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

S. P. Mandali's

Ramnarain Ruia Autonomous College

Syllabus for MSc Part I

Program: MSc

Program Code: Microbiology

(Choice Based Credit System for academic year 2022–2023)

PROGRAM OUTCOMES

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

PO	PO Description **A student completing Master's Degree in Science program will be able to:**
PO 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.
PO 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.
PO 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.
PO 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.
PO 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.
PO 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.

PO 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
PO 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM SPECIFIC OUTCOMES

PSO	Description **A student completing Master's Degree in Science program in the subject of Microbiology will be able to:**
PSO 1	Recall the basic concepts of gene expression and regulation, exemplify cytoplasmic inheritance and transposons. Analyse the genetics underlying cancer and cell cycle. Solve problems based on allelic and genotypic frequencies
PSO 2	Apply the principles of thermodynamics to understand stability of biological molecules, execute experiments for their detection and estimation in samples. Summarize the metabolism of one and two carbon compounds by microorganisms
PSO 3	Attribute pathogenesis of diseases to virulence mechanisms, outline the pathogenesis, transmission and treatment of emerging bacterial and viral infections. Recognize the role of microbiome in the overall physiology of humans.
PSO 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.
PSO 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.
PSO 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.

PSO 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
PSO 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.
PSO 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
PSO 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.
PSO 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

PSO 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.
PSO 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.
PSO 14	Understand, explain and Apply concepts in bioinformatics, proteomics, high throughput screening and pharmacogenomics for discovering new drugs
PSO 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.
PSO 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.

PSO 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.
PSO 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
			Practical based on Microbial Genetics	02
		RPSMIC 102 (Core Course)	MICROBIAL BIOCHEMISTRY	04
			Practical based on Microbial Biochemistry	02
		RPSMIC 103 (Core Course)	MEDICAL MICROBIOLOGY AND HUMAN MICROBIOME	04
			Practical based on Medical Microbiology and Human Microbiome	02
		RPSMIC 104/ RPSBCH104/ RPSBTK104 (Discipline Specific Elective)	CLINICAL MICROBIOLOGY and EPIDEMIOLOGY/ PLANT BIOCHEMISTRY/ CLINICAL DATA MANAGEMENT	04
			Practical based on Clinical Microbiology and Epidemiology/ Plant Biochemistry/ Clinical Data Management	02
		RPSMIC 105 (Ability Enhancement Course)	EMOTIONAL WELL-BEING THROUGH LOGIC-BASED THINKING	02
	II	RPSMIC 201 (Core Course)	CELL BIOLOGY	04
			Practical based on Cell Biology	02
		RPSMIC 202 (Core Course)	MICROBIAL BIOCHEMISTRY II	04
			Practical based on Microbial Biochemistry II	02
		RPSMIC 203 (Core Course)	ENVIRONMENTAL MICROBIOLOGY	04
			Practical based on	02

			Environmental Microbiology	
		RPSMIC 204/ RPSBCH204/ RPSBTK204 (Discipline Specific Elective)	**MICROBIAL APPROACHES TO QUALITY MANAGEMENT/ NUTRACEUTICALS AND FUNCTIONAL FOODS/ NANOTECHNOLOGY**	**04**
			Practical based on Microbial Approaches to Quality Management/ Nutraceuticals and Functional Foods/ Nanotechnology	**02**
		RPSMIC 205 (Ability Enhancement Course)	**RESEARCH METHODOLOGY**	**02**

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.

PRACTICALS: RPSMIC 101 (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

PRACTICALS: RPSMIC 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

PRACTICALS: : RPSMIC 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

	Core 1	Core 2	Core 3
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.

PRACTICALS: RPSMIC 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

	DSE 1
Viva	-
Quiz	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.

PRACTICALS: RPSBCH 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:

A) Internal Examination: 40%- 40 Marks

Particulars	**Practical I, II, III & IV**
Journal	05
Experimental tasks	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	**Practical I, II, III & IV**
Laboratory work	25
Viva	5
Total	**30**

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

PRACTICALS: RPSBTK 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

External Examination- 50 Marks Semester End Practical Examination

Particulars	Paper
Laboratory Work	40
Journal	05
Viva	05
Total	50

Overall Examination and Marks Distribution Pattern

Course	DSE		
	Internal	External	Total
Theory	40	60	100
Practicals	-	50	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't stipation	
	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't stipation- 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	Core 1			Core 2			Core 3			DSE 1			AECC	
	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

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) Pl-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

PRACTICALS: RPSMIC 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.

PRACTICALS: RPSMIC 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.

PRACTICALS: RPSMIC 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 Papers (Core 1,2 and 3):

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

	Core 1	Core 2	Core 3
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: RPSMIC 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-

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)	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

	DSE 2
Viva	-
Quiz	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: RPSBCH 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:

C) Internal Examination: 40%- 40 Marks

Particulars	**Practical I, II, III & IV**
Journal	05
Experimental tasks	15
Total	**20**

D) External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	**Practical I, II, III & IV**
Laboratory work	25
Viva	5
Total	**30**

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: RPSBTK 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-

e. 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.

f. 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

External Examination- 50 Marks Semester End Practical Examination

Particulars	Paper
Laboratory Work	40
Journal	05
Viva	05
Total	50

Overall Examination and Marks Distribution Pattern

Course	DSE		
	Internal	External	Total
Theory	40	60	100
Practicals	-	50	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	Core 1			Core 2			Core 3			DSE 1			AECC	
	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

MSC II Sem III and Sem IV Syllabus

S. P. Mandali's

Ramnarain Ruia Autonomous College

Syllabus for MSc Part II

Program: MSc

Program Code: Microbiology (RPSMIC)

(Credit Based Semester and Grading System for academic year 2022–2023)

