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

S.P.Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for MSc Part II

Program: MSc (Microbiology)

Program Code: RPSMIC

(Choice Based Credit System for academic year 2023-2024)

GRADUATE ATTRIBUTES

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

GA	**A student completing Master's Degree in Science program will be able to:**
GA 1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA 2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA 3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA 4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
GA 5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA 6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use

	management skills and lead a team for planning and execution of a task.
GA 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

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

	in higher animals and correlate it to genes with specific reference to Drosophila.
PO 7	Execute extraction, purification and analysis of various biomolecules. Compare the mechanisms of enzyme catalysis of different classes of enzymes and solve problems on enzyme kinetics. Recall different cell signalling mechanisms. Outline the biochemistry of degradation of various xenobiotics by microorganisms
PO 8	Recall methods used to study microbial ecology and execute analysis of samples from varied environments. Extrapolate potential of extremophilic proteins to industrial applications, attribute problems like biofouling and biocorrosion to microbial activity. Recall the role of microbes in soil and demonstrate their role in plant growth. Outline, appreciate and apply the principles of solid and hazardous waste management and appreciate various regulations enacted with respect to biosafety.
PO 9	Access appropriate biological databases and apply various bioinformatics tools for varied analysis, recall concepts of synthetic biology and systems biology. Extrapolate understanding of contemporary tools in Molecular Biotechnology for DNA sequencing, mutagenesis and protein expression studies. Execute experiments for preparation of nanoparticles and their analysis
PO 10	Understand and evaluate the significance of viral genetics in representative bacterial viruses and apply it in rDNA technology. Recall and extrapolate the types of animal and plant viruses, describe their mechanisms of infections, control and treatment. Explain and give an overview of emerging & re-emerging viral infections responsible for causing pandemics. Outline the mechanism of tumorigenesis by oncogenic viruses.
PO 11	Recall detailed mechanisms of innate and adaptive immunity, and emphasize the molecular interactions that help distinction of self from non self in immune mechanisms. Outline the mechanisms of immune tolerance and exemplify reasons for autoimmune diseases as well as

	cancer. Apply principles of immunoassays for execution of diagnosis of disorders and diseases. Summarize and illustrate concepts in immunotherapy. Extrapolate basics of vaccine development to combat emerging infections
PO 12	Understand and implement different concepts in microbial approaches to quality control and management in industries. Check food and water samples for microbiological quality as per prescribed standards and maintain records. Recall concepts and monitor processes in food industry, bottled water manufacturing units and monitor processes and products of pharmaceutical industry with emphasis on BIS regulations, regulatory frameworks, GMP and HACCP, GLP, ISO standards and validation.
PO 13	Recall and explain the principle and working of techniques like spectroscopy, chromatography, hyphenated techniques, PCR based assays, microarrays, electrophoresis, X ray diffraction and SPR and compare all the different types included under each technique. Understand and extrapolate these concepts to analyse biological samples for biomolecular composition and/or structure.
PO 14	Understand, explain and Apply concepts in bioinformatics, proteomics, high throughput screening and pharmacogenomics for discovering new drugs
PO 15	Recall and apply various concepts in modern Biotechnology like gene therapy, stem cell technology, 16SrRNA sequencing in fields like diagnostics, therapeutics and genetic counselling. Summarize and evaluate the biotechnological potential of fungi and algae for production of commercial products like pharmaceutics, pigments, enzymes, biofuels etc. and in processes like bioremediation and wastewater treatment. Summarize and interpret the laws for IPR, biodiversity conservation and recall the perspectives of bioethics. Implement patent searches and outline prerequisites and steps in patentability.

PO 16	Categorize biofuels and outline fermentation technologies for their manufacture. Exemplify enzymes with industrial potential and recall and explore technologies like immobilization for their application in industrial products. Explain techniques in protein engineering for increasing activity and specificity.
PO 17	Outline work plans and execute tasks independently and to completion. Coordinate and cooperate with team members for execution of experiments. Maintain records, make reports and interpret them for making summaries. Communicate information accurately and effectively. Follow ethical practices at workplace, take initiative, exhibit competency and imbibe other professional skills.
PO 18	Apply theoretical concepts effectively and think innovatively to translate ideas to research projects and projects to products. Understand the significance of microbiology as a science that has transdisciplinary relevance and immense potential to improve quality of life for all humankind.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc I	I	RPSMIC 101 (Core Course)	MICROBIAL GENETICS	04
		RPSMIC 102 (Core Course)	MICROBIAL BIOCHEMISTRY	04
		RPSMIC 103 (Core Course)	MEDICAL MICROBIOLOGY AND HUMAN MICROBIOME	04
		RPSMICP 101	Practical-I	02
		RPSMICP 102	Practical-II	02
		RPSMICP 103	Practical-III	02
		Student should select anyone of the following Course		
		RPSMIC 104 (Discipline Specific Course)	CLINICAL MICROBIOLOGY EPIDEMIOLOGY	04
		RPSBCH 104 (Discipline Specific Course)	PLANT BIOCHEMISTRY	
		RPSBTK 104 (Discipline Specific Course)	CLINICAL DATA MANAGEMENT	

