Shri Vile Parle Kelavani Mandal's

ITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBE JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: MASTER OF SCIENCE

Course: M.Sc. Microbiology

Semester: I & II

Choice Based Credit System (CBCS) with effect from the Academic year 2021-2022

A.C. No.: 11

Agenda No.: 4 (ix)

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the M.Sc. Microbiology, the learners should be enriched with knowledge and be able to-

PSO1: Have an in-depth understanding of microbiology and allied fields.
PSO2: Keep abreast of the emerging trends in various biosciences.
PSO3: Have a multidisciplinary and innovative approach in finding solutions to problems faced by society.
PSO4: Maintain high standards of professional and ethical values.
PSO5: Develop an entrepreneurial mindset so as to be job creators.
PSO6: Become responsible world citizens who will be enthusiastic lifelong learners.

PREAMBLE/ SALIENT FEATURES OF THE M. Sc. MICROBIOLOGY CURRICULUM

The grant of autonomy along with funding received under FIST has provided a platform for designing a curriculum that is dynamic and which meets the need of the hour. The inherent freedom under autonomy provides for a multisensory learning experience.

The revised syllabus has been designed keeping in mind the interdisciplinary nature of science in general and microbiology in particular. As postgraduates, the students will be expected to have sufficient understanding about the various fields of microbiology and allied areas, thus enabling them to build upon their existing knowledge and pursue any field of study that they wish.

Syllabus reforms involved discussions with experts from educational institutes, research and industry as well as a few past and present students. The syllabus will cover the essentials of microbial diversity, medical microbiology, microbial biochemistry, cell biology and molecular biology. It will also include courses on basic sciences like physics and statistics as required for a better understanding of biology. Courses on research methodology and instrumentation are also incorporated in the syllabus.

Care has also been taken, as far as possible, to give the students a local contextual approach. With a view to expanding the knowledge base of the students, the following topics have been included in the syllabus-

- Eukaryotic cellular organization
- Determinants of microbial pathogenicity
- Protein conformation and folding
- Study of microbial populations from extreme environments
- Theories of evolution
- Astrobiology

TRAINING AND TEACHING METHODOLOGY

Besides didactic lectures (delivered by in-house faculty as well as invited guest lecturers), students will be encouraged to present short reviews/ research papers. Wherever possible, the course instructor will use case studies to illustrate the concepts being taught. Students will be encouraged to actively engage in figuring out the principles by abstracting from the examples. Students will also be required to prepare a proposal for the research project that they are expected to undertake in the second year of their post-graduate studies.

The courses are as follows:

Semester I:

PSMAMB101: CELL BIOLOGY
PSMAMB102: MEDICAL MICROBIOLOGY
PSMAMB103: MICROBIAL BIOCHEMISTRY
PSMAMB104: TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS

Semester II:

PSMAMB201: MICROBIAL DIVERSITY AND SUSTAINABLE DEVELOPMENT
PSMAMB202: MOLECULAR BIOLOGY
PSMAMB203: ADVANCED VIROLOGY
PSMAMB204: RESEARCH METHODOLOGY

I profusely thank all the committee members for their effort in drafting the syllabus.

N.B.-

i. The duration of each theory lecture will be of 60 minutes. A course consists of 4 units. For each module, the total number of hours allotted are 15. The total number of lecture hours for each course will thus be 60. For the theory component, the value of one credit is equal to 15 learning hours.
ii. There will be one practical per batch for each course. The duration of each practical will be of 4 hours, i.e., of 240 minutes. For the practical component, the value of one credit is equal to 30 learning hours.
iii. Thus, in a week, a student will study 16 hours of theory and 16 hours of practical.

Course name	Course code	Number of hours/ week	Total number of hours	Number of credits
Cell Biology	PSMAMB101	4	4 X 15= 60	4
Medical Microbiology	PSMAMB102	4	4 X 15= 60	4
Microbial Biochemistry	PSMAMB103	4	4 X 15= 60	4
Tools and techniques: Biomolecular Analysis	PSMAMB104	4	4 X 15= 60	4
Microbiology Practical I	PSMAMBP11	2	4 X 15= 60	2
Microbiology Practical II	PSMAMBP12	2	4 X 15= 60	2
Microbiology Practical III	PSMAMBP13	2	4 X 15= 60	2
Microbiology Practical IV	PSMAMBP14	2	4 X 15= 60	2
Microbial Diversity and Sustainable Development	PSMAMB205	4	4 X 15= 60	4
Molecular Biology	PSMAMB202	4	4 X 15= 60	4
Advanced Virology	PSMAMB206	4	4 X 15= 60	4
Research Methodology	PSMAMB204	4	4 X 15= 60	4
Microbiology Practical I	PSMAMBP21	2	4 X 15= 60	2
Microbiology Practical II	PSMAMBP22	2	4 X 15= 60	2
Microbiology Practical III	PSMAMBP23	2	4 X 15= 60	2
Microbiology Practical IV	PSMAMBP24	2	4 X 15= 60	2

Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Presentation of a scientific paper	15 marks
Component 2 (CA-2)	Assignment based on the presentation	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of the examination will be two and half hours.

