"Dissemination of Education for Knowledge, Science and Culture"

-Shikshanmaharshi Dr. Bapuji Salunkhe.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(An Empowered Autonomous Institute)

DEPARTMENT OF MICROBIOLOGY

B. Sc. Part-III

Semester - V & VI

NEP Phase I

SYLLABUS

B.Sc.–III (Sem -V and VI) Microbiology

To be implemented from Academic Year 2025-2026

Programme Specific Outcome

Upon completion of B.Sc. Microbiology programme, student will be able to –

PSO1: Perform the basic techniques related to screening, isolation and cultivation of microorganism from various sources

PSO2: Understand microorganisms and their relationship with the environment

PSO3: Conduct the basic research with this microorganism and perform the diagnosticprocedures required in food, milk and pharmaceutical industries**.**

PSO4: Follow the aseptic techniques and conduct the process of sterilization as well as perform the techniques to control the microorganism

PSO5: Produce and analyze the microbial product at laboratory level.

STRUCTURE OF COURSE

UG degree in Major and Minor

(B.Sc.- III Semester- V & VI)

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR	Marks	
Semester-V										
1	DSC-IX	DSC03MIC51	Immunology	2	-	40	10	-	50	2
2	DSC-X	DSC03 MIC 52	Virology	2	-	40	10	-	50	2
3	DSC-XI	DSC03 MIC 53	Agricultural Microbiology	2	-	40	10	-	50	2
4	DSE – I	DSE03 MIC 51	Food and Industrial Microbiology	2	-	40	10	-	50	2
		DSE03 MIC 52	Fermentation Technology-I							
5	VSC-PR-IV	VSC03MIC59	Soil Microbiology		4	-	-	25	25	2
6	FP	FPR03MIC51	Field Project	2		-	-	50	50	2
7	DSC-PR-V	DSC03MIC59	DSC Microbiology Lab-5	-	12	-	-	75	75	6
8	MIN- IX	MIN03 MIC 51	Agricultural Microbiology	2		40	10	-	50	2
9	MIN-PR-V	MIN03 MIC 59	MIN-Microbiology Lab-5	-	4	-	-	25	25	2
Semester –V Total				**12**	**20**	**200**	**50**	**175**	**425**	**22**
Semester-VI										
1	DSC-XII	DSC03 MIC 61	Microbial Genetics – II	2	-	40	10	-	50	2
2	DSC-XIII	DSC03 MIC 62	Microbial Biochemistry	2	-	40	10	-	50	2
3	DSC-XIV	DSC03 MIC 63	Medical Microbiology – II	2	-	40	10	-	50	2
4	DSE-II	DSE03 MIC 61	Environmental Microbiology	2	-	40	10	-	50	2
		DSE03 MIC 62	Fermentation Technology-II							
5	VSC-PR-V	VSC03MIC69	Waste Water Management		4	-	-	25	25	2
6	OJT	OJT03 MIC 61	On Job Training	2	-	-	-	50	50	2
7	DSC-PR-VI	DSC03 MIC 69	DSC Microbiology Lab-6		12			75	75	6
8	MIN- X	MIN03 MIC 61	Environmental &Industrial Microbiology	2	-	40	10		50	2
9	MIN- PR-VI	MIN03 MIC 69	MIN-Microbiology Lab-6	-	4	-	-	25	25	2
Semester –VI Total				**12**	**20**	**200**	**50**	**175**	**425**	**22**

Abbreviations: TH-Theory, PR-Practical, PRO- Project, ESE- End Semester Examination, CIE-Continuous Internal Examination

Note: Minimum passing for 10 marks Internal evaluation = 04 marks
Minimum passing for 40 marks Theory paper = 16 marks
Minimum passing for 25 marks Practical = 10 marks
Minimum passing for 50 marks Practical /FP/OJT = 20 marks
Minimum passing for 100 marks Practical/FP = 40 marks
Passing percentage for Democracy, Election and Good Governance (DEGG) and Environmental Studies papers should be 40%

Separate passing for each Head - ESE, CIE and Practicals

SEMESTER –V

DSC-IX DSC03MIC51	IMMUNOLOGY Theory: 30 Hours (Credits -2)	No. of Hours per unit
Expected course outcome - **Upon successful completion of course, students are expected to be able to –** **CO1: Understand the overall organization of the Immune system.** **CO2: Explain the salient features of antigen antibody reaction and its use in diagnostics .** **CO3: Compare and contrast humoral versus adaptive immune system.** **CO4: Provide an overview of the interaction between the immune system and pathogen.**		
UNIT-I	1.Cells of Immune system – a. Hematapoiesis- characteristics & types of stem cells. b. Classification of cells of immune system – lymphoid & myeloid cells. c. Structure & function of lymphoid cells – T cell & T cell subsets, NK cells, B cells & dendritic cells. d. Structure & function of myeloid cells- Granulocytes, monocytes & macrophages. 2. Membrane receptors for antigen and their role in antigenrecognition a.Bcellsurfacereceptorforantigen(BCR) b.Tcellsurfacereceptorforantigen(TCR) c. NKreceptors 3. Molecular mechanism of antibodyproduction. a.Processingandpresentationofantigenby AntigenPresentingCell . b.Interaction of APC with T_H cell c.Interaction of B cell and T_H Cell d.Clonalproliferation and differentiation of activated B cell. e.Role of follicular dendritic cells in selection of high affinity B cell. f.Role of cytokines in proliferation and differentiation.	**8**
UNIT-II	1. Cytokines - a. Properties, types and function of cytokines	**7**

