Shri Acharyaratna Deshbhooshan Shikshan Prasarak Mandal, Kolhapur

Mahavir Mahavidyalaya, Kolhapur (Autonomous)

Affiliated to Shivaji University, Kolhapur

Syllabus for Choice Based Credit System (CBCS)
Bachelor of Science (B. Sc.) Programme

Part	III	Course	Microbiology

Under the Faculty of Science &Technology

(To be introduced from Academic Year 2023 – 24 onwards)
Subject to the revisions& modifications made from time to time

Mahavir Mahavidyalaya, Kolhapur (Autonomous)

Affiliated to Shivaji University, Kolhapur

(New syllabus under Autonomy to be introduced from June, 2023 onwards)

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**V**
Course	**Microbiology**	Course Code	**DSC**
Paper No.	**IX**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3 / Week**
Course Title	**Virology**		

Course Objectives:	
i)	To Understand the basic structure of Viruses.
ii)	To Understand Isolation, cultivation and purification of viruses
iii)	To Understand reproduction of viruses
iv)	To Understand basic concept of oncogenesis.

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I : **1) The Structural properties of viruses**: Capsids, Nucleic acids and envelope. Structure of T4 bacteriophage, TMV and HIV, Viroids and prions. **2) Reproduction of Bacteriophages** : a) One step growth experiment. b) Reproduction of T4 phage. **3) Isolation, cultivation and Purification of viruses** a) Isolation and cultivation of viruses: i) Animal virus - Tissue culture, chick embryo and live animals ii) Plant virus – Whole plant, Protoplasts, Insect cell culture iii) Bacteriophages - Plaque method b) Purification of viruses based on physico-chemical properties: i) Density gradient centrifugation ii) Precipitation **4) Methods of Enumeration of viruses** i) Latex droplet method (Direct electron microscopic count) ii) Plaque and pock assay method	01	23

Module II :		
1) Lysogeny a) Introduction i)Definition of lysogeny ii)Temperate phages b) Lysogeny by lambda phage i)Adsorption and penetration of λ phage ii)Circularization of lambda genome iii)Genetic map for lysogenic interaction iv)Expression of λ genes v)Establishment of repression vi)Maintenance of repression vii)Integration of λ genome into host genome **2) Reproduction of animal virus** - Adenovirus. **3) Reproduction of plant virus** – TMV **4) Oncogenesis**: a) Definition of oncogenesis b) Types of cancers c) Characteristics of cancer cells. d) Hypothesis about cancer. i) Somatic mutation hypothesis ii) Defective immunity hypothesis iii) Viral gene hypothesis e)Role of DNA viruses in cancer with special emphasis on Papova viruses. f) Role of RNA tumor viruses g) Provirus theory h) Protovirus theory i) Oncogene theory	01	22

Course Outcomes:
On complication of course , student will be able to :
1] Know the basic structure of viruses
2] Understand isolation, cultivation and purification of viruses
3] Know the Reproduction of viruses
4] Understand the types of cancer

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**V**
Course	**Microbiology**	Course Code	**DSC I2**
Paper No.	**X**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/Week**
Course Title	**Immunology**		

Course Objectives:	
i)	To understand cells of immune system
ii)	To understand compliment fixation
iii)	To study monoclonal antibodies production
iv)	To study concept of cytokines and Hypersensitivity

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I :	01	22
A) Cells and organs of the immune system: **I) Cells of the immune system** i. Hematopoiesis- Characteristics and Types of stem cells ii. Classification of cells of immune system-Lymphoid and myeloid cells iii. Structure and functions of Lymphoid cells- T cells and T cell subsets, NK cells, B cells and dendritic cells iv. Structure and functions of myeloid cells – Granulocytes, Monocytes and macrophages **II) Organs of the immune system** Primary and secondary lymphoid organs - Structure and functions of Thymus, bone marrow, spleen , lymph node and Mucosa associated lymphoid tissue(MALT) B) Molecular mechanism of antibody production: i. Processing and presentation of antigen by Antigen presenting cell. ii. Interaction of APC with TH cell iii. Interaction of B cell and TH cell iv. Proliferation and differentiation of activated B cells v. Role of follicular dendritic cells in selection of high affinity B cells vi. Role of cytokines in proliferation and differentiation **C) Complement:** i. Nature, Properties, Complement activation by classical and		