		RPSMICP 104/ RPSBCHP 104/ RPSBTKP 104	**Practical-IV**	**02**
		RPSMIC 105 (Ability Enhancement Compulsory Course)	**EMOTIONAL WELL-BEING THROUGH LOGIC-BASED THINKING**	**02**
	II	**RPSMIC 201 (Core Course)**	**CELL BIOLOGY**	**04**
		RPSMIC 202 (Core Course)	**MICROBIAL BIOCHEMISTRY II**	**04**
		RPSMIC 203 (Core Course)	**ENVIRONMENTAL MICROBIOLOGY**	**04**
		RPSMICP 201	**Practical-I**	**02**
		RPSMICP 202	**Practical-II**	**02**
		RPSMICP 203	**Practical-III**	**02**
		Student should select anyone of the following Course		
		RPSMIC 204 (Discipline Specific Course)	**MICROBIAL APPROACHES TO QUALITY MANAGEMENT**	**04**
		RPSBCH 204 (Discipline Specific Course)	**NUTRACEUTICALS AND FUNCTIONAL FOODS**	

		RPSBTK 204 (Discipline Specific Course)	NANOTECHNOLOGY	
		RPSMICP 204/ RPSBCH 204/ RPSBTK 204	Practical-IV	02
		RPSMIC 205 (Ability Enhancement Course)	RESEARCH METHODOLOGY	02
			Total Credits	26
MSc II	III	RPSMIC 301 (Core course)	IMMUNOLOGY	04
		RPSMICP 301	Practical based on Immunology	02
		RPSMIC 302 (Core course)	BIOINSTRUMENTATION	04
		RPSMIC 303 (Skill ehancement compulsory course)	BIOINFORMATICS AND BIOSTATISTICS	04
		RPSMICP 303	Practical based on Bioinformatics and Biostatistics	02
		RPSMIC 304	RESEARCH PROJECT	08

	IV	RPSMIC 401 (Core course)	VIROLOGY	04
		RPSMICP 401	Practical based on Virology	02
		RPSMIC 402 (Core course)	ADVANCES IN BIOTECHNOLOGY	04
		RPSMICP 402	Practical based on Advances in Biotechnology	02
		RPSMIC 403 (Core Course)	EMERGING AREAS IN BIOLOGY	04
		RPSMIC 404	INTERNSHIP	08

Course Code: RPSMIC 301(Core Course)

Course Title: Immunology

Academic year 2023-24

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 301 (Core Course)		**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) Introduction to Mechanisms of T dependent and independent responses	
III		**Immune tolerance and Autoimmunity**	**15**
	3.1	**Establishment of immune tolerance**	**6**
		a) Central Tolerance, Peripheral Tolerance, Regulatory T cells b) B cell tolerance	
	3.2	**Autoimmunity and Immune Linked Inflammatory diseases**	**7**
		a) **Autoimmunity** i. Spectrum of autoimmune diseases ii. Genetic factors for autoimmunity iii. Induction of autoimmunity iv. Treatment of autoimmune diseases	

		b) Introduction to Immune mediated inflammatory diseases (IMID) i. Definition and examples	
	3.3	**Cancer Immunology**	**2**
		a) Tumor antigens b) Anti-Tumor Immune responses	
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) Caroline L. Sokol and Andrew D. Luster, "The Chemokine System in Innate Immunity", *Cold spring Harbour Perspectives in Biology*, 2019.

