VIKRAMA SIMHAPURI UNIVERSITY
NELLORE

DEPARTMENT OF MICROBIOLOGY

M.Sc. MICROBIOLOGY

(2-Year Programme under Choice-Based Credit System)

PROGRAMME STRUCTURE, SYLLABUS AND EXAMINATION

(***Regulations-2020; Effective from the Academic Year 2020-21***)

VIKRAMA SIMHAPURI UNIVERSITY::NELLORE

DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

DEPARTMENT OF MICROBIOLOGY

VISION OF THE DEPARTMENT

To be a Centre of Excellence in basic and applied research and training young minds in the fieldof Microbiology.

MISSION OF THE DEPARTMENT

- To provide a platform for education of global standards in Microbiology using advanced methods and techniques.
- To carry out discovery-oriented research of international standards towards microbialproduct development.
- To establish academic and research collaborations with the industries and healthcareinstitutions at both national and international levels.
- To produce entrepreneurs and human resources for microbiology industries and centres.

PROGRAM OBJECTIVES

The aim of M.Sc. Microbiology (2-Year Programme) is to provide a broad overview of microbiology, and thus produce graduates withsufficient knowledge and expertise to apply them in basic microbial science research and teaching.

The program has following specific objectives:

1. To provide an intensive and in-depth knowledge to the students in diverse areas of basic microbiology,
2. To impart knowledge and skills necessary to generate recombinant DNA and genetically engineeredmicroorganisms,
3. To provide bioinformatics skills for microbial sequence data mining,
4. To train the students to take up wide variety of roles like researchers, scientists, and academicians, and
5. To provide the students hands on training for the technical review and literature search for designingresearch problems.

PROGRAM OUTCOMES (POs)

PO-1	**Knowledge Gaining:** Demonstrate comprehensive knowledge and skills in the fields of microbiology.
PO-2	**Computational Microbiology:** Apply computational modelling of proteins, drug

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	design and simulations to test the models and solve scientific problem.
PO-3	**Experimental Abilities:** Hypothesis testing, experimental designing, interpretation of the data to solve various problems in different areas of microbiology.
PO-4	**Scientific Communication:** Demonstrate communication skills, scientific writing and data recording abilities in all the fields of microbiology.
PO-5	**Ethical Awareness:** Demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animals handling, intellectual property rights, biosafety and handling of sensitive experiments; awareness about the difference between data beautification and data manipulation/scientific misconduct.
PO-6	**Collaboration & Teamwork:** Demonstrate the ability to work on research projects and assignments in the teams of students coming from different academic disciplines, diverse cultures and ethnicities.
PO-7	**Self-learning & Life-long Learning:** Demonstrate conceptual learning through systematic thinking and self-study and life-long learning that helps to solve scientific problems with well-defined solutions.
PO-8	**Leadership Qualities:** Demonstrate the ability to take initiative, set direction, design strategy, and build social cohesion not only in research labs but also in social contexts. Can independently carry out a complete scientific work process, including the theoretical background, hypotheses generation, collecting and analyzing data as along with the interpretation of results and their presentation.
PO-9	**Research Skills:** Demonstrate the ability to sense the scientific and technological trends in different academic and industry settings, identify the pertinent questions to be addressed, build hypotheses, and design experimental strategies to solve the scientific problems. Demonstrate the ability to use state-of-the-art digital tools and software to collect up-to-date literature and to mine the data, procure, analyze and present the data.
PO-10	**Emerging & Advanced Fields:** Aware of recent scientific updates, emerging and advanced technologies for quality work and to fulfill the need of the hour throughout life. Understands the role of microbiology in society, health related issues, environmental concerns and cultural problems through scientific interventions.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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PSO-1	Students will be able to demonstrate, apply their knowledge and find innovative solutions to solve the problems in the areas of microbiology, biochemistry, analytical techniques, genetics, biosafety, bioethics, intellectual property rights andentrepreneurship.This experience would enable students to familiarize with basic laboratory instruments and understand the principles of various protocols.
PSO-2	Students will be able to demonstrate and apply the principles of advanced methodologies by adopting emerging technologies in molecular biology, microbial physiology, metabolism, immunology, genetic engineering, bioinformatics, biostatistics and OMICS.
PSO-3	Students will be able to gain fundamental knowledge, understand various facets of procedures and their applications in the elective areas of microbiology including agricultural, food, dairy, environmental, marine, pharmaceutical and medical microbiology and microbial technology.
PSO-4	Students will be able to acquire knowledge in the research-oriented specialized areas including (a) emerging infectious diseases, (b) herbal and tissue culture technology, (c) molecular diagnostics, (d) probiotics, prebiotics and feed technology, (e) molecular phylogeny and nutraceuticals of marine sources, (f) translational research in animal sciences, and (g) molecular drug discovery and development.
PSO-5	Students will be equipped to understand three fundamental aspects in microbiological phenomenon: a) what to seek; b) how to seek; c) why to seek?Students will acquire life skills, innovative thinking, planning and setting-up of small-scale microbiology laboratories and industries by exploring, developing and gaining hands on experience in skill-oriented activities such as (a) research methodologies and scientific communication skills in microbiology, (b) submission of educational tour report, (c) delivering seminar in advances of microbiology, (d) analyzing the landmark discoveries critically in journal club, and (e) preparation of project poster and dissertation. This experience would enable them to begin a career in industry as well as in research laboratories conducting fundamental research.

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M.Sc. MICROBIOLOGY

(2-Year Programme under CBCS)

Yellow Colour: New Courses
Pink Colour: Revision of Syllabus

PROGRAMME STRUCTURE, SYLLABUS AND EXAMINATION

(Regulations 2020-21; Effective from the Academic Year 2020-21)

Course Type	Course Code	Title of the Course	Core / Elective	Hours per Week	Credits	Examination			
						Internal	External	Max. Marks	Duration (Hours)
FIRST SEMESTER									
THEORY	20RMB T-101	GENERAL MICROBIOLOGY	CC	4	4	30	70	100	3
	20RMB T-102	MICROBIAL GENETICS	CC	4	4	30	70	100	3
	20RMB T-103	BIOLOGICAL CHEMISTRY	CC	4	4	30	70	100	3
	20RMB T-104	ANALYTICAL TECHNIQUES IN BIOLOGY	CC	4	4	30	70	100	3
	20RBT T-105	INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY & BIOETHICS	GC	4	4	30	70	100	3
	20RMB P-101	GENERAL MICROBIOLOGY	CC	6	2	0	50	50	4

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PRACTICAL	20RMB P-102	MICROBIAL GENETICS	CC	6	2	0	50	50	4
	20RMB P-103	BIOLOGICAL CHEMISTRY	CC	6	2	0	50	50	4
	20RMB P-104	ANALYTICAL TECHNIQUES IN BIOLOGY	CC	6	2	0	50	50	4
		Total		**44**	**28**	**150**	**550**	**700**	**31**

CC: CORE COURSE
GC: GENERIC COURSE

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PROGRAMME STRUCTURE, SYLLABUS AND EXAMINATION

(Regulations 2020-21; Effective from the Academic Year 2020-21)

Course Type	Course Code	Title of the Course	Core / Elective	Hours per Week	Credits	Examination			
						Internal	External	Max. Marks	Duration (Hours)
SECOND SEMESTER									
THEORY	20RMB T-201	MICROBIAL PHYSIOLOGY & METABOLISM	CC	4	4	30	70	100	3
	20RMB T-202	MOLECULAR BIOLOGY	CC	4	4	30	70	100	3
	20RMB T-203	BIOSTATISTICS & BIOINFORMATICS	CC	4	4	30	70	100	3
	20RMB T-204	IMMUNOLOGY	CC	4	4	30	70	100	3
	20RMB T-205	BIOENTERPRENEURSHIP	GC	4	4	30	70	100	3
PRACTIAL	20RMB P-201	MICROBIAL PHYSIOLOGY & METABOLISM	CC	6	2	0	50	50	4
	20RMB P-202	MOLECULAR BIOLOGY	CC	6	2	0	50	50	4
	20RMB P-203	BIOSTATISTICS & BIOINFORMATICS	CC	6	2	0	50	50	4
	20RMB P-204	IMMUNOLOGY	CC	6	2	0	50	50	4
		Total		**46**	**28**	**180**	**620**	**700**	**31**

CC: CORE COURSE
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PROGRAMME STRUCTURE, SYLLABUS AND EXAMINATION

(Regulations 2020-21; Effective from the Academic Year 2021-22)

Course Type	Course Code	Title of the Course	Core / Elective	Hours per Week	Credits	Examination			
						Internal	External	Max. Marks	Duration (Hours)
THIRD SEMESTER									
THEORY	20RMB T-301	GENETIC ENGINEERING	CC	4	4	30	70	100	3
	20RMB T-302	'OMICS' MICROBIOLOGY	CC	4	4	30	70	100	3
	20RMB T-303A	INDUSTRIAL MICROBIOLOGY & BIOPROCESSING (*Elective-1*)	DCC	4	4	30	70	100	3
	20RMB T-303B	DAIRY MICROBIOLOGY (*Elective-1*)							
	20RMB T-304A	AGRICULTURAL MICROBIOLOGY (*Elective-2*)	DCC	4	4	30	70	100	3
	20RMB T-304B	FOOD MICROBIOLOGY (*Elective-2*)							
	20RBT T-305	EMERGING TECHNOLOGIES IN BIOLOGY	GC	4	4	30	70	100	3
	20RMB P-301	GENETIC ENGINEERING	CC	6	2	0	50	50	4

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PRACTIAL	20RMB P-302	'OMICS' MICROBIOLOGY	CC	6	2	0	50	50	4
	20RMB P-303A	INDUSTRIAL MICROBIOLOGY & BIOPROCESSING (*Elective-1*)	DCC	6	2	0	50	50	4
	20RMB P-303B	DAIRY MICROBIOLOGY (*Elective-1*)							
	20RMB P-304A	AGRICULTURAL MICROBIOLOGY (*Elective-2*)	DCC	6	2	0	50	50	4
	20RMB P-304B	FOOD MICROBIOLOGY (*Elective-2*)							
		Total		**44**	**28**	**150**	**550**	**700**	**31**

CC: CORE COURSE
GC: GENERIC COURSE
DCC: DISCIPLINE CENTRIC COURSE
Elective-1: Students must select one course from two electives (i.e. MB T-303A or MB T-303B)
Elective-2: Students must select one course from two electives (i.e. MB T-304A or MB T-304B)

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M.Sc. MICROBIOLOGY

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PROGRAMME STRUCTURE, SYLLABUS AND EXAMINATION

(Regulations 2020-21; Effective from the Academic Year 2021-22)

Course Type	Course Code	Title of the Course	Core / Elective	Hours per Week	Credits	Examination			
						Internal	External	Max. Marks	Duration (Hours)
FOURTH SEMESTER									
THEORY	20RMB T-401A	ENVIRONMENTAL MICROBIOLOGY (*Elective-3*)	DCC	4	4	30	70	100	3
	20RMB T-401B	MARINE MICROBIOLOGY (*Elective-3*)							
	20RMB T-402A	PHARMACEUTICAL MICROBIOLOGY (*Elective-4*)	DCC	4	4	30	70	100	3
	20RMB T-402B	MEDICAL MICROBIOLOGY (*Elective-4*)							
	20RBT T-EE403	RESEARCH METHODOLOGY & SCIENTIFIC COMMUNICATION SKILLS IN BIOLOGY	GC	4	4	30	70	100	3
	20RMB T-404A	EMERGING INFECTIOUS DISEASES	Research Oriented Specialization	4	4	30	70	100	3
	20RMB T-404B	HERBAL & TISSUE CULTURE TECHNOLOGY							
	20RMB T-404C	MOLECULAR DIAGNOSTICS							

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	20RMB T-404D	PROBIOTICS, PREBIOTICS & FEED TECHNOLOGY							
	20RMB T-404E	MOLECULAR PHYLOGENY & NUTRACEUTICALS OF MARINE SOURCES							
	20RMB T-404F	TRANSLATIONAL RESEARCH IN ANIMAL SCIENCES							
	20RMB T-404G	MOLECULAR DRUG DISCOVERY & DEVELOPMENT							
PRACTICAL	20RMB P-401A	ENVIRONMENTAL MICROBIOLOGY (*Elective-3*)	DCC	6	2		50	50	4
	20RMB P-401B	MARINE MICROBIOLOGY (*Elective-3*)							
	20RMB P-402A	PHARMACEUTICAL MICROBIOLOGY (*Elective-4*)	DCC	6	2		50	50	4
	20RMB P-402B	MEDICAL MICROBIOLOGY (*Elective-4*)							
SKILL ENHANCEMENT ACTIVITY	20RMB SEA-1	EDUCATIONAL TOUR	REPORT		1	25		25	HOD
	20RMB SEA-2	GRAND SEMINAR IN ADVANCES OF MICROBIOLOGY	SEMINAR	4	1	25		25	All Internal Faculty
	20RMB SEA-3	CRITICAL ANALYSIS OF LANDMARK DISCOVERIES	JOURNAL CLUB	4	1	25		25	Mentor
	20RMB SEA-4	POSTER PRESENTATION	POSTER	4	1	25		25	All Internal Faculty
	20RMB SEA-5	DISSERTATION	PROJECT		4		100	100	External Examiner

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TOTAL	**44**	**28**	**220**	**480**	**700**	**20**

CC: CORE COURSE
GC: GENERIC COURSE
DCC: DISCIPLINE CENTRIC COURSE-ELECTIVE
Elective-3: Students must select one course from two electives (i.e. MB T-401A or MB T-401B)
Elective-4: Students must select one course from two electives (i.e. MB T-402A or MB T-402B)
Specialization: Students must select one course from the group of Specialization courses (i.e. MB T-404A - MB T-404G)

Course Instructors and Mentors for Specialisations and Skill Enhancement Activities:
MB T-404A: Emerging Infectious Diseases - Dr. G. Vijaya Ananda Kumar Babu, Professor of Biotechnology
MB T-404B: Herbal & Tissue Culture Technology - Dr. C. Kiranmai, Assistant Professor of Biotechnology
MB T-404C: Molecular Diagnostics - Dr. Uday Sankar Allam, Assistant Professor of Biotechnology
MB T-404D: Probiotics, Prebiotics & Feed Technology - Dr. G. Mary Sandeepa, Assistant Professor of Biotechnology
MB T-404E: Molecular Phylogeny & Nutraceuticals of Marine Sources - Dr. K.V.L. Shrikanya Rao, Assistant Professor of Biotechnology
MB T-404F: Translational Research in Animal Sciences - Dr. S.B. Sainath, Assistant Professor of Biotechnology
MB T-404G: Molecular Drug Discovery & Development - Dr. Vidya Prabhakar Kodali, Assistant Professor of Biotechnology

20RMB T–101: GENERAL MICROBIOLOGY

SEMESTER-I	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to introduce the field of microbiology with special emphasis on microbial diversity, morphology, nutrition and methods for control of microbes.

Course Outcomes (COs): After completion of this course successfully, the students will be able to…..

1. Explain the historical discoveries made in the field of microbiology and the evolution of microbiology including virology,
2. Apply the knowledge of techniques for isolation and cultivation of microorganisms (algae, fungi, bacteria and virus),
3. Explain the diversity of bacteria, classification and identification with knowledge of general characters of various bacterial phyla,
4. Discuss the insights into the cellular composition of bacteria and viruses, and
5. Give the overview of virus replication strategies, sub-genomic RNAs, Virusoids, Viroids and Prions.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2		2				2
CO-2	3		3	3	3	2	3	2	2		2				2
CO-3	3		3	3	3	2	3	2	2		2				2
CO-4	3		3	3	3	2	3	2	2		2				2
CO-5	3		3	3	3	2	3	2	2		2				2

UNIT-I: GROUPS OF MICROORGANISMS

Historical development of Microbiology – Spontaneous generation, germ theory of disease. General characteristics of different groups of microorganisms. Outline Classification of bacteria as per Bergey's Manual of Systematic Bacteriology. Classification of bacteria – Numerical taxonomy, Chemotaxonomy, Nucleic acid-based, and 16S RNA-based classification. Fatty acid profile and cell wall composition in classification of bacteria. Ecological groupings of bacteria – Based on nutritional requirements, energy derivation, temperature and pH requirement, and salt tolerance.

UNIT-II: CULTURING OF MICROORGANISMS

Isolation of microorganisms – Serial dilution to extinction in liquid medium and streaking/spreading on solid medium. Other methods for isolating bacteria and fungi from soil and water. Replica-plating techniques for isolation of mutants. Identification of isolated microorganisms and automated identification. Culturing of microorganisms: Solid culturing techniques – Solidifying agents, gel surface culture, membrane surface culture, liquid culturing technique. Culture preservation: Methods for maintenance and preservation of microbial cultures: Short-term methods – Subculturing, glycerol stocks, storage at low temperature. Long-term methods – Freeze-drying, ultra-freezing, cryoprotective agents. Revival of stored cultures.

UNIT-III: STRUCTURE OF MICROORGANISMS

Microbial growth – Growth curves: S-shaped and J-shaped growth curves, growth rate and generation time. Growth measurement: Direct count, colony counts, most-probable numbers, biomass measurements, light scattering (turbidometry, nephelometry). Ultrastructure of a bacterial cell – An account of variant (capsule, flagellum, pilus, plasmids, endospore) and

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invariant (cell wall, cell membrane, mesosomes, nucleoid, ribosome) components of bacterial cell. Chemotaxis and Quorum sensing in bacteria. Biology of *Agrobacterium tumefaciens, Escherichia coli, Saccharomyces cerevisiae*, *Aspergillus* sp. and *Streptomyces* sp.

UNIT-IV: CLASSIFICATION OF VIRUSES

Introduction to virology. Physical, biological, and biochemical properties. Nomenclature and outline classification of viruses. Methods of cultivation, purification and assay of plant, animal and microbial viruses. Ultrastructure, genome organization and replication of viruses – TMV, Cauliflower mosaic virus, SV40, HIV, ØX 174, T4, lambda phage, M13. Biology of subviral agents – Viroids, prions, satellite viruses, defective interfering particles.

Recommended Books & References:

1. An Introduction to Microbiology by Tauro, Kapoor and Yadav.1986. New Age International.
2. An Introduction to Viruses (2nd edition) by Biswas and Biswas.1984. Vani Educational Books.
3. Bacteriology by Humphries.1974. Murray.
4. Basic Microbiology by Volk and Wheeler.1984. Harper & Row.
5. Bergey's Manual of Systematic Bacteriology (9th edition) volumes I to IV. 2005. Springer.
6. Brock's Biology of Microorganisms (9th edition) by Madigan, Martinko and Parker. 2000. Prentice Hall.
7. Fundamental Principles of Bacteriology by Salle.1984. Tata-McGraw-Hill Education.
8. General Virology by Luria, Darnell, Baltimore and Campbell.
9. Introduction to Microbiology by Ross.1986. Addison-Wesley Educational Publishers, Incorporated.
10. Introduction to Modern Virology (4th edition) by Dimmock and Primrose.1980. Blackwell.
11. Introduction to Virology by Smith and Ritche.1980. Chapman and Hall.
12. Matthews' Plant Virology by R.Hull.2006. Academic Press.
13. Methods for General and Molecular Bacteriology (2nd edition) by Gerhardt (Editor–in-Chief) American Society for Microbiology.
14. Microbiology (5th edition) Pelczar, Chan and Krieg.1993. Tata McGraw-Hill Education.
15. Microbiology: A laboratory manual by Cappuccino and Sherman. Pearson Education India.
16. Plant Viruses. M.V. Nayudu, 2006, Prentice Hall.

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20RMB T–102: MICROBIAL GENETICS

SEMESTER-I	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to take students through basics of genetics, and classical genetics covering prokaryotic/phage to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of recombination, gene transfer and genetic mapping in prokaryotes and eukaryotes.

Course Outcomes (COs): On successful completion of this course, students will be able to…..

1. Understand the basics of genetics and classical genetics of prokaryotic and eukaryotic organisms, and to describe fundamental molecular principles of genetics,
2. Understand the relationship between phenotype and genotype in bacteria,
3. Explain the organization of genetic material and chromosomes in both prokaryotic and eukaryotic organisms,
4. Understand the processes of recombination and gene transfer, and to describe the basics of genetic mapping and mutagenesis, and
5. Understand how gene expression is regulated.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2		2				2
CO-2	3		3	3	3	2	3	2	2		2				2
CO-3	3		3	3	3	2	3	2	2		2				2
CO-4	3		3	3	3	2	3	2	2		2				2
CO-5	3		3	3	3	2	3	2	2		2				2

UNIT-I: GENETIC MATERIAL

Genetic notations, conventions and terminology. Diversity in eukaryotic and prokaryotic genomes. Comparison of *E. coli* and human genome. Organization of DNA in a metaphase chromosome. Mitochondrial and chloroplast genomes. Concept of gene structure – Classical geneticist view to modern concept. Experimental evidences for colinearity of the gene and its product. Genetic material – DNA and RNA. Organization of histone genes, rRNA and tRNA genes in prokaryotes and eukaryotes. Constitutive genes, overlapping genes, split genes, regulatory genes, luxury genes, oncogenes and tumour suppressor genes.

UNIT-II: RECOMBINATION

Genetic recombination – Types of recombination: homologous, reciprocal and nonreciprocal, site-specific and illegitimate. Different models for mechanism of homologous recombination. Molecular mechanism of site-specific recombination. Coefficient of coincidence of double crosses, chiasma interference. Plasmids – Types, properties, functions, detection, amplification, incompatibility and isolation of plasmids. Episomes. Replication and transfer of F plasmid. Transposable elements – Insertion sequences, types of bacterial transposons, Spm and dSpm in maize, Ty elements of yeast, P and Copia elements of *Drosophila*. Mechanism of transposition. Relevance/importance of transposable elements.

UNIT-III: GENE TRANSFER

Modes of gene transfer in bacteria: Transformation – Discovery, and molecular mechanism of natural transformation and recombination. *In vitro* transformation – Cold $CaCl_2$ technique, electroporation and triparental mating. Transduction – Discovery, types of transduction: generalized, specialized, abortive, co-transduction. Mechanism for the development of

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defective virus particles (λdg and λpbio) during specialized transduction. Conjugation – Discovery of sex in bacteria. Development of Hfr strains. $F^+ \times F^-$, Hfr × F^- and F' × F^- (sexduction) crosses and their significance.

UNIT-IV: GENETIC MAPPING

Genetic mapping – Map units, mapping by recombination analysis and mapping of circular chromosomes. Mapping of bacterial chromosome by interrupted mating and transduction. Recombination in bacteriophages. Genetics of yeast and *Neurospora*. Benzer's studies on r-II locus of T4 bacteriophage to establish the units recon, muton and cistron. Eukaryotic viral genetics – Recombination, reassortment, genetic drift and shift, transcapsidation.

Mutagenesis – Mutagens (physical, chemical and biological), types of mutations, molecular mechanism of mutation. Isolation and analysis of mutants. Site-directed mutagenesis, transposon mutagenesis and their applications.