alternate pathway. ii. Biological consequences of complement activation **D) Monoclonal antibodies:** i. Concepts of Polyclonal and monoclonal antibodies ii. Production of mouse monoclonal antibodies by hybridoma technology. iii. Types of monoclonal antibodies- Mouse, Chimeric, Humanized and Human antibodies iv. Applications of monoclonal antibodies.		
Module II :	01	23
A) Cytokines: i. General characters of cytokines ii. Cytokines produced by different TH cells and Macrophages. iii. Effects of cytokines iv. Interferon–properties- types, inducers of Interferon, Mechanism of action- antiviral and immunoregulatory **B) Hypersensitivity:** i. Basic concept ,Gell and Coombs classification ii. Type I-Anaphylaxis iii. Type II-Blood transfusion reactions iv. Type III-Serum sickness. v. Type IV- Delayed type hypersensitivity –Allergy of infection, Allograft rejection. C) Immunological tolerance and Autoimmunity: i. Immunological tolerance a) Natural or self tolerance and induced tolerance b) Cellular mechanism of immunological tolerance- Central tolerance and peripheral tolerance c) Termination of tolerance ii. Autoimmunity : a) Concept b) Autoimmune diseases: Types, Immunopathological mechanisms-Rheumatoid arthritis, Treatment of autoimmune diseases		

Course Outcomes:
On complication of course , student will be able to :
1] know the cells of immune system
2] understand compliment fixation
3] know the monoclonal antibodies production
4] know the concept of cytokines and Hypersensitivity

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**V**
Course	**Microbiology**	Course Code	**DSC I3**
Paper No.	**XI**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/Week**
Course Title	**Food and Industrial Microbiology**		

Course Objectives:	
i)	To Understand food spoilage
ii)	To Understand food poisoning
iii)	To Understand basic concept of probiotic and application
iv)	To study fermentation process and production

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I: 1) Food Microbiology a) Food as a substrate for microorganisms: Intrinsic and extrinsic factors b) Sources of microorganisms to food c) Food spoilage: spoilage wine and beer, spoilage of vinegar d) General Principles and methods of food preservation e) Determination of: TDP, TDT, D, F, and Z values f) Food poisoning: a. Role of microorganisms in food poisoning b. Food poisoning: i) Staphylococcal ii) Fungal (aflatoxin) g) Food infections: food infection: Salmonellosis. h) Probiotics: Concept and applications 2) Industrial Microbiology A) Strain Improvement B) Scale up of fermentations C) Microbiological assays	01	22

Module II:		
1) Industrial Microbiology A. Preservation of industrially important microorganisms: Methods & Culture collection centers. B. Industrial production of: a. Alcohol: - Organisms used, Inoculum preparation, Fermentation media, Fermentation conditions, Extraction and Recovery. b. Grape wine: - Definition, types, production of table wine (Red and White) and microbial defects of wine c. Penicillin: - Organisms used Inoculum preparation, Fermentation media, Fermentation conditions, Extraction and Recovery. Concept of semi synthetic penicillin C. Downstream processing & product recovery : Centrifugation, flocculation, filtration, solvent extraction, distillation, precipitation, Crystallization and chromatography. D. Testing of sterility, pyrogen, carcinogenicity, toxicity and allergens	01	23

Course Outcomes:
On complication of course , student will be able to :
1] Know the details of food spoilage
2] Understand role of microorganism in food poisoning
3] know the application of Probiotic
4]Understand the microbial production of fermented product

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**V**
Course	**Microbiology**	Course Code	**DSC I4**
Paper No.	**XII**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/ Week**
Course Title	**Agricultural Microbiology**		

Course Objectives:	
i)	To Understand characteristics of soil and role of microorganism
ii)	To Understand microbial interaction in soil
iii)	To study Biofertilizer production
iv)	To study various plant disease

