine protease</p> <p>ii. ribonucleases</p> <p>iii. triose phosphate isomerase</p> <p>iv. lysozyme</p> <p>v. lactate and alcohol dehydrogenases</p> <p>vi. catalytic antibodies</p>	
III		Cell Signalling in Prokaryotes	15
	3.1	Introduction to two-component signalling systems	06
		<p>a) Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply, inorganic phosphate supply</p> <p>b) Effect of oxygen and light on the expression of photosynthetic genes in purple photosynthetic bacteria, response to osmotic pressure and temperature, response to potassium ion and external osmolarity, response to carbon sources</p> <p>c) Bacterial response to environmental stress-heat-shock response, repairing damaged DNA, the SOS response, oxidative stress</p>	
	3.2	Synthesis of virulence factors in response to	04
		<p>a) Temperature</p> <p>b) pH</p> <p>c) nutrient</p> <p>d) Osmolarity</p> <p>e) Quorum sensors</p> <p>f) Chemotaxis</p> <p>g) Photo responses</p> <p>h) Aero taxis</p>	
	3.3	Bacterial development and quorum sensing	05
		<p>a) Myxobacteria</p> <p>b) Caulobacter</p> <p>c) Bioluminescence</p> <p>d) systems similar to Lux R/Lux I in non-luminescent bacteria</p> <p>e) Biofilms.</p>	
IV		Biodegradation of Xenobiotics	15
	4.1	Microbial Degradation of	05
		<p>a) Polychlorophenols</p> <p>b) Decolorization and Degradation of Azo Dyes</p>	

		c) Degradation of High Molecular Weight Polynuclear Aromatic Hydrocarbons d) Bacterial Degradation of Petroleum Hydrocarbons	
	4.2	Biodegradation by Fungus of	05
		a) Aromatic Pollutants b) Chloro-organic Pollutants by White Rot Fungi	
	4.3.	Biodegradation of Xenobiotics	05
		a) Microbial Degradation of Plastics and Water-Soluble Polymers b) Degradation of PAHs: Organisms and Environmental Compartments c) Microbial Degradation of Alkanes	

References:

- Mathew, Van Holde and Ahern, "Biochemistry", 3rd Ed, Pearson Education, 2000
- Zubay, "Principles of Biochemistry", 4th Ed, 1995
- Horton and Moran, "Principles of Biochemistry", 5th Ed, Scrimgeour Pears Rawn, 2011
- Lehninger A.L., Cox and Nelson, "Principles of Biochemistry", 4th Ed, CBS Publishers and Distributors Pvt. Ltd. 1994
- Conn and Stumpf, "Outlines of Biochemistry", 5th Ed, John Wiley and Sons, 2006
- White D, "The physiology and biochemistry of prokaryotes", 2nd Ed, Oxford University Press, 2000
- Biotechnology H.J. Rehm and G. Reed, "Biotransformation's", Volume 6 a., Verlag and Chemie, 1984
- Doelle H.W., "Introduction to bacterial metabolism", Academic Press, 1975
- Atlas R M and Bartha, "Microbial ecology", Addison Wesley Longman Inc., 1998
- Shree Nath Singh, "Microbial Degradation of Xenobiotics" Springer, 2012.
- Segel. R, "Biochemical calculations", 3rd edition John Wiley and Sons, 1995

Practicals: RPSMIC2P2 (60 Contact Hrs)

- Isolation of Amylase from *Aspergillus spp* and its Purification strategy
- Purification of an extracellular enzyme (β amylase) by salting out and dialysis
- Enzyme kinetics effect of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity,
- Demonstration of proteolytic activity
- Determination of glucose isomerase present intracellularly in *Bacillus sp.*
- Adaptation of *E. coli* to anaerobiosis
- Chemotaxis of *Pseudomonas*

