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# S. P. Mandali's

# Ramnarain Ruia Autonomous College

*(Affiliated to University of Mumbai)*




## Syllabus for MSc Part I

## Program: MSc (Microbiology)

## Program Code: RPSMIC

(Credit Based Semester and Grading System for academic year 2021–2022)

# 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<br>**A student completing Master's Degree in Science program will be able to:** |
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| **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 |

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| | 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<br>**A student completing Master's Degree in Science program in the subject of Microbiology will be able to:** |
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| **PSO 1** | Recall the basic concepts of gene expression and regulation, exemplify cytoplasmic inheritance and transposons. Analyse the genetics underlying cancer and cell cycle. Solve problems based on allelic and genotypic frequencies |
| **PSO 2** | Apply the principles of thermodynamics to understand stability of biological molecules, execute experiments for their detection and estimation in samples. Summarize the metabolism of one and two carbon compounds by microorganisms |
| **PSO 3** | Attribute pathogenesis of diseases to virulence mechanisms, outline the pathogenesis, transmission and treatment of emerging bacterial and viral infections. Recognize the role of microbiome in the overall physiology of humans. Execute antibiotic susceptibility assays and evaluate efficacy in context of antibiotic resistance. Also, implement diagnostic tests for infectious diseases |
| **PSO 4** | Formulate a hypothesis, design a research project, execute the experiments including appropriate calibrations and controls, implement appropriate methods for data collection and analyse data with appropriate statistical tools. Abstract and paraphrase scientific information, extrapolate it and present it creatively in the appropriate scientific language for verbal and non-verbal communication, using ICT tools. |
| **PSO 5** | Recall the structure and functions of cell membrane and cytoskeleton as well as the concept of protein trafficking and transport. Compare various transport mechanisms, and analyse the significance of cell to cell communication. Explain the process of development and organogenesis in higher animals and correlate it to genes with specific reference to Drosophila. |

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| **PSO 6** | Execute extraction, purification and analysis of various biomolecules. Compare the mechanisms of enzyme catalysis of different classes of enzymes and solve problems on enzyme kinetics. Recall different cell signalling mechanisms. Outline the biochemistry of degradation of various xenobiotics by microorganisms |
| **PSO 7** | Recall methods used to study microbial ecology and execute analysis of samples from varied environments. Extrapolate potential of extremophilic proteins to industrial applications, attribute problems like biofouling and biocorrosion to microbial activity. Recall the role of microbes in soil and demonstrate their role in plant growth. Outline, appreciate and apply the principles of solid and hazardous waste management and appreciate various regulations enacted with respect to biosafety. |
| **PSO 8** | Access appropriate biological databases and apply various bioinformatics tools for varied analysis, recall concepts of synthetic biology and systems biology. Extrapolate understanding of contemporary tools in Molecular Biotechnology for DNA sequencing, mutagenesis and protein expression studies. Execute experiments for preparation of nanoparticles and their analysis |
| **PSO 9** | Understand and evaluate the significance of viral genetics in representative bacterial viruses and apply it in rDNA technology. Recall and extrapolate the types of animal and plant viruses, describe their mechanisms of infections, control and treatment. Explain and give an overview of emerging & re-emerging viral infections responsible for causing pandemics. Outline the mechanism of tumorigenesis by oncogenic viruses. |
| **PSO 10** | Recall detailed mechanisms of innate and adaptive immunity, and emphasize the molecular interactions that help distinction of self from non self in immune mechanisms. Outline the mechanisms of immune tolerance and exemplify reasons for autoimmune diseases as well as cancer. Apply principles of immunoassays for execution of diagnosis of disorders and diseases. Summarize and illustrate concepts in immunotherapy. Extrapolate basics of vaccine development to combat |

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| | emerging infections |
| **PSO 11** | Understand and illustrate different concepts in food microbiology like- fermentations, preservation, microbial analysis and quality control. Check food and water samples for microbiological quality as per prescribed standards and maintain records. Recall concepts and monitor processes in food industry and bottled water manufacturing units with emphasis on BIS regulations, regulatory frameworks, GMP and HACCP. |
| **PSO 12** | Recall and explain the principle and working of techniques like spectroscopy, chromatography, hyphenated techniques, PCR based assays, microarrays, electrophoresis, X ray diffraction and SPR and compare all the different types included under each technique. Understand and extrapolate these concepts to analyse biological samples for biomolecular composition and/or structure. |
| **PSO 13** | Understand, explain and monitor processes in pharmaceutical industry with respect to regulatory aspects, QA, QC, GLP, ISO standards and validation. Check microbial quality of bulk and finished pharmaceutical products, judge their quality and maintain records. Apply concepts in bioinformatics, proteomics, high throughput screening and pharmacogenomics for discovering new drugs |
| **PSO 14** | Recall and apply various concepts in modern Biotechnology like gene therapy, stem cell technology, 16SrRNA sequencing in fields like diagnostics, therapeutics and genetic counselling. Summarize and evaluate the biotechnological potential of fungi and algae for production of commercial products like 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 15** | Recall aspects in epidemiological study designs and public health surveillance and detect agents that could be associated with |

