University of Kota, Kota

Syllabus: M. Sc. (Microbiology) I & II Semester

Course Structure with Distribution of Marks:

Year / Semester	Serial Number, Code & Nomenclature of Paper			Duration of Exam	Teaching Hrs/Week & Credit			Distribution of Marks			Min. Pass Marks	
	Number	Code	Nomenclature		L	P	C	Conti. Assess.	Sem. Assess.	Total Marks	Conti. Assess.	Sem. Assess.
I Year/ I Semester	1.1	MIC101	General Microbiology	3 Hrs	4	--	4	30	70	100	12	28
	1.2	MIC102	Microbial Physiology and Biochemistry	3 Hrs	4	--	4	30	70	100	12	28
	1.3	MIC103	Microbial Genetics	3 Hrs	4	--	4	30	70	100	12	28
	1.4	MIC104	Biostatistics and Computer Applications	3 Hrs	4	--	4	30	70	100	12	28
	1.5	MIC111	Microbiology Laboratory-I	5 Hrs	--	16	8	--	100	100	--	50
	Total				**16**	**16**	**24**	**120**	**380**	**500**	**--**	
I Year II Semester	2.1	MIC201	Microbial Diversity	3 Hrs	4	--	4	30	70	100	12	28
	2.2	MIC202	Cell Biology and Enzymology	3 Hrs	4	--	4	30	70	100	12	28
	2.3	MIC203	Molecular Biology	3 Hrs	4	--	4	30	70	100	12	28
	2.4	MIC204	Immunology and Immunotechnology	3 Hrs	4	--	4	30	70	100	12	28
	2.5	MIC211	Microbiology Laboratory-II	5 Hrs	--	16	8	--	100	100	--	50
Total					**16**	**16**	**24**	**120**	**380**	**500**	**--**	
II Year / III Semester	**Serial Number, Code & Nomenclature of Paper**			**Duration of Exam**	**Teaching Hrs/Week & Credit**			**Distribution of Marks**			**Min. Pass Marks**	
	Number	**Code**	**Nomenclature**		**L**	**P**	**C**	**Conti. Assess.**	**Sem. Assess.**	**Total Marks**	**Conti. Assess.**	**Sem. Asses.**
	3.1	MIC301	Microbial Technology	3 Hrs	4	--	4	30	70	100	12	28
	3.2	MIC302	Microbial Ecology	3 Hrs	4	--	4	30	70	100	12	28
	3.3	MIC303	Medical Microbiology	3 Hrs	4	--	4	30	70	100	12	28
	3.4	MIC304	**Elective –I** 1) Computational Biology & Research Methodology 2) Biofuel and Bioenergy 3) Recent trends in RNA Biology 4) Microbiology of waste and Waste remediation	3 Hrs	4	--	4	30	70	100	12	28
	3.5	MIC311	Microbiology Laboratory –III	5 Hrs	--	16	8	--	100	100	--	50
	Total				**16**	**16**	**24**	**120**	**380**	**500**	**--**	
II Year/ IV Semester	4.1	MIC401	Food and Dairy Microbiology	3 Hrs	4	--	4	30	70	100	12	28
	4.2	MIC402	Environmental Microbiology	3 Hrs	4	--	4	30	70	100	12	28
	4.3	MIC403	Soil and Agriculture Microbiology	3 Hrs	4	--	4	30	70	100	12	28
	4.4	MIC404	**Dissertation**	--	--	--	--	--	--	100	--	--
	4.5	MIC411	Microbiology Laboratory-IV	5Hrs	--	16	8	--	100	100	--	50
Total					**16**	**16**	**24**	**120**	**380**	**500**	**--**	

Note:

The allotment of an elective shall reserve with the department, which depends upon the availability of faculty members, infrastructure and laboratory facility available to run the elective and an elective cannot be offered by the department if the number of students is less than the 25% of the total sanctioned strength of the programme.

The syllabus for each theory paper is divided into five independent units and each theory question paper will be divided into three sections as mentioned below:

- ***Section-A*** *shall have 01 compulsory question comprising 10 questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark and total marks of this section will be 10. This section will be compulsory in the paper.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words) and examiners are advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will contain five long answer type questions. One compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) of and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be instructed to design question paper covering from all five units.*

The pattern of question paper of internal and external shall be as follows:

(A) Continuous or Internal Assessment:
30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks)

First/Second Internal Test 20…….
Duration of Exam: 1.00 Hr Max. Marks: 15
Class: M.Sc. Semester:
Subject: Paper:

Note: The question paper contains three sections as under:
Section-A : One compulsory question with 04 parts. Please give short answers in 20 words for each part.
Section-B : 02 questions to be attempted having answers approximately in 250 words.
Section-C : 01 question to be attempted having answer in about 500 words.

SECTION A
Q.1(a) 1
(b) 1
(c) 1
(d) 1

SECTION B
3
3
3
3

SECTION C
5
5

(B) Semester or External Assessment:
70% weightage of Max. Marks (70 Marks out of 100 Max. Marks)

Duration of Examination: 3 Hours Max. Marks: 70
SECTION-A: 10x1=10
(Answer all questions)
(Two question from each unit with no internal choice)
Q. No. 1
(i) ……..…… **1 Mark**
(ii) ……..…… **1 Mark**
(iii) ……..…… **1 Mark**
(iv)……..…… **1 Mark**
(v)……..…… **1 Mark**
(vi)……..…… **1 Mark**
(vii)……..…… **1 Mark**
(viii)……..…… **1 Mark**
(ix)……..…… **1 Mark**
(x)……..…… **1 Mark**
SECTION-B: 5x5=25
(Answer all questions)
(One question from each unit with internal choice)
(Maximum two sub-divisions only)
Q. No. 2. . ……..……
Or
……..…….
5 Marks
Q. No. 3. ……..……
Or
……..……...
5 Marks
Q. No. 4. ……..……
Or
……..……
5 Marks
Q. No. 5. ……..……
Or
……..……...
5 Marks
Q. No. 6. ……..
Or
……..
5 Marks
SECTION-C: 1x15 + 2x10=35
(Answer any three questions including compulsory Q.No. 7)
(Maximum four sub-divisions only)
Q. No. 7. …… **15 Marks**
Q. No. 8. …… **10 Marks**
Q. No. 9. …… 1**0 Marks**

Q. No. 10. …… **10 Marks**
Q. No. 11. …… **10 Marks**

Distribution of Marks for Practical Examinations:

Time - 5 hrs	**Max. Marks –100** **Min. Marks -50**
Major Exercise	**25**
Minor Exercise	**15**
Preparation	**05**
Spotting	**10**
Seminar/Project	**20**
Record	**10**
Viva-voce	**15**
Total	**100**

SEMESTER-I

MIC 101-General Microbiology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT I

Overview of history of Microbiology: Contribution of Antonie Von Leeuwenhoek, Needham, Redi, Spallanzini, Tyndal, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Scope of Microbiology.

