RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

Scheme of Teaching and Examination

for

Two year Post Graduate Programme

M. Sc. (Microbiology)

(As per NEP 2020 Structure and Credit Distribution)

Course Effective from 2023-2024

Scheme of Teaching and Examination for M. Sc. (Microbiology)

As per NEP 2020 Structure and Credit Distribution of PG Degree Program

for Two Year Choice Based Credit System (Semester Pattern)

Effective from 2023-2024

Semester I

S N	Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total (Hrs)	Total Credit	Examination Scheme						
									Theory				Practical		
				(Th)	TU	P			Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
1	DSC	Microbial Metabolism	MMI1T01	4	-	-	4	4	3	80	20	40	-	-	-
2	DSC	Enzymology and Techniques	MMI1T02	4	-	-	4	4	3	80	20	40	-	-	-
3	DSE	Elective 1 (Choose any One) 1. Advance Techniques in Microbiology 2. Membrane Structure and Signal Transduction	MMI1T03	4	-	-	4	4	3	80	20	40	-	-	-
4	RM	Research Methodology	MMI1T04	4	-	-	4	4	2	80	20	40	-	-	-
5	LAB 1	Practical I	MMI1P01	-	-	6	6	3	2-6*				50	50	50
6	LAB 2	Practical II (Including Research Methodology)	MMI1P02	-	-	6	6	3	2-6*				50	50	50
Total				16	-	12	**28**	**22**	**-**	**320**	**80**	**160**	**100**	**100**	**100**

Marks of Theory Component= 400 Marks of Practical Component= 200 TOTAL = 600
Min.Passing: 160+100= 260

Semester II

S N	Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total (Hrs)	Total Credit	Examination Scheme						
									Theory				Practical		
				(Th)	TU	P			Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
1	DSC	Environmental Microbial Technology	MMI2T05	4	-	-	4	4	3	80	20	40	-	-	
2	DSC	Immunology and Immunodiagnostics	MMI2T06	4	-	-	4	4	3	80	20	40	-	-	
3	DSE	Elective 2 (Choose any one) 1. Microbial Metabolites 2.Pharmaceutical Microbiology	MMI2T07	4	-	-	4	4	3	80	20	40	-	-	
4	OJT	On Job Training / Field Project	MOJ2P01	-	-	8	8	4	3-8*	-	-	-	50	50	50
5	LAB 3	Practical III	MMI2P03	-	-	6	6	3	2-6*	-	-	-	50	50	50
6	LAB 4	Practical IV	MMI2P04	-	-	6	6	3	2-6*	-	-	-	50	50	50
Total				12	-	20	**32**	**22**		**240**	**60**	**120**	**150**	**150**	**150**

Marks of Theory Component = 300 Marks of Practical Component= 300 TOTAL = 600
Min. Passing: 120+150= 270

Semester III

S N	Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total (Hrs)	Total Credit	Examination Scheme						
									Theory				Practical		
				(Th)	TU	P			Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
1	DSC	Microbial Diversity,Evolution and Ecology	MMI3T08	4	-	-	4	4	3	80	20	40	-	-	-
2	DSC	Molecular Biology and Genetics	MMI3T09	4	-	-	4	4	3	80	20	40	-	-	-
3	DSC	Recombinant DNA Technology and Nanobiotechnology	MMI3T10	4	-	-	4	4	3	80	20	40	-	-	-
4	DSE	Elective 3 (Choose any one) 1. Drug and Disease Management 2. Bioinformatics	MMI3T11	4	-	-	4	4	3	80	20	40	-	-	-
5	LAB 5	Practical V	MMI3P05	-	-	4	4	2	-	-	-	-	50	50	50
6	RP	Research Project/ Dissertation (Core)	MRP3P01	-	-	8	8	4	-	-	-	-	50	50	50
Total				16	-	12	**28**	**22**		**320**	**80**	**160**	**100**	**100**	**100**

Marks of Theory Component= 400 Marks of Practical Component= 200 TOTAL = 600
Min.Passing: 160+100=260

Semester IV

S N	Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total (Hrs)	Total Credit	Examination Scheme						
									Theory				Practical		
				(Th)	TU	P			Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
1	DSC	Virology	MMI4T12	4	-	-	4	4	3	80	20	40	-	-	-
2	DSC	Microbial Fermentation & Techniques	MMI4T13	4	-	-	4	4	3	80	20	40	-	-	-
3	DSC	Medical Microbiology and Parasitology	MMI4T14	4	-	-	4	4	3	80	20	40	-	-	-
4	DSE	Elective 4 (Choose any one) 1. Vaccinology 2. Bioethics, Biosafety and IPR	MMI4T15	4	-	-	4	4	3	80	20	40	-	-	-
5	RP	Research Project / Dissertation (Core)	MRP4P02	-	-	12	12	6	-	-	-	-	100	100	100
Total				16	-	12	**28**	**22**		**320**	**80**	**160**	100	100	100

Marks of Theory Component= 400 Marks of Project Component= 200 TOTAL = 600

Min. Passing: 160+100=260

2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or
1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree

Total Credits for Four Semesters (Two Year Course): 4 * 22 = 88

Total Marks for Four Semesters (Two Year Course): 4 * 600 = 2400

Basket for ELECTIVE (DSE) Category Courses (Microbiology)

Semester	Course Category	Name of Course	Course Code
I	Elective 1	A. Advance Techniques in Microbiology B. Membrane Structure and Signal Transduction	MMI1T03
II	Elective 2	A. Microbial Metabolites B. Pharmaceutical Microbiology	MMI2T07
III	Elective 3	A. Drug and Disease Management B. Bioinformatics	MMI3T11
IV	Elective 4	A. Vaccinology B. Bioethics, Biosafety and IPR	MMI4T15

Abbreviations:

DSC: Discipline Specific Course, **DSE**: Discipline Specific Elective **SEE:** Semester End Examination**, CIE:** Continuous Internal Evaluation, **OJT:** On the Job Training (Internship/Apprenticeship), **FP:** Field Project, **RM:** Research Methodology, **RP**: Research Project

EVALUATION and DISTRIBUTION OF MARKS

(1) Continuous Internal Evaluation (CIE): Twenty (20) marks

a. Mid-Semester Examination: Maximum Marks 10, Duration of Examination: One Hour, Pattern of Question Paper: Multiple Choice Questions, Mode of examination: Online or offline.

b. Overall Participation: Maximum 10 Marks (Such as, Attendance in theory classes, seminar, assignment, quiz, participation in field tours, conferences, workshops, and the general behaviour in the department.)

Note: Total Marks of CIE will be 20 (i.e., 10+10). A candidate must have to secure minimum 50% marks (i.e., 10 out of 20 marks). Failing so, he/she shall not be allowed to appear in End Semester Examination.

(2) Semester End Examination (SEE)

a. Theory Paper: Maximum Marks: 80 (Eighty), Duration of Examination-Three Hours, The paper will be set so as to cover all units/sections of the syllabus as below:

Type of questions	Total Number of questions with Marks	No. of questions to be	Marks for Each Question	Total maximum marks
• Short answer questions • Long answer questions	**4 + 1 = 5** one long question from each unit (16 marks each) or two questions from each unit (8+8=16 marks each) + one short question on each unit (4 marks each)	**5**	**16**	**80**

3) General Scheme for Distribution of Marks in Practical Examination in Microbiology

Marks: 100 [SEE: 50 Marks] [CIE: 50 Marks]

a) **Continuous Internal Evaluation (CIE): Fifty (50) marks:** Attendance in practical classes, seminar, assignment, quiz, participation in field tours, conferences, workshops, and the general behaviour in the department

Note: Total Marks of CIE will be 50 marks. A candidate must have to secure minimum 50% marks (i.e., 25 out of 50 marks). Failing so, he/she shall not be allowed to appear in End Semester Examination

b) **Semester End Examination (SEE):** Time: 5-6 h (Two days Examination)

Exercise-1	15 Marks	- Evaluated jointly by Internal and External Examiner
Exercise-2	15 Marks	- Evaluated jointly by Internal and External Examiner
Record	10 Marks	- Evaluated by Internal
Viva-Voce	10 Marks	- Evaluated by External
Total	**50 Marks**	

4) General Scheme for Distribution of Marks in Project Examination in Microbiology

The project work will carry total 100 marks (SEE=50 + CIE=50) in Semester III and 200 marks (SEE=100 + CIE=100) in Semester IV and will be evaluated by both external and internal examiners in the Department. The examiners will evaluate the project work considering the coverage of subject matter, presentation, literature etc.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

Syllabus

for

Two year Post Graduate Programme

M. Sc. (Microbiology)

(As per NEP 2020 Structure Effective from 2023-2024)

M. Sc. Semester-I
Discipline Specific Core Course (DSC-1)-MICROBIOLOGY –Paper I
(MMI1T01) (MICROBIAL METABOLISM)

Course Outcomes: At the end of the course the students will be able to
1. Understand the biochemical basis of life forms
2. Learn the energy transformations in biological processes
3. Understand the synthesis of biomolecules
4. Understand synthesis and breakdown mechanisms in bacteria

DSC-1 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Carbohydrates and Lipids	Carbohydrates as informational molecules:-Sugar code, Plant Lectins: - ConA, GS4, WGA. Animal:- Galectin A, MBP-1.Viral:- HA, VPI. Bacterial:- LT,CT. Reverse TCA cycle, Biosynthesis of cell wall polysaccharides and bacterial peptidoglycan. Biosynthesis of microbial exopolysaccharides (alginate) Lipid:- Membrane lipids, biosynthesis of membrane phospholipids, Steroid transformation		**15 Hrs**
	Unit-II		
Proteins and Nucleic acids	**Proteins: C**haracteristics of alpha-helix and β-sheets. Ramachandran plot, Concept of protein domain and motif, common motifs and their role in metabolism, protein folding and denaturation curves, role of Chaperones and chaperonins. Biosynthesis of amino acids (only Aromatic, Acidic and Basic amino acid). Determination of primary structure of polypeptide (N-terminal, C-terminal determination, method of sequencing of peptides), **Nucleic acids:-** Structural details of Duplex DNA, Unusual structures: palindrome, inverted repeats, mirror repeats, triplet DNA, G tetraplex, secondary structure of RNA, purine and pyrimidine biosynthesis, degradation and regulation, salvage pathway, Inhibitors. DNA sequencing. (Maxam–Gilbert and Sanger dideoxy method)		**15 Hrs**

Unit III		
Photosynthesis	**Anoxygenic photosynthesis:-**Green sulphur bacterial, non-sulphur bacterial, purple phototrophic bacteria. **Oxygenic photosynthesis:-**Cyanobacteria. **Chemolithotrophy:-** Hydrogen oxidation and autotrophy in hydrogen bacteria. Oxidation of reduced sulphur compounds and Iron. **Bioluminiscence;** Biochemical pathway in bacteria	**15 Hrs**
Unit IV		
Nitrogen and Sulphur metabolism and methanogenesis	**Biochemical Mechanisms:** Nitrification and Anammox. Nitrate reduction and Denitrification. Nitrogen fixation: Symbiotic, nonsymbiotic. Sulphate reduction. Methanogenesis, Acetogenesis, Acetate use and autotrophy	**15 Hrs**

Suggested Books:

1. D. L. Nelson and M. M. Cox. 'Lehninger Principles of Biochemistry', Macmillan Int.

2. J. M. Berg, J. L. Tymoczko and L. Stryer. 'Biochemistry' 6 th edition, W. H Freeman and Company.

3. S. C. Rastogi. 'Biochemistry'. Tata McGraw Hill Publishing Company, New Delhi.

4. Gottschalk G. 'Bacterial Metabolism'. Springer, New York.

5. Doelle H.W. 1969. Bacterial Metabolism. Academic Press

6. Sandikar B. M. 'Basic Biochemistry and Microbial Metabolism'. Himalaya Publishing House, Mumbai.

7. Conn E. E. and Stmph P. K. 'Outlines of Biochemistry' John Wiley & Sons, New Delhi.

8. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press

9. Brock Biology of Microorganisms, Thirteenth Edition by Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, Benjamin Cummings, 1301 Sansome Street,San Francisco, CA 94111.