Question Number	Description	Marks	Total Marks
1	Question 1 will be based on Module I, question 2 on Module II, question 3 on Module III and question 4 on Module IV	A (1 x 10) = 10 marks B = 5 marks	15
2	Each question will be subdivided into two sub-questions "A" and "B". Sub-question "A" will have 2 questions (of 10 marks each) out of which any one will be attempted. Total marks allotted to sub-question "A" will be 10 marks. Sub-question "B" will be compulsory for 5 marks without internal choice.	A (1 x 10) = 10 marks B = 5 marks	15
		A (1 x 10) = 10 marks B = 5 marks	15
		A (1 x 10) = 10 marks B = 5 marks	15
3	It will have questions from all 4 modules of the course It will have 4 questions (of 5 marks each module, out of which any 3 will be attempted	3 x 5 marks	15
		Total Marks	**75**

Dr. Geeta Narayan
HOD

Dr. Meenakshi Vaidya
Approved by Vice –Principal

Dr. Krutika Desai
Approved by Principal

Program: M.Sc.				**Semester: I**	
Course: CELL BIOLOGY				**Course Code: PSMAMB101**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course is designed to acquaint the learner with the structure of and transport mechanisms across cell membranes in addition to learning about the respiratory and photosynthetic organelles. Learners will also be apprised with aspects of cell cycle, division, and communication.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Discuss the complexity of the membrane proteins; protein sorting and vesicular transport.
CO2: Compare various microscopic techniques for observing the intracellular structures.
CO3: Delineate the regulation of cell cycle and apoptosis.
CO4: Assess the role of cell adhesion molecules.
CO5: Summarize the stages in the development of multicellular organisms.
CO6: Explain cell to cell communication.
CO7: Describe how signaling takes place in various cells.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Membrane structure and transport**	**15**
2	**Cytoskeleton, Cell Junction, Cell Adhesion and Development of Multicellular Organisms**	**15**
3	**Cell Division, Cell Cycle and Cell Study**	**15**
4	**Cell communication**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**MEMBRANE STRUCTURE AND TRANSPORT** Cell membrane structure: Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins Bacteriorhodopsin Membrane Transport: Principles of membrane transport, ion channels and electrical properties of membranes. Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum, transport of proteins into mitochondria and chloroplasts Intracellular vesicular traffic: Endocytosis, exocytosis, transport from the ER through the Golgi apparatus Protein degradation	**15** **3** **4** **5** **3**	**1**
Module 2	**CYTOSKELETON, CELL JUNCTION, CELL ADHESION AND DEVELOPMENT OF MULTICELLULAR ORGANISMS** Cytoskeleton: Cytoskeletal filaments- Microtubules, Actin filaments and Intermediate filaments. The Cytoskeleton in bacteria- FtsZ ,BtubA & BtubB, MreB , ParM, MamK, Ta0583, FtsA, Crescentin Cell junction, Cell adhesion Extracellular matrix (ECM): components and ECM examples- Basal lamina and connective tissue ECM Types of cell-ECM junctions Focal adhesions Hemidesmosomes Types of cell-cell junction Adherens junction Desmosomes Tight junction Gap junction Cell-cell junctions in plants –plasmodesmata. Development of multicellular organisms	**15** **3** **2** **5**	**1**

	Universal Mechanisms of Animal cell development The Process of Development in Animals The Embryonic Cleavage Divisions and Blastula Formation Gastrulation and Morphogenesis Molecular Analysis of genes involved in *Drosophila* development Maternal-Effect Genes Determination of the Dorsal-Ventral and Anterior-Posterior Axes Body Segmentation Specification of cell types Organ formation Homeobox Genes in other Organisms	**5**	
Module 3	**CELL DIVISION, CELL CYCLE AND CELL STUDY** Mechanism of cell division Cell cycle and cell cycle control system S-phase Mitosis Cytokinesis Control of cell division and cell growth Apoptosis Programmed cell death Extrinsic Pathway of apoptosis Intrinsic Pathway of apoptosis Cell study Study of cells under the microscope, Phase contrast, Fluorescence microscopy, Confocal microscopy & Electron microscopy.	**15** **6** **4** **5**	**1**
Module 4	**CELL COMMUNICATION** Cell communication: Extracellular signal molecules, nitric oxide gas signal, classes of cell-surface receptor proteins Signalling through enzyme linked cell surface receptors: G protein coupled receptor, Docking sites, Ras, MAP kinase, Pl-3 kinase, TGF Signalling in plants: Serine / Threonine kinases, role of ethylene, Phytochromes	**15** **7** **3** **5**	**1**

PRACTICAL I- PSMAMBP11

1. Viability staining of cells using trypan blue
2. Comet assay to study DNA damage
3. Neutral red uptake
4. MTT assay for lymphocytes
5. Mitosis in onion root tip
6. Meiosis in Tradescantia
7. Study of cell cytology using Phase contrast Microscopy.
8. Study of Cell structure using Confocal Microscopy. Demonstration
9. Study of Cell structure using Fluorescence Microscopy.
10. Culturing and Handling of *Drosophila*.
11. Visualizing Actin filaments in *Drosophila* tissues

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. B. Albert, A. Johnson, J. Lewis, M. Raff, K. Roberts &P. Walter (2002)- Molecular Biology of the Cell; Garland Science
2. H. Lodish, A. Berk, S Lawrence Zipursky, P. Matsudaira, D.Baltimore, and J. Darnell(2000) - Molecular Cell Biology; W.H. Freeman
3. Cooper, G.M., Hausman R.E. (2009) The Cell: A Molecular Approach- 5th edition. ASM Press.
4. Walid El-Sharoud- Bacterial Physiology- A Molecular Approach edited by, 2008, Springer
5. Nelson D and Cox M (2017) 'Lehninger Principles of Biochemistry' W. H. Freeman & Co.