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I: 1) Soil Microbiology a. Physical characters. b. Chemical characters. c. Types of microorganisms in soil and their role in soil fertility. d. Microbiological interactions - Symbiosis, Commensalism, Amensalism, Parasitism, and Predation. 2) Role of microorganisms in elemental cycles a. Carbon cycle. b. Nitrogen cycle c. Phosphorous cycle 3) Role of Microorganisms in reclamation of soil. I) Manure and Compost Methods of Production: a) Green manure and farm yard manure b) City compost- Windrow and pit method. c) Vermicompost II) Optimal conditions for composting with reference to - Composition of organic waste, Availability of microorganisms, Aeration, C:N:P ratio, Moisture content, Temperature, pH and Time. III) Standards of City Compost and Vermicompost as per Fertilizer Control Order.	01	22

Module II:		
1) Types, production, methods of application and uses of : A) Biofertilizers i) Nitrogen fixing - Azotobacter, Rhizobium, and Azospirillum. ii) Phosphate Solubilizing Microorganisms. B) Biopesticides a) Bacillus thuringiensis b) Tricoderma spp. c) Beauveria bassiana 2) Biodegradation of : a) Cellulose b) Pesticides 3) Plant Pathology: a) Common symptoms produced by plant pathogens b) Modes of transmission of plant diseases. c) Plant diseases : i) Citrus Canker ii) Tikka disease of groundnut iii) Bacterial Blight of Pomegranate.	01	23

Course Outcomes:
On complication of course , student will be able to :
1] To know the physical, chemical characteristics of soil microbiology
2] To understand plant microbial interaction
3] To know the types , production , techniques of Biofertilizer
4] To understand Types , symptom and mode of transmission of plant diseases

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**VI**
Course	**Microbiology**	Course Code	**DSC I4**
Paper No.	**XIII**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/ Week**
Course Title	**Microbial Genetics**		

Course Objectives:	
i)	To understand chromosomal structure of *E.coil*
ii)	To Understand Mutation
iii)	To Study molecular techniques and applications
iv)	To understand Genetic engineering

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I: 1) Basic concepts of bacterial genome - a) Structural organization of E. coli chromosome - Folded Fiber model. b) One cistron - one polypeptide hypothesis. 2) Molecular mechanism of gene expression a) Concept of operon b) Pribnow box c) Genetic regulation in tryptophan operon 3) Mutations a) Expression of mutations - i) Time course of phenotypic expression. ii) Conditional expression of mutation. b) Suppressor mutations (with examples) - Genetic and non-genetic. 4) Methods of isolation and detection of mutants based on - a) Relative survival b) Relative growth c) Visual detection	01	22

Module II:		
1) Genetic complementation - Cis-trans test 2) Extrachromosomal inheritance : a) Kappa particles. b) Transposable elements - general properties and types. 3) Techniques in Molecular Biology – a) DNA sequencing (Sanger's method) b) DNA Finger printing c) PCR 4) Genetic engineering a) Introduction b) Tools of genetic engineering – i) Enzymes ii) Vectors-phage, plasmid and cosmid iii) DNA probe iv) Linkers and adaptors v) Cloning organisms - (Bacteria and Yeasts) vi) Genomic library and cDNA library c) Techniques – i) Isolation of desired DNA segment- Shotgun Method, cDNA synthesis, Chemical synthesis ii) Construction of r-DNA using appropriate vector- Use of restriction enzymes, Linkers, Adaptors, Homopolymer tails iii) Transfer to cloning organisms (Bacteria and Yeasts) iv) Selection of recombinant bacteria and yeasts – Blue and white screening, Colony hybridization technique. d) Application of genetic engineering in – i) Medicineii) Agriculture iii) Industry iv) Environment	01	23

Course Outcomes:
On complication of course , student will be able to :
1] To know the chromosomal structure of *E.coil*
2] Understand types of mutation and methods to isolates mutants
3] Understand principle working and application of molecular biology techniques
4] To know the tools and techniques used in Genetic engineering

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**VI**
Course	**Microbiology**	Course Code	**DSC I4**
Paper No.	**XIV**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/ Week**
Course Title	**Microbial Biochemistry**		

Course Objectives:	
i)	To study the basic concept of Enzymes and its Kinetics
ii)	To Study regulation of enzyme synthesis
iii)	To study Biosynthesis of DNA, RNA, protein and peptidoglycan
iv)	To study Carbohydrates metabolism

