AC/II(22-23).3.RPS9

S.P.Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for MSc Part I

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.
GA 2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA 3	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.
GA 4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
GA 5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently aswell as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA 6	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.
GA 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.
GA 8	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 inindustrial 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	RPSMIC.O501 (Core Course)	GENETICS	03
		RPSMIC.O502 (Core Course)	BIOCHEMISTRY	03
		RPSMIC.O503 (Core Course)	MEDICAL MICROBIOLOGY	03
		RPSMICP.O501	Practical based on Genetics	01
		RPSMICP.O502	Practical based on Biochemistry	01
		RPSMICP.O503	Practical based on Medical Microbiology	01
		RPSMIC.O 504	EPIGENETICS AND GENETIC BASIS OF CANCER	02
		RPSRMMIC.O505	RESEARCH METHODOLOGY	04
		Student should select anyone of the following Course		
		RPSMIC.O506 (Discipline Specific Course)	CLINICAL MICROBIOLOGY EPIDEMIOLOGY	03
		RPSBCH.O506 (Discipline Specific Course)	PLANT BIOCHEMISTRY	
		RPSBTK.O506 (Discipline Specific Course)	CLINICAL DATA MANAGEMENT	
		RPSMICP.O506 / RPSBCH.PO506 / RPSBTKP.O506	Practical based on CLINICAL MICROBIOLOGY EPIDEMIOLOGY/ PLANT BIOCHEMISTRY/	01

			CLINICAL DATA MANAGEMENT	
			Total Credits	**22**
		RPSMIC.E511 (Core Course)	**CELL BIOLOGY**	**03**
		RPSMIC.E512 (Core Course)	**MICROBIAL BIOCHEMISTRY**	**03**
		RPSMIC.E513 (Core Course)	**ENVIRONMENTAL MICROBIOLOGY**	**03**
		RPSMICP.E511	**Practical based on Cell biology**	**01**
		RPSMICP.E512	**Practical based on Microbial Biochemistry**	**01**
		RPSMICP.E513	**Practical based on Environmental Microbiology**	**01**
		RPSMIC.E514	**BIOINSTRUMENTATION**	**02**
		RPSMIC.E515	**FIELD PROJECT**	**04**
		Student should select anyone of the following Course		
		RPSMIC.E516 (Discipline Specific Course)	**MICROBIAL APPROACHES TO QUALITY MANAGEMENT**	**03**
		RPSBCH.E516 (Discipline Specific Course)	**NUTRACEUTICALS AND FUNCTIONAL FOODS**	
		RPSBTK.E516 (Discipline Specific Course)	**NANOTECHNOLOGY**	
		RPSMICP.E516 / RPSBCHP.E516 / RPSBTK.E516	**Practical-IV**	**01**
			Total Credits	**22**

Course Title: Genetics

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the post translational modifications, levels of gene expression
CO 2	Summarize principle and applications of variants of PCR technique
CO 3	Recall the basics of electrophoresis technique and apply it to study recent advances of the technique
CO 4	Understand the mechanism of operons in prokaryotes
CO 5	Understand the mechanism of gene regulation in prokaryotes and eukaryotes

Course Code: RPSMIC.O501 (Core Course)

Course Title: Genetics

Academic year 2023-24

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC. O501		**GENETICS-I**	**3/45**
I		**Control of Gene expression in Prokaryotes**	**15**
	1.1	**Introduction to Gene expression**	**03**
		a) Genes and Regulatory Elements b) Levels of Gene Regulation c) DNA-Binding Proteins	
	1.2.	**Operons**	**09**
		a) Operon Structure b) Negative and Positive Control: Inducible and c) Repressible Operons d) The lac Operon of E. coli e) lac Mutations f) Positive Control and Catabolite Repression g) The trp Operon of E. coli h) Attenuation in the trp Operon of E. coli	
	1.3	**Regulation of gene expression by RNA molecules**	**03**
		a) Antisense RNA molecules b) Riboswitches c) Ribozymes	
II		**Control of Gene expression in Eukaryotes**	**15**
	2.1	**Gene expression**	**05**
		a) Pre-mRNA processing and Small RNA molecules i. Structure of mRNA ii. Post transcriptional processing of pre-mRNA 1. Addition of 5"cap 2. Addition of Poly(A)tail 3. RNA splicing 4. RNA editing	

		ii. Small RNA molecules 1. RNA interference 2. Types 3. Processing 4. Function of micro RNAs	
	2.2	**Regulation of Gene expression**	**10**
		a) Regulation through modification of gene structure i. DNase I hypersensitivity ii. histone modifications iii. chromatin remodelling iv. DNA methylation. b) Regulation through regulatory molecules i. Transcriptional activators ii. Co-activators iii. Repressors iv. Enhancers v. Insulators c) Regulation through RNA processing & degradation d) Regulation through RNA interference	
III		**Molecular Biology Techniques**	**15**
	3.1	**Variations/ Modifications of PCR**	**05**
		Basics of PCR and its Modifications: a) Hot- Start PCR, b) Multiplex PCR, c) Nested PCR, d) RT-PCR, e) Broad Range PCR, f) Quantitative PCR, g) Real time PCR h) Touchdown PCR i) Colony PCR j) Digital PCR –Droplet	
	3.2	**Hybridization array technology**	**05**
		a) Applications of microarrays in microbiology b) Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays)	
	3.3	**Electrophoresis**	**05**
		a) Introduction to electrophoresis b) Agarose Gel Electrophoresis and	