	produced by TH cell and Macrophages 2. Interferon - a. Natureandtypesof Interferons b. InductionofInterferon c .Mechanismofaction. 3. Immunologicaltolerance: a. Toleranceinductioninadultsandneonatesbydrugandmonoclonalantibody b. Cellularmechanismofimmunologicaltolerance. c. Terminationoftolerance.	
UNIT-III	1. Complement – a.Natureand Propertiesof complement b.Complementactivation by classical and alternate pathway. c. Biologicalconsequencesofcomplementactivation. 2.Monoclonal antibodies- a. Basicconcepts-Mouse,HumanandHumanizedantibodies. b.Productionofmonoclonalantibodiesbyhybridomatechnology. c. Production of Humanized Monoclonal antibodies by recombinantDNA technology. d. Applicationsofmonoclonalantibodiesindiagnosis,treatmentandresearch.	**8**
UNIT-IV	1. New diagnostic techniques: a. RIA b. Dot BlotTechnique 2. Hypersensitivity– a..Basicconcept,GellandCoombsclassification b. TypeI-Anaphylaxis c. TypeII-Bloodtransfusionreactions	**7**

	d. TypeIII-Serumsickness e .Type IV- Delayed type hypersensitivity - Allograftrejection. 3. Autoimmunedisease: aTypes ofautoimmunediseases. b Treatmentofautoimmunediseases.	

Books Recommended:

A. For Immunology

1) Kubay, Kindt,Goldsby&Osborne .Immunology-6th edition-
2) EssentialImmunology-11th edition-Delves,Martin,BurtonandRoitt.
3) Immunology-AnIntroduction,4th edition–Tizzard.
4) BasicandClinicalImmunology5th edition-Stites,Stobo,H.H.Fudenberg.
5) EssentialsofImmunology-S.K.Gupta
6) Immunology–M.P.Arora

DSC-X DSC03MIC52	**VIROLOGY** Theory: 30 Hours (Credits -2)	**No. of Hours per unit**
Expected course outcome - **Upon successful completion of course, students will be able to –** **CO1: Describe various stages involved in multiplication cycle of viruses** **CO2: Understand methodological approaches in isolation, cultivation & purification of viruses.** **CO3: Distinguish characteristics of normal cell and cancerous cell.** **CO4: Explain various methods for enumeration of viruses.**		
UNIT – I	**1. The Structural properties of viruses**: a.Capsids, Nucleic acids andenvelope. b. StructureofT4bacteriophage,TMVandHIV,Viroids&prions. c. Onestepgrowthexperiment	**7**
UNIT – II	**1. Isolation, cultivation and Purification ofviruses** a. Isolation and cultivation of viruses- i. Animalvirus-Tissueculture,chickembryoandliveanimals. ii. Plantvirus–Protoplasts culture technique,Insecttissueculture iii. Bacteriophages - Plaque method. b. Purification of viruses using physico-chemicalproperties i.Density gradientcentrifugation ii. Precipitation **2. Methods of Enumeration ofviruses** a. Latexdropletmethod(Directmicroscopiccount) b. Plaqueandpockmethod	**8**
UNIT-III	**1. Lysogeny-** a.Definitionoflysogenyandtemperatephage, b.types of lysogenic phage. c. lysogenybylambda phage - adsorption &penetration genetic map for lysogenic interaction, expression of λ genes, establishment of repression, maintenance of repression, integration of λ genome in hostchromosome. 2. Reproductionofanimalviruses-Adenovirus. 3. Reproductionofplantviruses–TMV 4. ReproductionofT4phage.	**7**
UNIT-IV	**1. Oncogenesis:**	**8**

	a. Definition ofoncogenesis b. Types ofcancer c. Characteristicsofcancercells. d. Tumor suppressor genes and protooncogenes e. Hypothesis aboutcancer. i . Somatic mutationhypothesis ii. Viral genehypothesis • RoleofDNAviruseswithspecialemphasisonPapovaviruses. • Role of RNA tumor viruses Provirus theory, Protovirustheory, Oncogenetheory. iii. Defective immunityhypothesis.	

BooksRecommended:

1.General Microbiology -Stanier

2.Microbiology - Prescott,Klein

3. Microbiology -Davis

4.General Virology –Luria

5.GeneticsofBacteriaandtheirViruses-WilliamHayes.

6.GeneralMicrobiologyVol.II-PowarandDaginawala

7.Virology - Biswas andBiswas

DSC-XI DSC03MIC53	**AGRICULTURALMICROBIOLOGY** Theory: 30 Hours (Credits -2)	**No. of Hours per unit**
Expected course outcome - **Upon successful completion of course, students will be able to –** **CO1: Understand various plant microbe interactions especially rhizosphere and their applications especially the biofertilizers and their production techniques** **CO2: Understand various biogeochemical cycles – C, N, P cycle and microbes involved** **CO3: Perform isolation of agriculturally important microorganisms and formulate biofertilizers.** **CO4: Explain role of microorganisms and common symptoms of plant diseases.**		
UNIT-I	**1. SoilMicrobiology**. a. Physicalcharacters. b. Chemicalcharacters. c. Typesofmicroorganismsinsoilandtheirroleinsoilfertility. d. Microbiologicalinteractions- Symbiosis,Commensalism,Amensalism,Parasitism,Predation. **2. Role of microorganisms inelemental cycle** a.Carboncycle. b.Nitrogencycle c.Phosphorouscycle d.Sulfur cycle	**8**
UNIT-II	**1. Manure andCompost** a. Methods ofProduction of- i. Greenmanureandfarmyardmanure ii. City compost- Windrow and pitmethod. iii Vermicompost b.Optimalconditionsforcompostingwithreferenceto- Compositionoforganic waste, availability of microorganisms, aeration, C: N:P ratio, moisture content, temperature, pH,Time	**7**
UNIT-III	**1. Types, production, methods of application and uses of -** a. Biofertilizers i. Nitrogen fixing - *Azotobacter, Rhizobium, Azospirillum*. ii. Phosphate SolubilizingMicroorganisms.	**8**

	b. Biopesticides *i.Bacillusthuringiensis* *ii. Tricodermaspp.* **2. Biodegradation of -** a. Cellulose b. Pesticides	
UNIT-IV	**1. PlantPathology** a. Commonsymptomsproducedbyplantpathogens b. Modesoftransmissionofplantdiseases. c. Plant diseases- i. CitrusCanker ii. Tikka disease ofgroundnut iii.BacterialBlightofPomegranate. d. Control of plant disease caused by bacteria.	**7**