Recommended Books & References:

1. Chromosome Techniques: Theory and Practice. Sharma, A.K and A. Sharma. 1980. Butterworth.
2. Molecular Biology. Freifelder, D. 1990. Narosa Publication House, New Delhi
3. Principles of Genetics. Gardner, E.J and D.P. Snustad. 1996. John Willey, New York.
4. Genetics. Sambamurthy, A.V.S.S. 1999. Narosa Publishing House, New Delhi.
5. Principles of Genetics. Sinnot, E.W., L.C Dunn and T. Dobzhansky 1958. McGraw Hill, New York.
6. Theory and Problems in Genetics. Stansfield, W.D. 1991. McGraw Hill, New York.
7. Genetics. Strickberger, M.W. 1996. 3rd Edn. McMillan, New York.
8. Genetics. Winchester, A.M. 1967. Oxford and IBH., New Delhi.
9. Microbial Genetics. Maloy, S.R., J.E. Cronan and D. Freifelder. 1994. Jones and Bartlett Publishers, UK.
10. Genetics – A Conceptual Approach. Pierce, B. A.2006. 2nd Edn. W.H.Freeman and Company, New York.
11. Principles of Genetics. Gardner, E. J., M. J. Simmons and D. P. Snustad. 2004. 8th Edn. John Wiley and Sons, New York.
12. Genetics – A molecular approach. Russell, P.J. 2006. Pearson Education, USA.
13. Genetics analysis of Genes and Genomes. Hartl, D.L and E.W.Jones. 2001. 5th Edn. Jones and Bartlett Publishers, London.
14. Bacterial and Bacteriophage genetics, 4th Ed.2000.E.A.Birge, Springer publication.
15. Microbial genetics.1995. David Freifelder. Narosa Public. House.

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20RMB T–103: BIOLOGICAL CHEMISTRY

SEMESTER-I	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: This course is aimed to introduce the knowledge about structures and properties of biomolecules and their role in metabolic pathways.

Course Outcomes (COs): Upon successful completion of the course, the student will be able to…..

1. Explain the chemical basis of life, properties of biomolecules in water, the importance of pH, and biomolecular hierarchy,
2. Be able to explain the importance and classification of carbohydrates in biological systems,
3. Understand the structure and functions of amino acids, peptides and proteins, and to describe structural and functional relationships of model proteins,
4. Explain the physical and chemical properties of lipids and fatty acids, and
5. Distinguish between the structure and function of nucleic acids and discuss DNA as the genetic material.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2		2				2
CO-2	3		3	3	3	2	3	2	2		2				2
CO-3	3		3	3	3	2	3	2	2		2				2
CO-4	3		3	3	3	2	3	2	2		2				2
CO-5	3		3	3	3	2	3	2	2		2				2

UNIT-I: CARBOHYDRATES

Carbohydrates – Classification and properties of carbohydrates, mono (glucose, galactose, fructose) disaccharides (lactose, maltose, sucrose), polysaccharides (starch, glycogen, cellulose). Sugar acids, alcohols, deoxysugars and amino sugars. Structure and functions of mucopolysaccharides.

UNIT-II: AMINO ACIDS & PROTEINS

Amino Acids and Proteins - Chemistry of amino acids and proteins - Classification of amino acids, Structures of amino acids, Chemical reactions of amino acids. Peptide bond - Nature of peptide bond, pi/φ rotation. Ramachandran plot, Secondary structure predictions, helices and beta-sheets, Determination of primary structure. Proteins and their classification, properties of proteins, determination of amino acid sequences (N and C terminus) Tertiary/quaternary structure of proteins (myoglobin/hemoglobin model). Structural organization of proteins - Outline structures and biological functions. Protein folding and significance.

UNIT-III: LIPIDS & FATS

Lipids – Classification; structure and biological functions of fatty acids, glycolipids, triacylglycerols, phospholipids, terpenes and steroids. Physico-chemical properties and analysis of fats and oils. Structure and functions of prostaglandins, leukotrienes, thromboxanes. Types and functions of vitamins.

UNIT-IV: NUCLEIC ACIDS

Nucleic Acids – Structure of purines, pyrimidine, nucleosides, and nucleotides.Watson and Crick double helix structure. Properties and functions of nucleic acids (DNA, RNA). Different forms of DNA (A, B and Z forms) and RNA (mRNA, rRNA, tRNA and snRNA). DNA base composition and Chargoff's rule. Three-dimensional structure of tRNA. Chemical difference

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of DNA, RNA and significance. Isolation of nucleic acids. Denaturation and renaturation of nucleic acids, cot curves and chemical synthesis of DNA.

Recommended Books & References:

1. Biochemistry, Berg, J.M., L.J. Tymcozko and L. Stryer 2002. 5th Edn. W.H.Freeman and Company, New York.
2. Biochemistry, Garrett and Girisham, 2010, Cengage Learning.
3. Biochemistry, Lehninger. A.L. 1978. 2nd Edn. Kalyani Publishers, New Delhi.
4. Biochemistry, Voet, D and J. Voet.1995. 2nd Edn.1995. John Wiley and Sons, USA.
5. Harper's Biochemistry, Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2002. McGraw Hill Publishing Company, New Delhi.
6. Introductory Practical Biochemistry, Sawhney, S.K and R. Singh. 2001. Narosa Publishing House. New Delhi.
7. Practical Biochemistry: Principles and Techniques, Wilson and Walker. 1986. Cambridge University Press, New York.
8. Principles of Biochemistry, Lehninger, A. L. 1993. C. B.S., India.
9. Textbook of Biochemistry with Clinical Correlation, Devlin, T.M.1997. 4th Edn. Wiley-Liss, New York.
10. Textbook of Biochemistry, West and Todd. 1968. MacMillan, New York.

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20RMB T-104: ANALYTICAL TECHNIQUES IN BIOLOGY

SEMESTER-I	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The purpose of this course is to provide an understanding of fundamental concepts and underlying principles in the instruments used in Microbiology. In addition, the course is expected to develop analytical skills to enable them to interpret the data.

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Understand the theory and practice of bio-analytical techniques, and to understanding the instrumentation used in microbiology,
2. Familiarity with working principles, tools and procedures of analytical techniques.
3. Analyze the limitations and creative use of techniques for solving of the research problem.
4. Describe separation and isolation techniques including centrifugation, chromatography and electrophoresis for biological materials.
5. Understand the spectrophotometric, radioisotopic and crystallographic methodologies for analyzing biological samples.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2		2				2
CO-2	3		3	3	3	2	3	2	2		2				2
CO-3	3		3	3	3	2	3	2	2		2				2
CO-4	3		3	3	3	2	3	2	2		2				2
CO-5	3		3	3	3	2	3	2	2		2				2

UNIT-I: CENTRIFUGATION

Measurement of pH, biochemical buffers, selection of biochemical buffer, oxygen electrode and biosensors. Cell disruption methods – French press, sonication, freeze-thaw techniques, enzymatic method, use of liquid nitrogen in cell disruption. Centrifugation – Basic principles of sedimentation, types of centrifuges and rotors. Preparative ultracentrifugation – Differential centrifugation, density-gradient, analytical ultracentrifugation and applications in determination of molecular weight, purity and detection of conformational changes in macromolecules.

UNIT-II: CHROMATOGRAPHY

Separation methods – General principles and definitions. Methods based on polarity – Partition chromatography (paper chromatography), adsorption chromatography (thin-layer chromatography), gas-liquid chromatography, reverse-phase liquid chromatography. Methods based on size – Principle of Gel filtration, methodology and applications. Dialysis, ultrafiltration, lyophilization. Methods based on affinity – Principle of Affinity chromatography, methodology and applications (purification of proteins, nucleic acids). High-performance liquid chromatography – Principle, instrumentation, practical procedure and applications. Ion-exchange chromatography – Principle, ion-exchangers, methodology, pH and salt gradients for elution of proteins, amino acids and nucleotides. Amino acid analyzer.

UNIT-III: ELECTROPHORESIS

Electrophoresis – General principles and definitions. PAGE – Native PAGE, SDS-PAGE, Isoelectric focusing, 2D electrophoresis, identification of novel proteins in 2D gels, capillary

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electrophoresis. Agarose gel electrophoresis – Preparation, separation and determination of molecular size of DNA, denaturing agarose gel electrophoresis and their applications, recovery of DNA from agarose gels. Pulse-field gel electrophoresis – Principle, methodology and applications in separation of large DNA fragment. Blotting techniques- Western, Southern and Northern.

UNIT-IV: SPECTROSCOPY

Spectroscopy – Principles, laws of light absorption. Instrumentation and applications of UV-visible spectrophotometer, fluorescence spectroscopy, NMR, ESR. Mass spectroscopy – MALDI-TOF, ESI-MS. Radioisotope techniques – Types of isotopes, radioactive decay. Detection and measurement of radioactivity – GM counter, scintillation counter, autoradiography. Preparation of labelled compounds – Pulse chase studies and tracer techniques, isotopes used in biology, safety methods in handling radioisotopes. Optical activity of biomolecules – CD and ORD: principles and applications. X-Ray diffraction and Crystallography – Basic principle, applications in the determination molecular structure of protein and nucleic acids.

Recommended Books & References:

1. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, 2nd edition Ed. by BL. Williams and K. Wilson (Edward Arnold)
2. Analytical Biochemistry by David J. Holmes and Hazel peck
3. Biochemical Research Technique (A Practical Introduction by Ed. John M. Wriggles worth
4. Biological Spectroscopy by Iain D. Campbell and Raymond A. Dwek, the Benjamin/Cumming Pub. Co., California, London.
5. Biophysical Chemistry by C.R. Cantor and P.R. Schimmel, W.H. Freeman & Co., NY.
6. Biophysical Chemistry D. Freifelder, W.H. Freeman
7. Biophysics – Edited by W. Hoppe, W. Lehman Hi. Maskal and H. Ziegler (Springer-Verlag, Berlin) 1983
8. Experimental Techniques in Biochemistry by Drewer, AJ. and Asworth, R.B.
9. Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Ed. J.A. Glasel and M.P. Deutscher, (Academics Press), 1995.
10. Manometer and Biochemical Techniques by W.W Umbrit and R.H. Burris (Burgens
11. Molecular Biophysics – R.B. Setlow and E.C. Pollard (Addison Wiley publishing Co. USA)162
12. Practical Biochemistry: Principles & Techniques – Edited by Wilson & Walker, Cambridge Univ. Press, New York) 1986.
13. Principles of Physical Biochemistry by K.E. Vanholdem W.C. Johnson, P.S. Ho, (Prentice Hall), 1998.
14. Separation Methods in Biochemistry by S.J. Morris and P. Morris (Pitman)
15. The Determination of Molecular Structure by P.J. Wheatly (Oxford Clarenders press) 1968.
16. The Tools of Biochemistry by Terrance G. Cooper (Wiley)

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20RMB T-105: INTELLECTUAL PROPERTY RIGHTS,BIOSAFETY & BIOETHICS

SEMESTER-I	EXTERNAL ELECTIVE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are:

1. To provide basic knowledge on intellectual property rights and their implications in biological research and product development.
2. To become familiar with India's IPR Policy.
3. To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.
4. To become familiar with ethical issues in biological research. This course will focus on the consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Course Outcomes (COs): On completion of this course, students should be able to…..

1. Understand the rationale for and against IPR and especially patents,
2. Understand why India has adopted an IPR Policy and be familiar with the broad outline of patent regulations,
3. Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents,
4. Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations, and
5. Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3				3			2			2				2
CO-2	3				3			2			2				2
CO-3	3				3			2			2				2
CO-4	3				3			2			2				2
CO-5	3				3			2			2				2

UNIT-I: INTELLECTUAL PROPERTY RIGHTS

Introduction to IPR: Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

UNIT-II: PATENTING

Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement,

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procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

UNIT-III: BIOSAFETY

Biosafety: Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.

UNIT-IV: BIOETHICS

Bioethics: Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

Recommended Books & References:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI.
3. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). Bioethics: An Anthology. Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences-Case Studies of Policy Challenges from New Technologies, MIT Press
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Recombinant DNA Safety Guidelines, 1990. Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf

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13. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9

14. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8

15. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.

16. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp

17. Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments. Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB P–101: GENERAL MICROBIOLOGY

SEMESTER-I	CORE COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objective of this laboratory course is to provide practical skills on basic microbiological techniques and an understanding of fundamental microbiological research.

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Isolate microorganisms from different sources using different microbiological tools, and to identify different microorganisms using various identification methods. Demonstrate the bacterial growth curve,
2. Estimate the minimal inhibitory concentration of a given antibiotic,
3. Use different staining methods for the identification of microorganisms, and to preserve different microorganisms using various techniques,
4. Isolate and quantify bacteriophages from sewage samples, and
5. Observe symptomatic plant viral infection, and to estimate chlorophyll in virus-infected and non-infected leaves.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2		2				2
CO-2	3		3	3		3	3	2	2		2				2
CO-3	3		3	3		3	3	2	2		2				2
CO-4	3		3	3		3	3	2	2		2				2
CO-5	3		3	3		3	3	2	2		2				2

1. Study of typical compound microscope
2. Micrometry – measurement of a fungal spore
3. Determination of cell density by counting chamber
4. Isolation of bacteria from soil, air and water
5. Isolation of fungi from soil
6. Contact slide technique
7. Streak and Pour plate techniques
8. Development of a single colony of a bacterium
9. Preservation of microorganisms
   a) Subculturing on agar slants
   b) Preservation in soil
   c) Preservation by overlaying cultures with mineral oil
   d) Preservation in glycerol stocks
10. Stab culturing technique for motility demonstration
11. Hanging drop technique
12. Simple staining of a bacterium
13. Negative staining of a bacterium
14. Gram staining – Positive and negative

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15. Bacterial spore staining
16. Lactophenol-Cotton blue mounting of fungi
17. Oligodynamic action of metals
18. Isolation and quantification of bacteriophages from sewage
19. Symptomatic observation of plant virus infection.
20. Estimation of chlorophyll in virus-infected and non-infected leaves

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20RMB P–102: MICROBIAL GENETICS

SEMESTER-I	CORE COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this practical course are to develop the experimental skills in genetics covering prokaryote/phage to yeast and higher eukaryotic organism.

Course Outcomes (COs): On successful completion of this course, the students will be able to.....

1. Demonstrate Mendelian laws and construction of genetic maps. Genetics,
2. Perform experiments on antibiotic resistance,
3. Demonstrate bacterial transformation and conjugation using suitable methods,
4. Perform induction of mutations and isolation of mutants, and
5. Solve problems related to molecular genetics.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2		2				2
CO-2	3		3	3		3	3	2	2		2				2
CO-3	3		3	3		3	3	2	2		2				2
CO-4	3		3	3		3	3	2	2		2				2
CO-5	3		3	3		3	3	2	2		2				2

1. Separation of nucleic acids by using Agarose gel electrophoresis
2. Demonstration of Mendelian laws using color marbles or beads
3. Evaluation of segregation and random assortment using Chi square test or test of fitness.
4. Construction of genetic maps based on problems in two and three factor crosses
5. Assay of antibiotics and demonstration of antibiotic resistance
6. Bacterial transformation
7. Bacterial conjugation
8. Induction of mutation in bacteria by UV
9. Isolation of bacterial mutants
10. Problems related to molecular genetics

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20RMB P–103: BIOLOGICAL CHEMISTRY

SEMESTER-I	CORE COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objective of this laboratory course is to introduce students to experiments in biological chemistry. The course is designed to teach students the utility of a set of experimental methods in biochemistry in a problem-oriented manner.

Course Outcomes (COs): On completion of this course, students should be able to…..

1. Elaborate concepts of biochemistry with easy to run experiments,
2. Familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry,
3. Prepare buffers and solutions along with the measurement of pH,
4. Identify sugars, amino acids based on qualitative tests, and to estimate quantities of sugars, amino acids and nucleic acids by spectroscopic methods, and
5. Quantify lipids, fatty acids and cholesterol using different biochemical methods.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2		2				2
CO-2	3		3	3		3	3	2	2		2				2
CO-3	3		3	3		3	3	2	2		2				2
CO-4	3		3	3		3	3	2	2		2				2
CO-5	3		3	3		3	3	2	2		2				2

1. Preparations of buffers and pH measurement of buffers
2. General reactions of monosaccharides and specific reactions of individual sugars (glucose, fructose, galactose and ribose)
3. General reactions of amino acids (solubility, ninhydrin reaction)
4. Specific reactions for different amino acids - Xanthoproteic reaction, Millon's test, Glyoxylic reaction
5. Pauly's test, nitroprusside test and Ehrlich's test
6. General reactions (solubility) and tests of fatty acids, glycerol and terpenes
7. Tests for unsaturation
8. Titration of fatty acids
9. Titration curve of an amino acid and calculation of pK and pI values
10. Quantification of monosaccharides
11. Quantitative estimation of amino acids using the ninhydrin reaction and titration curves of amino acids
12. Spectra and quantitative estimation of base and nucleotides
13. Quantitative analysis of lipids
    a) Determination of acid value of fat
    b) Saponification value of fat
    c) Iodine number of fat
    d) Estimation of cholesterol

20RMB P-104: ANALYTICAL TECHNIQUES INBIOLOGY

SEMESTER-I	CORE COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objective of this laboratory course is to introduce students to experiments in analytical techniques in biology. The course is designed to teach students the utility of a set of experimental methods in biochemistry and biophysics in a problem-oriented manner.

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Prepare stock solutions, working solutions and buffers, and to identify the sugars and lipids by paper chromatography,
2. Analyze protein concentration in unknown samples using the standard graph, and to demonstrate titration of amino acids and their separation using thin-layer chromatography,
3. Separate proteins by gel filtration and polyacrylamide gel electrophoresis (PAGE), and to separate nucleic acids by using agarose gel electrophoresis,
4. Draw absorption spectra for amino acids, proteins and nucleic acids, and
5. Isolate and characterize plant pigments by spectrophotometric methods.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2		2				2
CO-2	3		3	3		3	3	2	2		2				2
CO-3	3		3	3		3	3	2	2		2				2
CO-4	3		3	3		3	3	2	2		2				2
CO-5	3		3	3		3	3	2	2		2				2

1. Preparation of buffers and measurement of pH
2. Separation and identification of amino acids by paper chromatography.
3. Separation and identification of sugars by TLC.
4. Separation and identification of lipids by TLC.
5. Separation of amino acids by Ion-exchange chromatography.
6. Separation of proteins by Gel filtration
7. Absorption spectra of amino acids, Proteins and nucleic acids
8. Verification of Beer's law.
9. Determination of molar extinction coefficient of p-nitrophenol.
10. Measurement of inversion of sucrose by polarimetry.
11. Dialysis of crude protein.
12. HPLC demonstration
13. Separation of proteins by PAGE
14. Separation of aminoacids by paper electrophoresis
15. Isolation and spectrophotometric characterization of plant pigments
16. Isolation of mitochondria by density gradient centrifugation

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M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF THEORY QUESTION PAPER

[Two questions from each Unit in two sections]

Time: 3 Hours **Max. Marks: 70**

Section-A

Answer any four questions

Each question carries 5 marks (4 x 5 = 20 marks)

1.
2.
3.
4.
5.
6.
7.
8.

Section-B

Answer all questions

Each question carries 12.5 marks (4 x 12.5 = 50 marks)

9. A.

or

B.

10. A.

or

B.

11. A.

or

B.

12. A.

or

B.

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M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF PRACTICAL QUESTION PAPER

Time: 3 Hours **Max. Marks: 50**

1.	Major experiment	(1 X 15 = 15 M)
2.	Minor experiment	(1 X 10 = 10 M)
3.	Spotters A. B. C. D. E.	(5 X 02 = 10 M)
4.	Record	(10 M)
5.	Viva-Voce	(05 M)

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20R20RMB T–201: MICROBIAL PHYSIOLOGY & METABOLISM

SEMESTER-II	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to build upon postgraduate level knowledge of microbial physiology with specific emphasis on different metabolic pathways.

Course Outcomes (COs): After completion of this course successfully, the students will be able to……

1. Discuss the transport of nutrients required for microbial growth,
2. Explain the respiratory and photosynthetic metabolism in bacteria,
3. Describe the carbohydrate metabolism in microorganisms,
4. Discuss fatty acid and amino acid metabolism, and
5. Explain the metabolism of lipids.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2			2			2
CO-2	3		3	3	3	2	3	2	2			2			2
CO-3	3		3	3	3	2	3	2	2			2			2
CO-4	3		3	3	3	2	3	2	2			2			2
CO-5	3		3	3	3	2	3	2	2			2			2

UNIT-I: TRANSPORT OF NUTRIENTS

Transport of nutrients in microbes – Structural organisation of plasma me20RMBrane in relationto transport, mechanisms of me20RMBrane transport (passive, facilitated, active and group translocation) with specific reference to sugars (glucose, lactose and arabinose), amino acids (proline) and ions (Na^+ and K^+). Coupling of transport of ions and metabolites to ATP/protongradient. Porins.

UNIT-II: PHOTOSYNTHESIS

Photosynthesis – Oxygenic and anoxygenic photosynthesis, structure of synthetic pigments, primary photochemistry of PS I and PS II, and photosynthetic electron transport, CO_2 fixation, halobacterial photosynthesis. Energy yield during aerobic respiration – Tricarboxylic acid cycle: Discovery, intracellular location, reactions of the cycle, amphibolic nature, anaplerotic reactions, glyoxylate pathway. ET pathway and energy derivation. Fermentation, Biochemical mechanisms of lactic acid, ethanol, butanol and citric acid fermentations. Anaerobic respiration: Nitrate and sulphate respiration, and energy yields.

UNIT-III: CARBOHYDRATE METABOLISM

Carbohydrate metabolism – Various pathways underlying utilization of different sugars (EMP, ED, HMP and phosphoketolase pathways) in microorganisms. Gluconeogenesis. Protein metabolism – Assimilation of inorganic nitrogen and sulphur, Biochemistry of nitrogen fixation. Biosynthesis of amino acids and their regulation with emphasis on tryptophan and histidine. Porphyrin biosynthesis. Signal transduction with reference to nitrogen metabolism. Catabolism of amino acids, transamination, oxidative deamination.

UNIT-IV: LIPID METABOLISM

Lipid metabolism – Biosynthesis of triacyl glycerols, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids. Microbial metabolism of aromatic and

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aliphatic hydrocarbons (camphor, 2,4-D and toluene) with emphasis on the role of monooxygenase and dioxygenase in the ring cleavage (*ortho*, *meta* and gentsiate cleavage) and reductive catabolism. Nucleotide metabolism – Biosynthesis of purnine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides. Regulation of nucleotide synthesis, catabolism of nucleotides. Secondary metabolism – Utilization of secondary metabolites for production of vitamins, toxins (aflatoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin).

Recommended Books & References:

1. An Introduction to bacterial physiology by Oginsky and U20RMBreit. 1954, W. H. Freeman.
2. Bacterial metabolism by Gottschalk.1986, Springer-Verlag.
3. Biochemistry by Garrett and Grisham.2010, Cengage Learning.
4. Biochemistry by Stryer.2010, W. H. Freeman.
5. Biochemistry by Zubay. 1992, McGraw-Hill Higher Education.
6. Fundamentals of Enzymology by Price and Stevens.1999, Oxford University Press.
7. Growth of bacterial cell by Ingraham, Lod and Neidhardt.1983, Sinauer Associates.
8. Microbial energetics by Dawes.1986 Blackie.
9. Microbial Physiology (3rd edition) by Moat and Foster. 2002, Wiley-Liss.
10. Principles of Biochemistry by Lehninger, Nelson and Cox. 2005, W H Freeman - USA.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20R20RMB T–202: MOLECULAR BIOLOGY

SEMESTER-II	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

Course Outcomes (COs): After completion of this course successfully, the students will be able to .....