10. Voet D. and Voet J. G. (2011). Biochemistry. United Kingdom: Wiley.

M. Sc. Semester-I

Discipline Specific Core Course (DSC-2)-MICROBIOLOGY –Paper 2 (MMI1T02)

(ENZYMOLOGY AND TECHNIQUES)

Course Outcomes:

1. Students will be able to understand general characteristics of enzymes
2. Students will learn the different mechanisms of enzyme catalysis.
3. Students will be able to Gain an understanding of enzyme kinetics and regulation.
4. Students will be able to understanding the various biochemical techniques based on enzymes like biosensors

DSC-2 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Fundamentals of Enzymology	Concept of enzyme specificity, Mechanism of enzyme action: Models, catalysis by proximity effect, acid-base catalysis, electrostatic interaction, metal ion catalysis, nucleophilic and electrophilic catalysis, preferential binding. Mechanism of action of lysozyme and serine proteases. Multienzyme complexes; Concept and mechanism of fatty acid synthase and pyruvate dehydrogenase complexes Isoenzyme; concept and Lactate dehydrogenases as marker enzymes Enzyme regulation; Allosteric (example ATCase), chemical modification and calmodulin mediated regulation.		**15 Hrs**
	Unit-II		
Enzyme Kinetics	Significance of Michaelis-Menten equation and its transformations. kinetics of enzyme inhibition, Kinetics of bisubstrate reaction & multistep reactions Allosterism: Kinetic analysis of allosteric enzymes. Covalent Modification, Feed -back inhibition**.**		**15 Hrs**

Unit III		
Enzyme Techniques	Techniques for isolation and purification of enzymes, methods for enzyme assays. Protein: ligand binding studies: association and dissociation constants, co-operative ligand binding MWC or concerted model, sequential model. Enzyme biosensors: General concept, glucose biosensor. Industrial applications of enzymes (Amylase, Protease, Cellulase) Protein engineering- Objectives & strategies of enzyme engineering. Methods of enzyme engineering. Protein engineering applications.	**15 Hrs**
Unit IV		
Immobilised enzymes	Immobilization techniques for cells (physical adsorption, ionic binding, covalent binding, lattice entrapment, membrane entrapment, micro encapsulation) and enzymes (covalent binding, entrapment, micro encapsulation, cross-linking, adsorption, ionic binding, affinity binding, chelation, disulfide bonds) Immobilized enzyme kinetics, Immobilized bioreactors Applications of immobilized enzymes	**15 Hrs**

Suggested Books:

1) Fundamentals of Enzymology- Nicholas Price and Lewis Stevens, Oxford Univesrity press
2) Biochemistry -Albert L. Lehninger, Kalyani Publishers
3) Outlines of Biochemistry- Conn & Stumph
4) Enzymes & Enzyme Technology - Anilkumar, MV Learning
5) "Enzymology and Enzyme Technology" by Bhatt S M .
6) Enzyme Technology" by S Shanmugam and T Sathishkumar …
7) The Biochemistry of copper By: Jack Peisach, Phillip Aisen.
8) Metabolic Pathways By:-David M.Greenberg.
9) Harper's Biochemistry By: Robert K.Myrray.
10) Enzymes: By Trevor Palmer.
11) Methods in Enzymology By: S. Berger, A. Kimmel.
12) Immobilization of Enzymes and cells By: Gordon Bickerstaff.
13) Enzymes -Biotechnology Hand book-by NIIR Board of Consultants & Engineers
Asia Pacific Business Press Inc,106-E ,Kamla Nagar,Delhi-110007

M. Sc. Semester-I
Discipline Specific Elective Course (DSE-1)-MICROBIOLOGY- Paper 3 (MMI1T03) (ADVANCE TECHNIQUES IN MICROBIOLOGY)

Course outcome: At the end of the course the students will be able to

1. Learn the basic biophysical techniques
2. Understand the design and working principle of various microscopes
3. Understand the bimolecular separation and identification techniques
4. Learn the advanced molecular techniques

DSE-1 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Biophysical Techniques-I	Determination of size, shape and Molecular weight of Macromolecules:-by Viscosity, CD/ORD, Light scattering, diffusion sedimentation and Centrifugation techniques. X-ray crystallography: Principle, instrumentation and applications		**15 Hrs**
	Unit-II		
Biophysical Techniques-II	**Electrophoresis:** Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary electrophoresis, immune-electrophoresis, Pulse field gel electrophoresis. **Chromatography**: Principle, instrumentation and applications of GLC, GC-MS and HPLC		**15 Hrs**
	Unit III		
Biophysical technique III	Blotting techniques: Western, Southern, Northern, Radioimmunoassay. NMR and its biological importance. Infrared spectroscopy, FTIR Spectroscopy and its application. Radiography : Basic concept, Autoradiography		**15 Hrs**
	Unit IV		
Microscopical Techniques.	Electron Microscopy: SEM, TEM, Staining procedures and microscopy. Fluorescent Microscopy: Staining procedures and Microscopy, FISH. Laser scanning, confocal microscopy, Atomic force microscopy. Cryoelectron microscopy.		**15 Hrs**

Suggested Books:

1. Biophysical Chemistry by Upadhyay, Upadhyay, Nath
2. Boyer R. F. (2000). Modern experimental biochemistry. India: Pearson Education.
3. Chakravarty R., Goel S. and Cai W. (2014). Nanobody: the "magic bullet" for molecular imaging? Theranostics. 4(4): 386-398.doi:10.7150/thno.8006
4. Dennison C. (2013). A guide to protein isolation. Netherlands: Springer Netherlands.
5. Desiderio D. M., Kraj A. and Nibbering N. M. (2009). Mass spectrometry: instrumentation, interpretation and applications. United Kingdom:Wiley.
6. Feldheim D. L. and Foss C. A., Jr. (Editors). (2002) Metal nanoparticles synthesis and characterization and applications. Taylor &Francis
7. Hofmann A., Walker J. M., Wilson K. and Clokie S. (2018). Wilson and Walker's Principles and techniques of biochemistry and molecular biology. United Kingdom: Cambridge University Press.
8. Narayanan P. (2007). Essentials of biophysics. India: New Age International.
9. Nölting B. (2013). Methods in modern biophysics. Germany: Springer Berlin Heidelberg.
10. Rutherford T. (2019). Principles of analytical biochemistry. Alexis Press LLC. New York.
11. Segel I. H. (2010). Biochemical calculations. 2nd Edition. India: Wiley India Private. Limited.

M. Sc. Semester-I
Discipline Specific Elective Course (DSE-1)-MICROBIOLOGY- Paper 3 (MMI1T03) (MEMBRANE STRUCTURE AND SIGNAL TRANSDUCTION)

Course Outcome:

1. Students will understand the structures and components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. Students will understand how the transport of molecules through cell membrane.
3. Students will understand different advance technique used for cell membrane study.

At the end of the course, the student has a strong foundation on the functions of the cell.

DSE-1 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Structure and organization of membranes	Prokaryotic and Eukaryotic Cell structure, Structure and function of Mitochondria, and Endoplasmic reticulum, prokaryotic membrane, Membrane junctions (Gap & tight junctions), Techniques for membrane study: Electron microscopic method, membrane vesicles, differential scanning colorimetry, flouroscence, photo bleaching recovery, flow cytometry		**15 Hrs**
	Unit-II		
Membrane Transport	Active and Passive transport, Uniport, ATP powered pumps, non-gated ion channels, co transport by symporters and antiporters, transepithelial transport.		**15 Hrs**
	Unit III		
Signal Transduction	General concept of cell signaling, G-protein coupled receptors and their effectors. RTK and MAP Kinases-Down regulations of pathways. Cytokine receptors and their mechanism (JAK-STAT pathway).		**15 Hrs**
	Unit IV		
Bacterial signal transduction	Basic two component system. Histidine kinase pathway. Sporulation as a model of bacterial signaltransduction. Osmoregulatory pathways. Heat shock proteins. Mating types of yeast. Bacterial Biofilm: Composition, formation and role.		**15 Hrs**

Suggested Books:

1. Principles of Biochemistry, A. L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing.
2. Harper's Biochemistry K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell,McGraw Hill/ Appleton and Lange.
3. Biochemistry (Fifth Edition), Lubert Stryer.
4. V. Voet and J. G. Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
5. Molecular Cell Biology by Bruce Albert.
6. Molecular Biology by Lodish, Darnell and Baltimore.
7. Molecular Biology of the gene by Watson et al 4th ed.
8. Cell and molecular biology by Gerald Karp.
9. Cell biology by Pollard and Earnshaw

M. Sc. Semester-I
MICROBIOLOGY - Paper-4 (MMI1T04)
(RESEARCH METHODOLOGY)

Course Outcomes:

After learning research methodology course, students will be able to

1. Identify and describe the characteristics of different types of research, including basic, applied, and patent-oriented research.
2. Apply scientific thinking and problem identification techniques in the research process.
3. Apply descriptive and inferential statistical analysis techniques to analyze and interpret research data and understand the concept of hypothesis and its importance in research, and apply appropriate research methods.
4. Develop skills in technical writing, research reporting, and the proper structure and organization of research documents and gain awareness of research ethics, academic integrity, and the importance of avoiding plagiarism and academic malpractice.

