AC/I(21-22).2(II).RPS9

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for MSc

Program: MSc (Microbiology)

Program Code: RPSMIC

(Choice Based Semester and Grading System
for academic year 2022-2023)

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	GA Description **A student completing Master's Degree in Science program will be able to:**
GA 1	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 as well 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 in industrial products. Explain techniques in protein engineering for increasing activity and specificity.

PO 17	Outline work plans and execute tasks independently and to completion. Coordinate and cooperate with team members for execution of experiments. Maintain records, make reports and interpret them for making summaries. Communicate information accurately and effectively. Follow ethical practices at workplace, take initiative, exhibit competency and imbibe other professional skills.
PO 18	Apply theoretical concepts effectively and think innovatively to translate ideas to research projects and projects to products. Understand the significance of microbiology as a science that has transdisciplinary relevance and immense potential to improve quality of life for all humankind.

PROGRAM OUTLINE (2022-24)

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc I	I	RPSMIC 101 (Core Course)	MICROBIAL GENETICS	04
		RPSMIC 102 (Core Course)	MICROBIAL BIOCHEMISTRY	04
		RPSMIC 103 (Core Course)	MEDICAL MICROBIOLOGY AND HUMAN MICROBIOME	04
		RPSMICP 101	Practical-I	02
		RPSMICP 102	Practical-II	02
		RPSMICP 103	Practical-III	02
		Student should select anyone of the following Course		
		RPSMIC 104 (Discipline Specific Course)	CLINICAL MICROBIOLOGY EPIDEMIOLOGY	04
		RPSBCH 104 (Discipline Specific Course)	PLANT BIOCHEMISTRY	
		RPSBTK 104 (Discipline Specific Course)	CLINICAL DATA MANAGEMENT	
		RPSMICP 104/ RPSBCHP 104/ RPSBTKP 104	Practical-IV	02
		RPSMIC 105 (Ability Enhancement Compulsory Course)	EMOTIONAL WELL-BEING THROUGH LOGIC-BASED THINKING	02
			Total Credits	26
	II	RPSMIC 201 (Core Course)	CELL BIOLOGY	04
		RPSMIC 202 (Core Course)	MICROBIAL BIOCHEMISTRY II	04
		RPSMIC 203 (Core Course)	ENVIRONMENTAL MICROBIOLOGY	04
		RPSMICP 201	Practical-I	02
		RPSMICP 202	Practical-II	02
		RPSMICP 203	Practical-III	02
		Student should select anyone of the following Course		
		RPSMIC 204 (Discipline Specific Course)	MICROBIAL APPROACHES TO QUALITY MANAGEMENT	04
		RPSBCH 204	NUTRACEUTICALS AND	

		(Discipline Specific Course)	**FUNCTIONAL FOODS**	
		RPSBTK 204 (Discipline Specific Course)	**NANOTECHNOLOGY**	
		RPSMICP 204/ RPSBCH 204/ RPSBTK 204	**Practical-IV**	**02**
		RPSMIC 205 (Ability Enhancement Course)	**RESEARCH METHODOLOGY**	**02**
			Total Credits	**26**

Course Code: RPSMIC 101 (Core Course)
Course Title: Microbial Genetics
Academic year 2022-23
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 (Core Course)		**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 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 d) mRNA surveillance e) Post translational modification of Proteins	
	1.2.	**Regulation of gene expression**	**09**
		a) Control of gene expression in prokaryotes 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 i. Regulation through modification of gene structure 1. DNase I hypersensitivity 2. histone modifications 3. chromatin remodelling 4. DNA methylation. ii. Regulation through regulatory molecules 1. Transcriptional activators 2. Co-activators 3. Repressors 4. Enhancers 5. Insulators iii. Regulation through RNA processing & degradation	**03** **06**

		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 *Salmonella*	
II		**Extensions and deviations from Mendelian Genetics**	**15**
	2.1	**Mitochondrial Inheritance**	**04**
		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 i) Mt DNA analysis for study of evolutionary relationships	
	2.2	**Chloroplast DNA (cp DNA)**	**03**
		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 cp DNA maps	
	2.3	**Examples of extranuclear inheritance**	**03**
		a) Leaf Variegation b) Poky mutant of Neurospora c) Yeast petite mutant, d) Human genetic diseases	
	2.4	**Horizontal Gene Transfer**	**02**
		Revision of a) Transformation in bacteria b) Conjugation c) Transduction	
	2.5	**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 d) Examples of epigenetic effects	
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 Trypansomes 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 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. *E. coli* ii. Yeast iii. *C. elegans* iv. *A. thaliana* v. *Mus musculus*	
	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,

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.

PRACTICAL-I: RPSMICP101 (Core Course) (60 CONTACT HRS)

a. β galactosidase assay
b. Separation of DNA using Agarose Gel Electrophoresis (AGE)
c. Isolation of genomic DNA from yeast
d. Problems on population genetics
e. Transformation of yeast
f. Artificial transformation of bacteria
g. Bacterial conjugation
h. Study of transduction

Course Code: RPSMIC 102 (Core Course)
Course Title: Microbial Biochemistry-I
Academic year 2022-23
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
CO 7	Understand the biochemical pathways for metabolism of one and two carbon compounds