Microbial World: Classification up to class level and distinctive characters of major groups: Viruses, Fungi, Algae and Protozoa.

Microbial Taxonomy: Taxonomy, Binomial Nomenclature, types of bacterial classification systems, new approaches to bacterial taxonomy. Bergey's manual of systematic bacteriology. Nutritional types [Definition and examples]. Classification on the basis of oxygen requirement.

UNIT II

Principles, Function & application of Microscopy: Light, Dark field, Phase Contrast, Fluorescence interference, Confocal and Electron (transmission and scanning) Microscopy. Hanging drop, Wet mounting Method.

Stains and Staining Techniques: Definition of Auxochrome, Chromophores, dyes, Classification of Stains, Mechanism of Gram's, Capsule, Endospore, Flagella, Acid fast staining.

UNIT III

Concept of asepsis: Definition of Sterilization, disinfection, Sanitization, Antisepsis, Sterilants and Fumigation.

Physical methods: Moist and Dry heat, Pasteurization, Tyndalization, Radiation, Filtration.

Chemical Methods: Phenol and its Derivatives, Aldehyde, Heavy metal, Halogens, Gas Sterilant.

Culture Media and Isolation Techniques: Natural and Synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.

Serial Dilution, Streak, Pour and Spread plate method. Maintenance and Preservation of pure cultures.

UNIT IV

Methods of reproduction in bacteria and new cell formation. Microbial Growth curve and its kinetics and growth yield. Determination of Cell mass and cell number. Environmental factors affecting growth - temperature, pH, osmotic pressure and nutrient Concentration.

Antimicrobial Therapy: Antibiotics their classification and Mechanism, Antibiotic sensitivity test- disk diffusion, Minimum Inhibitory Concentration, Minimum Lethal Concentration.

Unit V

Bacterial Morphology: size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Composition and detailed structure of gram positive and gram negative cell walls, spheroplasts, protoplasts, and L-forms. Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: structure, formation, stages of sporulation. Economic importance of Bacteria.

Text/Reference books:

1. Prescott, L.M., J.P Harley and D.AKlein, 2007. Microbiology VII Ed.Mc Grow Hill,
2. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
3. Stainer .General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
4. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
5. Alexopoulos CJ et al, Introductory Mycology 4th Edition
6. Woese,.C,R 1981 Archeabacteria , *Sci. Am*. 244:98-122
7. Salle A.J., Fundamental Principles of Bacteriology.

SEMESTER-I

MIC 102 - Microbial Physiology and Biochemistry

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT I

Biomolecules: Chemical structure, properties, classification and biological significance of carbohydrates, proteins, lipids and nucleic acids. Introduction to metabolism: Anabolism, catabolism, primary and secondary metabolism, Role of reducing power, precursor metabolites and energy rich compounds in cell metabolism

Water, acid, base and buffers, pH and pH indicators, Solutions, Redox, potential, Hydrogen bonding; Hydrophobic, Electrostatic and Vander Waal forces. Scope and importance of biochemistry.

Unit II

Amino acids; classification, chemical reactions and physical properties; biosynthesis and catabolism.

Metabolism of nucleotides: Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

Carbohydrate and glycobiology: Glycolysis and Gluconeogenesis, Citric acid cycle, Glyoxalate Cycle, Amphibolic and Anapleurotic reaction, Oxidative phosphorylation, light reaction of photosynthesis: Light and Dark reaction.

UNIT III

Metabolism of lipids and hydrocarbons,Lipid composition of microorganisms, biosynthesis and degradation of lipids, lipid accumulation in yeasts, hydrocarbon utilization, PHA synthesis and degradation.

Biological Nitrogen Fixation: Nitrogen fixing organisms, difference in symbiotic and non symbiotic fixation. Oxygen Protection mechanisms. nif gene organization and regulation.

Unit IV

Optical methods: Colorimetry, Photometry, Nephlometry, VIS, UV VIS and infra red spectrophotometry. Flame photometry, Photo spectrofluorimetry, Mossebauer spectroscopy, ESR and NMR. Isotopic tracer techniques- stable and radioactive isotopes and neutron activation.

UNIT V

Basic principles and applications of Chromatography (paper, thin layer, column, gel filtration, ion-exchange and affinity chromatography); GLC, HPLC. Centrifugation techniques- principle, types and applications. Principles and applications of electrophoresis for protein and DNA; Iso-electric focusing and 2D gel electrophoresis.

Text/Reference books:

1. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
3. Voet D and Voet JG. (2003). Biochemistry. John Wiley and sons New York.
4. Zubay G (2000). Biochemistry. W. C. Brown, New York.
5. Berg J, Tymoczko J, Stryer L (2001). Biochemistry. W. H. Freeman, New York.
6. Moat AG and Foster J W (2003). Microbial Physiology. John Wiley and Sons, New York.
7. Robert K., Murray M.D., Granner D.K., Mayes P.A.and Rodwell V.I. Harper's Biochemistry. McGraw-Hill/Appleton and Lange.
8. Biochemistry U, SatyaNarayan.
9. Biochemistry: Lehninger
10. Microbial Physiology: Moat, Foster and Spector
11. Fundamental of biochemistry by A.C.Dev.
12. J.L. Jain, Biochemistry.
13. Elements of biochemistry by H.R. Shrivastava.
14. Stainer .General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi

SEMESTER-I

MIC 103- Microbial Genetics

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT-I

Introduction to Molecular Genetics. DNA structure and types. Superhelicity in DNA. Law of DNA constancy, Cot curve and C value paradox, DNA renaturation kinetics and Tm value determination and interpretation, Repetitive DNA, Satellite DNA, Selfish DNA.

UNIT-II

Recombination: Types of recombination, Models for Homologous recombination, Molecular mechanism of homologous recombination, Homologous recombination in eukaryotes, Molecular mechanism and biological role of site specific recombination. Transposable elements in prokaryotes.

UNIT-III

Conjugation: Conjugation by *E. coli* F factor. (Structure of F factor and regulation of F-factor fertility), F- prime conjugation, Conjugation of fertility inhibited F-like plasmids, Hfr and Lfr conjugation and chromosomal transfer, Non-conjugative, establishment of cell contact.

UNIT-IV

Transformation: Mechanism of natural competence and transformation in *Bacillus subtilis, Streptococcus pneumoneae and Haemophilus influenzae.* Transformation by artificial competence. Gene linkage and mapping by transformation. Transduction- specialized and generalized transduction and its applications.

UNIT-V

Regulation of gene expression: Operon concept, catabolite repression, instability of bacterial RNA, positive and negative regulation: inducers and co-repressors. Negative regulation in *E. coli* lac operon. Positive regulation in *E. coli* arg operon; regulation by attenuation of his and trp operons.

Text/Reference books:

1. Concepts of genetics by klug and cummings
2. Genetics: From Genes to Genomes by Leland Hartwell, Leroy E. Hood, Michael L. Goldberg
3. Genetics: Analysis and Principles (3rd Edition) by Brooker
4. Gene cloning by T.A.Brown
5. Cell and molecular Biology by P.K. Gupta.