BooksRecommended

1. Soil Microbiology - An exploratory approach - MarkCoyne.
2. Agricultural Microbiology - N. Mukherjee and J.Ghosh.
3. IntroductiontoSoilMicrobiology-MartinAlexanderIIndEdition.
4. AgriculturalMicrobiology-RangaswamyandBhagyarajIIndEdition
5. Plantdiseases-R.S.Singh.
6. DiseasesofcropplantsinIndia-G.Rangaswamy.
7. SoilsandSoilsFertility-6thedition-FrederickR.Troeh(BlackwellpublishingCo.)
8. SoilMicrobiology-Singh,Purohit,Parihar.(AgrobiosIndia,2010)
9. Soil Microbiology and Biochemistry – Ghulam Hassan Dar (New India Publishing Agency, 2010)

DSE-I DSE03MIC51	FOOD AND INDUSTRIAL MICROBIOLOGY Theory: 30 Hours (Credits -2)	No. of Hours per unit
Expected course outcome - **Upon successful completion of course, students will be able to –** **CO1: Know methods used for industrial production of various products using microorganisms.** **CO2: Explain various techniques for product recovery after fermentation.** **CO3: Understand the cause of spoilage of food and methods for preservation of food.** **CO4: Design the methods for preservationofindustriallyimportantmicroorganisms.**		
UNIT-I	**1. Food Microbiology** a. Foodasasubstrateformicroorganisms. b. Foodborne diseases– i. Roleofmicroorganismsinfoodborne diseases ii. Food poisoning - Staphylococcal Fungal (aflatoxin) iii. Food infections –Salmonellosis. c. Food spoilage and its causes . d. General principles of food preservation .	**7**
UNIT-II	**1. Industrial Microbiology** a. Strain Improvement b. Scale up of fermentations c. Microbiologicalassays **2. Preservationofindustriallyimportantmicroorganisms–** a.Methods of preservation. b.Culturecollectioncenters	**8**
UNIT-III	**1. Industrial production of-** a. Amylase- Organismsused,i noculumpreparation,fermentationmedia,fermentationconditions, extraction andrecovery. b. Grape wine - Definition, types, production of table wine (Red and White), microbial defects ofwine c. Penicillin- Organismsused,i noculumpreparation,fermentationmedia, fermentationconditions,	**7**

	extractionand recovery.Conceptofsemisyntheticpenicillin d. Citric acid - Organismsused,i noculumpreparation,fermentationmedia,fermentationconditions, extraction andrecovery. e. SCP by using yeast . **2. Microbial Production of –** a. Vitamins - Vit. B_{12} b. Amino acids – Lysine 3**. Probiotics**- Concept, Production by using *Lactobacillus* & applications	
UNIT-IV	**1. Downstream processing &product recovery-** a. Centrifugation b. Flocculation c. Filtration d. Solvent extraction e. Distillation f. Precipitation g. Crystallization h. Chromatography. **2. Testing of sterility, pyrogen, carcinogenicity, toxicity and allergens**	**8**

Books Recommended:

A. For Food microbiology and industrial microbiology

1. Principles of fermentation technology- Peter F. Stanbury &Allan Whitaker (PergamonPress).
2. PrinciplesofMicrobialtechnology-Peppler,Vol.I&II.
3. Industrial Microbiology -Casida
4. IndustrialMicrobiology-A.H.Patel
5. IndustrialMicrobiology-Prescott&Dunn
6. Industrial Microbiology -Miller
7. PharmaceuticalMicrobiology-Huggo&Russel

DSE-I DSE03MIC52	**FERMENTATION TECHNOLOGY-I** Theory:30Hours(Credits-2)	**No.of Hours perunit/ credit**
CourseOutcomes-Oncompletionofcourse,studentswillbeableto– **CO1:Knowmethodsusedforindustrialproductionofvariousproductsusing microorganisms.** **CO2: Explain various techniques for product recovery after fermentation.** **CO3: Apply methods used for recovery of fermentation products.** **CO4:Identify the industrially important microorganisms using screening technique.**		
UNIT I	**1. Basic concepts of fermentation**. a. Definition, concept of primary and secondary metabolites b. Types of fermentations – Batch, continuous, dual and multiple. c. Typical Fermenter design – Parts and their functions d. Factors affecting fermentation process. **2. Fermentation Media**. Fermentation media – **i)** Water, carbon source, nitrogen source, precursors, growth factors, antifoam agents, chelating agents. **ii)** Use of wastes as Fermentation media – Molasses, sulphite waste liquor & corn steep liquor**.**	**8**
UNIT–II	**1. Screening:** Primary and secondary screening. **2. Production strains** i) Concept ii) Preparation of inoculum iii) Strain improvement	**7**

UNIT-III	**1. Scale upoffermentations** **2. Microbiologicalassays** **3.** Testingofsterility,pyrogen,carcinogenicity,toxicityandallergens.	**7**
UNIT-IV	**1. Downstreamprocessing&productrecovery-** 1. Centrifugation 2. Flocculation 3. Filtration 4. Solventextraction 5. Distillation 6. Precipitation 7. Crystallization 8. Chromatography.	**8**

Books Recommended:

1. Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2. Ratledge C and Kristiansen B. eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ
3. Old R.W and Primose S.D (1995) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4. Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5. Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.
6. Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology
7. Mukhopadhaya S.N. (2001) Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. N.Delhi.
8. Rehm H.J and Reed G. (1985) Biotechnology vol. I & II. VCH, Basel.
9. Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London.

MIN-I MIN03MIC11	**AGRICULTURALMICROBIOLOGY** Theory: 30 Hours (Credits -2)	**No. of Hours per unit**

Expected course outcome -

Upon **successful completion of course, students will be able to –**

CO1: Understand various plant microbe interactions especially rhizosphere and their applications especially the biofertilizers and their production techniques.