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

# PROGRAM OUTLINE

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

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

# Course Code: RPSMIC 101

# Course Title: Microbial Genetics

# Academic year 2020-21

**COURSE OUTCOMES:**

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

# DETAILED SYLLABUS

| Course Code | Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 101** | | **MICROBIAL GENETICS** | **4/60** |
| **I** | | **Gene expression and its regulation** | **15** |
| | **1.1** | **Gene expression** | **05** |
| | | a) Revision of prokaryote transcription and translation<br>b) Transcription process in eukaryotes<br>c) Pre-mRNA processing and Small RNA molecules<br>i. Structure of mRNA<br>ii. Post transcriptional processing of pre-mRNA<br>1. Addition of 5"cap<br>2. Addition of Poly(A)tail<br>3. RNA splicing<br>4. RNA editing<br>ii. Small RNA molecules<br>1. RNA interference<br>2. Types<br>3. Processing<br>4. Function of micro RNAs<br>d) mRNA surveillance<br>e) Post translational modification of Proteins | |
| | **1.2.** | **Regulation of gene expression** | **09** |
| | | a) Control of gene expression in prokaryotes<br>i. Levels of gene regulation<br>ii. DNA binding proteins<br>iii. Antisense RNA molecules<br>iv. Riboswitches<br>v. Operon (Revision with examples)<br>b) Control of gene expression in eukaryotes<br>i. Regulation through modification of gene structure<br>1. DNase I hypersensitivity<br>2. histone modifications<br>3. chromatin remodelling<br>4. DNA methylation.<br>ii. Regulation through regulatory molecules<br>1. Transcriptional activators<br>2. Co-activators<br>3. Repressors<br>4. Enhancers<br>5. Insulators<br>iii. Regulation through RNA processing & degradation | **03**<br><br><br><br><br><br>**06** |

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| | | iv. Regulation through RNA interference | |
| | **1.3** | **Chromosomal Rearrangements and effects on gene expression** | **01** |
| | | a) Amplification and deletion of genes<br>b) Inversions that alter gene expression<br>c) Phase variation in *Salmonella* | |
| **II** | | **Extensions and deviations from Mendelian Genetics** | **15** |
| | **2.1** | **Mitochondrial Inheritance** | **04** |
| | | a) Mitochondrial genome structure<br>b) Ancestral and derived mitochondrial genome<br>c) Mitochondrial DNA of Human, yeast and flowering plants<br>d) Endosymbiotic theory<br>e) General features of replication, transcription and translation of mitochondrial DNA<br>f) Codon usage in Mitochondria<br>g) Damage to Mitochondrial DNA and aging.<br>h) Evolution of mitochondrial DNA<br>i) Mt DNA analysis for study of evolutionary relationships | |
| | **2.2** | **Chloroplast DNA (cp DNA)** | **03** |
| | | a) Gene structure and organization<br>b) General features of replication, transcription and translation of cp DNA<br>c) Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA cp DNA maps | |
| | **2.3** | **Examples of extranuclear inheritance** | **03** |
| | | a) Leaf Variegation<br>b) Poky mutant of Neurospora<br>c) Yeast petite mutant,<br>d) Human genetic diseases | |
| | **2.4** | **Horizontal Gene Transfer** | **02** |
| | | Revision of<br>a) Transformation in bacteria<br>b) Conjugation<br>c) Transduction | |
| | **2.5** | **Epigenetics (Nature v/s Nurture)** | **03** |
| | | a) The concept of Epigenome<br>b) Molecular Mechanisms of epigenetic Changes<br>c) Cause of epigenetic effects- Alterations in Chromatin Structure<br>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 | |

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| | | b) Transposable Elements in Eukaryotes<br>i. Ac and Ds Elements in Maize<br>ii. P Elements and Hybrid Dysgenesis in Drosophila<br>iii. Retro-transposons Retrovirus like Elements Retroposons<br>iv. Transposable elements in Humans<br>c) The Genetic and Evolutionary Significance of Transposable Elements<br>d) Transposons and Genome Organization Transposons and Mutation<br>e) Transpositions that alter gene Expression<br>i. Antigenic variation in Trypansomes<br>ii. Mating type switching in yeast | |
| | **3.2** | **Population genetics** | **07** |
| | | a) Population and gene pool<br>i. Genotypic and Allelic frequencies<br>ii. Calculation of Genotypic frequencies and Allelic frequencies for autosomal and X linked loci<br>iii. Problems –calculation of allelic and genotypic frequencies<br>iv. Hardy-Weinberg Law, genotypic frequencies at HWE, Implications of the H-W Law<br>v. H-W proportions for multiple alleles,<br>vi. X-linked alleles<br>vii. Testing for H-W proportions and problems<br>viii. Genetic ill effects of in-breeding<br>b) Changes in the genetic structure of populations:<br>i. Mutation<br>ii. Migration and gene flow<br>iii. Genetic drift<br>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<br>b) Elaborating each model organism<br>i. *E. coli*<br>ii. Yeast<br>iii. *C. elegans*<br>iv. *A. thaliana*<br>v. *Mus musculus* | |
| | **4.2** | **Genetic basis of cancer** | **08** |
| | | a) Forms of Cancer, cancer and the Cell Cycle<br>b) Genetics Basis for Cancer<br>c) Oncogenes<br>d) Tumor-Inducing Retroviruses and Viral | |

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| | | Oncogenes<br>e) Cellular Homologs of Viral Oncogenes: The Proto-Oncogenes Mutant Cellular Oncogenes and Cancer<br>f) Chromosome Rearrangement and Cancer<br>g) Tumor Suppressor Genes<br>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: RPSMIC1P1 (60 CONTACT HRS)**