SEMESTER-I
MIC 104- Biostatistics & Computer Applications

Min. pass marks: 28 **Duration: 3 hour** **Max. Marks: 70**

UNIT-I

Introduction to Biostatistics: Basic definitions, scope of statistics in bioresearch, notations and applications.

Sampling: Representative sample, sample size, sampling techniques (Random and Non Random) and their merits and demerits.

Data collection and presentation: Types of data, methods of collection of primary and secondary data, Data presentation (Histogram, Frequency curve, Frequency polygon, ogive curves, Bar diagrams and Pie diagram).

UNIT-II

Statistical Measures:

Measures of Central Tendency: Mean, Mode, Median their Merits and Demerits.

Measures of Variability/ Dispersion: Mean deviation, Standard deviation, Range, Variance and Coefficient of variation.

UNIT III

Correlation: Definition, Types of correlation, calculation of correlation coefficient (Karl Pearson's, Rank Correlation)

Regression Analysis: Definition, Two regression lines, Regression equation and Coefficient.

Difference between Correlation and Regression.The Analysis of Variance(ANOVA). F distributions, One way and nested ANOVA.

UNIT-III

Probability: Types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems.

Probability distributions-Binomial, Poisson and Normal distributions, Distribution Curve.

Statistical Inference-Estimation, standard error, confidence interval for means and proportion.

Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square.

UNIT-V

Introduction of computer and its types. Hardware and software, operating system, Basic concept of MS- Office, MS- Word, Power Point, MS- Excel,DOS, I/O, Number system, memory, computer peripherals. LIMS and Computer Applications**.**

Text/Reference books:

1. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983).
2. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).
3. Computer fundamentals by P.K. Sinha.

MIC-111 (MICROBIOLOGY LABORATORY –I)

1. Techniques of pure culture isolation-pour plate, spread plate, streaking.
2. Triple Sugar Iron Test.
3. Antibiotics Sensitivity test
4. IMVIC Test
5. H_2S Production
6. Preparation of Basic Liquid Medium (Broth)
7. Preparation of Basic Potato Dextrose Agar
8. Preparation of Basic Nutrient Agar.
9. Simple staining of bacteria.
10. Negative staining of bacteria.
11. Differential staining of bacteria.
12. Endospore Staining.
13. Litmus Milk Test
14. Catalase Milk Test
15. Isolation of Microbial colony from Soil, Water, Air, Milk, food Samples.
16. Isolation of Microbial colony from Rhizosphere.
17. Isolation of Microbial colony from Phyloplanes.
18. Paper chromatography.
19. Qualitative estimation of lipid, carbohydrates & proteins.
20. Reducing sugar estimation by benedict's method.
21. Specification of fats
22. Creating charts in excel using different data.
23. Design a worksheet for numeric entries and perform required calculation.
24. Design a worksheet enters required data and perform aggregate function like sum, average, count etc.
25. Perform file operation like copy, save, rename, delete using window explore.
26. Calculate mean, mode and median
27. Calculate correlation & regression
28. Colorimetry: To determine the association constant of a. given indicator colorimetrically and to prepare the buffer solutions in pH range of 2.2 to 8.0
29. Spectrophotometry: To find out absorption spectrum of given chromophore and /or oxidised and reduced forms (sodium nitrate and borohydrate).
30. Thin layer chromatography: lipids, mixture of dyes.
31. Chlorophyl estimation: spectrum and turbidity correction in chloroplasts.
32. Polyacrylamide gel electrophoresis of proteins.
33. Study of sex linked gene inheritance.
34. Estimating gene frequencies in human population,
35. Estimation of heterozygotes frequencies.
36. Isolation / identification of auxotroph mutants in bacteria,
37. Recombination in Bacteria.
38. Pedigree analysis, analysis of human karyotes,
39. Chromosomal aberrations

40. Study of conjugation in bacteria.
41. Isolation of genomic DNA(microbes), purification of DNA,
42. Separation of DNA by gel electrophoresis.
43. Isolation of cytoplasmic RNA.
44. Electrophoresis of RNA on denaturing gels.
45. Immobilization of enzyme

SEMESTER-II
MIC 201- Microbial Diversity

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

Unit I

Introduction-Biodiversity. Origin of life, Evolution and Origin of Biodiversity, Species Concept, Evolutionary tree of microorganisms.

Classification of microorganisms – Haeckel's three kingdom concept, Whittaker's five kingdom concept, Three domain concept of Carl Woese, Classification systems-artificial or phonetic, natural and phylogenetic,Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology.

UNIT II

Fungi: Recent Trends in fungal systemetics (Alexopolus & Mims), General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, Life cycle (major group of Fungi), heterokaryosis Parasexuality and Heterothallism. Economic Importance (Agriculture, Environment, Industry, Medicine, Food, Biodeterioration, Mycotoxins).

UNIT III

Algae: Definition, occurrence, Classification upto class level, Ultra-structure, Reproduction and Life cycle. Economic importance (Agriculture, Industry, Environment and Food)

Protozoa: General Characteristics – Definition, Occurrence, Ultrastructure, Reproduction, Economic importance.

Virus: General characteristics – Definition, Structure, Reproduction and Ultrastructure, Capsids. Virus related agents–Viroids, Prions.

Bacteriophages: Structure, Life cycle –Lytic & Lysogenic

UNIT IV

Characteristics of important genera and physiology of: Chemoautotropihic and Methophilic eubacteria, Gram negative aerobic eubacteria, Gilding bacteria (Myxobacteria), Enteric group and related eubacteria, Gram negative anaerobic eubacteria, Gram negative eubacteria-Rickettsia, Chlamydia and Spirochaetes.

Gram positive eubacteria- Unicellular endospore forming eubacteria, Actinomycetes.

UNIT V

General Characters, Classification, Adaptations and Physiology of Archaebacteria: methanogens, Acidophiles, Halophiles, Thermoacidophiles.

Cyanobacteria: General characters , Ultra structure, Reproduction and Economic importance. Photosynthetic eubacteria : Anoxygenic and oxygenic photosynthesis, Sulfur or NonSulfur Bacteria (purple and green), Mollicutes. Gram positive fermentative eubacteria. Bdellovibrio and its interperiplasmic growth cycle.

Text/Reference books:

1. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark, Brock Biology of Microorganisms, 13thEdition,Pearson Education, Limited, 2011.
2. Pelczar, M.J., ChanE.C.S. and Krieg, N.R., Microbiology –Application based approach, 5th edition, Mc Graw Hill, 2009.
3. Tortora,G. Microbiology: An Introduction-Benjamin Cummings, 10thEdition, 2009.
4. Willey J, Sherwood and Woolwerton C, Prescott, Harley and Klein's, Microbiology, 8thEdition, McGraw Hill International, 2010.
5. Singh, Pandey, Jain. A text Book of Botany, 2016

SEMESTER-II

MIC 202- Cell Biology and Enzymology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

Unit I

Evolution of cell; Cell as a unit of living organism and structure of prokaryotic cell, Structural and functional features of eukaryotic cell: cell organelles; endoplasmic reticulum, golgi complex, lysosomes, vacuoles, peroxisomes, mitochondria, chloroplast, cytoskeleton, microtubules, nucleus, extracellular matrix etc.