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I: 1) Enzymes - A) Definition, properties, structure, specificity, mechanism of action (Lock & Key, Induced fit hypothesis), Basics of enzyme classification. B) Allosteric enzymes - Definition, properties, models explaining mechanism of action (Concerted and sequential models). Patterns of feed back inhibition. 2) Extraction and purification of enzymes. A) Methods of extraction of intracellular and extracellular enzymes. i) Choice of source and biomass development B) Methods of homogenization - cell disruption methods C) Purification of enzymes on the basis of - a) Molecular size, b) Solubility differences c)Electrical charge, d) Adsorption characteristic differences e) Differences in biological activity 2) Assay of enzymes - Based on substrate and product estimation. 3) Ribozymes and Isozymes. 4) Immobilization of enzymes - Methods and applications	01	22

Module II:		
1) Factors affecting enzyme activity a) Factors affecting catalytic efficiency of enzymes- i) Proximity and orientation, ii) Strain and distortion, iii) Acid base catalysis, iv) Covalent catalysis b) Environmental factors influencing enzyme activity- i)Substrate concentration, ii) Temperature, iii) pH, iv) Metal ions 2) Kinetics of single substrate-enzyme catalyzed reactions - Derivation of Michaelis-Menten equation, Lineweaver Burk Plot, Significance of Km and Vmax. 3) Microbial Metabolism I) Basics in carbohydrate metabolism a) PP pathway, ED pathway, Phosphoketolase pathway b) Pyruvate as a key intermediate c) Glyoxylate bypass II) Assimilation of - a) Carbon b) Nitrogen with respect to N2 and NH3 (GOGAT) c) Sulphur 4) Biosynthesis of - a) RNA, b) DNA, c) Proteins, d) Peptidoglycan 5) Regulation of enzyme synthesis. i) Positive control - Ara operon, ii) Negative control - Lac operon iii) Catabolite repression	01	23

Course Outcomes:
On complication of course , student will be able to :
1] To know the concept of enzymes
2] To understand Regulation of enzyme synthesis
3] The course cover the basics DNA, RNA , protein and peptidoglycan biosynthesis
4] To understand basic carbohydrates metabolism

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**VI**
Course	**Microbiology**	Course Code	**DSC I4**
Paper No.	**XV**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/Week**
Course Title	**Environmental Microbiology**		

Course Objectives:	
i)	To study general characteristics of liquids ,solid waste as per MPCB
ii)	To study sewage microbiology and characteristics
iii)	To study basic purpose of environment monitoring along with biological safety measures
iv)	To understand environment impact assessment ,bioremediation and bioleaching

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I:	01	22
1) General characteristics of waste) Liquid waste - pH, electrical conductivity, COD, BOD, total solids, total dissolved solids, total suspended solids, total volatile solids, chlorides, sulphates, oil & grease. b) Solid waste- pH, electrical conductivity, total volatile solids, ash. c) Standards as per MPCB. 2) Sewage Microbiology a) Physico-chemical and Biological characteristics b) Treatment i)Biological treatment: Trickling filter, Activated sludge process, Oxidation ponds, Anaerobic digestion, Septic tank, Root zone technology ii) Chemical treatment – Chlorination 3) Characteristics and treatment of waste generated by a) Sugar Industry b) Distillery c) Dairy Industry d) Hospital 4) Eutrophication a) Classification of lakes b) Sources		

c) Consequences d) Control		
Module II:		
1) Biological safety in laboratory a) Good Laboratory Practices b) Bio safety levels (BSL) 2) Environmental monitoring a) Definition and purpose b) Cleanroom classification c) Routine Environmental monitoring programme in pharmaceutical industries- Airmonitoring, Surface monitoring and Personnel monitoring. d) Bioburden test 5) Environmental Impact Assessment- Concept and Brief introduction 4) Bioremediation and Bioleaching a) Bioremediation i) Definition ii) Types iii) Applications. b) Bioleaching i) Introduction ii) Microorganisms involved iii) Chemistry of Microbial leaching iv) Laboratory scale and pilot scale leaching v) In situ leaching - Slope, heap vi) Leaching of Copper and Uranium	01	23