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

# Course Code: RPSMIC 102

# Course Title: Microbial Biochemistry-I

# Academic year 2020-21

**COURSE OUTCOMES:**

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

# DETAILED SYLLABUS

| Course Code | Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 102** | | **MICROBIAL BIOCHEMISTRY I** | **4/60** |
| **I** | | **Biochemical Calculations and Thermodynamics** | **15** |
| | **1.1** | **Biochemical Calculations** | **09** |
| | | a) SI Units Relevant to Biochemistry<br>i. Prefixes for Multiples and Fractions of Units<br>ii. Relative molecular mass (Mr)<br>iii. Stoichiometry<br>b) Various units of expressing and inter-converting concentration of solutions<br>i. Molarity<br>ii. Moles<br>iii. Normality<br>iv. Osmolarity<br>v. Molality<br>vi. Mole fraction<br>vii. Density<br>viii. Specific gravity<br>c) Bronsted Concept of conjugate acid–conjugate base pairs<br>i. Ionization of solutions<br>ii. pH<br>iii. Titration curves<br>iv. Buffers: preparation, action and their use in Biology<br>d) Henderson-Hasselbalch equation<br>i. Buffer capacity<br>ii. Polyproteic acids<br>iii. Amphoteric salts<br>iv. Ionic strengths<br>**(problem solving under all heads)** | |
| | **1.2** | **Thermodynamics** | **06** |
| | | a) Energy Transformations<br>b) First and second law of thermodynamics<br>i. Statement and Introduction<br>ii. Enthalpy, examples from biochemistry and energy conservation in living organisms<br>iii. Entropy of universe<br>iv. Protein denaturation<br>c) Gibbs Free Energy-Applications<br>i. Introduction | |

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| | | ii. Photosynthesis, glycolysis, and the citric acid cycle<br>iii. Oxidative phosphorylation and ATP hydrolysis<br>iv. Enzyme–substrate interaction<br>v. Protein solubility<br>vi. Protein stability | |
| **II** | | **Biomolecules** | **15** |
| | **2.1** | **Amino acids and Proteins** | **04** |
| | | a) Amino Acids and Peptides (Revision)<br>i. Properties of α-Amino Acids<br>ii. Acidic and Basic Side Chains<br>iii. The Peptide Unit<br>iv. Polypeptides<br>b) The Architecture of Folded Proteins<br>i. Conformations of Polypeptide Chains<br>ii. The Extended Chain β Structures<br>iii. Helices<br>iv. Turns and Bends, Domains, Subunits, and Interfaces<br>v. Packing of Side Chains<br>c) Dynamic Properties of Proteins<br>i. Packing of Side Cha Motion of Backbone and Side Chains<br>ii. Conformational Changes<br>iii. Denaturation and Refolding<br>iv. Effects of pH and Solvent<br>v. Irreversible Damage to Proteins | |
| | **2.2** | **Sugars, Polysaccharides and glycoproteins** | **03** |
| | | Structures and Properties of Simple Sugars<br>a) Glycosides, Oligosaccharides, Glycosylamines, and Glycation<br>b) Polysaccharides (Glycans)<br>c) Glycoproteins and Proteoglycans | |
| | **2.3** | **Lipids** | **03** |
| | | a) Lipid Structures<br>i. Fatty Acids, Fatty Alcohols, and Hydrocarbons<br>ii. Acylglycerols, Ether Lipids, and Waxes<br>iii. Phospholipids<br>iv. Glycolipids<br>v. Sphingolipids<br>vi. Sterols and Other Isoprenoid Lipids<br>b) Membranes-The Structure of Membranes | |
| | **2.4** | **Evolution of Metabolic pathway** | **05** |
| | | a) The primordial metabolism<br>b) The role of duplication and fusion of DNA sequences in the evolution of metabolic pathways in the early cells<br>c) Hypotheses on the origin and evolution of metabolic | |

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| | | pathways<br>d) The reconstruction of the origin and evolution of metabolic pathways | |
| **III** | | **One and two Carbon metabolism** | **15** |
| | **3.1** | **Metabolism of one carbon compounds** | **07** |
| | | a) Methylotrophs<br>i. Oxidation of methane, methanol, methylamines<br>ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens<br>b) Methanogenesis<br>i. Methanogenesis form H2, CO2, CH3OH, HCOOH, methylamines<br>ii. Energy coupling and biosynthesis in methanogenic bacteria<br>c) Acetogens: autotrophic pathway of acetate synthesis and CO2 fixation,<br>d) Carboxidotrophs: Biochemistry of chemolithoautotrophic metabolism<br>e) Cyanogens and cynotrophs<br>i. Cynogenesis<br>ii. Cyanide degradation | |
| | **3.2** | **Metabolism of two- carbon compounds** | **08** |
| | | a) Acetate<br>i. TCA<br>ii. Glyoxylate cycle<br>iii. Modified citric acid cycle<br>iv. Carbon monoxide dehydrogenase pathway and disproportionation to methane<br>b) Ethanol- acetic acid bacteria<br>c) Glyoxylate and glycollate<br>i. Dicarboxylic acid cycle<br>ii. Glycerate pathway<br>iii. Beta hydroxyaspartate pathway<br>d) Oxalate- as carbon and energy source<br>e) Highlight about sign of 1C/2C utilization | |
| **IV** | | **Transport of Biomolecules** | **15** |
| | **4.1** | **Transport of sugars** | **03** |
| | | a) Transport of D-Glucose and D-Fructose into *E. coli* cell.<br>b) Glucose transporters of erythrocytes, various glucose transporters present in humans (GLUT1-GLUT12) | |
| | **4.2** | **Transport of Fatty acid** | **03** |
| | | a) Mobilization of triacylglycerols stored in adipose tissue<br>b) Fatty acid entry into mitochondria via the acyl-carnitine/carnitine transporter | |
| | **4.3** | **Transport of proteins** | **09** |