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 102 (Core Course)		**MICROBIAL BIOCHEMISTRY I**	**4/60**
	I	**Biochemical Calculations and Water**	**15**
	1.1	**Biochemical Calculations**	**04**
		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**	**11**
		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**	**07**
		a) Amino Acids and Peptides (Revision) a. Properties of α-Amino Acids	

		b. Acidic and Basic Side Chains c. The Peptide Unit d. Polypeptides b) Protein Structure a. Four Levels of Protein structure – Primary, Secondary, Tertiary and Quaternary b. Conformation of peptide group – Planar Peptide bond c. Ramachandran Plot c) Secondary Structure a. Alpha Helix b. Beta Sheets c. Beta turns d) Tertiary Structure a. Supersecondary structures or Motifs b. Domains i. Protein structure of Keratin and Collagen	
	2.2	**Glycoproteins**	**04**
		a) Revision of Carbohydrates structures a) Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids	
	2.3	**Lipids**	**04**
		a) Revision of structure and classification of lipids b) Lipids as Signals, Cofactors, and Pigments	
III		**One and two Carbon metabolism**	**15**
	3.1	a) **Metabolism of one carbon compounds**	**07**
		a) Methylotrophs i. Oxidation of methane, methanol, methylamines ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens b) Methanogenesis i. Methanogenesis form H2, CO2, CH3OH, HCOOH, methylamines ii. Energy coupling and biosynthesis in methanogenic bacteria c) Acetogens: autotrophic pathway of acetate synthesis and CO2 fixation, d) Carboxidotrophs: Biochemistry of chemolithoautotrophic metabolism	
	3.2	**Metabolism of two- carbon compounds**	**08**
		a) Acetate 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	

		i. Dicarboxylic acid cycle ii. Glycerate pathway iii. Beta hydroxyaspartate pathway i. Oxalate- as carbon and energy source	
IV		**Transport of Biomolecules**	**15**
	4.1	**Transport of sugars**	**04**
		a) Transport of D-Glucose and D-Fructose into *E. coli* cell. b) Glucose transporters of erythrocytes, various glucose transporters present in humans (GLUT1-GLUT12)	
	4.2	**Transport of Fatty acid**	**04**
		a) Mobilization of triacylglycerols stored in adipose tissue c) Fatty acid entry into mitochondria via the acyl-carnitine/carnitine transporter	
	4.3	**Transport of proteins**	**07**
		a) Protein transport a. Sec System b. The Translocation of Membrane-Bound Proteins b) Extracellular Protein Secretion b) 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 Oxford University Press 2007

d) Gottschalk, G., Bacterial Metabolism, 2nd edition, 1985, Springer Verlag.

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

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

PRACTICAL-II: RPSMICP 102 (Core Course) (60 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) Enrichment, isolation and identification of *Methylobacterium*
k) Diffusion studies of molecules across RBCs

Course Code: RPSMIC 103 (Core Course)

Course Title: Medical Microbiology and Human Microbiome

Academic year 2022-23

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	Analysing and hypothesizing the effects of Human microbiome on different aspects of human physiology

DETAILED SYLLABUS

Course Code	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 103 (Core Course)		**MEDICAL MICROBIOLOGY AND HUMAN MICROBIOME**	**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 C.*auris,* Conditions caused by *Helicobacter pylori*, VRE (Vancomycin Resistant enterococci), Listeriosis, Leptospirosis	
II		**Study of Infections- II**	**15**
		Detailed Study of following infections 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 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		**Study of Human Microbiome**	**15**
	4.1	**Human Gut Microbiome**	**05**
		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	
	4.2	**Human Skin Microbiome**	**02**
		a) Diversity of skin microbiome	

		b) Function of skin microbiome c) Skin Microbiome in diseases	
	4.3	**Human Oral Microbiome**	**04**
		a) Diversity of oral microbiome b) Oral microbiome & health	
	4.4	**Human Urogenital Microbiome**	**04**
		a) Male and female genital microbiome b) Diversity of urogenital microbiome c) Urogenital microbiome & health	

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

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

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

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

l) 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.

m) Narendra Rathi And Akanksha Rathi, ―Rickettsial Infections: Indian Perspective‖, *Indian Pediatrics,* 2010, Volume 47.

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

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

PRACTICAL-III : RPSMICP 103 (Core Course) (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

Modality of Assessment for Core Courses:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks (Except for AECC)

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	20
2	Class test	20
	Total	**40**

B) External Examination- 60%- 60 Marks per paper (Except for AECC)

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

	RPSMICP 101	RPSMICP 102	RPSMICP 103
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.

DSE (Discipline Specific Elective)
Students have to select any one of the following courses
Course Code: RPSMIC 104
Course Title: Clinical Microbiology and Epidemiology
Academic year 2022-23

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 104 (Discipline Specific Elective)		**CLINICAL MICROBIOLOGY AND EPIDEMIOLOGY**	**04/60**
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 surgical procedures 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 I**	**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	**Bioterrorism**	**03**
		a) Introduction b) Threat Agents by category c) Sentinel Laboratory response to bioterrorism d) The Potential for Misuse of Biotechnology e) Some examples of biological agents as warfare – Bacillus anthracis, Yersinia pestis	
	3.4	**Biosecurity**	**01**
		a) Introduction b) Constituents of a Biosecurity hazard	
II		**EPIDEMIOLOGY II**	**15**
	2.1	**Healthcare-associated infections**	**04**
		a) Surveillance for HAIs b) Major types of HAIs c) The need for integrated infection control programs	
	2.2	**Molecular and Genetic Epidemiology**	**07**
		a) Definition – Molecular v/s Genetic epidemiology b) Epidemiologic evidence of genetic factors c) Causes of Familial Aggregation d) Gene Mapping: Segregation and Linkage analysis e) Genome Wide Association Studies (GWAS) Applications of genes in Epidemiologic designs	
	2.3	**Ethics in Research involving Human Participants**	**03**
		a) Introduction b) Historical perspective c) International Ethical and Research Practice	

		guidelines d) Contemporary examples e) The informed Consent process	
	2.4	**Epidemiology as a Profession**	**01**

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) Ann Aschengrau, George R Seage, Essentials of Epidemiology in Public Health, 3rd Ed.
j) Robert H. Friis and Thomas A. Sellers, Epidemiology for Public Health Practice, Jones & Bartlett Learning, LLC, 5th ed.
k) Kenrad E. Nelson, Infectious Disease Epidemiology – Theory and Practice, 3rd ed.