Course Outcomes:
On complication of course , student will be able to :
1] To know the concept characteristics of liquids ,solid waste as per MPCB
2]This point cover sewage microbiology and characteristics
3] To understand environment monitoring along with biological safety measures
4] To understand concept importance and application of environment impact assessment

Primary Information:			
Programme	**Bachelor of Science (B. Sc.) CBCS**		
Part	**III**	Semester	**VI**
Course	**Microbiology**	Course Code	**DSC I4**
Paper No.	**XVI**	Course Type	**Semester**
Total Marks	**50 Marks**	Implementation	**2023 – 24**
Total Credits	**02**	Contact Hours	**3/ Week**
Course Title	**Medical Microbiology**		

Course Objectives:	
i)	To understand various bacterial disease
ii)	To study viral ,fungal and protozoa diseases
iii)	To understand general principle of chemotherapy
iv)	To understand mode of action of antimicrobial agents

Course Syllabus
(CR = Credits / IH: Instructional Hours)

Modules	**CR**	**IH**
Module I:	01	23
BACTERIAL DISEASES Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by i)*Mycobacterium tuberculosis* ii)*Clostridium perfringens* iii)*Treponema pallidum* iv)*Pseudomonas aeruginosa* v)*Vibrio cholera* vi)*Staphylococcus aureus* vii)*Leptospira interrogans* viii)*Klebsiella pneumonia*		
Module II:	01	22
A. Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission and pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by 1) Protozoa : Plasmodium falciparum (malaria) 2) Viruses : i) Hepatitis A & B virus ii) Rabies virus iii)Dengue virus 3) Fungus: *Candida albicans*		

B. Chemotherapy 1) Chemoprophylaxis 2) General principles of chemotherapy 3) Mode of action of antimicrobial agents: a) Antibacterial drugs: Penicillin, Bacitracin, Piperacillin, cycloserine, Streptomycin, Tetracycline, Trimethoprim, Sulphonamides and Quinolones. b) Antiviral drug :AZT, c) Antifungal drugs: Ketoconazole, Griseofulvin, Nystatin d) Antiprotozoal drugs: Metranidazole, Mepacrine 4)Drug resistance: Reasons and Mechanism of drug resistance 5) Immunoprophylaxis: Vaccines and Immune Sera a) Vaccines-live attenuated, inactive, subunit, conjugate and DNA vaccines b) Immune Sera- examples with applications		

Course Outcomes:
On complication of course , student will be able to :
1] know the pathogenesis symptoms and treatment of various disease
2] Understand viral ,fungal and protozoa diseases
3] know the general principle of chemotherapy
4] Understand mode of action of antimicrobial agents

Practical Course

Course Objectives:

- To understand various techniques and practical procedures followed in virology and genetics
- To understand microbial bioassay.
- To understand estimation of carbon, Magnesium, calcium from soil sample.
- To understand the isolation of pathogen and their biochemical tests.

Course Syllabus

(CR = Credits / IH: Instructional Hours)

Modules	CR	IH
Practical - I (Virology and Microbial Genetics) **Major :** 1. Isolation of coliphages from sewage. 2. Effect of U.V. light on bacteria and graphical presentation of result. 3. Isolation of auxotrophic mutants by replica plate technique 4. Transfer of genetic material by transformation in E.coli 5. Isolation of chromosomal DNA from bacteria (J. Marmurs method or by Phenol chloroform method) **Minor :** 1. Electrophoretic separation of DNA. 2. Isolation of streptomycin - resistant mutants (gradient plate technique) 3. Testing of carcinogenicity of a substance by Ame's test **Practical - II (Food and Industrial Microbiology)** **Major :** 1. Assay of amylase by DNSA method (graphical estimation) 2. Bio-assay of Vitamin B12 3. Bio-assay of Penicillin. **Minor:** 1. Production of wine and examination for pH, colour and alcohol content. 2. Citric acid fermentation, recovery and estimation by titration. 3. Amylase production by using Bacillus species. 4. Isolation of lactic acid bacteria from fermented food. 5. Examination of milk by Direct microscopic count (DMC)		

Practical - III (Agricultural and Environmental Microbiology)

Major :

1. Isolation of *Azotobacter* from soil.
2. Isolation of *Xanthomonas* from infected citrus fruit.
3. Isolation of *Rhizobium* from root nodules.
4. Isolation of phosphate solublising bacteria from soil.
5. Determination of BOD of sewage

Minor :

1. Estimation of Calcium and Magnesium from soil (EDTA method)
2. Determination of organic carbon content of soil (Walkley and Black method)
3. Determination of COD of sewage.