RM-THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Research basics & objectives	1.1 Definitions; research, research methodology, discovery, invention & innovation. 1.2 General & specific characteristics of research. Types of research- Descriptive & analytical, Applied & fundamental, Qualitative & quantitative, Conceptual and empirical. 1.3 Steps of action- Genesis of problem, defining of problem & formulation of the problem. 1.4 Literature survey- Importance of literature survey in defining the problem-Primary & secondary sources-reviews , monographs, patents, web as a source of literature. 1.5 Identifying gaps in present knowledge. Research questions & development of working hypothesis.		**15 Hrs**

Unit-II		
Research Design	**2.1** Features of good research **2.2** Definition of hypothesis, assumption, postulates. Qualities of good hypothesis, Null Hypothesis and Alternative Hypothesis **2.3** Definition & types research methods, characteristics of survey methods their types & advantages. **2.4** Experimental method- definition, basic assumption, types of variables in experiment. Steps of experimental method.	**15 Hrs**
Unit III		
Bio-statistics & its application in research	**3.1** Definition of statistics & bio-statistics, population & types of population, individual, attribute, variate, frequency & frequency distribution, class interval, methods of grouping or class interval, class width & boundary, Accuracy and Precision. **3.2** Methods of data collection-Sampling , sampling errors, non sampling errors **3.3** Central tendency & measures of central tendency- mode, median, arithmetic mean of grouped & ungrouped data geometric mean, harmonic mean. **3.4** Measures of variance or dispersion- standard deviation or root mean deviation **3.5** Test of comparision - Chi square test, Student's t-test. **3.6** Correlation analysis. Linear regression. **3.7** Introduction to ANOVA, Use of statistical software. Application of Microsoft Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel). **3.8** Presentation of statistical data- Tables , Charts (bar charts, pie charts) & diagrams (histograms & dendrogram) & diagrams (bar charts, pie charts, histograms & dendrograms)	**15 Hrs**

Unit IV		
Technical, and research reporting, research ethics and plagiarism	**4.1** Research report-Concept and need of research report and scientific writing. Structure of thesis, structure of project report, structure of project proposal. Importance of abbreviations and acronyms. Significance of report writing . **4.2** Structure of Research paper, Types of scientific publications- magazines, journals, reviews, news-letters, various reference styles. Annotated bibliographies. **4.3** Academic integrity (Research Ethics), skills (rules) for good academic practice, understanding plagiarism and academic malpractice/ Copy write, plagiarism checker. **4.4** Impact Factor, Cite Score, *h*-Index, i10-Index, Citation Index. **4.5** Intellectual Property Rights (IPR) Introduction to IPR (Patents, Trademarks, Geographical indicators, and Copyright). **4.6** Online research tools; N-list, Zotero /Mendley, and Software for paper formatting like LaTeX tools; N-list, Mendley, plagiarism checker and LaTeX.	**15 Hrs**

Suggested Books:

1. Shanti Mishra, & Alok, S. (2011). *Handbook of Research Methodology: A Compendium for Scholars & Researchers*. Educreation Publishing.
2. Singh, Y. kumar. (2006). *Fundamentals of Research Methodology and Statistics*. New Age International Publishers.
3. Walliman, N. (2010). *Research Methods The Basics*. Routledge Taylor and Francis Group.

M. Sc. Semester-I

MICROBIOLOGY – PRACTICAL-1 (MMI1P01)

Course outcomes:

1.This course explains the enzyme activity determination of important hydrolytic enzymes.
2. Students will earn about the effect of different physical factors.
3. Students will able to isolate and purify the enzyme.
4. Students will able to isolate and identify Nitrogen fixing bacteria.
5. Students will be able to isolate Siderophore producing bacteria.

LAB-1	**Hours: 06 Hours /Week**	**Marks: 50+50=100**	**Credit: 03**
	Perform minimum 08 from following practical's		
	1) Detection of Urease enzyme activity, 2) Determination of kinetic constant of amylase: -Amylase activity, Vmax. Km. 3) Effect of pH and temperature on amylase activity. 4) Effect of inhibitors on amylase activity. 5) Estimation of protein by Lowry's method. 6) Production, isolation and purification of enzyme and determination of its activity. (any one enzyme) 7) Estimation of sucrose in presence of glucose. 8) Determination of UV absorption maxima of proteins, DNA and RNA. 9) Isolation of Siderophore producing bacteria. 10) Determination nitrate reduction and denitrification of microorganism 11) Determination of blood sugar by using glucose biosensor. 12) Titration curve of amino acid and determination of pK value. 13) Immobilization of enzyme and estimation of its activity.		**45 Hrs**

M. Sc. Semester-I
MICROBIOLOGY – PRACTICAL-2 (MMI1P02)

Course outcomes: After successful completion of this course, students will be able :

1. This course explains the techniques of protein biology
2. Students will learn about Subcellular organelles and isolation of Marker enzymes.
3. The performance of various molecular techniques will be understood
4. Students will learn various techniques of protein isolation and analysis techniques
5. Students will learn about techniques for Isolation and screening of industrially important microorganisms
6. Students will learn about statistical analysis of research data

LAB-2	Hours: 06 Hours /Week	Marks: 50+50=100	Credit: 03

Perform minimum 10 from following practical's and Experiment number 15, 16 and 17 are compulsory

45 Hrs

1) Separation of DNA by agarose gel electrophoresis
2) Separation of amino acids/sugars by paper chromatography.
3) Separation of serum proteins by paper electrophoresis.
4) Separation of amino acids by Thin layer chromatography.
5) SDS-Page of proteins.
6) Performance of affinity chromatography.
7) Performance of Gel filtration chromatography.
8) Demonstration of blotting technique [Western /Southern/Northern].
9) Ion exchange chromatography
10) Separation of Subcellular organelles and isolation of Marker enzymes
11) Demonstration of HPLC and GC.
12) Isolation and screening of industrially important microorganisms.
13) Determination of thermal death point and thermal death time of microorganisms.
14) Measurement of bacterial population by turbidometry method
15) Determination of Statistical averages / central tendencies. a) Arithmetic mean b) Median c) Mode.

	16) Representation of Statistical data by a) Histograms b) Pie diagrams c) Use of statistical software (SPSS). 17) Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation. 18) Tests of Significance-Application of following a) ChiSquare test b) t-test c) Standard error 19) Determination and interpretation of data by one and two way ANOVA.	

Suggested Books for Lab 1 & 2:

1) Microbes in Action: Seely, Wander Mark Tarporewala, Bombay

2) A Manual of Microbiology: A.J. Salle.

3) Microbiology Methods: Collins

4) Bacteriological Techniques: F.J.Baker

5) Introduction to Microbial Techniques: Gunasekaran

6) Biochemical methods: Sadashivam & Manickam

7) Laboratory Fundamentals of Microbiology: Alcamo, I.E., Jones and Bartlett Publishers

8) Biochemical techniques by Wilson and Walker.

9) Experimental Biochemistry by B. Sashidhar Rao and Vijay M. Deshpande.

10) Practical Biochemistry by David Plummer

11) An Introduction to Practical Biochemistry, 3rd Edition, Plummer D.T

12) Experiments in Microbiology, 4th Ed., Aneja K.R.

13) Handbook of Techniques in Microbiology, Karwa A S., Rai, MK and Singh HB

14) Methods in Enzymology By: S.Berger, A. Kimmel.

15) Laboratory Manual on Biotechnology-P. M. Swamy

16) Essentials of biostatistics & research methodology by Indranil, Saha, Bobby Paul.

M. Sc. Semester-II
Discipline Specific Core Course (DSC-3)-MICROBIOLOGY –Paper 5 (MMI2T05) (ENVIRONMENTAL MICROBIAL TECHNOLOGY)

Course Outcomes:

1. Be able to acquaint with microbial communities and their interaction.
2. Be able to know about role of microorganisms in treatment of waste materials.
3. Be able to know about the factors responsible for global warming.
4. Be able to know about restoration of degraded ecosystem.

DSC-3 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Biodeterioration, Biomagnification and Eutrophication	Biodeterioration: Definition and concept of biodeterioration, biodeterioration of woods, textile clothing and pharmaceutical products. Biodeterioration of stone monuments and approach for its restoration. Biomagnification: concept and consequences, Biomagnifications of heavy metals, chlorinated hydrocarbons and pesticides and mitigation methods. Eutrophication: Consequences of . waste water and sewage discharge in natural water bodies, Causes of eutrophication, Microbial changes induced by discharge of organic and inorganic pollutants, factors influencing eutrophication process and control of eutrophication.		**15 Hrs**
	Unit-II		
Biotransformation, Biodegradation and Bioleaching	Biotransformations: Mechanism of biotransformation, Metals and metalloids, mercury, pesticides such as hexachlorobenzene and DDT transformations. Biodegradation: Biodegradation of plastics, lignin, aliphatic, aromatic and asphalts hydrocarbons. Bioleaching of ores, leaching techniques and applications.		**15 Hrs**
	Unit III		
Restoration of degraded ecosystems	Concept of Reclamation, revegetation, Management of mine spoil dumps and tailing sites, Wastewater management using high rate transpiration systems, Concept of phytoremediation and applications. Case studies related to restoration of wasteland ecosystems using integrated biotechnological approach.		**15 Hrs**

Unit IV		
Global Environmental Problems	Global warming and climate change, Ozone depletion, UV-B, green house effect, acid rain, their impact and biotechnological approaches for management. Acid mine drainage and associated problems.	**15 Hrs**

Suggested Books:

1. Application of Microbes in Environmental and Microbial Biotechnology. Editors: Inamuddin, Mohd Imran, Ahamed, Ram Prasad, Copyright: 2022

2. Recent Advances in Microbial Degradation. Editors: Inamuddin, Mohd Imran Ahamed, Ram Prasad, Copyright: 2021

3. Environmental Pollution and Remediation, Editors: Ram Prasad Copyright: 2021

4. Advances in the Domain of Environmental Biotechnology

5. Recent Developments in Microbial Technologies. Editors: Ram Prasad, Vivek Kumar, Joginder Singh, Chandrama Prakash Upadhyaya, Copyright: 2021

6. Microbial Technology For Sustainable Environment Editors: Pankaj Bhatt, Saurabh Gangola, Dhanushka Udayanga, Govind Kumar

7. Microbial Ecology: Fundamentals and Applications (4th Edition) **Author:** Ronald M. Atlas, Richard Bartha

8. Brock Biology of Microorganisms (14th Edition) **Author:** Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, Thomas Brock

9. Environmental Microbiology 3rd Edition **Author:** Ian L. Pepper, Charles P. Gerba, Terry J. Gentry

10. Soil Microbiology 3rd Edition **Author:** Robert L. Tate III

11. Environmental Microbiology: From Genomes to Biogeochemistry 2nd Edition **Author:** Eugene L. Madsen

12. Manual of Environmental Microbiology **Author:** Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai

M. Sc. Semester-II
Discipline Specific Core Course (DSC-4)-MICROBIOLOGY –Paper 6 (MMI2T06) (IMMUNOLOGY AND IMMUNODIAGNOSTICS)

Course outcome:

1. This course gives an overview on the immune system including organs, cells and receptors
2. The students learn about molecular basis of antigen recognition, hypersensitivity reaction, antigen-antibody reactions.
3. The course develops in the student an appreciation for principles of immunology andits applications in treating human diseases.