1. Explain the physical properties of DNA and its organization in chromatin,
2. Explain the principles behind DNA replication, repair and reco20RMBination,
3. Discuss the transcription process and RNA polymerases and their action,
4. Explain the translation process in both prokaryotes and eukaryotes, and
5. Discuss the regulation of gene expression and operon concept.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2			2			2
CO-2	3		3	3	3	2	3	2	2			2			2
CO-3	3		3	3	3	2	3	2	2			2			2
CO-4	3		3	3	3	2	3	2	2			2			2
CO-5	3		3	3	3	2	3	2	2			2			2

UNIT-I: DNA REPLICATION

DNA Replication: Modes of replication. Experimental evidence for semi-conservative mode of replication: Meselson-Stahl and Cairns experiments. Replication fork, continuous and discontinuous DNA synthesis. Enzymes and proteins in replication – Single-strand DNA-binding proteins (SSB), Helicases, Topoisomerases, DNA ligases. Priming by RNA polymerase and primase. DNA polymerases – *E. coli* DNA polymerase I, II and III, and Eukaryotic DNA polymerases. Replication of *E. coli* chromosome and M13 genome. Rolling circle replication in λ bacteriophage. Eukaryotic DNA replication. Autonomous replication sequences (ARS). Regulation of ColE1 plasmid DNA replication. Termination and fidelity of DNA replication. Nearest neighbour base pair analysis. Inhibitors of DNA replication. Reverse transcriptase. DNA damage. Repair of thymine dimmers – Photoreactivation, excision repair, reco20RMBination repair, SOS repair.

UNIT-II: TRANSCRIPTION

Transcription (RNA biosynthesis): Polynucleotide phosphorylase. RNA polymerases – *E. coli* RNA polymerase, and eukaryotic RNA polymerases. Promoters and their characterization. Enhancer sequences. Initiation, elongation and termination of RNA synthesis. Monocistronic and polycistronic RNAs. Post-transcriptional modifications of eukaryotic hnRNA – Capping, methylation, polyadenylation and RNA splicing and splicing mechanisms. Splicing of nuclear pre-tRNA, group I and group II introns, and pre-mRNA splicing. Excision of multiple introns. Role of catalytic RNA. Inhibitors of transcription.

UNIT-III: TRANSLATION

Translation (Protein synthesis): Elucidation of the genetic code – Experimental studies of Nirenberg and Khorana. General features of genetic code, codon degeneracy and universality. Mitochondrial genetic code, tRNA role in protein synthesis. Amino acyl tRNA synthetases, wobble hypothesis. Mechanism of initiation, elongation and termination of protein synthesis.

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Translational factors. Inhibitors of protein synthesis – Antibiotics and other inhibitors. Post-translational modifications. Protein sorting and targeting. Signal hypothesis – Signal sequences, signal recognition particle, and molecular chaperones, protein degradation. Lysosomal degradation. Ubiquitin pathway – Protein stability and N-end rule.

UNIT-IV: GENE EXPRESSION

Regulation of gene expression: House-keeping genes, constitutive genes, and regulatory genes. Induction and repression. Regulatory proteins – DNA-binding motif of regulatory proteins. Role of zinc fingers, leucine zippers, helix-turn-helix. Regulation of gene expression in prokaryotic operons – Negative regulation and positive regulation. Fine structure of *lac* operon. Repressor and the catabolite activator proteins in gene regulation of *lac* operon. Dual functions of the repressor in *ara* operon. Transcriptional control by attenuation in *trp* operon. Regulation of gene expression in λ and *nif* operon. Regulation of gene expression in eukaryotes – *gal* operon in yeast. Eukaryotic translation control - Translation control by heme. Regulation of homeotic gene expression.

Recommended Books & References:

1. Molecular Biology of the Cell – B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson (Garland Publishing, New York and London)
2. Molecular Biology – A Comprehensive Introduction to Prokaryotes and Eukaryotes – D. Freifelder (Jones and Bartlett, USA)
3. Reco20RMBinant DNA: A Short Course – J.D. Watson, J. Tooze and D.T. Kurtz (Scientific American Book,
W.A. Preemon).
4. Molecular cloning: Laboratory Manual – Maniatis, E.F. Fritsch and J. Sa20RMBrook (Cold Spring HarborLaboratory, New York).
5. Modern Genetics (2nd Edition, 1984) – A.J. Ayala and W. Castra (Goom Helns, London).
6. Techniques in Molecular Biology (1992) – Ed., J. Walker and W. Castra (Geom Helns, London).
7. Practical Methods in Molecular Biology (1991) – R.F. Schecleif and P.C. Wensik (Springer Verlag).
8. Genes VIII. (1997) – Benjamin Lewin (Oxford University Press).

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DEPARTMENT OF MICROBIOLOGY

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20R20RMB T-203: BIOSTATISTICS & BIOINFORMATICS

SEMESTER-II	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to provide theory and practical experience of the use of bioinformatics tools and databases which facilitate investigation of molecular biology and evolution-related concepts and to give conceptual exposure of essential contents of statistics to students.

Course Outcomes (COs): On completion of this course, students should be able to .....

1. Develop an understanding of basic theory of these computational tools,
2. Gain working knowledge of these computational tools and methods,
3. Appreciate their relevance for investigating specific contemporary biological questions,
4. Critically analyse and interpret results of their study,
5. Gain broad understanding in mathematics and statistics, and
6. Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1		3	3	3	3	2	3	2	2			2			2
CO-2		3	3	3	3	2	3	2	2			2			2
CO-3		3	3	3	3	2	3	2	2			2			2
CO-4		3	3	3	3	2	3	2	2			2			2
CO-5		3	3	3	3	2	3	2	2			2			2

UNIT-I: BIOSTATISTICS BASICS

Data – Data types, collection of data, classification and tabulation. Measures of central tendencies – Mean, median and mode. Measures of variation - Range, quartile deviation, mean deviation and standard deviation. Coefficient of variation. Probability – Addition and multiplication theories, conditional probability and probability distributors – Binomial, poisson and normal distribution.

UNIT-II: BIOTATISTICS OF BIO-ASSAYS

Correlation and linear regression – Scatter diagram method – Karnal Pearson's Rank correlation methods. Regression lines – fitting of regression lines by least squares method – Regression coefficients and properties. Small sample tests – t, F and chi square tests. ANOVA – one-way and two-way classifications. CRD, RBD, LSD, Duncan's multiple range (DMR) test. Statistical basis of biological assyas-LD50, ED50, TCID50, PD50.

UNIT-III: BIOINFORMATICS BASICS

Introduction – Origin of bioinformatics biological data, computer and information technology contributions. Disciplines of bioinformatics – Genomics, transcriptomics, proteomics, functional genomics, structural genomics, metabolomics, pharmacogenomics, structure prediction and drug design.

Biological database - Introduction of database (DB), need, organization, search of DB. An overview of biological databases - NCBI, E20RMBL, DDBJ, SWISS-PROT, PDB and KEGG. Database querying with NCBI using key words, sequences (proteins and genes), finding similarities, identifying genes and proteins from different organisms.

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UNIT-IV: SEQUENCE ANALYSIS

Sequence alignment - Introduction, significance of sequence alignments and use of dot matrices. Pair wise and multiple sequence alignment (MSA) using Clustal programs such as Clustal X, Clustal W and Clustal Omega.

Sequence analysis - Concepts of sequence analysis and their importance. BLAST – blastn, blastp, blastx, tblastx, output analysis matrix BLOSSUM, PAM, e-value.

Submittion of DNA and protein sequence to databases - where and how to submit, FASTA, SEQUIN, genome centres. Submitting aligned sets of sequences, updating submitted sequences. Methods of phylogenetic analysis and PHYLIP.

Recommended Books & References:

1. Principles of Genome Analysis: A Guide to Mapping and Sequencing DNA from Different Organisms. Primrose SB. 2nd Ed. 1998.Blackwell Science: Oxford. ISBN 0-632-04983-9.
2. Genome Mapping: A Practical Approach. Dear P (Editor). 1st Ed.2000. Oxford University Press: Oxford, New York.
3. Developing Bioinformatics Skills. Alfonso Valencia and Blaschke. L (2005) Oreille's Publication.
4. Bioinformatics Sequence, Structure and Databanks ed. By Des Higgins Willie Taylor. (2006).
5. Introduction to Bioinformatics. 2002. By Lesk AM. Oxford: Oxford University Press.
6. Bioinformatics: Sequence and Genome Analysis. 2001. By Mount DW. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
7. Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. 2001. By Baxevanis, A. D., & Ouellette, B. F. New York: Wiley-Interscience.
8. Bioinformatics and Functional Genomics. 2015. Pevsner, J. Hoboken, NJ.: Wiley-Blackwell.
9. Structural Bioinformatics. 2009. By Bourne PE & Gu J. Hoboken, NJ: Wiley-Liss.
10. Introduction to Protein Science: Architecture, Function, and Genomics. 2004. By Lesk AM. Oxford: Oxford University Press.
11. Statistics Made Simple - Do It Yourself on PC. 2001 By K.V.S. Sarma, Printice-Hall.
12. Introduction to Bioinformatics, 2001 by T.A. Attwood and D.J. Parrysmith. Pearson Education Asia Publ.
13. Principles of Biostatistics. 2000, Marello-Pagno. Published by Duxbury, USA.
14. Statistical Methods. 2014. S.P. Gupta. Sultan Chand & Sons.
15. Fundamentals of Mathematical Statistics. S.C Gupta & Kapoor
16. Statistical Methods in Biological and Health Science. J. S. Milton & J.O. Tsokan.
17. Probability and Measure. New York: Wiley. 1986 by Billingsley P.
18. Fundamentals of Biostatistics. 2000. by Rosner B. Boston, MA: Duxbury Press.
19. Biostatistics, a Foundation for Analysis in the Health Sciences. 1987. by Daniel WW, New York: Wiley.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20R20RMB T–204: IMMUNOLOGY

SEMESTER-II	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Course Outcomes (COs): On completion of this course, students should be able to.....

1. Evaluate usefulness of immunology in different pharmaceutical companies,
2. Identify proper research lab working in area of their own interests,
3. Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses,
4. Figure out kind of immune responses in the setting of infection (viral or bacterial), and
5. Explain the antigen or antibody interaction.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2			2			2
CO-2	3		3	3	3	2	3	2	2			2			2
CO-3	3		3	3	3	2	3	2	2			2			2
CO-4	3		3	3	3	2	3	2	2			2			2
CO-5	3		3	3	3	2	3	2	2			2			2

UNIT-I: IMMUNE SYSTEM

Historical perspective of Immunology, Phylogeny of immune system. Cells of the immune system – B cells, T cells, phagocytes, inflammatory cells, antigen presenting cells. Organs – Primary, secondary and tertiary lymphoid organs. Types of immunity – Innate and acquired. Antigens – Nature, types, factors influencing antigenicity, haptens, adjuvants and superantigens. Antibodies – Structure, types, classes and functions. Antibody diversity – Theories of antibody diversity, mechanism of diversification, allelic exclusion.

UNIT-II: IMMUNE RESPONSES

T cell receptor – Structure and diversity. MHC – Types, structure, distribution, self-restriction. T and B cell activation. Maturation of lymphocytes – Positive and negative selection, process of maturation. Antigen processing and presentation – Cytosolic and endosomal pathways, T cell- and NK cell-mediated lysis of cells, ADCC. Complement system – Components, cascades, MAC, outcomes. Cytokines – Classification, properties and role as immunomodulators.

UNIT-III: HYPERSENSITIVITY

Hypersensitivity – Classification, mediators, mechanism, consequences of hypersensitive reaction. Autoimmunity – Concept of tolerance of autoimmune disorders, basis and therapy for autoimmune disorders. Transplantation – Transplantation antigens, mechanism of graft rejection, graft *versus* host reaction, immunosupressors. Tumor immunity – Tumors of immune system, immune responses against tumors. Immunodeficiency – Primary and secondary immunodeficiency, co20RMBined immunodeficiency, complement deficiency, AIDS. Immune response to infectious diseases- viral, bacterial, fungal, protozoan and other parasites.

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UNIT-IV: ANTIGEN-ANTIBODY INTERACTIONS

Antigen-antibody interactions – Principle, lattice hypothesis. Precipitation reaction – Radial immunodiffusion, Ouchterlony technique, immunoelectrophoresis, counter current and rocket electrophoresis. Agglutination reactions – Bacterial and hemeagglutination, passive agglutination, agglutination inhibitions assay. RIA and ELISA – Principle, methodology and application. Immunofluorescence, FAACS, immunoblotting. Hybridoma technology – Polyclonals, monoclonals, HAT medium, selection, production of monoclonal antibodies and applications. Vaccines – Concept of immunization, routes of vaccination. Types of vaccines – Whole organism (attenuated and inactivated) and component vaccines (synthetic peptides, DNA vaccines, reco20RMBinant vaccines, subunit vaccines, idiotypic-based vaccines, deletion vaccines, glycoconjugate vaccines). Vaccine delivery systems.

Recommended Books & References:

1. Roitts Essentials of Immunology. Riott, I.M and P.J. Delves. 2001. 10th Edn. Blackwell Scientific Publications. USA.
2. Elements of Immunology. Ratogi, S.C. 2002. CBS publishers, New Delhi.
3. Immunology understanding the immune system. Elgert, K.D. 1996. Wiley – Liss. USA.
4. Immunobiology: The Immune System in Health and Disease. Janeway, C.A., P. Travers, M. Walport and J.D. Capra.1999. 4th Edn. Current biology Publications. USA.
5. Medical Immunology. Stites, D.P., A.I. Terr and T.G. Parslow. 1997. 9th Edn. Prentice-Hall International, USA.
6. Immunology. Kuby, J. 2001. 2nd Edn. W.H. Freeman and Company, New York.
7. Cellular and Molecular Immunology. Abbas, A. K and A.H. Lichtman 2003. 4th Edn. Saunders, China.
8. Immunology. Male, D, J. Brostoff, D.B. Roth and I. Roitt. 2006. Elsevier, Canada.
9. Immune modulating Agents. Kresina, T.F. 1998.Marcel Dekker, New York.
10. Kuby Immunology. Kindt, T.J., R.A. Goldsby and B.A. Osborne. 2007. 6th Edn. W.H. Freeman and Company, New York.

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DEPARTMENT OF MICROBIOLOGY

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20R20RMB T-205: BIOENTERPRENEURSHIP

SEMESTER-II	GENERIC FOUNDATION COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: Research and business belong together, and both are needed. In a rapidly developing life science industry, there is an urgent need for people who co20RMBine business knowledge with the understandingof science & technology. Bioentrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Course Outcomes (COs): On completion of the course, students will be able to …..

1. Gain entrepreneurial skills, understand the various operations involved in venture creation,
2. Identify scope for entrepreneurship in microbiology,
3. Utilize the schemes promoted through knowledge centres and various agencies,
4. Gain knowledge pertaining to management and leadership and
5. Able to build up a strong network within the industry.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2		2				2
CO-2	3		3	3	3	2	3	2	2		2				2
CO-3	3		3	3	3	2	3	2	2		2				2
CO-4	3		3	3	3	2	3	2	2		2				2
CO-5	3		3	3	3	2	3	2	2		2				2

UNIT-I: INNOVATION AND ENTREPRENEURSHIP IN BIO-BUSINESS

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

UNIT-II: BIO MARKETS - BUSINESS STRATEGY AND MARKETING

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

UNIT-III: FINANCE AND ACCOUNTING

Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

UNIT-IV: TECHNOLOGY MANAGEMENT

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Recommended Books & References:

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

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DEPARTMENT OF MICROBIOLOGY

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20R20RMB P–201: MICROBIAL PHYSIOLOGY &METABOLISM

SEMESTER-II	CORE COURE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to build upon postgraduate level hands on practical knowledge of microbial physiology with specific emphasis on different metabolic pathways.

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Growth curve establishment in *E. coli*,
2. Determine the effect of temperature and pH on bacterial growth,
3. Isolation and purification of enzymes in bacteria,
4. Bioassay of microbial toxins and their toxicity test, and
5. Measure CO_2/O_2 evolution during respiration/photosynthesis of microorganisms.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2			2			2
CO-2	3		3	3		3	3	2	2			2			2
CO-3	3		3	3		3	3	2	2			2			2
CO-4	3		3	3		3	3	2	2			2			2
CO-5	3		3	3		3	3	2	2			2			2

1. Establishment of growth curve of *E. coli* in a shake culture.
2. Influence of temperature and pH on growth of *E. coli.*
3. Determination of thermal death point of a bacterium.
4. Determination of thermal time of a bacterium
5. Assay of chymotrypsin and trypsin.
6. Isolation and partial purification of enzymes, amylases and cellulases.
7. Determination of characteristics of enzyme-catalyzed reaction (V_{max} and K_m).
8. Effect of temperature and pH on the rate of enzyme catalysed reaction.
9. Immobilization of enzymes.
10. Characterisation of immobilised enzymes.
11. Measurement of CO_2/O_2 evolution during respiration/photosynthesis of microorganisms
12. Isolation and assay of the following microbial enzymes:
13. (a) Urease, (b) amylase, (c) Protease, (d) Lipase, (e) Catalase (f) Transaminase, (g) Invertase, (h) Pectinase, (i) Nitrate reductase, (k) Cellulase, (l) Aldolase, (m) Glutamine synthetase, (n) GOGAT.
14. Bioassay of microbial toxins and toxicity test.
15. Estimation of chitin in fungal cultures.

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20R20RMB P-202: MOLECULAR BIOLOGY

SEMESTER-II	CORE COURE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to provide students with experimental knowledge of molecular biology and genetic engineering.

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Perform transformation, conjugation and transduction,
2. Express heterologous protein in bacterial system,
3. Perform protein-protein interaction by yeast two hybrid assay,
4. Isolate genomic DNA, plasmid DNA, RNA and protein from bacteria and yeast,
5. Perform restriction mapping of a plasmid, and
6. Correlate genotype with phenotype.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2			2			2
CO-2	3		3	3		3	3	2	2			2			2
CO-3	3		3	3		3	3	2	2			2			2
CO-4	3		3	3		3	3	2	2			2			2
CO-5	3		3	3		3	3	2	2			2			2

1. Determination of log phase during culturing of *E. coli*
2. Demonstration of β-galactosidase induction in *E. coli lac*$^+$ strains.
3. Estimation of DNA by diphenylamine method.
4. Determination of purity and quantity of DNA by UV absorption method.
5. Determination of melting temperature (Tm) of DNA
6. Estimation of RNA by orcinol method.
7. PAGE electrophoresis of proteins.
8. Problems related to molecular genetics.
9. Southern and western blotting.
10. Electro-elution of DNA.
11. Restriction digestion of DNA.
12. Separation of RE-digested fragments by gel electrophoresis.
13. Restriction mapping of a plasmid.
14. Cloning of foreign DNA insert into a plasmid followed by transformation.
15. Polymerase chain reaction.

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20R20RMB P–203: BIOSTATISTICS & BIOINFORMATICS

SEMESTER-II	CORE COURE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: Course Objectives: The aim of this course is to and to give practical exposure of essential contents of statistics and to provide practical training in bioinformatic methods including accessing major public sequence databases, use of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages to students.

Course Outcomes (COs): On completion of this course, students should be able to …..

1. Use various statistical tools including Chi square test, t-test, F-test, DMR test, ANOVA: one-way and two-way, CRD, RBD and LSD.
2. Describe contents and properties of most important bioinformatics databases,
3. Perform text- and sequence-based searches and analyze and discuss results in light of molecular biological knowledge,
4. Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming, and
5. Predict secondary and tertiary structures of protein sequences.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1		3	3	3		3	3	2	2			2			2
CO-2		3	3	3		3	3	2	2			2			2
CO-3		3	3	3		3	3	2	2			2			2
CO-4		3	3	3		3	3	2	2			2			2
CO-5		3	3	3		3	3	2	2			2			2

1. Chi square test, t-test, F-test, DMR test
2. ANOVA: one-way and two-way.
3. CRD, RBD and LSD
4. Familiarization with Windows, UNIX and Internet
5. Database searching (Give name of the gene/protein search sequence with key words, download the sequence, locate related literature references)
6. Use of tools at NCBI, E20RMBL and SWISSPORT
7. BLAST analysis and FASTA analysis
8. Pair wise and multiple sequence alignment (CLUSTAL X/W/Omega)
9. Finding composition of sequence, open reading frames
10. Detecting signals, Motifs and repeats in sequence
11. Phylogenetic tree construction (PHYLIP)
12. Design of PCR primer

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Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20R20RMB P-204: IMMUNOLOGY

SEMESTER-II	CORE COURE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this laboratory course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells etc. and how they can be used in respective research work.

Course Outcomes (COs): After completion of this course successfully, the students will be able to……

1. Learn important immunological techniques such as ELISA, Western blotting, cell culture techniques, Flow cytometry, assays to monitor the immune responses etc.,
2. These techniques are routinely used by the diagnostic, vaccine and sera manufacturing companies hence this will open avenues for students in Biotech industries, and
3. Hand on practical exposure to these techniques would enhance entrepreneurship Skills of the students.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2			2			2
CO-2	3		3	3		3	3	2	2			2			2
CO-3	3		3	3		3	3	2	2			2			2
CO-4	3		3	3		3	3	2	2			2			2
CO-5	3		3	3		3	3	2	2			2			2

1. Staining of blood smear and identification of different leukocytes
2. Determination of A, B, O and Rh blood groups in human beings
3. Identification of primary and secondary lymphoid organs
4. Recognition of T-cell by rosette formation
5. Preparation of antigen
6. Injection of antigen into experimental animals by different routes.
7. Bleeding of test animals for antiserum
8. Electrophoretic study of normal and immune serum
9. Preparation of immunoglobulins from serum
10. Separation of immunoglobulins by gel electrophoresis
11. Labeling of purified immunoglobulins by gel with enzymes/dyes
12. Different serological tests
    a. Agglutination – *Brucella* system
    b. Precipitation test – Ring interface and agar gel double diffusion tests
    c. Immunoelectrophoresis – Counter current and Rocket
    d. Hemagglutination and Hemagglutination inhibition tests
    e. Labeled antibody test – ELISA, Dot ELISA, FAT and Western blotting
    f. Viral infectivity neutralization test

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13. Cell-mediated immunity tests

    a. Leukocyte migration inhibition

    b. Opsonic index

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M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF THEORY QUESTION PAPER

[Two questions from each Unit in two sections]

Time: 3 Hours **Max. Marks: 70**

Section-A

Answer any four questions

Each question carries 5 marks (4 x 5 = 20 marks)

1.
2.
3.
4.
5.
6.
7.
8.

Section-B

Answer all questions

Each question carries 12.5 marks (4 x 12.5 = 50 marks)

9. A.

or

B.

10. A.

or

B.

11. A.

or

B.

12. A.

or

B.

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M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF PRACTICAL QUESTION PAPER

Time: 3 Hours **Max. Marks: 50**

1.	Major experiment	(1 X 15 = 15 M)
2.	Minor experiment	(1 X 10 = 10 M)
3.	Spotters A. B. C. D. E.	(5 X 02 = 10 M)
4.	Record	(10 M)
5.	Viva-Voce	(05 M)

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20R20RMB T–301: GENETIC ENGINEERING

SEMESTER-III	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Explain the basic principles behind molecular cloning,
2. Apply the knowledge of molecular cloning and design cloning strategy,
3. Apply most appropriate reco20RMBinant-DNA techniques and other contemporary molecular techniques tounderstand the function of gene,
4. Explain various contemporary techniques towards gene knockout, and
5. Analyse published journal articles in the field of reco20RMBinant DNA technology.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2			2			2
CO-2	3		3	3	3	2	3	2	2			2			2
CO-3	3		3	3	3	2	3	2	2			2			2
CO-4	3		3	3	3	2	3	2	2			2			2
CO-5	3		3	3	3	2	3	2	2			2			2

UNIT-I: SCOPE & MILESTONES

Scope and milestones in genetic engineering. Classification, nomenclature and importance of restriction endonucleases and modification enzymes. Properties and application of DNA ligases, polynucleotide kinase, alkaline phosphatases, S1 nuclease, terminal transferase, Bal 31 nuclease. Cloning vectors – Characteristics of a cloning vector. Disadvantages of natural plasmids in gene cloning. Artificial plasmids as cloning vectors – Construction of pBR322. Vectors used for cloning genes in *E. coli* (plasmids, bacteriophage derivatives, cosmids, BACs), yeast (YACs, shuttle vectors), higher plants (Ti plasmid derivatives, caulimovirus), and animal cells (constructs of SV 40 and retroviruses). DNA and RNA probes – Synthesis and their applications. Bacterial strains used for cloning (*E. coli* JM101, strain C43 (DE3).

