Telephone No: 2419208/2419315/2419219/2419361
Fax: 0821-2419363/2419301

e-mail : registrar@uni-mysore.ac.in
www.uni-mysore.ac.in

UNIVERSITY OF MYSORE

Established: 1916

Vishwavidyanilaya Karyasoudha,
Crawford Hall, Mysore-570 005.

No.AC.2(S)/378/2020-21

Dated: 19.08.2020

NOTIFICATION

Sub: Minor changes in the syllabus of V & VI semester of B.Sc. Microbiology from the Academic Year 2020-21.

Ref: 1. Decision of Board of Studies in Microbiology (UG) meeting held on 16.12.2019.
2. Decision of the Faculty of Science & Technology Meeting held on 18.02.2020.
3. Decision of the Academic Council meeting held on 18.06.2020.

*****

The Board of Studies in Microbiology (UG) which met on 16.12.2019 has recommended to make minor changes in the V & VI semester syllabus of B.Sc. Microbiology program from the Academic Year 2020-21.

The Faculty of Science and Technology and Academic Council meeting held on 18.02.2020 and 18.06.2020 respectively have approved the above said proposal and the same is hereby notified.

The modified syllabus of B.Sc. Microbiology program is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

Draft approved by the Registrar

Deputy Registrar(Academic),
Deputy Registrar (Academic)
University of Mysore
Mysore-570 005

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DoS in Psychology, Manasagangotri, Mysore.
3. The Chairperson, BoS in Microbiology, DoS in Microbiology, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Microbiology, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
7. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
8. Office file.

UNIVERSITY OF MYSORE, MYSURU

B. Sc. MICROBIOLOGY

SYLLABUS

for

CHOICE BASED CREDIT SYSTEM (CBCS)

&

CONTINUOUS ASSESSMENT AND GRADING

PATTERN (CGPA)

Board of Studies in Microbiology
Department of Studies in Microbiology
University of Mysore Manasagangotri,
Mysuru 570 006 Karnataka, India

2020-2021

Microbiology Syllabus for Choice Based Credit System (CBCS) at Undergraduate Level Proposed Semester-wise distribution of the course structure Semester – I

Sl. No.	Code No.	Type of the Paper	Title of the Paper	Credit Pattern in L:T:P	Credit Value	Hours /Week L:T:P
1	MB-1.1	DSC	Introduction to Microbiology and Microbial Diversity	4:0:2	6	4:0:4
			Semester – II			
1	MB-2.1	DSC	Microbial Physiology and Molecular Biology	4:0:2	6	4:0:4
			Semester – III			
1	MB-3.1	DSC	Microbial Genetics and Recombinant DNA Technology	4:0:2	6	4:0:4
			Semester – IV			
1	MB-4.1	DSC	Environmental and Agricultural Microbiology	4:0:2	6	4:0:4
			Semester – V			
			Any one of the following			
1	MB-5.1	DSE 1.1	Food and Industrial Microbiology	4:0:2	6	4:0:4
2	MB-5.2	DSE 1.2	Microbial Biotechnology and Bioinformatics	4:0:2	6	4:0:4
			Any one of the following			
1	SE-1.1	Discipline specialization	Microbial Quality Control in Food and Pharmaceutical Industries	2:0:0	2	2:0:0
2	SE-1.2	Discipline specialization	Microbiological Analysis of Air and Water	2:0:0	2	2:0:0
			Semester – VI			
			Any one of the following			
1	MB-6.1	DSE 1.1	Immunology and Medical Microbiology	4:0:2	6	4:0:4
2	MB-6.2	DSE 1.2	Advances in Microbiology,Biostatistics and Intellectual Property Rights	4:0:2	6	4:0:4
			Any one of the following			
1	SE-2.1	Discipline specialization	Microbial Diagnosis in HealthClinics	2:0:0	2	2:0:0
2	SE-2.2	Discipline specialization	Management of Human Microbial diseases	2:0:0	2	2:0:0

DSC - Discipline Specific Course, DSE- Discipline Specific Elective, SEC- Skill Enhancement Course

SCHEME OF VALUATION

MAXIMUM MARKS

COURSE TYPE	C1		C2		C3		TOTAL
	THEORY	LAB	THEORY	LAB	THEORY	LAB	
DSC	10	5	10	5	50	20	100
DSE	10	5	10	5	50	20	100
SEC	10	-	10	-	30		50

NOTE;

1. C1 AND C2 WILL BE CONDUCTED FOR 20 MARKS (THEORY) WITH 1 HOUR DURATION, 10 MARKS (LAB) WITH CONTINUOUS ASSESMENT THROUGH RECORD VALUATION AND MARKS REDUCED TO ASSIGNED MARKS.
2. C3 WILL BE CONDUCTED FOR 100 MARKS (THEORY) WITH 3HOUR DURATION, 40 MARKS (LAB) WITH 3 HOUR DURATION AND REDUCED TO ASSIGNED MARKS.
3. IN CASE OF GE, C1 AND C2 WILL BE CONDUCTED FOR 10 MARKS WITH 1 HOUR DURATION AND REDUCED TO ASSIGNED MARKS. C3 WILL BE CONDUCTED FOR 30 MARKS.

I SEMESTER

DSC-1:INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Paper I **64 (4hrs/week)**

Unit I: **History of Microbiology and Microscopy** **16 hrs**

History of Microbiology: Branches and scope of Microbiology. Theory of spontaneousgeneration and biogenesis.Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, and Edward Jenner, C. J. Butler.Mundkar.Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three domain classification systems.

Microscopy: Light Microscopy-Different types of Microscopes, their construction and workingprinciples. Compound microscope (Types-Bright field, Dark field, Phase contrast and Fluoresecence).Electron Microscope-Principle, construction and mode of operation of Scanning and Transmission electron microscope.

Unit II: **Techniques in Microbiology16 hrs**

Staining techniques for light microscopy: Types of microbiological stains and principles ofstaining.Simple staining (positive and negative), differential staining (Gram's staining and acid fast staining),structural staining (capsule, Cell wall, flagella and Endospore of bacteria), nuclear staining.Wet mounting method-Staining of algae and fungi. Hanging drop method.

Sterilization Techniques: Physical Methods;a)Heat- i)Dry heat (Hot Air Oven, Incineration) ii) Moist heat (Autoclave, Tyndallization) b) Filtration: Types of Filters (Membrane filters and HEPA filter c) Radiation methods: UV radiation. Chemical methods:Definition of terms-disinfectants, antiseptics, Sanitizers, Microbicides, microbiostatic.Use and mode of action of alcohols, aldehydes, halogens, phenols, heavy metals, Detergents:Quaternary ammonium compounds.

Unit III: **Microbial Diversity** **16 hrs**

Bacteria: General characteristics of archaeal and eubacterial groups.Classification in brief as per Bergey's Manual of Systematic Bacteriology.Cellorganization:Cell size, shape and arrangement, capsule, flagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls. Cell Membrane: Structure, function and chemical composition of bacterial. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.

Study of the following in brief with examples: *Rickettsiae, Mycoplasma, Chlamydia, Spirochaetes,Actinomycetes.* Cyanobacteria: occurence, structure, reproduction of the following: *Microcystis,Anabaena.*

Unit IV: **Study of Viruses, Fungi, Algae and Protozoa** **16 hrs**

Viruses: General characteristics of viruses. Concept of viroids and Prions. Structureof Viruses, Importance of viruses.Study of structure and replication of viruses: a)Bacteriophages-T4 phage b) Cyanophages c) Phytophagenae-TMV d) Zoophagenae-Influenza.