DSC-4 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Overview of the Immune system and CMI	Cells involved in Immune system: Hematopoiesis, Lymphocytes, mononuclear phagocytes, Antigen Presenting cells, Granulocytes. Lymphoid organ: Lymphatic system, Primary and Secondary lymphoid organs. Complement System: Pathways of complement activation, regulation of complement system, Biological functions of complement system. Inflammation: Intracellular cell adhesion molecules, Mechanism of cell migration, Inflammation. Pathways of antigen processing and presentation. Cell Mediated Immunity: General properties of effector T cells, Cytotoxic T Cells, Natural Killer cells, Antibody-Dependent cell mediated cytotoxicity. T-Cell dependent and T-cell independent defense mechanisms.		**15 Hrs**
	Unit-II		
Specific Immune Response	Cancer and the Immune system: Origin and Terminology, Malignant Transformation of cells, oncogenes and cancer induction, Tumor Antigens, Immune surveillance theory, Tumor evasion of theImmune system, Cancer Immunotherapy. Transplantation Immunology: Immunological basis of Graft Rejection, Mechanism of Graft rejection. Immunosuppressive therapy: General and specific. Clinical Transplant. Tolerance: Central and peripheral tolerance to self antigens, Mechanism of induction of natural tolerance.		**15 Hrs**

Unit III		
Immune Dysfunction	Immunodeficiency disorders:- Phagocytic cell defect (Chediak-Higashi syndrome); B-cell deficiency (Bruton's X-linked hypogammaglobulinemia); T-cell deficiency disorder (DiGeorge Syndrome); Combined B-cell & T-cell deficiency disorder (SCID-Severe combined immunodeficiency diseases, Wiskott-Aldrich syndrome); Complement deficiencies and secondary immunodeficiency conditions carried by drugs, nutritional factors & AIDS. Autoimmunity and autoimmune diseases:-General consideration, Etiology, Clinical categories, Diagnosis and treatment. RA (Rheumatoid arthritis); SLE (Systemic Lupus Erythematosus); Guillain-Barre Syndrome; Multiple sclerosis; Mysthenia gravis; Grave's disease; Goodpasture syndrome, Autoimmune haemolytic disease; Pernicious anaemia. Hypersensitivity :- Type I, Type II, Type III & Type IV	**15 Hrs**
Unit IV		
Immuno-diagnostics	Precipitation reactions: Immunodiffusion, immunoelectrophoresis, Agglutination reactions: Bacterial Agglutination, Heamagglutination, Passive agglutination, Reverse passive agglutination and agglutination inhibition. Immunodiagnostic techniques: Radio-Immuno assay, ELISA, Chemiluminiscence immunoassay, Western blotting technique, Complement fixation test, Immunofluorescence, Immunoelectron microscopy.	**15 Hrs**

Suggested Books:

1. Essentials of Immunology by Riott I .M. 1998. ELBS, Blackwell Scientific Publishers, London.
2. Immunology 2nd Edition by Kuby J. 1994. W.H. Freeman and Co. New York.
3. Immunology - Understanding of Immune System by Claus D. Elgert. 1996. Wiley -Liss, New York.
4. Fundamentals of Immunology by William Paul.
5. Cellular and Molecular Immunology. 3rd Edition by Abbas.
6. Immunobiology: The Immune System in Health and Disease. 3rd Edition by Travers.
7. Immunology- A short Course. 2nd Edition by Benjamin.
8. Manual of Clinical Laboratory and Immunology 6th Edition. 2002 by Noel R. Rose, Chief Editor: Robert G. Hamilton and Barbara Detrick (Eds.), ASM Publications.
9. Pocket Guide to Clinical Microbiology. 2nd Edition. 1998 by Patrick R. Murray, ASM Publications.
10. Immunology, 6th Edition Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne, Freeman, 2002.
11. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
12. Fundamental of Immunology, Paul, 4th edition, Lippencott Raven, 1999.
13. Monoclonal antibodies Goding, , Academic Press. 1985.

M. Sc. Semester-II
Discipline Specific Elective Course (DSE-2)-MICROBIOLOGY- Paper 7 (MMI1T03) (MICROBIAL METABOLITES)

Course Outcomes

1. Acquaint with basics of microbial metabolites, newer bioactive molecules and Immunomodulators.
2. Understand structure and mode of action of secondary metabolites. Knows the concept of Quorum sensing.

DSE-2 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Introduction of metabolites	Metabolites: General account of metabolites, secondary metabolites. Classification, structure and mode of action of secondary metabolites. Plants secondary metabolites: Digitoxine, Salicylic acid, Mycotoxins- Aflatoxin, Ochratoxin, Patulin. Biopolymers: Polypeptides (collagen, casein and serum albumin), Polynucleotides and polysaccharides (amylose, amylopectin, alginate, cellulose) and other biopolymers like chitin, Xanthan, dextrin, Gellan, Pullulan, curdlan and hyluronic acid. Polyamines: Brief outline and functions of polyamines. Synthesis of linear polyamine-putrescine, cadoverine, spermidine and spermine. Secondary Metabolite Production by Cyanobacteria, Enzyme inhibitors and Immunomodulators		**15 Hrs**
	Unit-II		
Antimicrobial drugs: Secondary metabolites	Antibiotics: History and discovery of antibiotics, Antibiotic resistance, Mechanisms of antibiotic resistance. Structure and mode of action of antibiotics: Aminoglycosides (Amikacin), Carbapenems (Imipenim), Microlids (Azithromycin), Nitrofuran (Nitrofurantoin), Penicillin (Amoxicillin), Quinolones (Gatifloxacin /Ciprofloxacin), Sulphonamides (Sulfamethoxazole), Tetracyclines (Doxycyclines), Chloramphenicol, Fucanazole. New Molecules- Angucyclines (baikalomycins A–C), rabelomycin and 5-hydroxy-rabelomycin		**15 Hrs**

Unit III		
Pigments as metabolites	General account of pigments. Microbial pigments: Bacteriochlorophylls, Carotenoids of prokaryotes, rhodopsin and accessory pigments (Pulcherrimin and indigoidin) Defensive role of pigments. Vaso-relaxants or contractants, Diuretics or laxatives Marine bacteria synthetizing bio-pigment- prodigiosin, astaxanthin, violacein, zeaxanthin, lutein or lycopene Industrial Importance of Pigmented Compounds	**15 Hrs**
Unit IV		
Microbial vitamins	Antioxidants. Characteristics of fats and water soluble vitamins. Structure, function and chemistry of: Retinol (vitamin A), Riboflavin (vitamin B2), Cynocobalamine(Vitamin B12) and ascorbic acid (vitamin C). Deficiency diseases in humans:Xerophthalmia, BeriBeri, Pellegra, Scurvey, Keratomalacia, osteoporosis, Osteomalacia, Cheilosis,Glossitis, Pernicious anemia and Erythroid hypoplassia.	**15 Hrs**

Suggested Books:

1. General Microbiology by Hans G. Schlegel, C. Zaborosch. Publisher: Cambridge University Press
2. Biotechnology. A Textbook of Industrial Microbiology, by W. Crueger and A. Crueger.
3. Publisher :Sinauer Associates.
4. Industrial microbiology by G. Reed, Publishers: CBS
5. Biology of Industrial microorganisms By A. L. Demain.
6. Stanbury P.F.A. Whitaker and Hall. Principles of fermentation technology
7. Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment by H.C. Vogel, C.L. Todaro, C.C. Todaro. Publisher: Noyes Data Corporation/ Noyes Publications.
8. New Products and New Areas of Bioprocess Engineering (Advances in Biochemical
9. Engineering/Biotechnology, 68) by T. Scheper. Publisher : Springer Verlag. New and Future Developments in Microbial Biotechnology and Bioengineering: Microbial Secondary Metabolites Biochemistry and Applications byVijai G. Gupta (editor), Anita Pandey (editor)
10. Biotechnology of Antibiotics and Other Bioactive Microbial Metabolites by Giancarlo Lancini, Rolando Lorenzetti
11. Bacterial physiology and metabolism by Kim B.H. and Gadd G.M. 2008. Publisher: Cambridge University Press, Cambridge.

M. Sc. Semester-II
Discipline Specific Elective Course (DSE-2)-MICROBIOLOGY- Paper 7 (MMI2T07) (PHARMACEUTICAL MICROBIOLOGY)

Course Outcomes:

1) Students will gain the knowledge regarding Drug discovery and drug development

2) Students will get knowledge about production of various types of enzymes antibiotic resistance and development of new therapeutic drugs to the students.

3) Students will have a deep insight into the antimicrobial agents and their mode of action.

4) Students get knowledge about Regulatory practices, biosensors applications in Pharmaceuticals and Quality Assurance

DSE-2 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Introduction to Chemotherapeutic agents	History and development of chemotherapeutic agent, Properties of antimicrobial agents, Types of chemotherapeutic agents – Synthetic, Semisynthetic, Natural Antibiotics Antimicrobial agents: antibacterial, antifungal, antiviral, antiprotozoal and anti cancer antibiotics and drugs and their mode of action.		**15 Hrs**
	Unit-II		
Preservation, Antibiotic resistance and development of new therapeutics	Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc. Preservative stability and efficacy. methods of Preservative evaluation and testing Development of antibiotic resistance, Mechanism of antibiotic resistance, Antimicrobial Peptides: History, properties, sources, mode ofaction, application. Phage therapy: introduction to phages, lytic cycle, types of phages involved in phage therapy Plant based therapeutic agents		**15 Hrs**
	Unit III		
Microbial production and Spoilage of pharmaceutical Products	Microbial contamination and spoilage of pharmaceutical products (sterile injectibles non injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase,streptodornase), New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials		**15 Hrs**

Unit IV		
Regulatory practices, biosensors applications in Pharmaceuticals and Quality Assurance	Introduction to pharmacopoeia: Food and Drug Administration (FDA) regulation and Indian Pharmacopoeia (IP), British Pharmacopoeia (BP), United States Pharmacopoeia(USP) Good Laboratory Practices (GLP) Good Manufacturing Practices (GMP) and Current Good Manufacturing Practices (cGMP), Government regulatory practices and policies, FDA perspective. Rational drug design. Biosensors in pharmaceuticals Application of microbial enzymes in pharmaceuticals. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory) Safety in Microbiology laboratory.	**15 Hrs**

Suggested Books:

1. Pharmaceutical Microbiology – Edt. byW.B.Hugo&A.D.Russell Sixth edition. Blackwell scientific Publications.
2. Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II.Academic Press New York.
3. Prescott's Microbiology 8th Edition by Willey, Joanne, Sherwood, Linda, Woolverton, Chris
4. Pharmaceutical Microbiology by AshutoshKar
5. Quinolinone antimicrobial agents – Edt. by David C. Hooper, JohnS.Wolfson .ASM Washington DC.
6. Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
7. Biotechnology – Edt. By H.J.Rehm &G.Reed, Vol 4. VCH Publications, Federal Republic of Germany.
8. Pharmaceutical Biotechnology by S.P.Vyas &V. K. Dixit. CBS Publishers& Distributors, New Delhi.
9. Good Manufacturing Practices for Pharmaceuticals Second Edition, by Sydney H.Willig, Murray M.Tuckerman, William S.Hitchings IV. Mercel Dekker NC New York.
10. Advances in Applied Biotechnology Series Vol 10, Biopharmaceuticals in transition. Industrial Biotechnology Association by Paine Webber.Gulf Publishing Company Houston.
11. Drug Carriers in biology & Medicine Edt. by Gregory Gregoriadis.Academic Press New York.
12. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan lalIhhpunjani. CBS Publishers & Distributors, New Delhi.