Course Code: RPSMIC 301

Course Title: Virology

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

Course Code/Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 301		**VIROLOGY**	**4/60**
I		**Viral Genetics & Bacterial Viruses**	**15**
	1.1	**Viral genetics**	**04**
		a) Mapping the Bacteriophage genome. b) Phage phenotypes c) Genetic recombination in phages d) Genetic fine structure mapping e) Deletion mapping f) Genes within genes: Bacteriophage ΦX174 g) Constructing phage vectors-phage display vectors, suicide vectors, combining phage vectors and transposons	
	1.2	**Bacteriophages**	**02**
		General properties of phages, properties of phage infected Bacterial cultures, Specificity of Phage Infection	
	1.3	***E.coli* Phage T4**	**02**
		Properties of T4 DNA, Genetic organization, the T4 growth cycle, Replication of T4 DNA	
	1.4	***E.coli* PhageT7 and Lambda**	**03**
		Organization of theT7 genes, Growth Cycle, Regulation of transcription of T7phage.	
	1.5	***E.coli* Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle.**	**04**
II		**Plant Viruses**	**15**
	2.1	**Plant viruses: General features & infection process**	**04**
		a) Morphology b) Modes of Transmission c) General life cycle d) Symptoms of infection	
	2.2	Virus-plant interactions: steps in induction of disease	**04**
	2.3	Plant satellite viruses and satellite Nucleic acids	**02**
	2.4	Citrus Tristeza Virus (CTV): Viral structure, Genome,	**03**

		Host range, Transmission, Symptoms and Control.	
	2.5	Diagnosis and control of viral infections in plants	**02**
III		**Animal Viruses**	**15**
		Study of Structure, replication, life cycle, pathogenesis, transmission, clinical features- Signs & symptoms, diagnosis and control of following viral infections:	
	3.1	**Rabies**	**02**
	3.2	**Polio**	**03**
	3.3	**Hepatitis**	**04**
	3.4	**Pox virus, Vaccinia Virus, Orthopox virus, Variola Virus**	**03**
	3.5	**HSV and Varicella Zoster**	**02**
	3.6	**Epstein Barr & Cytomegalovirus**	**01**
IV		**Oncogenic Viruses & Emerging Viral infections**	**15**
	4.1	a) Molecular mechanisms of virally induced tumor formation by i. RNA tumor viruses (Retroviruses) ii. DNA tumor viruses b) Oncolytic Viruses	**07**
	4.2	Ebola Virus	**02**
	4.3	Nipah Virus	**02**
	4.4	Corona Virus	**02**
	4.5	Methods to deal with emerging viral infections	**02**

REFERENCES:

a) Luria, General Virology, 3rd Edition, John Wiley & Sons, 1978

b) Edward Birge, Bacterial and Bacteriophage Genetics, 5th edition, Springer Publications, 2006

c) Flint, Enquist, Racaniello & Skalka, Principles of Virology– Vol I and II, 3rd Edition, ASM, 2008

d) Teri Shors, Understanding Viruses, 3rd Edition, Jones and Bartlett pub, 2016.

e) Roger Hull, Matthew's Plant Virology, 4th edition, Academic Press, 2001.

f) Edward K Wagner, Basic Virology, 3rd Edition, Blackwell Publishing house, 2008.

g) CDC, "Preventing Emerging Infectious Diseases: A Strategy for the 21st Century Overview of the Updated CDC Plan", *MMWR*, September 11, 1998 / 47(RR15):1-14

h) Devendra T Mourya *et al*, "Emerging/re-emerging viral diseases & new viruses on the Indian horizon", *Indian Journal of Medical research*, 2019, (149): 447- 467

i) Aditi, M. Shariff, "Nipah virus infection: a review", *Epidemiology and infection*, 2019,

(95):147.

j) Raj K Singh *et al*, "Nipah virus: epidemiology, pathology, immunobiology and advances in diagnosis, vaccine designing and control strategies – a comprehensive review", *Veterinary Quarterly*, 2019, (39): 26-55

k) Shamimul H *et al*, "Ebola virus: A global public health menace: A narrative review", *Journal of Family Medicine and Primary Care*, 2019, 8(7): 2189–2201.

l) Denis M *et al*, "Ebola virus disease", *The Lancet*, 2019, (393):936-948

m) Yan-Rong Guo *et al*, "The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status", *Military Medical Research*, 2020, (7) 11

n) Xiaowei L *et al*, "Molecular immune pathogenesis and diagnosis of COVID-19", *Journal of Pharmaceutical Analysis*, 2020

o) Hussain A Rathod *et al*, "The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak", *Journal of Autoimmunity*, 2020, (109): 102433

PRACTICALS: RPSMIC 3P1 (60 CONTACT HRS)

a) Enrichment of coliphages & phage assay.
b) One step growth curve.
c) Induction of lytic cycle.
d) Chick embryo inoculation.
e) Case Studies on emerging viral infections.

Course Code: RPSMIC 302

Course Title: Immunology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Explain the defense mechanisms in the human body against various infectious agents
CO 2	Recall the key players of innate and adaptive immune response
CO 3	Compare the T cell dependent and T cell independent immune responses
CO 4	Integrate the understanding of immune tolerance to distinguish between autoimmune and Immunity Mediated Inflammatory Disease
CO 5	Distinguish between immune tolerance and immune therapy and extend its application to treatment of Cancer
CO 6	Apply the understanding of immunological techniques for analysis of immune responses
CO 7	Critically evaluate the newer methods of vaccine developments
CO 8	Demonstrate the presence of immune cells in human peripheral blood