General characteristics,thallus structure, reproduction and economic importance: a)**Algae**-*Spirogyra, Diatoms* and*Gracilaria*b)**Fungi**:*Rhizopus, Saccharomyces, Aspergillus,*

c)Protozoa: General account, sturcture and reproduction of *Euglena, andParamaecium*

I SEMESTER

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

PRACTICAL-I **(4hrs/week)**

1. Microbiology good laboratory practices and biosafety.
2. Study the principle and applications of important instruments (autoclave, hot air oven, incubator, inoculation chamber, Inoculation loop, Inocultion needle, membrane filter, laminar air flow system, colony counter. biological safety cabinets, BOD incubator, pH meter) used in the microbiology laboratory.
3. Study of compound microscopes,their handling including oil immersion objective.
4. Preparation of stains, mordant and mounting media-Methylene blue, Crystal violet, Safranin, Nigrosin, CarbolFuchsin, Malachite green, Grams iodine, Cotton blue.

5-7. Preparation of micororganisms for light microscopic observation-simple(direct andindirect)staining, differential staining(Gram staining),Structural staining(capsule staining).

8. Observation of bacterial motility by Hanging drop method.
9. Microscopic measurements of microorganisms/spores using stage and ocular micrometer.

10. Study of cyanobacteria- *Microcystis,Anabaena*

11-12. Study of *Rhizopus, Saccharomyces, Aspergillus, Penicillium*using temporary mounts

13-14 Study of *Spirogyra, Diatoms and Gracilaria* using temporary mounts

15. Study of the following protozoans using permanent mounts/photographs: *Euglena,Paramaecium*and*Entamoeba*
16. Display of photographs of microscopes and scientists mentioned in the theory.

SUGGESTED READING

1. Alexopoulas, C.J. and Mims, C.W., Introductory Mycology, Wile Eastern Limited, New Delhi.
2. Atlas, R. M. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
3. Bold, H.C. and Wynne, M. J. Introduction to Algae, Prentice Hall of India Private Limited , New Delhi.
4. Bos, L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
5. Brock, T.D.and Madigan, M.T. Biology of Microorganisms, Prentice Hall of India Private Ltd,New Delhi.
6. Cappucino. J. and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
7. Carter, J. and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
8. Dimmock, N. J., Easton, A. L and Leppard, K. N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
9. Dubey, R. C. and Maheshawari, D.K, (2013) Text book of Microbiology, S Chand and company limited, Ramnagar, New Delhi.

10. Flint, S. J., Enquist, L. W., Krug, R. M., Racaniello, V. R. and Skalka, A. M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
11. Lansing, M. Prescott,John, P.Harley,DonaldA.Klein. (2002). Microbiology, 5th edition WCB McGraw Hill, New york.
12. Levy, J. A., Conrat, H. F. and Owens, R. A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
13. Madigan, M. T., Martinko, J. M., Dunlap, P. V. and Clark, D. P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
14. Michael, J.Pelczar, Jr.E.C. S. Chan and Moel (2001). Microbiology, McGraw Hill Book Company, New york).
15. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
16. Srivastava, S. and Srivastava, P. S. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.
17. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L. and Painter, P. R. (2005). General Microbiology. 5th edition McMillan.
18. Tortora, G. J., Funke, B. R. and Case, C. L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
19. Versteeg, J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.
20. Wagner, E. K., Hewlett, M. J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

II SEMESTER

DSC-2: MICROBIAL PHYSIOLOGY AND MOLECULAR BIOLOGY

Paper II **64 (4hrs/week)**

Unit I: **Microbial Nutrition** **16 hrs**

Bacterial Nutrition: Major nutritional types of microorganisms, Nutritional requirements ofmicroorganisms, Uptake of nutrients-passive, facilitated, active transport, group translocation. Bacterial growth: Growth rate and generation time (Definition), growth curve-phases of growth and their significance, Physical and chemical factors affecting growth (temperature, pH, light, oxygen, saline). Measurement of growth by cell number and cell mass.

Cultivation of Bacteria: a) Culture Media-Synthetic and non-synthetic-solid, liquid and semi-solid media, Special media-Enriched, Selective, transport, differential, enrichment media. b) Cultivation of aerobic and anaerobic bacteria. c) Pure culture Techniques- Serial dilution, pour plate, spread plate, streak plate. Colony characteristics. d) Maintenance and preservation of pure cultures.

Unit II:**Microbial Metabolism** **16 hrs**

Chemoheterotrophic Metabolism: Aerobicrespiration:Concept of aerobic respiration,anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain. Anaerobic respiration**:** Fermentation-Alcohol fermentation and Pasteur effect; Lactate fermentation.

Phototrophic Metabolism and Nitrogen and Lipids metabolism: Photosynthesis:photosyntheticmocroorganisms, oxygenic and anoxygenic types, light as a source of energy, photosynthetic pigments and apparatus in prokaryotes. Mechanism of photosynthesisin bacteria. Nitrogen Metabolism:Biological nitrogen fixation-symbiotic and asymbiotic nitrogen fixation, nodule formation, mechanism and biochemistry of N_2 fixation, nitrification and denitrification. A brief account on lipid metabolism-biosynthesis of triglycerides, β-oxidation.

Unit III: **Genetic material** **16 hrs**

Structure and types: Historical of genetics. Chromosomes: prokaryotic and eukaryoticorganization. Watson and Crick model of DNA, DNA types, supercoiling of DNA,denaturation and renaturation DNA, cot curves.Organelle DNA - mitochondria and chloroplast DNA. Types of RNA, structure and its functional importance.

DNA Replication: DNA replication in prokaryotes-Enzymes and proteins involved in DNAreplication; DNA polymerases, DNA ligase, primase, telomerase. General Mechanism, Modes: semi-conservative, semi-discontinuous replication. Various models of DNA replication including rolling circle, Θ (theta) mode of replication.

Unit IV: **Genetic regulation** **16 hrs**

Transcription: Transcription- Definition, promoter- concept and strength of promoter, RNAPolymerase and the transcription unit.Post-transcriptional processing- Split genes, concept of introns and exons, RNA splicing, concept of alternative splicing, polyadenylation and capping, Transcriptional regulation at initiation with example from lac operons.

Translation: Gene-Protein relationship: One gene one enzyme and one gene- one polypeptide concept, colinearity of genes and proteins. Genetic code-features,Wobblehypothesis.Translational machinery, Charging of tRNA, aminoacyltRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes.

SEMESTER-II
MICROBIAL PHYSIOLOGY AND MOLECULAR BIOLOGY

PRACTICAL-II **(4hrs/week)**

1. Cleaning and sterilization of glassware.
2. Preparation of media-nutrient broth, nutrient agar, potato dextrose agar.
3. Cultivation of microorganisms on agar plate (point inoculation) broth, anaerobic cultivation (gaspak method).
4. Preparation of physiological saline and serial dilution.
5. Estimation of CFU count by spread plate method/pour plate methodand study of colony characteristics.
6. Isolation of pure cultures of bacteria by streak plate methods
7. Maintenance and preservation of bacterial cultures on fresh agar slants, overlaying with mineral oil, stab culture
8. Effect of temperature, pH and carbon source on growth of microorganisms.

9. Measurement of growth by cell mass using tubidometer/ photocolorimeter/ spectrophotometer.
10. Measurement of growth by cell number using Haemocytometer.
11. Study of root nodules for bacteroids
12. Acid and gas prodction from carbohydrates-demonstration of fermentation of lactose.
13. Starch hydrolysis and Gelatin hydrolysis.
14. Catalase and urease activity.
15. Study of different types of DNA, RNA, semi-conservative replication of DNA transcription and translation using micrographs and model / schematic representations.