M. Sc. Semester-II
MICROBIOLOGY – PRACTICAL-3 (MMI2P03)

Course Outcomes:

1. Be able to perform techniques in environmental microbiology
2. Be able to understand different parameters in environment microbiology

LAB-3	Hours: 06 Hours /Week	Marks: 50+50=100	Credit: 03
Perform minimum 10 from following practical's			
	1. Determination of Colour, Turbidity, temperature as physical characteristics of water and sewage 2. Determination of pH, alkalinity and acidity of water and sewage 3. Determination of total solids of waste water. 4. Determination of hardness of sewage, oil and grease. 5. Determination of oil and grease contents in water and sewage 6. Determination of Dissolve oxygen in sewage 7. Determination of Chemical Oxygen Demand in sewage. 8. Determination of nitrate nitrogen in water and sewage by UV - spectrophotometric method 9. Determination of the concentration of sulphate in water and sewage by using turbidometric method, 10. Determination of the concentration of chloride in water and sewage by Mohr's titrimetric method, 11. Determination of the concentration of phosphorus in water and sewage by stannous chloride method 12. Sample (water and sewage) preparation for metal analysis, 13. Determination of the concentration of mercury in water and sewage by spectrophotometric method, 14. Determination of the concentration of lead in water and sewage by spectrophotometric method, 15. Determination of the concentration of copper in water and sewage by spectrophotometric method 16. Determination of Microbiological characteristics of water and sewage 17. Determination of Microbiological analysis of soil: 18. Screening of antibiotic producing microorganism from soil, 19. To demonstrate ammonification process in soil 20.To demonstrate nitrification process in soil 21. To demonstrate denitrification process in soil	**45 Hrs**

Suggested Books:

1. Environmental Science and Biotechnology by A. G. Murugesan and C. Rajkumari ISBN 10: 8180940098 / ISBN 13: 9788180940095 Editorial: MJP Pub, Chennai, 2005
2. Practical Manual of Wastewater by Barbara Hauser CRC Press 2019
3. Standard Methods for the Examination of Water and Wastewater, 24th edition APHA AWWA, 2023.
4. Handbook Of Water And Wastewater Analysis Hardcover – 1 January 2007 by Kanwaljit Kaur

5. Handbook of Methods in Environmental Studies: Water and Waste Water Analysis by S.K. Maiti, Oxford Book Company 2011
6. Water and Wastewater Laboratory Techniues by Roy- Keith Smith Water Environment Federation, Second Edition.
7. Industrial Water Analysis Handbook Author: Natarajan Manivasakam, Chemical Publishing Book 2011
8. Methods of Soil Analysis, Part 2: Microbiological and Biochemical Properties: 12 (SSSA Book Series) by Peter J. Bottomley, J. Scott Angle, R. W. Weaver, 2014

10. Soil Microbiology, Ecology, and Biochemistry by Paul and Clark, 1989

11. Advanced Techniques in Soil Microbiology by Ajit Varma and Ralf Oelmuller 2007 Springer Publication

M. Sc. Semester-II
MICROBIOLOGY – PRACTICAL-4 (MMI2P04)

Course Outcomes:

1. Be able perform various diagnostic technique in immunology.
2. Be able to gain knowledge of different bacterial diseases and their diagnosis

LAB-4	**Hours: 06 Hours /Week**	**Marks: 50+50=100**	**Credit: 03**
Perform minimum 10 from following practical's			
	1) Determination of concentration of antigen in the serum sample by Immunodiffusion technique 2) Perfromance of Immunoelectrophoresis technique to separate immunoglobulins 3) Determination of Blood grouping and Rh type 4) Detection of typhoid antigen using Widal [slide and tube] tests. 5) Detection of Syphilis using TRUST [Toludine Red Unheated Serum Test] 6) Performance of Australian latex antigen test. 7) Performance of Antistreptolysin 'O'test [ASO] 8) Performance of Pregnancy test. 9) Performance of Rheumatoid arthritis test [RA] 10) Detection for the presence of antibodies to Syphilis by RPR [rapid plasma reagin] test. 11) Performance of *Treponema pallidum* haemagglutination test (TPHA). 12) One step test for Qualitative detection of HBs. 13) ELISA [Enzyme Linked Immunosorbent Assay]-HIV and HBs. 14) Serological detection of tuberculosis by Quanti FERON – TB Gold test 15) Isolation & Identification of Rosettee cells. 16) Total and Differential counting of WBC.		**45 Hrs**

Suggested Books:

1. Hudson, L. and Hay, F.C. (1989). Practical Immunology. 3rd Edition, Blackwell scientific Publications, Oxford.
2. Myers, R.L. (1989). Immunology: A Laboratory Manual. Wm. C.Brown Publishers. Dubuque, Lowa.
3. Rastogi, S.C. (1996). Immunodiagnostics Principles and Practice. New Age International (P) Ltd., New Delhi.
4. Talwar, G.P. (1983). A Hand Book of Practical Immunology. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Talwar, G.P. and Gupta, S.K. (1992). A Hand Book of Practical and Clinical Immunology. Vol. 1 - 2. CBS Publishers & Distributors, Delhi.
6. Turgeon, M.L. (1990). Immunology and Serology in Laboratory Medicine. The C.V. Mosby Company, Baltimore.
7. Frank C. Hay, Olwyn M. R. Westwood (2008) Practical Immunology, 4th Edition Wiley-Blackwell Publisher
8. Ray Edwards (1999) Immunodiagnostic –A Practical Approach by Oxford University Press
9. *Imunodiagnostics* Principles and *Practice*. A Hand *Book* of *Practical* and Clinical *Immunology*. Vol. 1 -2 , New Age International (P) Ltd.
10. Garvey, J.S., Cremer, N.E. and Sussdorf, D.H. (1977). Methods in Immunology. A Laboratory Text for Instruction and Research. 3rd Edition. The Benjamin Cummings Publishing Company Advanced Book Program, London.
11. Praful B. Godkar (Author), Darshan P. Godkar (2018) Textbook Of Medical Laboratory Technology Clinical Laboratory Science And Molecular Diagnosis 2 Vol Set, 3rd Ed Bhalani Publishing House

M. Sc. Semester-III
Discipline Specific Core Course (DSC-5) -MICROBIOLOGY- Paper 8
(MMI3T08) (MICROBIAL DIVERSITY, EVOLUTION AND ECOLOGY)

Course Outcomes

1. Students should gain understanding of major concepts in microbial ecology.
2. Students will understand contemporary techniques used to analyze microbial communities and community function.
3. Students should understand microbial evolution and ecosystem management.

DSC-5 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Study of microbial diversity	Distribution, Abundance, Ecological Niches. Types-Bacterial, Archael, Eucaryal, Characteristics and Classification of Archae Thermophiles classification, habitat and thermophilic adaptations. Commercial aspects of thermophiles and application of thermoenzymes. Acidophiles- Classification, life at low pH, acido-tolerance, applications. Alkaliphiles- Isolation, habitat distribution and taxonomy, Enzymes of alkaliphiles and their applications. Psychrophiles- Microbial diversity at cold ecosystem, cold sensing, cold adapted enzymes, cryoprotectants and ice binding proteins, role of exopolymers in microbial adaptations to sea ice. Halophiles- Classification, Halophilicity and Osmotic protection, Hypersaline Environments, Prokaryotic halophiles: Halobacteria – osmo-adaptations or halotolerance mechanism, Applications of halophiles and their extremozymes. Barophiles- Classification, high pressure habitat adaptation to high pressure, life under pressure, applications of barophiles.		**15 Hrs**

Unit-II		
Methods of studying microbial diversity	Introduction to Species richness, Total number of species, Species evenness and Distribution of species. Methods of biodiversity analysis: Biochemical Methods -1. Plate Count: Selective plating & Direct viable counts 2. Community physiological profiling (CLPP) 3. Fatty acid methyl ester analysis (FAME), advantages & disadvantages of biochemical methods. Molecular based methods : 1. G+C content 2. Nucleic acid re-association and hybridization 3. DNA Microarrays 4. DNA Cloning & Sequencing 5. PCR-based methods DGGE/TGGE, Single strand conformation polymorphism (SSCP), Restriction fragment length polylymorphism (RFLP), Terminal restriction fragment length polymorphism (T-RFLP) Ribosomal intergenic spacer analysis (RISA) / Automated ribosomal intergenic spacer analysis (ARISA). Highly repeated sequence characterization or microsatellite regions, advantages & disadvantages of molecular methods. Study of Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis.	**15 Hrs**
Unit III		
Study of Microbial Evolution	Evolution of earth and early life forms. Primitive life forms:-RNA world, molecular coding, energy and carbon metabolism, origin of Eukaryotes, endosymbiosis. Methods for determining evolutionary relationships:-Evolutionary chronometers, Ribosomal RNA sequencing, signature sequences, phyllogenetic probes, microbial community analysis. Derivation of Microbial Phyllogeny:-characteristics of domain of life, classical taxonomy, chemotaxonomy, bacterial speciation. Genetic structure of population:-Genotype frequency, allele frequencies. Hardy-Weinberg Law: -Assumptions, predictions, derivation, extension and natural selection.	**15 Hrs**

Unit IV		
Microbial Interactions and Ecosystem Management	Population, guilds, communities, homeostatis, Environment and microenvironment. . Terrestrial environment, deep, surface ecosystems. Fresh water environment, lake and river microbiology. Marine Microbiology and Hydrothermal vents. Microbial Interactions: Competition and coexistence, Gause hypothesis, syntrophy, commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals. Management and improvement of waste land/barren land. Oil spills, damage and management petroleum and oil shore management.	**15 Hrs**

Suggested Books:

1. Advances in applied microbiology. Vol.X, edited by Wayne W. Umbreit and D. Pearlman Academic Press.

2. Brock biology of Microorganisms. XI edition. By Michael T. Madigan, John M. Martinko. Pearson Education International.

3. Extreme environment. Metabolism of microbial Adaptation. Milton R., Heinirich Academic Press.
4. Extremophiles by Johri B.N. 2000. Springer Werlag, New York.

5. Microbial diversity by Colwd D., 1999, Academic Press.

6. Microbial ecology. Fundamental and applications by Ronald M. Atlas and Richard Bartha. II and IV edition.

7. Microbial Ecology. Ii edition by R. Campbell. Blackwell scientific publication. 8. Microbial life in extreme Environment. Edited by D.J. Kushner. Academic Press.

