

Proposed Modular B.Sc. Microbiology Syllabus

Choice Based Credit System (CBCS)

&

Continuous Assessment and Grading

Pattern (CGPA)

2020-21

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

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
<u>Semester – I</u>						
1	MB-1.1	DSC	Introduction to Microbiology and Microbial Diversity	4:0:2	6	4:0:4
<u>Semester – II</u>						
1	MB-2.1	DSC	Microbial Physiology and Molecular Biology	4:0:2	6	4:0:4
<u>Semester – III</u>						
1	MB-3.1	DSC	Microbial Genetics and Recombinant DNA Technology	4:0:2	6	4:0:4
<u>Semester – IV</u>						
1	MB-4.1	DSC	Environmental and Agricultural Microbiology	4:0:2	6	4:0:4
<u>Semester – V</u>						
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
<u>Semester – VI</u>						
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 Health Clinics	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

Note: 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	15	-	15	-	35		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 15 MARKS WITH 1 HOUR DURATION AND REDUCED TO ASSIGNED MARKS. C3 WILL BE CONDUCTED FOR 35 MARKS.

I SEMESTER

DSC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Paper - I

64 (4 hrs/week)

Unit I: History of Microbiology and Microscopy

16 hrs

History of Microbiology: Microbial Origin and Evolution – LUCA, Branches and scope of Microbiology. Theory of spontaneous generation and biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, and Edward Jenner, Martinus Beijerinck Elie Metchnikoff, Alexander Fleming. Contributions of Indian scientists to Phycology and contributions of eminent Mycologists. Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility.

Microscopy: Light Microscopy- Different types of Microscopes, their construction and working principles. Simple microscopes (dissection microscope), Compound microscope (Types-Bright field, Dark field, Phase contrast and Fluorescence) Stereo microscope. Electron Microscope- Principle, construction and mode of operation of Scanning and Transmission electron microscope.

Preparation of specimen for electron microscopic studies -Fixation, Embedding, Ultra Thin Sectioning, Negative staining, Shadow Casting, and Freeze Etching. Advantages and limitations of TEM and SEM

Unit II: Techniques in Microbiology

16 hrs

Staining techniques for light microscopy: Types of microbiological stains and principles of staining. Simple staining (positive and negative), differential staining (Gram's staining and acid fast staining), structural staining (Cell wall, Capsule, 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 (Depth filters- Seitz filters, Sintered glass filter diatomaceous earth filters) Screening filters- (Membrane filters) and HEPA filter c) Radiation methods: UV radiation- (Ionizing and Non-Ionizing radiations). Chemical methods: Definition of terms-disinfectants, antiseptics, Sanitizers, Microbicides, microbiostatic. Use and mode of action of alcohols, aldehydes, halogens, phenols, peroxides, heavy metals, Detergents: Quaternary ammonium compounds.

Unit III: Microbial Diversity

16 hrs

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

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

Unit IV: Study of Viruses, Fungi, Algae and Protozoa

16 hrs

Viruses: General characteristics of viruses. Concept of viroids, Satellite viruses, virusoids and Prions. Structure of Viruses, Importance of viruses. Study and chemical composition of viruses. Isolation, Identification, cultivation of viruses. Nomenclature of viruses. Classification of viruses-ICTV and Baltimore system of classification. Structure and replication of viruses: a) Bacteriophages - T4 phage b) Cyanophages c) Phytophagenaе - TMV d) Zoophagenaе - Influenza.

General characteristics, thallus structure, reproduction and economic importance:

a) **Algae-** *Chlorella*, *Spirogyra*, *Diatoms* and *Gracilaria* b) **Fungi:** *Rhizopus*, *Saccharomyces*, *Aspergillus*, *Penicillium*, *Agaricus* and *Fusarium* and c) **Protozoa:** General characteristics, structure and reproduction of *Entamoeba*, *Euglena*, *Paramecium* and *Giardia*.