SUGGESTED READINGS

1. Becker, W. M., Kleinsmith, L. J., Hardin, J. and Bertoni, G. P. (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
2. Brock, T. D. and Madigan, M.T.,(2012). Biology of Microoragnisms, Prentice hall of India Pvt. Ltd, New Delhi.
3. De Robertis, E. D. P. and De Robertis, E. M. F. (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Gardner, E. J., Simmons, M. J., Snustad, D. P. (2008). Principles of Genetics. 8th Ed. Wiley-India.
5. Gottschalk, G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
7. Krebs, J., Goldstein. E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
8. Lansing, M., Prescott,J.,Ohn, P., Harley,DonaldA.Klein,(2002) Microbiology,5th ed. WCB McGraw Hill, New york.
9. Madigan, M. T. and Martinko, J. M. (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
10. Moat, A. G. and Foster, J. W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
11. Nelson David, L and Cox Michael, M., Lehninger,(2008) Principles of Biochemistry, Macmillan Press, Worth Publishers, New Delhi.
12. Reddy, S. R. and Reddy, S. M. (2005). Microbial Physiology. Scientific Publishers India.
13. Sambrook, J. and Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
14. Stanier, R. Y., Ingrahm, J. I, Wheelis, M. L. and Painter, P. R. (1987). General Microbiology. 5th edition, McMillan Press.
15. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

III SEMESTER

DSC-3: MICROBIAL GENETICS AND RECOMBINANT DNA TECHNOLOGY

Paper III **64 (4hrs/week)**

Unit I **Genetic recombination and Phage genetics** **16 hrs**

Genetic Exchange: Transformation- Discovery, mechanism of natural competence. Conjugation-discovery, mechanism, Hfr and F' strains.Transduction-Generalized transduction, specialized transduction.Interrupted mating technique.Genome organization of*Escherichia coli,Saccharomyces*.

Phage Genetics: Features of T4 genome. , Genetic basis of lytic versus lysogenic switch of phagelambda.

Unit II **Genetics of Plasmids and Transposons** **16 hrs**

Plasmid genetics: Types of plasmids- F plasmid, R Plasmids, Ti plasmids, linear plasmids,yeast-2 μ plasmid.

Transposable elements: Prokaryotic transposable elements-Insertion Sequences, composite andnon-composite transposons.

Mutation: Mutations andmutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Functional mutants (loss and gain of function mutants); Uses of mutations. Damage and repair of DNA: Photoreactivation&SOS repair. Ames test.

Unit III **Introduction to Genetic Engineering** **16 hrs**

Molecular tools in gene cloning:Milestones in genetic engineering. Cloning tools: Restrictionmodification systems- Types, Mode of action, nomenclature, applications of restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases, methylases, Terminal deoxynucleotidyltransferase, kinases and phosphatases, and DNA ligases. **Cloning Vectors**: Definition and Properties Plasmid vectors: pBR and pUC series.Bacteriophage lambda and M13 based vectors. Cosmids, BACs, YACs.

Unit IV **Methods in Molecular Cloning** **16 hrs**

Isolation and Detection of DNA: Isolation of genomic DNA and plasmid DNA, separation of DNA by Agarose gelelectrophoresis,Transformation of DNA: Physical method (Microinjectio,n Biolisticand electroporation) Chemical method (Calcium phosphate and Liposome mediated DNA transfer), Electrical method(Electroporation). Blotting techniques-Southern blotting, Northern blotting, dot blot, DNA microarray analysis, Western blotting.PCR.DNA sequencing-Maxam and Gilbert method, Sanger's method and automated method of sequencing.

Applications of Recombinat DNA Technology: Genomic and cDNA libraries: construction anduses. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - Cotton, Gene therapy, recombinant vaccines.

SEMESTER-IV
MICROBIAL GENETICS AND RECOMBINANT DNA TECHNOLOGY

PRACTICAL-IV **(4hrs/week)**

1. Isolation of antibiotic resistant mutants by replica plating method
2. Study of survival curve of bacteria after exposure to ultraviolet (UV) light
3. Isolation of antibiotic resistant mutants by gradient plate method.
4. Study of effect of metals on bacterial cells
5. Demonstration of Bacterial Conjugation
6. Preparation of Buffers – TAE, TE, Lysis buffer
7. Estimation of DNA by dipenylamine method
8. Estimation of RNA by orcinol method.
9. Isolation of genomic DNA from bacteria.
10. Isolation of Plasmid DNA from bacteria.
11. Separation and Visualization of DNA by Agarose Gel Electrophoresis.
12. Preparation of competent cells for transformation
13. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
14. Isolation of coliphages from sewage.
15. Spotters based on the theory syllabus.

SUGGESTED READING

1. Brown, T. A. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark, D. P. and Pazdernik, N. J. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Gardner, E. J., Simmons, M. J. and Snustad, D. P. (2008). Principles of Genetics. 8th Ed. Wiley-India.
4. Klug, W. S., Cummings, M. R., Spencer, C. and Palladino, M. (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.
5. Krebs, J., Goldstein, E. and Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
6. Maloy, S. R., Cronan, J. E. and Friefelder, D.(2004) Microbial Genetics 2nd edition. Jones and Barlett Pub.
7. Pierce, B. A. (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.
8. Primrose, S. B. and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
9. Primrose, S. B. and Twyman, R. M. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
10. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
11. Sambrook, J. and Russell, D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

12. Sambrook, J. and Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
13. Watson, J. D., Baker, T. A., Bell, S. P. et al., (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings.
14. Wiley, J. M., Sherwood, L. M. and Woolverton, C. J. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.

IV SEMESTER

DSC-4: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Paper IV **64 (4hrs/week)**

Unit I **Microbiology of Air and Soil** **16 hrs**

Aeromicrobiology: Definition,aim and scope of aerobiology. Sources of microorganisms,Airomicroflora of indoor and outdoor environment, factors affecting air spora. Techniques of trapping air-borne microorganisms: Gravity slide, Petriplateexposre, Vertical clinder spore trap, Rotorod sampler, Andersen sampler, impingers and filtration.

Microbiology of Soil: Definition andtypes soil, soil profile and physical characteristics of soil-mineral particles, organic residues, water and gases. Microbial flora of soil: a brief account of bacteria, fungi, actinomycetes, and viruses. Role of microbes in soil processes: Biodegradation of pectin, cellulose and lignin. Rhizosphere microorganisms: Rhizosphere and rhizoplane. Plant growth promoting rhizobacteria.Plant microbe interaction-mycorrhizae.

Unit II **Microbiology of water and Waste water** **16 hrs**

Aquatic Microbiology: Water as a microbial habitat. Microorganisms of freshwater, marinewater and brackish water.Water borne disease; Bacterial- Cholera, Viral – Hepatitis, Protozoan – Amoebiasis.Biological indicators of faecal pollution. Microbiological analysis of water: SPC,Tests for coliform, MPN, IMViC reactions, membrane filter technique. Water purificatiion in municipal water supply.

Sewage Microbiology: Sources of waste water. Physical, chemical and microbiologicalcharacteristics of waste water. Waste water treatment: Single dwelling unit-septic tank,municipal waste water treatment-primary(screening,coagulation and sedimentation), secondary(trickling filter, activated sludge process, oxidation pond) tertiary (any one). Methods of solid waste disposal (composting and biogas).BOD.

Unit III **Microbes in sustainable agriculture** **16 hrs**

Biofertilization:Biofertilizers-Definition,types-Nitrogen fixing, phosphate solubilizing andVAM. Mass production, mode of applications, advantages and limitations of bacterial inoculants (*Rhizobium, Azotobacter, Azospirillum,cyanobacteria*).Role of VAM in soil fertility. Novel combination of microbes as biofertilizers.