9. Microbiology : Dynamics and Diversity by Perry.

10. Microbiology of Extreme Environment . Edited by Clive Edward. Open University Press. Milton Keynes.

11. Microbiology of extreme Environment and its potentials for Biotechnology. Edited by N. S. Da Coasta, J. C. Duarata,, R.A.D. Williams. Elsisver applied science, London

12. Thermophiles. General, Molecular and applied Microbiology. Thomas D.Brock. Wiley Interscience publication.

13. Microbial Ecology: Fundamentals and Applications. 4th ed. (Addison-Wesley) Atlas, R.M., and R. Bartha. 1998.

M. Sc. Semester-III
Discipline Specific Core Course (DSC-6) -MICROBIOLOGY- Paper 9
(MMI3T09) (MOLECULAR BIOLOGY AND GENETICS)

Course Outcomes: At the end of the course the students will be able to

1. Demonstrate knowledge of the central dogma of biology
2. Understand the DNA proof reading and repair system of DNA.
3. Know about DNA regulation and post translation modification to became functional proteins
4. Basic understanding of genetics and hereditary

DSC-6 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
Unit-I			
Genome organization and Gene Regulation	Structural organization of genome (prokaryotes and eukaryotes), Cot curve analysis, C-value paradox. Regulation of gene expression : An overview on levels of regulation, terminology and operon concepts, enzyme induction and repression; positive and negative regulation in E. coli- lac and ara operons; regulation by attenuation – his and trp operons; antitermination – N protein and nut sites in Lambda phage. Organization and regulation of nif and nod gene expression in bacteria; gal operon in yeast. Global regulatory responses-heat shock response, stringent response and regulation by small molecules such as cAMP and PPGP		**15 Hrs**
Unit-II			
DNA Replication and DNA Repair	General principles, Characteristics of replication, various modes of replication. relation between cell cycle and DNA synthesis, enzymology of DNA replication in prokaryotes and eukaryotes, Mechanism of DNA replication in prokaryotes and eukaryotes, inhibitors of DNA replication. Types of DNA damage-deamination, oxidative damage, alkylation and pyrimidine dimers; repair pathways – mismatch, short patch repair, nucleotide/base, excision repair, recombination repair and SOS repair system.		**15 Hrs**

Unit III		
Protein Biosynthesis and DNA binding proteins	Central dogma theory and flow of genetic information, genetic code and its elucidation, structure and composition of prokaryotic and eukaryotic ribosomes, structural features of rRNA, mRNA and tRNA in relation to function, steps of protein biosynthesis (activation of amino acids, initiation, elongation, termination) in prokaryotes and eukaryotes; post translational modification of proteins and their sorting and targeting; regulation of translation; inhibitors of protein biosynthesis DNA binding proteins: Enhancer sequences and control of transcription. Identification of protein – binding sites on DNA, control of transcription by interaction between RNA polymerases and promoter region, use of alternate sigma factors, controlled termination attenuation and anti termination	**15 Hrs**
Unit IV		
Genetics	Mendelian principles (Dominance, segregation, independent assortment, allele, multiple allele), Pseudoallele, codominance, incomplete dominance, pleiotrophy, genome imprinting, penetrance and expressivity, linkage and crossing over, sex linkage, Sex-limited and sex-influenced characters, linkage maps, gene mapping with molecular markers and by using somatic cell hybrid. Deviation from Mendelism: Complex patterns of inheritance, quantitative traits and inbreeding Non-Mendlian inheritance: Cytoplasmic inheritance and imprinting	**15 Hrs**

Suggested Books:

1. Molecular Genetics of Bacteria, 3rd ed. 1998. J.W. Dale. Wiley Publ.
2. Bacterial and Bacteriophage Genetics. 4th ed. 2000. By E.A. Birge. Springer.
3. Modern Genetic Analysis by Griffith.
4. Genetics by Gardner.
5. Molecular Cell Biology. 1995, 3rd ed. by Lodish et al. Scientific American books, W.H. Freeman and Company.

6. Molecular Biology. 1995, by David Freifelder, Narosa Publ. House. 9. Text Book of Molecular Biology. 1994, by Sivarama Sastry et al, Macmillan India Ltd.
7. Genes VIII. 1997. by B. Lewin. Oxford University Press. The Biochemistry of nucleic acids. 1992, 11th ed. by Adams et al, Chapman and Hall.
8. Biochemistry. 1995 by L. Stryer. W.H. Freeman and Co.Biochemistry, 1998, 4th ed. by G.L. Zubay. W.C.B. Publ.
9. Microbial Genetics. 1995, by David Freifelder. Narosa Publ. House.
10. Biochemistry and Molecular Biology. 1997, by W.H. Elliott & D.C. Elliott. Oxford University Press.
11. . Molecular biology of the Gene. 1998, 5th ed. Watson et al, Addison Wesley Longman.
12. Concepts of Genetics, Klug WS and Cummings MR – Prentice Hall

M. Sc. Semester-III

Discipline Specific Core Course (DSC-7) -MICROBIOLOGY- Paper 10 (MMI3T10) (RECOMBINANT DNA TECHNOLOGY AND NANOBIOTECHNOLOGY)

Course Outcomes: At the end of the course the students will be able to

1. Understand the application of recombinant DNA technology in biotechnological research.
2. Achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in basic and applied fields of life science researches
3. Understand the Synthesis, characterization and application of nanomaterials in biological sciences

DSC-7 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Molecular Cloning Methods	**DNA cloning**: Enzymes used in recombinant DNA technology, High capacity cloning vectors (cosmid, YAC, BAC & PAC), genomic library, cDNA library and chromosome libraries, Transformation, Gene knockout techniques in bacterial and eukaryotic organisms. Screening and identification of genes, Expression vectors, heterologous probes, oligonucleotide probes, microarrays. RNA Analysis and Gene Expression- Methods for RNA isolation and purification. Analysis of gene expression. **PCR**:Steps, advantages,limitations,application,RT-PCR,		**15 Hrs**
	Unit-II		
Other molecular tools for study in Genes	Restriction mapping: DNA sequencing dideoxy and pyrosequencing, DNA fingerprinting. S1 Mapping, primer expressions, DNase footprinting, DMS footprinting. Nuclear run on transcription, reporter gene transcription. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.		**15 Hrs**
	Unit III		
Application of rDNA technology	Overview of the diverse applications of rDNA technology, Gene therapy and its potential in treating genetic disorders, Strategies for gene delivery in therapeutic applications, Production of biopharmaceutical (Somatostatin and anticancer drugs) using recombinant DNA technology, Industrial applications of genetic engineering, such as enzyme production (Proteases and lysozyme), biofuel production, and bioremediation. Introduction to synthetic biology and its integration with genetic engineering.		**15 Hrs**

Unit IV		
Nano-Biotechnology	Concept of Nano-Biotechnology, Properties of nanomaterials, Classification of nanomaterials. Synthesis of nanoparticles: Silver and Silver oxide nanoparticles, Zinc and Zinc oxide nanoparticles. Techniques for detection of nanoparticles: UV-Visible and Infra-red Spectroscopy, and XRD Applications of Nano-Biotechnology: Agriculture and food processing, Biosensors, Drug and gene delivery sysyem, Cancer diagnostic and treatment. Limitations of Nanoparticles	**15 Hrs**

Suggested Books:

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3. Benjamin Lewis, Genes VIII (3rd Ed.) Oxford University & Cell Press, NY.2004 .
4. Genome 4 (2017) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
5. Brown T.A . Genomes, 2nd ed, 2002 , Taylor and Francis publishers, New York 5) Primrose S.B, Twyman R.m., and Old R.w.,
6. Principles of gene manipulations, 6th ed, 2002, Blackwell publishers, Oxford.
7. Walker M.J., and Raply R. Molecular biology and biotechnology 4th ed, 2000, Panima publishers, New delhi.,
8. Challa S. S. R. Kumar, Josef Hormes, Carola Leuschner , "Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact", Wiley – VCH.
9. D.S. Goodsell, "Bionanotechnology: Lessons from Nature", Wiley Press.
10. Genomic Medicine: Principles and Practice (2014) 2nd ed., Ginsburg, GS, and Willard, HF, Oxford University Press, ISBN: 978-0199334468.
11. Molecular Genetics and Genomics (2020) 1st ed., Krebs, JE, and Goldstein, ES, Jones & Bartlett Learning, ISBN: 978-1284154544

M. Sc. Semester-III
Discipline Specific Elective Course (DSE-3)-MICROBIOLOGY- Paper 11
(MMI3T11) (DRUG AND DISEASE MANAGEMENT)

Course Outcomes: At the end of the course the students will be able to

1. Acquire knowledge of the terms prodrug, drug, and drug latentiation.
2. Learn about a variety of anti-infective drugs' mechanisms of action, including those of iodophores (providone-iodine), benzylkonium chloride, and genita violet.
3. Understanding the variety of antifungal, antitubercular, antiprotozoal, antimalarial, and antihistaminic medicines' mechanisms of action

DSE-3 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Drug latentiation and Prodrug	History, Prodrug design-Basic concept, Prodrugs to improve patient acceptability, carrier-linked prodrugs, (carrier linkages for various functional groups , carrier-linked bipartite prodrugs, macromolecular drug carrier systems) bioprecursors prodrugs (hydrolytic activation, elimination activation, oxidative activation, reductive activation, nucleotide activation, phosphorylation activation, sulfation activation and decarboxylation ac tivation). , carboxylic acids and alcohols, amines, carboxyl compounds. **Drug-microbe:** Host-parasite relationship, mechanism of drug action and drug resistance including MDR.		**15 Hrs**
	Unit-II		
Antimicrobial agents (chemistry & mode of action)	Anti infective agents:Iodophores (povidone-Iodine), Benzalkonium chloride, gentian violet, mercury compounds. **Antifungal agents:**Ketoconazole, Nystatin, Griseofulvin. Amphotericin B, Clotrimazole, Econazole, Fluoronazole, Miconazole,Tolnaftate, **Antitubercular agents:** Isoniazid, cycloserine Aminosalicylate sodium, Capreomycin, Ethambutol, Rifampicin.		**15 Hrs**

Unit III		
Anti-inflammatory agents (chemistry & mode of action)	**Histamines and Antihistaminic agents**: Cimetidine, Ranitidine, Omeprazole. **H_1 First-Generation:** Meclizine, Clemastine, Hydroxyzine, Brompheniramine, Dimetindene, Doxylamine **H_1 Second-Generation:**Loratadine, Cetirizine, levocetirizine, **H_2:** Ranitidine, Cimetidine, Famotidine, **Analgesic agents:** Paracetamol (acetaminophen) ibuprofen- or diclofenac- *Opioid* Morphine, and their derivatives **Anti-inflammatory analgesics**-Phenylbutazone and oxyphenbutazone, Prostagacetylated salicylates (aspirin), non-acetylated salicylates (diflunisal, salsalate), propionic acids (naproxen, ibuprofen, acetic acids (diclofenac, indomethacin), enolic acids (meloxicam, piroxicam) anthranilic acids	**15 Hrs**
Unit IV		
Anti Parasitic agents (chemistry & mode of action)	**Antiprotozoal agents:** 8-Hydroxyquinoline ,Hydroxychloroquine, Metronidazole Nifursemizone, Ornidazole Antimalarials: Quininesulphate, Atovaquone/Proguanil (Malarone) Chloroquine. Doxycycline.Mefloquine. Primaquine. Pyrimethamine.	**15 Hrs**