Supplementary Readings:

1. Karp G. (2002). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
2. Lewin's cells 3rd edition, edited by George Plopper, David Sharp & Eric Sikorski, Jones & Bartlett learning
3. S. C. Lakhotia & H. A. Ranganath- Experiments with Drosophila for Biology Courses -. Indian Academy of Sciences, Bengaluru, India. March 2021, ISBN: 978-81-950664-2-1
4. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: I**	
Course: MEDICAL MICROBIOLOGY				**Course Code: PSMAMB102**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course will help the learner be acquainted with the molecular mechanisms underlying various endemic and emerging and re-emerging microbial infections.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Review rickettsial, fungal and protozoal infections with emphasis on molecular pathogenesis.
CO2: Inspect the role of various factors contributing to the emergence of new infectious diseases and the spread and evolution of older diseases; propose the measures for combating emerging diseases.
CO3: Summarize various methods of genetic testing of diseases.
CO4: Explore the possible uses of gene therapy for cancer.
CO5: Give an overview of pharmacogenomics, pharmacogenetics and toxicogenetics.
CO6: Debate about discrimination in various fields based on social and genetic aspects of an individual.
CO7: Explain the basics of tissue engineering and synthetic biology

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Rickettsial and Fungal Infections**	**15**
2	**Protozoan Infections**	**15**
3	**Emerging/Re-emerging infections**	**15**
4	**Medical Biotechnology**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**RICKETTSIAL AND FUNGAL INFECTIONS** Overview of rickettsial infections with reference to- Bacteriology, Taxonomy and Phylogeny of Rickettsia. Physiopathology, Pathology and Immunity. Arthropods and Rickettsia. Animals and Rickettsia. Selected Rickettsial infections- Epidemic Typhus. Rickettsial pox. African Tick-Bite Fever. Mediterranean Spotted Fever. Other Tick-Borne Rickettsioses. **FUNGAL INFECTIONS** Candidiasis; Cryptococcosis Histoplasmosis, Aspergillosis Pneumocystis infections, Coccidioides infections Blastomycosis Host immunity to fungal infections	**15** **5** **10**	**1**
Module 2	**PROTOZOAN INFECTIONS** Amoebae, pathogenic free-living amoebae, microsporidians, ciliates, flagellates, apicomplexans Infections caused by- *Entamoeba histolytica* *Balantidium coli* *Giardia lamblia* *Trichomonas vaginalis* *Leishmania* *Trypanosoma*	**15** **5** **3** **2** **2** **3**	**1**
Module 3	**EMERGING/ RE-EMERGING INFECTIONS** The role of infectious diseases in the world today; The links between infectious diseases, poverty and civil unrest;	**15** **5**	**1**

	Factors contributing to the emergence of new infectious diseases and the spread and evolution of older diseases; Prevention of emerging/ re-emerging infectious diseases; Strategies and response capacities in India for combating emerging infections Study of the following infections- Cholera Nipah virus Chikungunya Chandipura Virus HIV Dengue Epidemic and Pandemic influenza SARS Leptospirosis COVID-19 The emerging threat of bioweapons	**10**	
Module 4	**MEDICAL BIOTECHNOLOGY** Genetic Testing of diseases and disorders, Immunogenetics; Karyotyping Advanced techniques in Molecular biotechnology- implications in medical diagnostics and gene therapy. Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination Tissue Engineering- overview, Biomolecular Engineering Synthetic biology- overview	**15** **4** **5** **6**	**1**

PRACTICAL II-PSMAMBP12

1. Kit-based detection of Dengue.
2. Report on internship at a pathological laboratory.
3. Report on accreditation agencies for clinical laboratories.
4. Literature review pertaining to an infectious disease based on the syllabus.

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. Lisa A. Beltz (2011)- Emerging Infectious Diseases: A Guide to Diseases, Causative Agents, and Surveillance Publisher- John Wiley & Sons
2. Judith Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
3. S. Riedel, J. A. Hobden, S. Miller, S. A. Morse, T.A. Mietzner, B. Detrick, T.G. Mitchell, J.A. Sakanari, P. Hotez, R. Mejia (2019)- Jawetz, Melnick, & Adelberg's - Medical Microbiology; McGraw Hill Education
4. R. Goering, H. Dockrell, M. Zuckerman, P. Chiodini- Mims' Medical Microbiology and Immunology (6th Edition); Elsevier

Supplementary Readings

1. Sherwood L. Gorbach, John G. Bartlett, and Neil R. Blacklow (2001) Infectious Diseases- Publisher-Lippincott Williams & Wilkins;
2. Felissa R., FABMGG Lashley, and Jerry D. - Emerging Infectious Diseases: Trends and Issues, Second Edition; FAAN Durham
3. Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, Oxford University Press, India (2010)
4. Baldwin, Bayer, Dickinson, Ellis, Freemont, Kiney Polliz, Stan- (2016) Synthetic biology, a primer Rev. ed; Imperial College Press

Reference articles:

1. T. Dikid, S.K. Jain, A.Sharma, A. Kumar, and J.P. Narain- Emerging & re-emerging infections in India: An overview -, Indian J Med Res. 2013 Jul; 138(1): 19–31.
2. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: I**	
Course: MICROBIAL BIOCHEMISTRY				**Course Code: PSMAMB103**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course is designed to familiarize the learner with detailed aspects of structure and function of bioorganic molecules, as well as the transport and metabolism of selected biomolecules.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Predict the protein stability based on its structure.
CO2: Evaluate the role of various factors in determining the structure of proteins.
CO3: Elucidate the mechanism of transfer of biomolecules.
CO4: Appraise the metabolic pathways for one and two carbon compounds by microbes.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Protein Chemistry and Enzymology**	**15**
2	**Bacterial Response to Stress & Adaptation**	**15**
3	**Microbial Metabolism**	**15**
4	**Protein Secretion in Bacteria**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**PROTEIN CHEMISTRY AND ENZYMOLOGY** Protein chemistry Overview of structure and properties of amino acids(self-study) problems Protein primary and secondary structure: Primary structure Secondary structure - α Shelices & β sheets Amphiphilic helices and sheets- structure, Ramchandran plots, fibrous and globular proteins e.g. of fibrous proteins problems Protein folding: Factors determining secondary and tertiary structure Kinetics of protein folding Chaperones and chaperonins Protein folding diseases (case study) Enzymology: Extraction and purification Enzyme catalysis, kinetics of single substrate and multisubstrate, kinetics of enzyme inhibition problems	**15** **2** **3** **4** **6**	**1**
Module 2	**BACTERIAL RESPONSE TO STRESS & ADAPTATION** Response to physiological stress: Two component signaling system aerobic-anaerobic shifts- Arc and Fnr system, Response to inorganic phosphate supply Regulation of porin synthesis Response to carbon source Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors Chemotaxis- response to environment sporulation Quorum sensing in Gram positive, Gram-negative bacteria, and myxobacteria Biofilms, their organization, signals involved in their formation and dispersal, applications of study on biofilms in pathogenic and non-pathogenic environments	**15** **6** **3** **6**	**1**