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 302		**IMMUNOLOGY**	**04/60**
I		**Defense against infectious agents**	**15**
		a) Viral infections b) Bacterial infections c) Fungal infections d) Parasitic and worm infections e) Emerging and re-emerging infections	**4** **4** **2** **3** **2**
II		**Mechanisms of Innate immunity and Acquired Immunity**	**15**
	2.1	**Innate Immunity**	**7**
		a) Inflammation i) Role of cytokines and chemokines in leucocyte recruitment ii) Inflammatory mediators b) Phagocytosis i) Role of PAMP's ii) Soluble pattern recognition molecules iii) TLR's and CLR's c) Evasion of Innate immune mechanisms	
	2.2	**Acquired Immunity**	**8**
		a) Molecular basis of diversity of immunoglobulin molecules i) Mechanism of VDJ recombination ii) Other mechanisms of generation of antibody diversity b) Mechanisms of T dependent responses i) Antigen presentation by B cells ii) Formation of germinal centres iii) Somatic hypermutations and class switching c) Mechanisms of T independent responses i) Types of T independent antigens ii) B-1 B cells and Marginal zone B cells	
III		**Immune tolerance and Autoimmunity**	**15**
	3.1	**Establishment of immune tolerance**	**6**
		a) Central Tolerance, Peripheral Tolerance, Regulatory T cells b) B cell tolerance	
	3.2	**Autoimmunity and Immune Linked Inflammatory diseases**	**7**
		a) **Autoimmunity** i. Spectrum of autoimmune diseases ii. Genetic factors for autoimmunity iii. Induction of autoimmunity	

		iv. Treatment of autoimmune diseases **b) Immune linked inflammatory diseases (IMID)** i. Definition and examples ii. Inflammation & IMID iii. Genetic basis of IMID iv. Epidemiology of IMID v. Treatment of IMID	
	3.3	**Cancer Immunology**	**2**
		a) Tumor antigens b) Anti-Tumor Immune responses	
IV		**Techniques in Immunology, Immunotherapy and Vaccines**	**15**
	4.1	**Techniques in Immunology**	**8**
		a) Cellular Techniques i. Flow Cytometry ii. Fluorescence-activated cell sorting (FACS) iii. Immunohistochemistry b) Methodologies for developing therapeutic antibodies- Humanization of mAbs and Human antibody-producing mice	
	4.2	**Immunotherapy**	**4**
		a) Cancer Immunotherapy b) Using cytokines and Mab's for Immunotherapy c) Plantibodies	
	4.3	**Vaccines**	**3**
		a) Newer approaches to vaccine development b) Malarial vaccine	

REFERENCES:

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

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

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

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

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

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

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

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

i) Laura Walker, Dennis Burton, “Passive Immunotherapy of Viral Infections: ‘Super-antibodies’ enter the fray”, *Nature Reviews Immunology,* 2018, Volume 18.

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

k) Hani El-Gabalawy, Lyn C. Guenther And Charles N. Bernstein, “Epidemiology of Immune-Mediated Inflammatory Diseases: Incidence, Prevalence, Natural History, and Comorbidities”, *The Journal of Rheumatology,* 2010;85;2-10

l) T. David, S. F. Ling and A. Barton, “Genetics of immune-mediated inflammatory diseases”, *Clinical and Experimental Immunology*, 2018, 193: 3–12

m) Linlin Chen, Huidan Deng, *etal,* “Inflammatory responses and inflammation-associated diseases in organs”, *Oncotarget*, 2018, Vol. 9, (No. 6), pp: 7204-7218

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

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

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

PRACTICALS RPSMIC 3P2 (60 Contact Hrs)

a) Phagocytosis & Phagocytic index
b) Collection of human blood & separation of mononuclear cells by Ficoll Hypaque density gradient centrifugation,
c) Counting of viable cells by trypan blue
d) Separation of T and B cells
e) Rocket immunoelectrophoresis
f) SRID
g) Demonstration of Flow cytometry
h) Assignment on modern vaccines

Course Code: RPSMIC 303

Course Title: Food and water Microbiology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Outline the process of production of different fermented foods
CO 2	Construct a cause and effect model system for effective preservation of foods
CO 3	Understand microbiology of modern foods like probiotics, nutraceuticals and dehydrated foods
CO 4	Execute collection, processing and microbiological analysis of food and water samples
CO 5	Implement monitoring protocols for the quality of food and water using principles of HACCP
CO 6	Apply basic knowledge of fermented foods, food preservation, microbial analysis and standards to evaluate current techniques and improvise technology in food manufacturing or bottled water manufacturing units

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 303		**FOOD MICROBIOLOGY AND WATER MICROBIOLOGY**	**04/60**
I		**Microbiology of fermented and non-fermented foods**	**15**
	1.1	**Basic concepts of Food Microbiology**	**02**
		Revision of a) Sources of microbes in food b) Normal microbiological quality of food c) Factors influencing microbial growth in food	
	1.2	**Production of fermented foods**	**07**
		a) Starter cultures and their stress adaptations b) Fermented meat product- Sausage c) Fermented cereal product- Soy sauce, d) Fermented milk product- Blue cheese and Swiss cheese e) Fermented legume product - Idli	
	1.3	**Nutraceuticals and Probiotics**	**04**
		a) Microbial fructooligosaccharides b) Probiotics and Prebiotics i. Probiotics ii. Screening of Potential Probiotics iii. Industrial Aspects of Probiotic Production iv. Prebiotics	
	1.4	**Non- fermented food products**	**02**
		a) Desiccated foods b) Dehydrated foods	
II		**Control of microbes in food**	**15**
	2.1	**Methods of control**	**01**
		a) Control of access b) Control by physical removal	
	2.2	**Control by regulating the factors that affect microbial growth**	**10**
		a) Control by temperature b) Control by reduced a_w c) Control by low pH and organic acids d) Control by modified atmosphere	
	2.3	**Control by chemicals and physical methods**	**02**
		a) Control by antimicrobial preservatives and additives b) Control by irradiation	