PRACTICAL-IV: RPSMICP 104 (Discipline Specific Elective) (60 CONTACT HRS)

a) QC of laboratory media
b) QC of laboratory reagents
c) Use of chromogenic media for detection of antibiotic resistant bacteria
d) Detection of Beta lactamase producing *S.aureus* using nitrocefin disc's
e) Antimicrobial susceptibility testing- disc method according to CLSI guidelines
f) QA of Antibiotic Susceptibility Test- disc method
g) Antibiotic Susceptibility Test – microdilution methods according to CLSI guidelines
h) Checkerboard assay
i) E-test
j) Octa-disc method for AST
k) Case Studies of epidemiological strategies
l) Data analysis of epidemiological surveys
m) Group project on collecting data for surveillance

Modality of Assessment for RPSMIC 104 (Discipline Specific Elective)

Course Title: Clinical Microbiology and Epidemiology

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 any other	20
2	Class test	20
	Total	**40**

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

RPSMICP 104	
Particulars	**Marks**
Quiz/Viva	25
Laboratory work	25
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.

Course Code: RPSBCH 104 (Discipline Specific Elective)

Course Title: Plant Biochemistry

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Study the structural details of the plant cell
CO 2	Illustrate the chemistry of different plant pigments in order to explore their isolation, characterization and applications in various fields
CO 3	Explain and understand the biochemistry of photosynthetic process and its relation to man and its environment.
CO 4	Understand the mechanism of Nitrogen fixation and its importance in agricultural production and environment
CO 5	Acquire knowledge about the importance of secondary metabolites and its industrial applications.
CO 6	Identify the class and functions of secondary metabolites and appreciate their role in physiology of plants
CO 7	Know the significance of plant growth regulators in the development of plants
CO8	Understand the basics of plant tissue culture as it is an important tool for both basic and applied aspects of plant-based research
CO9	Become competent to explain relation between Photosynthesis, growth hormones and Plant growth
CO10	Develop skills and knowledge to conduct basic research work in the field of Plant Biochemistry

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSBCH 104 (Discipline Specific Elective)		**PLANT BIOCHEMISTRY**	**04/60**
	I	**Overview of Plant cell structure, plant pigments & plant metabolism**	**15**
	1.1	Plant cell wall (structure), Overview of Leaf structure	**3**
		a) Upper epidermis b) palisade mesophyll c) spongy mesophyll d) lower epidermis e) Guard cells and stomata	
	1.2	Specialized plant cells	3
		a) Parenchyma, Sclerenchyma, Collenchyma, Xylem and phloem, Bulliform cells b) Concept of apoplast, apoplastic and symplastic pathways	
	1.3	Plant pigments	3
		a) Primary pigment - Chlorophyll (Types and function) b) Role of accessory pigments and their biological significance c) Carotenoids, Xanthophylls, Betalains, Anthocyanins and other flavonoids	
	1.4	Plant Micronutrients	1
	1.5	Nitrogen metabolism	5
		a) Sources of Nitrogen, different forms of nitrogen in plants b) Conversion of nitrate to nitrite & finally to ammonia, biological nitrogen fixation in plants c) Sulphur metabolism, Phosphorous metabolism	
	II	**Photosynthesis, Photorespiration and plant movements**	**15**
	2.1	Photosynthesis	1
	2.2	a) Light reactions: Light harvesting complexes, Absorption of light, Photophoshorylation: Cyclic and Non-cyclic (Z scheme) b) Dark reactions: Calvin cycle, regulation of Calvin cycle, C4 cycle and CAM pathway, Synthesis of glucose, starch, sucrose	2 5

		c) Photorespiration, Photoperiodism and photoinhibition d) Physiology of plant movements i. Physical movements – Xerochasy, Hydrochasy ii. Vital movements – Protoplasmic streaming, paratonic movements iii. Tactic movements - Chemotaxis, Phototaxis, Thermotaxis iv. Tropic movements – Chemo / geo / hydro / photo / thigmo tropism v. Nastic movements - Seismonasty, Nyctynasty, Photonasty, Chemonasty, Thermonasty	4 3
	III	**Regulation of plant growth, secondary metabolites and Sexual reproduction in plants**	**15**
	3.1	Plant Growth Substances	2
		Structure and Function of Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic Acid	
	3.2	Secondary metabolites of plants	4
		Nitrogen containing compounds (Alkaloids), Terpenes & Phenolic compounds – Shikimic acid pathway, Mevalonic acid pathway, MEP Pathway	
	3.3	Reproduction in plants	7
		a) Asexual reproduction in gymnosperms. b) Life Cycle of Gymnosperms c) Sexual Reproduction in angiosperms: Structure of plant gametes. Life cycle of angiosperm d) Double fertilization in plants e) Post fertilization events in plants	
	3.4	Plant Tissue Culture: Principles & techniques of PTC	2
	IV	**Phytoremediation**	**15**
	4.1	Concept of Phytoremediation: Process and mechanism contaminant removal, General contaminants of air, water and soil	4
	4.2	Mechanisms of Phytoremediation	5
		a) Phytoextraction, phytostabilization, phytotransformation, phytostimulation, phytovolatalization and Rhizofiltration b) Enzymes involved in phytoremediation	
	4.3	Control of environmental pollution by Phytoremediation	6
		a) Criteria for selection of plants b) Phytoremediation of air, water and soil pollutants and their Case studies	