Unit II

Biological membranes: Membrane structure and transport mechanisms- passive diffusion, active and co-transposrt, secondary active transport, membrane selectivity, electrolyte selectivity, non electrolyte selectivity, stimuli, receptors, second messengers and cellular response, membrane channels and pumps.

Cell signaling and signal transduction pathways- MAPK/ERK pathway, cAMP dependent pathway, IP_3/DAG Pathway.

UNIT III

Classification, nomenclature and general properties of enzymes, mechanism of enzyme action, enzyme inhibition, enzyme kinetics, Coenzyme, Allosteric and other regulations of enzyme activity

Enzyme Kinetics: Bioenergetics and Catalysis, Single substrate kinetics: Equilibrium and Steady state kinetics, significance of Km, Vmax & Kcat.

UNIT IV

Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, non competitive and uncompetitive, mixed, partial, substrate and allosteric inhibition. Mechanism of Enzyme Action, Enzyme activators, co-enzymes and co-factors in enzyme catalysis, Enzyme and substrate specificity.

UNIT V

Isoenzymes and its physiological significance, Ribozymes and Abzymes.

Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents. Enzyme Immobilization Enzymes in non conventional media, Enzymes sensors, Enzymes as analytical reagents.

Text/Reference books:

1. Biochemistry: Lubert Stryer
2. Biochemistry: Lehninger

3. Microbial Physiology: Moat, Foster and Spector
4. Molecular biology of the cell: Bruce Alberts et al.
5. Cell and molecular biology: Gerald Karp.
6. Cell and molecular biology: DeRobertis and DeRobertis.
7. Molecular cell biology: By Lodish et al.
8. Genetic Engineering by Nicoll

SEMESTER-II
MIC 203- Molecular Biology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT I

The nature of Genetic material: The structure of DNA and RNA. Organization of Microbial Genomes, Organization of Eukaryotic Genomes, Chromatin arrangement, nucleosome and solenoid structure of DNA. Mutations : Types of Mutations and mutagens. Molecular mechanisms of induced mutation : DNA damages and it repair pathways.

UNIT II

DNA Replication: Central dogma. DNA replication in prokaryotes and eukaryotes- Initiation , elongation and termination. Enzymology of replication. Proofreading of DNA with reference to specific enzymes and co-factors. Regulation of replication. Genetic code.

UNIT III

Transcription: Transcription machinery of prokaryotes and eukaryotes -initiation, elongation and termination, various transcription enzymes and cofactors. Transcription eukaryotes -initiation, elongation and termination Types of RNA polymerase. Promoters, enhancers, silencers, activators. Regulation of transcription

UNIT IV

Translation: Mechanisms of translation in prokaryotes and eukaryotes- initiation, elongation and termination. RNA processing: splicing, capping and polyadenylation, rRNA and tRNA, processing, RNA Editing, RNAi : :miRNAs and siRNA, Post-transcriptional gene regulation. Ribozymes.

UNIT V
Genetic Engineering: Principle and basic tools. Gene cloning vectors: Plasmids, phage vector- Ti and Ri plasmid, Phagemids, Cosmids, shuttle vectors, Artificial chromosomes (BAC, YAC, HAC), Application of genetic engineering. DNA sequencing methods, Gene amplification - PCR and its applications,

Text/Reference books:

1. Concepts of genetics by klug and cummings
2. Genetics: From Genes to Genomes by Leland Hartwell, Leroy E. Hood, Michael L. Goldberg
3. Genetics: Analysis and Principles (3rd Edition) by Brooker
4. Gene cloning by T.A.Brown
5. Genetic Engineering by Nicoll

SEMESTER-II
MIC 204- Immunology & Immunotechnology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT-I

Structure, composition and types of cells and organs involved in immune system, Innate and acquired immunity. Immunization – Modern methods of producing vaccines. Humoral and cell mediated immune responses.

UNIT-II

Antigens: Structure and properties, Types– Iso and allo – haptens, adjuvants, antigen specificity, vaccines and toxoids. Immunoglobulins- structure, heterogeneity, types and subtypes, physico-chemical and biological properties. Theories of antibody production. Generation of antibody diversity.

Complement –Complement pathways and biological consequences of complement activation.

UNIT-III

Antigen- Antibody interaction -*In vitro* methods - Agglutination, Precipitation, Complement fixation, Immunofluorescence, ELISA, Radioimmunoassays; Immuno blotting. *In vivo* methods: Skin tests and immune complex tissue demonstrations and their applications in diagnosis of microbial diseases. Hybridoma Technology: Monoclonal antibodies production and their applications.

UNIT-IV

Structure and functions of MHC and the HLA systems, HLA and tissue transplantation – Tissue typing methods for organ and tissue transplantations in humans, graft versus host reaction and rejection. Tumor immunology – tumor specific antigens, immune response to tumors, immunodiagnosis of tumors – detection of tumor markers – alpha foetal proteins.

UNIT-V

Antibody: Mediated – type I. Anaphylaxis; Type II. Antibody dependent cell cytotoxicity; Type III immune complex mediated reactions; Type IV Cell mediated hypersensitivity reactions. Autoimmunity – mechanism and diseases. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies

Text/Reference books:

1. Essentials of Immunology, Author- Roitt, I.M., ELBS. Blackwell Scientific Publishers, London.
2. Immunology II Edition, Author- Kuby, J. WH., Freemanand Company, New York.
3. Immunology. Author- Klaus D. Elgert ,Wiley-Liss. NY.
4. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes). Authors- Topley and Wilson's, Edward Arnold, London.
5. The Experimental Foundations of Modern Immunology. Authors- Clark, V.R., John Willey and Sons, Incl.
6. Fundamental Immunology. Author – W.E. Paul, Raven Press, New York.
7. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brown publishers.
8. Immunology. Authors – D.M. Weir and J. Steward 7thEd. (1993).

MIC 211 (MICROBIOLOGY LABORATORY –II)

1. Determination of blood group.
2. Determination of Rh factor.
3. Estimation of haemoglobin content.
4. Isolation of chromosomal and plasmid DNA. from bacteria.
5. Gel electrophoresis of DNA and examination of Agarose gels
6. To perform total leucocyte count on the given blood sample.
7. To perform differential leucocyte count of the blood sample
8. To separate serum from the blood sample
9. To perform immunodiffusion by ouchterlony method
10. To perform immunoelectrophoresis with a given sample.
11. Rocket immunoelectrophoresis
12. Radial immunodiffusion
13. To perform DOT ELISA
14. Enzyme assays (LDH, beta galactosidase, acid phosphate, arginase, succinic dehydrogenase) Time, Temperature, Protein concentration, cofactors. LDH: K_m and V_{max} various kinetic plots: Use of computer packages for parametric and non-parametric methods and non-linear regression
15. Isolation of plasmid DNA - i) mini preparation ii) large scale isolation.
16. DNA ligation
17. Transformation of E.coli.
18. Blotting and hybridization with labeled- DNA probes (Southern Blot) Techniques.
19. DNA hybridization.
20. Northern blot techniques. In situ detection of RNA in embryos / tissue.
21. Fragment separation by restriction endonuclease enzyme.