	2.4	**Newer methods of Controlling Microbial growth**	**02**
		a) Novel emerging techniques of food preservation b) Control by combination of methods (Hurdle concept)	
III		**Detection of Microbes in food and water**	**15**
	3.1	**Conventional methods**	**05**
		a) Sampling for microbial analysis b) Qualitative methods of microbial detection c) Quantitative microbial enumeration in food d) Detection of Bacterial toxins e) Toxicological evaluation of food additives	
	3.2	**Modern methods**	**05**
		a) Nucleic acid-based methods i. Oligonucleotide DNA microarray ii. Loop-mediated isothermal amplification (LAMP) iii. Nucleic acid sequence-based amplification (NASBA) b) Biosensors for food analysis	
	3.3	**Microbiological analysis of Potable water**	**05**
		a) Drinking water risk assessment b) Regulatory Framework c) Types of bottled water d) Microbiology of bottled water e) Potential chemical and microbiological hazards	
IV		**Controlling the Microbiological Quality of food and water**	**15**
	4.1	**Controlling the Microbiological Quality of food**	**07**
		a) Quality and Criteria b) Sampling Schemes c) QC using microbiological control d) Control at source e) Codes of GMP f) HACCP g) Laboratory Accreditation	
	4.2	**Controlling the Microbiological Quality of water**	**08**
		a) BIS Regulations regarding the production of bottled waters with respect to final quality of the product. b) The application of HACCP in the bottling plants c) Point of use water purifier units d) Types of water purifiers.: Microbiological specifications and methods used to certify water purifiers	

REFERENCES:

a) Bibek Ray and Arun Bhunia, "Fundamental Food Microbiology", 4th Ed. CRC Press, 2008
b) James Jay, M Loessner and D Golden, "Modern Food Microbiology", 7th Ed, 2005
c) Adams M R and Moss M O, "Food Microbiology", 3rd Ed. RSC Publishing. 2008
d) Petra Foerst, Chalat Santivarangkna, "Advances in Probiotic Technology", CRC Press A Science Publishers Book, 2016
e) Edward R. Farnworth, "Handbook of Fermented Functional Foods", 2nd Ed. CRC Press, 2003
f) Elmer H Marth, James Steele, "Applied Dairy Microbiology", 2nd Ed. CRC Press, 2001
g) Pressman P., Clemens R., Hayes W., & Reddy, "Food additive safety", Toxicology Research and Application, 2017, 1, 239784731772357. doi:10.1177/2397847317723572
h) Fei Law Jodi Woan et al, "Rapid methods for the detection of foodborne bacterial pathogens: principles, applications, advantages and limitations", Frontiers in Microbiology, 2014, 5:770 doi: 10.3389/fmicb.2014.00770
i) Guidelines For Drinking-Water Quality WHO 2008
j) Rosenberg, F. A., "The microbiology of bottled water", Clinical Microbiology Newsletter, 2003, 25(6), 41–44. doi:10.1016/s0196-4399(03)80019-3
k) Manual For Packaged Drinking, Water Bureau Of Indian Standards, January 2005
l) Damikouka, I., Katsiri, A., & Tzia, C., "Application of HACCP principles in drinking water treatment", Desalination, 2007, 210(1-3), 138-145. doi:10.1016/j.desal.2006.05.039
m) Pooi, C. K., & Ng, H. Y. (2018). Review of low-cost point-of-use water treatment systems for developing communities. Npj Clean Water, 1(1). doi:10.1038/s41545-018-0011-0

PRACTICALS: RPSMIC3P3 (60 CONTACT HRS)

a) Microbiological study of fermented foods (Idli batter)
b) Microbiological load in carrot and apple juice, salad, mayonnaise
c) Quality Assessment and Analysis of Raw and Pasteurized milk
d) Film medium for detection of coliforms in water and food
e) To detect coliform and faecal coliform bacteria in water by the membrane filtration method
f) Study of efficiency of water purifiers and comparative assessment

Course Code: RPSMIC 304

Course Title: Tools and Techniques: Biomolecular analysis

Academic year 2020-21

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	Summarize principle and applications of variants of PCR technique
CO 4	Recall the basics of electrophoresis technique and apply it to study recent advances of the technique
CO 5	Explain the use of microscopic and diffraction techniques to study nanostructures
CO 6	Summarize methods other than microscopy and diffraction to study nanomaterials
CO 7	Implement the knowledge of various techniques to carryout research project

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 304		**TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS**	**4/60**
I		**Spectroscopic Techniques** Principle and applications of:	**15**
	1.1	**UV-visible spectroscopy**	**02**
	1.2	**IR spectroscopy**	**02**
	1.3	**Atomic Absorption Spectroscopy**	**02**
	1.4	**Raman Spectroscopy**	**02**
	1.5	**Mass spectroscopy**	**05**
	1.6	**Circular Dichroism Spectroscopy**	**02**
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**
		a) Principle b) LC-MS c) GC-MS	
III		**Molecular Biology Techniques**	**15**
	3.1	**Variations/ Modifications of PCR**	**05**
		a) Hot- Start PCR, b) Multiplex PCR, c) Nested PCR, d) RT-PCR, e) Broad Range PCR, f) Arbitrarily primed PCR,	

		g) Quantitative PCR, h) Real time PCR i) Touchdown PCR j) Colony PCR k) Digital PCR –Droplet l) Loop mediated isothermal amplification	
	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) 2D- Gel Electrophoresis b) Capillary Electrophoresis	
IV		**Microscopy and Nanotechnological Techniques**	**15**
	4.1	**Microscopy**	**09**
		a) Scanning Probe Microscopes – i. Scanning tunneling microscope (STM) ii. Atomic force microscope (AFM) b) Electron Microscopy: i. Scanning Electron Microscopy ii. Transmission Electron Microscopy c) Confocal Microscopy	
	4.2	**Diffraction Techniques- X Ray Diffraction**	**02**
	4.3	**Other methods**	**04**
		a) Dynamic Light Scattering b) Zeta Potential c) Zeta Sizer d) SPR	