Biological control: Introduction, Biopesticides: Definition types-bacterial, viral and fungal - mode of action,factors influencing, target pests. Microbial herbicides .GM crops-advantages, social and environmental aspects of Bt crops.

Unit IV :**Plant pathology**

Introduction to plant pathology: Historical developments in brief, classification of plantdiseases,Spread of diseases in general.Stages in development of a disease

Plant diseases: Study of symptoms, etiology, epidemiology and management of diseases causedby fungi (Tikka disease of groundnut, Downy mildew of grapes, blast disease of paddy, Rust of sorghum and powdery mildew of mulberry), bacteria (Citrus canker, Bacterial blight of rice, Mycoplasm (Sandal spike), viruses (Bunchy top of banana) and viroid(Potato spindle tuber disease)..

SEMESTER-IV
ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

PRACTICAL-IV **(4hrs/week)**

1. Isolation of air-borne microorgnisms (bacteria and fungi) by petriplate exposure method
2. Demonstation of air samplers-Gravity slide technique, equipment/photographs of vertical cylinder spore trap, Rotarod sampler, Hirst spore trap, Andersen sampler, bead bubbler, Membrane filter
3. Isolation and enumeration of bacteria from soil by serial dilution method.
4. Standard analysis of water samples and Determination of MPN
5. IMViC reactions
6. Water quality testing by H_2S strip test
7. Microscopic observation of water samles for biological indicator microorganisms of water pollution
8. Display of photographs of water purification process (Baffles, Flocuulator, Clarifier, Sand filter, Backwash, chlorinometer and chloroscope)
9. Determination of BOD of sewage
10. Estimation of total solids of sewage
11. Display of photographs-Septic tank, Trickling filter, activated sludge process, oxidation pond, sedimentation tank, anaerobic digester
12. Study of antagonism between microorganisms.
13. Study of VAM, Biofertilizer and Biopesticides samples
14. Study of plant diseases: Gram staining of citrus canker specimen and mounting of fungal specimens-Downy mildew of grapes, powdery mildew of mulbery, rust of sorghum, blast disease of paddy and tikka disease of groundnut.
15. Visit to water treatment plant/sewage treatment plant, industrial effluent treatment plant and agriculture research station.

SUGGESTED READING

1. Alexander, A.M. 1987. Introduction to soil Microbiology, 5th ed., John Wiley and sons.
2. Atlas, R. M. and Bartha, R. (1993). Microbial Ecology: Fundamentals and applications, 3rd ed., Benjamin and Cummings Pub.Co.Newyork.
3. Daniel Environmental Microbiology.
4. Grant, W.D. and P.E, Long: 1981 Environmental Microbiology, Thomson Litho ltd.
5. Mehrotra, R.S., Plant Pathalogy, Tata McGraw Hill Pubilications Limited, New Delhi.
6. Michael, J.Pelczar, Jr.E.C.S. Chan, Moel: Microbiology, McGraw Hill Book Company, New york).
7. Mitchell, R. (1992), Introduction to Environmental Microbiology, Prentice Hall Inc, Englewood Cliffs.
8. Powar and Daginwala (1996). General Microbiology, Vol 2. Himalaya Publishing House, Bombay.
9. Powar and Daginwala (1996). General Microbiology, Vol 1. Himalaya Publishing House, Bombay.
10. Rangaswamy, G. and Bagyaraj, D.J.(2001), Agricultural Microbiology, 2nd ed. Prentice hall of India pvt.ltd., New Delhi.
11. Rao, M.N. and Datta , A.K. (1987).Waste Water Treatment. Oxford and I.B.H.
12. Rheinhermer, G. (1986). Aquatic Microbiology JhonWiely and sons, New york.
13. SubbaRao, N.S.(2002) Soil Microorganisms and Plant Growth 4th ed., Oxford and IBH Pub.Co.Pvt.ltd., New Delhi.
14. SubhaRao, N.S., 1988. Biofertilizers in Agricultural 2nd ed.Oxford and IBH Pub.Co., New Delhi.

V SEMESTER

DSE-1.1: FOOD AND INDUSTRIAL MICROBIOLOGY

Paper V **64 (4hrs/week)**

Unit I **Food Microbiology** **16 hrs**

Spoilage of food: Food as a substrate for growth of microorganisms. Intrinsic and extrinsicfactors that affect growth and survival of microbes in foods.Sources of contamination.Microbial spoilage of fruits, vegetables, meat, fish and canned foods.

Principles and methods of food preservation: Physical methods of food preservation:temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids (propionates, benzoates, sorbates), Sulphur dioxide, nitrite and nitrates.

Unit II **Dairy Microbiology** **16 hrs**

Microbiology of milk: Sources of contamination of milk. Methods to detect microbial quality bySPC, Reductase test, Phosphotase test. Biochemical changes of milk-souring,gassy fermentation, proteolysis, lipolysis, ropiness. Starter culture and its role.Therapeutic value of

Yoghurt, Butter milk.Cheese (preparation and types).Preservation of milk and milk products-Pasteurization, UHT.

Food infection and safety: Food infection (Salmonellosis) and Food intoxication (Aflatoxin,Botulism). Food safety and quality control- brief account of HACCP, FSSAI and Food safety and standard act 2006.

Unit III **Industrial microbiology** **16 hrs**

Fermentor and fermentation medium: Microorganisms of industrial importance. Types ofstock culture. Strain improvement. Fermentation media: Production medium, Inoculum medium, Raw materials (Molasses and its types, corn steep liquor, sulphite waste liquor and whey). Buffers, Precursors, inhibitors and Antifoam agents. Design of typical fermentor: Devices for aeration, agitation.

Industrial processes-Batch and Continuous fermentation, Surface, Submerged and Solid statefermentation.**Downstream processing**-Precipitation, filtration, centrifugation, distillation, cell disruption, solvent recovery, drying, crystallization.

Unit IV **Industrial production** **16 hrs**

Microbial production of industrial products:Industrial production and uses of Ethyl alcool,wine, Penicillin, Citric acid, Amylase, *Spirulina*. Mushroom cultivation- White button mushroom and its nutrional value.

Enzyme immobilization: Methods of immobilization, advantages and applications ofimmobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

V SEMESTER
FOOD AND INDUSTRIAL MICROBIOLOGY

PRACTICAL-V **(4hrs/week)**

1. a) Isolation and enumeration of bacteria from food utensils
   b) Isolation and identification of fungi from food utensils
2. a) Isolation and enumeration of bacteria from spoiled vegetables/fruits
   b) Isolation and identification of fungi from spoiled vegeables/fruits
3. Quantitative examination of bacteria in raw and pasteurized milk by SPC method
4. Turbidity test to detect efficiency of sterilization
5. Methylene blue reductase test and Resazurin test to determine the quality of milk.
6. Determination of efficiency of Pasteurization by Phosphatase test
7. Casien hydrolysis test
8. Litmus milk test.
9. Isolation and biochemical characterization of lactic acid bacteria from fermented milk products.
10. Preparaion of wine from grapes
11. Preparation of alcohol using jaggery/molasses
12. Estimation of citric acid produced from *Aspergillusniger* by titrimetric method
13. Estimation of % alcohol in a given sample by specific gravity bottle method
14. Culturing of *Spirulina*