		Polyacrylamide Gel Electrophoresis (Revision) c) 2D- Gel Electrophoresis d) Capillary Electrophoresis	

REFERENCES:

a) Russell, P.J., "iGenetics- A Molecular Approach", 3rd Ed, Pearson International Edition

b) Snustad & Simmons, "Principals of Genetics", 3rd Ed, John Wiley & Sons Inc

c) Pierce, B.A, "Genetics- A Conceptual Approach", 2nd Ed, W.H. Freeman & Co

PRACTICAL: RPSMICP.O501 (15 CONTACT HRS)

a. Diauxic Growth Curve
b. β galactosidase assay
c. Separation of DNA using Agarose Gel Electrophoresis (AGE)
d. Isolation of genomic DNA from yeast
e. Primer designing
f. Demonstration of PCR

Course Code: RPSMIC.O502 (Core Course)
Course Title: Biochemistry
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the basics of biochemical calculations like SI units and expression of concentration
CO 2	Remember the basics of amino acids and peptides and understand further details about secondary structure of polypeptide chain.
CO 3	Differentiate between various polysaccharides like glycoproteins and proteoglycans
CO 4	Explain the method of transport of four major biomolecules into the cell
CO 5	Execute various chemical methods to characterize the biomolecules
CO 6	Understand chemical properties of water to understand aqueous biochemistry

Course Code: RPSMIC.O502 (Core Course)
Course Title: Biochemistry
Academic year 2023-24
COURSE OUTCOMES:

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC.O502 (Core Course)		**BIOCHEMISTRY**	**3/45**
I		**Biochemical Calculations and Thermodynamics**	**15**
	1.1	**Biochemical Calculations**	**09**
		a) SI Units Relevant to Biochemistry 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 i. Molarity ii. Moles iii. Normality iv. Osmolarity v. Molality vi. Mole fraction vii. Density viii. Specific gravity **(problem solving under all heads)**	
	1.2	**Water**	**06**
		a) Physical properties of water i. Water as polar molecule – Hydrogen bonding ii. Hydrophilic Substances Dissolve in Water iii. The Hydrophobic Effect Causes Nonpolar Substances to Aggregate in	

		Water iv. Water Moves by Osmosis and Solutes Move by Diffusion b) Chemical Properties of Water i. Ionization of water ii. Acids and Bases Alter the pH iii. Bronsted Concept of conjugate acid-conjugate base pairs iv. Titration curves v. Buffers: preparation, action and their use in Biology vi. Henderson-Hasselbalch equation i. Buffer capacity	
II		**Biomolecules**	**15**
	2.1	**Amino acids and Proteins**	**04**
		a) Amino Acids and Peptides (Revision) i. Properties of α-Amino Acids ii. Acidic and Basic Side Chains iii. The Peptide Unit iv. Polypeptides a) Protein Structure a. Four Levels of Protein structure – Primary, Secondary, Tertiary and Quaternary b. Conformation of peptide group – Planar Peptide bond c. Ramachandran Plot b) Secondary Structure a. Alpha Helix b. Beta Sheets c. Beta turns c) Tertiary Structure a. Supersecondary structures or Motifs b. Domains i. Protein structure of Keratin and Collagen	
	2.2	**Glycoproteins**	**03**
		a) Revision of Carbohydrates structures a) Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids	
	2.3	**Lipids**	**03**
		a) Revision of structure and classification of lipids b) Lipids as Signals, Cofactors, and	

		Pigments	
III		**Transport of Biomolecules**	**15**
	3.1	**Transport of sugars**	**04**
		a) Transport of D-Glucose and D-Fructose into *E. coli* cell. Glucose transporters of erythrocytes, various glucose transporters present in humans (GLUT1-GLUT12)	
	3.2	**Transport of Fatty acid**	**04**
		a) Mobilization of triacylglycerols stored in adipose tissue Fatty acid entry into mitochondria via the acyl-carnitine/carnitine transporter	
	3.3	**Transport of proteins**	**07**
		a) Protein transport a. Sec System b. The Translocation of Membrane-Bound Proteins b) Extracellular Protein Secretion c) The type I pathway - Hemolysin secretion by E. coli	

