AC/II (21-22).2.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

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

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

PROGRAM SPECIFIC OUTCOMES

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

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

	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

	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

		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 301

Course Title: Virology

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

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

	2.4	Citrus Tristeza Virus (CTV): Viral structure, Genome, 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**

REFERENCES:

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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.

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

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

i) Aditi, M. Shariff, “Nipah virus infection: a review”, *Epidemiology and infection*, 2019, (95):147.
j) Raj K Singh *et al*, “Nipah virus: epidemiology, pathology, immunobiology and advances in diagnosis, vaccine designing and control strategies – a comprehensive review”, *Veterinary Quarterly*, 2019, (39): 26-55
k) Shamimul H *et al*, “Ebola virus: A global public health menace: A narrative review”, *Journal of Family Medicine and Primary Care*, 2019, 8(7): 2189–2201.
l) Denis M *et al*, “Ebola virus disease”, *The Lancet*, 2019, (393):936-948
m) Yan-Rong Guo *et al*, “The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status”, *Military Medical Research*, 2020, (7) 11
n) Xiaowei L *et al*, “Molecular immune pathogenesis and diagnosis of COVID-19”, *Journal of Pharmaceutical Analysis*, 2020
o) Hussain A Rathod *et al*, “The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak”, *Journal of Autoimmunity*, 2020, (109): 102433

PRACTICALS: RPSMIC 3P1 (60 CONTACT HRS)

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

Course Code: RPSMIC 302

Course Title: Immunology

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

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

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

REFERENCES:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PRACTICALS RPSMIC 3P2 (60 Contact Hrs)

a) Phagocytosis & Phagocytic index

b) Collection of human blood & separation of mononuclear cells by Ficoll Hypaque density gradient centrifugation,

c) Counting of viable cells by trypan blue

d) Separation of T and B cells

e) Rocket immunoelectrophoresis

f) SRID

g) Demonstration of Flow cytometry

h) Assignment on modern vaccines

Course Code: RPSMIC 303

Course Title: Food and water Microbiology

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

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

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

REFERENCES:

a) Bibek Ray and Arun Bhunia, "Fundamental Food Microbiology", 4th Ed. CRC Press, 2008
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c) Adams M R and Moss M O, "Food Microbiology", 3rd Ed. RSC Publishing. 2008
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f) Elmer H Marth, James Steele, "Applied Dairy Microbiology", 2nd Ed. CRC Press, 2001
g) Pressman P., Clemens R., Hayes W., & Reddy, "Food additive safety", Toxicology Research and Application, 2017, 1, 239784731772357. doi:10.1177/2397847317723572
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i) Guidelines For Drinking-Water Quality WHO 2008
j) Rosenberg, F. A., "The microbiology of bottled water", Clinical Microbiology Newsletter, 2003, 25(6), 41–44. doi:10.1016/s0196-4399(03)80019-3
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l) Damikouka, I., Katsiri, A., & Tzia, C., "Application of HACCP principles in drinking water treatment", Desalination, 2007, 210(1-3), 138-145. doi:10.1016/j.desal.2006.05.039
m) Pooi, C. K., & Ng, H. Y. (2018). Review of low-cost point-of-use water treatment systems for developing communities. Npj Clean Water, 1(1). doi:10.1038/s41545-018-0011-0

PRACTICALS: RPSMIC3P3 (60 CONTACT HRS)

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

Course Code: RPSMIC 304

Course Title: Tools and Techniques: Biomolecular analysis

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the principles of various spectroscopic methods
CO 2	Attribute various applications in biological sciences to the appropriate chromatographic technique
CO 3	Summarize principle and applications of variants of PCR technique
CO 4	Recall the basics of electrophoresis technique and apply it to study recent advances of the technique
CO 5	Explain the use of microscopic and diffraction techniques to study nanostructures
CO 6	Summarize methods other than microscopy and diffraction to study nanomaterials
CO 7	Implement the knowledge of various techniques to carryout research project

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 304		**TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS**	**4/60**
I		**Spectroscopic Techniques** Principle and applications of:	**15**
	1.1	**UV-visible spectroscopy**	**02**
	1.2	**IR spectroscopy**	**02**
	1.3	**Atomic Absorption Spectroscopy**	**02**
	1.4	**Raman Spectroscopy**	**02**
	1.5	**Mass spectroscopy**	**05**
	1.6	**Circular Dichroism Spectroscopy**	**02**
II		**Chromatographic Techniques**	**15**
	2.1	**Gas Chromatography**	**05**
		a) Principle b) Instrumentation c) Operation d) Calibration e) Accuracy f) Applications	
	2.2	**High Performance Liquid Chromatography**	**05**
		a) Principles b) Instrumentation c) Operation d) Calibration, e) Accuracy f) Applications	
	2.3	**High Performance Thin Layer Chromatography**	**02**
		a) Theory of TLC b) HPTLC: Development, data and results c) Applications	
	2.4	**Hyphenated techniques**	**03**
		a) Principle b) LC-MS c) GC-MS	
III		**Molecular Biology Techniques**	**15**
	3.1	**Variations/ Modifications of PCR**	**05**
		a) Hot- Start PCR, b) Multiplex PCR, c) Nested PCR, d) RT-PCR, e) Broad Range PCR,	

		f) Arbitrarily primed PCR, g) Quantitative PCR, h) Real time PCR i) Touchdown PCR j) Colony PCR k) Digital PCR –Droplet l) Loop mediated isothermal amplification	
	3.2	**Hybridization array technology**	**05**
		a) Applications of microarrays in microbiology, b) Microarray platform technologies (oligonucleotide microarrays, cDNA microarrays)	
	3.3	**Electrophoresis**	**05**
		a) 2D- Gel Electrophoresis b) Capillary Electrophoresis	
IV		**Microscopy and Nanotechnological Techniques**	**15**
	4.1	**Microscopy**	**09**
		a) Scanning Probe Microscopes – i. Scanning tunneling microscope (STM) ii. Atomic force microscope (AFM) b) Electron Microscopy: i. Scanning Electron Microscopy ii. Transmission Electron Microscopy c) Confocal Microscopy	
	4.2	**Diffraction Techniques- X Ray Diffraction**	**02**
	4.3	**Other methods**	**04**
		a) Dynamic Light Scattering b) Zeta Potential c) Zeta Sizer d) SPR	