REFERENCES:

a) Biochemistry & Molecular Biology of Plants - Bob B. Buchanan - Wilhelm Gruissem and Russel L. Jones
b) Plant Biochemistry - Heldt H.-W., Piechulla B.
c) Methods in plant biochemistry and molecular biology - Dashek, William V
d) Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet - Alan Crozier
e) Plant Physiology - Taiz and Zeiger - Sinauer Associates Inc.
f) Plant Biochemistry - Caroline Bowsher, Martin steer, Alyson Tobin - Garland science
g) Plant Biochemistry - P.M Dey and J.B. Harborne - Academic Press
h) Biochemical methods - S Sadashivam and A Manickam - New Age International publishers.

PRACTICAL - IV: RPSBCHP 104 (Discipline Specific Elective) (60 CONTACT HRS)

a) Study of medicinal plants for human health and their health benefits
b) Extraction of essential oils from plants
c) Phytochemical analysis – Qualitative test
d) Quantitative estimation of Total Phenolic content
e) Study of effect of Eutrophication on water quality
f) Preparation of growth media using plant waste
g) Total carbohydrate content by Anthrone method
h) Estimation of Vitamin C Content in plant by dye method.
i) Effect of phytohormones on plant growth

Modality of Assessment for RPSBCH 104 (Discipline Specific Elective)

Course Title: Plant Biochemistry

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

B) External Examination- 60%- 60 Marks

1. Duration - These examinations shall be of **02 ½ HOURS** duration.

Paper Pattern:

Question	Options	Marks	Questions based on
Q.1.A)	Any 1 out of 2	8	Unit 1
Q.1.B)	Compulsory	7	
Q.2.A)	Any 1 out of 2	8	Unit 2
Q.2.B)	Compulsory	7	
Q.3.A)	Any 1 out of 2	8	Unit 3
Q.3.B)	Compulsory	7	
Q.4.A)	Any 1 out of 2	8	Unit 4
Q.4.B)	Compulsory	7	
	Total	60	

II)Practical Examination Pattern:

Semester End Practical Examination:

RPSBCHP 104	
Particulars	**Marks**
Quiz/Viva	25
Laboratory work	25
Total	**50**

RPSBTK 104 (Discipline Specific Elective)

Course Title: Clinical Data Management

Academic year 2022-23

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Discuss the ethical issues in human subjects research
CO 2	Imagine and understand the different phases of clinical trials
CO 3	Analyse the roles and responsibilities of the investigator and the institution
CO 4	Examine various regulatory issues related to clinical studies
CO 5	Recall the companies and organizations associated in this field
CO 6	Develop interest on medical writing and design a clinical study report

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSBTK 104 (Discipline Specific Elective)		CLINICAL DATA MANAGEMENT	04/60
	I	**Drug discovery and Preclinical toxicology**	15
		Pre-Clinical toxicology: General Principals, Systemic toxicology, (Single dose and repeat dosetoxicity studies), Carcinogenicity, Mutagenicity,Teratogenicity, Reproductive toxicity, Local toxicity, Genotoxicity, animal toxicity requirements	
	II	**Introduction to Clinical trials**	15
		Introduction to clinical trials, Historical guidelines in clinical research (Nuremberg code, Declaration of Helsinki and Belmonte report), ICH-GCP guidelines (E6-R1), Phases of clinical trials.	
	III	**Clinical study design**	15
		Clinical study methodology and regulations: Principles, types (single blinding, double blinding, open access, randomized trials and their examples), Design of protocol, CRF, e-CRF, IB, ICF and preparation of trial reports, Regulations involved (ICMR guidelines) and ethics.	
	IV	**Medical Writing**	15
		Medical Writing: Literature search and medical articles, contract writing, publication, abstracts, bibliography clinical study reports, principles and softwares in CDM	

REFERENCES:

a) EC R1 guidelines
b) ICMR ethical guidelines
c) D & C Rules – ScheduleY
d) Law Of Intellectual Property Rights Shiv Sahai Singh Deep& Deep Publications (p) Ltd
e) WTO And Intellectual Property Rights By Talwar Sabanna (2007)Serials Publications.
f) IPR: Unleashing the Knowledge Economy(2003) Prabuddha Ganguli Tata Mcgraw Hill publication

PRACTICAL-IV: RPSBTKP 104 (Discipline Specific Elective) (60 CONTACT HRS)

a) Action query based on various scenarios: vendor data query,eCRF data query, date Mis-Match query in ERCF on AE form and study conclusion form.
b) design and Raise a query as per given scenario: data missing query,out of sequence data on AE/commed form.missing labs query on visits already performed etc.
c) Designing eCRF form based on given protocol (only particular sections of protocol will be given)
d) Designing of eCRF completion guidelines based on given protocol.
e) Perform Screening process of various drug molecules before performing preclinical toxicity study.
f) Perform preclinical toxicity study on cell lines and microorganisms using drugs screened in exp no.5
g) Various ways to resolve vendor issues.