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

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

PRACTICAL-I: RPSMIC301 (Core Course) (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) Rocket immunoelectrophoresis

e) SRID

f) Demonstration of Flow cytometry

Course Code: RPSMIC 302 (Core Course)

Course Title: Tools and Techniques: Biomolecular analysis

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the principles of various spectroscopic methods
CO 2	Attribute various applications in biological sciences to the appropriate chromatographic technique
CO 3	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 302 (Core Course)		**TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS**	**4/60**
I		**Spectroscopic Techniques** Principle and applications of:	**15**
	1.1	**UV-visible spectroscopy**	**03**
	1.2	**IR spectroscopy**	**04**
	1.3	**Atomic Absorption Spectroscopy**	**03**
	1.4	**Mass spectroscopy**	**05**
II		**Chromatographic Techniques**	**15**
	2.1	**Gas Chromatography**	**05**
		a) Principle b) Instrumentation c) Operation d) Calibration e) Accuracy f) Applications	
	2.2	**High Performance Liquid Chromatography**	**05**
		a) Principles b) Instrumentation c) Operation d) Calibration, e) Accuracy f) Applications	
	2.3	**High Performance Thin Layer Chromatography**	**02**
		a) Theory of TLC b) HPTLC: Development, data and results c) Applications	
	2.4	**Hyphenated techniques**	**03**
		Principle of a) LC-MS b) GC-MS	
III		**Molecular Biology Techniques**	**15**
	3.1	**Variations/ Modifications of PCR**	**05**

		Basics of PCR and its Modifications: a) Hot- Start PCR, b) Multiplex PCR, c) Nested PCR, d) RT-PCR, e) Broad Range PCR, f) Quantitative PCR, g) Real time PCR h) Touchdown PCR i) Colony PCR j) Digital PCR -Droplet	
	3.2	**Hybridization array technology**	**05**
		a) Applications of microarrays in microbiology, b) Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays)	
	3.3	**Electrophoresis**	**05**
		a) 2D- Gel Electrophoresis b) Capillary Electrophoresis	
IV		**Microscopic Techniques**	**15**
	4.1	**Microscopy**	**12**
		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	

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

d) Skoog, Holler and Nieman, "Principles of Instrumental Analysis", 5th Ed. Australia, Thomson Brock/Cole

e) Wilson and Walker, "Principles and Techniques of Biochemistry and Molecular Biology", 7th Ed., Cambridge University Press, 2010.

f) Sauer, S., & Kliem, M., “Mass spectrometry tools for the classification and identification of bacteria”. *Nature Reviews Microbiology*, 2010, 8(1), 74-82.

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

h) Don R, Cox P, Wainwright B, Baker K, Mattick J., "'Touchdown' PCR to circumvent spurious priming during gene amplification", *Nucleic Acids Res*, 1991, 19 (14): 4008.

i) Hecker K, Roux K., "High and low annealing temperatures increase both specificity and yield in touchdown and stepdown PCR". *BioTechniques*. 1996, 20 (3): 478-85.

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.

Course Code: Discipline Specific Skill Enhancement Course

Course Title: Bioinformatics and Biostatistics

Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the basic principles of Bioinformatics
CO 2	Analyse the sequence data using Bioinformatics tools
CO 3	Summarize the types and uses of various bioinformatics tools
CO 4	Understand the phylogenetic analysis and tools to conduct the analysis
CO 5	Implement bioinformatics tools for genetic analysis and structure building
CO 6	Understand the basic concepts of biostatistics
CO 7	Apply the simple linear regression for calculation
CO 8	Understand the concept of Hypothesis testing

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC SECC		**Bioinformatics and Biostatistics**	**04/60**
	I	**Basics of Bioinformatics**	**15**
		a) Introduction to Bioinformatics i. What Is Bioinformatics? ii. Goal iii. Scope iv. Applications v. Limitations vi. New Themes	**02**
		b) Introduction to Biological Databases i. What Is a Database? ii. Types of Databases iii. Biological Databases iv. Pitfalls of Biological Databases v. Information Retrieval from Biological Databases	**03**
		c) Pairwise Sequence Alignment i. Evolutionary Basis ii. Sequence Homology versus Sequence Similarity iii. Sequence Similarity versus Sequence Identity iv. Methods v. Scoring Matrices vi. Statistical Significance of Sequence Alignment	**04**
		d) Database Similarity Searching i. Unique Requirements of Database Searching ii. Heuristic Database Searching iii. Basic Local Alignment Search Tool (BLAST) iv. FASTA v. Comparison of FASTA and BLAST vi. Database Searching with the Smith-Waterman Method	**03**
		e) Multiple Sequence Alignment i. Scoring Function ii. Exhaustive Algorithms iii. Heuristic Algorithms	**03**