15. Visit to food industries/ food research laboratories, dairy industries and distilleries.

SUGGESTED READING

1. Adams, M.R. and Moss, M. O.(1995) Food Microbiology. Royal Society of Chemistry , Cambridge University Press.
2. Anathanarayanan, C and Paniker, C.K.J. (2009) Text Book of Microbiology, 9th ed. Orinet Longman ltd., Chennai.
3. Banwart, G.J.(1987) Basic Food Microbiology. CBS Publishers and distributors, New Delhi.
4. Casida,L. E. Jr (1968) Industrial Mirobiology. New Age International Publishers.
5. Frazier &Westhoff, D.C. (1995) Food Microbiology Tata McGraw Hill Pub. Company Ltd.,NewDehli.
6. Thomas, J. Kindt, Richard, A. Goldsby, Barbara A. Osborne, Janis Kuby, W. H. Freeman, (2007) Kuby Immunology, W. H. Freeman and Company New York.
7. Jagadish Chandra (1996). Text Book of Medical Mycology. Oreint Longman.
8. Jawetz, Melnick and Adelberg(2007) Medical Microbiolgy, Prentice Hall Inc, London.
9. Jay, J.M. (1985). Modern Food Microbiology.CBS Publishers and distributors, New Delhi.
10. Mackie and Mccatney, Medical Microbiolgy I and II. CharchillLivingston , 14th ed.
11. NandhiniShetty (1993). Immunology: Inductory Text Book . New Age International Ltd.
12. R.P.Singh, (2007) Immunology and Medical MicrobiologyKalyani Publishers; 2 edition
13. Rajan, S. (2007) Medical Microbiology. MJP Publishers, Chennai.
14. Roitt, I. M. (1997)Essentials of Immunology, ELBS, Blackwell Scientific Publishers, London.
15. Stanbury, P.T. and Whitaker,(1984) Principles of Fermentation Technology,PergamongPress, Newyork.
16. Tizard, I.R. (1998) . Immunology An Introduction, 2nd ed. W.B. Saunders, Philadelphia.

V SEMESTER

DSE-1.2: MICROBIAL BIOTECHNOLOGY AND BIOINFORMATICS

Paper V **64 (4hrs/week)**

Unit I **Microbial Biotechnology and its Applications** **16 hrs**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture(PGPR, Biofertilizers; *Rhizobium*, *Azotobacter*, Mycorrhizae). Genetically engineered microbes for industrial application: Bacteria and yeast.

Recombinant microbial production processes in pharmaceutical industries - Streptokinase,recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial insecticides, bioplastics Microbial biosensors.

Unit II **Microbial Products and their Recovery** **16 hrs**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization.

Microbes for Bio-energy and Environment: Bio-ethanol and bio-diesel production:commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery.

Unit III **Introduction to Bioinformatics** **16 hrs**

Introduction to Computer Fundamentals: RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.

Introduction to Bioinformatics and Biological Databases: Biological databases - primary and secondary- nucleic acid,genome, protein sequence and structure, FASTA. Examples; NCBI, EMBL, DDBJ, Uniprot, PDB.

Unit IV **Applications of bioinformatics** **16 hrs**

Sequence Alignments, Phylogeny and Phylogenetic trees: Local and Global Sequencealignment, pairwise and multiple sequence alignment.Types of phylogenetic trees, Different approaches of phylogenetic tree construction.Genome, transcriptome and proteome.

Protein Structure Predictions: Hierarchy of protein structure - primary, secondary and tertiarystructures, modeling Structural Classes, Motifs, Folds and Domains. Protein structure prediction.

SEMESTER-V

MICROBIAL BIOTECHNOLOGY AND BIOINFORMATICS

PRACTICAL-V **(4hrs/week)**

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins
6. Introduction to different operating systems - UNIX, LINUX and Windows
7. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
8. Sequence retrieval using BLAST
9. Sequence alignment & phylogenetic analysis using clustalW&phylip

SUGGESTED READING

1. Glazer, A. N. and Nikaido, H. (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press.
2. Glick, B. R., Pasternak, J. J. and Patten, C. L. (2010) Molecular Biotechnology 4th edition, ASM Press.
3. Gupta, P. K. (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
4. Lesk, M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition.
5. Pradeep and SinhaPreeti, (2007). Foundations of Computing, 4th ed., BPB Publications.

6. Prescott, Harley and Klein's Microbiology by Willey, J. M., Sherwood, L. M., Woolverton, C. J. (2014), 9th edition, McGraw Hill Publishers.
7. Primrose and Twyman, (2003) Principles of Genome Analysis & Genomics. Blackwell.
8. Rastogi, S.C., Mendiratta, N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication.
9. Ratledge, C. and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
10. Saxena Sanjay, (2003) A First Course in Computers, Vikas Publishing House.
11. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

V SEMESTER
SE-1.1: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES

Paper V **32 (2hrs/week)**

Unit I **Biosafety** **16 hrs**

Good laboratory practices: Good laboratory practices, Good microbiological practicesBiosafety cabinets; Working of biosafety cabinets, using protective clothing, specification for BSL1, BSL-2, BSL-3. Discarding biohazardous waste-Methodology of Disinfection, Autoclaving & Incineration.

Determining Microbes in Samples: Culture and microscopic methods- Standard plate count, Direct microscopic counts, Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit II **Microbiological quality analysis of Food and Water** **16 hrs**

Pathogenic Microorganisms of Importance in Food & Water: Enrichment culture technique,Detection of specific microorganisms, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay).

Food safety and Standard: HACCP for Food Safety and Microbial Standards. Hazard analysisof critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water-BIS standards for common foods and drinking water.

SUGGESTED READING

1. Baird, R. M., Hodges, N. A. and Denyer, S. P. (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
2. Garg, N., Garg, K. L. and Mukerji, K. G. (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Harrigan, W. F. (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.

4. Jay, J. M., Loessner, M. J., Golden, D. A. (2005) Modern Food Microbiology, 7th edition. Springer.

V SEMESTER

SE-1.2: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

Paper V **32 (2hrs/week)**

Unit I**AnalyticalAeromicrobiology** **16 hrs**

Microflora of Air: Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and theirimpact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Collection of air sample and Analysis: Bioaerosol sampling, air samplers, methods of analysis,CFU, culture media for bacteria and fungi, Identification characteristics. Control Measures: Fate of bioaerosols, inactivation mechanisms- UV light, HEPA filters, desiccation, Incineration

Unit II **Water Microbiology** **16 hrs**

Microbiological analysis of water sample: Microbiological analysis of water sample collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Control of microbes in water: Water borne pathogens, Control of waterborne pathogens- Precipitation, chemical disinfection, filtration, high temperature, UV light.

SUGGESTED READING

1. da Silva, N., Taniwaki, M. H., Junqueira, V. C., Silveira, N., Nascimento, M. S. and Gomes, R. A. R. (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press.
2. Atlas, R. M. and Bartha, R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
3. Maier, R. M., Pepper, I. L. and Gerba, C. P. (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Hurst, C. J, Crawford, R. L., Garland, J. L. and Lipson, D. A. (2007) Manual of Environmental Microbiology, 3rd edition, ASM press.

VI SEMESTER
DSE-2.1: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Paper VI **64 (4hrs/week)**

Unit I **Immunity and Immune system** **16 hrs**

Introduction to immune system: History of immunology.Contributions of following scientiststo the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Peter Medawar, Neils K Jerne, Tonegawa. Types of immunity-innate (non specific) and Adaptive immunity (specific)- Antibody (humoral) mediated immunity and cell mediate immunity.