- h) Effect of temperature and water activity on swarming of *Proteus*
- i) Different bacteriolytic response associated with addition of lysozyme and salt.
- j) Microbial degradation of polycyclic aromatic hydrocarbons (PAHs) enrichment, isolation and screening of bacteria
- k) Aqueous two-phase partitioning
- l) Extraction of protein by precipitation with Acetone

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Course Code: RPSMIC 203
Course Title: Environmental Microbiology
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recollect basic concepts of microbial ecology
CO 2	Design, execute and implement a protocol for sample collection from a natural environment and its microbiological analysis
CO 3	Discriminate and select the best genomic technique for microbial studies of different environmental samples
CO 4	Demonstrate an in depth understanding of microbial ecology of soil and marine environments
CO 5	Apply the understanding on industrial applications of extremophiles to explore and innovate for newer products
CO 6	Summarize the significance of microbes in elemental cycles
CO 7	Interpret the role of rhizosphere bacteria in plant growth and implement techniques for exploring them for commercial applications
CO 8	Explain and appreciate various regulations enacted with respect to biosafety and hazardous waste management

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 203		ENVIRONMENTAL MICROBIOLOGY	04/60
I		Microbial Ecology	15
	1.1	Basic concepts of Microbial Ecology, Sample collection and processing	05
		a) Revision of basic concepts of Microbial Ecology <ul style="list-style-type: none"> i. Concepts ii. Niche iii. Habitat iv. Ecosystem v. Microbial diversity vi. Interactions between micro-organisms vii. Ecological succession b) Environmental sample collection and processing <ul style="list-style-type: none"> i. Soils and Sediment ii. Water 	
	1.2	Techniques for microbial analysis	08
		a) Cultural Methods b) Physiological Methods: Measuring microbial activity in pure culture <ul style="list-style-type: none"> i. Carbon respiration ii. Stable isotope probing iii. Use of radioisotopes as tracers iv. Adenylate energy charge v. Enzyme assays c) Functional genomics, Metagenomics & Proteomics- based approach d) Immunological methods e) Nucleic acid-based methods f) Recombinant DNA Techniques <ul style="list-style-type: none"> i. RFLP ii. Denaturing/Temperature gradient iii. Plasmid analysis iv. Reporter genes v. Rep PCR fingerprinting and Microbial diversity 	
	1.3	Environmental genomics	02
		a) Metagenomics	

		<ul style="list-style-type: none"> b) Meta-transcriptomes c) Metaproteomics 	
II		Study of Marine Ecosystem & Extremophiles	15
	2.1	Marine microbiology	03
		<ul style="list-style-type: none"> a) Marine and estuarine habitats b) Characterization and stratification of the oceans: Vertical and horizontal zones of marine habitats c) Marine microbes <ul style="list-style-type: none"> i. Characteristics ii. Distribution iii. Composition & activity d) Marine pathogens 	
	2.2	Extremophiles	08
		<ul style="list-style-type: none"> a) Habitat b) Effect of extreme conditions on cellular components c) membrane structure d) nucleic acids e) proteins f) Adaptation mechanism in microorganisms in diverse environments g) Study, Industrial Applications and Biotechnological applications of proteins from: <ul style="list-style-type: none"> i. Thermophiles ii. Psychrophiles iii. Halophiles iv. Piezophiles v. Acidophiles vi. Alkaliphiles vii. Xerophiles viii. Radiation resistant organisms ix. Methanogens 	
	2.3	Mechanisms of metal resistance, Metal transformations, Microbial metal remediation	02
	2.4	Geomicrobiology	02
		<ul style="list-style-type: none"> a) Biofouling b) Biocorrosion c) Bioleaching 	
III		Soil and Agricultural Microbiology	15
	3.1	Soil Microbiology	03
		<ul style="list-style-type: none"> a) Litho ecosphere <ul style="list-style-type: none"> i. Soil formation ii. Properties (physical and chemical) b) Soil communities 	