		iv. Practical Issues	
	II	**Advances in Bioinformatics**	**15**
		a) Phylogenetics Basics i. Molecular Evolution and Molecular Phylogenetics ii. Terminology iii. Gene Phylogeny versus Species Phylogeny iv. Forms of Tree Representation v. Why Finding a True Tree Is Difficult vi. Procedure	**04**
		b) Phylogenetic Tree Construction Methods and Programs i. Distance-Based Methods ii. Character-Based Methods iii. Phylogenetic Tree Evaluation iv. Phylogenetic Programs	**05** **02**
		c) Protein Structure Basics (Revision) i. Amino Acids ii. Peptide Formation iii. Dihedral Angles iv. Hierarchy v. Secondary Structures vi. Tertiary Structures vii. Determination of Protein Three-Dimensional Structure viii. Protein Structure Database	**04**
		d) Protein Structure Visualization, Comparison, and Classification i. Protein Structural Visualization ii. Protein Structure Comparison iii. Protein Structure Classification	
	III	**Basic Biostatistics**	**15**
		a) Introduction to Biostatistics i. Introduction ii. Some Basic Concepts iii. Measurement and Measurement Scales iv. Sampling and Statistical Inference v. The Scientific Method and the Design of Experiments	**03**
		b) Descriptive statistics i. Introduction ii. Grouped Data: The Frequency Distribution	**04**

		iii. Descriptive Statistics: Measures of Central Tendency iv. Descriptive Statistics: Measures of Dispersion c) Probability distributions i. Introduction ii. Probability Distributions of Discrete Variables iii. The Binomial Distribution iv. The Poisson Distribution v. Continuous Probability Distributions vi. The Normal Distribution vii. Normal Distribution Applications d) Simple Linear regression and correlation i. Introduction ii. The Regression Model iii. The Sample Regression Equation iv. Evaluating the Regression Equation v. Using the Regression Equation vi. The Correlation Model vii. The Correlation Coefficient	**05** **03**
	IV	**Advanced Biostatistics**	**15**
		a) Estimation i. Introduction ii. Confidence Interval for a Population Mean iii. The t Distribution iv. Confidence Interval for the Difference Between Two Population Means v. Confidence Interval for a Population Proportion vi. Confidence Interval for the Difference Between Two Population Proportions vii. Determination of Sample Size for Estimating Means viii. Determination of Sample Size for Estimating Proportions ix. Confidence Interval for the Variance of a Normally Distributed Population x. Confidence Interval for the Ratio of the Variances of Two Normally Distributed Populations b) Hypothesis testing i. Introduction ii. Hypothesis Testing: A Single Population Mean	**05** **06**

		iii. Hypothesis Testing: The Difference Between Two Population Means iv. Paired Comparisons v. Hypothesis Testing: A Single Population Proportion vi. Hypothesis Testing: The Difference Between Two Population Proportions vii. Hypothesis Testing: A Single Population Variance viii. Hypothesis Testing: The Ratio of Two Population Variances ix. The Type II Error and the Power of a Test x. Determining Sample Size to Control Type II Errors c) Analysis of Variance i. Introduction ii. The Completely Randomized Design iii. The Randomized Complete Block Design iv. The Repeated Measures Design v. The Factorial Experiment	**04**

REFERENCES:

a) Jin Xiong Ëssential Bioinformatics" Cambridge University Press, 2006
b) Henrik Christensen, "Introduction to Bioinformatics in Microbiology", Springer International Publishing, 2018
c) Arthur Lesk, "Introduction to Bioinformatics", Oxford University Press, 2013
d) Horgan Richard and Kenny Louise, "Omic technologies: genomics, transcriptomics, proteomics and metabolomics", SAC review, 2011, 13:189-195
e) Jonathan Pevsner, Bioinformatics and Functional Genomics, 3rd Edition, 2015, Wiley Blackwell
f) Wayne Daniel, Chad Cross ""BIOSTATISTICS A Foundation for Analysis in the Health Sciences" Wiley, 10th Edition, 2013

PRACTICALS: SECC (60 CONTACT HRS.)

a) Exploration of DNA and protein databases
b) Pair-wise and multiple alignment of DNA and Amino acid sequences
c) Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained
d) Visiting & exploring various databases mentioned in syllabus
e) Using BLAST and FASTA for sequence analysis
f) Six frame translation of given nucleotide sequence
g) Restriction analysis of given nucleotide sequence
h) Pair-wise alignment and multiple alignment of a given protein sequences
i) Formation of phylogenetic tree
j) Problems based on Biostatistics theory syllabus

Modality of Assessment for Core Courses and Skill Enhancement compulsory course:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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

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

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

a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.