Lymphatic system: cells and tissues of immune sysem-structure and role of primary lymphoidorgans (bone marrow, thymus), secondary lymphoid organs (spleen, lymph nodes and tonsils), Lymphoid tissues- MALT, GALT and CALT). B &T lmphocytes. Antigens- Definition, properties and types, Adjuvants. Antibodies-definition, structure, class- properties and functions of Immunoglobulins.Monoclonal antibodies and applications.

Unit II **Serological tests, Immunological disordersand Immunoprophylaxis** **16 hrs**

Antigen-antibody reactions: Definition**,** Salient features, Agglutination (Blood grouping,Widaltest) Precipitation (Gel diffusion techniques, Immunoelectroporesis), Neutralization, complement fixation test. Immunofluorescent techniques-RIA, ELISA.Serotyping.

Types of Autoimmunity andHypersensitivity with examples; Immunodeficiencies - SCID, Leukocyte adhesion deficiency, CGD-Types of tumors, Immunoprophylaxis-Vaccines-Types-Killed, Live attenuated and Toxoid with an example each. National immunization schedule (tabular Form)

Unit III **Medical Microbiology** **16 hrs**

Introduction to medical microbiology: History and development of medical microbiology.Normal flora of human body-skin, oral cavity, respiratory tract and urogenital tract.Infection-types of infection, modes of disease transmission, portal of entry of pathogen.Pathogenesis, virulence, attenuation and exaltation with an example each.Collection, transport and culturing of clinical samples.

Bacterial diseases: Cultural and biochemical characteristics, pathogenesis,symptoms, mode oftransmission, prophylaxis and control of bacterial infections *Mycobacterium tuberculosi*s. Gastrointestinal diseases: *Helicobacter pylori* Others:*Treponemapallidum.*

Unit IV **Viral, Fungal and Protozoan disease and Chemotherapy** **16 hrs**

Human pathogen: Pathogenesis, clinical symptoms, laboratory diagnosis, epidemiology,prophylaxis and treatment of Viral diseases (Dengue, AIDS, serum Hepatitis).A brief description of swine flu, Chikungunya. Fungal diseases-transmission, symptoms and

prevention of cutaneous mycoses (*Tinea*infection), systemic mycoses (Histoplasmosis)and opportunistic mycoses (Candidiasis). Protozoan diseases (Malaria).

Chemotherapy: General characteristics, types of chemotherapeutic agents. Mode of action of Antibacterial (Penicillin,Streptomycin) Antifungal (Nystatin), antiviral-Acycloguanosine. Antibiotic resistance, MDR, MRSA.

SEMESTER-VI
IMMUNOLOGY AND MEDICAL MICROBIOLOGY

PRACTICAL-VI **(4hrs/week)**

1. Determination of blood group and Rh factor
2. Demonstration of prcipitationreacion- ODD
3. Demonsatration of single Radial Immuno Diffusion
4. Widal Test
5. RPR test
6. Differential count of WBC
7. Culturing of microorganisms-Urine culture
8. Identify bacteria (*E. coli*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
9. Cultural, morphological and biochemical characteristics of *Staphylococcus.*
10. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar.
11. Study of bacterial flora of skin by swab method
12. Perform antibacterial sensitivity by Kirby-Bauer method
13. Study of various stages of malarial parasite in RBCs using permanent mounts.
14. Material/Microscopic observation/display of photographs of human pathogens as per theory syllabus- *Mycobacterium tuberculosis, Salmonellatyphi,*Hepatisis virus, HIV, *Candida albicans, Tinea, Plasmodium.*
15. Visit to pharmaceutical and pathology laboratory.

SUGGESTED READING

1. Abbas, A. K., Lichtman, A. H. and Pillai, S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Ananthanarayan, R. and Paniker, C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
3. 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.
4. Delves, P., Martin, S., Burton, D. and Roitt, I. M. (2006). Roitt's Essential Immunology.11th edition WileyBlackwell Scientific Publication, Oxford.
5. Glodsby Richard A., Kindt Thomas J. and Osborne Barbara A., Kuby Immunology, W. H. Freeman and Company New York.

6. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
7. Gupte, S.M.D. (1986). Short Text Book of Medical Microbiology. Jaypee Brothers, Medical Publishers, New Delhi.
8. Jagadish Chandra, (1996). Text Book of Medical Mycology. Oreint Longman.
9. Jawetz, Melnick, Adelberg, Medical Microbiolgy, Prentice Hall Inc, London.
10. JayaramPanicker, C.K. 1993 Text Book of Medical ParsitologyJaypee Brothers, Medical Publishers, New Delhi.
11. Mackie and Mccatney, Medical Microbiolgy I and II. CharchillLivingston , 14th ed.
12. Madigan, M. T., Martinko, J. M., Dunlap, P. V. and Clark, D. P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
13. Murphy, K., Travers. P. and Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland Science Publishers, New York.
14. NandhiniShetty 1993. Immunology: Inductory Text Book . New Age International Ltd.
15. Peakman, M. and Vergani, D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
16. R.P.Singh, Immunology and Medical Microbiology.
17. Rajan, S. Medical Microbiology. MJP Publishers, Chennai.
18. Richard, C. and Geiffrey, S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
19. Roitt, I.M., Essentials of Immunology, ELBS, Blackwell Scientific Publishers, London.
20. Stanbury, P.T. and Whitaker,(1984) Principles of Fermentation Technology, Pergamong Press, Newyork.
21. Tizard, I.R. (1998). Immunology An Introduction, 2nd ed. W.B. Saunders, Philadelphia.
22. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

DSE-2.2: ADVANCES IN MICROBIOLOGY, BIOSTATISTICS AND INTELLECTUAL PROPERTY RIGHTS

Paper VI **64 (4hrs/week)**

Unit I **Genomics and Metagenomics** **16 hrs**

Evolution of Microbial Genomes: Salient features of sequenced microbial genomes, coregenome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT).

Metagenomics: Brief history and development of metagenomics, Understanding bacterialdiversity using metagenomics approach. Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Unit II**Recent developments in Microbiology** **16 hrs**

Molecular Basis of Host-Microbe Interactions: Epiphytic fitness and its mechanism in plantpathogens, Hypersensitive response (HR) to plant pathogens and its mechanism. Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.

Systems and Synthetic Biology: Networking in biological systems, Quorum sensing in bacteria,Co-ordinated regulation of bacterial virulence factors, Future implications of synthetic biology.

Unit III **Biostatistics** **16 hrs**

Introduction to biostatistics: Data structure, sampling methods, data collection, tabulation. Graphical representation, histogram, frequency, polygon, frequency curve, mean, median, mode, mean deviation, standard deviation, standard error, co-efficient of variation.

Hypothesis testing: Z test, T test, Anova, multiple comparisons, LSD, DMRT, Chi – square test, regression and correlation. Non parametric.

Unit IV **Intellectual Property Rights** **16 hrs**

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & RelatedRights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications, importance of IPR, patentable and non patentables.