UNIT-II: GENE CLONING

Cloning strategies: Generation of DNA fragments containing a gene (shot-gun method, Southern analysis, and cDNA synthesis). Joining of DNA fragments to vector molecules – Cohesive termini ligation and blunt-end ligation using linkers, adaptors and homopolymer tails. Introduction of reco20RMBinant DNA molecules into appropriate cloning hosts – Preparation of competent cells, use of Cold $CaCl_2$ transformation, electroporation, and triparental mating techniques. *In vitro* packaging of reco20RMBinant cosmids. Introduction of reco20RMBinant cosmids into *E. coli* cells. Screening of reco20RMBinants for a positive clone – Genetic, biochemical and hybridization methods. Construction of DNA libraries – Genomic and cDNA libraries, screening of libraries.

UNIT-III: GENE EXPRESSION

Over expression of cloned genes: Polymerase chain reaction – Principle, types (RT-PCR, nested, multiplex and inverse PCR), primer design, and application of PCR. PCR amplification

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of cloned gene. Characteristics of expression vectors. Construction of expression vectors – Vectors having inducible *lac* and *taq* promoters. Codon optimization. Engineering hosts for over expression. IPTG-induction of a cloned gene expression. Expression of proteins with His tag and its significance in simultaneous expression, and purification of reco20RMBinant proteins. Problems associated with expression of cloned genes – Inclusion bodies, solubilisation and reconstruction of expressed proteins. Restriction mapping of linear and circular DNA. Sequencing of cloned gene – Sanger's method, Maxam-Gilbert's method, and automated sequencing.

UNIT-IV: GENE REGULATION

Studying gene regulation – Northern blot, primer extension, S1 mapping and reporter assays. Construction of a reco20RMBinant *E. coli* strain expressing human insulin. *Agrobacterium*-mediated gene cloning for developing a transgenic plant – Development of a reco20RMBinant *Agrobacterium* strain and transforming female reproductive tissue or following microinjectionand particle bo20RMBardment methods. Selection of transformants. Identification of transformed cells and micropropagation of transformed cell into callus, and regeneration of transgenic plants. Transfection – Salient features and its significance in transforming animal cells. Development of transgenic mice. Application of site-directed mutagenesis in protein engineering. DNA Finger-printing – RAPD, RFLP and AFLP analysis, and their applications. Antisense technology. Gene therapy and applications. Microarrays. Proteomics – Principle, techniques and applications.

Recommended Books & References:

1. Concepts of Biotechnology D. Balasubramanian.
2. DNA Cloning: A Practical Approach, DM Glover and BD Hames, IRL Press
3. DNA Science. A first Course in Reco20RMBinant Technology, DA Mickloss and GA Freyer, Cold Spring HarborLaboratory Press, New York 1990
4. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, SL Berger and AP Kimmel, Academic Press, Inc San Diego, 1998
5. Methods in Enzymology Vol. 185, Gene Expression Technology, D V Goeddel, Academic Press, Inc. San Diego, 1990
6. Milestones in Biotechnology. Classic Papers on Genetic Engineering. JA Davies and WS Reznikoff, Butterworth-Heinemann, Boston, 1992
7. Molecular and Cellular methods in Biology and Medicine. PB Kaufman, W.Wu.D Kim and LJ Cseke, CRC
8. Molecular Biotechnology – Glick and Pasternack. Panima Publ.
9. Molecular Biotechnology (2nd Edn) SB Primrose, Blackwell Scietific Pub. Oxford, 1994
10. Molecular Cloning: A Laboratory Manual, J. Sa20RMBrook, E. Ffrisch and T. Maniatis, Old Spring HarborLaboratory Press New York, 2000
11. Principles of Gene Manipulation by Old and Primrose, Blackwell
12. Route Maps in Gene Technology, MR Walker and R Rapley, Biackwell Science Ltd, Oxford 1997

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DEPARTMENT OF MICROBIOLOGY

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20RMB T-302: 'OMICS' MICROBIOLOGY

SEMESTER-III	CORE COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objective of this course is to give an introduction to Genomics and other global Omics technologies, theory and practical aspects of these technologies and applications of these technologies in biology. The student should be able to gain working knowledge of these technologies and appreciate their ability to impart a global understanding of biological systems and processes in health and disease.

Course Outcomes (COs): On completion of this course, students should be able to .....

1. Overview of genome variation in population including technologies to detect these variation
2. Understand how High-throughput DNA sequencing (HTS) can be used to identify disease causing genetic variants in monogenic diseases
3. Understand how Genome-wide association study (GWAS) can detect disease associated markers in multifactorial diseases
4. Understand how HTS technologies can be used to explore changes in gene expression, and
5. Application of various OMICs technologies.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1		3	3	3	3	2	3	2	2			2			2
CO-2		3	3	3	3	2	3	2	2			2			2
CO-3		3	3	3	3	2	3	2	2			2			2
CO-4		3	3	3	3	2	3	2	2			2			2
CO-5		3	3	3	3	2	3	2	2			2			2

UNIT-I: GENOMICS

Organization and structure of genomes in prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion); Genome mapping methods (genetic and physical); RAPD, RFLP, SNP analyses; Fluorescence in-situ Hybridization (FISH) techniques; Advances in gene finding and functional prediction; Chain termination and chemical degradation sequencing methods. Genome-Wide Association (GWA) analysis; Comparative Genomic Hybridization (CGH); Massively Parallel Signature Sequencing (MPSS); Whole genome shot-gun sequencing and its applications; Introduction of Next Generation Sequencing (NGS). Genome projects - General introduction to genome projects (rice genome project and *Mycobacterium tuberculosis* genome project). Special emphasis on Human Genome Project (HGP) – Science behind HGP, benefits of HGP, ELSI of HGP in use of genetic information, genetic testing standard, quality and commercialization.

UNIT-II: TRANSCRIPTOMICS

Introduction, overview and methods of transcriptomics. Designing and producing microarrays; cDNA microarray technology; oligonucleatide arrays and designs; Sample preparation, labeling, hybridization, generation and analysis of microarray data. Gene expression analysis by cDNA and oligonucleotide arrays; Micro array experimental analysis and data analysis; Bioinformatic analysis of large-scale microarray data for comparative transcriptomics.

UNIT-III: PROTEOMICS

Outline of a typical proteomics experiment, Identification and analysis of proteins by 2D analysis, Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting, Mass spectrometry: ion source (MALDI, spray sources), analyzer (ToF,

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quadrupole, quadruple ion trap) and detector; Post translational Modifications: Quantitative proteomics, clinical proteomics and disease biomarkers, mass spectral tissue imaging and profiling; Protein-protein interactions: Surfaceomes and Secretomes, Solid phase ELISA, pull-down assays (using GST-tagged protein) tandem affinity purification, far western analysis, by surface plasmon resonance technique; Yeast two hybrid system, Phage display, Protein interaction maps, Protein arrays-definition; applications- diagnostics, expression profiling.

UNIT-IV: METABOLOMICS

Introduction and overview of metabolites, sample collection and processing, Non tracer and tracer (radio labelled)-based techniques in metabolomics (HPLC, NMR, LC-MS and GC-MS); Metabolome data processing derived by various techniques, analysis of databases (MetaboLight, Meta Cyc, MMCD etc.), Analysis tools, Metabolic pathways and network analysis Metabolic flux analysis (TCA, Amino acids, fatty acids, intermediary metabolites), Stoichiometric metabolic flux analysis, 13C metabolic flux analysis (MFA), Metabolic control analysis (MCA); Applications of metabolomics; Integration of metabolomics data sets with other data (eg. Transcriptomics, enzyme activity, etc.).

Recommended Books & References:

1. Alex Sánchez-Pla, Ferran Reverter, M. Carme Ruíz de Villa, Manuel Comabella, Transcriptomics: mRNA and Alternative Splicing. Journal of Neuroimmunology, Volume 248, issues 1-2,15 July 2012, pp 23-31.
2. Brown TA (2006) Genomes, 3rd Edition, Garland Science.
3. Campbell AM and Heyer LJ (2007) Discovering Genomics, Proteomics and Bioinformatics. Benjamin Cummings.
4. Griffiths WJ, Metabolomics, Metabonomics and Metabolite Profiling, (The Royal Society of Chemistry UK) (2008) ISBN 978-0-85404-299-9
5. Hunt S.P., and F. J. Livesey, (2000) Functional Genomics.
6. Liebler DC (2002) Introduction to Proteomics: Tools for the New Biology, Humana Press, Totowa NJ. USA.
7. Melanie J Filiatrault, Progress in Prokaryotic Transcriptomics, Current Opinion in Microbiology, Volume 14, Issue 5, October 2011, Pages 579-586.
8. Primrose S and Twyman R (2006) Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell.
9. Rehm H (2006) Protein Biochemistry and Proteomics, 4th Edition, Academic Press.
10. Teresa Whei-Mei Fan (Editor), Andrew M. Lane (Editor), Richard M. Higashi (Editor) (2012) The Handbook of Metabolomics, Springer ISBN 978-1-61779-618-0.
11. Twyman R. M. (2004), Principles of Proteomics. Taylor & Francis.
12. Twyman RM. (2013) Principles of Proteomics, Second Edition by Garland Science Taylor & Francis Group New York and London.
13. Voit, E.O., 2000 Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists. Ca20RMBridge University Press.

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DEPARTMENT OF MICROBIOLOGY

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20RMB T-303A: INDUSTRIAL MICROBIOLOGY & BIOPROCESSING

(ELECTIVE-1)

SEMESTER-III	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of microbiology industry.

Course Outcomes (COs): Upon completion of this course, students should be able to:

1. Appreciate relevance of microorganisms from industrial context, and to carry out stoichiometric calculations and specify models of their growth,
2. Give an account of design and operations of various fermenters, and to present unit operations together with the fundamental principles for basic methods in production technique for bio-based products,
3. Calculate yield and production rates in a biological production process, and also interpret data,
4. Calculate the need for oxygen and oxygen transfer, and
5. Critically analyze any bioprocess from market point of view, and to give an account of important microbial/enzymatic industrial processes in food and fuel industry.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: FERMENTATION

Raw materials used as media for industrial fermentations. Development of inocula for industrial fermentations. Isolation, preservation and strain improvement of industrially important microorganisms.

Bioreactor – Designing and application of a biofermentor. Aeration, agitation and sterilization of fermentors. Surface, submerged, batch and continuous fermentations. Scale-up of fermentations.

UNIT-II: BIOPROCESSING

Bioprocessing – Recovery of particulates, product isolation, extraction, precipitation, chromatography, centrifugation, me20RMBrane separation, electrophoresis, distillation, super- critical fluid extraction, whole broth processing, integrated product separation, and purification.

Single cell protein (SCP) – Production from cellulose and sewage. Food from microorganisms – edible mushrooms and cultivation of mushrooms (button).

Commercial production of cheese, yogurt, production of flavoring components.

Biofuels – Methane, hydrogen, alcohol (gasohol).

UNIT-III: INDUSTRIAL PRODUCTION

Industrial production of (1) antibiotics – Streptomycin, penicillin, cephalosporin, and tetracycline, (2) biomass production of *Bacillus megaterium*, *Acinetobacter cerificans*, *Candida utilis* from hydrocarbons, (3) organic acids – Citric acid, lactic acid, (4) amino acids

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– L-lysine, (5) enzymes – Amylases, proteases and laccases, stabilization of enzymes, (6) vaccines – rabies, FMD vaccine, hepatitis B, (7) alcohol – ethanol and butanol. Esterification of biofuels, Steroid transformations.

UNIT-IV: LEACHING & IMMOBILIZATION

Microbial leaching – Organisms of leaching, chemistry of microbial leaching, commercial process.

Immobilization of enzymes and immobilization of cells – Methods, applications, advantages and disadvantages. Reco20RMBinant DNA products - interferon.

Fermentation economics – Market potential, some effects of legislation on production of antibiotics and reco20RMBinant proteins, plant and equipment, continuous culture, recovery costs,water usage and recycling, effluent treatment.

Basics of Nanomaterials, Introduction to Nanobiotechnology and role of microbes in Nanobiotechnology and their applications. Bioethics and Biosafety, Intellectual property rights and protection.

Recommended Books & References:

1. Biotechnology Vol III. Dellweg (Editor).1983, VCH.
2. Biotechnology: A Textbook of Industrial Microbiology 2nd edition by Crueger and Crueger. 1990, Sinauer Associates.
3. Concepts in Biotechnology by Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman.2004, Universities Press.
4. Immobilized cells: Principles and Application by Tampion and Tampion.1987, Ca20RMBridge University Press.
5. Industrial Microbiology by Casida.1968, Wiley.
6. Industrial Microbiology by Miller and Litsky.1976, McGraw-Hill.
7. Industrial Microbiology by Thoma.1977, Dowden, Hutchinson & Ross.
8. Methods in Food and Dairy Microbiology by Diliello.1982, Avi Pub. Co.
9. Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd edition) by Glazer and Nikaido.2007, Ca20RMBridge University Press.
10. Microbial Enzymes and Bioconversions by Rose.1980, Academic Press.
11. Microbial Technology Vol I by Peppler and Pearlman (Editors).1979, Academic.
12. Microbial Technology Vol II by Peppler and Pearlman (Editors). 1979, Academic
13. Microbiology: A Laboratory Manual by Cappuccino and Sherman. Pearson Education India
14. Prescott & Dunn's Industrial Microbiology 4th edition Editor Reed. 1982, AVI Pub. Co.
15. Principles of Fermentation Technology (2nd edition) by Stanbury, Whitaker and Hall.1999, Butterworth-Heinemann.

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20RMB T-303B: DAIRY MICROBIOLOGY
(ELECTIVE-1)

SEMESTER-III	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: This course is designed …..
1. To understand concepts in dairy microbiology
2. To complement the students with the basic knowledge of dairy microbiology
3. To acquaint the students with preservation techniques for dairy products

Course Outcomes (COs): After successful completion of this course, students will be able to …..
1. Know the concepts related to popular milk products, milk examination and spoilage.
2. Comprehend knowledge regarding fermented milk products,
3. Understand the milk spoilage and infection,
4. Gain the knowledge in the preparation of dairy products, and
5. Understand diverse strategies for preservation of dairy products.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: MILK & MICROORGANISMS
Milk – Contents and their percent; Microbiology of milk and milk processing; Microbiology of raw milk, processed milk, cream and butter, concentrated milk, flavoured milk and dried milk; Microbiology of ice cream and related products.

UNIT-II: MILK FERMENTATION
Starter cultures-Fermented milk, Therapeutic milk, Butter, Yoghurt, Soft cheese and hard chesses; Introduction to probiotics, prebiotics and synbiotics; Quality control in dairy industry; Hazard Analysis Critical Control Point (HACCP).

UNIT-III: MILK & DAIRY PRODUCTS
Role of microbes in milk and dairy products; Microbiological examination of raw/pasteurized milk, standard plat count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, ability of milk to cause diseases.

UNIT-IV: CONTAMINATION OF MILK
Pathogens: *Arthrobacter spp., Bacillus cereus, Campylobacter* spp., *Clostridium botulinum, Clostridium perfringens, Cronobacter sakazakii, Escherichia coli, Listeria monocytogenes, Mycobacterium, Micrococcus, Salmonella* spp., *Staphylococcus aureus, Yersinia enterocolitica, Aspergillus* spp., *Fusarium* spp., *Mucor, Penicillium, Geotrichum, Cladosporium, Yeast, Phoma* spp., *Gluvaromysis, Beberomysis, Alternaria, Eurotium.*

Cleaning and sanitizing in milk production and processing; Control of microorganisms in dairy processing; Regulatory control of milk and dairy products; Treatment of dairy wastes.

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Recommended Books & References:

1. Britz T., Robinson RK. 2008. Advanced Dairy Science and Technology. Wiley Blackwell.
2. Elmer HM., James S. 2001. Applied Dairy Microbiology. Second Edition. CRC Press.
3. Robinson RK. 2002. Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products. Third edition. Wiley.
4. Yousef AE., Carlstrom C. 2003. Food Microbiology: A Laboratory Manual. Wiley.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB T-304A: AGRICULTURAL MICROBIOLOGY

(ELECTIVE-2)

SEMESTER-III	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: This course is designed .....

1. To impart in-depth information on soil and agriculture
2. To make the students understand the role of microbes in agriculture
3. To give an overview on plant microbe interaction. To understand infection process and control measures
4. To know the importance of biofertilizers and biopesticides
5. To make the students to know about various techniques involved in biofertilizers and biopesticides production

Course Outcomes (COs): By the end of this course students will be able to .....

1. Understand the role of microbes in the different cycles and their role in agriculture,
2. Understand biological nitrogen fixation in sy20RMBiotic and non-sy20RMBiotic associations with plants,
3. To know the value, production, application and crop response of biofertilizers and biopesticides,
4. To have an in-depth knowledge on biopesticides and their role in pest control, and
5. Understand the diseases and causing microorganisms in plants.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: ORGANIC MATTER & MICROORGANISMS

Organic matter – Nature, synthesis and decomposition.

Microbial decomposition of carbonaceous constituents – Cellulose, hemicellulose, starch, pectin, lignin, chitin.

Rhizosphere – Nature, extent, influence of root exudates on microflora, rhizosphere effect and its alteration, plant growth promoting rhizobacteria and siderophore production.

Nature and ecological significance of ectotrophic and endotrophic mycorrhizal associations, survival of soil-borne pathogens.

UNIT-II: CYCLING OF NUTRIENTS

Significance of global nitrogen cycling. Microbiology and ecological significance of ammonification, nitrification and denitrification.

Dinitrogen fixation – Ecology and biology of non-sy20RMBiotic and sy20RMBiotic (including stem- nodulating rhizobia) nitrogen fixation, associative sy20RMBiosis, mechanism of dinitrogen fixation, methods for evaluation of biological nitrogen fixation, significance of nitrogenfixation.

Role of microorganisms in transformations of phosphorus, sulphur and iron.

UNIT-III: BIOFERTILIZERS & BIOPESTICIDES

Biofertilizers – Cultivation, mass production and inoculation of *Rhizobium*, *Azotobacter*, *Azospirillum*, *Azolla* and cyanobacteria, phosphate-solubilizing bacteria. Carrier-based inoculants, methods of application, quality control, agronomic importance.

Recycling of agricultural wastes - Microbiology and biochemistry of biogas production.

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Biopesticides – *Bacillus thuringiensis*, *B. sphaericus, B. popilliae,* microbial control of plant pathogens (baculoviruses). Biocontrol- Microbial control of plant pathogens- Trichoderma. Useful genes from microorganisms for agriculture (herbicide resistant, Bt, viral).

UNIT-IV: PLANT DISEASES

Major plant disease symptoms caused by fungi, bacteria and viruses.
Plant diseases – Principles, symptoms and control measures of the following diseases:
Fungal – Tikka, red rot of sugarcane, *Fusarium* wilts (red gram, cotton and flax).
Bacterial – Blight of rice, citrus canker.
Viral and mycoplasmal – Bud necrosis of groundnut, citrus mosaic, little leaf of brinjal, tomato leaf curl.
Principles of plant disease control.

Recommended Books & References:

1. Biofertilizers in Agriculture and Forestry (3rd edition) by Subba Rao.1993, International Science Publisher.
2. Brock's Biology of Microorganisms (9th edition) by Madigan, Martinko and Parker. 2002, Prentice Hall/Pearson Education.
3. Experimental Microbial Ecology by Burns and Slater.1982, Blackwell Scientific Publications.
4. Fundamentals of Nitrogen Fixation by Stewart.1982, Cup Archive.
5. Introduction to Soil Microbiology by Alexander.1977, Wiley.
6. Introduction to Soil Microbiology by Alexander.1977, Wiley.
7. Microbial Ecology by Campbell. 1977, Wiley.
8. Microbial Ecology: Fundamentals and Applications (4th edition) by Atlas and Bartha.1997, Benjamin Cummings.
9. Nitrogen in the environment by: Nelson and Mc Donald.1978, Academic Press.
10. Plant Pathology by Agrios.1988, Academic Press.
11. Progress in Microbial Ecology by Mukerji, Agnihotri and Singh.1984, Print House (India).
12. Soil fertility and fertilizers by Tisdale, Nelson, Beaton and Havlin.
13. Soil Microbiology and Biochemistry by Paul and Clark..1989, Academic Press.
14. Soil Microorganisms by Gray and Williams.1971, Oliver and Boyd.
15. Soils: An Introduction to soils and plant growth by Miller and Donahue.1990, Prentice Hall.

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20RMB T-304B: FOOD MICROBIOLOGY

(ELECTIVE-2)

SEMESTER-III	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to .....

1. Gain knowledge on the microbes associated with food spoilage, food borne illness and rapid detection of pathogens
2. Gain knowledge to differentiate food spoilage and fermentation, learn the process of fermentation to prepare value added food and microbial enzymes involved in food industry and bio-preservation
3. Learn regulatory aspects in food microbiology.

Course Outcomes (COs): This course should be to help the students to .....

1. Obtain a good understanding of food microbiology and become qualified for a food microbiologist position in industry or in government,
2. Determine microorganisms and their products in foods, understand causes of food spoilage and predict the microorganisms that can spoil a given food, when prepared, processed and stored under given conditions,
3. Understand the causes of food-borne microbial diseases and predict pathogens that can grow in a given food, when prepared, processed and stored under given conditions,
4. Predict the necessary measures to control the spoilage and pathogenic microorganisms in food, and
5. Gain he knowledge in food analysis.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: FOOD PRESERVATION

Microorganisms important in food microbiology: molds, yeast and bacteria – general characteristics, classification and importance. Principles of food preservation, preservation by use of high temperature, low temperature, drying and desiccation. Chemical preservatives and additives. Preservation by radiation.

UNIT-II: SPOILAGE OF FOOD

Factors influencing microbial growth in food: Extrinsic and intrinsic factors. Microbial spoilage of food. Chemical changes caused by the microorganisms during spoilage. Spoilage of fish, meat, poultry, eggs, fruits and vegetables. Detection of spoilage and characterization.

UNIT-III: FOOD BORNE DISEASES

Classification of food borne diseases. Food borne infections: *Brucella*, *Bacillus cereus*, *Clostridium perfringens*, *Yersinia enterocolitica*, *Escherichia coli*, *Salmonella* spp. Food intoxication: Staphylococcal intoxication, Clostridial poisoning (*Clostridium botulinum*). Food adulteration and prevailing food standards in India.

UNIT-IV: FOOD ANALYSIS

Microorganisms as source of food: Single Cell Protein (SCP). Mushrooms and food value of mushrooms. Food conversions: Lactic acid conversions, soyabean conversions and Bakery. Microbiological estimation of food: Sample collection, preparation and analysis techniques.

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Recommended Books & Reference:

1. Food Microbiology, by William C. Frazier and Dennis C. Westhoff, Fourth edition, Tata McGraw-Hill Publishing Company Limited, New Delhi
2. Food science By Norman N. Potler, Joseph H. Hotchkiss. Fourth edition, CBS Publishers and Distributors, New Delhi
3. Modern Food Microbiology by James M. Jay, Fourth Edition, CBS Publishers and Distributors, New Delhi.