REFERENCES:

a) Segel. R, “Biochemical calculations”, 3 rd edition John Wiley and Sons,1995

b) Lehninger A.L., Cox and Nelson, “Principles of Biochemistry”, 4th Edition, CBS Publishers and Distributors Pvt. Ltd. 1994

c) David White, “The Physiology and Biochemistry of Prokaryotes”, 3 rd Edition OxfordUniversity Press 2007

d) Laurence A. Moran, H. Robert Horton, K. Gray Scrimgeour, Marc D. Perry, Principles ofBiochemistry, 5th Edition, 2012, Pearson

e) Donald Voet, Judith G. Voet, Charlotte W. Pratt, FUNDAMENTALS OF Biochemistry, 3 rdEdition, 2008 John Wiley and Sons

PRACTICAL: RPSMICP.O502 (Core course) (15 CONTACT HRS)

a) Preparation of buffers

b) Determination of pK and PI value for an amino acid

c) Extraction of total lipids
d) Identification of fatty acids and other lipids by TLC
e) Determination of degree of unsaturation of fats and oils
f) Estimation of total sugars by phenol-sulphuric acid method
g) Determination of molar absorption coefficient(ε)of l-tyrosine
h) Determination of the isoelectric point of the given protein
i) Estimation of polyphenols /tannins by Folin-Denis method
j) Diffusion studies of molecules across RBCs

Course Code: RPSMIC.O503 (Core Course)

Course Title: Medical Microbiology

Academic year 2023-24

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

Course Code: RPSMIC.O503 (Core Course)

Course Title: Medical Microbiology

Academic year 2023-24

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC. O503 (Core Course)		**MEDICAL AND CLINICAL MICROBIOLOGY**	**03/ 45**
	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 C.*auris,* Conditions caused by *Helicobacter pylori*, VRE (Vancomycin Resistant enterococci), Listeriosis, Leptospirosis	
	II	**Study of Infections- II**	**15**
	2.1	**Detailed Study of following infections**	**15**
		including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment: Chikungunya, Dengue, Swine flu and Hepatitis - All types, Viral meningitis & encephalitis	
	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**	**06**

		defense systems	
		a) Biofilms- Structure, development, biofilms on implants and prosthetic devices, Biofilm eradication b) Colonization of host surfaces c) Evading host responses	

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

e) Jana Jass, Sussane Surma et al, "Medical Biofilms. Detection Prevention and Control", Wiley, 2003

f) Kendra Rumbaugh, Iqbal Ahmed, "Antibiofilm agents-From Diagnosis to treatment and Prevention", Springer Series on Biofilms Vol 8, Springer, 2014

g) Indira Kudva, Nancy Cornick *et al, "*Virulence Mechanisms of Bacterial Pathogens", 5th ed, ASM Press, 2016

h) A brief guide to emerging infectious diseases and zoonoses. WHO.

i) Nett JE, "Candida auris: An emerging pathogen "incognito", *PLoSPathog*, 2019, 15(4): e1007638. https://doi.org/10.1371/journal.

j) Spivak ES, Hanson KE, "Candida auris: an emerging fungal pathogen", *J Clin Microbiol,* 2018, 56:e01588-17.

k) Abdad MY, Abou Abdallah R, Fournier P-E, Stenos J, Vasoo S, "A concise review of the epidemiology and diagnostics of rickettsioses: Rickettsia and Orientispp", *J Clin Microbiol*, 2018, 56: e01728-17. https://doi.org/10.1128/JCM.01728-17.

l) Narendra Rathi And Akanksha Rathi, "Rickettsial Infections: Indian Perspective", *Indian Pediatrics,* 2010, Volume 47.

m) Haake, D. A., &Levett, P. N., "Leptospirosis in Humans", *Leptospira and Leptospirosis*, 2014, 65-97. doi:10.1007/978-3-662-45059-8_5.

n) Yunjin Lee, Emily Puumala, Nicole Robbins, and Leah E. Cowen, Antifungal Drug Resistance: Molecular Mechanisms in Candida albicans and Beyond, Chemical Reviews, 2017

PRACTICAL: RPSMICP.O503 (Core Courses) (15 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

Modality of Assessment for Core Courses

RPSMIC.O501, RPSMIC.O502, RPSMIC.O503:

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 anyother	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

	RPSMIC.O501	RPSMIC.O502	RPSMIC.O503
Viva	05	05	05
Quiz	05	05	05
Laboratory work	40	40	40
Total	**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.