I SEMESTER

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

PRACTICAL - I

(4 hrs/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, Inoculation needle, membrane filter, laminar air flow system, colony counter. biological safety cabinets, BOD incubator, pH meter, centrifuge and colorimeter) used in the microbiology laboratory.
3. Study of simple and compound microscopes, their handling including oil immersion objective.
4. Measurement of microbial cell size by micrometry.
5. Preparation of stains, mordant and mounting media- Methylene blue, Crystal violet, Safranin, Nigrosin, Carbol Fuchsin, Malachite green, Grams iodine, Cotton blue.
- 5-7. Preparation of micrororganisms for light microscopic observation-simple (direct and indirect) staining, differential staining (Gram staining and Acid fast staining), Structural staining (Cell wall, Endospore and Capsule of bacteria).
8. Observation of bacterial motility by Hanging drop method.
9. Wet mounting of fungi and algae.
10. Microscopic measurements of microorganisms/spores using stage and ocular micrometer.
11. Study of cyanobacteria- *Microcystis*, *Spirulina* and *Anabaena*.
- 11-12. Study of *Rhizopus*, *Saccharomyces*, *Aspergillus*, *Penicillium*, *Agaricus* and *Fusarium* using temporary mounts.
- 13-14 Study of *Chlorella*, *Spirogyra*, *Diatoms* and *Gracilaria* using temporary mounts.
15. Study of the following protozoans using permanent mounts/photographs: *Entamoeba*, *Euglena*, *Paramecium* and *Giardia*.
16. Display of photographs of microscopes and Microbiologists mentioned in the theory.

SUGGESTED READINGS

1. Alexopoulos, 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, Donald A. Klein. (2002). *Microbiology*, 5th edition WCB Mc Graw 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*, Mc Graw 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 (4 hrs/week)

Unit I: Microbial Nutrition

16 hrs

Bacterial Nutrition: Major nutritional types of microorganisms, Nutritional requirements of microorganisms, Uptake of nutrients-passive, facilitated, active transport and Group Translocation. Siderophores. Bacterial growth: Growth rate and generation time (Definition), growth curve-phases of growth and their significance, Physical and chemical factors affecting growth. Measurement of growth by cell number and cell mass.

Cultivation of Bacteria: a) Culture Media-Types of 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, agar slants/slopes/stabs, Point inoculation and Micromanipulator-single cell isolation. Colony characteristics. d) Maintenance and preservation of pure cultures. e) **Culture Collection Centres** – ATCC and MTCC (a brief account)

Unit II: Microbial Metabolism

16 hrs

Chemoheterotrophic Metabolism: Aerobic respiration: Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain- uncouplers and inhibitors. Anaerobic respiration: Fermentation-Alcohol and lactic acid fermentation. Pasteur effect. **Phototrophic Metabolism and Nitrogen and Lipids metabolism:** Photosynthesis:photosynthetic microorganisms, oxygenic and anoxygenic types, light as a source of energy, photosynthetic pigments and apparatus in prokaryotes. Mechanism of photosynthesis in bacteria. Comparative account of photosynthesis in prokaryotes and eukaryotes. Nitrogen Metabolism: Biological nitrogen fixation-symbiotic and asymbiotic nitrogen fixation, nodule formation, mechanism and biochemistry of N₂ 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 and development of genetics. Chromosomes: prokaryotic and eukaryotic organization. Watson and Crick model of DNA, DNA types, super coiling 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 DNA replication; DNA polymerases, DNA ligase, primase, telomerase. General Mechanism, Modes: Bidirectional and unidirectional replication-conservative, semi-conservative and dispersive. Various models of DNA Replication: rolling circle and Θ (theta).

Unit IV: Gene Expression and Regulation

16 hrs

Transcription: Transcription- Definition, promoter- concept and strength of promoter, RNA Polymerase and the transcription unit. Post-transcriptional processing- Split genes, concept of introns and exons, RNA splicing and processing-concept of alternative splicing, polyadenylation and capping. RNA interference: si RNA, miRNA and its significance.

Translation: Gene-Protein relationship: One gene one enzyme and one gene- one polypeptide concept, colinearity of genes and proteins. Genetic code-features, Wobble hypothesis.

Mechanism of translation process in-Initiation, Elongation and termination. (both prokaryotes and eukaryotes)

Gene Regulation: Lac Operon Concept.