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20RBT T-305: EMERGING TECHNOLOGIES IN BIOLOGY

SEMESTER-III	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research toolkit better.

Course Outcomes (COs): After completion of this course successfully, the students will be able to …..

1. Explain the mechanism of function of different microscopes and their applications to biological sciences
2. Explain the basis of 1D and 2D NMR and to interpret NMR spectra of small molecules, and to discuss different techniques in mass spectrometry and their applications to biological sciences
3. Conceptualize mathematical modelling a cellular process from molecular to cellular level
4. Explain technologies employed from single cell to multicellular systems using various approaches used in a laboratory to industrial scale using automated and robotic system for high throughput molecular and cellular analysis for research and development of microbiological products
5. Discuss the process of reco20RMBination and gene editing from a natural defense to development of new technologies for engineering a gene function *in vitro* and *in vivo*.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	3			2		2
CO-2	3	3	3	3	3	2	3	2	2	3			2		2
CO-3	3	3	3	3	3	2	3	2	2	3			2		2
CO-4	3	3	3	3	3	2	3	2	2	3			2		2
CO-5	3	3	3	3	3	2	3	2	2	3			2		2

UNIT-I: IMAGING TECHNOLOGY

Transmission Electron Microscopy, Scanning Electron Microscopy, Cryo Electron Microscopy, Atomic Force Microscopy, 2D-IR microscopy, Confocal microscopy, Fluorescence Lifetime Imaging Microscopy (FLIM), Fluorescence Resonant Energy Transfer (FRET).

UNIT-II: SPECTROSCOPIC TECHNOLOGY

Mass Spectroscopy, LC-MS, GC-MS, Quad-Time of Flight (Q-TOF), Matrix Assisted Laser Desorption Ionisation (MALDI)-TOF, Solution and Solid State Nuclear Magnetic Resonance (NMR) Spectroscopy, Fourier Transform (FT)-NMR, X-ray crystallography, Circular dichroism.

UNIT-III: CRISPR-Cas TECHNOLOGY

History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.

UNIT-IV: TECHNOLOGY OF NANOBODIES

Introduction to nanobodies, co20RMBining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.

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Recommended Books & References:

1. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
2. Chakravarty, R., Goel, S., & Cai, W. (2014). Nanobody: The "Magic Bullet" for Molecular Imaging? Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.
3. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers, C., Songa, E. B., Hammers, R. (1993). Naturally Occurring Antibodies Devoid of Light Chains. Nature, 363(6428), 446-448. doi:10.1038/363446a0.
4. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
5. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity. Science, 337(6096), 816-821. doi:10.1126/science.1225829.
6. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi:10.1016/j.cell.2015.12.041.
7. Ledford, H. (2016). The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a.
8. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). Molecular Imprint of Enzyme Active Site by Camel Nanobodies. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.
9. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). doi:10.1126/science.aad5147.
10. Nelson, P. C., Radosavljević, M., & Bro20RMBerg, S. (2004). Biological Physics: Energy, Information, Life. New York: W.H. Freeman.
11. Phillips, R., Kondev, J., & Theriot, J. (2009). Physical Biology of the Cell. New York: Garland Science.
12. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics:
13. Sidhu, S. S., & Koide, S. (2007). Phage Display for Engineering and Analyzing Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
14. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni, M. (2013). Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody. Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.
15. Steyaert, J., & Kobilka, B. K. (2011). Nanobody Stabilization of G Protein-Coupled Receptor Conformational States. Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
16. Structure, Dynamics, Function. Ca20RMBridge: Ca20RMBridge University Press.
17. Verheesen, P., & Laeremans, T. (2012). Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation. Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.
18. Vincke, C., & Muyldermans, S. (2012). Introduction to Heavy Chain Antibodies and Derived Nanobodies. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-968-6_2.

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20RMB P-301: GENETIC ENGINEERING

SEMESTER-III	CORE COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to provide students with experimental knowledge of genetic engineering.

Course Outcomes (COs): After completion of this course, students should be able to .....

1. Prepare antibiotic selection media and competent cells,
2. Perform la20RMBda phage DNA isolation and restriction mapping of DNA,
3. Gain hands-on experience in gene cloning, protein expression and purification,
4. Perform gene expression in *E. coli* and PCR, RFLP, RAPD and DNA sequencing,
5. Begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2			2			2
CO-2	3		3	3		3	3	2	2			2			2
CO-3	3		3	3		3	3	2	2			2			2
CO-4	3		3	3		3	3	2	2			2			2
CO-5	3		3	3		3	3	2	2			2			2

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of la20RMBda phage DNA
3. Agarose gel electrophoresis and restriction mapping of DNA
4. Construction of restriction map of plasmid DNA
5. Cloning in plasmid/phagemid vectors –Selection of positive clones using blue/white colours.
6. Preparation of helper phage and its titration using M13 mp18/19 vectors.
7. Preparation of single stranded DNA template
8. DNA sequencing
9. Gene expression in *E.coli* and analysis of gene product
10. PCR
11. Reporter gene assay (Gus/CAT/b-GAL)
12. RFLP
13. RAPD

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20RMB P-302: 'OMICS' MICROBIOLOGY

SEMESTER-III	CORE COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The aim is to provide practical training in bioinformatics methods including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.

Course Outcomes (COs): On completion of this course, students should be able to .....

1. Describe the contents and properties of the most important bioinformatics databases,
2. Perform text- and sequence-based searches and analyze and discuss the results in light of molecular biological knowledge,
3. Explain the major steps in pairwise and multiple sequence alignment, explain the principle and execute pairwise sequence alignment by dynamic programming,
4. Predict the secondary and tertiary structures of protein sequences, and
5. Begin a career in bioinformatics by using emerging technologies of OMICs.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1		3	3	3		3	3	2	2			2			2
CO-2		3	3	3		3	3	2	2			2			2
CO-3		3	3	3		3	3	2	2			2			2
CO-4		3	3	3		3	3	2	2			2			2
CO-5		3	3	3		3	3	2	2			2			2

1. Using NCBI and Uniprot web resources.
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, E20RMBL, Genbank, Entrez, Swissprot / TrE20RMBL, UniProt.
4. Similarity searches using tools like BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Phylogenetic analysis of protein and nucleotide sequences.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Using RNA structure prediction tools.
9. Use of various primer designing and restriction site prediction tools.
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).
11. Construction and study of protein structures using Deepview/PyMol.
12. Homology modelling of proteins.
13. Use of tools for mutation and analysis of the energy minimization of protein structures.
14. Use of miRNA prediction, designing and target prediction tools.

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20RMB P-303A: INDUSTRIAL MICROBIOLOGY & BIOPROCESSING

(ELECTIVE-1)

SEMESTER-III	DISCIPLINE SPECIFIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of microbiology industry.

Course Outcomes (COs): Upon completion of this course, students should be able to:

1. Appreciate relevance of microorganisms from industrial context,
2. Carry out stoichiometric calculations and specify models of their growth, and to give an account of design and operations of various fermenters,
3. Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products,
4. Calculate yield and production rates in a biological production process, and also interpret data, and to calculate the need for oxygen and oxygen transfer, and
5. Critically analyze any bioprocess from market point of view, and to give an account of important microbial/enzymatic industrial processes in food and fuel industry.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Fermentation process during curdling – Estimation of lactose, lactic acid, protein and bacterial count.
2. Screening of microorganisms for antimicrobial activity.
3. Strain improvement.
4. Production and estimation of streptomycin/penicillin by dye method.
5. Testing of disinfectants by phenol-coefficient method.
6. Determination of MIC of antimicrobial agents.
7. Screening for amylase producing organisms.
8. Screening for organic acid-producing organisms.
9. Isolation of yeasts.
10. Alcohol fermentation by yeast.
11. Preparation of wine from grapes/fruits.
12. Citric acid production by *Aspergillus niger*, lactic acid fermentation by *Lactobacillus delbrueckii*.
13. Production of xylanase from *Penicillium* sp.
14. Immobilization of microbial cells.

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20RMB P-303B: DAIRY MICROBIOLOGY

(ELECTIVE-1)

SEMESTER-III	DISCIPLINE SPECIFIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: This course is designed .....

1. To understand concepts in dairy microbiology
2. To complement the students with the basic knowledge of dairy microbiology
3. To acquaint the students with preservation techniques for dairy products

Course Outcomes (COs): After successful completion of this course, students will be able to .....

1. Understand the concepts related to popular milk products, milk examination and spoilage,
2. Perform the enumeration of bacteria in milk,
3. Examination of dairy products for spoilage,
4. Gain knowledge regarding fermented milk products, milk spoilage and infection, and
5. Understand diverse strategies for preservation of dairy products.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Enumeration of bacteria in raw and pasteurized milk by SPC method.
2. Determination of quality of a milk sample by 20RMBRT.
3. Detection of nu20RMBer of bacteria in milk by breed-count method.
4. Litmus milk test. 16. Microbial quality of milk products.
5. Microbiological examination of Ice-cream and Dairy products
6. Production and estimation of lactic acid by Lactobacillus sp. and Streptococcus sp.
7. Isolation of food poisoning bacteria from dairy products
8. Production of fermented milk by Lactobacillus acidophilus.
9. Rapid analytical techniques in food quality control using microbial biosensors.
10. Isolation of lactococcal cultures from fermented milks.
11. Examination of purity and activity of starter cultures.
12. Preservation of starter cultures by freeze drying and other methods.
13. Preparation of concentrated starters and quality evaluation.
14. Inhibition of starters by antibiotic residues and other inhibitors
15. Plasmid profiles of some lactococcal cultures.
16. Identification of lactic starters by molecular biology techniques (demonstration).
17. Conjugal transfer of plasmids in lactococci. (demonstration).
18. Production of bacteriocins by LAB.

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20RMB P-304A: AGRICULTURAL MICROBIOLOGY

(ELECTIVE-2)

SEMESTER-III	DISCIPLINE SPECIFIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: Agricultural microbiology course is designed with the objective to provide general introduction of soil and in-depth information on soil microbial diversity and the role of microorganisms in biogeochemical cycling of elements like C,N,P and trace elements and soil fertility.

Course Outcomes (COs): After completion of the course, a student will be able to achieve these outcomes .....

1. The importance of physical, chemical and biological properties of soil.
2. Role of microorganisms in biogeochemical cycling.
3. Microbiology and physiology of degradation of native and organic matter and Nitrogen fixation.
4. The mechanism of plant growth promotion.
5. Production, application and use of microbes as biofertilizers

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Determination of physico-chemical characteristics of the soil environment - Soil texture and pH.
2. Estimation of organic matter content in soils.
3. Study of microbial activity in soil by respirometry (CO_2 evolution).
4. Decomposition of cellulose in soil by microflora.
5. Isolation and study of rhizosphere microflora, determination of R:S ratio.
6. Isolation of *Rhizobium* from root nodule.
7. Population estimation of *Azotobacter* from rhizosphere soil.
8. Population estimation of *Azospirillum* sp. in rhizosphere soil.
9. Population estimation of nitrifiers from rhizosphere soil.
10. Isolation of phosphate solubilising bacteria from rhizosphere soil.
11. Observation of VA mycorrhizae in crop plants.

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20RMB P-304B: FOOD MICROBIOLOGY

(ELECTIVE-2)

SEMESTER-III	DISCIPLINE SPECIFIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to acquaint the students to recent advances in microbiological technologies in food industry to produce new products with desirable characteristics. These include characteristics such as disease and drought-resistant plants, leaner meat and enhanced flavor and nutritional quality of foods.

Course Outcomes (COs): On completion of this course, students should have gained knowledge and skills about recent advances in biotechnologies related to food technology. Students will be able to …..

1. Isolate food borne bacteria (*Campylobacter, Salmonella, Yersinia, E. coli*) from various food sources using differential media,
2. Identify food borne isolates by biotechnological tools,
3. Isolate and characterize food borne viruses (rotavirus, hepatitis virus, polio virus, enterovirus) using biotechnological tools,
4. Detect and enumerate indicator and index microorganisms for food borne pathogens (total enterobacteria, total coliform & aerobic spore former), and
5. Examine the spoilage-causing bacteria and fungi in food samples – fruits, vegetables, bread. This expertise is useful for the students to gain the access into food industries.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Isolation of food borne bacteria (*Campylobacter, Salmonella, Yersinia, E. coli*) from various food sources using differential media.
2. Enumeration of food borne fungi
3. Confirmation of food borne isolates by microbiological tools.
4. Isolation and characterization of food borne viruses (rotavirus, hepatitis virus, polio virus, enterovirus) using biotechnological tools.
5. Detection and enumeration of indicator and index microorganisms for food borne pathogens (total enterobacteria, total coliform & aerobic spore former).
6. Identification of spoilage causing bacteria and fungi of food samples – fruits, vegetables, bread.
7. Determination of TDT.
8. Determination of TDP.
9. Detection and quantification of Aflatoxin B1.
10. Detection of food-borne bacteria by immunoassays.
11. Detection and enumeration of microorganisms present in Utensils.
12. Enumeration and quantification type of microorganisms present in fruit and vegetable.

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13. Isolation and identification of pathogenic microorganisms from canned food.
14. Food preservation methods.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF THEORY QUESTION PAPER

[Two questions from each Unit in two sections]

Time: 3 Hrs **Max. Marks: 70**

Section-A

Answer any four questions

Each question carries 5 marks (4 x 5 = 20 marks)

1.
2.
3.
4.
5.
6.
7.
8.

Section-B

Answer all questions

Each question carries 12.5 marks (4 x 12.5 = 50 marks)

9. A.

   or

   B.

10. A.

    or

    B.

11. A.

    or

    B.

12. A.

    or

    B.

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M.Sc. MICROBIOLOGY

(Effective from 2021-22)

PATTERN OF PRACTICAL QUESTION PAPER

Time: 3 Hours **Max. Marks: 50**

1.	Major experiment	(1 X 15 = 15 M)
2.	Minor experiment	(1 X 10 = 10 M)
3.	Spotters A. B. C. D. E.	(5 X 02 = 10 M)
4.	Record	(10 M)
5.	Viva-Voce	(05 M)

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB T–401A: ENVIRONMENTAL MICROBIOLOGY
(ELECTIVE-3)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms-tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Course Outcomes (COs): On completion of the course, students will be able to …..

1. Understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.
2. Explore the microorganisms present in different environments and their estimations,
3. Identify various recalcitrant pollutants in the environment and molecular approaches to environmental management, and application of biotechnology to assess and control pollution,
4. Understand the biodegradation and bioremediation processes used in the clean-up of the environments, and
5. Explain various methods for treatment and disposal of industrial effluents.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: ENVIRONMENT & MICROORGANISMS

Concept of environment – Structure, function and development. Brief account of the habitat for microorganisms – Soil, water and atmosphere. Microbiology of soil – Diversity, abundance of predominant microorganisms, methods of isolation and estimation. Beneficial and antagonistic interactions among microorganisms. Microbiology of air – Microorganisms and microbial propagules in air, techniques for microbial analysis of air, air-borne pathogens. Microbiology of water – Plankton populations, water-borne pathogens, detection methods for water-borne pathogens, methods of sampling and estimation of water microflora, control of enteric pathogens. BOD and COD measurements.

UNIT-II: ENVIRONMENTAL POLLUTION & MANAGEMENT

Microbial contribution to pollution - pollution by pathogenic microbes, pollution with oxygen-demanding carbonaceous materials, mineral pollutants, heat pollution, pollution by recalcitrant chemicals, oil pollution. Molecular approaches to environmental management – Extracellular genetic transfer, genetic modification, tracking genes in the environment, genetic ecology, application of biotechnology to assess and control pollution.

UNIT-III: BIODEGRADATION & BIOREMEDIATION

Microbial degradation of environmental pollutants – Isolation of microorganisms degrading environmental pollutants by enrichment culture, Recalcitrance of pesticides in soils, their influence on soil microflora, microbial degradation of pesticides with special reference to DDT, genetic exchange in degradation of xenobiotic chemicals. Effect of acid rain on soil microbial processes. Petroleum Microbiology – Historical developments, environmental

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aspects, deterioration of products, petroleum and petrochemical spills, oil recovery, microbial oxidation of hydrocarbons, microbial products from hydrocarbon fermentations, biosynthetic and transformation products. Bioremediation, role of transgenic bacteria.

UNIT-IV: TREATMENT OF INDUSTRIAL EFFLUENTS

Treatment and disposal of industrial effluents – Physical, chemical, and biological treatment. Aerobic process – Trickling filters, towers, biologically-aerated filters (BAFs), rotating biological contactors (rotating disc contactors), rotating drums, fluidized-bed systems, activated sludge process. Anaerobic treatment – anaerobic digestion, anaerobic digesters, anaerobic filters, up-flow anaerobic sludge blankets (UASB). Newer approaches to sewage treatment - starter cultures for treatment processes. Aerobic sewage treatment – Air lift process; aeration with pure oxygen, methane production. Disposal of effluents into seas and rivers, lagoons (oxidation ponds), spray irrigation, well disposal, landfilling, incineration, disposal of effluents of sewers.

Recommended Textbooks & References:

1. Environmental Microbiology by Mitchell. 2009, John Wiley and Sons.
2. Environmental Microbiology by Grant and Long. 1981, Wiley.
3. Environmental Microbiology: A Laboratory Manual by Peppler, Gerba and Brendecke. 1995, Academic Press.
4. Microbial Ecology: Fundamentals and Applications (4th edition) by Atlas and Bartha.1998, Pearson Education India.
5. Introduction to Soil of Microbiology (2nd edition) by Alexander. 1977, Wiley.
6. Brock's Biology of Microorganisms (9th edition) by Madigan, Martinko and Parker.2010, Benjamin-Cummings Publishing Company.
7. Soil Microorganisms by Gray and Williams,1971, Oliver and Boyd.
8. Microbiology of the Atmosphere by Gregory. 1973, Wiley.
9. Aquatic Microbiology by Skinner and Shewar.
10. Microbial Ecology by Campbell.1977, Wiley.
11. Microbial Aspects of Pollution by Skyes and Skinner.1971, Academic Press.
12. Experimental Microbial Ecology by Burns and Slater.1982, Blackwell Scientific Publications.
13. Soils: An Introduction to Soils and Plant Growth by Miller and Donahue. 1990, Prentice Hall.
14. Soil Fertility and Fertilizers by Tisdale, Nelson, Beaton and Havlin.
15. Nitrogen in the Environment by: Nelson and McDonald. 1978, Academic Press.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB T-401B: MARINE MICROBIOLOGY
(ELECTIVE-3)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objective of this course is to provide information about the microbes available in aquatic environment, their role and interaction with environment.

Course Outcomes (COs): After completing this course, students should be able to .....

1. Understand marine environment and ecological features along with its composition and physico-chemical parameters,
2. Explain principal features of microbial diversity in oceans, and to describe and discuss marine microbes in terms of physiological capability and biogeochemical role,
3. Synthesize microbial ecosystem function in pelagic and benthic marine habitats, and to summarize advanced technologies for enumeration of marine microflora,
4. Understand seafood and associated food-borne diseases and characterization of infectious agents of seafood animals, and
5. Discuss HACCP in seafood product and manufacture and EU food hygiene Legislation.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: MARINE MICROBIAL ECOLOGY & DIVERSITY

Introduction: Marine environment, Seawater, Marine sediments, Habitats for marine microorganisms; Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, Viruses, viroids and prions and actinomycetes in coastal, shallow, deep sea, hydrothermal vents, mangrove and in coral ecosystem; Marine Sy20RMBiotic Microorganisms; Ecology: Survival of indigenous organisms and fate of non-indigenous organisms in the marine environment, Predatory-prey relationship (food-web), Degradation of complex molecules, Colonisation of surfaces Chemotaxis, Attachment, Sy20RMBiotic Association; Biogeochemical Processes: Nutrient cycling, Carbon cycle, Nitrogen cycle, sulphur cycle, Iron cycling, Phophorus cycling and other cycles. Photosynthesis, Quorum sensing, Temperature dependent microbial growth, Lethal and mutagenic factors, Protection system from osmotic damage.

UNIT-I: DIVERSITY OF MARINE MICROORGANISMS

Taxonomy of Marine Microorganisms: Prokaryotes: Phototrophs containing bacterial chlorophyll, Cyanobacteria, Prochloron, Gliding bacteria, Budding and appendaged bacteria, Aerobic gram negative rods and cocci, Facultatively anaerobic gram negative rods, Gram negative anaerobic rods and cocci, Gram negative chemolithotrophs (ammonia or nitrogen oxidizing or sulphur bacteria), Methane bacteria, Aerobic positive cocci, Actinomycetes and related bacteria, Spirochaetes, Oceanospiralles, Magnetotactic bacteria, Bdellovibrio, Sulphur and sulphur reducing bacteria. Eukaryotes: Microalgae, Diatoms, Fungi, Yeast, Protozoa; Virus: Classification; Extremophiles.

UNIT-III: TECHNIQUES IN MARINE MICROBIOLOGY

Sampling: Water, sediment and aquatic content (General Experimental Procedures and remote sensing). Direct observation and enumeration of microbes: Light and electron microscopy to study morphology and structure of microbes, Epifluorescence light microscopy - enumeration of marine microbes, confocal laser scanning microscopy - recognition of living microbes within their habitat, Flow cytometry - nu20RMBer and size of particles. Culture-based methods for isolation and identification of microbes: Specific culture media and conditions for growth, Enrichment cultures, Phenotypic testing, Analysis of microbial components for classification and identification. Nucleic acid-based methods: Sequencing of ribosomal RNA genes, Isolation of genomic DNA or RNA from the culture, PCR, Genomic finger printing, GC ratio and DNA-DNA hybridization used in taxanomy, DNA sequencing, Denaturing gradient gel electrophoresis (DGGE) and Terminal restriction fragment length polymorphism (TRFLP), Metagenomics, Fluorescent hybridization for visualization and quantification of microbes, Metatranscriptomics, Metaproteomics and Microarrays.

UNIT-IV: MICROFLORA OF SEA FOOD & DISEASES

Microbiology of healthy organisms: Plants, Invertebrates and Vertebrates; Diseases of Invertebrates: Vibriosis, Shell disease, Gaffkemia, Epibiotic associations, Fungal diseases, Viral diseases, Rickettsial diseases; Diseases of Vertebrates: Bacterial pathogens, fungi, protozoa and viruses; Sea Food Microbiology: Classification of seafood: Chilled and frozen raw fish, Chilled and frozen prepared fish products, Molluscan and crustacean shellfish, Cured, smoked and Dried fish, Fermented fish. Microflora of seafood: Initial flora, Processing and its effect on Microflora, Spoilage and causative flora, Pathogens profile, Pathogens growth and survival; Food born infection and Intoxication caused by seafood microbes: Fish and Shellfish Toxins originated from marine microbes; Microbiological standard for seafood: HACCP in seafood product and Manufacture, EU food hygiene Legislation; Marine Microbes and Biotechnology: Pharmaceutical compounds: Antibiotic, Antiviral, Antitumor compounds; Health promoting products: probiotic, prebiotic, immune-stimulants, enzymes; Other products: Biofuels, Antifouling compounds, Surfactants; Application in different fields: Aquaculture, Food Industry, Biomimetics, Nanotechnology and Bioelectronics.

Recommended Textbooks & References:

1. Gram, L., (2009) Microbial Spoilage of Fish and Seafood, Springer.
2. Krichman, D.L., (2000) Microbial Ecology of the Oceans. Wiley-liss, New York.
3. Madigan MT and J.M. Martinko., (2006) Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA.
4. Munn, C.B., (2004) Marine Microbiology: Ecology and Applications, BIOS scientific Publishers
5. Paul, J., (2001). Methods in Microbiology: Marine Microbiology, Academic Press,
6. Pelczar M.J. Jr., Chan E.C.S. and Kreig N.R., (2001) Microbiology, (5th Edition), Tata McGraw Hill.
7. Reed G, Prescott and Dunn's, (2004) Industrial Microbiology, (4th Edition), CBS Publishers.