Course Code: RPSMIC.O 504 (Core Course)

Course Title: EPIGENETICS AND GENETIC BASIS OF CANCER

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Implement the knowledge about oncogenes and cancer genetics in research
CO 2	Outlining the significance of cytoplasmic inheritance, giving emphasis to the evolutionary relationship of inheritance
CO 3	Understand the genetic basis of cytoplasmic inheritance
CO 4	Understand the association of mutations with cancer

Course Code: RPSMIC.O 504 (Core Course)

Course Title: EPIGENETICS AND GENETIC BASIS OF CANCER

Academic year 2023-24

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC.O 504 (Core Course)		**Epigenetics And Genetic Basis Of Cancer**	**02/ 30**
	I	**Extensions and deviations from Mendelian Genetics**	**15**
	1.1	**Mitochondrial Inheritance**	**05**
		a) Mitochondrial genome structure b) Ancestral and derived mitochondrial genome c) Mitochondrial DNA of Human, yeast and flowering plants d) Endosymbiotic theory e) General features of replication, transcription and translation of mitochondrial DNA f) Codon usage in Mitochondria g) Damage to Mitochondrial DNA and aging. h) Evolution of mitochondrial DNA Mt DNA analysis for study of evolutionary relationships	
	1.2	**Chloroplast DNA (cp DNA)**	**04**
		a) Gene structure and organization b) General features of replication, transcription and translation of cp DNA Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA cp DNA maps	
	1.3	**Examples of extranuclear inheritance**	**03**
		a) Leaf Variegation b) Poky mutant of Neurospora c) Yeast petite mutant, Human genetic diseases	
	1.4	**Epigenetics (Nature v/s Nurture)**	**03**

		a) The concept of Epigenome b) Molecular Mechanisms of epigenetic Changes c) Cause of epigenetic effects- Alterations in Chromatin Structure Examples of epigenetic effects	
	II	**Genetic basis of cancer**	**15**
	2.1	**Introduction to cancer**	**04**
		a) Forms of Cancer, cancer and the Cell Cycle b) Tumor Formation c) Cancer As a Genetic Disease d) The Role of Environmental Factors in Cancer	
	2.2	**Cancer and mutations**	**05**
		a) Oncogenes and Tumor-Suppressor Genes b) Genes That Control the Cycle of Cell Division c) DNA-Repair Genes d) Genes That Regulate Telomerase e) Genes That Promote Vascularization and the Spreadof Tumors f) MicroRNAs and Cancer g) The Cancer Genome Project	
	2.3	**Inherited Cancers and Knudson's Two-Hit Hypothesis**	**01**
	2.4	**Changes in Chromosome number and Cancer**	**01**
	2.5	**Viruses and Cancer**	**02**
	2.6	**Epigenetics and Cancer**	**01**
	2.7	**Study of Colorectal cancer**	**01**

REFERENCES:

a) Snustad& Simmons, "Principals of Genetics", 3rd Ed, John Wiley & Sons Inc

b) Pierce, B.A, "Genetics- A Conceptual Approach", 2nd Ed, W.H. Freeman & Co

Modality of Assessment for Core Course RPSMIC.O 504

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 20 Marks

Sr No	Evaluation type	Marks
1	Class test	20
	Total	**20**

B) External Examination- 60%- 30 Marks per paper

3. Duration- These examinations shall be of **one hour fifteen minutes**.
4. Theory question paper pattern-
    c. There shall be **two** 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

Course Code: RPSRMMIC.O505

Course Title: Research Methodology

Academic year 2023-24

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
RPSRMMIC.O505		**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**
		a) Introduction to principal bibliographic databases b) Medical and scientific internet search engines c) Reference management softwares d) Significance of cite when you write e) Bibliographic format: output styles	
	2.3	**Hypothesis and testing of hypothesis**	**04**
		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**
		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**
		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**
		a) Sampling frame b) Importance of probability sampling c) Types of sampling 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**
		a) Types of Variables i. Ordinal ii. Discontinuous iii. Continuous iv. Derived	
	3.3	**Statistical methods**	**09**
		Statistical methods 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 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 i. Large sample Tests a. Testing significance of single population mean b. Testing significance of two population mean ii. Small sample Tests 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. χ2 test a. Testing single population variance b. Testing Goodness of fit c. Testing association between two attributes iv. F-test- Testing equality of variance a. ANOVA- one-way classification, two-way classification	
	IV	**Scientific writing and Communication**	**15**
	4.1	**Report writing**	**03**
		a) Types of research reports b) Guidelines for writing a report c) Report format d) Appendices e) Miscellaneous information	
	4.2	**Scientific communication**	**05**
		a) Types of scientific documents 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	
	4.5	**Modes of communication**	**03**
		a) Communication by presentations i. Structure and types of presentation ii. PowerPoint presentation	

		iii. Handing 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) Rosner B.A., "Fundamentals of Biostatistics", Cengage Learning, 2011
c) Petter Laake, Haakon Breien Benestad and Bjorn Reino Olsen, "Research methodology in the medical and biological sciences" 1st Ed, Academic Press, 2007
d) Ranjit Kumar, "Research Methodology- A step-by-step Guide for beginners", 3rd Ed, Sage publications, 2005
e) Daniel WW, "Biostatistics: A foundation for analysis in health sciences", 10th Edn, Cross CL., Wiley. 2013
f) McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., Yarkoni, T. (2016). How open science helps researchers succeed. eLife, 5. doi:10.7554/elife.16800
g) Satish G. Patil, "How to plan and write a budget for research grant proposal?", Journal of Ayurveda and Integrative Medicine, Volume 10, Issue 2, 2019, Pages 139-142