REFERENCES:

a) Kulkarni Sulabha, “Nantotechnology: Principles and Practices”, New Delhi, Capital Publishing Company, 2011.

b) Persing, H.D. et al., “Molecular Microbiology: Diagnostic principles and Practice”, Washington D.C., ASM press, 2004.

c) Upadhyay, Upadhyay and Nath, “Biophysical Chemistry: Principles and Techniques”, Mumbai, Himalaya Publishing House, 2012

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j) Bergkessel, M., & Guthrie, C., “Colony PCR. Laboratory Methods in Enzymology: DNA”, 2013, 299–309.

k) https://www.bio-rad.com/en-in/applications-technologies/droplet-digital-pcr-ddpcr-technology?ID=MDV31M4VY

l) Kanagal-Shamanna, R., “Digital PCR: Principles and Applications. Methods in Molecular Biology”, 2016, 43–50.

m) Notomi, T., Mori, Y., Tomita, N., & Kanda, H., “Loop-mediated isothermal amplification (LAMP): principle, features, and future prospects”, *Journal of Microbiology*, 2015, 53(1), 1–5.

n) A. Zlatkis and R.E. Kaiser, “HPTLC High Performance thin-layer chromatography Journal of Chromatography”, Library Vol 9 Elsevier Scientific Publishing Company, 1977

o) https://www.chem.uci.edu/~dmitryf/manuals/Fundamentals/DLS%20measurement%20principles.pdf

p) Sourav Bhattacharjee, “DLS and zeta potential – What they are and what they are not?”, *Journal of Controlled Release*, 2016, 235:337–351 Review Article

q) Patel Kalpesh et al, “Introduction to hyphenated techniques and their applications in pharmacy”, *Pharm Methods*. 2010 Oct-Dec; 1(1): 2–13.

PRACTICALS: RPSMIC3P4 (60 CONTACT HRS)

a) Research project and Dissertation

b) Research poster presentation

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	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 6	04	All four units
Q.5) b)	Any 4 out of 6	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

II) Practical Examination Pattern

	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	-
Viva	05	05	05	-
Quiz	05	05	05	-
Laboratory work	35	35	35	-
Thesis Writing	-	-	-	30
Research Poster Presentation	-	-	-	20
Total	**50**	**50**	**50**	**50**

Journal

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

Research project work

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

Overall Examination and Marks Distribution Pattern

Semester III

Course	301			302			303			304			
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Grand total
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**400**
Practicals	**-**	**50**	**50**	**-**	**50**	**50**	**-**	**50**	**50**	**-**	**50**	**50**	**200**

Course Code: RPSMIC 401
Course Title: Pharmaceutical Microbiology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Recall the principles and terminologies used in pharmaceutical industry
CO 2	Design experiments on bioburden determination
CO 3	Execute microbial and sterility testing of pharmaceutical products
CO 4	Monitor the factors which affect the quality of a pharmaceutical product
CO 5	Outline the process of validation and audit validation
CO 6	Apply various softwares used for studying 3D structures of drug and target molecule for drug discovery
CO 7	Critique suitable candidates as potential drugs based on theoretical knowledge
CO 8	Design effective antimicrobial preservation methods for cosmetic products

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 401		**PHARMACEUTICAL MICROBIOLOGY**	**04/60**
I		**Principles and applications of GMP in pharmaceuticals**	**15**
	1.1	General Principles of QC,QA and GMP f) The concept of Quality g) The regulatory factors h) QC, QA and GMP i) Quality assurance beyond GMP j) IS and ISO standards: 9000, 17025	**07**
	1.2	Microbiology for Pharmaceutical industries a) Microbiological culture media and laboratory techniques b) Laboratory management c) Bioburden determination	**08**
II		**Quality management and regulatory aspects**	**15**
	2.1	Premises and contamination control	**02**
		a) Location b) Design c) Structure d) Layout e) Services and cleaning	
	2.2	Introduction to Documentation and Validation	**03**
	2.3	Auditing and Sterilization	**05**
		a) Auditing in Pharmaceutical Industry b) Audit Validation c) Sterilization and Sterility Assurance d) Chemical and Biological Indicators: Measuring sterilization e) Auditing Sterilization Processes and Facilities	
	2.4	Endotoxin and pyrogen testing	**03**
	2.5	Risk assessment and Microbiology	**02**
III		**Cosmetic Microbiology**	**15**
	3.1	History of cosmetic microbiology	**01**
	3.2	Global regulatory and toxicological aspects of cosmetic preservation	**04**
	3.3	Antimicrobial preservation efficacy and microbial content	**06**

		testing	
	3.4	Preservation of cosmetics	**04**
		A. Preservation strategy B. Antimicrobial mechanisms of selected preservatives and the bacterial response	
IV		**Drug Discovery and Pharmacology**	**15**
	4.1	Modern Methods of Drug Discovery	**02**
	4.2	Proteomics	**02**
	4.3	Bioinformatics	**02**
	4.4	High throughput screening technology	**02**
	4.5	Natural products for lead identification	**02**
	4.6	The role of protein 3D structures in the drug discovery process	**03**
	4.7	Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics	**02**

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m) Sharp John, “Quality in the manufacture of medicines and other healthcare products” Pharmaceutical Press, 2000.

n) Tim Sandle, “Pharmaceutical Microbiology- Essentials for Quality Assurance and Quality control”, Woodhead Publishing, Elsevier, 2016

o) Philip A,Taylor and Francis, “Cosmetic Microbiology a practical approach”, 2nd Ed. 2006

p) Hillisch A and Hilgenfeld R, “Modern Methods of drug discovery”, Springer International, 2009

q) S.B.Primrose, “Principles of Gene Manipulation and Genomics”, 7th Ed, Blackwell Publishing, 2006

r) Rosamund Baird and Norman A Hodges, “Handbook of Microbiological Quality Control Pharmaceutical and Medical Device”, Taylor & Francis e-Library, 2005.