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20RMB T–402A: PHARMACEUTICAL MICROBIOLOGY

(ELECTIVE-4)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to equip students with biomanufacturing principles and good manufacturing practices for production of pharmaceuticals, testing their efficacy, drug targeting and delivery methods.

Course Outcomes (COs): Students should develop conceptual clarity and knowledge about systems for quality manufacturing of pharmaceuticals and should be able to …..

1. Understand biotechnological methods for developing pharmaceutical products,
2. Explore biotechnology and microbiology products as medicines for human use,
3. Explain fundamental principles for testing therapeutics and their clinical trials,
4. Aware of drug targeting, principles and its importance in therapeutics, and
5. Understand methods for delivery of biopharmaceuticals.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: HISTORY & DEVELOPMENT

Definition - history of development of pharmaceutical products by biotechnological methods like genetic reco20RMBinant vaccines, microbial and non-microbial products. Scope of biotechnology, microbiology and biochemical products in pharmaceutical industry. Implementation of Rapid Microbiological Methods (RMM) for pharmaceutical laboratories. New drugs - need and design, drug-receptor interactions, antagonisms, biological activity, efficacy and stimulus, receptors and ion channels, ion gating co-operatively effect of solvent on drug-receptor interactions, drug docking.

UNIT-II: TESTING OF PRODUCTS

Methods of testing products for anti-microbial potentials, pharmacological activities and biopesticidal properties - conventional and rapid enzyme inhibitor techniques; *in vivo* methods - use of animal models for confirmation of in vitro properties - transgenic systems - preclinical, toxicological studies - acute, sub-acute, chronic studies. Clinical trials - definition - design - specific objectives - types of clinical trials-phase I, II & II - randomized controlled clinical trials - multicentric double-blind clinical trials - pharmaceutical/drug regulations for commercializing new biotechnology and microbiology products for human use - PDA and Indian regulations.

UNIT-III: BIOLOGICAL PRODUCTS

Biotechnology and microbiology products as medicines and pharmaceutical products: Biochemicals - proteases - ethanol, vinegar, citric acid and glutamic acid; vitamins B12;

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drugs for infection and metabolic, immunomodulatory - insulin - interferons, cytokines as biopharmaceuticals, B-cell growth factors, tissue plasminogen activator. r-DNA based production of regulatory proteins, blood products, hormones, vaccines (eg. Hepatitis B vaccine, HIV vaccine and other vaccines in pipeline), therapeutic enzymes and nucleic acid therapeutics. Application of RELP in forensic, disease prognosis, genetic counseling, pedigree, variation.

UNIT-IV: DRUG TARGETING

Targeting, principles and its importance in therapeutics. Methods in drug targeting, advantages and disadvantages in targeting, protein and peptide-based drug delivery systems. Drug discovery - impact of genomics and related technologies upon drug discovery. Delivery of biopharmaceuticals: Oral delivery systems – Pulmonary delivery – Nasal, transmucosal and transdermal delivery systems. Application of biotechnology and microbiology to animal health and disease diagnosis. Development of kits and their application in disease diagnosis. Gene therapy, vector engineering, strategies of gene delivery, gene replacement, augmentation, gene correction, gene regulation and silencing. Safety and bioethical issues in pharmaceutical technology.

Recommended Textbooks & References:

1. Abbas and Lippincott (2006). A Short Course in Immunology. Blackwell Publishers, New York.
2. Alice Sr. Bringhamtpn, [NY13904] US Drug discovery, Tamas bartifai, Harold L.Dorn's The Scientific world Ltd., Newburry, U.K.
3. Biopharmaceuticals-Walsh, John Willey and Sons, New York 1998
4. Elgert (2004). Immunology by Press London. Practical Manual in Microbiology. Academic Press, New York.
5. Hand Book of Pharmaceutical Biotechnology- Jay P.Rho, Star4lonic The Haworth press.
6. Harlow, David Lane, Panima (2006). Antibodies. A Lab Manual, Ed. Publishers, Bangalore.
7. Masakazu Tsuchiya (2010) Bacterial Endotoxins Test by bioprocess awards
8. Michael J. Miller (2013) The Implementation of Rapid Microbiological Methods by European Pharmaceutical company
9. Pharmaceutical Biotechnology- Daan J.A. Crommelin, Robest D. Sindelar, Daan JA Crommelin Amazon.
10. Physical Methods to Charecterize Pharmaceutical Protines - James. N. Herron, Wim Jiskoor and Daan J.A. Crommelin Amazon. Wm From clone to clinic (Developments in Biotherapy)-Daan J.A. Crommelin and H.Schellekom Amazon.Wm.
11. Sandle, T. (2012). The CDC Handbook: A Guide to Cleaning and Disinfecting Cleanrooms, Grosvenor House Publishing: Surrey, UK
12. Sandle, T. and Saghee, M.R. (2013). Cleanroom Management in Pharmaceuticals and Healthcare, Euromed Communications: Passfield, UK
13. Sandy Rubio (2011) Validation of Microbiological Methods by Business Horizons;
14. Surendra Narain and Ravindra Narain (2004) Immuno Biotechnology by Domirant Publishers, New Delhi.
15. Talwer (2004). Practical Manual in Microbiology. Academic Press, New York.
16. Tim Sandle, (2011) Selection of Microbiological Culture Media and Testing Regimes.

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20RMB T–402B: MEDICAL MICROBIOLOGY

(ELECTIVE-4)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: This course will provide a perspective and exposure to medical aspects of bacteriology, virology, mycology, parasitology and infectious diseases along with concepts of symptoms, pathogenesis, transmission, prophylaxis and control, a conceptual understanding of host-pathogen interactions using well-characterized systems as examples. The student should have a good grasp of disease-causing microbes and their interactions with host.

Course Outcomes (COs): On completion of this course, students should be able to .....

1. Compare and contrast different microbial diseases, including properties of different types of pathogens, and mechanisms of pathogenesis, and to summarize the role of host in infectious disease, including natural barriers to infection, innate and acquired immune responses to infection, and inflammation,
2. Understand characteristic and pathogenic features and prophylaxis of important bacterial species and their causing infections and diagnosis, and to explain antimicrobial chemotherapy, mechanisms of action of clinically used antimicrobial drugs,
3. Identify fungal and protozoan species and their causing allergies and diseases,
4. Understand molecular diagnostic methods in the detection of cancers and viral infections, and
5. Compare and contrast experimental approaches for identifying virulence genes and advantages and disadvantages of each approach for specific pathogens.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	2	3	2	2				2		2
CO-2	3		3	3	3	2	3	2	2				2		2
CO-3	3		3	3	3	2	3	2	2				2		2
CO-4	3		3	3	3	2	3	2	2				2		2
CO-5	3		3	3	3	2	3	2	2				2		2

UNIT-I: HISTORY & PUBLIC HEALTH

Historical developments, public health and importance of communicable diseases. Diagnosis of infectious diseases, guidelines to practice and management. Specimen collection and transport, specimen primary observation, processing and preservation of culture and laboratory safety, Host-parasite interactions in bacterial infections. Bacterial toxins – Types and modes of action, symptoms and syndromes of bacterial diseases. Epidemiology – Transmission of pathogens, pathogenic mechanisms. Nosocomial infections – An overview, classification, epidemiology, host biological environment, physical environment and inanimate environment. Nosocomial infections, urinary tract infections.

UNIT-II: BACTERIAL DISEASES

Cocci and their clinical importance. General characters, pathogenicity and prophylaxis of *Streptococcus*, *Staphylococcus*, *Neisseria, Corynebacterium diphtheriae* and *Clostridium tetani*. Bacilli of medical importance – Gram positive and negative bacilli, endospore-forming aerobic bacilli, acid fast bacilli, *Mycobacterium tuberculosis* and *M. leprae*. Antimicrobial chemotherapy, mechanisms of action of clinically used antimicrobial drugs. Antimicrobial drugs for systemic administration – Penicillins, cephalosporins, tetracyclins, erythromycins, anti-tubercle drugs.

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UNIT-III: FUNGAL & PROTOZOAN DISEASES

Mycotic diseases – Superficial mycosis, deep mycosis, respiratory allergies due to fungi, *Candida albicans*, *Aspergillus fumigatus*, *Blastomyces dermatidis*, mycotic poisoning, Protozoa – Parasitic species, pathogenic and molecular aspects of severe malaria, *Plasmodium vivax* and *P. falciparum*, Amoebiasis, Leishmaniasis. Sources and pathogenic mechanism of *Leishmania* disease.

UNIT-IV: CANCERS & VIRAL DISEASES

Pathology and laboratory diagnosis of virus associated human cancers, Human papilloma virus, Hepatitis B virus, Herpes simplex virus and AIDS virus. Molecular diagnostic methods in the detection of diseases, diagnosis of bacterial infections. Diseases caused by prions – Kuru, CJD disease, sub-acute spongiform, encephalopathy.

Recommended Textbooks & References:

1. A Textbook of Microbiology (6th edition) by Anantanarayan. 2006. Orient Blackswan.
2. Bailey and Scott's Diagnostic Microbiology by Ellen Jo Baron, Lance R. Peterson, Sydney M. Finegold.1994, Mosby.
3. Clinical Diagnosis and Management – Laboratory Methods by John Bernard Henry. 1996, Saunders.
4. Medical Microbiology by Cruickshank Vol. I and II.1975. Churchill Livingstone.
5. Medical Virology. 2000 6th Edi. White and Fenner. Academic Press.
6. Microbiology (4th edition) by Bernard, Davis, Dulbecco
7. Reviews of Medical Microbiology by Jawetz, Melnick and Adebery
8. Textbook of Medical Parasitology (4th edition) by Jayaram Paniker. 2007, Jaypee Brothers, Medical Publishers.
9. Zinsser Microbiology by Joklik, Wille, Amos and Wilfert.1992, Appleton & Lange.

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20RBT T–403: RESEARCH METHODOLOGY & SCIENTIFIC COMMUNICATION SKILLS INBIOLOGY

SEMESTER-IV	GENERIC COURSE	THEORY	60 HOURS	4 CREDITS

Course Objectives: The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Course Outcomes (COs): On completion of the course, students will be able to …..

1. Understand history and methodologies of scientific research, applying these to recent published papers,
2. Understand and practice scientific reading, writing and presentations,
3. Appreciate scientific ethics through case studies,
4. Develop scientific literature reading skills, and
5. Develop formal presentation skills using PPT and effective scientific writing skills.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2					3
CO-2	3	3	3	3	3	2	3	2	2	2					3
CO-3	3	3	3	3	3	2	3	2	2	2					3
CO-4	3	3	3	3	3	2	3	2	2	2					3
CO-5	3	3	3	3	3	2	3	2	2	2					3

UNIT-I: SCIENCE METHODOLOGIES

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology. Preparation for research - Choosing a mentor, laboratory and research question; maintaining a lab notebook.

UNIT-III: PROCESS OF COMMUNICATION

Concept of effective communication - setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences.

UNIT-III: PRESENTATION SKILLS

Formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation and presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

UNIT-IV: SCIENTIFIC COMMUNICATION

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific

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paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Recommended Textbooks & References:

1. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. American Scientist, 78(Nov-Dec 1990), 550-558.
2. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively*. Delhi: Macmillan India.
3. Movie: Naturally Obsessed, The Making of a Scientist.
4. *On Being a Scientist: a Guide to Responsible Conduct in Research.* (2009). Washington, D.C.: National Academies Press.
5. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research*. Oxford: Oxford University Press.

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20RMB T–404A: EMERGING INFECTIOUS DISEASES

(SPECIALIZATION-1)

SEMESTER-IV	SPECIALIZATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: Dr. G. VIJAYA ANANDA KUMAR BABU
PROFESSOR OF BIOTECHNOLOGY

Course Objectives: The objectives of this course are ....

1. To describe and analyze the ecological, environmental, microbial, host and social factors contributing to the emergence and re-emergence of infectious diseases in humans.
2. To develop the ability in assessing the factors that led to the emergence of contemporary emerging infectious disease events and evaluating the options for their control.
3. To critically evaluate the role of the "One health concept" and its role in preventing emergence of, and response to novel infectious diseases.
4. To develop and justify public health response plans to deal with contemporary emerging infections.

Course Outcomes (COs): On completion of the course, students will be able to .....

1. Describe the environmental, ecological, societal, microbial and host factors associated with the emergence of infectious diseases in humans,
2. Analyse the ecological and biological factors that led to the emergence and spread of emerging and re-emerging infectious diseases and critically evaluate the options available for control,
3. Review the strategies and challenges for pathogen eradication and the concept of biosecurity,
4. Identify the agents of emerging diseases and their control and prevention methods, and to explain the problems associated with antibiotic resistance, bioterrorism and biodefence, and
5. Critically evaluate the concept of "One Health" that unites human and veterinary medicine in control of zoonotic and emerging infections.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: INFECTIOUS DISEASES & SOCIETY

Definition – emerging and re-emerging infectious diseases; Critical factors in the emergence or re-emergence of infectious diseases; Disease emergence and transmission of infectious diseases; Impact of infectious diseases on society; Global governance and public health preparedness and response; International efforts to prevent and control infectious diseases. Challenges in infectious disease research.

UNIT-II: AGENTS OF EMERGING INFECTIONS

Zoonotic, protozoan and vector-borne infectious diseases; Specific agents of emerging infectious diseases – Ebola, HIV/AIDS, HTLV, Influenza, MRSA, Norovirus, SARS-CoV-2 and COVID-19, SARS and MERS, Henipaviruses (Nipah and Hendra), Smallpox, Tuberculosis, Tularemia, Lyme disease, Brucellosis, Malaria, Chikungunya, Dengue, West Nile, Yellow Fever, Zika; Pathogens of pandemic potential and pathogens of critical regional importance.

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UNIT-III: ANTIBIOTIC RESISTANCE & THREAT

Definition, types and history of antibiotics; Causes of antibiotic resistance; Mechanisms of antibiotic resistance; Infections resistant to antimicrobial drugs; Categorization of the top drug-resistant threats; Resistance to fluoroquinolone, beta-lactam and colistin antibiotics. Use of bacteriophages to co20RMBat antibiotic-resistant bacteria; Multiple-Drug Resistant (MDR) bacteria; Problems and research of antibiotic resistance.

UNIT-IV: BIOTERRORISM & BIODEFENCE

Historical perspective on biowarfare/bioterrorism; Definition and potential bioterrorism agents – Plague and Anthrax; Classification of bioterrorism agents; Prions, Agroterrorism; Biodefense research. Human microbiome - basics and metagenomics; Research progress on microbiota in health and disease.

Recommended Textbooks & References

1. Antibiotics and Antibiotic Resistance by Ola Sköld (2011) John Wiley & Sons, Inc.
2. Bennett and Brachman's Hospital Infections, ed.6 by William R. Jarvis (2014) Lippincott Williams & Wilkins.
3. Essentials of Clinical Infectious Diseases, Second Edition. by William F. Wright (2018) Springer.
4. Foundations of Infection Control and Prevention by Christine Mcguire-Wolfe (2018) JB Learning.
5. Harrison's Infectious Diseases, ed.3 by Dennis L. Kasper; Anthony S. Fauci (2017) McGraw-Hill Education.
6. Hunter's Tropical Medicine and Emerging Infectious Disease, ed. 10 by Timothy P. Endy; Tom Solomon; David R. Hill; Naomi Aronson (2020) Elsevier.
7. Infectious Disease Epidemiology, 3rd ed. by Kenrad E. Nelson; Carolyn Williams (2014) JB Learning.
8. Infectious Diseases, ed.4 by Jonathan Cohen; William G. Powderly; Steven M. Opal (2017) Elsevier.
9. Introduction to Clinical Infectious Diseases by Joseph Domachowske (Editor) (2019) Springer.
10. Krasner, R. (2010). The Microbial Challenge: Science, Disease, and Public Health (3rd EDITION) (2013) JB Learning.
11. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases, ed.9 by John E. Bennett; Raphael Dolin; Martin J. Blaser (2020) Elsevier.
12. Tropical Infectious Diseases: Principles, Pathogens and Practice, 3rd ed. by Richard L. Guerrant; David H. Walker; Peter F. Weller (2011) Saunders
13. Vaccines for Biodefense and Emerging and Neglected Diseases by Alan D. T. Barrett; Lawrence R. Stanberry (2009) Academic Press.

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Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB T–404B: HERBAL & TISSUE CULTURE TECHNOLOGY

(SPECIALISATION-2)

SEMESTER-IV	SPECIALISATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: Dr. C. KIRANMAI
ASSISTANT PROFESSOR OF BIOTECHNOLOGY

Course Objectives: This course will give a brief understanding of various methods and applications involved in Plant Tissue Culture and Plant Genetic Transformation and their application in crop improvement with the following objectives.

1. To understand concepts and techniques in plant tissue culture,
2. To know concepts on production of secondary metabolites and its enhancement,
3. To understand DNA delivery methods, and
4. To understand concepts on design of gene construct and application of transgenic plants.

Course Outcomes (COs): On completion of this course, students should be able to .....

1. Learn concepts and techniques in plant tissue culture,
2. Learn concepts of production of secondary metabolites and its enhancement,
3. Explain *in vitro* culture methods and applications,
4. Understand how DNA can be delivered into the plant cells, and
5. Design gene construct and apply various methods to produce transgenic plants.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: CONCEPTS & TECHNIQUES IN PLANT TISSUE CULTURE

Totipotency; Tissue culture media; Plant hormones and morphogenesis; Direct and indirect organogenesis; Direct and indirect somatic e20RMBryogenesis; Applications of plant tissue culture – Micropropagation of field and ornamental crops; National certification and Quality management of TC plants; Virus elimination by meristem culture, meristem tip culture and micrografting; Virus indexing – PCR, ELISA; Nucleic acid hybridization and electron microscopy; Artificial seeds. *In vitro* germplasm storage and cryopreservation.

UNIT-II: *IN VITRO* CULTURE METHODS & APPLICATIONS

Callus culture and *in vitro* screening for stress tolerance; Large-scale cell suspension culture - Production of alkaloids and other secondary metabolites - techniques to enhance secondary metabolite production; Biotransformation, Protoplast culture - isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybridization - Production of Somatic hybrids and Cybrids – Applications; Somaclonal and gametoclonal variations – causes and applications.

UNIT-III: DNA DELIVERY METHODS

Plant genetic engineering – DNA delivery methods: vector-mediated method – Agrobacterium tumefaciens and direct DNA delivery methods. Agrobacterium-mediated

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method - Agrobacterium biology; Ti plasmid-based transformation; crown gall and hairy root disease, Ti and Ri plasmids, T-DNA genes, borders, overdrive, chromosomal and Ti plasmid virulence genes and their functions, vir gene induction, mechanism of T-DNA transfer; Ti plasmid vectors, vir helper plasmid, super virulence and monocot transformation, binary vector; Floral dip transformation; Direct DNA delivery methods - protoplasts using PEG; electroporation; particle bo20RMBardment; Chloroplast transformation and transient expressionby viral vectors.

UNIT-IV: DESIGN OF GENE CONSTRUCT & APPLICATION OF TRANSGENIC TECHNOLOGY

Factors influencing transgene expression – designing gene constructs - Promoters and polyA signals; Protein targeting signals; Plant selectable markers; Reporter genes; Positive selection; Selectable marker elimination; Transgene silencing; Strategies to avoid transgene silencing; Analysis of transgenic plants – PCR, Western blot and ELISA; Applications of transgenic crop technology - Herbicide resistance; Insect Resistance, Virus Resistance, Resistance to Bacterial and Fungal diseases, Drought Resistance, Modifications of seed Protein Quality, Golden Rice, Molecular pharming - production of antibodies and pharmaceuticals in plants.

Recommended Textbooks & References:

1. Adrian Slater, Nigel Scott and Mark Fowler. (2008). *Plant Biotechnology - the Genetic Manipulation of Plants*. Second Edition. Oxford University Press.
2. Bhojwani and Dantu, (2013). *Plant Tissue Culture: an Introductory Text*, Springer, New Delhi.
3. Bhojwani, S.S and Razdan. M.K. (2009). *Plant Tissue Culture-Theory and Practice*. Elsevier India Pvt. Ltd
4. Cassells, A. C and Peter B. Gahan. (2006). *Dictionary of Plant Tissue Culture*. Food Products Press, an Imprint of the Haworth Press, Inc., New York-London-Oxford
5. *Genetic Transformation* - http://www.intechopen.com/books/genetic-transformation
6. *Genetic Transformation* - https://link.springer.com/book/10.1007% 2F978-3-662-07424-4
7. *Introduction to Molecular Biology and Genetic Engineering* - http://www.fao.org/ docrep/014/i1905e/i1905e00.pdf.
8. Paul Christou and Harry Klee. (2004). *Handbook of Plant Biotechnology*, 2nd volume set, Wiley publisher.
9. *Plant Tissue Culture*- https://link.springer.com/book/10.1007%2F978-81-322-1026-9
10. *Plant Tissue Culture, Development and Biology* - http://www.ebook777.com/plant-tissue-culture-development-biotechnology/

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DEPARTMENT OF MICROBIOLOGY

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20RMB T–404C: MOLECULAR DIAGNOSTICS
(SPECIALISATION-3)

SEMESTER-IV	SPECIALISATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: Dr. UDAY SANKAR ALLAM
ASSISTANT PROFESSOR OF BIOTECHNOLOGY

Course Objectives: The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including the pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Course Outcomes (COs): On completion of the course, students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases and able to …..

1. Explain basic molecular and advanced approaches for diagnosis,
2. Explore flow cytometry and its applications,
3. Identify variations in DNA and its association with specific disease,
4. Understand different immunogenetic techniques and their applications in diseases, and
5. Explain the genetic counselling and its importance in identifying diseases and associated ethical issues.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: BASIC MOLECULAR DIAGNOSTICS

Historical perspective of clinical diagnosis and molecular diagnostics; Nucleic acid-based diagnosis: Extraction of Nucleic acids: sample collection, methods of extraction from various diagnostic materials, assessment of quality, storage: Nucleic acid hybridization: Blotting Techniques and their interpretations: Southern and Northern Blotting methods and applications in clinical diagnosis: Polymerase Chain Reaction: Principle, components, optimization and analysis of PCR products: PCR based methods for mutation detection and gene expression: Real-Time PCR, ARMS, QF-PCR, OLA and primer Extension: Electrophoresis: PAGE and Capillary Electrophoresis: Application of electrophoresis in DNA Diagnosis-SSCP, heteroduplex analysis, denaturing gradient gel, detection of mismatched nucleotides /RNA-DNA duplexes; RFLP and DNA sequencing in the clinical diagnostics.

UNIT-II: ADVANCED TECHNIQUES IN MOLECULAR DIAGNOSIS

Testing DNA variation for disease association: SNPs; Methods of typing: Traditional approaches (PCR-Sequencing), Microchips (Affymetrix) and Taqman: Microarray in analysis of gene expression; DNA microarray platforms: cDNA analysis, oligonucleotide arrays: Introduction to SAGE, CGH, array CGH and SNP arrays: Analysis of DNA methylation: Methylation in health and disease; Principle and inheritance; DNA methylation in pathology and cancer: PCR based methods in detection of methylation; Bisulfite modification and methylation-specific PCR and Restriction analysis; Real-Time PCR methodologies (MethyLight), Profiling and arrays: Primer Designing for MSPs; Application of DNA methylation in disease diagnosis: cancer (malignancies) and imprinting disorders.