Modality of Assessment for Core Course RPSMIC.O 505

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 and Assignment / Long Answer/ Case Study or anyother	20
2	Class test	20
	Total	**40**

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

5. Duration- These examinations shall be of **two hours and thirty minutes**.
6. Theory question paper pattern-
    e. There shall be **four** questions each of **15** marks. On each unit there shall be one question
    f. 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

Q.4) a)	Any 2 out of 3	10	Unit 4
Q.4) b)	Any 5 out of 7	5	Unit 4

DSE (Discipline Specific Elective)
Students have to select any one of the following courses

Course Code: RPSMIC.O506

Course Title: Clinical Microbiology and Epidemiology

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Apply appropriate methodologies to tackle the threat of antibiotic resistance
CO 2	Perform and analyze 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
RPSMIC.O 506 (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	**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	**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) Analyzing 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 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: RPSMICP.O506 (Discipline Specific Elective) (15 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 RPSMIC.O506:

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 anyother	10
2	Class test	20
	Total	**30**

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

7. Duration- These examinations shall be of **two hours**.
8. Theory question paper pattern-
    g. There shall be **three** questions each of **15** marks. On each unit there shall be one question.
    h. 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

	RPSMICP.O506
Viva	05
Quiz	05
Laboratory work	40
Total	**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.

Semester II

Course Code: RPSMIC.E511 (Core Course)

Course Title: Cell Biology

Academic year 2023-24

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	Deconstruct the process of meiosis
CO 6	Execute & implement the techniques used to study cell structure & its components.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC. E511 (Core Course)		**CELL BIOLOGY**	**3/45**
	I	**Cell structure and cytoskeleton**	**15**
	1.1	**Techniques to study cell and cellular structure.**	02
	1.2	**Cell membrane structure**	03
		a) Lipid bilayer b) Membrane proteins c) Spectrins d) Glycophorin e) Multi pass membrane protein f) Bacteriorhodopsin	
	1.3	**Cytoskeleton**	05
		a) Cytoskeletal filaments b) Microtubules c) Actin regulation d) Molecular motors e) Cell behaviour	
	1.4	**Cell Junctions and cell adhesion**	05
		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**
		a) Principles of membrane transport i. Ion channels ii. electrical properties of membranes b) Types of diffusion 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**
		a) Compartmentalization of cells b) Transport of molecules between the nucleusand cytosol, peroxisomes, Endoplasmic reticulum c) Transport of proteins into mitochondria and chloroplasts	
	2.3	**Intracellular vesicular traffic**	**03**
		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**
		a) M-phase b) Cytokinesis	
	3.2	**Cell cycle and Programmed cell death**	**03**
		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**
		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**
		a) Docking sites b) Ras c) MAP kinase d) PI-3kinase e) TGF	
	3.5	**Signalling in plants**	**01**
		a) Serine/ Threonine kinases b) Role of ethylene c) Phytochromes	

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

PRACTICAL: RPSMICP.E511 (Core Course) (15 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) 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.E512 (Core Course)
Course Title: Microbial Biochemistry
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the basics of biochemical techniques for extraction and purification of biomolecules
CO 2	Compare models 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	Analyse 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. E512 (Core Course)		**MICROBIAL BIOCHEMISTRY**	**3/45**
	I	**Analytical Biochemistry**	**15**
	1.1	**Methods of purification of proteins**	**4**
		a) Salting out of proteins using ammonium sulphate b) Solvent precipitation of proteins c) Purification of proteins using column chromatography – Ion exchange, Gel filtration, Affinity, HPLC d) Measures of purity - Enzyme units, specific activity	
	1.2	**Methods of analysis of proteins**	**4**
		a) 2D- Gel electrophoresis – SDS PAGE and Isoelectric focusing b) Protein sequencing by Sanger Sequencing, Edman Degradation, Mass spectrometry c) Protein structure determination by X ray diffraction, NMR	
	1.3	**Methods of analysis of carbohydrates**	**2**
	1.4	**Methods of analysis of lipids**	**5**
		a) Lipid Extraction using organic Solvent b) Adsorption Chromatography c) Gas-Liquid Chromatography-Mass Spectrometry	
	II	**Enzymology**	**15**
	2.1	**Introduction to enzymes**	**07**
		a) Discovery of enzymes b) Enzyme classification – E.C. number of enzymes	