CO2: Understand various biogeochemical cycles – C, N, P cycle and microbes involved

CO3: Perform isolation of agriculturally important microorganisms and formulate biofertilizers.

CO4: Explain role of microorganisms and common symptoms of plant diseases.

UNIT-I	**1. SoilMicrobiology**. a.Physicalcharacters. b.Chemicalcharacters. c.Typesofmicroorganismsinsoilandtheirroleinsoilfertility. d.Microbiologicalinteractions– i.Symbiosis, ii.Commensalism, iiiAmensalism, iv.Parasitism, v.Predation. **2. Role of microorganisms inelemental cycle** a.Carboncycle. b.Nitrogencycle c.Phosphorouscycle d.Sulfur cycle	**8**
UNIT-II	**1. Manure andCompost** a. Methods ofProduction- i. Greenmanureandfarmyardmanure ii. City compost- Windrow and pitmethod. iii Vermicompost b.Optimalconditionsforcompostingwithreferenceto- Compositionoforganic waste, Availability of microorganisms, aeration, C: N:P ratio, Moisture content, Temperature, pH,Time.	**7**

UNIT-III	**1. Types, production, methods of application and uses of -** **a. Biofertilizers** i. Nitrogen fixing - *Azotobacter, Rhizobium, Azospirillum*. ii. Phosphate SolubilizingMicroorganisms. **b. Biopesticides** *i.Bacillusthuringiensis* *ii. Tricodermaspp.* **2. Biodegradation by bacteria & fungi-** a. Cellulose b. Pesticides	**8**
UNIT-IV	**1. PlantPathology** a. Commonsymptomsproducedbyplantpathogens b. Modesoftransmissionofplantdiseases. c. Plant diseases- i. CitrusCanker ii. Tikka disease ofgroundnut iii.BacterialBlightofPomegranate. iv. Control of plant disease caused by bacteria.	**7**

BooksRecommended

6. Soil Microbiology - An exploratory approach - MarkCoyne.
7. Agricultural Microbiology - N. Mukherjee and J.Ghosh.
8. IntroductiontoSoilMicrobiology-MartinAlexanderIIndEdition.
9. AgriculturalMicrobiology-RangaswamyandBhagyarajIIndEdition
10.Plantdiseases-R.S.Singh.
6. DiseasesofcropplantsinIndia-G.Rangaswamy.
7. SoilsandSoilsFertility-6thedition-FrederickR.Troeh(BlackwellpublishingCo.)
8. SoilMicrobiology-Singh,Purohit,Parihar.(AgrobiosIndia,2010)
9. Soil Microbiology and Biochemistry – Ghulam Hassan Dar (New India Publishing Agency, 2010)

PRACTICAL

SEMESTER V

DSC-PR-V DSC03MIC59	DSC Microbiology Lab-V (Credits -4)
PRACTICALS BASED ON IMMUNOLOGY	
	Major: 1. Determination of Antibacterial activity of the serum. 2. Enzyme Linked Immunosorbent Assay (ELISA)- DOT 3. Determination of C- Reactive Protein (CRP) in Blood. 4. Detection of Rheumatoid factor in blood .(Slide agglutination test) **Minor:** 1. Sample handling 2. Determination of Total Blood cell count 3. Determination of Differential blood cell count. 4. Separation of serum and plasma from blood. 5. EstimationofhaemoglobinbySahli'smethod. 6. DeterminationofESRofthebloodsample(Westergrenmethod)
PRACTICALS BASED ON VIROLOGY	
	Major: 1. Isolationofcoliphagesfromsewage. 2. Isolation of high titre of bacteriophage. 3. Enumeration of bacteriophage in a sample by plaque forming unit (PFU) method . 4. Determination of one step growth curve of bacteriophage. 5. Determination of cross infectivity of *E.coli* phage. **Minor:** 1. Demonstration of viruses inoculation by chick embryo technique **2.** Demonstration of PCR

PRACTICALS BASED ON AGRICULTURAL MICROBIOLOGY	
	Major: 1. Isolation of Azotobacter fromsoil. 2. IsolationofXanthomonasfrominfectedcitrusfruit. 3. IsolationofRhizobiumfromrootnodules. 4. Isolationofphosphatesolubilizingbacteriafromsoil. 5. Isolation of Trichoderma from soil . **Minor:** 1. Determination of texture of soil. 2. Determination of color of soil . 3. Determination of pH of soil . 4. EstimationofCalciumfromsoil(EDTAmethod) 5. EstimationofMagnesiumfromsoil(EDTAmethod) 6. Determinationoforganiccarboncontentofsoil(WalkleyandBlackmethod)

DSE-PR-V **DSE03MIC59**	**DSC Microbiology Lab-V.** **PRACTICALS BASED ON FOOD AND INDUSTRIALMICROBIOLOGY** **(Credits -4)**
	Major: 1. Production of wine. 2. Examination of wine for pH, color and alcohol content. 3.Determination of microflora of vegetables and fruits. 4. Isolation and detection of aflatoxins from given food sample. 5. Detection for the presence of yeast and mold from given sample. 6. Sterility testing of pharmaceutical product. 7. Rapid detection of food pathogens (*E.coli*&*Staphylococcus*) from given food sample **Minor:** 1. Citric acid fermentationand recovery. 2. Estimation of citric acid by titration. 3. Amylase production by using *Bacillus* species. 4. Isolation of lactic acid bacteria from fermented food.

	5. Sauerkraut production. 6. Examination of milk by Directmicroscopic count (DMC)

VSC-PR-IV VSC03MIC 59	**PRACTICALS BASED ON SOIL MICROBIOLOGY** (Credits -2)	**No. of Hours per unit**
Expected course outcome - **On completion of course, student will be able to –** **CO1: Explain physical and chemical characteristics of soil.** **CO2: Describe the role of microorganisms in soil fertility.** **CO3: Describe the role of microorganisms in various elemental cycles.** **CO4: Define soil quality and its relation to Soil Microbiology**		
	1) Determination of color & pH of soil. 2) Determination of temperature & humidity of soil. 3) Determination of water content of soil. 4) Determination of total bacterial count of soil. 5) Determination of texture of soil. 6) Estimation of total nitrogen content of soil. 7) Estimation of total phosphorous content of soil. 8) Estimation of potassium content of soil.	