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

Paper pattern:

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	Unit 1
Q.2)	Any 2 out of 3	12	Unit 2
Q.3)	Any 2 out of 3	12	Unit 3
Q.4)	Any 2 out of 3	12	Unit 4
Q.5) a)	Any 4 out of 5	04	All four units
Q.5) b)	Any 4 out of 5	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

II) Practical Examination Pattern

	RPSMICP 301	RPSMICPSECC
Viva	05	05
Quiz	05	05

Laboratory work	40	40
Total	**50**	**50**

Journal

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

Course Code:

Course Title: Research Project

Academic year 2023-24

8 credits

Modality of Assessment for Research Project:

Dissertation Marking Pattern

	Marks
Proposal Writing and Presentation	40
Thesis	60
Poster Presentation	40
Viva Voce	20
Lab meetings	40
Total	**200**

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			SECC			Research Project				
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Proposal Writing and Presentation	Thesis	Poster and Viva Voce	Lab meets	Grand total
Theory	40	60	100	40	60	100	40	60	100		-	-	-	300
Practical	-	50	50	-	-	-	-	50	50					100
Research Work										40	60	60	40	200

Semester 4

Course Code: RPSMIC 401 (Core Course)

Course Title: Virology

Academic year 2023-24

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 401 (Core Course)		**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 the T7 genes, Growth Cycle, Regulation of transcription of T7phage.	
	1.5	***E.coli* Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle.**	**04**
II		**Plant Viruses**	**15**
	2.1	**Plant viruses: General features & infection process**	**04**
		a) Morphology b) Modes of Transmission c) General life cycle d) Symptoms of infection	
	2.2	Virus-plant interactions: steps in induction of disease	**04**
	2.3	Plant satellite viruses and satellite Nucleic acids	**02**
	2.4	Citrus Tristeza Virus (CTV): Viral structure, Genome, Host range, Transmission, Symptoms and Control.	**03**

	2.5	Diagnosis and control of viral infections in plants	**02**
III		**Animal Viruses**	**15**
		Study of Structure, replication, life cycle, pathogenesis, transmission, clinical features- Signs & symptoms, diagnosis and control of following viral infections:	
	3.1	**Rabies**	**02**
	3.2	**Polio**	**03**
	3.3	**Hepatitis**	**04**
	3.4	**Pox virus, Vaccinia Virus, Orthopox virus, Variola Virus**	**03**
	3.5	**HSV and Varicella Zoster**	**02**
	3.6	**Epstein Barr & Cytomegalovirus**	**01**
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**

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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.
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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.
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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

PRACTICAL: RPSMICP401 (60 CONTACT HRS)

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

Course Code: RPSMIC 402 (Core Course)
Course Title: Emerging areas in Biology
Academic year 2023-24

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Identify & implement potential solutions for energy needs by evaluating existing & novel biomass to energy technologies
CO 2	Explain and recall the alternative sources for exhaustible fuels in the form of variety of biofuels.
CO 3	Critique the current and emerging trends of enzyme technology & discuss the applications of enzymes.
CO 4	Understand & execute methods for production, purification, characterization & immobilization of enzymes.
CO 5	Discuss & recall the principles & procedure of protein engineering techniques.

DETAILED SYLLABUS

Course Code	Sub-Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 402 (Core Course)		**EMERGING AREAS IN BIOLOGY**	**04/60**
I		**Bioenergy and Bioconversions**	**15**
	1.1	Classification of biofuels: a) Conventional and Advanced Biofuels 1st generation biofuels- sugar and starch-based ethanol, conventional biodiesel, biogas b) 2nd generation biofuels – cellulosic ethanol, advanced biodiesel, biooils and biobutanol c) 3rd generation biofuels- Biohydrogen and algal based fuels. d) 4th generation biofuels e) Syngas/ Biogas production i. Types of feedstocks ii. Process types and digestors used	**09**
	1.2	Microbial fuel cells	**03**
	1.3	a) Bioconversion of Lignocelluloses into food and feed rich in protein b) Bioconversion of industrial cellulosic pulp materials to protein-enriched food and feeds	**03**
II		**Enzyme Technology**	**15**
	2.1	Different types enzymes, production and enzymatic analysis and assay methods	**08**
		a) Amylases b) Cellulases c) Lipases d) Laccases e) Proteases	
	2.2	Enzyme immobilization- Need, methods, Carriers andapplications	**05**
	2.3	Therapeutic enzymes	**02**
III		**Contemporary tools in Molecular Biotechnology I**	**15**
	3.1	**DNA Sequencing and Physical mapping**	**04**
		a) Dideoxynucleoside method for sequencing of DNA b) Automated DNA sequencing c) High-throughput Sequencing d) Restriction Mapping reference	
	3.2	**Heterologous protein production in eukaryotic cells**	**06**