		c) Lowering of activation energy of reaction by enzymes d) Enzyme Kinetics – Steady state assumption and Michaelis Menten Kinetics e) Lineweaver Burk plot f) Reversible enzyme inhibition – Competitive, non competitive, uncompetitive – Mechanism, graph, examples g) Irreversible enzyme inhibition	
	2.2	**Enzyme regulation:**	**04**
		a) General properties of allosteric enzymes b) Two themes of allosteric regulations – Concerted model and sequential model c) Regulation by covalent modification	
	2.3	**Mechanisms of enzyme catalysis**	**04**
		a) Detailed mechanisms of enzyme catalysis: i. RNaseA ii. Lysozyme	
	III	**Cell Signaling in Prokaryotes**	**15**
	3.1	**Two-component signaling systems - I**	**10**
		a) Introduction to two-component signaling systems - Components of two-component signaling systems b) Response by facultative anaerobes to anaerobiosis c) Response to Nitrate and Nitrite: The Nar Regulatory System d) Response to Nitrogen Supply: The Ntr Regulon e) Response to Inorganic Phosphate Supply: The Pho Regulon	
	3.2	**Two-component signaling systems - II**	**05**
		a) Response to Carbon Sources: Catabolite Repression – Cra and Cre system b) Chemotaxis	

REFERENCES:

a) Donald Voet, Judith G. Voet, Charlotte W. Pratt, FUNDAMENTALS OF Biochemistry, 3rd Edition, 2008 John Wiley and Sons

b) Horton and Moran, "Principles of Biochemistry", 5th Ed, Scrimgeour Pears Rawn, 2011
c) Lehninger A.L., Cox and Nelson, "Principles of Biochemistry", 4th Ed, CBS Publishers and Distributors Pvt. Ltd. 1994
d) White D, "The physiology and biochemistry of prokaryotes", 2nd Ed, Oxford University Press, 2000

PRACTICAL: RPSMICP.E512 (15 CONTACT HRS)

a) Isolation of Amylase from *Aspergillus spp* and its Purification strategy
b) Purification of an extracellular enzyme (βamylase) by salting out and dialysis
c) Enzyme kinetics effect of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity,
d) Demonstration of proteolytic activity
e) Determination of glucose isomerase present intracellularly in *Bacillus sp.*
f) Chemotaxis of *Pseudomonas*
g) Effect of temperature and water activity on swarming of *Proteus*
h) Aqueous two-phase partitioning
i) Extraction of protein by precipitation with Acetone
j) Separation of proteins using Polyacrylamide Gel Electrophoresis (PAGE)

Course Code: RPSMIC.E513 (Core Course)
Course Title: Environmental Microbiology
Academic year 2023-24

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. E513 (Core Course)		**ENVIRONMENTAL MICROBIOLOGY**	**03/45**
	I	**Microbial Ecology**	**15**
	1.1	**Basic concepts of Microbial Ecology**	**04**
		a) Microbial Ecology i. General ecological concepts ii. Ecosystem Service: Biogeochemistry b) The Microbial Environment i. Environments and microenvironments ii. Surfaces and Biofilms iii. Microbial Mats	
	1.2	**Techniques for microbial analysis**	**11**
		a) Culture-Dependent Analyses of Microbial Communities i. Enrichment ii. Isolation b) Culture-Independent Microscopic Analyses of Microbial Communities i. General Staining Methods ii. Fluorescence In Situ Hybridization (FISH) c) Measuring Microbial Activities in Nature i. Chemical Assays, RadioisotopicMethods, and Microsensors ii. Stable Isotopes iii. Linking Genes and Functions to Specific Organisms: SIMS, Flow Cytometry, and MAR-FISH iv. Linking Genes and Functions to Specific Organisms:Stable Isotope Probing and Single-Cell Genomics	

	II	**Extremophiles and Biogeochemical cycles**	**15**
	2.1	**Extremophiles**	**08**
		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: i. Thermophiles ii. Psychrophiles iii. Halophiles iv. Piezotolerant and Piezophilic Bacteria and Archaea v. Acidophiles vi. Alkaliphiles vii. Xerophiles viii. Radiation resistant organisms ix. Methanogens	
	2.2	**Biogeochemical cycles**	**05**
		a) Biogeochemical cycles i. Carbon - Carbon Reservoirs, Photosynthesis and Decomposition, Carbon Balances and Coupled Cycles ii. Nitrogen - Nitrogen Fixation and Denitrification, Ammonification and Ammonia Fluxes, Nitrification and Anammox iii. Sulphur - Hydrogen Sulfide and Sulfate Reduction, Sulfide and Elemental Sulfur Oxidation-Reduction, Organic Sulfur Compounds	
	2.3	**Human Impacts on the Carbonand Nitrogen Cycles**	**02**
		a) CO2 and Global Warming b) Anthropogenic Effects on the Nitrogen Cycle	
	III	**Environmental Waste Management**	**15**
	3.1	**Solid waste management**	**02**

		a) Solid waste generation and Characterization b) Material recycling c) Biological Treatment of Solid waste	
	3.2	**Wastewater and Drinking Water Treatment**	**05**
		a) Primary and SecondaryWastewater Treatment i. Wastewater and Sewage ii. Wastewater Treatment and Biochemical Oxygen Demand iii. Primary Wastewater Treatment iv. Secondary Anaerobic Wastewater Treatment v. Secondary Aerobic Wastewater Treatment b) Advanced Wastewater Treatment i. Biological Phosphorus Removal ii. Contaminants of Emerging Concern	
	3.3	**Hazardous waste management**	**04**
		a) Biological Principles b) Treatment Approaches c) Hazardous Waste Biodegradation d) Mixed, Aerobic, Anaerobic hazardous Waste Reactors.	
	3.4	**Biohazards**	**04**
		a) Introduction b) levels of biohazards c) Risk assessment d) Proper cleaning procedures e) Biomedical waste management	