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| | | a) Protein transport: extracellular protein secretion, drug export system<br>b) Folding of periplasmic proteins, translocation of folded proteins | |

**REFERENCES:**


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


**PRACTICALS: RPSMIC1P2 (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
l) Diffusion studies of molecules across yeasts cells

## Course Code: RPSMIC 103

## Course Title: Medical and Clinical Microbiology

## Academic year 2020-21

### COURSE OUTCOMES:

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

# DETAILED SYLLABUS

| Course Code | Sub-Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 103** | | **MEDICAL AND CLINICAL MICROBIOLOGY** | **04/ 60** |
| **I** | | **Study of Infections – I** | **15** |
| | | Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment:<br><br>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 and introduction to microbiome** | **15** |
| | **2.1** | **Detailed Study of following infections** | **06** |
| | | including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment<br>Chikungunya, Dengue, Swine flu | |
| | **2.2** | **Gut Microbiome studies** | **09** |
| | | a) Stomach, small and large intestinal microbiome<br>b) Function of the Human Gut Microbiota<br>c) Gut Microbiota in health and disease<br>d) Gut-brain axis | |
| **III** | | **Virulence regulation and strategies to evade defense** | **15** |
| | **3.1** | **Revision of Virulence mechanisms in pathogens** | **02** |
| | **3.2** | **Mechanisms of virulence regulation** | **04** |
| | | a) Types of regulation<br>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<br>b) Colonization of host surfaces<br>c) Evading host responses | |
| **IV** | | **Clinical Microbiology- Antibiotic resistance and Antibiotic susceptibility testing** | **15** |
| | **4.1** | **Antibiotic resistance in microbes** | **07** |

| | | | |
|---|---|---|---|
| | | a) Mechanisms of Antifungal agents<br>b) Mechanisms of antibiotic resistance in bacteria and fungi<br>c) Transfer of antibiotic resistance<br>d) Maintaining antibiotic resistance through Selective Pressure | |
| | **4.2** | **Antibiotic susceptibility testing** | **08** |
| | | a) Tests that predict the effectiveness of therapy<br>i. Antibiotic Susceptibility Testing Methods- Indications, standardization, QC, Procedures and interpretation<br>ii. Detection of resistance- Beta lactamase and ESBL<br>iii. Antibiograms<br>b) Tests that monitor the effectiveness of therapy<br>i. Molecular detection<br>ii. MBC<br>iii. Serum killing curves<br>iv. Testing antibiotic combinations<br>v. Time kill curves<br>c) Test of therapeutic efficacy and avoidance of toxicity | |

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a) Ananthnarayan & Paniker, "Textbook of Microbiology", 8th edition, University press 2009

b) Richard Goering, Hazel Dockerell *et al*, "Mim's Medical Microbiology, 5th ed, Saunders, Elsevier, 2013

c) David Greenwood *et al*, "Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control", 17th Edition, Churchill Livingstone/Elsevier, 2012

d) Julian R. Marchesi, "The Human Microbiota and Microbiome, Advances in Molecular and Cellular Microbiology", CABI press, 2014

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

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

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

h) J. Vandepitte, J. Verhaegen *et al*, "Basic laboratory procedures in clinical bacteriology", 2nd ed, WHO, Geneva, 2003

i) Gary Procop, Elmer Koneman *et al, "*Koneman's Color Atlas and Textbook of Diagnostic Microbiology", 7th Edition, Wolters Kluwer, 2017

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

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

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

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

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

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

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

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


**PRACTICALS: RPSMIC1P3 (60 CONTACT HRS)**

a) Diagnosis for HIV - Trispot/ ELISA for AIDS (Demonstration)

b) Mono - Spot Test for diagnosis of Chikungunya (Demonstration expt.)

c) Diagnosis of leptospirosis – Kit method (Demonstration)

d) Diagnosis for *Helicobacter pylori* HPSA (Helicobacter pylori) (Demonstration expt.) (kit method)

e) Study of Quorum Sensing in *C.violaecium*

f) Study of Quorum sensing inhibitors

g) Detection of Biofilm formation on different surfaces

h) Determination of Minimum Biofilm Inhibition Concentration of an antibiotic

i) Study of biofilms in flow systems

j) Antibiotic Susceptibility Test – microdilution methods according to CLSI guidelines

k) Checkerboard assay

l) E-test

## Course Code: RPSMIC 104

## Course Title: Research Methodology

## Academic year 2020-21

**COURSE OUTCOMES:**

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

# DETAILED SYLLABUS

| Course Code | Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 104** | | **RESEARCH METHODOLOGY** | **4/60** |
| **I** | | **Research Fundamentals and Terminology** | **15** |
| | **1.1** | **Philosophy of natural science** | **02** |
| | | a) Traditional philosophy of science<br>b) Scientific explanation and modes of inference<br>c) Scientific rationality<br>d) Theory testing | |
| | **1.2** | **Introduction to research** | **02** |
| | | a) Definition of research<br>b) Scientific research<br>c) General characters of research<br>d) Objectives of research<br>e) Classification and types of research | |
| | **1.3** | **Research methodology** | **03** |
| | | a) Types of research methods<br>b) Research methods verses methodology<br>c) Research and scientific method<br>d) Research process<br>e) Criteria of good research | |
| | **1.4** | **Strategies and analysis** | **04** |
| | | a) Research conditions<br>b) Importance of controls<br>c) Experimental protocol and experimental routine | |
| | **1.4** | **Research problem** | **01** |
| | | a) Selection of a research problem<br>b) Necessity of defining a research problem<br>c) Technique involved in defining a research problem | |
| | **1.5** | **Study designs** | **03** |
| **II** | | **Preparation for research project and data collection methods** | **15** |
| | **2.1** | **Literature search** | **02** |
| | | a) Concept of Information literacy<br>b) Method: Systematic literature search<br>c) Literature Search Technique<br>d) Methodology filters<br>e) Concept of Quality of literature<br>f) Impact factor | |
| | **2.2** | **Personal reference database** | **02** |
| | | a) Introduction to principal bibliographic | |