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UNIT-III: CYTOGENETIC TECHNIQUES

Flow Cytometry and LCM: Principle; Clinical applications: enumeration of peripheral; blood cells in HIV infection and Immunophenotype Characterization in various blood disorders; Laser Capture Microdissection and separation of normal and aberrant cells: application and perspective in molecular diagnostics; Molecular Cytogenetic: Chromosomal abnormalities and indications of chromosomal evolution; Fluorescence in situ Hybridization; General procedures of FISH, M-FISH, SKY and CGH; Clinical applications of FISH: Correlation with the pathobiology of disease, disease prognosis and monitoring, correlation with molecular data; protein-based molecular diagnostics: Immunoproteomics and detection methods based on Antigen-Antibody interactions; ELISA; Western Blotting and Far Western Blotting applications and perspectives; Immunohistochemistry and Immunocytochemistry: Methods and interpretations: application in tumour diagnosis and infectious diseases; correlation with molecular data.

UNIT-IV: IMMUNOGENETIC TECHNIQUES & GENETIC COUNSELING

HLA Typing: HLA/MHC genetic; Molecular methods of HLA typing; PCR–Sequence specific Primers; Sequence-Specific Oligonucleotide probe Hybridization, Forensic Diagnosis: DNA typing: Overview; Techniques for human identification; Evidence collection and sample preparation; PCR amplification of STR loci: Electrophoresis and data analysis: Molecular Diagnosis and Genetic Counselling: Clinical genetic services; Uses of genetic testing; components of genetic counselling process; Genetic Counselling and Genetic testing; Ethical, social and legal issues related to molecular genetic testing; Informed consent for clinical testing and research; Confidentiality and Discrimination; Gene patenting.

Recommended Textbooks & References:

1. Coleman WB & Tsongalis GJ (2006) Molecular Diagnosis for the Clinical Laboratories, 2nd Edition, Human Press.
2. Darby & Hewiston, (2006). In Situ Hybridization Protocols, (3rd edition), Human press.
3. Francesco Falciani. (2007), Microarray Technology through Applications, Taylor & Francis.
4. Iankowski & Polak, (1996) Clinical Gene Analysis and Manipulation: Tools, Techniques and Trouble Shooting, 1st Edition, Ca20RMBridge University press.
5. Jochen Decker, Molecular Diagnosis of Infectious Diseases, Human press.
6. Sharpe & Carter, (2006). Genetic Testing, Care, Consent & Liability, Wiley-Liss.

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DEPARTMENT OF MICROBIOLOGY

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20RMB T–404D: PROBIOTICS, PREBIOTICS & FEED TECHNOLOGY

(SPECIALISATION-4)

SEMESTER-IV	SPECIALISATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: Dr. G. MARY SANDEEPA
ASSISTANT PROFESSOR OF BIOTECHNOLOGY

Course Objectives: This course will give a brief understanding of various methods and applications involved in the processing of prebiotics, probiotics, and feed. It will also give a general outline of various safety norms that should be taken care of.

Course Outcomes (COs): On completion of this course, students should be able to…..

1. Have basic understanding of the biotechnology involved in probiotics, prebiotics and feed,
2. Apply this knowledge for future research,
3. Explain various methods for analysis of intestinal microflora,
4. Identify physical, chemical and biological effects of feed processing, and
5. Apply probiotics for humans, farm animals and poultry, and to understand health hazards due to residual pesticides in feeds.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: HISTORY & SCOPE

Introduction, history, scope of Probiotics, Probiotics and Feed Biotechnology; normal microflora of GI tract; Introduction to feed processing and preservation, microbial bioconversion of lignin and cellulose-rich feeds, factors affecting delignification; Role of microbes in rumen fermentation in ruminant animals; Methane gas production manipulation by biotechnology tools.

UNIT-II: METHODS OF ANALYSIS

Methods for analysis of intestinal microflora, microorganisms and proteins used in probiotics, Mechanism of action of prebiotics and probiotics, immune response to probiotics, anti-mutagenic and anti-tumour activities of lactic acid bacteria, probiotics and immune system, lactic acid bacteria as live vaccines; Genetic modification of intestinal lactobacilli and bifidobacteria, reco20RMBinant probiotics; Genetic manipulation of organisms to enhance bioconversion ability, manipulation of rumen fermentation by selective removal of protozoa and fungi.

UNIT-III: FEED PROCESSING & TECHNOLOGY

Methods of feed processing - physical, chemical and biological effect of processing on nutritional quality and utilization; Diversity of organisms involved, fermentation techniques, large scale bioconversion of substrates, pretreatment of feeds, chemical vs. microbial treatment of feeds, anti-nutritional factors present in feeds, microbial detoxification of aflatoxins, mimosine and other anti-metabolites present. Role of probiotics and prebiotics in inducing gut immunity.

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UNIT-IV: APPLICATIONS & SAFETY CONCERNS

Application of probiotics for humans, farm animals and poultry, probiotics and intestinal infections, lactose intolerance, probiotics regulatory issues; Sy20RMBiotics, traditional probiotic products, probiotics-industrial perspective, contradictions, precautions and adverse reactions; Effect of feed additives like antibiotics, methane inhibitors, genetic manipulation of rumen microflora to improve feed utilization, single-cell protein as animal feed. Health hazards due to residual pesticides in feeds.

Recommended Textbooks & References

1. Ana Paula do Carmo and Koen Venema Eds. (2015). *Probiotics and Prebiotics: Current Research and Future Trends*, Caister Academic Press.
2. Asa Ljungh and T. Wadstrom, Eds. (2009). *Lactobacillus Molecular Biology: from Genomics to Probiotics,* Caister Academic Press.
3. Gerald W. Tannock, Caister, (2005). *Probiotics and Prebiotics: Scientific Aspects* Ed. Academic Press.
4. Huffnagle GB and Wernick S (2007). *The Probiotics Revolution: the Definitive Guide to Safe, Natural Health,* Bantam Books.
5. Kalidas S, Paliyath G, Pometto A and Levin RE. (2004). *Functional Foods and Biotechnology*, CRC Press.
6. Perdigon G and Fuller R. (2000). *Probiotics: Immunomodulation by the Gut Microflora and Probiotics*, Springer.

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB T–404E: MOLECULAR PHYLOGENY & NUTRACEUTICALS OF MARINE SOURCES

(SPECIALISATION-5)

SEMESTER-IV	SPECIALISATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: DR. K.V.L. SHRIKANYA RAO
ASSISTANT PROFESSOR OF BIOTECHNOLOGY

Course Objectives: This course will give a brief understanding of various methods and applications involved in marine sciences with following objectives.

1. To acquaint knowledge about general outlines of marine resources,
2. To gain insights into the concepts of molecular phylogeny and its application in the taxonomic identification of fish species,
3. To better understand the scope of genetics and application of biotechnological principles in fisheries, and
4. To gain knowledge about the nutraceuticals and bioactive compounds from marine sources.

Course Outcomes (COs): On completion of this course, students should be able to …..

1. Know about the marine ecosystem and understand the ocean management practices (national and international),
2. Understand the applications of different biotechnological techniques and process in exploring the potential marine organism utilizations,
3. Gain the knowledge in role of genetics in fisheries research and use of genetic tools in aquaculture industry,
4. Understand the basic knowledge on how to isolate the bioactive compounds from marine origin and use of those compounds in various fields (biomedical, chemical industry, food industry, cosmetics, etc.). One can apply his own ideas in future research to obtain noble outcome (for the benefit to mankind and to protect our environment), and
5. Finally, the student may get an opportunity to do his/her research in marine sciences, join as a researcher in research institutes and fetch a job in aquaculture sector, oceanography information centers, pharmacy, etc.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: OCEANOGRAPHY & MARINE BIOLOGY

Physical environmental factors: Temperature, pressure, ocean currents, tides, waves, substratum, abrasion. Chemical environmental factors: oxygen, carbon dioxide and carbonates, hydrogen sulphide, hydrogen-ion concentration, inorganic salts, dissolved organic matter. Classification of marine habitat. Law pertaining to the seas. Microbes in the sea: viruses, bacteria, fungi, microalgae and protozoans and their classification. Microbes in extreme environments and their significance- thermophiles, psychrophiles, halophiles and barophiles.

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UNIT–II: MOLECULAR TAXONOMY & PHYLOGENETICS

Molecular Basis of Evolution: Genome structure; Sources of genetic variation (Reco20RMBination, Mutations, Indels, Gene duplication); fast and slow-evolving sequences; Homologous, Paralogous and Orthologous genes. Concept of Neutral theory of molecular evolution. Evolution and Speciation (Allopatric, Sympatric and Parapatric speciation), Factors responsible for speciation. Phylogenetic species concept, Phylogenetic trees, Concept of monophyly, paraphyly and polyphyly. Genetic distances: observed and expected distances, Phylogenetic reconstruction using distance and character-based methods, Maximum Parsimony, Maximum Likelihood and Bayesian Inferences.

UNIT-III: ADVANCES IN FISHERIES & GENETICS

Scope and importance of fish genetics: Chromosomal polymorphism, Gynogenesis, androgenesis, production of super males. Genetic improvement in fish. Population genetics: Changes in allelic and genotypic frequency, effective population size, inbreeding and coefficient. Genome size in fishes, Mechanism of variations in genome size. Karyotyping and chromosome banding- C-banding, G-banding, NOR banding. Transgenic biology, allopheny. Applications of gene cloning in aquaculture. DNA markers: Allozymes, RFLP, VNTRs, Satellite DNA, Minisatellite DNAs, Microsatellite DNAs, RAPD, RFLP, AFLP, Mitochondrial DNA, Expressed sequence Tag (EST), Single Nucleotide Polymorphism (SNP). Transcriptome associated markers - Type I markers. DNA marker maps: Radiation hybrid mapping and integrated maps.

UNIT-IV: NUTRACEUTICAL & BIOACTIVE COMPOUNDS

Commercially important and potential species, Isolation and culture methods of microalgae, macroalgae, aerobic and anaerobic microbes from sea. Extraction and screening of bioactive compounds. Marine natural products act at me20RMBrane receptor; Marine natural products as: Antibacterial, antifungal, antiparasitic, antitumor compounds, tumor promoters, cytotoxic, anti-inflammatory, analgesic compounds, antiviral agents, anticoagulant, antithro20RMBic, antilipidemic compounds and used for drugs, cosmetics and food supplements. Marine lipids, Polysaccharides, Marine probiotics, Marine natural pigments, Chitosan, commercially important marine peptides/enzymes, Vitamins and biofuel from micro algae. Metabolites affect microfilament-mediated processes. Clinical applications of marine proteins. Marine toxins: Saxitoxin, brevitoxin and ciguatoxin. Marine peptides & alkaloids: pyridoacridine, pyrrolocridine indole, pyrrole, isoquinoline, alkaloids. Role of biotechnology in marine pollution control.

Recommended Textbooks & References:

1. Avise J.C. (1994) Molecular Markers, Natural History and Evolution. Springer, US, 516pp.
2. Bhakuni, D.S. & Rawat, D.S. (2005) Bioactive Marine Natural Products. Springer-Anamaya, New York, New Delhi, 382pp
3. David H Attaway and Oskar R Zaborsky. (1993) Marine Biotechnology, volume I Pharmaceutical and Bioactive Natural Products. New York, London. Plenum Press. 500pp.
4. T.J. Pandian, C.A. Strussmann & M.P. Marian (eds). (2005) Fish Genetics and Aquaculture Biotechnology. Science Publishers, Enfield, USA, 162 pp
5. Fusetani, N. (2000) Drugs from the Sea. Karger Publisher, Switzerland, 158 pp.
6. Johnston R (ed) (1976). Marine pollution. Academic Press, London, p 729.
7. Kirchman, L., (2008) Microbial Ecology of the Oceans. Second edition, John Wiley and Sons.
8. Lemey, P., Salemi, M & Vananmme, A-M. (2009). The Phylogenetic Handbook: A Practical Approach to Phylogenetic Analysis and Hypothesis Testing. Ca20RMBridge University Press.UK, 749 pp

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9. Lodge, J., Lund P. & Minchin S. (2007) Gene Cloning. Taylor and Francis, UK, 462 pp
10. Nei, M. & Kumar, S. (2000) Molecular Evolution and Phylogenetics. Oxford University Press, NY, 348 pp.

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11. Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna (2005) Textbook of Fish Genetics and Biotechnol. ICAR
12. Riley, J.P. and Chester, R. (1989) Introduction to Marine Chemistry. Academic Press, New York.
13. Srivastava, C.B.L. and Mahal, K. (1999) A textbook of fishery science and Indian fisheries. Shree Publishers.
14. Sumich, J.L., (1999). Introduction to the Biology of Marine life. Seventh Edition. The Mc Graw Hill Companies Inc.
15. Sverdrup, H.U., Johnson, M.W. and Fleming, R.H. (1958) The Oceans- their Physics, Chemistry and General Biology, Prentice- Hall Inc. New Jersey.

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Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB T–404F: TRANSLATIONAL RESEARCH IN ANIMAL SCIENCES

(SPECIALISATION-6)

SEMESTER-IV	SPECIALISATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: Dr. S.B. SAINATH
ASSISTANT PROFESSOR OF BIOTECHNOLOGY

Course Objectives: Translational Research is an applied science wherein knowledge gained through basic research is useful for the welfare of human health. There are four units covered in this course. Unit-I encompasses analytical, molecular and *in silico* approaches used in biomedicine. Unit-II introduces translational research and their applications to the students. In addition, this unit also provides insights into how translational research using different animal models are useful to treat human diseases. Unit-III covers different areas of translational research and their applications in biomedicine. Unit-IV is designed to gain knowledge about how "bench to bedside research" is crucial for human health care system, translational research in reproductive medicine is taken as example. This unit emphasizes how basic research in animal models and application of emerging technologies in reproductive medicine are directly benefit humans. Following are the course objectives.

1. The central objective of this course is to introduce the translational research in animal sciences to students,
2. Students will be able to gain the basic principles and "bench to bedside" applications of translational research in biomedicine, and
3. Students will be able to understand various facets of translational science and how it impacts human health.

Course Outcomes (COs): On completion of this course, students should be able to understand as follows…..

1. Knowledge: Students will be able to understand the potential of different model systems (in vivo and in vitro) in translational research,
2. Career opportunities: Successful completion of this course will give ample opportunity for students to enter different fields such as pharma companies, clinical labs, biomedical engineers and computational biologists and also research programs,
3. Out-of box thinking abilities: Students will be encouraged to design research problem for their project work (in this area or area of their choice of interest). This stimulates out-of-box thinking abilities,
4. Scientific temperament: Students will be able to understand three fundamental aspects of translational research: what to seek; how to seek; and why to seek?, and
5. Innovative thinking: Promote innovative thinking among the students wherein they translate their ideas into commercially relevant and societal applicability.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: TOOLS IN TRANSLATIONAL RESEARCH

Analytical, biochemical and Molecular techniques: HPLC, GC and LC/LC-MS; Flow cytometry; 2D gel electrophoresis; 2D DIGE, EMSA; AAS; FT-IR assays; Western Blotting; ELISA; NMR; CRISPR/Cas-9 technology; rDNA technology; qPCR; COMET assay;

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Reporter assays using animal cell culture; Confocal microscopy; TEM and SEM; MRI; X-rays; Bioreactors; Microarrays; Next generation sequencing; *In silico* analysis: Molecular docking tools, and ADME analysis; QSAR studies; Subtractive genomics; *In vivo* live cell imaging techniques.

UNIT-II: MODELS IN TRANSLATIONAL RESEARCH

Translational research: definition, applications, National and International status; *In vivo* animal models: Fishes (zebrafish) and Mammals (mice, guinea pigs, rats, rabbits); *Amphioxus*; Invertebrate models: molluscs, *Drosophila* and *Caenorhabditis elegans*; Extrapolation of animal studies to humans; *In vitro* models: Cell lines in translational research; Transgenic animals: general concepts; and applications; Organs-on-a chip; Translational aspects of the microbiome. General outlines and applications of translation research in *in vivo* and *in vitro* models and their relevance to humans (Eg: Cancer research, neuromedicine, infectious diseases, regenerative medicine, metabolic diseases; immunotherapy and reproductive medicine); Bioreactors in tissue engineering.

UNIT-III: EMERGING AREAS IN TRANSLATIONAL RESEARCH

Epigenetics and epigenomics: Definition, processes (Methylation, Sumoylation; Ubiquitylation; Acetylation, Phosphorylation) and mechanisms; Integrated Omics (Genomics, proteomics, metabolomics and transcriptomics); Biomarkers for diagnosis, diseases, and prognosis; Nanomedicine: General outlines, inorganic and organic nanoparticles in biomedicine, and emerging challenges; Predictive toxicology: Tox-21 library and machine learning programs (support vector machines, random forest, decision trees, neural networks; regression models; *K*-nearest learning and ense20RMBle learning); General outlines and applications of emerging areas: Drug design and development, Nutritional therapeutics, Systems biology, Computational biology, Stem cell Research and Therapy.

UNIT-IV: TRANSLATIONAL RESEARCH IN REPRODUCTIVE MEDICINE

Mice and rat models as translational tools in reproductive medicine; anatomy and physiological events: Gametogenesis and steroidogenesis; Endocrine regulation of reproduction; Endocrine disruption by man-made chemicals; Developmental exposure studies; Reprotoxic endpoints: biochemical, molecular and developmental land marks, teratogenic, histological, and Fertility efficacy); Translational tools: Application of 'omics', nanotechnology, nutritional therapeutics, (plant-based pharmaco-active compounds and antioxidants) and transgenic technology in reproductive research.

Recommended Textbooks & References:

1. Wilson and Walker (Seventh Edition), Principles and techniques of Biochemistry and molecular biology, Ca20RMBridge University Press, New York (2007)
2. Andreas D. Baxevanis and B. F. Francis Ouellette (Eds), Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition (2001)
3. Rodwell, V. W., Kennelly, P. J., Bender, D., Botham, K. M., & Weil, P. A. Harper's Illustrated Biochemistry 31/e (31th ed.). New York : Blacklick: McGraw-Hill Education McGraw-Hill Companies, (2018)
4. Shayne C. Gad (Ed), Animal Models in Toxicology (3rd edition), CRC Press (2018)
5. Ramesh Gupta (3rd edition), Reproductive and Developmental Toxicology, Academic press (2022)
6. Zarcovik (Ed), Antioxidiants and second messengers of free radicals, (2019), Freely available online (MDPI)
7. Parekattil, S., Esteves, S., Agarwal, A. (Eds) Male Infertility. Springer, Cham (2020).
8. Sobti and Sobti (Eds); Biomedical Translational Research. Springer Singapore (2022)

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9. Wang X (Ed) Translational Animal Models in Drug Discovery and Development. Bentham Books (2012)
10. Warnik JE and Kauleff, AV (Eds) Translational Neuroscience in Animal research, Ist edition. Nova Science Pub Inc; (2010)
11. E.R. Banerjee (Ed). Perspectives in Translational Research in Life Sciences and Biomedicine. Springer, Singapore (2016)
12. J Pradeep Kiran and S.B. Sainath (Eds). *Brucella Melitensis*: identification and characterization of potential drug targets. Elsevier Publisher (2021)
13. Published articles: useful links

https://www.frontiersin.org/articles/10.3389/fenvs.2016.00011/full
https://link.springer.com/chapter/10.1007/978-94-024-1045-7_3
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8936165/
https://www.pnas.org/doi/10.1073/pnas.1515202112
https://www.sciencedirect.com/science/article/pii/S135964461830518X
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3204888/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3361696/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6179858/
https://translational-medicine.biomedcentral.com/articles/10.1186/s12967-021-02747-zhttps://www.sciencedirect.com/science/article/pii/S0895435620310945

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20RMB T–404G: MOLECULAR DRUG DISCOVERY &DEVELOPMENT

(SPECIALISATION-7)

SEMESTER-IV	SPECIALISATION	THEORY	60 HOURS	4 CREDITS

COURSE INSTRUCTOR: Dr. VIDYA PRABHAKAR KODALI
ASSISTANT PROFESSOR OF BIOTECHNOLOGY

Course Objectives: This course will give a broad overview of research and development carried out in industrial setup towards drug discovery.

Course Outcomes (COs): After completion of this course successfully, the students will be able to……

1. Understand the concept of drug discovery in terms of target identification, target validation, assay development, drug screening and lead identification,
2. Conceptualize the process of lead optimization and the role of efficacy and toxicity *in-vitro* and *in-vivo*,
3. Understand the process of further development of a candidate drug for its stabilization, pharmacology and pre-clinical assessment.
4. Familiarize regulatory guidelines from IND application to clinical development.
5. Orienting towards current practices of pharmaceutical industry for drug development.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	2	3	2	2	2				3	3
CO-2	3	3	3	3	3	2	3	2	2	2				3	3
CO-3	3	3	3	3	3	2	3	2	2	2				3	3
CO-4	3	3	3	3	3	2	3	2	2	2				3	3
CO-5	3	3	3	3	3	2	3	2	2	2				3	3

UNIT-I: TARGET IDENTIFICATION & SCREENING

Identification of target or drug leads associated with a particular disease by a nu20RMBer of different techniques including co20RMBinations of molecular modeling, co20RMBinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors.

UNIT-II: MOLECULAR MODELLING

Drug/receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of co20RMBinatorial libraries of drug-like molecules, macromolecularand chemical databases.

UNIT-III: LEAD OPTIMIZATION

Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a function of its physicochemical parameters

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such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, *etc.*; Bioanalytical assay development in support of *in vitro* and *in vivo* studies (LC/MS/MS, GC/MS and ELISA).

UNIT-IV: PRECLINICAL DEVELOPMENT

Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies. Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.

Recommended Textbooks & References:

1. Brody, T. (2016) *Clinical Trials: Study Design, Endpoints and Biomarkers,* Drug Safety, and FDA and ICH Guidelines. Academic Press.
2. Krogsgaard-Larsen *et al. Textbook of Drug Design and Discovery*. 4th Edition. CRC Press.
3. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
4. Nally, J. D. (2006) *GMP for Pharmaceuticals*. 6th edition. CRC Press

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20RMB P–401A: ENVIRONMENTAL MICROBIOLOGY

(ELECTIVE-3)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objective of this laboratory course is to provide practical skills on environmental biotechnology techniques.

Course Outcomes (COs): After completion of this course successfully, the students will be able to……

1. Estimate different microorganisms from various sources,
2. Study of different enzyme activities in soil,
3. Observe root nodules in various legumes,
4. Analyse the pesticidal effects on microflora, and
5. Observe ammonification and nitrification levels in soil samples, and to study of coliforms in sewage samples.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Estimation and enumeration of bacteria, actinomycetes and fungi in soil by dilution-plating method.
2. Isolation of *Azospirillum* spp. from soil by enrichment culture technique.
3. Soil enzyme activities - Urease, catalase.
4. Observations of root nodules of legumes.
5. Effects of pesticides on populations of bacteria in soil.
6. Effect of pesticides on pure cultures of bacteria.
7. Enumeration of microflora in water samples.
8. Qualitative and quantitative analysis of sewage for coliforms.
9. Differentiation of coliforms isolated from sewage.
10. Observation of air-borne microflora by Petri plate exposure.
11. Winnogradsky column.
12. Ammonification and nitrification in soil.

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20RMB P–401B: MARINE MICROBIOLOGY
(ELECTIVE-3)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to teach fundamental biochemical, microbiological and molecular biological laboratory techniques for investigating experimental problems. Using data generated in a range of experiments, students should be able to apply relevant theoretical concepts to analyze the data and evaluate experimental outcomes.