Module 3	**MICROBIAL METABOLISM** Metabolism of C1 compounds: Carbon dioxide, Methane, Methanol, Methylamine Degradation of aliphatic hydrocarbon: Oxidation of alkanes and alkenes- Aerobic degradation- monoterminal & diterminal oxidation e.g. Propane oxidation, n-decane oxidation, undecane oxidation, methylketone oxidation, hexanediol and octanediol oxidation. Branched alkanes. Degradation of cycloalipathic compounds Anaerobic degradation of alkanes and alkenes Degradation of aromatic hydrocarbon: Ortho& meta cleavage cathecol, protocatechuate and gentisic acid e.g. Benzoic acid, naphthalene, phenanthrene, anthracene	**15** **7** **4** **4**	**1**
Module 4	**PROTEIN SECRETION IN BACTERIA** Cell membrane and membrane proteins Protein secretion in Gram negative bacteria Export across cell membrane Two-step secretion pathways Sec translocase Twin-Arginine translocase Translocation across the outer membrane Type V Two-partner secretion Chaperone/Usher pathway Type-II One-step secretion pathways Type-I Type-III Type-IV Type-VI Protein secretion in Gram positive bacteria Sec, SRP & Tat dependent secretion ESX-I(Snm) pathway Pseudopilin-Export (Com) pathway Folding of periplasmic proteins Protein secretion in Archea Protein export and drug export system Bacterial protein secretion and biotechnology application	**15** **6** **6** **3**	**1**

PRACTICAL III-PSMAMB13

1. Determination of pK and PI value for an amino acid
2. Determination of molar absorption coefficient (ε) of L- tyrosine
3. Determination of the isoelectric point of the given protein
4. Production, Extraction and purification of enzyme-amylase/protease-
    a. Purification of enzyme by salting out, aqueous two-phase partitioning, use of organic solvents, Ion exchange chromatography, Gel exclusion chromatography
5. Kinetics of purified enzyme- effect of substrate concentration, pH, temperature, inhibitors, Determination of Km& Vmax, use of different plots to interpret Km
6. Determination of molecular weight of protein- SDS PAGE, Gel exclusion chromatography
7. Adaptation of E. coli to anaerobiosis
8. Chemotaxis of Pseudomonas.
9. Effect of temperature and water activity on swarming of Proteus
10. Microbial degradation of polycyclic aromatic hydrocarbons (PAHs)- enrichment, isolation and screening of bacteria.
11. PAH degradation studies Plasmid curing and determination of chemotaxis by drop assay method.

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. D. Nelson and M. Cox – Lehninger: Principles of Biochemistry, 6th edition; W.H. Freeman and Company New York
2. GN Cohen,- Microbial Biochemistry 3rd edition, Springer
3. Zubay, G., Wm.C- Principles of Biochemistry, 4th edition,. Brown Publishers, 1998
4. Gottschalk- Bacterial metabolism 2nd edition, Springer- Verlag, 1985
5. White D-The physiology and biochemistry of prokaryotes, 3rd edition, Oxford University Press
6. Doelle. H.W- Introduction to bacterial metabolism 2nd edition,., Academic Press
7. Trevor Palmer- Understanding Enzymes (2nd Edition) Ellis Horwood, 1985
8. Voet. D. and Voet J.G-.Biochemistry, 4th edition, , John Willey and Sons Inc.,

Supplementary Readings

1. Segel I.H - Biochemical Calculations, John Wiley and Sons, 1995
2. Mathew, Van Holde and Ahern- Biochemistry 4th edition, Pearson Education
3. Walid El- Sharoud- Bacterial Physiology- A Molecular Approach Springer
4. Colin Ratledge- Biochemistry of microbial degradation.
5. C Anthony- The Biochemistry of Methylotrophs, , Academic press
6. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: I**	
Course: TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS				**Course Code: PSMAMB104**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (SEE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course aims to familiarize the learner with relevant tools and techniques of biomolecular analysis routinely used in microbiology.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Explain the principle of spectroscopic of techniques.
CO2: Identify the appropriate chromatographic technique for analysis or purification of metabolites.
CO3: Compare and describe selected techniques used in molecular biology.
CO4: Enlist and understand the techniques used for studying nanoparticles.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Spectroscopic Techniques**	**15**
2	**Chromatographic Techniques**	**15**
3	**Nanotechnology Techniques**	**15**
4	**Molecular Biology Techniques**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**SPECTROSCOPIC TECHNIQUES** Design of spectrophotometers- Single beam, Double beam and split beam. Errors in spectrophotometric analysis. Applications- Basic concepts or principles, overview of components, calibration and applications of- UV-visible spectroscopy; Flame Photometry; Fluorimetry and Phosphorimetry (Spectro fluorimeters and phosphorimeters); Infra-Red-Single beam, double beam and FTIR, Raman spectroscopy; Nuclear Magnetic Resonance; Mass Spectroscopy; Atomic Absorption Spectroscopy	**15** **4** **5** **6**	**1**
Module 2	**CHROMATOGRAPHIC TECHNIQUES** Introduction to Chromatography- separation procedure b) development procedure classification terminology Basic concepts in chromatography: requirements of an ideal detector, types of detectors in LC and GC, comparative account of detectors with reference to their applications (LC and GC respectively), qualitative and quantitative analysis. Concept of plate and rate theories in chromatography: efficiency, resolution, selectivity and separation capability. Van Demeter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions. High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications. Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Diode array type and fluorescence detector, Applications of HPLC. Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications.	**15** **2** **2** **5**	**1**