	3.2	Agricultural microbiology	04
		<ul style="list-style-type: none"> a) Factors affecting microbial load of soils b) Relationship between plants and microbe's rhizosphere, phyllosphere. c) Beneficial uses of microorganisms for plant growth and development d) Interactions with aerial plant structures 	
	3.4	Biofilms in plant-associated habitats	03
		<ul style="list-style-type: none"> a) In the phyllosphere (impact on survival and bacterial interactions, interaction of plants with epiphytic biofilms,) b) In the Rhizosphere (ubiquity and importance for rhizosphere bacteria, impact of rhizosphere biofilms on plant biology) 	
	3.5	Biogeochemical cycles and Degradation	05
		<ul style="list-style-type: none"> a) Biogeochemical cycles <ul style="list-style-type: none"> i. Carbon ii. Nitrogen iii. Oxygen b) Degradation of complex polymers <ul style="list-style-type: none"> i. Cellulose ii. Lignin iii. Lignocellulose 	
IV		Environmental & natural resources management and safety standards	15
	4.1	Environmental Impact Assessment and Sustainable Development	02
	4.2	Microbes and global warming	02
		<ul style="list-style-type: none"> a) Microbial contribution to green-house gases b) Combating Greenhouse effect using microbes c) Concept of carbon credits 	
	4.3	Solid waste management	02
		<ul style="list-style-type: none"> a) Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or bio methanation. b) Non-biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling. 	
	4.4	Hazardous waste management	03
		<ul style="list-style-type: none"> a) Hazardous waste from paint, pesticides and chemical industries and their composition b) Probable means to reduce waste through Common Effluent Treatment Plants. 	
	4.6	Biohazards	03
		<ul style="list-style-type: none"> a) Introduction b) levels of biohazards 	

		c) Risk assessment d) Proper cleaning procedures e) Biomedical waste management	
	4.7	Biosafety guidelines for GMOs and LMOs	03
		a) Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. b) Overview of national regulations and relevant international agreements. c) Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)	

References:

- a) Brock Madigan, Martinko, Dunlap, Clark, "Biology of microorganisms", 12th Ed, Pearson Intl, 2011
- b) R. M. Atlas and R. Bartha, "Microbial Ecology - Fundamentals and Applications" Addison Wesley Longman Inc, 1998
- c) Johri and Satyanarayana, "Microbial Diversity- Current Perspective and Potential Application", International Pvt. Ltd, New Delhi, India, 2005
- d) Fred Rainey, Aharon Oren, "Methods in Microbiology- Extremophiles", Vol 35, Academic press, 2006
- e) R.M Maier, I. L. Pepper and C. P. Gerba, "Environmental Microbiology", Academic Press, 2010
- f) Rastogi & Sani, "Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment", *Microbes and Microbial Technology*, 2011, pp 29-57,
- g) A K Bej and M H Mahbubani, "Applications of the polymerase chain reaction in environmental Microbiology", *Genome Res*, 1992, 1: 151-159
- h) Rolf Daniel, "The Metagenomics of soil", Vol 3, Nature reviews, 2005
- i) Susannah Green Tringe and Edward M. Rubin, "Metagenomics: DNA sequencing of environmental samples", Volume 6, 2005
- j) Colin Munn, "Marine Microbiology: Ecology and Applications", Garland publishing. ISBN: 0815365179
- k) G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj, "Agricultural Microbiology", PHI Learning Pvt. Ltd., 2004
- l) Iqbal Ahmad, Farah Ahmad, John Pichtel, "Microbes and Microbial Technology: Agricultural and Environmental Applications", Springer, 2011.
- m) S. K. Maiti, "Water and Wastewater analysis: Handbook of methods in environmental studies", Volume 1, ABD Publishers, 2004