Suggested Books:

1. The Organic Chemistry of Drug Design and Drug Action, Silverman R. B., Academic Press.
2. Textbook of Drug Design and Discovery, Eds. Krogsgaard-Larsen P., Liljefors T., Madsen U., Taylor & Francis.
3. Drug Discovery – A History, Sneader W., Wiley.
4. Medicinal Chemistry: An Introduction, Thomas G, Wiley.
5. Drug Discovery – A History, Sneader W, John Wiley & Sons, Ltd.
6. Comprehensive Medicinal Chemistry, Series Ed., Hansch C., Pergamon Press.
7. Wilson and Gisvold's, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott-Raven
8. Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins.
9. Drug Metabolizing Enzymes-Cytochrome P450 and Other Drug Metabolizing Enzymes in Drug Discovery and Development, Lee JS, Obach SR and Fisher MB, Marcel Dekker, Fontis India, 2003
10. Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns EH, Lipinski CA, Thakker DR and
Wang B, AAPS Press, 2004
11. Drug Metabolism – Current Concepts, Ionescu C and Caira MR, Springer International Edition
12. Handbook of Drug Metabolism, Woolf TF, Marcel Dekker, 1999
13. Abby L .Parrill.M .Rami Reddy.Rational Drug Design.Novel Methodology and Practical Applications. ACS Symposium Series; American Chemical Society: Washington, DC, 1999.
14. J. Rick Turner. New drug development design, methodology and, analysis. John Wiley & Sons, Inc., New Jersey.

M. Sc. Semester-III
Discipline Specific Elective Course (DSE-3)-MICROBIOLOGY- Paper 11
(MMI3T11) (BIOINFORMATICS)

Course Outcomes:

1. The program aims to utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge
2. Better understanding of dynamic biological processes and their understanding at molecular level enabled through and correlated using internet and Bioinformatics.
3. To introduce new age concepts of big data in the 'omics' era and their analysis

DSE-3 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Basic Concepts and Computer Coding	Basic Concept of Computer Organization, Internet, File Transfer Protocol, Browser, Home Page, Hyper text transfer protocol, Uniform Resource Locator, Hyperlink and Web Applications. Computer Coding:- Number system, decimal number system, binary number system, binary to decimal conversion, Binary arithmetic, octal number system, hexadecimal number system.		**15 Hrs**
	Unit-II		
Genomics and Proteomics	Genomics: Nucleotide sequence Databases, its Analysis and Identification Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences. Dot Plots, Simple alignments, Dynamic programming global and local alignments BLAST,FASTA,Scoring matrices,and alignment scores. Multiple sequence alignments. Pattern of substitution within genes, substitution number estimations, molecular clocks. Protein Data bank (PDB), Nucleic Acid Data Bank (NDB),Molecular modeling Data Bank (MMDB)		**15 Hrs**

Unit III		
Phyllogenetics	Phylogenetic analysis:-Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools-Phylip, ClustalW. Parsimony,Inferred ancestral sequence, consensus tress,comparison of phyllogenetic methods.	**15 Hrs**
Unit IV		
Protein structure prediction	Protein Structure Prediction:- Homology modeling, prediction of protein structure from sequences, functional sites. protein identification and characterization:- AACompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept, Predicting transmembrane helices, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction.	**15 Hrs**

Suggested Books:

1. DNA Sequencing: From Experimental Methods to Bioinformatics *Author(s): Luke Alphey*
2. Bioinformatics: The Machine Learning Approach *Author(s): P.Baldi and S. Brunak*
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition *Author(s): Andreas D. Baxevanis and B. F. Francis Ouellette (Eds)*
4. Bioinformatics for Dummies *Author(s): Jean-Michel Claverie and Cedric Notredame*
5. Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis *Author(s): Ingvar Eidhammer, Inge Jonassen, William R.T. Taylor*
6. Bioinformatics: Genomics and Proteomics Vikas Publishing House (7 November 2014) Author Ruchi Singh

M. Sc. Semester-III
MICROBIOLOGY – PRACTICAL-5 (MMI3P05)

Course Outcomes:

1. Be able perform various diagnostic technique in immunology.
2. Be able to gain knowledge of different bacterial diseases and their diagnosis

LAB-5	Hours: 04 Hours /Week	Marks: 50+50=100	Credit: 02
	Perform minimum 10 from following practical's		
	1) Antibiotic Sensitivity Test by Kirby-Bauer Disk Diffusion method and Isolation of antibiotic resistant microbes. 2)Determination of purity and quantitification of DNA by UV absorption method 3)Determination of melting temperature (Tm) of DNA . 4)Quantification of RNA by orcinol method 5) Isolation of genomic DNA. 6)Analysis of G+C percentage in bacterial DNA 7)DNA fingerprinting by RAPD. 8)Restriction analysis of genomic DNA. 9)Southern blotting analysis of DNA. 10) Isolation of plasmid DNA and determination of molecular size of plasmid DNA. 11) Amplification of gene by PCR. 12) Isolation of RNA by agarose gel electrophoresis. 13)Ligation of DNA into plasmid vectors. 14)Preparation of competent cells. 15)Transformation of E. coli with standard plasmids. 16) Selection of recombinant clones by blue – White screening. 17) Synthesis of silver nanoparticles 18) Synthesis of ZnO nanoparticles through non-aqueous route. 19) To study antibacterial/antifungal activity of nanomaterial.		**30 Hrs**

Suggested Books:

1. Microbiology Laboratory Manual, 5th Edition, James G. Cappucciino and Natalie Sherman
2. Molecular Cloning A Laboratory Manual 1 3rd Edition, J. Sambrook, E.F Fristsch and T. Maniatis
3. Molecular Cloning A Laboratory Manual 2 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis
4. Methods of General and Molecular Bacteriology, 1993. Edited by Philip. Gerhardt, ASM Publications.

M. Sc. Semester-IV
Discipline Specific Core Course (DSC-8)-MICROBIOLOGY –Paper 12
(MMI4T12) (VIROLOGY)

Course Outcomes: At the end of the course the students will be able to

1. Understand the role of different Viruses in the fields of Microbial science..
2. Understand have about Classification, Composition and the Nomenclature and at the end emerging fields of science with respect to Virology.
3. Develop practical skills to perform different test in identifying important Viruses

DSC-8 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
Concept of Virology	History, Classification and composition of viruses Brief outline on discovery of viruses (Origin and evolution), Terminology, Differentiation with other groups of microorganisms. Nomenclature and classification of viruses (Regenmortel et.al.2005, 8th Report of ICTV). Genetic classification Morphology and structure of viruses (size and shape/ symmetry). Chemical composition of viruses (viral capsid, spikes, envelopes and types of viral nucleic acids). Assay of Viruses. Viroids and Prions (Definition, structure, properties and diseases) Interferon: Types and mechanism of action		**15 Hrs**
	Unit-II		
Bacterial viruses	Bacterial viruses Bacteriophages- Structural organization; life cycle (Extracellular phase; attachment, penetration of nucleic acid, transcription, translation, replication, maturation and release of phage particles) of ΦX174, T4, lambda, M13 and Mu Phages. Bacteriophage typing, One step growth curve.		**15 Hrs**
	Unit III		
Animal & Plant Viruses	Animal and Plant viruses**Life cycle, pathogenesis and laboratory diagnosis of following viruses.Animal Viruses**:-**RNA viruses:**Picorna, Orthomyxo, Rhabdovirus and HIV. **DNA viruses**: Pox, Herpes, Adeno and Hepatitis viruses. Oncogenic viruses: Papova viruses, EB virus, HTLV viruses. **Plant virus**: TMV, Cauliflower mosaic virus, potato virus.		**15 Hrs**

Unit IV		
Diagnostic virology	General methods of Diagnosis and antiviral drugs **Serological methods:** -Haemadsorption; Haemadsorption inhibition; haemagglutination; Haemagglutination inhibition(HAI); Complement fixation immunofluorescence methods. ELISA and Radioimmunoassays (RIA). **Antiviral agents:** Structure and Mechanism of action of: Amantadine, Rimantidine, Vidarabine, Acyclovir, Ganciclovir, Ribavirin, Foscarnet, Stavudine, Lamivudine. **NNRTIS** (non-nucleoside RT inhibitors) - Nevirapine; Delavirdine and Efavirenz. Protease inhibitors- Saquinavir, Indinavir and Ritonavir	**15 Hrs**

Suggested Books :

1. Virology :Principles and Application. John Carter and Venesia Saunders.
2. Introduction to Modern Virology, 7th Edition Nigel J. Dimmock, Andrew J. Easton, Keith N. Leppard.
3. Prescott, Hurley. Klein-Microbiology, 7th edition, International edition, McGraw Hill.
4. Kathleen Park Talaro& Arthur Talaro - Foundations in Microbiology International edition 2002,| McGraw Hill.
5. Michael T. Madigan & J. M. Martin, Brock, Biology of Microorganisms 12th Ed.International edition 2006, Pearson Prentice Hall.
6. Plant Viruses, Diseases and Their Management .by Kajal Kumar Biswas

M. Sc. Semester-IV
Discipline Specific Core Course (DSC-9)-MICROBIOLOGY –Paper-13
(MMI4T13) (MICROBIAL FERMENTATION & TECHNIQUES)

Course Outcomes: At the end of the course the students will be able to

1. Design of bioreactor and its tools, fermentation kinetics.
2. Recovery, purification, packaging and storage of microbial products.
3. Production of different microbial products.

Laboratory management and operations, data preparation and regularly adopted practices in industries.