Modality of Assessment for RPSBTK 104 (Discipline Specific Elective)

Course Title: Clinical Data Management

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/ Case Study/ Project based/ Written Assignment / Presentation	20
2	Class test (Multiple Choice)	20
	Total	**40**

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.A)	Any 1 out of 2	8	Unit 1
Q.1.B)	Compulsory	7	
Q.2.A)	Any 1 out of 2	8	Unit 2
Q.2.B)	Compulsory	7	
Q.3.A)	Any 1 out of 2	8	Unit 3
Q.3.B)	Compulsory	7	
Q.4.A)	Any 1 out of 2	8	Unit 4
Q.4.B)	Compulsory	7	
	Total	60	

II) Practical Examination Pattern

Examination- 50 Marks Semester End Practical Examination

RPSBTKP 104	
Particulars	**Marks**
Laboratory work	40
Journal	05
Viva	05
Total	**50**

Course Code: RPSMIC 105 (Ability Enhancement Course)
Course Title: Emotional Well Being through Logic Based Thinking
Academic year 2022-23

COURSE OUTCOMES:

CO 1	Understand the connection between thinking patterns, emotions, and behaviour
CO 2	Identify one's faulty thinking patterns (fallacies) and methods for refuting them
CO 3	Replace faulty thinking patterns with positive and rational thinking patterns.
CO 4	Using philosophical antidotes to promote a healthy state of mind

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 105 (Ability Enhancement Course)		**EMOTIONAL WELL BEING THROUGH LOGICAL WELL BEING**	**02/30**
	I	**Relation between Emotions and Thinking**	**15**
		a) Fundamentals of emotional well-being. b) Tracing the thoughts behind an emotional problem. c) Some prominent faulty thinking patterns/fallacies causing harm to oneself and others: i. Demanding perfection ii. World Revolves Around Me iii. Damnation iv. Awfulizing v. Can'tstipation	
	II	**Strengthening rational thinking patterns**	**15**
		a) How to refute the fallacies i. Fallacy-Antidotes-Virtues framework b) Some uplifting Antidotal reasoning to overcome the fallacies c) Corresponding Guiding virtues for the fallacies: i. Demanding perfection- Metaphysical security ii. World Revolves Around Me- Empathy iii. Damnation- Respect iv. Awfulizing- Courage v. Can'tstipation- Temperance.	

REFERENCES:

a) Elliot D Cohen, What Would Aristotle Do: Self-Control through the Power of Reason, Prometheus Books, 2003.

Modality of Assessment:

AECC paper- Semester End examination -50 marks

Overall Examination and Marks Distribution Pattern

Semester I

Course	RPSMIC 101			RPSMIC 102			RPSMIC 103			RPSMIC 104/ RPSBCH 104/ RPSBTK 104			RPSMIC 105	
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Total	Grand total
Theory	40	60	100	40	60	100	40	60	100	40	60	100	50	450
Practical	-	50	50	-	50	50	-	50	50	-	50	50	00	200
Total for Semester														650

Semester II

Course Code: RPSMIC 201 (Core Course)
Course Title: Cell Biology

Academic year 2022-23

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 (Core Course)		**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
		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 nucleus and 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	
IV		**Developmental Biology**	**15**
	4.1	**The Process of Development in Animals**	**04**
		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**
		Molecular Analysis of Genes Involved in Development	
	4.3	**Maternal Gene Activity in Development**	**03**
		Maternal-Effect Genes	
	4.4	**Development of Drosophila**	**07**
		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	

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

PRACTICAL-I: RPSMICP 201 (Core Course) (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) 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.
k) Observing animal cells under a light microscope (Cheek epithelial cells)
l) Preparation of liver tissue samples for histochemical analysis
m) Observing microtubules by immunofluorescent labelling
n) Separation of blood cells by density gradient centrifugation
o) Measurement of chlorophyll concentration to analyse plant response to light availability
p) Effect on plant growth in presence and absence of ethephon
q) Demonstration of maintaining and cultivating Animal cell lines

Course Code: RPSMIC 202 (Core Course)
Course Title: Microbial Biochemistry-II
Academic year 2022-23

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 202 (Core Course)		**MICROBIAL BIOCHEMISTRY II**	**4/60**
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 Regulation by covalent modification	
	2.3	**Mechanisms of enzyme catalysis**	**04**

		a) Detailed mechanisms of enzyme catalysis: i. RNaseA i. 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	
IV		**Biodegradation of Xenobiotics**	**15**
	4.1	**Microbial Degradation of**	**05**
		a) Polychlorophenols b) Decolorization and Degradation of Azo Dyes 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:

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

e) Shree Nath Singh, ¯Microbial Degradation of Xenobiotics‖ Springer, 2012.

PRACTICAL-II: RPSMICP 202 (Core Course) (60 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) Extraction of enzyme (βamylase) by precipitation with Acetone
d) Enzyme kinetics: effect of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity,
e) Demonstration of proteolytic activity
f) Determination of glucose isomerase present intracellularly in *Bacillus sp.*
g) Adaptation of *E. coli* to anaerobiosis
h) Chemotaxis of *Pseudomonas*
i) Effect of temperature and water activity on swarming of *Proteus*
j) Microbial degradation of polycyclic aromatic hydrocarbons (PAHs) enrichment, isolation and screening of bacteria
k) Aqueous two-phase partitioning
l) Separation of proteins using Polyacrylamide Gel Electrophoresis (PAGE)

Course Code: RPSMIC 203 (Core Course)
Course Title: Environmental Microbiology
Academic year 2022-23