PRACTICAL: RPSMIC4P1 (60 CONTACT HRS)

r) Sterility testing and reporting (as per Pharmacopia)

s) Preparation of cosmetic product and its stability study

t) Microbial load in cosmetic product as per IS 14648:2011 w.r.t heterotrophic counts, presence of *Pseudomonas spp, Staphylococci spp, P.acne*

u) Efficacy testing of preservatives like parabens as per ISO 11930

v) Performance of an audit of a test with proper documentation

Course Code: RPSMIC402

Course Title: Advances in Biotechnology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Summarize the prenatal diagnostic techniques used for diagnosing genetic disorders.
CO 2	Justify the significance of gene therapy & understand antisense technology used for treatment of genetic disorders.
CO 3	Explain the importance of stem cell technology in regenerative medicine.
CO 4	Analyze and compare the advanced techniques & its utility for detection of pathogens.
CO 5	Evaluate the commercialization potential of fungal strains & understand the current trends in fungal biotechnology.
CO 6	Interpret the potential of microalgae in producing biofuels & biofertilizers.
CO 7	Explain IPR, traditional bill law, biodiversity law & ethics in biological research.
CO 8	Design & execute experiments to harness the commercial potential of fungal & algal strains, also to write, read and understand the patent claims.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 402		**ADVANCES IN BIOTECHNOLOGY**	**04/60**
I		**Medical Biotechnology**	**15**
	1.1	**Diagnostics & therapeutic approach for Genetic disorders**	**07**
		a. Pre- natal diagnosis- Sample collection, processing, Advantages, disadvantages	**01**
		b. Karyotyping, FISH & PCR	**02**
		c. Gene Therapy: Vectors, Gene targeting & Tissue Specific Expression	**02**
		d. Antisense Technology	**01**
		e. Introduction to Genetic Counselling	**01**
	1.2	**Modern Diagnostic approach for pathogens**	**05**
		a. Optical Tweezer b. 16S rRNA Sequencing c. Spectrometry d. VITEK e. API 20 f. FAME g. BIOLOG	
	1.3	**Stem Cell Technology**	**03**
		a. Introduction to Stem cells & types b. Regenerative medicine c. Genomic Reprogramming of cells d. Stem cells in Neurodegenerative disorders e. Stem cells in physiological dysfunctions Eg: Diabetes	
II		**Exploring microbes for commercial products (Fungal Biotechnology)**	**15**
	2.1	**Introduction Fungal world**	**02**
		a. An overview of Fungi and fungal activities b. Fungal growth and Fungal nutrition c. Mycology: A Neglected Megascience	
	2.2	**Genetics of Fungus**	**02**
		a. Fungal Genetics b. Fungal Genomics	
	2.3	**Fungal Pigments**	**03**
		a. Genetic basis of pigment production b. Factors affecting pigment production c. Fermentation for pigment synthesis d. Mycotoxins and their replacement e. Relevance of pigments in various fields	

	2.4	**Applications of Fungal Biotechnology**	**04**
		a. Metabolic capacities of fungi for bioremediation b. Fungal biomolecules and their Implications c. Fungal Biocatalysts in the textile industry and waste water treatment	
	2.5	**Current trends in Fungal Biotechnology**	**04**
		a. Myconanotechnology b. Fungal Antitumor agents c. Production of recombinant Peptides like Peptaibiotics and peptaibols	
III		**Exploring microbes for commercial products (Algal Biotechnology)**	**15**
	3.1	**The microalgal cell**	**03**
		a. Introduction b. Structural and Morphological features of Microalgae c. Ultrastructure and cell division d. Cell growth and development e. Microalgal systematics	
	3.2	**Basic culturing Techniques**	**03**
		a. Isolation of Microalgae b. Screening of Microalgae for bioactive molecules c. Measurement of Growth Parameters d. Modes of culture	
	3.3	**Mass Production of Microalgae: Photobioreactors**	**03**
		a. Definition of photobioreactors b. Classification of photobioreactors c. Types of bioreactors d. Tubular photobioreactors e. Flat photobioreactors f. Vertical cylinders and sleeves g. Axenic photobioreactors h. Scale up of photobioreactors	
	3.4	**Applications of Algal Biotechnology**	**03**
		a. Microalgae as platforms for Recombinant proteins b. Algae as a source of Biofuel c. Algae as biofertilizer for rice	
	3.5	**Current trends in Algal Biotechnology**	**03**
		a. Targeted Genetic Modification of Cyanobacteria b. Phylogenomics in Algal research	
IV		**IPR and Bioethics Traditional Knowledge & Biodiversity conservation.**	**15**
	4.1	**Types of IPR & the Need of IPR in Biotechnology**	**02**
		a. What is IPR? b. Types of IPR: Patents, Trade Marks & Service Marks, Design Registration, Trade Secrets, Geographical indications, Protection of New Plant Varieties, Copyright.	

		c. Need & Implications: Technology Transfer, Commercialization, Economic and policy implications d. Global Harmonization: TRIPS Agreement	
	4.2	**Pre-requisites for patentability, the process & its Implications**	**03**
		a. Criteria to be fulfilled for Patentability - new/novel, non-obvious/inventive step, useful/capable of industrial application. b. Steps in patentability: Application to the grant of patent c. Implications of IPR in Biotechnology	
	4.3	**Patentability in Biology: What Can and What Cannot be patented?**	**03**
		a. Indian Scenario of patentability b. Global Scenario of patentability c. Implications in policy making and commercialization due to variables	
	4.4	**Bioethics: Issues & Perspectives in the discipline of Microbiology**	**02**
		a. Ethics involved while working with Microorganisms b. Bioweapons- an Ethical issue c. Bioethics: An Indian perspective	
	4.5	**Ethical guidelines for Biomedical research in Human subjects**	**01**
	4.6	**Safety, ethical, moral implications of Genetic engineering**	**01**
	4.7	**The protection of Traditional Knowledge Bill, 2016**	**01**
	4.8	**Biodiversity Law**	**02**
		a. Need for a biodiversity law b. National Guidelines c. International Guidelines	