MIN-PR-I MIN03MIC19	**PRACTICALS BASED ON AGRICULTURAL MICROBIOLOGY** **(Credits -4)**
	Major: 1.Isolation of Azotobacter fromsoil. 2.IsolationofXanthomonasfrominfectedcitrusfruit. 3.IsolationofRhizobiumfromrootnodules. 4.Isolationofphosphatesolubilizingbacteriafromsoil. 5.Isolation of Trichoderma from soil . **Minor:** 1.Determination of texture of soil. 2.Determination of color of soil . 3.Determination of pH of soil . 4.EstimationofCalciumfromsoil(EDTAmethod) 5.EstimationofMagnesiumfromsoil(EDTAmethod) 6.Determinationoforganiccarboncontentofsoil(WalkleyandBlackmethod)

SEMESTER VI

DSC XII DSC03MIC61	MICROBIAL GENETICS Theory: 30 Hours (Credits -2)	No. of Hours per unit
Expected course outcome - **Upon successful completion of course, students will be able to –** **CO1: Understand molecular mechanism involved in gene regulation** **CO2: Understand the basic concept of operon and mutation.** **CO3: Discuss the principle, working and applications of molecular biology techniques including PCR and DNA sequencing.** **CO4: Explain techniques used to manipulate genes & formation of clones**		
UNIT-I	1. One cistron - one polypeptidehypothesis. 2. Molecular mechanism of geneexpression a. Concept ofoperon b. Pribnowbox c. Genetic regulation in tryptophanoperon	**7**
UNIT-II	1. Mutations a. Expression of mutations- i.Time course of phenotypicexpression. ii.Conditional expression ofmutation. b. Suppressor mutations (with examples) - Genetic andnon-genetic. 2. Methods of isolation and detection of mutants based on- a. Relativesurvival b. Relativegrowth c. Visualdetection	**8**
UNIT – III	1.Genetic complementation - Cis-transtest 2.Extrachromosomal inheritance - a. Kappaparticles. b. Transposable elements – general properties andtypes. 3.Techniques in Molecular Biology– a. DNA sequencing (Sanger's method) b. DNA Fingerprinting c. PCR d. Blotting techniques- Southern, Western, Northern	**7**

UNIT-IV	1.Geneticengineering a. Introduction b. Tools of genetic engineering i. Enzymes ii. Vectors-phage, plasmid and cosmid iii. DNAprobe – methods of preparation and detection. iv. Linkers andadaptors v. Cloning organisms - (Bacteria andYeasts) vi. Genomic library and cDNAlibrary c. Techniques– i. Isolation of desired DNA segment- Shotgun Method, cDNA synthesis, Chemical synthesis ii. Construction of r-DNA using appropriate vector- Use of restrictionenzymes,Linkers, Adaptors Homopolymer tails iii. Transfer to cloning organisms (Bacteria andYeasts) iv. Selection of recombinant microorganism Blue and white screening, Colony hybridizationtechnique. **d. Application of genetic engineering in–** i. Medicine- ii. Agriculture iii. Industry iv. Environment v. Understanding biology	**8**

BooksRecommended:

1.Genetics -Stickberger.
2. Genes - Benjamin Lewin IXed.
3.Principles of gene manipulation - Primrose andOld
4.Genetic Engineering - Second Ed. Desmond S. T.Nicholl
5.Recombinant DNA - J. D.Watson
6.Biochemistry –Lehninger
7.Molecular Biology of Gene - J. D.Watson

DSC XIII DSC03MIC62	**MICROBIAL BIOCHEMISTRY** Theory: 30 Hours (Credits -2)	**No. of Hours per unit**
Expected course outcome - **Upon successful completion of course, students are expected to be able to –** **CO1: Explain Metabolic pathways and Bioenergetics** **CO2: Understand Various downstream processing** **CO3: Understand Basic concept related to enzyme** **CO4: Determine enzyme production and its activity**		
UNIT I	**1. Enzymes-** a. Definition, properties, structure, specificity, classification and mechanism of action (Lock &Key, Induced fithypothesis) b. Allostericenzymes- Definition,properties,modelsexplaining mechanismofaction. c. Ribozymes –concept, significance. dIsozymes- definition, properties, example. e. Factorsaffectingcatalyticefficiencyofenzymes i. Proximity andorientation ii. Strain anddistortion. iii. Acid basecatalysis iv. Covalentcatalysis f. EnzymekineticsDerivationofMichaelis-Mentenequation, LineweaverBurkPlot,SignificanceofKm& Vmax. g. Regulationofenzymesynthesis. i. Positive control -Ara operon ii. Negative control -Lac operon iii. Cataboliterepression	**7**
UNIT II	**1.. Extraction &purification ofenzymes.** a. Methodsofextractionofintracellularandextracellularenzymes. i. Choiceofsourceandbiomassdevelopment ii. Methodsofhomogenization-celldisruptionmethods	**8**

	iii. Purificationofenzymesonthebasisof- • Molecularsize • Solubilitydifferences • Electricalcharge • Adsorption characteristicdifferences **2. Assayofenzymes-Basedonsubstrateandproductestimation**. **3. Immobilizationofenzymes-Methods&applications** **4. Confirmation of purified enzymes**	
UNIT III	**1. Basic concepts of-** a.Glyoxylatebypass b.Phosphoketolase pathway c.Bioluminescence–Occurrence,mechanism&applications. **2. Assimilation of-** a.Carbon b.NitrogenwithrespecttoN_2andNH_3(GOGAT) c.Sulphur	**7**
UNIT IV	1**. Prokaryotic Biosynthesis of-** a.RNA b.DNA c.Proteins d. Peptidoglycan	**8**

Books Recommended:

B. For Microbial Biochemistry

1. Enzymology-Prise&Stevens
2. Enzymes-Biochemistry,Biotechnology,clinicalchemistry-TrevorPalmer.
3. Enzymes -Dixon and Webb
4. LehnigersPrinciplesofBiochemistrybyDavidNelson&MichaleCox,Fifthedition.
5. General Microbiology -Stanier
6. Principles&techniquesofBiochemistry-Wilson&Walker, 6thedition.