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 (Core Course)		**ENVIRONMENTAL MICROBIOLOGY**	**04/60**
I		**Microbial Ecology**	**15**
	1.1	**Basic concepts of Microbial Ecology, Sample collection and processing**	**07**
		a) Revision of basic concepts of Microbial Ecology 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 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 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 i. RFLP ii. Denaturing/Temperature gradient iii. Plasmid analysis iv. Reporter genes v. Rep PCR fingerprinting and Microbial diversity	
II		**Study of Marine Ecosystem & Extremophiles**	**15**
	2.1	**Marine microbiology**	**03**
		a) Marine and estuarine habitats	

		b) Characterization and stratification of the oceans: Vertical and horizontal zones of marine habitats c) Marine microbes i. Characteristics ii. Distribution iii. Composition & activity d) Marine pathogens	
	2.2	**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. 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**
		a) Biofouling b) Biocorrosion c) Bioleaching	
III		**Soil and Agricultural Microbiology**	**15**
	3.1	**Soil Microbiology**	**03**
		a) Litho ecosphere i. Soil formation ii. Properties (physical and chemical) b) Soil communities	
	3.2	**Agricultural microbiology**	**04**
		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 structure	
	3.4	**Biofilms in plant-associated habitats**	**03**

		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**
		a) Biogeochemical cycles i. Carbon ii. Nitrogen iii. Oxygen b) Degradation of complex polymers i. Cellulose ii. Lignin iii. Lignocellulose	
IV		**Environmental & natural resources management and safety standards**	**15**
	4.1	**Environmental Impact Assessment and Sustainable Development**	**01**
	4.2	**Microbes and global warming**	**03**
		a) Microbial contribution to green-house gases b) Combating Greenhouse effect using microbes c) Concept of carbon credits	
	4.3	**Solid waste management**	**02**
		a) Solid waste generation and Characterization b) Material recycling c) Biological Treatment of Solid waste	
	4.4	**Hazardous waste management bioremediation**	**03**
		a) Biological Principles b) Treatment Approaches c) Hazardous Waste Biodegradation d) Mixed, Aerobic, Anaerobic hazardous Waste Reactors	
	4.6	**Biohazards**	**03**
		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) Colin Munn, ―Marine Microbiology: Ecology and Applications‖, Garland publishing. ISBN: 0815365179
g) G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj, ―Agricultural Microbiology‖, PHI Learning Pvt. Ltd., 2004
h) Iqbal Ahmad, Farah Ahmad, John Pichtel, ―Microbes and Microbial Technology: Agricultural and Environmental Applications‖, Springer, 2011.
i) Thomas H. Christensen, ―Solid Waste Technology and Management‖, Blackwell Publishing Limited, 2011
j) Deepak Yadav, Pradeep Kumar, ―Hazardous Waste management: An overview of cost effective solutions‖, Elsevier, 2022.

PRACTICAL-III: RPSMICP 203 (Core Course) (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. Phosphorus
    ii. Chloride
    iii. Organic matter
    iv. Calcium carbonate content
d) Microbial analysis of soil
    i. Microbial load
    ii. Presence of cellulose, lignin & xylan degraders

iii. Detection of siderophore producing bacteria
iv. Isolation of Plant Growth Promoting bacteria from Rhizosphere (IAA producers)
v. Dehydrogenase Activity of Soils

e) Visit to CETP

Modality of Assessment for Core Courses:

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 any other	20
2	Class test	20
	Total	**40**

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

	RPSMICP 201	RPSMICP 202	RPSMICP 203
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.

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

Course Code: RPSMIC 204

Course Title: Microbial Approaches to Quality Management

Academic year 2022-23

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 204 (Discipline Specific Elective)		**MICROBIAL APPROACHES TO QUALITY MANAGEMENT**	**04/60**
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 i. FDA Food Safety Modernization Act. ii. ISO 9001:2008: A Quality Management System Standard iii. Food Safety Management System Standards (FSMS) iv. Global Food Safety Initiative v. GFSI Recognized Schemes vi. ISO 22000:2005 vii. ISO 9001 and FSSC 22000 viii. FSSAI	**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	**06**

		d) Drinking-water regulations and supporting policies and programmes	
III		**Quality Control and Quality Assurance in Pharmaceutical Industry**	**15**
		A. Laboratory management and design B. Introduction to Pharmacopoeia- IP, BP, USP C. Microbiological examination of nonsterile products D. Sterility Testing E. Antibiotic Potency Testing	
IV		**Quality Control and Quality Assurance in Pharmaceutical and Cosmetic Industry**	**15**
		A. Pyrogen Testing and Bioburden determination B. Antimicrobial Effectiveness Testing and Preservation of Cosmetics a) Preservative Effectiveness Testing b) Preservation of cosmetics c) Aspects of cosmetic preservation	8 7

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-IV: RPSMICP 204 (Discipline Specific Elective) (60 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) Performance of an audit of a test with proper documentation
f) Bioburden determination of manufacturing unit
g) Determination of efficacy of sterilization methods.
h) Demonstration of endotoxin/pyrogen testing
i) Microbiological load in carrot and apple juice, salad, mayonnaise
j) Quality Assessment and Analysis of Raw and Pasteurized milk
k) To detect coliform and faecal coliform bacteria in water by the membrane filtration method
l) Study of efficiency of water purifiers and comparative assessment
m) MIC of food preservative
n) Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT)
o) Potability testing of drinking Water.
p) Film medium for detection of coliforms in water and food
q) Dip slide technique for detection of organisms from food and water samples

Modality of Assessment for RPSMIC 204 (Discipline Specific Elective)

Course Title: Microbial Approaches to Quality Management

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 any other	20
2	Class test	20
	Total	**40**

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

RPSMICP 204	
Particulars	**Marks**
Quiz/Viva	25
Laboratory work	25
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.