SEMESTER-III
MIC 301 – Microbial Technology

Min. pass marks: 28 **Duration: 3 hour** **Max. Marks: 70**

UNIT- I

Industrial micro organisms: Isolation, screening and strain improvement. Preservation and maintenance of industrially important microbes. Primary and secondary metabolites. Media for industrial fermentation : Input economizing, carbon, nitrogen, mineral sources, buffers, precursors, inhibitors, inducers and antifoam agents. Industrial sterilization process for media, air and equipment.

UNIT-II

Basic design and operation of a microbial fermentor. Types of Fermenters. Basic principles of scale –up. Concept of submerged, surface, solid state fermentation, Batch and continuous fermentations.
Downstream processing: Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods.

UNIT-III

Extraction: Solvent, two phase, liquid extraction, supercritical fluid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying devices.
Microbial products of commercial use: Primary metabolites: Citric acid, Lactic acid, Vinegar; Glutamic acid, L – lysine; Acetone.
Secondary metabolites: Streptomycin, Penicillin,Vitamin B12, Riboflavin,steroid transformation.

UNIT- IV.

Microbial Enzymes :Tannases, Proteases, Amylases,
New Vaccines Technology : DNA Vaccines, Synthetic peptide, vaccines, multivalent peptide Vaccines.
Production of biopharmaceuticals through GEMs: Insulin, Interferons, Tissue plasminogen activator, Streptokinase.

UNIT- V

Protein Engineering : Adding disulphur bonds, Amino acid substitution, Reducing sulfhydroxyl residues, Increasing enzyme activity and modifying specificity and its applications.
Immobilization of enzymes and cells: Parameters for choosing a matrix for immobilization, types of methods for immobilizations. Applications of immobilization techniques**.**

Reference Books:

1. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
2. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
3. Creuger and Creuger (2004). Biotechnology- A textbook of Industrial Microbiology, Sinaeur Associates.

4. Casida LE (2001). Industrial Microbiology, Wiley Eastern.
5. Manual of Industrial Microbiology and Biotechnology, Demain & Davies, 2nd ed.
6. Microbial Biotechnology A. N. Glazer and H. Nikaido
7. Biotechnology An Introduction Susan R. Barnum
8. Topics in Enzyme & Fermentation Biotechnology Volumes by Wisemen
9. S.N. Jogdand. Medical Biotechnology
10. S.N. Jogdand. Biopharmaceuticals

SEMESTER-III
MIC 302 – Microbial Ecology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT- I

Ecosystem: Abiotic and biotic components, Food chains, food web, trophic levels. Microbial communities: structure, dynamics and stability. Population selection within communities, r & k strategies. Succession and biodiversity into microbial communities. Diversity indices.

UNIT- II

Microbial Adaptations: Abiotic limitations to microbial growth-Liebig's law of the minimum, Shelfords's law of tolerance, Environmental factors: temperature, radiation, pressure, salinity, organic compounds, inorganic compounds.

.

UNIT -III

Microbial interactions with animals: Symbiosis of algae and invertebrates, endosymbionts of insects. Symbiosis and cellulose digestion. Endosymbiogenesis.

Rumen "Microorganisms: their metabolism and ecological behavior. Bacterial and protozoan fermentation of carbohydrates. Dietary proteins and other nitrogenous substances. Rumen dysfunction and detoxification mechanisms.

UNIT -IV

Microbe-Microbe interactions: Neutralism, antagonism, competition, commensalisms, amensalism, mutualism, synergism, syntropism, parasitism and predation. Microbial interactions with plants: Interactions with plant roots- Rhizosphere, Mycorrhizae, Lichen. Biological Nitrogen- fixation in nodules, rhizobia, legumes and non-leguminous plants.

UNIT-V

Microbiology of Extermophiles(Stress microbiology): Stress sequestration in halophiles, osmophiles, thermophiles, xerophiles, barophiles. Heavy metal detoxificants.

Quantitative microbial ecology: Modern and conventional methods used to study microorganism, sampling procedure, microbial enumeration, biomass determination.

Reference Books:

1. Alexander ,M. 1997. Introduction to Soil Microbiology. John Wiley and sons Inc., New York.
2. Ronald M. Atlus,2011. Microbial Ecology: Fundamental and applications . Richard Bartha.
3. David L. Kirchman, 2009. Microbial ecology of Oceans.
4. Robert , S. Burlage Ronald Maltus , 1998. Techniques in Microbial Ecologt. ASM press
5. Larry Barton, Diana E. Northup, 2011. Microbial Ecology. John Publisher , Academic press.
6. Journals of Microbial ecology
7. FEMS journal of microbial ecology

SEMESTER-III
MIC303 – Medical Microbiology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT –I
Early discovery of pathogenic microorganisms, Contributions made by eminent scientists. Classification of medically important micro organisms.
Infection: types of infection, sources of infection, reservoirs and vehicles of infection, predisposing factors.
Host-parasite relationship governing the infection and establishment of disease, factors affecting virulence.

UNIT II
Normal microflora of human body: Normal flora of Skin, Mouth, Upper respiratory tract, Intestinal tract, Urino-genital tract, eye. Role of resident flora. Mechanism of bacterial and viral pathogenicity, colonization and growth, Virulence, Toxin: exotoxins, enterotoxins, endotoxins, neurotoxins, avoidance of host defense mechanisms, damage to host cell.

UNIT III
Clinical microbiology: Collection, handling and transport of specimens; brief account of isolation and identification of microorganisms from specimens.
Etiology, symptoms, mode of transmission, disease development and preventive measures of following diseases:
Airborne transmission diseases: Streptococcal diseases, Diptheria, Tuberculosis, Influenza,
Leprosy, Small pox, Chicken pox, Measles

UNIT – IV
Etiology, symptoms, mode of transmission, disease development and preventive measures of following diseases:
Sexually transmitted diseases : Gonorrhea, Syphilis and AIDS
Animal transmitted disease : Rabies
Insect transmitted disease: Rickettsia, Malaria, Plague, Dengue fever
Soil borne diseases : Tetanus
Food and water-borne diseases: Cholera, Typhoid, Hepatitis, Poliomyelitis, Amoebiasis
Fungal Diseases**:** Superficial mycoses, cutaneous mycoses, sub-cutaneons mycoses and systemic mycoses. Candidasis, Aspergillosis

UNIT - V
Antimicrobial agents: History, Antibiotics, Antifungal and Antivirals (Classification of common drugs, their spectrum and mode of action)
Methodologies for testing of antibacterial, antifungal, and antiviral drugs (*in vivo* and *in vitro* infectivity models), drug resistance mechanism.