- n) S.K. Maiti, "Soil analysis Handbook of methods in environmental studies", Volume 2, ABD Publishers, 2004
- o) H. V. Jadhav, "Environmental management", Vipul Prakashan, 2002
- p) R.K. Jain, "Environmental management"
- q) M. H. Fulekar, "Industrial hygiene and safety"
- r) Medini Duccio et al, "Microbiology in the post-genomic era", Vol-6, *Nature review Microbiology*, 2008

Practicals: RPSMIC2P3 (60 Contact Hrs)

- a) Enrichment & isolation of thermophiles from hot springs/compost heaps & extraction of thermophilic enzymes & determination of their specific activity.
- b) Physical analysis of soil
 - i. Particle size analysis
 - ii. Water retention capacity
 - iii. Bulk density and tap density
- c) Chemical analysis of soil
 - i. Nitrogen
 - ii. Phosphorus
 - iii. Chloride
 - iv. Organic matter
 - v. Calcium carbonate content
- d) Microbial analysis of soil
 - i. Microbial load
 - ii. Presence of cellulose, lignin & xylan degraders
 - iii. Detection of inorganic metabolism
 - iv. Detection of siderophore producing bacteria
 - v. Isolation of iron bacteria
 - vi. Isolation of Plant Growth Promoting bacteria from Rhizosphere
 - vii. Dehydrogenase Activity of Soils
 - viii. Determination of nitrogen mineralization and nitrification in soils and the influence of chemicals on these processes
- e) Visit to CETP

Course Code: RPSMIC204
Course Title: Emerging Areas in Biology I
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand basics of bioinformatics and execute the analysis of molecular data using different databases & software.
CO 2	Design primer for PCR reaction & carryout phylogenetic analysis.
CO 3	Discuss the concept of synthetic biology & systems biology
CO 4	Illustrate & implement the methods for biosynthesis of nanoparticles & discuss its applications.
CO 5	Summarize and compare the principles of different Nucleic acid Sequencing methods.
CO 6	Compare and analyze the process of protein expression in prokaryotic & eukaryotic systems.
CO 7	Interpret the significance of concepts like directed mutagenesis, mapping & quantifying transcription & measuring protein accumulation.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 204		EMERGING AREAS IN BIOLOGY I	04/60
I		Bioinformatics	15
	1.1	Bioinformatics Basics	07
		a) Introduction b) Genome sequencing projects: technologies and impact c) Annotation, Databases and Protein Structures d) Pairwise Alignment, Multiple Alignment, and BLAST	
	1.2	Introduction to omics	03
		a) Definitions of proteomics, genomics, transcriptomics b) High dimensional Biology c) The omic experiment	
	1.3	Applications of Bioinformatics	05
		a) Primer Design b) Phylogenetic Analysis	
II		Synthetic and systems biology	15
	2.1	Synthetic Biology	10
		a) Basic concepts in Engineering Biology b) Parts, Devices and Systems c) Logic gates d) Synthetic Gene Circuits and examples like Oscillators, Toggle Switches	
	2.2	Overview of Systems biology	05
		a) Approaches and methodologies, b) Analysis of biological Networks, c) Network Dynamics d) Network Motifs and Functional Modules, e) Dynamical Models f) Artificial Intelligence in Systems Biology	
III		Nanobiotechnology	15
	3.1	Synthesis of nanostructures	07
		a) Physical b) Chemical c) Biological d) Microbiological methods	