Course Code: RPSBCH 204 (Discipline Specific Elective)
Course Title: Nutraceutical and Functional Foods

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the Basics of Nutraceuticals as Science
CO 2	Comprehend the Properties, structure and functions of various Nutraceuticals
CO 3	Demonstrate the use of Nutraceuticals as remedies
CO 4	Develop Novel Food and food Ingredients: Polysaccharides, low caloric sweeteners
CO 5	Illustrate the effect of Anti-nutritional factors and Limitations of Nutraceuticals & Functional foods

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSBCH 204 (Discipline Specific Elective)		**NUTRACEUTICALS AND FUNCTIONAL FOODS**	**04/60**
	I	**Nutraceutical Science**	**15**
	1.1	Introduction to Nutraceuticals as Science	1
	1.2	Classification, scope & future prospects of the Nutraceutical Science	3
	1.3	Sources of Nutraceuticals	3
		Plant sources, Animal sources, Microbial sources and Minerals	
	1.4	Applied aspects of the Nutraceutical Science.	1
	1.5	Relation of Nutraceutical Science with other Sciences	4
		Medicine, Human physiology, genetics, food technology, chemistry and nutrition	
	1.6	Analysis of nutraceuticals- Techniques (Spectroscopic, Voltammetric, Chromatographic)	3
	II	**Bioceuticals**	**15**
	2.1	Properties, structure and functions of various Nutraceuticals	
		a) Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate b) Use of proanthocyanidins, grape products, flaxseed oil, minor millets as Nutraceuticals.	3
	2.2	Development of Novel Food and food Ingredients:	6
		Naturally produced flavour modifiers, Single Cell Proteins, Marine Algae as food supplements	
	2.3	Food supplements and food ingredients as by products - Fishery, poultry/animal husbandry and agriculture/dairy industries.	3
	III	**Food remedies**	**15**
	3.1	Food as a remedy	
		a) Nutraceuticals bridging the gap between food and drugs b) Nutraceuticals in treatment for cognitive decline	3 2

		c) Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers	4
	3.2	Brief idea about some Nutraceutical rich supplements	6
		a) Bee pollen, Caffeine, Green tea, Lecithin, Mushroom Extract b) Chlorophyll, Kelp and Spirulina	
	IV	**Anti-nutritional Factors & Limitations of Nutraceuticals**	**15**
	4.1	Anti-nutritional factors present in foods	2
		Types of inhibitors present in various foods and how they can be inactivated	
	4.2	General idea about role of Probiotics and Prebiotics as nutraceuticals. Recent advances in techniques & feeding of substrates	4
	4.3	Assessment of nutritional status and Recommended Daily allowances	2
	4.4	Non Nutrient Effect of Specific Nutrients : Proteins and Peptides and Nucleotides, Trans fats, Vitamins, Minerals	4
	4.5	Issues on functional foods and nutraceuticals in animals	3

REFERENCES:

a) Nutraceuticals: Efficacy, Safety and Toxicity by Ramesh C. Gupta
b) Nutraceuticals: The Complete Encyclopedia of Supplements, Herbs, Vitamins and Healing Foods by Arthur J. Roberts, Genelle Subak-Sharpe, et al.
c) Advances in Nutraceutical Applications in Cancer: Recent Research Trends and Clinical Applications (Nutraceuticals) by Sheeba Varghese Gupta and Yashwant V Pathak
d) Nutraceuticals in Health and Disease Prevention (Infectious Disease and Therapy Book 6) by PETER. PAUL HOPPE, Klaus Kramer, et al.
e) Nutrigenomics and Nutraceuticals: Clinical Relevance and Disease Prevention by Yashwant V. Pathak and Ali M. Ardekani
f) Pharmaceuticals to Nutraceuticals: A Shift in Disease Prevention by Dilip Ghosh and R.B.Smarta
g) Handbook of Nutraceuticals and Functional Foods (Modern Nutrition) by Robert E.C. Wildman and Richard S. Bruno

PRACTICAL-IV: RPSBCHP 204 (Discipline Specific Elective) (60 CONTACT HRS)

a) To determine the lactose present in the Soy-milk by Cole's method
b) Determination of reducing sugars by Nelson: Somogyi Method
c) Protein Estimation by Bradford's method
d) Determination of Hardness of water
e) Estimation of Cholorogenic acid (Anti-Nutritional Factor)
f) Estimation of phytic acid by Heubner and Stadler Method
g) Estimation of Vitamin C by Folin Phenol method
h) Optimization and Analysis of probiotics
i) Comparative assessment of Fat content in Full cream milk and low fat milk

Modality of Assessment for RPSBCH 204 (Discipline Specific Elective)

Course Title: Nutraceutical and Functional Foods

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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-

Paper Pattern:

Question	Options	Marks	Questions based on
Q.1.A)	Any 1 out of 2	8	Unit 1
Q.1.B)	Compulsory	7	
Q.2.A)	Any 1 out of 2	8	Unit 2
Q.2.B)	Compulsory	7	
Q.3.A)	Any 1 out of 2	8	Unit 3
Q.3.B)	Compulsory	7	
Q.4.A)	Any 1 out of 2	8	Unit 4
Q.4.B)	Compulsory	7	
	Total	60	

II) Practical Examination Pattern:

Semester End Practical Examination:

RPSBCHP 204	
Particulars	**Marks**
Quiz/Viva	25
Laboratory work	25
Total	**50**

Course Code: RPSBTK 204 (Discipline Specific Elective)
Course Title: Nanotechnology