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a) Jogdand S. N., Medical Biotechnology, 2008, Himalaya Publishing House.
b) Judit Pongracz, Mary Keen, Medical Biotechnology, 2009, Churchill Livingstone, Elsevier.
c) Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, 2010, Oxford University Press, India
d) Richard Re, The application of Antisense technology to medicine, 2000, The Oschner Journal, 2(4).
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g) Ricardo Franco-Duarte, Lucia Cernáková 3 , Snehal Kadam , Karishma S. Kaushik , Bahare Salehi, , Antonio Bevilacqua , Maria Rosaria Corbo , Hubert Antolak , Katarzyna Dybka-Stepien , Martyna Leszczewicz , Saulo Relison Tintino , Veruska Cintia Alexandrino de Souza, Javad Sharifi-Rad , Henrique Douglas Melo Coutinho , Natália Martins and Célia F. Rodrigues. Advances in Chemical and Biological Methods to Identify Microorganisms—From Past to Present, 2019, Microorganisms, 7(130).

h) Singhal N. et al "MALDI-TOF mass spectrometry: an emerging technology for microbial identification and diagnosis", Front Microbiol. 2015; 6: 791.

i) MICROBIAL IDENTIFICATION USING THE BIOMÉRIEUX VITEK® 2 SYSTEM David H. Pincus bioMérieux

j) Wenhuan Xu* & Zhiwei Ge "Application and Optimization of Biolog EcoPlates in Functional Diversity Studies of Soil Microbial Communities" Matec web of conferences 22 04015 (2015)

k) Bacterial Identification by Gas Chromatographic Analysis of Fatty Acid Methyl Esters (GC-FAME) Technical Note #101 Myron Sasser May 1990 Last Revised July 2006

l) Jim Deacon, "Fungal Biology", 4th Ed, Blackwell Publishing, 2006

m) Tulasi Satyanarayana and Sunil K. Deshmukh, "Developments in Fungal Biology and Applied Mycology", Springer, 2017

n) Dinabandhu Sahoo, "The Algae World", Volume 26, Springer, 2015.

o) Robert Andersen, "Algal culturing Techniques", Elsevier Academic Press, 2005

p) Yuan Kun Lee, Microbial Biotechnology: Principles & Applications, 2nd edition, 2006, World Scientific Publishing Company.

q) Prabuddha Ganguli, IPR- Unleading the knowledge economy, 1st Edition, 2017, McGraw Hill education.

r) Kshitij Kumar Singh, Biotechnology and IPR – Legal and Social Implications, 2015, Springer Publications.

s) Law and National Biodiversity Strategies and Action Plans by the Law Division for the United Nations Environment Programme. A booklet issued by UN Environment committee.

t) P Desikan, A Chakrabarti, V Muthuswamy. "Ethical issues in microbiology", *Indian Journal of Medical Microbiology*, 2011, 29(4).

u) Dr. Mohammed Sarosh Khan, Dr. Rakesh Kumar Gorea, Dr. Shafqat Qamar, Dr. Gulam Mustafa, Abhinav Gorea, "Some ethical Perspectives in the Discipline of Microbiology", International Journal of ethics, trauma & Victimology, 2015, 1(2).

v) Ajit Avasthi, Abhishek Ghosh, Sidharth Sarkar, Sandeep Grover, "Ethics in medical research: General principles with special reference to psychiatry research", 2013, Indian Journal of Psychiatry 55(1).

w) The Protection Of Traditional Knowledge, Genetic Resources And Expressions Of Folklore Act, 2016, WIPO.

PRACTICAL: RPSMIC 4P2 (60 CONTACT HRS)

a) IPR Case studies: An innovative approach to understand IPR & it's Implications.
b) Case study on Bioethics: An innovative approach to understand bioethics & it's significance.
c) Study of pigment production & purification from Trichoderma
d) Isolation and detection of laccase producing fungi
e) Production, purification and immobilization of fungal amylase.
f) Culturing microalgae in the lab & studying the effect of growth parameters on its multiplication.
g) Bioprospecting algae for oils and flavouring compounds
h) Visit to algal cultivation units

Course Code: RPSMIC403

Course Title: Emerging areas in Biology II

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Demonstrate a basic understanding of epidemiological strategies, study designs and evaluate the data for its statistical relevance.
CO 2	Discuss and understand the strategies to detect & monitor biological agents used for bioterrorism & exemplify the significance of biosecurity.
CO 3	Identify & implement potential solutions for energy needs by evaluating existing & novel biomass to energy technologies
CO 4	Explain and recall the alternative sources for exhaustible fuels in the form of variety of biofuels.
CO 5	Critique the current and emerging trends of enzyme technology & discuss the applications of enzymes.
CO 6	Understand & execute methods for production, purification, characterization & immobilization of enzymes.
CO 7	Discuss & recall the principles & procedure of protein engineering techniques.