REFERENCES:

a) Brock Madigan, Martinko, Dunlap, Clark, “Biology of microorganisms”, 12th Ed, Pearson Intl, 2011

b) Fred Rainey, Aharon Oren, “Methods in Microbiology- Extremophiles”, Vol 35, Academic press, 2006

c) R.M Maier, I. L. Pepper and C. P. Gerba, “Environmental Microbiology”, Academic Press, 2010

d) Thomas H. Christensen, “Solid Waste Technology and Management”, Blackwell Publishing Limited, 2011

e) Deepak Yadav, Pradeep Kumar, “Hazardous Waste management: An overview of cost effective solutions”, Elsevier, 2022.

PRACTICAL: RPSMICP.E513 (Core Course) (15 CONTACT HRS)

a) Enrichment & isolation of thermophiles from hot springs/compost heaps & extraction of thermophilic enzymes & determination of their specific activity.
b) Enrichment & isolation of Halophiles
c) To detect coliform and faecal coliform bacteria in water by the membrane filtration method
d) Isolation of Azotobacter and Rhizobium from Soil
e) Determination of Biological and Chemical Oxygen Demand
f) Estimation of Phosphorus content from Waste water
g) Study of Nitrification
h) Microbial analysis of soil
    i. Microbial load
    ii. Dehydrogenase Activity of Soils

Modality of Assessment for Core Courses

RPSMIC.E511, RPSMIC.E512, RPSMIC.E513:

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 anyother	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

	RPSMIC.E511	RPSMIC.E512	RPSMIC.E513
Viva	05	05	05
Quiz	05	05	05
Laboratory work	40	40	40
Total	**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.

Course Code: RPSMIC.E514 (Core Course)

Course Title: Bioinstrumentation

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the principles of various spectroscopic methods
CO 2	Attribute various applications in biological sciences to the appropriate chromatographic technique
CO 3	Understand the advanced chromatographic and spectroscopic methods
CO 4	Understand the applications of chromatographic and spectroscopic methods in biological science

Course Code: RPSMIC.E514 (Core Course)

Course Title: BIOINSTRUMENTATION

Academic year 2023-24

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC. E514		**BIOINSTRUMENTATION**	**2/30**
I		**Spectroscopic Techniques** Principle and applications of:	**15**
	1.1	**UV-visible spectroscopy**	**03**
	1.2	**IR spectroscopy**	**04**
	1.3	**Atomic Absorption Spectroscopy**	**03**
	1.4	**Mass spectroscopy**	**05**
	II	**Chromatographic Techniques**	**15**
	2.1	**Gas Chromatography**	**05**
		a) Principle b) Instrumentation c) Operation d) Calibration e) Accuracy f) Applications	
	2.2	**High Performance Liquid Chromatography**	**05**
		a) Principles b) Instrumentation c) Operation d) Calibration, e) Accuracy f) Applications	
	2.3	**High Performance Thin Layer Chromatography**	**02**
		a) Theory of TLC b) HPTLC: Development, data and results c) Applications	
	2.4	**Hyphenated techniques**	**03**
		Principle of a) LC-MS	

		b) GC-MS	

REFERENCES:

a) Upadhyay, Upadhyay and Nath, "Biophysical Chemistry: Principles and Techniques", Mumbai, Himalaya Publishing House, 2012
b) Skoog, Holler and Nieman, "Principles of Instrumental Analysis", 5th Ed. Australia, Thomson Brock/Cole
c) Wilson and Walker, "Principles and Techniques of Biochemistry and Molecular Biology", 7th Ed., Cambridge University Press, 2010.