Course Outcomes (COs): Upon successful completion of this course, students are expected to demonstrate competence in the laboratory techniques employed in molecular biology and fisheries, conservation and oceanography experiments, and should be able to …..

1. Prepare differential media for marine microorganisms,
2. Isolate and purify bacteria from marine sources
3. Demonstrate drug resistance and antibiotic sensitivity on marine organisms
4. Study growth conditions for various marine microorganisms
5. Screen for bioactive compound producing bacteria

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Preparation of media for cultivation of bacteria (differential and selective).
3. Isolation of bacteria in pure culture by streak plate method.
4. Study of colony and growth characteristics of some common bacteria: *Bacillus, E. coli, Staphylococcus, Streptococcus, etc.*
5. Preparation of bacterial smear and Gram's staining.
6. Enumeration of bacteria: standard plate count.
7. Antimicrobial sensitivity test and demonstration of drug resistance.
8. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
9. Determination of phenol co-efficient of antimicrobial agents.
10. Determination of Minimum Inhibitory Concentration (MIC)
11. Isolation and identification of bacteria from soil/water samples.

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20RMB P–402A: PHARMACEUTICAL MICROBIOLOGY

(ELECTIVE-4)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objectives of this course are to provide practical skills on production of pharmaceuticals, testing their efficacy, drug targeting and delivery methods.

Course Outcomes (COs): After completion of this course successfully, the students will be able to…..

1. Develop pharmaceutical products using biotechnological methods,
2. Identify biotechnology and microbiology products as medicines for human use,
3. Test efficacy of therapeutics and biological drugs,
4. Apply drug targeting methods for various pharmaceuticals, and
5. Perform various experiments on the production Understand methods for delivery of biopharmaceuticals.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Screening of citric acid and lactic acid producing microorganisms.
2. Screening of cellulase, amylase and protease producing microorganisms.
3. Production of fungal amylase by solid state or submerged fermentation.
4. Partial purification of amylase by ammonium sulphate precipitation and dialysis/column chromatography and calculation of specific activity and fold purification.
5. Determination of KLa of laboratory fermenter.
6. Sterility testing of pharmaceutical products by direct inoculation and me20RMBrane filtration methods as per Indian Pharmacopoeia (IP).
7. Cell disruption by sonication and estimation of intra cellular protein.
8. Comparison of ethanol production using pure carbohydrate and agro-industrial waste.
   a) Determination of pH, TSS (0Brix).
   b) Determination of alcohol (ethanol) percentage.
   c) Determination of phenol content.
   d) Estimation of reducing & total sugar.
9. Microbial production of dextran by *Leuconostoc mesenteroides* (Estimation of reducing and total sugar, Dextransucrase activity, extraction of dextran, pH, Characterization by TLC and viscosity).
10. ELISA detection of anti-HIV sera.
11. ELISA detection of HBsAg.

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20RMB P–402B: MEDICAL MICROBIOLOGY

(ELECTIVE-4)

SEMESTER-IV	DISCIPLINE CENTRIC COURSE	PRACTICAL	30 HOURS	2 CREDITS

Course Objectives: The objective of this laboratory course is to provide practical skills on basic techniques and understanding of fundamental medical microbiological research with following objectives.

1. Preparation of selective media used for bacterial cultures and their preservation,
2. Estimation of normal microflora in biological samples,
3. Observation of fungal and bacterial cells under microscope

Course Outcomes (COs): After completion of this course successfully, the students will be able to.....

1. Prepare selective media used for bacterial cultures and their preservation,
2. Estimate the normal microflora in blood, urine and pus,
3. Determination of antibiotic sensitivity,
4. Examine biological samples for microbial infections, and
5. Observe fungal and bacterial species under microscope.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3		3	3	2	2				2		2
CO-2	3		3	3		3	3	2	2				2		2
CO-3	3		3	3		3	3	2	2				2		2
CO-4	3		3	3		3	3	2	2				2		2
CO-5	3		3	3		3	3	2	2				2		2

1. Identification of *Staphylococcus* and mycobacteria using Gram stain and acid-fast staining techniques.
2. Collection and culture of nosocomial microorganisms.
3. Determination of MIC of an antibiotic
4. Sensitivity of bacteria to antibiotics – Disc diffusion and agar tube-well methods
5. Bacterial examination of blood, urine and pus.
6. Examination of blood smears for malaria.
7. Blood hemoglobin estimation.
8. Erythrocyte sedimentation rate.
9. Liver function test for hepatitis virus.
10. Slide observations: *Candida albicans*, *Mycobacterium leprae,* bacterial spores, *Corynebacterium* sp., *Clostridium tetani*, *Aspergillus fumigatus.*

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20RMB SEA–1: EDUCATIONAL TOUR

(SKILL ENHANCEMENT ACTIVITY - REPORT)

SEMESTER-IV	SKILL ENHANCEMENT ACTIVITY-1	REPORT	1 WEEK	1 CREDIT

Course Objectives: The objectives of this course are …..

1. To help student gain practical knowledge,
2. To keep students update on the latest trends in the industries.

Course Outcomes (COs): After visiting an industry, the students will be able to……

1. Identify the inputs and outputs for different operations and processes performed at the workplace,
2. Know the new technologies and instrumentation being used in the industry,
3. Observe theoretical and practical differences in execution of experimental procedures,
4. Explain current trends in premier institutes and established industries, and
5. Find the next path in choosing right option and building career in life, and to write a detailed report on the educational tour.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	3	3	3	2	3				3	3
CO-2	3		3	3	3	3	3	3	2	3				3	3
CO-3	3		3	3	3	3	3	3	2	3				3	3
CO-4	3		3	3	3	3	3	3	2	3				3	3
CO-5	3		3	3	3	3	3	3	2	3				3	3

EDUCATIONAL TOUR

Educational tours to the Premier Research Institutes, Universities, Industries, etc. are an essential part of the academic curriculum in postgraduate programmes. Being a part of interactive learning, such educational visits give students a major exposure to real working environments along with a practical perspective of a theoretical concept relevant to their domain. In addition to that, industrial visits bridge the widening gap between theoretical learning and practical exposure by giving students the first-hand exposure to identify the inputs and outputs of different operations and processes performed at the workplace. Intending to go beyond classroom learning, the educational tours contribute a lot in holistic student development by letting students learn about the current trends, the future scenario of the institute and industry and the new technologies and instrumentation that are being used in the Research Institute, University, Industry, etc.

The education tour should be planned for a period of 7 days to visit Premier Research Institutes, Universities, Laboratories, Industries (Biotechnology, Pharmacy, Aquaculture, Diary, Food, etc.), National Botanical Gardens, National Zoological Parks, National Biodiversity Hubs, National Science Museums, etc. The students should submit a report within a week after completing the educational tour. The Head of the Department should evaluate the report of each student.

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20RMB SEA–2: GRAND SEMINAR IN ADVANCES OFMICROBIOLOGY

(SKILL ENHANCEMENT ACTIVITY - SEMINAR)

SEMESTER-IV	SKILL ENHANCEMENT ACTIVITY-2	SEMINAR	4 HOURS	1 CREDIT

Course Objectives: The objectives of this course are to prepare the students to select a topic of advanced areas of Microbiology and develop oral skills to present it in a seminar.

Course Outcomes (COs): Students should be able to learn how to …..

1. Select a seminar topic of their interest in the advances of Microbiology,
2. Prepare PPT on the topic selected for presentation,
3. Present the selected topic effectively and fearlessly,
4. Develop skills in collecting useful information related to the topic and effective communication skills, and
5. Answer the questions posed by the classmates and teachers.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3		3		2	3				3	2
CO-2	3		3	3	3		3		2	3				3	2
CO-3	3		3	3	3		3		2	3				3	2
CO-4	3		3	3	3		3		2	3				3	2
CO-5	3		3	3	3		3		2	3				3	2

SELECTION OF SEMINAR TOPIC & PRESENTATION

Students should select a seminar topic of their interest in the advances of Microbiology and present it effectively in a seminar through PowerPoint Presentation. Students are advised to discuss with mentor for selecting a seminar topic and preparation of PPT and presentation. All faculty me20RMBers should analyse the presentation skills of each student.

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20RMB SEA–3: CRITICAL ANALYSIS OF LANDMARK DISCOVERIES

(SKILL ENHANCEMENT ACTIVITY – JOURNAL CLUB)

SEMESTER-IV	SKILL ENHANCEMENT ACTIVITY-3	JOURNAL CLUB	4 HOURS	1 CREDIT

Course Objectives: The objectives of this course are to familiarize students in the journal club with classic literature of landmark discoveries to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.

Course Outcomes (COs): Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology and able to …..

1. Select a classical paper on a milestone discovery and find how it was made,
2. Able to analyse critically about thought and necessity behind the work done,
3. Understand classical materials and methods chosen for the discovery made,
4. Explain the outcome of the work and its importance and place as a milestone discovery, and
5. Able to understand classical papers and discuss with classmates and mentor in the journal club, and write a mini-review on milestone discoveries.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3	3	3	3	2	3			2		3
CO-2	3		3	3	3	3	3	3	2	3			2		3
CO-3	3		3	3	3	3	3	3	2	3			2		3
CO-4	3		3	3	3	3	3	3	2	3			2		3
CO-5	3		3	3	3	3	3	3	2	3			2		3

SELECTION OF PAPER & WRITE-UP OF MINI-REVIEW

In the Journal Club, students may be divided into groups and each group may be responsible for one classical paper. Each week there may be a 2-hour presentation-cum-discussion for each of the papers. At the end of the semester, each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed. The mentor should evaluate the critical analyzing capacity of each student.

Following are the lists of milestones and classic papers and some suggested reference materials. These advances or milestones will be grouped into major discussion areas. Students may be divided into groups and each group may be responsible for one major area.

MILESTONES OF THE CENTURY

1950s

- Discoveries about the structure and function of biological macromolecules.
- Identification of DNA as the carrier of genetic information.
- Directed synthesis of dinucleotide by Alexander Todd.
- Phosphodiester oligonucleotide synthesis by Har-Gobind Khorana and colleagues.
- Central Dogma of Life - Francis Crick - RNA acts as an intermediary between DNA and protein.
- Mechanism of semiconservative DNA replication - Meselson and Stahl in 1958.

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- Discovery of DNA polymerase and production of DNA *in vitro* - Arthur Kornberg.
- Confirmation of Central Dogma.

1960s

- Identification of genetic codon by Crick - *In vitro* protein translation by Marshall Nirenberg.
- Development of phosphotriester oligonucleotide synthesis methods by Robert Letsinger and Colin Reese.
- First nucleic acid sequence (tRNA) and cracking of genetic code by Nirenberg, Holley, and Khorana, winning a 1968 Nobel Prize.
- Isolation of thermostable DNA polymerase from a hot spring bacterium in Yellowstone National Park by Thomas Brock.

1970s

- Reco20RMBinant DNA, cloning, and gene synthesis and sequencing.
- Discovery of restriction enzyme and sequence-specific DNA cutting and production of reco20RMBinant DNA and transgenic organisms.
- Discovery of messenger RNA sequence rearrangement – alternate splicing Roberts and Sharp shared a 1993 Nobel Prize for this work.
- Edwin Southern – development of DNA blotting technique, which enabled researchers to identify, locate, and quantitate specific DNA sequences in a sample of genomic DNA.
- Development of efficient DNA sequencing method by Frederick Sanger - first genome sequence of a DNA-based organism, bacteriophage fX174.

1980s

- Approval of first reco20RMBinant protein drug by FDA (1982): insulin for the treatment ofdiabetes, developed by Genentech.
- Invention of PCR by Kary Mullis (1983) and subsequent wave of PCR-based innovations.
- Discovery of Transposons by Barbara McClintock as genetic tool.
- Development of first reco20RMBinant chimeric monoclonal antibodies (1984) as moderntherapeutics.
- DNA fingerprinting as a forensic tool (1989).

1990s

- Arrival of huge volumes of genomic and transcriptomic tools - automated sequencing and DNA microarray technologies.
- Human Genome Project began in 1990.
- Invention of DNA microarrays by Pat Brown and colleagues.
- Development of bioinformatics.
- Prediction of gene function from coding sequences, elucidation of noncoding DNA structures.
- Cloning of Dolly the sheep.

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After 2000

- Acceleration of Genome sequencing projects – completion of *Drosophila*, *Arabidopsis* and human genomes.
- Invention of quantitative real-time PCR (qPCR) for the analysis of nucleic acids in applications such as forensics, food safety testing, and gene expression analysis.
- RNA interference: Biomedical researchers Andrew Fire and Craig Mello publish a study showing how small RNA molecules influence genetic pathways in *C. elegans* worms, opening up a new field of research into RNA interference. RNAi-based therapies could address a wide variety of illnesses, including AIDS, cancer, Huntington's and Alzheimer's disease.
- Development of NGS technologies – 3K rice and 1K Arabidopsis genome projects.
- Genetic mapping – Classical work of Tanksley in Tomato; Case studies in rice and pulses - mapping and fine mapping of major traits.
- GWAS and Association mapping – classical examples.
- Advancements in genotyping – SSR/SNP genotyping methods; sequencing-based genotyping.
- Mapping using Multi-parental populations (MAGIC, NAM, GBS).
- Genetic engineering in crop plants – Golden rice, Bt crops, herbicide tolerance, improved quality in crops.
- Genome Engineering – Conceptualization and advancements in crop plants.

CLASSICAL PAPERS OF LANDMARK DISCOVERIES

Cell Biology

1. A protein-conducting channel in the endoplasmic reticulum. Simon SM & Blobel G.; Cell. 1991 May 3;65(3):371-80
   Note: This paper demonstrates the existence of a protein conducting channel
   Study help - A brief history of Signal Hypothesis

2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway. Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15
   Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion

3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum. Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45
   Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC)
   Suggested reference paper - A biochemical assay for identification of PCC.

4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi. Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16
   Note: This paper describes setting up of an in vitro reconstituted system for transport between Golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP etc.

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5. A complete immunoglobulin gene is created by somatic reco20RMBination. Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14
Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following reco20RMBination.

6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition. Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87
Note: This paper suggests that different chemical odorants associate with different cell-specific expression of a transme20RMBrane receptor in Drosophila olfactory epithelium where a large family of odorat receptors is expressed.

7. Kinesin walks hand-over-hand. Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30;303(5658):676-8
Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.

Genetics

8. Mutations affecting segment nu20RMBer and polarity in Drosophila. Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980
Note: This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.

9. Information for the dorsal-ventral pattern of the Drosophila e20RMBryo is stored as maternal mRNA. Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7 *Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes*

10. Hedgehog signalling in the mouse requires intraflagellar transport proteins. Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7
Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it.
Suggested Reference paper - Design and execution of a e20RMBryonic lethal mutation screen in mouse.

Molecular Biology

11. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8
Note: In this one page paper Watson and Crick first described the structure of DNA double helix
Study help - Watson_Crick_Nature_1953_annotated

12. Messelson and Stahl experiment demonstrating semi-conservative replication of DNA. Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82

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Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology"

13. In vivo alteration of telomere sequences and senescence caused by mutated Tetrahymena telomerase RNAs. Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990
Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

14. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from Pneumococcus type III. Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58.
Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.

15. Independent functions of viral protein and nucleic acid in growth of bacteriophage. Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56.
Note: Note: This paper demonstrates that DNA, and not protein, component of phages enters bacterial cells.

16. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8
Note: In this one page paper Watson and Crick first described the structure of DNA double helix Study help - Watson_Crick_Nature_1953_annotated

17. Transposable mating type genes in Saccharomyces cerevisiae. James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979
Note: This paper provided evidence for 'cassette hypothesis' of yeast mating type switches i.e. interconversion of mating types in yeast (S. cerevisiae) occurs by DNA rearrangement.

18. Messelson & Stahl experiment demonstrating semi-conservative replication of DNA. Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82
Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology"

19. In vivo alteration of telomere sequences and senescence caused by mutated Tetrahymena telomerase RNAs. Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990
Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

Animal Cloning

20. Edwards JL, Schrick FN, McCracken MD, van Amstel SR, Hopkins FM, Welborn MG, Davies CJ. Cloning adult farm animals: a review of the possibilities and problems associated with somatic cell nuclear transfer. American Journal of Reproductive Immunology 2003; 50:113-123, Blackwell Munksgaard, 2003

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21. Bin Wang, Jiangfeng Zhou. Specific genetic modifications of domestic animals by gene targeting and animal cloning. Reproductive Biology and Endocrinology 2003; 1:103, Biomed Central, 2003.

22. Atsuo Ogura, Kimiko Inoue, Teruhiko Wakayama. Recent advancements in cloning by somatic cell nuclear transfer. Philosophical Transactions of The Royal Society B 2013; 368: 20110329

23. Mizutani, E., Torikai, K., Wakayama, S., Nagatomo, H., Ohinata, Y., Kishigami, S., & Wakayama, T. (2016). Generation of cloned mice and nuclear transfer e20RMBryonic stemcell lines from urine-derived cells. Scientific Reports, 6, 23808. http://dx.doi.org/10.1038/srep23808

24. Rudenko, L., Matheson, J., & Sundlof, S. (2007). Animal cloning and the FDA—the risk assessment paradigm under public scrutiny. Nature Biotechnology, 25(1), 39-43. http://dx.doi.org/10.1038/nbt0107-39

25. Smith, L. C., Bordignon, V., Babkine, M., Fecteau, G., & Keefer, C. (2000). Benefits and problems with cloning animals. The Canadian Veterinary Journal, 41(12), 919–924

Genomics

26. Goddard, M. & Hayes, B. (2007). Genomic selection. Journal of Animal Breeding and Genetics, 124(6), 323-330. http://dx.doi.org/10.1111/j.1439-0388.2007.00702.x

27. Meuwissen, T., Hayes, B., & Goddard, M. (2013). Accelerating Improvement of Livestock with Genomic Selection. Annual Review of Animal Biosciences, 1(1), 221-237. http://dx.doi.org/10.1146/annurev-animal-031412-103705

Hybridoma Technology

28. Samoilovich, S., Dugan, C., & Macario, A. (1987). Hybridoma technology: new developments of practical interest. Journal Of Immunological Methods, 101(2), 153-170. http://dx.doi.org/10.1016/0022-1759(87)90147-5

Stem Cell Technology

29. Trounson, A. & DeWitt, N. (2016). Pluripotent stem cells progressing to the clinic. Nature Reviews Molecular Cell Biology, 17(3), 194-200. http://dx.doi.org/10.1038/nrm.2016.10

30. Stadtfeld, M. & Hochedlinger, K. (2010). Induced pluripotency: history, mechanisms, and applications. Genes & Development, 24(20), 2239-2263. http://dx.doi.org/10.1101/gad.1963910.

31. Yamanaka, S. (2012). Induced Pluripotent Stem Cells: Past, Present, and Future. Cell Stem Cell, 10(6), 678-684. http://dx.doi.org/10.1016/j.stem.2012.05.005

Dairy Technology

32. Simons, J., McClenaghan, M., & Clark, A. (1987). Alteration of the quality of milk by expression of sheep β-lactoglobulin in transgenic mice. Nature, 328(6130), 530-532. http://dx.doi.org/10.1038/328530a0

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DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Microbiology (2 Year Course) at Vikrama Simhapuri University, Nellore with effect from the Academic Year 2020-2021.

20RMB SEA–4: POSTER PRESENTATION
(SKILL ENHANCEMENT ACTIVITY - POSTER)

SEMESTER-IV	SKILL ENHANCEMENT ACTIVITY-4	POSTER	4 HOURS	1 CREDIT

Course Objectives: The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin the development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.

Course Outcomes (COs): Students should be able to demonstrate the following abilities:

1. Formulate a scientific question.
2. Present a scientific approach to solve the problem.
3. Interpret, discuss and communicate scientific results in written form.
4. Gain experience in writing a scientific proposal.
5. Learn how to present and explain their research findings to the audience effectively.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3		3	3	3		3		2	3				3	3
CO-2	3		3	3	3		3		2	3				3	3
CO-3	3		3	3	3		3		2	3				3	3
CO-4	3		3	3	3		3		2	3				3	3
CO-5	3		3	3	3		3		2	3				3	3

PROJECT PROPOSAL PREPARATION

Selection of research lab and research topic - Students should first select a lab wherein they would like to pursue their dissertation. The supervisor should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis-driven. Review of literature - Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.

Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, etc.

Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for the dissertation.

POSTER PRESENTATION OF PROPOSAL

Students will have to present a project proposal through a poster (Portrait format with 48" high x 36" wide (91.44 x 121.92 cm) size only) within a month of their fourth semester after selection of the topic in their specialization. They should be able to explain the novelty and importance of their research topic. All faculty me20RMBers will examine the poster.

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20RMB SEA–5: DISSERTATION
(SKILL ENHANCEMENT ACTIVITY - PROJECT)

SEMESTER-IV	SKILL ENHANCEMENT ACTIVITY-5	PROJECT	45 DAYS	4 CREDITS

Course Objectives: The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and dissertation writing.

Course Outcomes (COs): Students should be able to learn how to select and defend a topic of their research, and how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas:

1. In-depth knowledge of the chosen area of research, and capability to critically and systematically integrate knowledge to identify issues that must be addressed within the framework of a specific thesis.
2. Competence in research design and planning, and capability to create, analyse and critically evaluate different technical solutions.
3. Ability to conduct research independently, and ability to perform analytical techniques/experimental methods.
4. Project management skills, and report writing skills, and
5. Problem solving skills, and communication and interpersonal skills.

Mapping of COs with POs and PSOs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	3	3	3	3	3	2	3				3	3
CO-2	3	3	3	3	3	3	3	3	2	3				3	3
CO-3	3	3	3	3	3	3	3	3	2	3				3	3
CO-4	3	3	3	3	3	3	3	3	2	3				3	3
CO-5	3	3	3	3	3	3	3	3	2	3				3	3

PLANNING & PERFORMING EXPERIMENTS

Based on the project proposal submitted earlier as suggested by the mentor, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic in thrust areas with societal significance. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment. After fourth semester theory examinations, students should go to the selected institutes, industries or laboratories, and complete the proposed project and submit their dissertation within a period of 45 days. After submission of the dissertation, students should be ready for PowerPoint Presentation and viva-voce examination.

DISSERTATION WRITING

At the end of their project, a dissertation has to be written giving all the details such as Abstract, Introduction, Review of Literature, Aims & Objectives, Materials & Methods, Results & Discussion and Conclusion along with future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file a patent application.

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ORAL PRESENTATION

At the end of their project, a PowerPoint presentation will have to be given by the students to explain the work done by them in detail. Along with summarizing their findings, they should also be able to discuss the future expected outcome of their work.

VIVA-VOCE EXAMINATION

At the end of the presentation, each student will have to answer the questions posed by the examiner.

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M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF THEORY QUESTION PAPER

[Two questions from each Unit in two sections]

Time: 3 Hours **Max. Marks: 70**

Section-A

Answer any four questions

Each question carries 5 marks (4 x 5 = 20 marks)

1.
2.
3.
4.
5.
6.
7.
8.

Section-B

Answer all questions

Each question carries 12.5 marks (4 x 12.5 = 50 marks)

9. A.

or

B.

10. A.

or

B.

11. A.

or

B.

or

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M.Sc. MICROBIOLOGY

(Effective from 2020-21)

PATTERN OF PRACTICAL QUESTION PAPER

Time: 3 Hours **Max. Marks: 50**

1.	Major experiment	(1 X 15 = 15 M)
2.	Minor experiment	(1 X 10 = 10 M)
3.	Spotters A. B. C. D. E.	(5 X 02 = 10 M)
4.	Record	(10 M)
5.	Viva-Voce	(05 M)

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