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT,Patent of Addition; Patent licensing and agreement;

SEMESTER-VI
ADVANCES IN MICROBIOLOGY, BIOSTATISTICS AND INTELLECTUAL PROPERTY RIGHTS

PRACTICAL-VI **(4hrs/week)**

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. Demonstration of PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers

4. Mean, Median, Mode from grouped and ungrouped Data set
5. Standard Deviation and Coefficient of Variation
6. Correlation
7. Regression

SUGGESTED READINGS

1. Bare Act, (2007).Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Bouarab, K., Brisson, and Daayf, F. (2009) Molecular Plant-Microbe interaction CAB International.
3. Caetano-Anolles, G. (2010) Evolutionary Genomics and Systems Biology, , John Wiley and Sons.
4. Danial, D (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
5. Edmondson. A. and Druce, D. (1996) Advanced Biology Statistics, Oxford University Press.
6. Fraser, C. M., Read, T. D. and Nelso,n K. E. (2004) Microbial Genomes, Humana Press.
7. Goel, D. and Prashar, S. (2013). IPR, Biosafety and Bioethics. Pearson.
8. Kankanala, C. (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
9. Klipp, E., Liebermeister, W. 9(2009) Systems Biology – A Textbook, Wiley –VCH Verlag.
10. Madigan, M. T., Martink, J. M., Dunlap, P. V. and Clark, D. P. (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings.
11. Miller, R. V. and Day, M. J.(2004) Microbial Evolution- Gene establishment, survival and exchange, ASM Press 3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press.
12. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
13. Sangdun, C. (2007) Introduction to Systems Biology, Humana Press.
14. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. (2008) IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.
15. Singh, K. K. (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.
16. Voit, E. O. (2012) A First Course in Systems Biology, Istedition,Garland Science.
17. Wilson,B. A., Salyers, A. A., Whitt, D. D. and Winkler, M. E. (2011)Bacterial Pathogenesis-A molecular Approach, 3rd edition, ASM Press.

VI SEMESTER

SE-2.1: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

Paper VI **32 (2hrs/week)**

Unit I **Sample collection, Examination and Diagnosis** **16 hrs**

Collection of clinical samples: Collection of Clinical Samples. How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage. Disease associated clinical samples for diagnosis.Importance of Diagnosis of Diseases Bacterial (Tuberculosis), Viral (HIV), Fungal (Candidiasis) andProtozoan Diseases (Palsmodium) of various human body systems.

Diagnostic Methods: diagnostic methods for M. Tuberculosis, HIV, Candida, Plasmodium.

Unit II**Pathogens detection by serological and molecular methods** **16 hrs**

Detection of pathogens:Serological and Molecular Methods: Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR. Kits for Rapid Detection of Pathogens- Typhoid, Dengue and HIV, Swine flu.Testing for Antibiotic Sensitivity in Bacteria- Importance,Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.

SUGGESTED READING

1. Ananthanarayan, R. and Paniker, C. K. J. (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
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. Randhawa, V. S., Mehta, G. and Sharma, K. B. (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd.
4. Tille, P. (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.
5. Collee, J. G., Fraser, A. G., Marmion, B. P. and Simmons, A. (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

VI SEMESTER

SE-2.2: MANAGEMENT OF HUMAN MICROBIAL DISEASES

Paper VI **32 (2hrs/week)**

Unit I **Human diseases** **16 hrs**

Human diseases types: Infectious and non infectious diseases, microbial and non microbialdiseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections.

Microbial diseases: Respiratory microbial diseases, gastrointestinal microbial diseases, Nervoussystem diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/ Ebola)- causes, spread and control, Mosquito borne disease- Types and prevention.

Unit II **Therapeutics and Prophylaxis of Microbial diseases** **16 hrs**

Treatments for Microbial diseases: Treatment using antibiotics: beta lactam antibiotics(penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides. Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Prevention of Microbial Diseases: General preventive measures, Importance of personalhygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

SUGGESTED READINGS

1. Ananthanarayan, R. and Paniker, C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
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. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
4. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

Madigan, M. T., Martinko, J. M., Dunlap, P. V. and Clark, D. P. (2014).Brock Biology of Microorganisms.14th edition.Pearson International Edition.

I SEMESTER
PRACTICAL-I: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Duration: 3 hours **Max. Marks: 20**

Write critical notes on A, B and C. **2x3=06 Marks**

(Microbiologists/ Microscopes/ Stains/ Disinfectants/ Laboratory equipments/ Different groups of bacteria)

II. Stain the given material D by…….. method. Write the principle and procedure. Leave the preparation for evaluation. **04 Marks**
(Direct staining/ indirect staining/ Gram staining/ Cell wall staining/Endospore staining)
(Preparation-2 Marks, Principle and Procedure- 2 Marks)

III. Identify the materials E, F and G with labelled diagrams and reasons. 2x3=06 Marks
(One material each from Cyanobacteria, Algae and Fungi)
(Identification- 1 Mark, Diagram and Reasons- 1 Mark)

IV. Identify the slides H and I with labelled diagrams and reasons. **2x2=04 Marks**
(One from Cyanobacteria/Algae, Another from Fungi/Protozoa)
(Identification- 1 Mark, Diagram and Reasons- 1 Mark)

II SEMESTER
PRACTICAL-II: MICROBIAL PHYSIOLOGY AND MOLECULAR BIOLOGY

Duration: 3 hours

Max. Marks: 20

I. Write critical notes on A, B and C. **2x3=06 Marks**
(Spectrophotometer, Colorimeter, pH meter, Culture media, DNA and RNA types, DNA replication, Transcription, Translation)

II. Conduct the given biochemical test D. Record and interpret the result. **04 Marks**
(Lactose fermentation / Gelatin and Starch hydrolysis / Catalase test / Oxidase test)
(Demonstration- 2 Marks, Results- 1 Mark, Interpretation- 1 Mark)

III. Demonstrate or perform the experiment E giving principle and procedure. Record the result. 06 Marks (Serial dilution / pour plate / spread plate / streak plate / point inoculation)
(Demonstration- 2 Marks, Principle- 1 Mark, Procedure- 2 Marks, Results- 1 Mark)

IV. Interpret the results of the experiment F and its significance. 04 Marks

(Effect of temperature on microbial growth / Effect of pH on Microbial growth / Effect of carbon source on microbial growth / Colony characteristics / Stab culture / Overlaying with mineral oil)

(Result interpretation- 2 Marks, Significance- 2 Marks)

III SEMESTER
PRACTICAL-III: MICROBIAL GENETICS AND RECOMBINANT DNA TECHNOLOGY

Duration: 3 hours **Max. Marks: 20**

I. Write critical notes on A, B and C. 2x3=06 Marks

(Transformation, Conjugation, Transduction, Genetic map, *Escherichia coli*, Plasmid, Transposons, DNA polymerases, pBR322, Bacteriophage, Microinjection, Biolistic, Southern blotting, Northern blotting, Microarray analysis, Western blotting, Colony hybridization)

II. Prepare/Demonstrate D. Write the significance. 04 Marks

(Phosphate buffer / Citrate buffer / competent cell)

(Preparation- 2 Marks, Significance- 2 Marks)

III. Demonstrate or perform the experiment E giving principle and procedure. Record the result. 06 Marks (Survival curve of bacteria exposure to UV light / Replica plating technique) (Demonstration- 2 Marks, Principle- 1 Mark, Procedure- 2 Marks, Results- 1 Mark)

IV. Write protocol for the experiment F by giving principle. 04 Marks

(Isolation of Plasmid DNA from *E.coli* /AMES test / Amplification of DNA by PCR /Blue white screening of recombinants /Bacterial conjugation) (Protocol writing- 3 Marks, Principle- 1 Mark)

IV SEMESTER
PRACTICAL-IV: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Duration: 3 hours **Max. Marks: 20**

I. Write critical notes on A, B and C. 2x3=06 Marks

(Air samplers, Baffles, Floculator, Clarifier, Sand filter, Backwash, chlorinometer, chloroscope, Septic tank, Trickling filter, activated sludge process, oxidation pond, sedimentation tank, anaerobic digester, Specimens of plant diseases, Biofertilizers)

II. Mount the given material D.Identify with reasons andlabelled diagrams. 04 Marks

(*Rhizobium* from root nodules / Fungal or bacterial plate exposed to air / Specimens of plant diseases / Bacterial or Fungal isolates from soil) (Preparation- 2 Marks, Identification- 1 Mark, Labelled diagram- 1 Mark)