	Gas Chromatography: Principles, Instrumentation of GC with special reference to sample injection systems – split/split less, column types, solid/ liquid stationary phases, column switching techniques, temperature programming, Thermionic and mass spectrometric detector, operation, calibration, accuracy and Applications. Processing Chromatography data: Chromatogram, Chromatography software.	**4** **2**	
Module 3	**NANOTECHNOLOGY TECHNIQUES** Nanotechnology: Definition, Different classes of nanomaterials, synthesis of nanomaterials, nano structures and applications, Nanophotonics, Imaging & diagnostic techniques from nano to Micro scale Characterization using optical and chromatography techniques Microscopy: Scanning Probe Microscopes - scanning tunnelling microscope (STM), atomic force microscope (AFM), magnetic force microscope (MFM), scanning near field microscope (SNOM), Electron Microscopy: SEM, TEM, CCD camera and application Diffraction Techniques: X-ray diffraction (XRD) Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies (XPS)/Auger electron spectroscopy	**15**	**1**
Module 4	**MOLECULAR BIOLOGY TECHNIQUES** Variations/ Modifications of PCR: Hot- Start PCR, Multiplex PCR, Nested PCR, RT-PCR, Broad Range PCR, arbitrarily primed PCR, Quantitative PCR,Real time PCR Hybridization array technology: applications of microarrays in microbiology, Microarray platform technologies (oligonucleotide microarrays, Cdna microarrays) FISH with other techniques: (confocal laser scanning microscopy, microautoradiography, flow cytometry, immunofluorescence, microsensors, peptide, nucleic acids)	**15** **5** **5** **5**	**1**

PRACTICAL IV- PSMAMBP14

1. Amplification of DNA using PCR.
2. Visit to the instrumentation facility of an institute of repute.

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. A. Upadhyay, K. Upadhyay & N. Nath. Biophysical chemistry; 2009; Himalaya Publishing
2. D.A Skoog, Holler and Nieman, Principles of Instrumental Analysis, 5th Ed. Australia, Thomson Brock/Cole.
3. Keith Wilson and John Walker- Principles and Techniques of Biochemistry and Molecular Biology; 2010; Cambridge University Press
4. Clive R. Newton, Alex Graham. (1997) PCR; BIOS Scientific Publishers

Supplementary Readings

1. Robert E Henkin, Mark A Boles, Gary Dillehay, James R Halama, Stephen M Karesh , Robert Wargner and Michael Zimmer- Nuclear Medicine -Vol I-
2. Ian D. Wilson, Michael Cooke Colin F. Pool (Ed)- Encyclopaedia of Separation Sciences-
3. David J. Scott, Stephen E. Harding and Arthur J. Rowe (Ed)- Analytical Ultracentrifugation Techniques and Methods
4. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: II**	
Course: MICROBIAL DIVERSITY AND SUSTAINABLE DEVELOPMENT				**Course Code: PSMAMB205**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course is designed to equip the learner with a deeper understanding of microbial distribution and diversity. It also gives an overview of bioinformatics, astrobiology and the theories of evolution. In addition, it underlines the importance of sustainable development in today's era.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Summarize the physiology, biochemistry and applications of extremophiles
CO2: Appraise the basics of astrobiology
CO3: Discuss the importance of microbial biodiversity
CO4: Explore the role of various microorganisms in bioprospecting
CO5: Understand the importance of natural resource management and sustainable development.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Extremophiles**	**15**
2	**Microbial Diversity**	**15**
3	**Bioinformatics, Theories of Evolution and Astrobiology**	**15**
4	**Environmental Management, Safety Standards and Sustainable Development**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**EXTREMOPHILES-I** Physiology, Biochemistry and Applications of Thermophiles Psychrophiles Piezophiles Acidophiles Alkaliphiles Halophiles	**15** **6** **6** **3**	**1**
Module 2	**MICROBIAL DIVERSITY** The expanse of microbial diversity. Estimates of total number of species, measures and indices of diversity, the species concept for prokaryotes and eukaryote; Culture-dependent microbiology Newer approaches for exploring unculturable bacteria: Culture independent molecular methods, Methods of extracting total bacterial DNA from a habitat; the metagenomics approach. Bioprospecting Pharmacologically active agents of microbial origin Industrial enzymes Novel antifoulants and anti-biofilm agents from microbes Conservation of microbial gene pools	**15** **1** **4** **5** **5**	**1**
Module 3	**BIOINFORMATICS, THEORIES OF EVOLUTION AND ASTROBIOLOGY** Bioinformatics Introduction Definition, aims, tasks and applications of Bioinformatics. Database, tools and their uses; Importance, Types and classification of databases Nucleic acid sequence databases Protein sequence databases Enzyme databases Alignment: Pairwise and Multiple sequence alignment, Phylogenetic analysis and Tree construction Theories of evolution History of molecular evolution Neutral theory of evolution	**15** **5** **5** **5**	**1**

	Mechanisms of Molecular Evolution The Modern Molecular Clock Astrobiology		
Module 4	**ENVIRONMENTAL MANAGEMENT, SAFETY STANDARDS & SUSTAINABLE DEVELOPMENT** ENVIRONMENTAL & NATURAL RESOURCE MANAGEMENT & SAFETY STANDARDS Natural resources: Renewable/ non renewable. Land, water, forest, minerals, energy, food. Associated problems and management practices. Environmental Impact Assessment and Sustainable Development Solid waste management: Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non biodegradable waste like plastics, glass metal scrap and building materials and plastic recycling, metal recycling. Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these waste through Common Effluent Treatment Plants. Biomedical and electronic waste management, recovery of precious metals from electronic waste resources. Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures. Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS) SUSTAINABLE DEVELOPMENT Definition and concepts of sustainable development Sustainable development and the need for strategic response Nature of sustainable development strategies Goals of sustainable development Strategies to achieve sustainable development Green Technology	**15** **10** **5**	**1**