DSC- 9 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
Unit-I			
General Principles of Fermentation	General Principles of Fermentation, Bioreactors: Typical Bioreactor and designing of their tools, Fermentation kinetics and Monods Model:-Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response (bacterial stress response), Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation. Process optimization: factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.		**15 Hrs**
Unit-II			
Downstream Processing	Downstream Processing and scale up. Downstream processes: types of processing units and systems, Storage and packaging methods. Scale up; scale down: criteria involved therein. Productivity, power requirements, Basic control theory.		**15 Hrs**
Unit III			
Industrial Fermentation	Industrial Fermentation of Products - Biofuels (Conventional):- Hydrogen, Methane, Antibiotics:- Streptomycin, Cephalosporin. Probiotic: *Lactobacillus sakei*. Biopolymers:- Xanthan, Polyhydroxyalkanoates. Thermostable enzymes:-Proteases. Biosurfectants. Carotenoides Aminoacids:- Glutamic acid. Vitamins:-riboflavin. Fatty acids (Palmetate, oleate).		**15 Hrs**

Unit IV		
Pharmaceutical industry	Pharmaceutical industry: Laboratory management and design, Bio burden determination, Specified and objectionable microorganisms, Guidelines for preparing a laboratory information file, Assessment of pharmaceutical water systems and Endotoxin and pyrogen testing, Sterilization and sterility assurance, Cleaning and disinfection of production area, Clean rooms and environmental monitoring.	**15 Hrs**

Suggested Books:

1. Pelczar MJ Jr., Chan ECS and Kreig NR., "Microbiology", 5th Edition, Tata McGraw Hill, 1993.
2. Fermentation technology. (1994). Cassida
3. Bioprocess engineering: Down stream processing & recovery of bioproducts, safety in biotechnology and regulations. (1990). Behrens, D. & Kramer, P.(Ed).
4. Enzymes- a practical introduction to structure mechanism and data analysis (2000). Copeland, R.A. 8. Enzymes: Biochemistry, Biotechnology & clinical chemistry (2004). Palmer, T.
5. Encyclopedia of bioprocess technology. Vol 1-5. (1999). Flickinger, M.C. & Drew, S.W.(Ed).
6. Schuler &Kargi, Bio-process Engg. PHI
7. Bailey &Olis, Biochemical Engg. Fundamentals, McGraw-Hill, 1990
8. Mukhopadhyay, S.N. Process Biotechnology Fundamentals, Viva Books Pvt. Ltd. 2001
9. Perry, Chilton & Green, Chemical Engineers' Handbook, McGraw-Hill
10. Bioseparations: Principles & Techniques (2005). Sivasankar B.

M. Sc. Semester-IV
Discipline Specific Core Course (DSC-10)-MICROBIOLOGY –Paper-14
(MMI4T14) (MEDICAL MICROBIOLOGY AND PARASITOLOGY)

Course Outcomes: At the end of the course the students will be able to

1. Understand types and stages of infection, process of infection. Mechanism of microbial infection
2. learn about pathogenic bacteria, pathogenic fungi, Parasites &Helminths
3. Also learn about New emerging infections, community associated infection and Multidrug resistant microorganisms

DSC-10 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**

	Unit-I	
Infection	**Infection:** Definition, Types, stages of infection, process of infection. **Establishment of pathogenic microorganisms**: Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts, Aggresssins and toxins.	**15 Hrs**
	Unit-II	
Bacteriology	**Pathogenic Bacteria:** Morphological characteristic, Pathogenesis and Laboratory diagnosis including rapid methods of following pathogenic bacteria; *Klebsiella pneumoniae; Proteus vulgaris; Clostridium perfringes; Shigella dysenteriae, Pseudomonas aeruginosa: Vibrio cholerae;, Corynebacterium diphtheriae*	**15 Hrs**
	Unit III	
Mycology and Parasitology	**Pathogenic Fungi:** Morphological characteristics, pathogenesis and laboratory diagnosis of following pathogenic fungi:- *Microsporum; Trichophyton; Histoplasma capsulatum; Blastomyces dermatitidis; Candida albicans; Cryptococcus neoformans; Pneumocystis carinii.* **Parasites:** *Entamoeba histolytica; Giardia Lamblia; Leishmania donovani.* **Helminths***:Taenia saginata; Taeniasolium; Hymenolepis nana; Schitosoma haematobium*	**15 Hrs**
	Unit IV	
New emerging Infections	**New emerging infections:** -*Streptococcus suis; community associated Methicilin resistant Staphylococcus aureus*(MRSA), *Bordetella pertussis,* H1N1, *Multi-drugresistant tuberculosis. Candida auris, Vancomycin resistant enterococci*	**15 Hrs**

Suggested Books:

1. Medical Microbiology.By:G.F.Brooks,J.S.Butel,S.A.morse.
2. Text book of Microbiology.By:Ananthanarayan and Panikar.
3. Medical Microbiology.By:B.S.Nagoba and A.Pichare.
4. Clinical Microbiology and Infection control.By;Elaine Larson.
5. Bacterial Pathogenesis;Molecular and cellular mechanism.By;CamilaLocht and Michel Simonet.
6. Brock Biology of Microorganisms.By: Madigan M.T John M. Martinko and Parker J
7. Viruses and Interferon; current research. By:Karen Mossam
8. Lentiviruses and Macrophages:Molecular and Cellular intereactions. By:Moira Desporf.
9. Molecular Biology of the gene. By: J.D.Watson, N.h.Hoppkins, J.W.Roberts, J.A.Steitz & A.M.Weiner.
10. Essentials of Medical Microbiology: Apurba Sankar Sastry, Bhat Sandhya K.
11. Milestones in Microbiology: by Brock TD

M. Sc. Semester-IV
Discipline Specific Elective Course (DSE-4)-MICROBIOLOGY- Paper-15 (MMI4T15) (VACCINOLOGY)

Course Outcomes: At the end of the course the students will be able to

1. Know the basic concepts of immunity and infection prevention.
2. Know the various vaccination kinds and how they work.
3. Promote analytical and critical decision-making skills by asking questions and working through vaccination-related problems.
4. Establish a broad awareness of the advantages and disadvantages of vaccinations and the skills necessary to evaluate one's own and one's family members' risks

DSE-4 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**

Unit-I

Basic concepts of vaccination	A:Introduction to vaccines: a) Historical background of vaccination b) Infections and mechanisms of disease induction c) Basic concepts of immunity (Active and passive immunization;) and protection against infection B. Types of Vaccine- Live, killed, recombinant DNA , DNA vaccines: merits and demerits and protein-based vaccines; Peptide vaccines, conjugate vaccines, RNA Vaccines merits and demerits, Hybrid vaccine; role and properties of adjuvants, antibody engineering- chimeric and hybrid monoclonal antibodies. Vaccine against cancer T cell based vaccine, edible vaccine merits and demerits and therapeutic vaccine; Success stories in vaccinology e.g. Hepatitis, Polio, Small pox, DPT	**15 Hrs**

Unit-II

Implementation of vaccination	A:Global vaccination programmes a) Extended Program of Immunization (EPI) for children b) Disease-eradication programs using vaccines c) Mother and child protection via vaccines Pandemic and seasonal influenza vaccination d) Mass immunization programmes B: Vaccination policy and implementation C: New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine.	**15 Hrs**

Unit III		
Vaccine development and application	**Vaccine development and application** A: Making a vaccine and its approval for use in human Biological basis of vaccine development, Novel strategies, Vaccine safety, Vaccine policy issues. a) Targets for vaccine development b) Assessment of new vaccines Approval processes for new vaccine B: Unmet vaccination needs in the public health a) Novel and new infection b) Vaccines for Cancer c) Animal vaccine needs for human health protection. d) Advances in Vaccine development and challenges faced for: HIV, Measles and Tuberculosis and Benefits of vaccination	**15 Hrs**
Unit IV		
Vaccine trials and good clinical practice	Phases of vaccine trials, development of a vaccine protocol, product management, data collection and management, outreach and awareness Overview of national and international regulatory requirements/ guidance for production, Quality control and Current Good Manufacturing Practices (cGMP) implementation. Importance and implementation of cGMP in the production of safe and efficacious biological products/ vaccines, andclean-in-place (CIP) cycle development for process equipment. Equipment cleaning and validation. Validation of sterilization equipment's. Toxicity and potency evaluation of bacterial and viral vaccines: overview of currently approved methods and alternative methods under development.	**15 Hrs**

Suggested Books:

1. *Vaccines,6thEdition*-ByStanleyA.Plotkinet al.Saunders,ISBN: 978-1-4557-0090-5(http://www.sciencedirect.com/science/book/9781455700905)

2. *HealthTopics–Vaccines.World Health Organization .Webaccess: http://www.who.int/topics/vaccines/en/*

3. Vaccines and immunization .US Center for Disease Control and Prevention (CDC) Webaccess: http://www.cdc.gov/vaccines/

4. Immunization against infectious disease (theGreenBook).PublicHealth England.Webaccess: https://www.gov.uk/government/collections/immunisation-against-infectious-disease-the-green-book

5. Recombinant and synthetic vaccines 1994. G.P. 1 Taiwan K.V.S. Rao, V.S. Chauhan, Eds. PP. 528. Springer Scan Publication.

6.New Generation Vaccines. Fourth Edition, Myrone M. Levine , Myron M. Levine, Gordon Dougan , Michael F. Good , Margaret A. Liu , Gary J. Nabel , James P. Nataro, RinoRappuoli.

7.Vaccine Development and Manufacturing. Emily P. Wen (Editor), Ronald Ellis (Editor), Narahari S. Pujar (Editor).

8.Vaccines & Vaccine Technologies. Jose Ronnie Vasconcelos.

9.Indian Pharmacopeia.

M. Sc. Semester-IV
Discipline Specific Elective Course (DSE-4)-MICROBIOLOGY- Paper-15 (MMI4T15) (BIOETHICS, BIOSAFETY AND IPR)

Course Outcomes: At the end of the course the students will be able to

1. Comprehend biosafety regulations and guidelines governing the handling,containment and transport of hazardous materials and apply biosafety principles to ensure environmental and public safety.
2. Understand intellectual property(IP) and differentiate between patents, copyrights, trademark and trade secrets.

DSE-4 THEORY	**Hours: 04 Hours /Week**	**Marks: 80+20=100**	**Credit: 04**
	Unit-I		
History and Basic Concepts	Brief history of bioethics Past and current approaches to bioethics Principles of bioethics – respect of autonomy, non-maleficence, justice, beneficence Medical ethics Public health ethics Ecology and Environmental Ethics		**15 Hrs**
	Unit-II		
Bioethics and Biosafety I	Microbiology and biotechnology research ethics Biomedical Research Ethics Genetic engineering –safety, social, moral and ethical considerations Bioethics, bioweapons and the microbiologist - India's perspective Definition and history of biosafety Principles of biosafety Different levels of biosafety and guidelines		**15 Hrs**
	Unit III		
Bioethics and Biosafety II	Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, Cartagena protocol on biosafety, WTO agreements related to biosafety, Biosafety issues in germplasm Cross border movement Risk management issues - containment. General principles of biosecurity		**15 Hrs**

Unit IV		
IPR	General principles for the laboratory and environmental biosafety Biosafety issues in microbiology and biotechnology laboratories Trade-Related Aspects of Intellectual Property Rights Introduction to copyrights, trademarks, trade secrets, patents, geographical indications in IPR Indian patent act, amendments and patent filing Protection of plant variety and farmers right act Guidelines of IPR on the commercialization of biotechnology products	**15 Hrs**

Suggested Books:

1. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
2. Biosafety in Microbiology and biomedical laboratories, 5th Ed. (2009): CDC, NIH publication. HHS publication (21-1112
3. * Rajul K Gupta (2017) Food Safety in the 21st Century: Public Health Perspective. Academic Press.
4. http://dbtbiosafety.nic.in/
5. Alexandra George (2006) Globalisation and Intellectual Property. Ashgate publishing company
6. David Pressman (2016) Patent It Yourself 18th edition, Nolo Publishers

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