Practical - IV Medical Microbiology

Major :

1. Isolation of following pathogens from clinical samples (wherever possible) and identification of the same by morphological, cultural and biochemical characteristics.

a) *Pseudomonas aeruginosa*
b) *Staphylococcus aureus*
c)*Candida albicans*

2. Determination of MIC of streptomycin against E.coli by broth method

Minor :

1. Determination of sensitivity of common pathogens to antibiotics by paper disc method.
2. Serological tests:

a) Widal test -Quantitative
b) Rapid Diagnostic Test for Malaria
c)DemonstrationofEnzymeLinkedImmunosorbentAssay(ELISA)

3. Haematology:

a) Estimation of haemoglobin by Sahli's method
b) Determination of ESR of the blood sample(Wintrobe method)
c) Determination of PCV
d) Total and differential blood cells count.

4. Urine analysis: Physical and chemical examination of urine.

a) Microscopic examination of urine-crystals, RBCs, pus cells and bacteria.

b) Test for protein (Acetic acid test) c) Test for ketone bodies (Rothra'stest) d) Test for bile salt and bile pigments. e) Test for sugar (Benedict's method)		

Course Outcomes:
On complication of course , student will be able to :
Know the isolation of colipahge and DNA from bacteria
Understand the bioassay
Know the isolation of bio fertilizer
Understand the estimation of Carbon , Calcium , Magnesium
Know the pathogens and their cultural and biochemical characteristics

Reference Materials -	
Books for Reference	
1.	Practical Biochemistry - Plummer
2.	Soil, Plant, and Water Analysis – P. C. Jaiswal
3.	Medical Lab Technology – Ramnik and Sood
4.	Biochemical methods – S. Sadasivam, A. Manickam
5.	Chemical and biological analysis of water - Dr. R. K. Trivedy and P. K. Goel

Suggested methods of Teaching:	
i)	Offline Traditional Board Teaching
ii)	Power Point Presentation
iii)	Online Teaching on platform of Zoom or Google Meet

Scheme of Course Evaluation		
1.	End Semester Examination (ESE)	40
2.	Continuous Internal Evaluation (CIE)	10
3.	**Total Marks**	**50**

Suggested techniques for Continuous Internal Evaluation (10 Marks)	
1.	Seminar
2.	Field Report
3.	Assignments
4.	Open book test
5.	Offline / online MCQ test
6.	Diagram test
7.	Visit/Tour report
8.	Surprise test

Question Paper Pattern (40 Marks) Theory Exam		
Q. No.	**Nature / Type of Question**	**Marks**
1.	Multiple Choice Questions (MCQ) 6 Questions	**6 Marks** (1 Marks for each question)
2.	Write answers in short 5 Questions	**10Marks** (2 Marks for each question)
3.	Write Short Notes Attempt any 3 out of 5 questions	**12Marks** (4 Marks for each question)
4.	Write descriptive question Attempt any 1 out of 2 questions	**6 Marks**
5.	Write descriptive question Attempt any 1 out of 2 questions	**6 Marks**
6.	**Total Marks**	**40**

Practical Examination

(A) The practical examination will be conducted on two consecutive days for three hours per day per batch of the practical examination.

(B) Each candidate must produce a certificate from the Head of the Department in her/his college, stating that he/she has completed in a satisfactory manner the practical course on lines laid down from time to time by Academic Council on the recommendations of Board of Studies and that the journal has been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and have written a report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of the year. Candidates must produce their journals at the time of practical examinations.

Nature of Question paper and distribution of marks for B. Sc III Microbiology Practical Examination-

Practical I, II, III & IV

Q.1 Major Experiment	20 Marks
Q.2 Minor Experiment	15 Marks
Q.3 Journal	05 Marks
Spotting	10 Marks
Viva-voce	10 Marks
Tour report	20 Marks