Reference Books:
1. Ananthanarayan and Jayaram Paniker. Textbook of Microbiology, 4th ed. Orient Longman, 2000.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013)Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby

4. Medical Microbiology-David Green wood
5. Text book of Microbiology,Ananthanarayan& Jayaram Panicker
6. Jawetz-Medical Microbiology-Geo F.Brooks,Janet S Butel.

SEMESTER-III

MIC304 –(1) Computational Biology & Research Methodology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT-I

Introduction of computers, Microsoft Office (Excel, word, and PPT) – Data Entry – graphs – aggregate functions – formula and functions. Different number systems and BIT, BYTE, WORD, secondary storage media. data representation and storage binary codes, binary system and its relationship to Boolean Operations. Biological databases: Primary and secondary databases Nucleic acids (DNA/RNA), Metabolic pathways, Microbial and Cellular data bases,

UNIT-II

Tools for DNA sequence analysis, protein sequence analysis; Usage of sequence alignment and searching tools for Gene Identification. Sequence Aligenment: Comparisons of Nucleic acids & Proteins. Sequence and structural, global and local, pairwise and multiple alignment techniques. Using Biological databases; Structure visualization and Building; Protein Sequence Analysis; Genome Analysis; Protein Secondary and Tertiary structure prediction; Homology Modeling; Phylogenetic Analysis Software and Tools.

UNIT–III

Computational approaches to protein structure prediction: Threading and Homology based approaches, Experimental techniques for 3-D structure elucidation: X-ray crystallography, Gene prediction: Interpolated Markov Model, Hidden Markov Model, Dynamic programming, Significance of computational approaches in studying protein & DNA structure and function. Introduction to ab-initio, semi-empirical & molecular mechanical methods, Methods to model Nucleic Acids (DNA & RNA).

UNIT-IV

Disease / disorder and Drug targets. Concept of receptor / target site. Concepts in molecular recognition. Drug-like properties and associated empirical rules. structure based drug design; Applications of QM methods; Molecular descriptors in QSAR studies, Small molecule force field parameters (charges), potentials, Active site identification, ligand docking , Drug stability, synthesizability and drug delivery.Steps and software of drug designing. Phylogenetic analysis, MEGA, Phylip**.**

UNIIT-V

Research Methodology: Introduction-Basic research, applied research, need based research. Identification of the problem, defining the problem Research Project planning. Literature search-information sources, library resources-books, abstracts hand books, procedure manuals, enoyclopedias, annual report, data banks, CDROMS, online literature search- internet access, websites, directories of information resources.

Progress of research- evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communication, impact factor of journals, plagiarism.

Reference Book:

1. Principles of Technical Writing by Robert Hays. Addison-Wesley, 1965 2.
2. Rastogi. S. C, Mendiratta. N and Rastogi. P. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd.3rd edition.
3. Zhumur Ghosh & Bibekanand Mallick, Bioinformatics: Principles and Applications, Oxford University Press, Second Edition
4. Teresa K. Attwood and David J. Parry – Smith. 2005. Introduction to Bioinformatics. Pearson education, Singapore.
5. A.R. Leach, Molecular Modeling- Principles and Applications, Second Edition, Pearson.
6. David W. Mount. 2003. Bioinformatics: Sequence & Genome Analysis.CBS Publishers and Distributors. New Delhi.
7. Westhead. D. R, Parish. J. H and Twyman. R. M, 2003. Bioinformatics. Viva Books Private Limited, New Delhi.
8. C.R., Kothari,Research methodology.

Practicals:

1. Working on Biological databases, NCBI, DDBJ, EMBL.
2. Visualizing and Retrieving protein and nucleic acid sequences, structures, EST sequences, SNP data using database browsers and genome browsers.
3. Converting sequences between different formats.
4. Nucleic acid sequence analysis by using detecting ORF's, identification of translational and transcriptional signals, gene predictions, codon usage, RNA fold analysis.
5. Sequence alignment and applications: pairwise alignment-dot matrix comparisons, global and local alignment, Database searching-different pairwise methods. Use of scoring matrices and gap penalities.
6. MSA, Progressive alignment and iterative alignment approaches. Use of profile methods for motif detection. Phylogeny approaches. BLAST and FASTA
7. Protein Sequence analysis and structure predication
8. Working on docking and visualizing software.

SEMESTER-III
MIC 304 –(2) Biofuel and Bioenergy

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT I

Biomass for energy. Calorific value and its estimation. Co-generation of energy. Alternatives as biofuels: Alkanes, Biobutanol, bioethanol, biomethanol, biodiesel, biogas, hydrogen, syngas/synfuels and other energy dense molecules and their comparisons.

UNIT II

Starch to sucrose conversion and Sucrose to ethanol fermentation. Distillation and Quantification of ethanol. Biobutanol production, Estimation of biobutanol. Biogas production. Biogas and methane estimation. Bio gas Bottling Plant Technology, Application of Bio gas slurry in agriculture , Design of Biogas for cold climates
.

UNIT III

Lignocelluosics hydrolysis, Fermentation of pentoses and other issues in bioethanol production form lignocellulosics
Global biodiesel scenario. Oil crops. Wastewater remediation and biomass generation for biofuel purposes. Commercialized microalgae (Spirulina, Dunaliella, Hematococcus, Chlorella, and others) and their production.

UNIT IV

Systems of microalgae Cultivation, harvesting and protection from grazers. Economics of microalgae production.
Cultivation of seaweeds. Techniques of lipid extraction and conversion to biodiesel (lipid transesterification), Biodiesel quality and its assessment.

UNIT V

Food vs Fuel debate. Carbon sequestration and its necessity. Carbon credits. Biorefinery, Thermochemical Conversion Processes (Gasification: Biofuels from Synthesis Gas and Pyrolysis) Biochemical Conversion Processes, Photobiological conversion: Biohydrogen production.
Strategies of genetic engineering of organisms for biofuel production. Microbial Fuel Cells.

Reference Books:

1. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
2. Reference book: Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).
3. Kothari D. P. and Nagrath I. (2009); Basic Electrical Engineering, Third Edition, McGraw Hill, India

4. Zemansky M. and Dittman R. (2011); Heat and Thermodynamics, McGraw Hill, India
5. Wadhwa C. L. (2012); Generation, Distribution and Utilization of Electrical Energy, Third Edition, New Age International
6. Balachandran P. (2010); Engineering Fluid Mechanics, Prentice Hall India
7. Dessler A. (2011); Introduction to Modern Climate Change, Cambridge University Press

Practical

1. Liquid bio- fuel production and characterization.
2. Biogas production by anaerobic digestion and analysis.
3. Production of energy from microbes (microbial fuel cell)
4. Biodiesel production and characterization from non-edible vegetable oil – preparation and characterization.
5. Bio Energy and Biofuel: Biogas production and application .
6. Bioethanol production.
7. Cultivation of seaweeds.