DSC XIV DSC0 3MIC 63	**MEDICAL MICROBIOLOGY** Theory: 30 Hours (Credits -2)	**No. of Hours per unit**
Expected course outcome - **Upon successful completion of course, students are expected to be able to –** **CO1: Correlate disease symptoms with causative agent, isolate and identify pathogens.** **CO2:Understand mechanism of action of antimicrobial drugs and their uses as prophylactic agents.** **CO3:Explain pathogenicity of organisms associated with human infections.** **CO4:Explain different antimicrobial agents with respect to their mode of action uses.**		
UNIT I	1. Morphology,culturalandbiochemicalcharacteristics,antigenicstructure,modesoftransmissionandpathogenesis, symptoms,laboratorydiagnosis,preventionandcontrolofdiseasescausedby– a. *Mycobacteriumleprae* b.*Clostridiumperfringens,* c. *Treponemapallidum*	**8**
UNIT II	Morphology, cultural and biochemical characteristics, antigenic structure, modes oftransmission and pathogenesis, symptoms,laboratorydiagnosis,preventionandcontrolofdiseasescausedby– a.*Pseudomonasaeruginosa* b. *Vibrio cholera* c..*Streptococcus mutans* d..*Helicobacter pylori*	**7**
UNIT III	1. Morphology,culturalandbiochemicalcharacteristics,antigenicstructure,modesoftransmissionandpathogenesis, symptoms,laboratorydiagnosis,preventionandcontrolofdiseasescausedby- a. Protozoa:*Plasmodium falciparum*(malaria) b. Viruses:i) Hepatitis A & B virus ii) Rabiesvirus	**8**

	iii) Dengue virus c Fungi:*Candidaalbicans*	
UNIT IV	**1.**Chemotherapy a.Generalprinciplesofchemotherapy b.Modeof action of Penicillin, Streptomycin, Bacitracin, ,sulphonamideandQuinolones onmicroorganisms. c.Antiviraldrug:AZT d. Antifungal drugs:Ketoconazole e. Antiprotozoal drugs: Metronidazole f. Mechanismofdrugresistance g. Chemoprophylaxis **2.** Genetherapy–Concept,advantages&disadvantages. **3.** ImmunoprophylaxisVaccinesandImmuneSera a. Vaccines-liveattenuated,heat killed,subunit,conjugateandDNAvaccines b. ImmuneSera–exampleswithapplications	**7**

Books Recommended:

B. For Medical Microbiology

1) Microbiology -Davis
2) Immunology&serology-AshimChakravarty
3) MedicalMicrobiology16theditionbyDavidGreenwood,RichardCBSlack,JohnPeutherer
4) MedicalBacteriology-Dey&Dey
5) MedicalBacteriologyincludingMedicalMycology&AIDS-NCDey&T.K.Dey
6) PrincipalsandPracticeofClinicalBacteriology–A.M.Emmerson

DSE-II DSE03MIC61	**ENVIRONMENTALMICROBIOLOGY** Theory: 30 Hours (Credits -2)	**No. of Hours per unit**
Expected course outcome - **Upon successful completion of course, students will be able to –** **CO1: Understand the basic principle of environment microbiology and be able to apply these principles to understanding and solving environmental problems.** **CO1: Know the Microorganisms responsible for water pollution and their transmission** **CO1: Describe classification of lakes, sources, consequences and control of eutrophication.** **CO1: Explain various bioburden test and clean room concepts.**		
UNIT I	1.General characteristics of waste- a. 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 perMPCB 2.Eutrophication a. Classification oflakes b. Sources c. Consequences d. Control	**7**
UNIT II	1.SewageMicrobiology a. Physico-chemical and biologicalcharacteristics b. Treatment methods- i. Physical treatment: Screening, Sedimentation ii. Biological treatment: Trickling filter, Activated sludge process, Oxidationponds, Anaerobic digestion (Biomethanation), Septic tank. iii. Chemical treatment – Chlorination **2**.Characteristics and treatment of waste generatedby Hospitals	**8**

UNIT III	**1. Biological safety inlaboratory** a. Good LaboratoryPractices b. Bio safety levels(BSL) **2. Environmental monitoring** a. Definition andpurpose b. Cleanroom- Concept, classification, prevention of contamination in clean rooms c. Routine Environmental monitoring programme in pharmaceutical industries- Air monitoring, Surface monitoring and Personnelmonitoring. d. Bioburdentest **3. Environmental Impact Assessment-** Concept and Brief introduction	**7**
UNIT IV	**1. Bioremediation andBioleaching** **a. Bioremediation** i. Definition ii. Types iii. Applications. **b. Bioleaching** i. Introduction ii. Microorganismsinvolved iii. Chemistry of Microbialleaching iv. Laboratory scale and pilot scaleleaching v. In situ leaching - Slope,heap vi. Leaching of Copper andUranium	**8**

BooksRecommended

1. BiochemistryandMicrobiologyofPollution-HigginsandBurns.
2. WasteWaterTreatment-DattaandRao(OxfordandIBH)
3. EnvironmentChemicalHazards-RamKumar(SwarupandSons,NewDelhi).
4. EnvironmentPollution-TimmyKatyal(SatkeAnmolPub.NewDelhi).
5. EcologyofPollutedWater-Vol.II-AnandKumar(AphPub.Co.NewDelhi).
6. EnvironmentPollutionandManagementofwastewatersbyMicrobialTechniques- PathadeandGoel(ABDPub.Jaipur)

DSE-II DSE03MIC61	**FERMENTATION TECHNOLOGY II** Theory:30Hours(Credits-2)	**No.of Hours perunit/ credit**

CourseOutcomes–

Oncompletionofcourse,studentswillbeableto–

CO1:Knowmethodsusedforindustrialproductionofvariousproductsusing microorganisms.