Academic year 2022-23

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Discuss the basics of nanotechnology, tools used for characterising nanomaterials and specific applications of nanotechnology.
CO 2	Examine the nanorobotics devices of nature.
CO 3	Analyse and interpret the latest developments in nanotechnology in the field of medical sciences.
CO 4	Explain drug delivery systems using nanotechnology.
CO 5	Apply nanomaterials in food, cosmetics, agriculture, environment management.
CO 6	Assess and appreciate the thrust in the domain and encourage it to take ahead in research.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSBTK 204 (Discipline Specific Elective)		NANOTECHNOLOGY	04/60
	I	**Nutraceutical Science Introduction to nanotechnology - principles and applications**	15
		Introduction, synthesis of nanomaterials, biological methods, use of microbial systems & plant extracts, use of proteins & templates like DNA. Characterization of nanomaterials, analysis techniques, properties of nanomechanical, optical, magnetic properties, electrical conductivity, thermal conductivity	
	II	**Carbon nanotubes, Nanorobotics devices of nature: ATP synthase, the kinen, myosin, dynein, flagella modulated motion**	15
	III	**Nanomedicine**	15
		Nanomedicine : biopharmaceuticals ,implantable materials,implantable chemicals,surgicals aids,diagnostic tools ,nanosensors and nanoscanning,nano enabled drug delivery system,nanorobotics in medicine	
	IV	**Applications of nanotechnology**	15
		Application of nanomaterials in food, cosmetics, agriculture, environment management	

REFERENCES:

a) The Nanoscope encyclopedia of nanoscience and nanochehnology, Vol I, V and VI (2005) Dr. Parag Diwan and Ashish Bhardwaj Pentagon Press New Delhi.

b) Nano forms of carbon and its applications (2007) Prof. Maheshwar Sharon and Dr. Madhuri Sharon Manad Nanotech Pvt.Ltd.

c) Biotech Nanotechnology lessons from Nature (2004) David Goodsell Wiley-Liss A John Wiley and sons.

d) Nanotechnology- Basic science and emerging technologies (2005) Willson Kannangava, Smith, Simmons, RaguseOverseasePress.

e) Textbook of Biotechnology (2005) R. C. Dubey S. Chand andCo.

f) Nanotechnology- Principles and practices S. K. Kulkarni Capital PublishingCo.

PRACTICAL-IV: RPSBTKP 204 (Discipline Specific Elective) (60 CONTACT HRS)

a) Antibacterial studies of silver nanoparticles by MIC method.
b) Testing the cell viability of metal oxide nanoparticles using tissue culture technique.
c) Synthesis of Metal Nanoparticles by Chemical reduction method and their UV-VIS absorption studies.
d) Synthesis of nanoparticles using bacterial system and their UV-VIS absorption studies.
e) Synthesis of nanoparticles using plant extract and their UV-VIS absorption studies.
f) Synthesis of nanoparticles using fungal system and their UV-VIS absorption studies.
g) Analysis of nanoparticles using UV vis spectrophotometer , TEM ,SEM -data interpretation

Modality of Assessment for RPSBTK 204 (Discipline Specific Elective)
Course Title: Nanotechnology

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Assignment/ Case Study/ Project based/ Written Assignment / Presentation	20
2	Class test (Multiple Choice)	20
	Total	**40**

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

3. Duration- These examinations shall be of **two hours and thirty minutes**.

4. Theory question paper pattern-

c. 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.

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

Paper pattern:

Question	Options	Marks	Questions based on
Q.1.A)	Any 1 out of 2	8	Unit 1
Q.1.B)	Compulsory	7	
Q.2.A)	Any 1 out of 2	8	Unit 2
Q.2.B)	Compulsory	7	
Q.3.A)	Any 1 out of 2	8	Unit 3
Q.3.B)	Compulsory	7	
Q.4.A)	Any 1 out of 2	8	Unit 4
Q.4.B)	Compulsory	7	
	Total	60	

II) Practical Examination Pattern

Examination- 50 Marks Semester End Practical Examination

RPSBTKP 204	
Particulars	**Marks**
Laboratory Work	40
Journal	05
Viva	05
Total	50

Course Code: RPSMIC 205 (Ability Enhancement Course)
Course Title: Research Methodology

Academic year 2022-23

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

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 205 (Ability Enhancement Course)		**RESEARCH METHODOLOGY**	**2/30**
	I	**Research Fundamentals and Terminology**	**15**
	1.1	**Introduction to research**	**02**
		a) Definition of research b) Scientific research c) General characters of research d) Objectives of research a) Classification and types of research	
	1.2	**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	
	1.3	**Strategies and analysis**	**03**
		a) Research conditions b) Importance of controls e) Experimental protocol and experimental routine	
	1.4	**Research problem**	**02**
		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 and Sampling**	**05**
	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	

		g) 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, e) 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	
	2.5	**Experimental data processing**	**04**
		a) Processing operations b) Problems in processing c) Elements of analysis in data processing d) Software for data processing	

REFERENCES:

a) Kothari, C.R, ¯Research Methodology- Methods and Techniques‖, New Delhi, Wiley Eastern Limited. 1985

b) Petter Laake, Haakon Breien Benestad and Bjorn Reino Olsen, ¯Research methodology in the medical and biological sciences‖ 1st Ed, Academic Press, 2007

c) Ranjit Kumar, ¯Research Methodology- A step-by-step Guide for beginners‖, 3rd Ed, Sage publications, 2005

Modality of Assessment:

AECC paper- Semester End examination -50 marks

Overall Examination and Marks Distribution Pattern

Semester II

Course	RPSMIC 201			RPSMIC 202			RPSMIC 203			RPSMIC 204/ RPSBCH 204/ RPSBTK 204			RPSMIC 205	
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Total	Grand total
Theory	40	60	100	40	60	100	40	60	100	40	60	100	50	450
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	00	200
	Total for Semester													650