PRACTICAL IV- PSMAMBP21

1. PRACTICALS BASED ON BIOINFORMATICS-
   1.1. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained
   1.2. Visiting & exploring various databases mentioned in syllabus and
   1.3. Using BLAST and FASTA for sequence analysis
   1.4. Fish out homologs for given specific sequences (by teacher - decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology)
   1.5. Six frame translation of given nucleotide sequence
   1.6. Restriction analysis of given nucleotide sequence
   1.7. Pair-wise alignment and multiple alignment of a given protein sequences
   1.8. Formation of phylogenetic tree
2. Isolation of bacteria from-
   2.1. Hot springs
   2.2. Acidic environments
   2.3. Halophilic environment
   2.4. Screening of enzymes from the above culture(s)

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
2. G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj- Agricultural Microbiology; 2nd Edition,2007; PHI learning Pvt Ltd
3. Iqbal Ahmad, Farah Ahmad, John Pichtel- Microbes and Microbial Technology: Agricultural and Environmental Applications.. Springer, 2011, New York
4. Colin Munn- Marine Microbiology: Ecology and Applications, 2nd edition
5. S. K. Agarwal Resource ecology; 1993; Himanshu Publications
6. Om V. Singh (2013) Extremophiles: Sustainable Resources and Biotechnological Implications; Wiley Blackwell
7. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. Addison Wesley Longman, Inc.
8. R.K. Jain and others- Environmental management.

Supplementary Readings

1. Koki Horikoshi (ed.) (2011) Extremophiles Handbook; Springer.
2. R.M. Maier, I. L. Pepper and C. P. Gerba 2010, Environmental Microbiology Academic Press
3. H. V. Jadhav- Environmental management., Vipul Prakashan , 2002
4. Gerday, Charles, Glansdorff, Nicolas (2007) Physiology and Biochemistry of Extremophiles; ASM Press.

5. Rastogi &Sani, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment Microbes and Microbial Technology, 2011, pp 29-57,

Reference articles:

1. Wilpiszeski RL, Aufrecht JA, Retterer ST, Sullivan MB, Graham DE, Pierce EM, Zablocki OD, Palumbo AV, Elias DA. 2019. Soil aggregate microbial communities: Towards understanding microbiome interactions at biologically relevant scales. Appl Environ Microbiol 85: e00324-19 - PHI Learning Pvt. Ltd., 2004
2. Richard Jacoby, Manuela Peukert, Antonella Succurro, Anna Koprivova and Stanislav Kopriva- The role of soil microorganisms in plant mineral nutrition - current knowledge and future directions; Frontiers in Plant Science; Sep 2017; Vol 8: Marine Microbiology
3. Hrudayanath Thatoi & Bikash Chandra Behera & Rashmi Ranjan Mishra & Sushil Kumar Dutta "Biodiversity and biotechnological potential of microorganisms from mangrove ecosystems: a review-, Ann Microbiol, 2012 Marine microbiology- -Ecology and applications
4. Rolf Daniel- The Metagenomics of soil by,470/ June2005/ vol3, ww.nature.com/ reviews
5. Susannah Green Tringe and Edward M. Rubin- Metagenomics: DNA sequencing of environmental samples, ,806/ November2005/ Volume6 www.nature.com/ reviews/ genetics
6. S.N. Baharum, E.K. Beng and M.A.A. Mokhtar, 2010. Marine Microorganisms: Potential Application and Challenges. Journal of Biological Sciences, 10: 555-564.
7. A K Bej and M H Mahbubani, Applications of the polymerase chain reaction in environmental Microbiology. Genome Res. 1992 1: 151-159
8. R. S. Ambasht- Modern trends in ecology and environment.
9. M. H. Fulekar- Industrial hygiene and safety.
10. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: I**	
Course: MOLECULAR BIOLOGY				**Course Code: PSMAMB202**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (SEE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course acquaints the learner with the finer aspects of the structure, replication, transcription, regulation, repair and recombination of genetic material. It is also designed to impart knowledge about selected concepts and techniques related to molecular biology.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Elucidate the chromosomal structure
CO2: Describe the detailed mechanism of chromosome replication and transcription.
CO3: Explain how regulation of genes is effected in prokaryotes and eukaryotes.
CO4: Elaborate on the principles of selected advanced techniques used in molecular biology.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Chromosome Structure, Replication and Transcription**	**15**
2	**Regulation of Gene Expression**	**15**
3	**Repair and Recombination**	**15**
4	**Essential Concepts and Techniques**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**CHROMOSOME STRUCTURE, REPLICATION AND TRANSCRIPTION** Maintenance of chromosome structure Genome Sequence and Chromosome Diversity Chromosome Duplication and Segregation The nucleosome Higher-Order Chromatin Structure Regulation of chromatin structure Nucleosome assembly Replication of DNA Replication in prokaryotes – review Replication in eukaryotes Topoisomerases- their role in replication Telomerase Transcription Transcription in prokaryotes- review Transcription in eukaryotes RNA processing- addition of 5′ cap, addition of Poly(A) tail, RNA splicing, RNA editing	**15** **5** **5** **5**	**1**
Module 2	**REGULATION OF GENE EXPRESSION** Control of gene expression in prokaryotes Multiple sigma factors; sigma factor switching. Riboswitches RNA interference Operons (at least one inducible and one repressible) Control of gene expression in eukaryotes DNase I hypersensitivity, histone modifications, chromatin remodelling, DNA methylation Regulation through transcriptional activators, Coactivators & repressors, enhancers and insulators Regulation through RNA processing & degradation Regulation through RNA interference Regulation of replication.	**15** **5** **5** **5**	**1**
Module 3	**REPAIR AND RECOMBINATION** The mutability and repair of DNA Replication errors and their repair	**15** **5**	**1**