CO2: Explain various techniques for product recovery after fermentation.

CO3: Understand the importance of fermentation economics.

CO4:Know Computer applications in downstream processing.

UNIT I	**A. Industrialproduction–** OrganismsusedInoculumpreparation,Fermentation media,Fermentationconditions, ExtractionandRecovery. **1. Primary metabolite:** **i) Vitamin**: Vitamin B12, riboflavin, β carotene, **ii) Aminoacids**:Lysine**&**Glutamic acid **iii) Organic acid**:Citricacid**&**Lactic acidacetic acids, lactic acids, kojic acids, Itaconic acids **i)**	**7**
UNIT II	**2. Secondary metabolite** **i) Antibiotics:** **a.** Penicillin & semi-synthetic penicillin **b.** Streptomycin **ii) Alcoholic Beverages:** Wine: a) Red Table Wine b) Sparkling Wine- Champagne **3. Enzyme:** ii) Amylase iii) Protease iv) lipase	**8**
UNIT-III	**A. Production of biofuels** **1.** Bioethanol- microorganisms used, fermentation condition, recovery, purification of Ethanol **2.** Biogas- Biomass used, Microbiology & Biochemistry of biogas production, **3.** Biodiesel production from algae **B. Probiotics-** Concept,Productionbyusing*Lactobacillus*andapplications **C.** Production of SCP by using yeast	**8**

UNIT IV	**A. Fermentation economics** – discovery and process development, strain improvement, market potential, plant and equipment, operating cost, contract manufacturing, return on investment – recovery cost. Water usage and recycling and effluent treatment. **B. Computer applications in downstream processing** - Introduction, History, General specific applications, System configuration. Product formulation, monitoring of downstream processing, process integration.	**7**

MIN-II MIN03MIC21	ENVIRONMENTALMICROBIOLOGY Theory: 30 Hours (Credits -2)	No. of Hours per unit
Expected course outcome - **Upon successful completion of course, students will be able to –** **CO1: Understand the basic principle of environment microbiology and be able to apply these principles to understanding and solving environmental problems.** **CO1: Know the Microorganisms responsible for water pollution and their transmission** **CO1: Describe classification of lakes, sources, consequences and control of eutrophication.** **CO1: Explain various bioburden test and clean room concepts.**		
UNIT I	**1.General characteristics of waste-** a. 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 perMPCB **2. Eutrophication** a. Classification oflakes b. Sources c. Consequences d. Control	**7**
UNIT II	**2.SewageMicrobiology** a. Physico-chemical and biologicalcharacteristics b. Treatment methods- i. Physical treatment: Screening, Sedimentation ii. Biological treatment: Trickling filter, Activated sludge process, Oxidationponds, Anaerobic digestion (Biomethanation), Septic tank. iii. Chemical treatment – Chlorination	**8**

UNIT III	**1. Biological safety inlaboratory** a. Good LaboratoryPractices b. Bio safety levels(BSL) **2. Environmental monitoring** a. Definition andpurpose b. Cleanroom- Concept, classification, prevention of contamination in clean rooms c. Routine Environmental monitoring programme in pharmaceutical industries- Air monitoring, Surface monitoring and Personnelmonitoring. d. Bioburdentest **3. Environmental Impact Assessment-** Concept and Brief introduction	**7**
UNIT IV	**1. Characteristics and treatment of waste generatedby Hospitals** **2. Bioremediation andBioleaching** **a. Bioremediation** i. Definition ii. Types iii. Applications. **b. Bioleaching** i. Introduction ii. Microorganismsinvolved iii. Chemistry of Microbialleaching iv. Laboratory scale and pilot scaleleaching v. In situ leaching - Slope,heap vi. Leaching of Copper andUranium	**8**

BooksRecommended

1. EnvironmentalPollutionbyChemicals-Walker,Hulchiason.
2. BiochemistryandMicrobiologyofPollution-HigginsandBurns.
3. EnvironmentalPollution-LaurentHodge,Holt.
4. WasteWaterTreatment-DattaandRao(OxfordandIBH)
5. Sewageandwastetreatment–Hammer
6. EnvironmentChemicalHazards-RamKumar(SwarupandSons,NewDelhi).
7. EnvironmentPollution-TimmyKatyal(SatkeAnmolPub.NewDelhi).

DSC-PR-VI DSC03MIC69	DSC Microbiology Lab-VI **(Credits -4)**
PRACTICALS BASED ON GENETICS	
	Major: 1. EffectofU.V.lightonbacteriaandgraphicalpresentationofresult. 2. Isolationofauxotrophicmutantsbyreplicaplatetechnique 3.Transferofgeneticmaterialbytransformationin*E. coli* 4.IsolationofchromosomalDNAfrombacteria(J.Marmursmethod) 5..Isolationofstreptomycin-resistantmutants(gradientplatetechnique) **Minor:** 1.Electrophoretic separation ofDNA. 2.Spectrophotometric analysis of DNA in extracted solution. 3. Demonstration of PCR. 4. Isolation of Lac negative mutants of *E. coli* 5. Testing of carcinogenicity of a substance by Ames test.
PRACTICALS BASED ON BIOCHEMISTRY	
	Major: 1. AssayofamylasebyDNSAmethod(graphicalestimation) 2. Immobilization of enzymes by sodium alginate method. 3. Bio-assay of Vitamin B12 4. Bio-assay of Penicillin. 5. Protein purification by using ammonium sulfate precipitation. **Minor :** **1.**Seperation and detection of amino acid by TLC 2. Effect of activator on enzyme activity 3. Effect of inhibitor on enzyme activity. 4. Effect of pH on enzyme activity. 5. Effect of temperature on enzyme activity
PRACTICALS BASED ON MEDICAL MICROBIOLOGY	
	Major: 1.Isolation of *Pseudomonasaeruginosa* from clinical samples (wherever possible) and identificationof the same by morphological,culturaland biochemical characteristics.