III. Demonstrate or perform the experiment E giving principle and procedure. Record the result. 06 Marks

(Petriplate exposure method, Isolation and enumeration of bacteria from soil /Determination of MPN /Determination of BOD of sewage /Estimation of total solids of sewage /antagonism between microorganisms)

(Demonstration- 2 Marks, Principle- 1 Mark, Procedure- 2 Marks, Results- 1 Mark)

IV. Conduct or Identify the given test F. Record and interpret the result. 04 Marks

(Presumptive test / Confirmed test /Indole production test / MR test / VP test / H_2S strip test)

(Conduct / Identification- 2 Marks, Result- 1 Mark, Interpretation- 1 Mark)

V SEMESTER

PRACTICAL-V: FOOD AND INDUSTRIAL MICROBIOLOGY

Duration: 3 hours **Max. Marks: 40**

I. Write critical notes on A, B and C. 3x3=09 Marks

(Yoghurt, Butter milk. Cheese, Molasses, Antifoam agents, Fermentor, Ethyl alcool, Wine, Penicillin, Lactic acid, Citric acid, Amylase, *Spirulina*,*Chlorella*, Mushroom) (One from Food Microbiology, Two from Industrial Microbiology)

II. Demonstrate or perform the experiment D giving principle and procedure. Record the result. 10 Marks

(Isolation and enumeration of bacteria from food utensils /Isolation and identification of fungi from food utensils /Isolation and enumeration of bacteria from spoiled vegetables/fruits /Isolation and identification of fungi from spoiled vegeables/fruits) (Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

III. Demonstrate or perform the experiment E giving principle and procedure. Record the result. 10 Marks

(Estimation of citric acid produced from *Aspergillusniger* by titrimetric method / Estimation of % alcohol in sample by specific gravity bottle method)

(Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

IV. Conduct the given test for milk sample F. Record and interpret the result.06 Marks (Methylene blue reductase test / Resazurin test / Phosphatase test / Litmus milk test) (Demonstration- 2 Marks,Principle- 1 Mark, Procedure- 2 Marks, Results- 1Mark)

V. Viva-voce 05 Marks

V SEMESTER

PRACTICAL-V: MICROBIAL BIOTECHNOLOGY AND BIOINFORMATICS

Duration: 3 hours **Max.Marks: 40**

I. Write critical notes on A, B and C. **3x3= 09 Marks**
(Photographs or Charts partaining to the syllabus)
(Two from Microbial Technology, One from Bioinformatics)

II. Demonstrate or perform the experiment D giving principle and procedure. Record the result. 10 Marks (Quantification of pigment produced from fungi / Activity of xylanase or lipase producing bacteria / Characterization of algal Single Cell Proteins) (Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

III. Analyze the given sequence of genes or amino acidsE for homology. 10 Marks
(Sequence retrieval using BLAST / Sequence alignment & phylogenetic analysis using clustalW&phylip /Primary structure analysis protein / Secondary structure prediction using psipred / Homology modeling using Swissmodel) (Homology analysis- 6 Marks,Data interpretation- 4 Marks)

IV. Write the biological applications of the given Operating Systems or Database F. Mention its significance. 06 Marks (UNIX / LINUX / Windows / NCBIPDB / DDBJ / Uniprot / PDB) (Applications- 3 Marks, Significance- 3 Marks)

V. Viva-voce **05 Marks**

VI SEMESTER

PRACTICAL-VI: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Duration: 3 hours **Max. Marks: 40**

I. Write critical notes on A, B and C. **3x3=09 Marks**
(Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, bone marrow, thymus, spleen, lymph nodes, tonsils, Monoclonal antibodies,*Mycobacteriumtuberculosis, Tryponemapallidum, Salmonella typhi,* Hepatisis virus, poliovirus, HIV, *Candida albicans, Tinea, Plasmodium, Trichomonasvaginalis*)(Two from Immunology, One from Medical Microbiology)

II. Demonstrate or perform the experiment D giving principle and procedure. Record the result. 10 Marks (Blood group and Rh factor / Ouchterlony Double Diffusion / Single Radial Immuno Diffusion / Widal test / RPR test / Differential count of WBC) (Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

III. Demonstrate or perform the experiment E giving principle and procedure. Record the result. 10 Marks (Bacterial flora of skin by swab method / Antibacterial sensitivity by Kirby-Bauer method / Isoloation of bacteria from urine sample calibrated loop method) (Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

IV. Conduct the given biochemical test F for the bacterial culture by giving principle and procedure. Record and interpret the results. 06 Marks (TSI test / Nitrate reduction test / Urease production test / Catalase tests / Oxidase test) (Demonstration- 2 Marks,Principle- 1 Mark, Procedure- 2 Marks, Results- 1Mark)

V. Viva-voce **05 Marks**

VI SEMESTER
PRACTICAL-VI: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Duration: 3 hours **Max. Marks: 40**

I. Write critical notes on A, B and C. **3x3=09 Marks**
(Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, bone marrow, thymus, spleen, lymph nodes, tonsils, Monoclonal antibodies,*Mycobacteriumtuberculosis, Tryponemapallidum, Salmonella typhi*, Hepatisis virus, poliovirus, HIV, *Candida albicans, Tinea, Plasmodium, Trichomonasvaginalis*)(Two from Immunology, One from Medical Microbiology)

II. Demonstrate or perform the experiment D giving principle and procedure. Record the result. 10 Marks (Blood group and Rh factor / Ouchterlony Double Diffusion / Single Radial Immuno Diffusion / Widal test / RPR test / Differential count of WBC) (Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

III. Demonstrate or perform the experiment E giving principle and procedure. Record the result. 10 Marks (Bacterial flora of skin by swab method / Antibacterial sensitivity by Kirby-Bauer method / Isoloation of bacteria from urine sample calibrated loop method) (Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

IV. Conduct the given biochemical test F for the bacterial culture by giving principle and procedure. Record and interpret the results. 06 Marks (TSI test / Nitrate reduction test / Urease production test / Catalase tests / Oxidase test) (Demonstration- 2 Marks,Principle- 1 Mark, Procedure- 2 Marks, Results- 1Mark)

V. Viva-voce **05 Marks**

VI SEMESTER
PRACTICAL-VI: ADVANCES IN MICROBIOLOGY, BIOSTATISTICS AND INTELLECTUAL PROPERTY RIGHTS

Duration: 3 hours **Max. Marks: 40**

I. Write critical notes on A, B and C. **3x3=09 Marks**
(Horizontal gene transfer, Quorum sensing in bacteria, Biofilm formation, Photographs or charts related to syllabus)
(One from Advances in Microbiology, One from Biostatistics, One from IPR)

II. Demonstrate or perform the experiment D giving principle and procedure. Record the result. **10 Marks**
(Extraction of metagenomic DNA from soil / PCR amplification of metagenomic DNA)
(Demonstration- 4 Marks, Principle- 1 Mark, Procedure- 3 Marks, Results- 2 Marks)

III. Find the given parameter E for the biological data. **10 Marks**
(Mean, Median, Mode from grouped and ungrouped Data set / Standard Deviation and Coefficient of Variation / Skewness and Kurtosis / Correlation / Regression)

IV. Write protocol for the given concept F. Mention the significance. **06 Marks**
(Case study to understand how the poliovirus genome was synthesized in the laboratory / Case study to understand how networking of metabolic pathways in bacteria takes place / Filing primary applications for patents / Study of steps of a patenting process 5)
(Protocol writing- 3 Marks, Significance of the method- 3 Mark)

V. Viva-voce **05 Marks**