		a) *Saccharomyces cerevisiae* b) Pichia pastoris c) Baculovirus- Insect cell d) Mammalian cell	
	3.3	**Directed Mutagenesis**	**05**
		a) Oligonucleotide directed mutagenesis with plasmid DNA b) PCR amplified oligonucleotide directed mutagenesis c) Random mutagenesis with degenerate oligonucleotide primer d) Random mutagenesis with nucleotide analogues e) Error-prone PCR f) DNA shuffling g) Mutant proteins with unusual amino acids	
IV		**Contemporary tools in Molecular Biotechnology II**	**15**
	4.1	**Mapping and quantifying transcriptions**	**02**
		a) Northern Blotting b) S1 mapping c) Primer extension reference d) Run-off transcription e) G-less cassette transcription	
	4.2	**Measuring transcription rates in vivo**	**02**
		a) Nuclear Run-on b) Reverse transcription-PCR	
	4.3	**Assaying DNA–protein, protein-protein interactions**	**04**
		a) Filter binding and Gel mobility shift assays b) Foot printing methods c) Chromatin immuno-precipitation (ChIP) d) Yeast-two Hybrid assay	
	4.4	**Genome Editing with CRISPR/Cas9**	**05**
		a) Brief history & Components of CRISPR b) Advantages over TALENs or ZFNs c) Target Specificity of CRISPR/Cas9 d) Configuration for Gene Inactivation, Gene Correction with CRISPR	

REFERENCES:

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

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

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

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

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k) Michael Wink, "An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology", Wiley VCH, 2006

l) Robert F. Weaver. "Molecular Biology, 5th edition", WCB/McGraw-Hill, 2012.

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

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

PRACTICAL: RPSMIC402 (60 CONTACT HRS)

1. Qualitative detection of Amylases,Cellulases,Lipases,Laccases,Proteases from bacteria.

2. Enzyme assay of Amylases,Cellulases,Lipases,Laccases,Proteases

3. Immobilisation of Amylases,Cellulases,Lipases,Laccases,Proteases

Course Code: RPSMIC 403 (Core Course)

Course Title: Advances in Biotechnology

Academic year 2023-24

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 403 (Core Course)		**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 b. Karyotyping, FISH & PCR c. Gene Therapy: Vectors, Gene targeting & Tissue Specific Expression d. Antisense Technology e. Introduction to Genetic Counselling	**01** **02** **02** **01** **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**	**05**
		a. An overview of Fungi and fungal activities b. Fungal growth and Fungal nutrition c. Fungal Genetics	
	2.2	**Applications of Fungal Biotechnology**	**10**
		a. Fungal bioremediation b. Fungal Biocatalysts in the textile industry and waste water treatment c. Fungal Pigments	

		d. Myconanotechnology e. Fungal Antitumor agents and Recombinant Peptides	
III		**Exploring microbes for commercial products (Algal Biotechnology)**	**15**
	3.1	**The microalgal cell**	**04**
		a. Introduction b. Structural and Morphological features of Microalgae c. Ultrastructure and cell division d. Cell growth and development e. Microalgal systematics	
	3.2	**Basic culturing Techniques**	**07**
		a. Isolation of Microalgae b. Screening of Microalgae for bioactive molecules c. Measurement of Growth Parameters d. Modes of culture e. Introduction to Photobioreactors and their types	
	3.4	**Applications of Algal Biotechnology**	**04**
		a. Microalgae as platforms for Recombinant proteins b. Algae as a source of Biofuel c. Algae as biofertilizer for rice	
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	

REFERENCES:

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).

e) Robert Lanza, Anthony Atala, Essentials of Stem Cell Biology, 3rd edition, 2012, Academic Press, Elsevier.

f) Gary. S. Stein, Maria Borowski, Mai. X. Luong, Meng-Jiao Shi, Kelly. P. Smith, Priscilla Vazquez, Human stem cell technology & biology: A Research guide & Laboratory Manual, 2011, Wiley- Blackwell.

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)
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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.

Course Code: RPSMIC 404

Course Title: Internship

Academic year 2023-24

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**

PRACTICAL: RPSMICP404 (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