| | | | |
|---|---|---|---|
| | | databases<br>b) Medical and scientific internet search engines<br>c) Reference management softwares<br>d) Significance of cite when you write<br>e) Bibliographic format: output styles | |
| | **2.3** | **Hypothesis and testing of hypothesis** | **04** |
| | | a) Meaning, nature of hypothesis,<br>b) Functions of hypothesis,<br>c) Importance of hypothesis,<br>d) Kinds of hypothesis,<br>e) Characteristics of good hypothesis,<br>f) Formulation of hypothesis | |
| | **2.4** | **Methods and techniques of data collection** | **03** |
| | | a) Types of data<br>b) methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study, methods)<br>c) methods of secondary data collection (internal/external), schedule method | |
| | **2.4** | **Experimental data processing** | **04** |
| | | a) Processing operations<br>b) Problems in processing<br>c) Elements of analysis in data processing<br>d) Software for data processing | |
| **III** | | **Sampling, Sampling distribution and Statistics** | **15** |
| | **3.1** | **Sampling** | **05** |
| | | a) Sampling frame<br>b) Importance of probability sampling<br>c) Types of sampling<br>i. Simple random sampling<br>ii. Systematic sampling<br>iii. Stratified random sampling<br>iv. Cluster sampling<br>d) Problems due to unintended sampling<br>e) Ecological and statistical population in the laboratory | |
| | **3.2** | **Variables** | **01** |
| | | a) Types of Variables<br>i. Ordinal<br>ii. Discontinuous<br>iii. Continuous<br>iv. Derived | |
| | **3.3** | **Statistical methods** | **09** |
| | | **Statistical methods**<br>a. Effect measure, Comparing two proportions, Measures of association in 2 x 2 tables, Normal distribution, Comparison of means, Non-parametric methods, Regression analysis | |

| | | | |
|---|---|---|---|
| | | b. hypothesis testing and confidence interval<br>i. Null and alternate hypothesis<br>ii. Type-I & Type-II errors<br>iii. Level of significance,<br>iv. Power of test<br>v. p value<br>c. Parametric tests<br>i. Large sample Tests<br>a. Testing significance of single population mean<br>b. Testing significance of two population mean<br>ii. Small sample Tests<br>a. Testing significance of single population mean<br>b. Testing difference between two independent normal population mean<br>c. Testing difference between two correlated normal population mean<br>d. Testing significance of correlation coefficient<br>iii. χ2 test<br>a. Testing single population variance<br>b. Testing Goodness of fit<br>c. Testing association between two attributes<br>iv. F-test- Testing equality of variance<br>a. ANOVA- one-way classification, two-way classification | |
| **IV** | | **Scientific writing and Communication** | **15** |
| | **4.1** | **Report writing** | **03** |
| | | a) Types of research reports<br>b) Guidelines for writing a report<br>c) Report format<br>d) Appendices<br>e) Miscellaneous information | |
| | **4.2** | **Scientific communication** | **05** |
| | | a) Types of scientific documents<br>i. Journal articles<br>ii. Books<br>iii. Thesis<br>iv. Conference<br>v. Project reports<br>b) Components of a research paper<br>c) Publication process<br>d) Copy right transfer and co-authorship<br>e) Open access | |
| | **4.3** | **How to write grant application** | **02** |

| | | | |
|---|---|---|---|
| | **4.4** | **Communication skills** | **02** |
| | | a) Importance of communication<br>b) The process of communication<br>c) Verbal and nonverbal communication | |
| | **4.5** | **Modes of communication** | **03** |
| | | a) Communication by presentations<br>i. Structure and types of presentation<br>ii. PowerPoint presentation<br>iii. Handing PowerPoint<br>iv. Slide organisation and Content management<br>v. Body language, gestures and voice modulation<br>b) Communication by Email<br>c) Poster presentations<br>d) Oral presentations<br>i. Preparing for a lecture<br>ii. Delivering a lecture | |

**REFERENCES:**


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

b) Rosner B.A., "Fundamentals of Biostatistics", Cengage Learning, 2011

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

d) Ranjit Kumar, "Research Methodology- A step-by-step Guide for beginners", 3rd Ed, Sage publications, 2005

e) Daniel WW, "Biostatistics: A foundation for analysis in health sciences", 10th Edn, Cross CL., Wiley. 2013

f) McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., Yarkoni, T. (2016). How open science helps researchers succeed. eLife, 5. doi:10.7554/elife.16800

g) Satish G. Patil, "How to plan and write a budget for research grant proposal?", Journal of Ayurveda and Integrative Medicine, Volume 10, Issue 2, 2019, Pages 139-142


**PRACTICALS: RPSMIC1P4 (60 CONTACT HRS)**

a) Writing the Literature review on research topic that the students wishes to take for dissertation

b) Problem solving on Biostatistics (manually and using Microsoft Excel)

c) Abstract writing or summary for a research paper

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

## II) Practical Examination Pattern

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

## Journal

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

### Overall Examination and Marks Distribution Pattern

### Semester I

| Course | 101 | | | 102 | | | 103 | | | 104 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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** |