Modality of Assessment for Core Course RPSMIC.E514

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 20 Marks

Sr No	Evaluation type	Marks
1	Class test	20
	Total	**20**

B) External Examination- 60%- 30 Marks per paper

3. Duration- These examinations shall be of **one hour fifteen minutes**.
4. Theory question paper pattern-
    c. There shall be **two** 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

Course Code: RPSMIC.E515

Course Title: FIELD PROJECT

Academic year 2023-24

(Discipline Specific Elective)
Students have to select any one of the following courses

Course Code: RPSMIC.E516

Course Title: Microbial Approaches to Quality Management

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Execute collection, processing and microbiological analysis of food, water, pharmaceutical and cosmetic samples
CO 2	Implement monitoring protocols for the quality of food and water using principles of HACCP
CO 3	Apply basic knowledge of microbial analysis and standards to evaluate current techniques and improvise technology in industries like food, bottled water, cosmetic and pharmaceutical manufacturing units
CO 4	Recall the principles and terminologies used in pharmaceutical industry
CO 5	Design experiments on bioburden determination
CO 6	Execute microbial and sterility testing of pharmaceutical products
CO 7	Monitor the factors which affect the quality of a pharmaceutical product
CO 8	Outline the process of validation and audit validation
CO 9	Design effective antimicrobial preservation methods for cosmetic products

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC.E 516 (Discipline Specific Elective)		**MICROBIAL APPROACHES TO QUALITY MANAGEMENT**	**03/45**
	I	**Introduction to Quality Control and Quality Assurance**	**15**
	1.1	Basics of Quality and Audits a) Introduction to Basics of Quality b) Total Quality Management c) Quality Assurance d) Audits e) Manufacturing Audits: Control of Processing Operations	**08**
	1.2	Good Manufacturing Practices and HACCP a) Plant Sanitation: Good Manufacturing Practice Audits b) Hazard Analysis and Critical Control Points	**07**
	II	**Quality Control and Quality Assurance in Food and Water Industry**	**15**
	2.1	Quality Assurance in Food Industry a) Food Safety Assurance and Standards b) Microbiological Examination Methods for food c) Role of International and National Organisations	**09**
	2.2	Quality Assurance in Water Industry a) General considerations and principles b) A conceptual framework for implementing the Guidelines c) Verification of drinking-water quality d) Drinking-water regulations and supporting policies and programmes	**06**
	III	**Quality Control and Quality Assurance in**	**15**

		Pharmaceutical Industry and Cosmetic	
		a) Laboratory management and design b) Introduction to Pharmacopoeia- IP, BP, USP c) Microbiological examination of nonsterileproducts d) Sterility Testing e) Antibiotic Potency Testing f) Pyrogen Testing and Bioburden determination g) Antimicrobial Effectiveness Testing and Preservation of Cosmetics h) Preservative Effectiveness Testing i) Preservation of cosmetics	

REFERENCES:

a) Rosamund M.Baird, Norman A.Hodges, Stephen P.Denyer, Handbook of Microbiological Quality Control: Pharmaceuticals and Medical Devices Taylor and Francis

b) Food And Drug Administration, Office Of Regulatory Affairs, Office of Regulatory Science, Document Number:ORA.007, Pharmaceutical Microbiology Manual, Revision #: 02 Revised: 25 Aug 2020

c) Tim Sandle, "Pharmaceutical Microbiology- Essentials for Quality Assurance and Quality control", Woodhead Publishing, Elsevier, 2016

d) Philip A,Taylor and Francis, "Cosmetic Microbiology a practical approach", 2nd Ed. 2006

e) WHO drinking water guidelines, Manual For Packaged Drinking, Water Bureau Of Indian Standards, January 2005

f) Food Safety Management Programs by Debby Newslow

g) Microbiological Examination Methods for Food and Water by Neusely da Silva

h) Food Safety Management A Practical Guide for the food Industry by Yasmine Motarjem

i) Quality Assurance for Food Industry- A Practical Approach. 3rd Edition, J. Andres Vasconcellos

j) Government of India, Ministry of Health. (1955). Pharmacopoeia of India : (the Indian pharmacopoeia). Delhi :Manager of Publications,

k) The United States pharmacopeia. The National formulary. (1979). Rockville, Md. :United States Pharmacopeial Convention, Inc.,

l) British Pharmacopoeia Commission. British Pharmacopoeia 2016. London: TSO; 2016.

PRACTICAL: RPSMICP.E516 (Discipline Specific Elective) (15 CONTACT HRS)

a) Sterility testing and reporting (as per Pharmacopoeia)
b) Preparation of cosmetic product and its stability study
c) Microbial load in cosmetic product as per IS 14648:2011 w.r.t heterotrophic counts, presence of *Pseudomonas spp, Staphylococcus spp, P.acne*
d) Efficacy testing of preservatives like parabens as per ISO 11930
e) Determination of efficacy of sterilization methods.
f) Microbiological load in carrot and apple juice, salad, mayonnaise
g) Quality Assessment and Analysis of Raw and Pasteurized milk
h) Study of efficiency of water purifiers and comparative assessment
i) Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT)
j) Potability testing of drinking Water.

Modality of Assessment for Discipline Specific Elective RPSMIC.E516:

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 anyother	10
2	Class test	20
	Total	**30**

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

5. Duration- These examinations shall be of **two hours**.
6. Theory question paper pattern-
    e. There shall be **three** questions each of **15** marks. On each unit there shall be one question.
    f. 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

	RPSMICP.O506
Viva	05
Quiz	05
Laboratory work	40
Total	**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.