SEMESTER-III
MIC 304 –(3) Recent trends in RNA Biology

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT-I

Introduction to RNA Biology, Properties of ribonucleic acids. Types of RNAs found in cells. RNA world hypothesis, RNA structure and folding, analytical techniques for studying RNA biology, Function of the RNA molecule is regulated by proteins and small ligands.

UNIT II

m-RNA processing- Capping, Tailing and splicing and Alternative splicing.
r-RNA splicing. t-RNA formation and splicing. RNase P recognition, modifications, editing, tRNA mimics, charging and proofreading.

UNIT III

Discovery of RNA interference , Posttranscriptional Processing of microRNA.
RNA dependent protein complex: target Pairing and RISC Function, microRNA Target Genomics (with introduction to bioinformatic tools). Harnessing RNAi as a tool. RNAs as enzymes.

UNIT IV

Long Noncoding RNA: Genome Organization and Mechanism of Action: from Heterochromatin to Long Noncoding RNAs in Drosophila, Expanding the Arena of Gene Function and Regulation. Long Noncoding RNAs in the Yeast (*S. cerevisiae*) and Plants. RNA biology of disease-associated microsatellite repeat expansions

UNIT V

microRNA function in vertebrate development. miRNAs in cancer: tumor suppressors and oncogenes. Small Bacterial RNAs –CRISPR , piRNAs , SnoRNAs , lincRNAs , miRNAs and diseases. A case study of miRNA function in human disease

RNA Science and its Applications.

Reference Books:

- MicroRNAs -From Basic Science to Disease - Krishnarao Appasani- Cambridge University Press
- RNAi: A Guide to Gene Silencing - Gregory J. Hannon - Cold Spring Harbor Laboratory Press.
- RNA Biology: Gunter Meister,
- Goyal A. et al. (2017). Challenges of CRISPR / Cas9 applications for long non-coding RNA genes. Nucleic Acids Research 45: e12
- utschner T. et al. (2013). The non-coding RNA MALAT1 is a critical regulator of the metastasis phenotype of lung cancer cells. Cancer Res, 73(3), 1180–1189.

- A Simple Laboratory Practical to Illustrate RNA Mediated Gene Interference Using Drosophila Cell Culture Received for publication, April 15, 2009, and in revised in 2010

Practicals:

1. A Simple Laboratory Practical to Illustrate RNA Mediated Gene Interference Using Drosophila Cell Culture.
2. Staining of RNA
3. Targets and functions of miRNAs encoded by the human herpesvirus Kaposi's sarcoma-associated herpesvirus (KSHV)
4. Molecular machinery for histone modifications in yeast, Drosophila and human cells

SEMESTER-III

MIC304 –(4) Microbiology of Wastes and Waste Remediation

Min. pass marks: 28 **Duration: 3 hours** **Max. Marks: 70**

UNIT I

Bioremediation and Bioaugmentation: Pollution, wastes, their types and characterization. Methods of treatment-Physical, chemical, biological-aerobic and anaerobic (Oxidation ponds, HRABP, ASP, Trickling Filter, Fluidized Bed Reactor, Biogas, Rotating contactor).

UNIT II

Bioaccumulation of metals and detoxification, biosorption, scavenging. Biodegradation of Xenobiotics (Pesticides and dyes).
Biofilms in natural and manmade environments. Solid waste treatment (Agricultural/urban): Degradable wastes: Saccharification, gasification, composting, vermicompost, mushroom compost, ensilage.

UNIT III

Utilization of solid wastes- food (SCP, mushroom, yeast), fuel (ethanol, methane-biogas plant), manure (composting). Non biodegradable solid waste and its management: Landfill development, incineration and recycling.

UNIT IV

Fuel Gas Management: Treatment strategies and microbiological options. Fuel desulfurization. Biological alternatives for xenobiotic and Chemical synthesis (biopesticides, biosurfactants, biocolours and Biofuel).

UNIT V

Genetically Engineered Microorganisms for bioremediation. Genetic modification of crops. Environmental concerns regarding release of GMOs.
Nanotechnology : Concept, scope and techniques. Microorganisms and nanotechnology.

Reference Books:

1. Alexander M 1971. Microbial Ecology. John Wiley & Sons Inc., New York.
2. Eldowney Ec S., Hardman DJ. and Waite S 1993. Pollution: Ecology and biotretament. Longman Scientific Technical.

3. Baker KH and Herson DS 1994. Bioremediation. Mc Graw Hill Inc., New York.
4. Michel R. 1999. Introduction to environmental microbiology.
5. Atlas & Bartha. Microbial Ecology
6. Indu Shekhar. Environmental Biotechnology
7. Environmental engineering and management S. K. Dhameja, Publ: Kataria & Sons
8. Experimental ecology R.M. Atlas

Practicals:

1. Production of Single cell protein
2. Mushroom cultivation.
3. Bioremediation of polluted soils by plants/ microbes.
4. Laboratory demonstration of vermin-composting
5. Field visit to recycling industries.
6. Qualitative and Quantitative estimation of solid waste from different sites.

MIC 311-Microbiology Laboratory -III

1. Components and Operation of a Bioreactor
2. Batch fermentation in conical flask
3. Solid state fermentation
4. Screening of microbes for production of industrially important enzymes.
5. Optimization of conditions for optimal production of enzyme: - Media composition, Incubation temperature, Aeration, Incubation time.
6. Purification of antimicrobial metabolites from a microbe.
7. Production of amylase and cellulase.
8. Immobilization of cells and enzymes.
9. Instrumentation of fermentor. Design of various types of fermentors & bioreactors
10. Production of ethanol & wine from grapes.
11. Production of ethanol from wheat flour
12. To enumerate microorganisms from different natural habitats.
13. To study the bacterial ecology in fresh water environment
14. To study the microbial diversity of soil.
15. To study the microbial ecology of the rhizosphere and determination of rhizospheric effect.
16. To study the effect of various salt concentrations on bacterial fungal growth.
17. To study the effect of osmotic pressure on bacterial fungal growth.
18. To determine the microbial biomass from different natural habitats.
19. To learn pure culture techniques used for isolation and purification of microorganisms.
    a. Streak plate method.
    b. Pour plate method.
    c. Spread plate method
20. Identification of human blood groups.
21. Estimation of blood haemoglobin.
22. Perform Total Leukocyte Count of the given blood sample.
23. Perform Differential Leukocyte Count of the given blood sample
24. Separate serum from the blood sample.
25. Practicals based on Elective.

SEMESTER-IV
MIC-401 Food and Dairy Microbiology

Min. pass marks: 28 **Duration: 3 hour** **Max. Marks: 70**

UNIT I

Starter cultures and their biochemical activities; production of Industrial alcoholic & alcoholic beverages: Bear, Wine & Whisky; Production of Single cell protein and Baker's yeast; Mushroom cultivation, Food and dairy products: Cheese, bread, Keffir, Acidophilous, milk, Kumiss and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages, Fermented food-Idli, Dosa.