**Semester End Examination: (Deviation from the usual modality)**

**Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.**

## Course Code: RPSMIC201

## Course Title: Cell Biology

## Academic year 2020-21

**COURSE OUTCOMES:**

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

# DETAILED SYLLABUS

| Course Code | Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 201** | | **CELL BIOLOGY** | **4/60** |
| **I** | | **Cell structure and cytoskeleton** | **15** |
| | **1.1** | **Techniques to study cell and cellular structure.** | 02 |
| | **1.2** | **Cell membrane structure** | 03 |
| | | a) Lipid bilayer<br>b) Membrane proteins<br>c) Spectrins<br>d) Glycophorin<br>e) Multi pass membrane protein<br>f) Bacteriorhodopsin | |
| | **1.3** | **Cytoskeleton** | 05 |
| | | a) Cytoskeletal filaments<br>b) Microtubules<br>c) Actin regulation<br>d) Molecular motors<br>e) Cell behaviour | |
| | **1.4** | **Cell Junctions and cell adhesion** | 05 |
| | | a) Anchoring<br>b) Adherence junctions<br>c) Desmosomes<br>d) Gap junctions<br>e) Cell-cell adhesion<br>f) Cadherins | |
| **II** | | **Membrane Transport and Compartmentalization** | **15** |
| | **2.1** | **Membrane Transport (Revision)** | **05** |
| | | a) Principles of membrane transport<br>i. Ion channels<br>ii. electrical properties of membranes<br>b) Types of diffusion<br>i. Passive Diffusion, and Facilitated Diffusion,<br>ii. Ion channels – Ligand gated and voltage gated channels,<br>c) Active transport – ion pumps (e.g.: Na+-K+ pump) | |
| | **2.2** | **Intracellular Compartments and protein sorting** | **07** |
| | | a) Compartmentalization of cells<br>b) Transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum<br>c) Transport of proteins into mitochondria and chloroplasts | |

| | | | |
|---|---|---|---|
| | **2.3** | **Intracellular vesicular traffic** | **03** |
| | | a) Endocytosis<br>b) Exocytosis<br>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<br>b) Cytokinesis | |
| | **3.2** | **Cell cycle and Programmed cell death** | **03** |
| | | a) Control system<br>b) Intracellular control of cell cycle events<br>c) Apoptosis<br>d) Extracellular control of cell growth and apoptosis | |
| | **3.3** | **Cell communication** | **03** |
| | | a) Extracellular signal molecules<br>b) Nitric oxide gas signal<br>c) Classes of cell-surface receptor proteins | |
| | **3.4** | **Signalling through enzyme linked cell surface receptors** | **04** |
| | | a) Docking sites<br>b) Ras<br>c) MAP kinase<br>d) Pl-3kinase<br>e) TGF | |
| | **3.5** | **Signalling in plants** | **01** |
| | | a) Serine/ Threonine kinases<br>b) Role of ethylene<br>c) Phytochromes | |
| **IV** | | **Developmental Biology** | **15** |
| | **4.1** | **The Process of Development in Animals** | **04** |
| | | a) Evo-Devo: The Study of Evolution and Development<br>b) Meiosis- Oogenesis, spermatogenesis and fertilization<br>c) The Embryonic Cleavage Divisions and Blastula Formation<br>d) Gastrulation and Morphogenesis | |
| | **4.2** | **Genetic Analysis of Development in Model Organisms** | **01** |
| | | a) Genetic Analysis of Development Pathways<br>b) Molecular Analysis of Genes Involved in Development | |
| | **4.3** | **Maternal Gene Activity in Development** | **03** |
| | | Maternal-Effect Genes | |
| | **4.4** | **Development of Drosophila** | **07** |
| | | a) Determination of the Dorsal-Ventral and Anterior-Posterior Axes in Drosophila Embryos<br>b) Zygotic Gene Activity in Development<br>c) Specification of Cell Types | |

| | | | |
|---|---|---|---|
| | | d) Genes of drosophila<br>i. Drosophila signalling genes<br>ii. gradient of nuclear gene regulatory protein<br>iii. Dpp and Sog setup<br>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: RPSMIC2P1 (60 CONTACT HRS)**

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

# Course Code: RPSMIC 202

# Course Title: Microbial Biochemistry-II

# Academic year 2020-21

## COURSE OUTCOMES:

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

# DETAILED SYLLABUS

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

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

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

## REFERENCES:


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


## PRACTICALS: RPSMIC2P2 (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) Purification of an extracellular enzyme by (βamylase) Ion-Exchange chromatography
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) Extraction of protein by precipitation with Acetone
m) Separation of proteins using Polyacrylamide Gel Electrophoresis (PAGE)