	3.2	Applications of nanomaterials	08
		<ul style="list-style-type: none"> a) Biomolecules as nanostructures b) Nanoparticulate carrier systems c) Micro and Nanofluidics d) Nano-biosensors e) Drug and gene delivery systems f) Chip technologies g) Nano imaging h) Nanomedicine i) Cancer diagnostics and treatment 	
IV		Contemporary tools in Molecular Biotechnology	15
	4.1	DNA Sequencing and Physical mapping	04
		<ul style="list-style-type: none"> a) Dideoxynucleoside method for sequencing of DNA b) Automated DNA sequencing c) High-throughput Sequencing d) Restriction Mapping reference 	
	4.2	Heterologous protein production in eukaryotic cells	03
		<ul style="list-style-type: none"> a) <i>Saccharomyces cerevisiae</i> b) <i>Pichia pastoris</i> c) Baculovirus- Insect cell d) Mammalian cell 	
	4.3	Directed Mutagenesis	05
		<ul style="list-style-type: none"> a) Oligonucleotide directed mutagenesis with plasmid DNA b) PCR amplified oligonucleotide directed mutagenesis c) Random mutagenesis with degenerate oligonucleotide primer d) Random mutagenesis with nucleotide analogues e) Error-prone PCR f) DNA shuffling g) Mutant proteins with unusual amino acids 	
	4.4	Mapping and quantifying transcriptions	02
		<ul style="list-style-type: none"> a) S1 mapping b) Primer extension reference c) Run-off transcription d) G-less cassette transcription 	
	4.5	Measuring protein accumulation in vivo:	01
		<ul style="list-style-type: none"> a) Assaying DNA –protein interactions b) Foot printing methods c) Chromatin immune-precipitation (ChIP) 	

References:

- a) Bernard R. Glick, Jack J. Pasternak, "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press, 2010
- b) Henrik Christensen, "Introduction to Bioinformatics in Microbiology", Springer International Publishing, 2018
- c) Arthur Lesk, "Introduction to Bioinformatics", Oxford University Press, 2013
- d) Geoff Baldwin et al, "Synthetic Biology- A Primer", Imperial College Press, 2015
- e) Robert Meyer, "Synthetic Biology", 2 volume set, Wiley-Blackwell, 2015
- f) Iman Tavassoly, Joseph Goldfarb, Ravi Iyengar, "Systems biology primer: the basic methods and approaches", *Essays in Biochemistry*, 2018, 62 (4) 487-500.
- g) Michael Wink, "An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology", Wiley VCH, 2006
- h) Horgan Richard and Kenny Louise, "Omic technologies: genomics, transcriptomics, proteomics and metabolomics", *SAC review*, 2011, 13:189-195
- i) Sulabha Kulkarni, "Nanotechnology: Principles and Practices", 3rd Ed, Springer International Publishing, 2015

Practicals: RPSMIC 2P4 (60 Contact Hrs.)

- a) Exploration of DNA and protein databases
- b) Pair-wise and multiple alignment of DNA and Amino acid sequences
- c) Primer design and conceptual PCR troubleshooting
- d) Designing of Synthetic Gene Circuits
- e) Preparation of Nano silver particles by Wet reduction Method (Chemical) using Neem Extract (plants) & fungi (Microbiological)
- f) Preliminary characterization of Nano silver by UV spectrometry
- g) Antimicrobial effect of Ionic silver and Nano silver prepared by above methods
- h) Study of Nano silver coated Gauze/textiles for antimicrobial effect on different bacteria
- i) Demonstration of PCR

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation/ Assignment	15
2	One class test (Multiple choice questions/ objectives)	20
3	Active participation in routine class instructional deliveries	05

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

1. Duration- These examinations shall be of **two hours and thirty minutes**.
2. Theory question paper pattern-
 - a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.
 - b. All questions shall be compulsory with internal choice within the questions.

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 6	04	All four units
Q.5) b)	Any 4 out of 6	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

II) Practical Examination Pattern

	Paper I	Paper II	Paper III	Paper IV
Viva	05	05	10	-
Quiz	-	10	-	-
Laboratory work	25	35	40	20
Proposal Writing	-	-	-	30
Research Proposal Presentation	20	-	-	-
Total	50	50	50	50

Journal

1. 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.
2. 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.

Research Proposal writing

Candidates are required to present duly certified Research proposal and make the PowerPoint presentation of the research proposal for evaluation by the examiner.

Overall Examination and Marks Distribution Pattern

Semester II

Course	201			202			203			204			Grand total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200