	DNA damage Repair of DNA damage Homologous recombination at the molecular level Models for homologous recombination Homologous recombination protein machines Homologous recombination in eukaryotes Mating type switching Genetic consequences of the mechanisms of homologous recombination Examples of gene regulation by recombination Site-specific recombination and transposition of DNA Conservative site-specific recombination Biological roles of site-specific recombination V(D) J recombination	**5** **5**	
Module 4	**ESSENTIAL CONCEPTS AND TECHNIQUES** Molecular tools for studying genes and gene activity Use of recombinant DNA technology to identify human genes (Huntington's diseases, Cystic fibrosis), molecular diagnosis of human diseases, human gene therapy) Molecular separations Gel electrophoresis Two-dimensional gel electrophoresis Ion-exchange chromatography Gel filtration chromatography Affinity chromatography Labelled tracers Autoradiography Phosphorimaging Liquid scintillation counting Nonradioactive tracers Using nucleic acid hybridization Southern blots DNA fingerprinting and DNA typing In situ hybridization: Locating genes in chromosomes Immunoblots DNA sequencing and physical mapping The Sanger Chain-Termination Sequencing method Automated DNA sequencing High-throughput Sequencing Restriction Mapping Site-directed mutagenesis Mapping and quantifying transcripts Northern blots	**15** **6** **6**	**1**

	S1 mapping Primer extension Run-off transcription and G-less cassette transcription Measuring transcription rates in vivo Nuclear run-on transcription Reporter gene transcription Measuring protein accumulation in vivo Assaying DNA –protein interactions Filter binding Gel mobility shift DNase Footprinting DMS footprinting and other footprinting methods Chromatin immunoprecipitation (ChIP) Assaying protein-protein interactions Finding RNA sequences that interact with other molecules SELEX Functional SELEX Knockouts and Transgenics	**3**	

PRACTICAL II- PSMAMBP22

1. β galactosidase assay
2. UV mutagenesis
3. Acridine orange mutagenesis
4. Isolation of mutants by Replica plate technique
5. Penicillin enrichment technique
6. Ames test
7. Southern hybridization technique [Demonstration]
8. Northern Blotting technique [Demonstration]
9. Restriction mapping
10. Design of primer
11. Electrophoresis of proteins.

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. Weaver R. F.- Molecular Biology, 5th edition; 2008; McGraw Hill
2. Benjamin Pierce- Genetics: A Conceptual Approach, 7th edition; 2020; Macmillan Learning

3. J. D. Watson, A. B. Tania, P.B. Stephen, Gann A, Losick R.- Molecular Biology of the Gene; 7th edition; 2017; Pearson Education

Supplementary Readings

4. Goldstein, Elliott-Gene X; 2009; Jones & Bartlett Learning
5. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: II**	
Course: ADVANCED VIROLOGY				**Course Code: PSMAMB206**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course is designed encompass the advanced knowledge about the bacterial, plant and animal viruses. In addition, it discusses the viruses in relation to human health.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Describe the life cycle of different types of viruses.

CO2: Comprehend the diseases caused by plant and animal viruses

CO3: Enlist the re-emerging viruses and understand the strategies to prevent their transmission

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Bacterial Viruses**	**15**
2	**Plant Viruses**	**15**
3	**Animal Viruses**	**15**
4	**Virology in Relation to Human Health**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**BACTERIAL VIRUSES**	**15**	**1**
	Bacteriophages: General properties of phages, properties of phage infected Bacterial cultures, Specificity of Phage Infection	**3**	
	E. coli Phage T4: Properties of T4 DNA, Genetic organization, the T4growth cycle, Replication of T4 DNA	**3**	
	E.coli Phage T7: Organization of the T7 genes, Growth Cycle, Regulation of transcription of T7 phage.	**4**	
	E.coli Phage (phi) X174, Filamentous DNA phages, Single stranded RNA phages, Lysogenic cycle.	**3**	
Module 2	**PLANT VIRUSES**	**15**	**1**
	Plant viruses: Morphology, Transmission of plant viruses, symptoms of plant diseases caused by viruses.	**4**	
	Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids	**3**	
	TMV, Citrus Tristeza Virus (CTV): Viral structure, Genome, Host range, Transmission, Symptom and Control.	**6**	
	Diagnosis of viral infections in plants	**2**	
Module 3	**ANIMAL VIRUSES**	**15**	**1**
	Animal Viruses: Influenza viruses- Classification, Clinical features, replication, genetic variation, Treatment and Surveillance	**4**	
	Rabies virus, epidemiology, Pathogenesis, Immunity, Management of human rabies, Viral life cycle, genetic variation.	**3**	
	Pox virus: Clinical features, Structure of virus, replication, Vaccinia, orthopox virus, Chicken pox virus.	**4**	
	Herpes Virus: Clinical signs and symptoms, varicella Zoster virus, Epstein-Barr virus, Cytomegalovirus, Life cycle, laboratory diagnosis, treatment	**4**	

Module 4	**VIROLOGY IN RELATION TO HUMAN HEALTH** Human Immunodeficiency Virus: transmission, epidemiology, life cycle, prevention, Diagnosis. Hepatitis Virus: Clinical features, epidemiology, Laboratory diagnosis, life cycle, Genetic diversity, prevention New and reemerging viruses, Evolution and adaptation, ecological factors, climate variability, human factors-social behavior, exposure to zoonotic diseases, human movement Oncogenic and Oncolytic viruses Rubella virus Overview of mycoviruses, algal viruses, protozoal viruses	**15** **5** **5** **5**	**1**

PRACTICAL III- PSMAMBP23

1. One step growth curve for coliphage
2. Students have to complete any 2-3 courses from Swayam or other reputed platforms for 60 hours.