UNIT II

Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs, enzyme biotransformations, Role of Plant tissue culture for improvement of food additives; color and flavor, Genetic modifications of microorganisms; detection and rapid diagnosis. Genetically modified foods and crop.

UNIT III

Food borne infections and intoxications; with examples of infective and toxic types-Clostridium, Salmonella, Staphylococcus Mycotoxins in food with reference to Aspergillus species. Food hygiene and control. Microbial contamination and spoilage of food.

UNIT IV

Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation. Chemical and naturally occurring antimicrobials. Use of biosensors in food industry.

UNIT V

Food control agencies and their regulations. Quality assurance: Microbiological quality standards of food Intellectual property rights and animal welfare, Government regulatory practices and policies. FDA, EPA, HACCP, ISI Risk analysis; consumer and industry perceptions.

Suggested Readings:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

SEMESTER-IV

MIC 402 – Environmental Microbiology

Min. Pass Marks: 28 Duration: 3 Hours Max. Marks: 70

UNIT- I

Introduction of environmental microbiology.Applications of microbes in solving environmental pollution problems. Microbes as pollutants and pollution indicators.

Aerobiology: Microbiology of air, droplet nuclei, aerosol, Assessment of air quality. Brief account of transmission of air borne microbes(viruses, bacteria and fungi). Microbiology of indoor and outdoor environments,

.

UNIT II

Water microbiology- Fresh and marine water microflora, water blooms and eutrophication and biomagnifications. Self purification of water bodies, oxidation ditches. ASP, Tricking filters.. Anaerobic fermenter. Removal of phosphorus and nitrogen. Disinfection of potable water supplies and hospital waste;Bacterial indicators of water safety. Biofilms and their importance.

UNIT III

Biodeterioration: biodeterioration of buildings and monuments of cultural heritage, microbial deterioration of paper, textile , leather, rubber, glass, paints and metals: Principles methods for their protection.

Biodegradation of recalcitrants and xenobiotics : Synthetic polymers, pesticides and hydrocarbons.

UNIT IV

Biomonitoring: Objectives of biomonitoring. Parameters for biomonitoring. Microorganisms as bioindicators and applications of bioindicators. Role of Dianococcus radiodurans in disposal of radioactive waste material and its future in environmental biotechnology.

UNIT V

Techniques in environment microbiology : Methods for determination of numbers,biomass and activities of microbes in soil,water,plant surface and dead organic materials.Bioremediation techniques : *In situ* (Bioventing,air sparging,liquid delivery system,anerobic bioremediation and phytoremediation) and *ex-situ* (Land farming, composting,biopiling & slurry-phase)

Recommended Books:

1. Alexander ,M. 1997. Introduction to soil Microbiology. John Wiley and sons Inc., New York.
2. Environmental microbiology: principles and applications by Patrick K. Jjemba.Science publisher,2004.
3. Environmental microbiology by P. D. Sharma, Alpha Sciences international, 2005.
4. Environmental microbiology, second edition, by Ralph, Ji Doug Gu, wiley.

5. Environmental microbiology by Ian Papper and Charles Gerba, Elsevir Press.
6. Environmental microbiology by Rose Environmental microbiology Vol III-IV, 1999
7. Practical microbiology, third edition , by Dubey , D K. Maheswari, S. Chand publishers, 2012
8. Advances in applied Bioremediation, Springer.
9. Atlas R M and Bartha, 1993. Microbial Ecology, Bejaminn Cummings Publishing Co.Redwood City CA

MIC 403 – Soil & Agriculture Microbiology

Min. Pass Marks: 28 **Duration: 3 Hours** **Max. Marks: 70**

UNIT I

Soils : origin and evolution, soil profiles. Major physicochemical and biological characteristics, phases of soil. Microorganisms in various soil types. Role of microorganisms Rhizosphere and phyllosphere,lithification.
Decomposition of plant litter. Microbes involved. Composts. Silage, Methane, Biogas plants, Industrial fermentations of litter. Protein production, liquid fields from plant biomass. Hydrogen generation, pyrolysis and saccharification.
Microbial decomposition of cellulose, hemicellulose, lignin, starch, chitin and keratin.

UNIT II

Carbon cycle: Fixation of organic and inorganic carbon compounds, immobilization, mineralization and primary effect, biological deposition and degradation of carbonates, role of microbes in carbon cycle
Nitrogen cycle: mechanism of biological nitrogen fixation-ammonification-nitrification-denitrification and microorganisms involved in such processes.
Phosphorus cycle: Biological importance and. Interconversion of various forms. PSM, mechanism of solubilization, microbial reduction of oxidised P and oxidation of reduced P.

UNIT IV
Sulphur cycle: biological importance, sulphur oxidizing and reducing bacteria, microbial oxidation and reduction of sulphur, fomation of acid and coal mine drainage. Theory and practice of microbial mining. Desulphurization.

Host parasite relationship and control measures, symptomatology of various diseases.
Viral: TMV ,Yellow Vein Mosaic of Okra.
Bacterial : Citrus canker, crown gall.
Fungal : Green ear, Cotton wilt, Tikka groundnut and Wheat rusts.

UNIT V
Biofertilizers:-Types, production technology, storage and application-PGPR, Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Phosphate solubilising bacteria, carrier based inoculants. Mycorrhiza and its types.
Microbial pesticides organisms and their targets, effect on target pests and production technology.

Recommended Books:

1. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.
2. P.D.Sharma.2006. Plant pathology. Alpha Science International.19.
3. Sharma.P.G. 2006. Plant Pathology. Rastogi Publication.

MIC 404 Dissertation work

Max. Marks: 100

- The candidate is required to show article to faculty in/before interpreting his/her experimental work
- Three computerized bound copies of the Dissertation shall be submitted to the college during the final M.Sc. practical examination.

MIC 411-Microbiology Laboratory-IV

1. To study the micro-flora of air (indoor and outdoor).
2. Isolation of phosphate solubilizing micro- organism from soil and water.
3. Demonstration of biological treatment.
4. Determination of dissolved oxygen of water.
5. Determination of BOD of water (raw/ treated).
6. Determination of COD of water (raw/ treated).
7. Determination of alkalinity
8. Determination of chlorine in water.
9. Demonstration of VAM.
10. Production of Biofertilizers: Rhizobium / Azotobacter sp.
11. Analysis of soil: Texture, pH, moisture content, water holding capacity, percolation and capillary action.
12. Isolation and study of microbes (bacteria and fungi) from Rhizosphere and Rhizoplane.
13. Isolation of Rhizobium from root modules of legumes (Trigonella / Cicer / Soybean)
14. Isolation of free nitrogen fixers ((Azotobactor, Azospirillum) from soil
15. MBRT of milk samples and their standard plate count.
16. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
17. Isolation and detection of food borne bacteria (*Staphylococcus* or *Salmonella*) from different food samples.
18. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
19. Isolation of spoilage microorganisms from dairy products
20. Isolation of spoilage microorganisms from food products.
21. Preparation of Yogurt/Dahi.
22. Isolation of Lactic acid bacteria from milk products.