	2. Isolation of *Klebsiella pneumoniae* from clinical samples (wherever possible) and identificationof the same by morphological,culturaland biochemical characteristics. 3. Isolation of *Candidaalbicans* from clinical samples (wherever possible) and identificationof the same by morphological,culturaland biochemical characteristics. 4.Determination of MIC of streptomycin against E.coli by broth method . 5. Determination of sensitivity of common pathogens to antibiotics by paper disc method . **Minor:** 1. Widaltest -Quantitative 2. Physicalandchemicalexaminationofurine. 3. Detection of presence of sugar in urine. 4.Detection of presence of protein in urine (Aceticacidtest) 5. Detection of presence of ketonebodies(Rothra'stest) 6. Detection of presence of bilesalt.

DSE-PR-II	PRACTICALS BASED ON FERMENTATION TECHNOLOGY-II
	Major 1. Isolation and identification of probiotic micro flora from natural sources or any commercial formulation 2. Production of Biogas from organics waste 3. Production of alcohol from molasses 4. Screening of organic acid producers & amine producers 5. Screening of Amylase, Protease & Lipase producers 6. Screening of Vitamin producers. **Minor:** 1.Chemical assay of Vitamin C. 2.Chemical assay of Penicillin. 3.Estimation of alcohol 4.Examination of milk by Directmicroscopic count (DMC) 5.Sauerkrautproduction.

DSE-PR-II	PRACTICALS BASED ON ENVIRONMENTAL MICROBIOLOGY
	Major: 1. Microbial testing of Water: Presumptive,confirmedandcompletedtest. 2. Determination of Most Probable Number of Water 3. Determinationof CODofsewage. 4. DeterminationofBODofsewage **Minor:** 1.Determination of color&pH of water. 2.Determination of total alkalinity of water 3.Determination of chloride content of water

MIN-PR-II	**ENVIRONMENTAL MICROBIOLOGY (Credits -4)**
	Major: 1. Microbial testing of Water: a. Presumptive,confirmedandcompletedtest. 2. Determination of Most Probable Number of Water 3. Determinationof CODofsewage. 4. DeterminationofBODofsewage **Minor:** 5. Determination of color& pH of water. 6. Determination of total alkalinity of water 7. Determination of chloride content of water

VSC-PR-IV **VSC03MIC69**	**WASTE WATER MANAGEMENT** (Credits -2)	**No. of Hours per unit**
Expected course outcome - **On completion of course, student will be able to –** **i. Explain physical and chemical characteristics of waste water** **ii. Examine various types of solid waste in water and categorize it.**		
	1) Determination of color & pH and Temperature of Water 2) Determination total alkalinity of water 3) Determination of electric conductivity of water 4) Determination of Specific gravity of water 5) Determination of oil and grease content of water 6) Determination of Total solid content of water	

Practical Examination

A) The practical examination will be conducted on three (3) consecutive days for not less than 6hours on each day of the practicalexanimation.

B) Each candidate must produce a certificate from the Head of the Department in his/her college stating that he/she has completed in a satisfactory manner the practical course on the guidelines laid down from time to time by Academic Council on the recommendation of Board of studies and has been recorded his/her observations in the laboratory journal and written a report on each exercise performed. Every journal is to be checked and signed periodically by a member teaching staff and certified by the Head of the Department at the end of staff and certified by the Head of the Department at the end of the semester . Candidates are to produce their journal at the time of practical examination.

C) Nature of question paper and distribution of marks for B.Sc. Part III MicrobiologyPractical Examination

PracticalsPaper DSC I, II, III &DSE I/II

Semester V

Section I/II/III/ and DSE-PRIV

Q.1MajorExperiment	10Marks
Q. 2MinorExperiment	05Marks
Q.3Journal	05Marks
Q.4 Seminar	10Marks

Semester VI

Section I/II/III/ and DSE-PRIV

Q.1MajorExperiment	10Marks
Q. 2MinorExperiment	05Marks
Q.3Journal	05Marks
Q.4Seminar	10Marks

Nature of Question Paper

Instructions: 1) All the questions are **compulsory**.

2 Figures to the right indicate **full** marks.

3)Draw neat labeled diagrams **wherever** necessary.

4) Use of calculator is allowed.

Time: 2 hours **Total Marks: 40**

PAPER DSC IX/X/XI/DSE I/II

Q.1.A Select correct alternative. **(8)**

i)
a) b) c) d)

ii)
a) b) c) d)

iii)
a) b) c) d)

iv)
a) b) c) d)

v)
a) b) c) d)

vi)
a) b) c) d)

vii)
a) b) c) d)

viii)
a) b) c) d)

Q.2. Attempt any Two **(16)**

i)
ii)
iii)

Q.3. Attempt any Four **(16)**

i)
ii)
iii)
iv)
v)
vi)

Instruction to paper setters: Equal weight age should be given to all units.

For Continuous Internal Examination: (10 marks)

***Select any one for B.Sc.III ---- (10 marks)**

1) Unit test
2) Home assignment
3) Project
4) Seminar

SCHEME OF MARKING (THEROY)

Sem.	Core Course	Marks	Evaluation	Paper	Answer Books	Standard of passing
V	DSCIX	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)
V	DSCX	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)
V	DSCXI	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)
V	DSE-I	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)

SCHEME OF MARKING (CIE) Continuous Internal Evaluation

Sem.	Core Course	Marks	Evaluation	Paper	Answer Books	Standard of passing
VI	DSC XII	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)
VI	DSC XIII	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)
VI	DSC XIV	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)
VI	DSE-II	40	Semester wise	Each paper of 40 marks	As per Instruction	40% (16 marks)

SCHEME OF MARKING (PRACTICAL)

Sem.	Course	Marks	Evaluation	Paper	Sections	Standard of passing
V AND VI	Practical I,II,III&IV	150	Semester Wise	Four	As per Instruction	45%

***A separate passing is mandatory**