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. Flint, Enquiest, Racanillo and Skalka, Principles of virology, 2nd ed. ASM Press.
2. Terry Shors (2009) Understanding Viruses, Jones and Bartlett Publishers.

Supplementary Readings

3. Wagner, Hewlett Bloom and Camerini- Basic Virology, 3rd ed Blackwell Publishers
4. Any other reference sources as recommended by the course instructor.

Program: M.Sc.				**Semester: I**	
Course: RESEARCH METHODOLOGY				**Course Code: PSMAMB204**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
04	04	-	06	25	75

Learning Objectives:

The course trains the learner to conduct a systematic literature search, strategize, plan, organize data and formulate a research project in a scientific manner, with the help of relevant statistical tools.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Formulate a research project by identifying gaps through a literature search
CO2: Postulate a hypothesis and test the same
CO3: Carry out analysis of experimental data

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Research Methodology**	**15**
2	**Biostatistics - Introduction**	**15**
3	**Theory of Probability**	**15**
4	**Hypothesis Testing, Parametric and Nonparametric Tests**	**15**
	Total	**60**
PRACTICALS		**120**

Unit	Topic	No. of Hours	No. of Credits
Module 1	**RESEARCH METHODOLOGY** Strategies, planning and analysis Scientific problem Objectives of research Short term and long term goals Research conditions Research design- characteristics of a good research design, types of research design Repeatability, reproducibility and reliability Experimental protocols Literature search Information literacy Systematic literature search How to formulate a query: PICO Search techniques Methodology filters Critical appraisal Impact factor Medical and scientific internet Principal bibliographic databases Citation style Reference management software e.g. Mendeley, Zoreto Ethics in science Introduction to ethics Scientific conduct and misconduct Authorship issues Plagiarism Basic principles of human research ethics- international regulation Ethics of animal research- CPCSEA, Institutional ethics committee, OECD guidelines	**15** **5** **5** **5**	**1**
Module 2	**BIOSTATISTICS- INTRODUCTION** Introduction- definition, scope and limitations Measurement scales, variables & their measurements Collection of data, classification & tabulation- diagrammatic & graphical representation Measures of central tendency -mean, median, mode, geometric mean Measures of dispersion- Range, Q.D., M.D., variance, standard deviation	**15** **6**	**1**

	Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations & their equations, interpretation of regression coefficients, principles of least squares, Two regression lines, curve fitting Karl Pearson's coefficient of correlation, Spearman's coefficient of correlation Sampling-sampling frame, importance of probability sampling, simple random sampling, systemic sampling, stratified random sampling, cluster sampling	**5** **4**	
Module 3	**THEORY OF PROBABILITY** Random experiments, sample space of an experiment, event, mutually exclusive events, exhaustive events, independent events, additional theory (statement only), conditional probability, multiplication theorem (statement only), Bayes' theorem. Discrete distribution- Binomial distribution, Poisson distribution Continuous distribution- Normal distribution and its properties, Sampling distribution	**15** **5** **5** **5**	**1**
Module 4	**HYPOTHESIS TESTING, PARAMETRIC AND NON-PARAMETRIC TESTS** HYPOTHESIS TESTING Null and alternate hypothesis Type-I & Type-II errors Level of significance, Power of test p value PARAMETRIC TESTS Large sample Tests Testing significance of single population mean Testing significance of single population proportion Testing significance of two population mean Testing significance of two population proportion Small sample Tests Testing significance of single population mean Testing difference between two independent normal population mean Testing difference between two correlated normal population mean Testing significance of correlation coefficient $\chi 2$ test	**15** **4** **6**	**1**

	Testing single population variance Testing Goodness of fit Testing association between two attributes F-test- Testing equality of variance ANOVA- one-way classification, two-way classification INTRODUCTION TO NON-PARAMETRIC TESTS Rank test-sign test The Wilcoxon Signed-Rank test for location Testing single population mean Testing difference between correlated (match pair) population means Testing difference between two independent population means The Mann-Whitney Test(Mann-Whitney-Wilcoxon test -for equality of medians) The Kolmogorov-Smirnov Goodness- of -Fit Test The Kruskal-Wallis One-Way Analysis of Variance by Ranks The Friedman Two-Way Analysis of Variance by Ranks	**5**	

PRACTICAL IV- PSMAMBP24

1. TUTORIALS ON-
   - Writing review article
   - Preparation of poster
   - Problems on biostatistics
   - Writing project proposal (project will be completed in semesters-III & IV)

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Suggestive Readings:

Essential Readings:

1. Petter Laake, Haakon Benestad and Bjorn Reino Olsen- Research Methodology in medical and Biological Sciences, Academic Press
2. Pradip kumar Sahu- Research Methodology: A guide for Researchers in Agricultural Science, Social Science and other related fields, Springer 2006
3. Ranjit Kumar, 2005 Research Methodology- A step-by-step Guide for beginners, 3rd edition, Sage publications
4. Rosner B- Fundamentals of Biostatistics. 7th Edn. Duxbury Thomson 2011

Supplementary Readings

1. Daniel WW, Cross CL- Biostatistics: A foundation for analysis in health sciences. 10th Edn, Wiley.2013
2. Zar JH- Biostatistical Analysis. 5th Edition Pearson Education.2010.
3. Pagano M., Gauvreau K- Principles of Biostatistics., 2nd Edn. Cargege Learning, 2010
4. Gupta SP- Statistical Methods. 4th Edn Sultan Chand & Co., 2011
5. D'Agostino RB., Sullivan LM., Beiser AS- Introductory Applied Biostatistics, Thomson Brooks/Cole 2006.
6. Any other reference sources as recommended by the course instructor.