# Course Code: RPSMIC 203

# Course Title: Environmental Microbiology

# Academic year 2020-21

**COURSE OUTCOMES:**

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

# DETAILED SYLLABUS

| Course Code | Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 203** | | **ENVIRONMENTAL MICROBIOLOGY** | **04/60** |
| **I** | | **Microbial Ecology** | **15** |
| | **1.1** | **Basic concepts of Microbial Ecology, Sample collection and processing** | **05** |
| | | a) Revision of basic concepts of Microbial Ecology<br>i. Concepts<br>ii. Niche<br>iii. Habitat<br>iv. Ecosystem<br>v. Microbial diversity<br>vi. Interactions between micro-organisms<br>vii. Ecological succession<br>b) Environmental sample collection and processing<br>i. Soils and Sediment<br>ii. Water | |
| | **1.2** | **Techniques for microbial analysis** | **08** |
| | | a) Cultural Methods<br>b) Physiological Methods: Measuring microbial activity in pure culture<br>i. Carbon respiration<br>ii. Stable isotope probing<br>iii. Use of radioisotopes as tracers<br>iv. Adenylate energy charge<br>v. Enzyme assays<br>c) Functional genomics, Metagenomics & Proteomics- based approach<br>d) Immunological methods<br>e) Nucleic acid-based methods<br>f) Recombinant DNA Techniques<br>i. RFLP<br>ii. Denaturing/Temperature gradient<br>iii. Plasmid analysis<br>iv. Reporter genes<br>v. Rep PCR fingerprinting and Microbial diversity | |
| | **1.3** | **Environmental genomics** | **02** |
| | | a) Metagenomics<br>b) Meta-trancriptomics | |

| | | | |
|---|---|---|---|
| | | c) Metaproteomics | |
| **II** | | **Study of Marine Ecosystem & Extremophiles** | **15** |
| | **2.1** | **Marine microbiology** | **03** |
| | | a) Marine and estuarine habitats<br>b) Characterization and stratification of the oceans: Vertical and horizontal zones of marine habitats<br>c) Marine microbes<br>i. Characteristics<br>ii. Distribution<br>iii. Composition & activity<br>d) Marine pathogens | |
| | **2.2** | **Extremophiles** | **08** |
| | | a) Habitat<br>b) Effect of extreme conditions on cellular components<br>c) membrane structure<br>d) nucleic acids<br>e) proteins<br>f) Adaptation mechanism in microorganisms in diverse environments<br>g) Study, Industrial Applications and Biotechnological applications of proteins from:<br>i. Thermophiles<br>ii. Psychrophiles<br>iii. Halophiles<br>iv. Piezophiles<br>v. Acidophiles<br>vi. Alkaliphiles<br>vii. Xerophiles<br>viii. Radiation resistant organisms<br>ix. Methanogens | |
| | **2.3** | **Mechanisms of metal resistance, Metal transformations, Microbial metal remediation** | **02** |
| | **2.4** | **Geomicrobiology** | **02** |
| | | a) Biofouling<br>b) Biocorrosion<br>c) Bioleaching | |
| **III** | | **Soil and Agricultural Microbiology** | **15** |
| | **3.1** | **Soil Microbiology** | **03** |
| | | a) Litho ecosphere<br>i. Soil formation<br>ii. Properties (physical and chemical)<br>b) Soil communities | |
| | **3.2** | **Agricultural microbiology** | **04** |
| | | a) Factors affecting microbial load of soils<br>b) Relationship between plants and microbe's rhizosphere, phyllosphere. | |

| | | | |
|---|---|---|---|
| | | c) Beneficial uses of microorganisms for plant growth and development<br>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,)<br>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<br>i. Carbon<br>ii. Nitrogen<br>iii. Oxygen<br>b) Degradation of complex polymers<br>i. Cellulose<br>ii. Lignin<br>iii. Lignocellulose | |
| **IV** | | **Environmental & natural resources management and safety standards** | **15** |
| | **4.1** | **Environmental Impact Assessment and Sustainable Development** | **02** |
| | **4.2** | **Microbes and global warming** | **02** |
| | | a) Microbial contribution to green-house gases<br>b) Combating Greenhouse effect using microbes<br>c) Concept of carbon credits | |
| | **4.3** | **Solid waste management** | **02** |
| | | a) Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or bio methanation.<br>b) Non-biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling. | |
| | **4.4** | **Hazardous waste management** | **03** |
| | | a) Hazardous waste from paint, pesticides and chemical industries and their composition<br>b) Probable means to reduce waste through Common Effluent Treatment Plants. | |
| | **4.6** | **Biohazards** | **03** |
| | | a) Introduction<br>b) levels of biohazards<br>c) Risk assessment<br>d) Proper cleaning procedures<br>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.<br>b) Overview of national regulations and relevant international agreements.<br>c) Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS) | |

**REFERENCES:**


a) Brock Madigan, Martinko, Dunlap, Clark, "Biology of microorganisms", 12th Ed, Pearson Intl, 2011
b) R. M. Atlas and R. Bartha, "Microbial Ecology - Fundamentals and Applications" Addison Wesley Longman Inc, 1998
c) Johri and Satyanarayana, "Microbial Diversity- Current Perspective and Potential Application", International Pvt. Ltd, New Delhi, India, 2005
d) Fred Rainey, Aharon Oren, "Methods in Microbiology- Extremophiles", Vol 35, Academic press, 2006
e) R.M Maier, I. L. Pepper and C. P. Gerba, "Environmental Microbiology", Academic Press, 2010
f) Rastogi & Sani, "Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment", *Microbes and Microbial Technology*, 2011, pp 29-57,
g) A K Bej and M H Mahbubani, "Applications of the polymerase chain reaction in environmental Microbiology", *Genome Res,* 1992, 1: 151-159
h) Rolf Daniel, "The Metagenomics of soil", Vol 3, Nature reviews, 2005
i) Susannah Green Tringe and Edward M. Rubin, "Metagenomics: DNA sequencing of environmental samples", Volume 6, 2005
j) Colin Munn, "Marine Microbiology: Ecology and Applications", Garland publishing. ISBN: 0815365179
k) G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj, "Agricultural Microbiology", PHI Learning Pvt. Ltd., 2004
l) Iqbal Ahmad, Farah Ahmad, John Pichtel, "Microbes and Microbial Technology: Agricultural and Environmental Applications", Springer, 2011.
m) S. K. Maiti, "Water and Wastewater analysis: Handbook of methods in environmental studies", Volume 1, ABD Publishers, 2004
n) S.K. Maiti, "Soil analysis Handbook of methods in environmental studies", Volume 2, ABD Publishers, 2004
o) H. V. Jadhav, "Environmental management", Vipul Prakashan, 2002
p) R.K. Jain, "Environmental management"
q) M. H. Fulekar, "Industrial hygiene and safety"

r) Medini Duccio et al, “Microbiology in the post-genomic era”, Vol-6, *Nature review* Microbiology, 2008