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PRACTICALS: RPSMIC3P4 (60 CONTACT HRS)

a) Research project and Dissertation

b) Research poster presentation

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	40

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

1. Duration- These examinations shall be of **two hours and thirty minutes**.
2. Theory question paper pattern-
   a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.
   b. All questions shall be compulsory with internal choice within the questions.

Paper pattern:

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	Unit 1
Q.2)	Any 2 out of 3	12	Unit 2
Q.3)	Any 2 out of 3	12	Unit 3
Q.4)	Any 2 out of 3	12	Unit 4
Q.5) a)	Any 4 out of 6	04	All four units
Q.5) b)	Any 4 out of 6	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

II) Practical Examination Pattern

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

Journal

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

Research project work

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

Overall Examination and Marks Distribution Pattern

Semester III

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

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: RPSMIC 401
Course Title: Pharmaceutical Microbiology

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

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

	3.3	Antimicrobial preservation efficacy and microbial content testing	**06**
	3.4	Preservation of cosmetics	**04**
		A. Preservation strategy B. Antimicrobial mechanisms of selected preservatives and the bacterial response	
IV		**Drug Discovery and Pharmacology**	**15**
	4.1	Modern Methods of Drug Discovery	**02**
	4.2	Proteomics	**02**
	4.3	Bioinformatics	**02**
	4.4	High throughput screening technology	**02**
	4.5	Natural products for lead identification	**02**
	4.6	The role of protein 3D structures in the drug discovery process	**03**
	4.7	Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics	**02**

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

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

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

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PRACTICAL: RPSMIC4P1 (60 CONTACT HRS)

a) Sterility testing and reporting (as per Pharmacopia)

b) Preparation of cosmetic product and its stability study

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

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

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

Course Code: RPSMIC402

Course Title: Advances in Biotechnology

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSMIC 402		**ADVANCES IN BIOTECHNOLOGY**	**04/60**
I		**Medical Biotechnology**	**15**
	1.1	**Diagnostics & therapeutic approach for Genetic disorders**	**07**
		a. Pre- natal diagnosis- Sample collection, processing, Advantages, disadvantages 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**	**02**
		a. An overview of Fungi and fungal activities b. Fungal growth and Fungal nutrition c. Mycology: A Neglected Megascience	
	2.2	**Genetics of Fungus**	**02**
		a. Fungal Genetics b. Fungal Genomics	
	2.3	**Fungal Pigments**	**03**
		a. Genetic basis of pigment production b. Factors affecting pigment production c. Fermentation for pigment synthesis d. Mycotoxins and their replacement e. Relevance of pigments in various fields	

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

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

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a) Jogdand S. N., Medical Biotechnology, 2008, Himalaya Publishing House.

b) Judit Pongracz, Mary Keen, Medical Biotechnology, 2009, Churchill Livingstone, Elsevier.

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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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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.

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

v) Ajit Avasthi, Abhishek Ghosh, Sidharth Sarkar, Sandeep Grover, “Ethics in medical research: General principles with special reference to psychiatry research”, 2013, Indian Journal of Psychiatry 55(1).
w) The Protection Of Traditional Knowledge, Genetic Resources And Expressions Of Folklore Act, 2016, WIPO.

PRACTICAL: RPSMIC 4P2 (60 CONTACT HRS)

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

Course Code: RPSMIC403

Course Title: Emerging areas in Biology II

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

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

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

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

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

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

o) Industrial Biocatalysis, (2015) Edited by Peter Grunwald, Pan Standard Publishing, CRC Press Taylor & Francis Group

p) Glick, Jack J. Pasternak, “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, ASM Press, 2010

PRACTICALS: RPSMIC3P3 (60 CONTACT HRS):

a) Case Studies of epidemiological strategies

b) Internship presentation

Course Code: RPSMIC 404

Course Title: Internship

Academic year 2020-21

COURSE OUTCOMES:

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

DETAILED SYLLABUS

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

PRACTICALS: RPSMIC4P4 (60 CONTACT HRS)

Internship report

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	40

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

1. Duration- These examinations shall be of **two hours and thirty minutes**.
2. Theory question paper pattern-
   a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.
   b. All questions shall be compulsory with internal choice within the questions.

Paper pattern:

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	Unit 1
Q.2)	Any 2 out of 3	12	Unit 2
Q.3)	Any 2 out of 3	12	Unit 3
Q.4)	Any 2 out of 3	12	Unit 4
Q.5) a)	Any 4 out of 6	04	All four units
Q.5) b)	Any 4 out of 6	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

Theory Examination Pattern- RPSMIC 404:

Internship evaluation by guide/ mentor- 60 marks

Internship report evaluation by internal faculty- 40 marks

II) Practical Examination Pattern

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

Journal

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

Internship Report

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

Overall Examination and Marks Distribution Pattern

Semester IV

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

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.