DETAILED SYLLABUS

Course Code	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 403		**EMERGING AREAS IN BIOLOGY II**	**04/60**
I		**Epidemiology, Bioterrorism and Biosecurity**	**01/15**
	1.1	**Epidemiology**	**10**
		a. Historical aspects-definition b. Descriptive Epidemiology-aims and uses c. Epidemiological principles in prevention and control of Diseases d. Study Designs: i. Introduction ii. Observational Versus Experimental approaches in Epidemiology iii. Overview of study designs used in Epidemiology iv. Ecologic Studies v. Cross-Sectional studies vi. Case-Control studies e. Public health surveillance: i. Purpose and characteristics ii. Identifying health problems for surveillance iii. Collecting data for surveillance iv. Analyzing and interpreting data v. Disseminating data and interpretation vi. Evaluating and improving surveillance	
	1.2	**Bioterrorism**	**03**
		a. Introduction b. Threat Agents by category c. Detection, Monitoring, and Identification of BT Agents d. The Potential for Misuse of Biotechnology e. Some examples of biological agents as warfare – Smallpox, *Bacillus anthracis, Yersinia pestis*	
	1.3	**Biosecurity**	**02**
		a. Introduction b. Constituents of a Biosecurity hazard	
II		**Bioenergy and Bioconversions**	**15**
	2.1	Classification of biofuels: a. Conventional and Advanced Biofuels 1st generation biofuels- sugar and starch-based ethanol, conventional biodiesel, biogas b. 2nd generation biofuels – cellulosic ethanol, advanced biodiesel, biooils and biobutanol	**09**

		c. 3rd generation biofuels- Biohydrogen and algal based fuels. d. 4th generation biofuels e. Syngas/ Biogas production i. Types of feedstocks ii. Process types and digestors used	
	2.2	Microbial fuel cells	**03**
	2.3	a. Bioconversion of Lignocelluloses into food and feed rich in protein b. Bioconversion of industrial cellulosic pulp materials to protein-enriched food and feeds	**03**
III		**Enzyme Technology**	**15**
	3.1	Different types enzymes, production and enzymatic analysis and assay methods	**08**
		a. Amylases b. Cellulases c. Lipases d. Laccases e. Proteases	
	3.2	Enzyme immobilization- Need, methods, Carriers and applications	**05**
	3.3	Therapeutic enzymes	**02**
IV		**Protein Engineering**	**15**
	4.1	Modifications of proteins a. Adding disulphide bonds b. Changing Asparagine to other amino acids c. Reducing number of free sulfhydryl residues	**05**
	4.2	Modifications of enzymes a. Increasing enzyme activity, enzyme stability and specificity b. Modifying metal cofactor requirement and protein specificity c. Decreasing protease sensitivity d. Altering multiple properties e. Directed Evolution of Industrial enzymes	**10**

REFERENCES:

a) Principles of epidemiology in public health practices 3rd Ed. (www.cdc.gov/training/products/ss1000)

b) Ann Aschengrau, George R Seage, Essentials of Epidemiology in Public Health, 3rd Ed.

c) Kenrad E Nelson, Carolyn Maters Williams, “Infectious Disease Epidemiology – theory and practice”, 3rd Ed, Jones & Bartlett Learning (Year)

d) Burt Anderson, Herman Friedman, Mauro Bendinelli, “Microorganisms and Bioterrorism”, Springer Science, 2006

e) FAO Biosecurity Tool Kit, Food and Agriculture Organization of the United Nations Rome, 2007 (http://www.fao.org/3/a1140e/a1140e.pdf)

f) Biofuels Production, Ed by Vikash Babu, Ashish Thapliyal & Girijesh Kumar Patel, 2014, Scrivener Publishing LLC. Co-published by John Wiley & Sons, Inc.
g) Introduction to Biofuels, David M. Mousdale, 2010, CRC Press Taylor & Francis Group
h) Biofuels, Alternative Feedstocks and Conversion Processes, Ed by Ashok Pandey, Christian Larroche, Steven Cricke, Claude-Gilles Dussap, Edgard Gnansounou, 2011, Academic Press
i) Advances in agricultural Microbiology 1st edition, Editor: N.S. Subba Rao
j) Cui, H., Wang, L., & Yu, Y. (2015). Production and Characterization of Alkaline Protease from a High Yielding and Moderately Halophilic Strain of SD11 Marine Bacteria. Journal of Chemistry, 2015, e798304. https://doi.org/10.1155/2015/798304
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m) Microbial Laccases and their Applications: A Review. (n.d.). https://doi.org/10.3923/ajbkr.2011.98.124
n) Sadhu, S., & Maiti, T. K. (2013). Cellulase Production by Bacteria: A Review. Microbiology Research Journal International, 235–258 Bernard R.
o) Industrial Biocatalysis, (2015) Edited by Peter Grunwald, Pan Standard Publishing, CRC Press Taylor & Francis Group
p) Glick, Jack J. Pasternak, “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, ASM Press, 2010

PRACTICALS: RPSMIC3P3 (60 CONTACT HRS):

a) Case Studies of epidemiological strategies
b) Internship presentation

Course Code: RPSMIC 404

Course Title: Internship

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

Course Code	Course/ Unit Title	Credits
RPSMIC 404	**INTERNSHIP**	**04**
	Internship to research institute/industry	**16 weeks**

PRACTICALS: RPSMIC4P4 (60 CONTACT HRS)

Internship report

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	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 6	04	All four units
Q.5) b)	Any 4 out of 6	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

Theory Examination Pattern- RPSMIC 404:

Internship evaluation by guide/ mentor- 60 marks

Internship report evaluation by internal faculty- 40 marks

II) Practical Examination Pattern

	Paper I	Paper II	Paper III	Paper IV
Viva	05	05	-	-
Quiz	05	05	-	-
Laboratory work	40	40	-	-
Internship presentation	-	-	50	
Internship report	-	-	-	50
Total	**50**	**50**	**50**	**50**

Journal

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

Internship Report

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

Overall Examination and Marks Distribution Pattern

Semester IV

Course	401			402			403			404			
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal (Internship report evaluation by internal Faculty)	External (Internship evaluation by Guide /mentor)	Total	Grand total
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practical	-	50	50	-	50	50	-	50	50	-	50	50	200