**PRACTICALS: RPSMIC2P3 (60 CONTACT HRS)**

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

# Course Code: RPSMIC204

# Course Title: Emerging Areas in Biology I

# Academic year 2020-21

**COURSE OUTCOMES:**

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

# DETAILED SYLLABUS

| Course Code | Unit | Course/ Unit Title | Credits/ Lectures |
|---|---|---|---|
| **RPSMIC 204** | | **EMERGING AREAS IN BIOLOGY I** | **04/60** |
| **I** | | **Bioinformatics** | **15** |
| | **1.1** | **Bioinformatics Basics** | **07** |
| | | a) Introduction<br>b) Genome sequencing projects: technologies and impact<br>c) Annotation, Databases and Protein Structures<br>d) Pairwise Alignment, Multiple Alignment, and BLAST | |
| | **1.2** | **Introduction to omics** | **03** |
| | | a) Definitions of proteomics, genomics, transcriptomics<br>b) High dimensional Biology<br>c) The omic experiment | |
| | **1.3** | **Applications of Bioinformatics** | **05** |
| | | a) Primer Design<br>b) Phylogenetic Analysis | |
| **II** | | **Synthetic and systems biology** | **15** |
| | **2.1** | **Synthetic Biology** | **10** |
| | | a) Basic concepts in Engineering Biology<br>b) Parts, Devices and Systems<br>c) Logic gates<br>d) Synthetic Gene Circuits and examples like Oscillators, Toggle Switches | |
| | **2.2** | **Overview of Systems biology** | **05** |
| | | a) Approaches and methodologies,<br>b) Analysis of biological Networks,<br>c) Network Dynamics<br>d) Network Motifs and Functional Modules,<br>e) Dynamical Models<br>f) Artificial Intelligence in Systems Biology | |
| **III** | | **Nanobiotechnology** | **15** |
| | **3.1** | **Synthesis of nanostructures** | **07** |
| | | a) Physical<br>b) Chemical<br>c) Biological<br>d) Microbiological methods | |
| | **3.2** | **Applications of nanomaterials** | **08** |
| | | a) Biomolecules as nanostructures | |

| | | | |
|---|---|---|---|
| | | b) Nanoparticular carrier systems<br>c) Micro and Nanofluidics<br>d) Nano-biosensors<br>e) Drug and gene delivery systems<br>f) Chip technologies<br>g) Nano imaging<br>h) Nanomedicine<br>i) Cancer diagnostics and treatment | |
| **IV** | | **Contemporary tools in Molecular Biotechnology** | **15** |
| | **4.1** | **DNA Sequencing and Physical mapping** | **04** |
| | | a) Dideoxynucleoside method for sequencing of DNA<br>b) Automated DNA sequencing<br>c) High-throughput Sequencing<br>d) Restriction Mapping reference | |
| | **4.2** | **Heterologous protein production in eukaryotic cells** | **03** |
| | | a) *Saccharomyces cerevisiae*<br>b) Pichia pastoris<br>c) Baculovirus- Insect cell<br>d) Mammalian cell | |
| | **4.3** | **Directed Mutagenesis** | **05** |
| | | a) Oligonucleotide directed mutagenesis with plasmid DNA<br>b) PCR amplified oligonucleotide directed mutagenesis<br>c) Random mutagenesis with degenerate oligonucleotide primer<br>d) Random mutagenesis with nucleotide analogues<br>e) Error-prone PCR<br>f) DNA shuffling<br>g) Mutant proteins with unusual amino acids | |
| | **4.4** | **Mapping and quantifying transcriptions** | **02** |
| | | a) S1 mapping<br>b) Primer extension reference<br>c) Run-off transcription<br>d) G-less cassette transcription | |
| | **4.5** | **Measuring protein accumulation in vivo:** | **01** |
| | | a) Assaying DNA –protein interactions<br>b) Foot printing methods<br>c) Chromatin immune-precipitation (ChIP) | |

**REFERENCES:**


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


**PRACTICALS: RPSMIC 2P4 (60 CONTACT HRS.)**

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

# Modality of Assessment:

## I) Theory Examination Pattern:

### A) Internal Assessment- 40%- 40 Marks

| Sr No | Evaluation type | Marks |
|---|---|---|
| 1 | One Review writing/ Review paper presentation/Research paper presentation 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 |
|---|---|---|---|---|
| **Viva** | 05 | 05 | 10 | - |
| **Quiz** | - | 10 | - | - |
| **Laboratory work** | 25 | 35 | 40 | 20 |
| **Proposal Writing** | - | - | - | 30 |
| **Research Proposal Presentation** | 20 | - | - | |
| **Total** | **50** | **50** | **50** | **50** |

**Journal**

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

**Research Proposal writing**

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

### Overall Examination and Marks Distribution Pattern

### Semester II

| Course | 201 | | | 202 | | | 203 | | | 204 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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** |

**Semester End Examination: (Deviation from the usual modality)**

**Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.**