SEMESTER - II

MICROBIAL PHYSIOLOGY AND MOLECULAR BIOLOGY

PRACTICAL - II

(4 hrs/week)

1. Cleaning and sterilization of glassware.
2. Preparation of media-nutrient broth, nutrient agar, potato dextrose agar, Czapek dox agar, MacConkey's 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 method and 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 turbidometer/ photocolormeter/ spectrophotometer.
10. Study of bacterial growth Curve.
11. Identification of bacteroids from root nodules.
12. Measurement of growth by cell number using Haemocytometer.
13. Demonstration of fermentation of lactose and Kunhe's fermentation tube.
14. Starch hydrolysis and Gelatin hydrolysis.
15. Catalase and oxidase tests.
16. **Test to determine N₂ cycle:**
 - a) **Ammonification test:** To demonstrate the liberation of ammonia from nitrogenous organic compounds
 - b) **Nitrification test:** To demonstrate the enzymatic conversion of ammonia to nitrate by soil microorganisms
 - c) **Denitrification test:** To demonstrate the reduction of nitrates to nitrogen gas
17. 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 Microorganisms*, 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, Donald A. Klein, (2002). *Microbiology*, 5th ed. WCB Mc Graw 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 (4 hrs/week)

Unit I: Genetic recombination and Mutation

16 hrs

Genetic Exchange: Transformation- Discovery, mechanism of natural competence. Conjugation - discovery, mechanism, Hfr and F' strains. Transduction- Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination.

Mutation: Genome organization of *Escherichia coli*, *Saccharomyces*. Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Damage and repair of DNA: Photoreactivation & SOS repair. Ames test.

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, Plasmid replication and partitioning, Host range, plasmid amplification, Regulation of copy number and curing of plasmids.

Transposable elements: Prokaryotic transposable elements-Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon.

Phage Genetics: Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda.

Unit III: Introduction to Genetic Engineering

16 hrs

Molecular tools in gene cloning: Milestones in genetic engineering. Cloning tools: Restriction modification systems- Types, Mode of action, nomenclature, applications of restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases, methylases, Terminal deoxynucleotidyl transferase, 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 DNA, separation of DNA by Agarose gel electrophoresis, Transformation of DNA: Physical method (Microinjection and Biolistic) 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-types and applications. DNA sequencing- Maxam and Gilbert method, Sanger's method and automated method of sequencing. RFLP, DNA Finger printing.

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

SEMESTER - III

MICROBIAL GENETICS AND RECOMBINANT DNA TECHNOLOGY

PRACTICAL - III

(4 hrs/week)

1. Preparation of Master and Replica Plates.
2. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
3. Preparation of competent cells for transformation.
4. Demonstration of bacterial conjugation.
5. Demonstration of bacterial transformation and transduction.
6. Demonstration of AMES test.
7. Isolation of Genomic DNA.
8. Study the effect of physical (UV) and chemical (Metals) mutagens on bacterial cells.
9. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
10. Demonstration ligation of DNA fragments.
11. Demonstration of cloning of DNA insert and Blue white screening of recombinants.
12. Interpretation of sequencing gel electrophorograms.
13. Designing of primers for DNA amplification.
14. Demonstration of amplification of DNA by PCR.
15. Demonstration of Southern blotting.
16. Isolation of antibiotic resistance mutant by gradient plate technique.
17. Preparation of buffers: TE and TAE.
18. Estimation of DNA by DPA method
19. Estimation of RNA by orcinol method.
20. Study of following photographs: Vectors, Plasmids, blotting technique, Electrophoresis, PCR and Transgenic plant and animals.

SUGGESTED READINGS

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 (4 hrs/week)

Unit I: Microbiology of Air and Soil

16 hrs

Aeromicrobiology: Definition, aim and scope of aerobiology. Sources of microorganisms, Air microflora of indoor and outdoor environment, factors affecting air spora. Techniques of trapping air-borne microorganisms: Gravity slide, Petriplate exposure, Vertical cylinder spore trap, Rotorod sampler, Andersen sampler and Hirst spore trap, impingers and filtration.

Microbiology of Soil: Definition and types of 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, algae, protozoa 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.

Microbial Interactions: Positive Interactions- Mutualism, Synergism and Ammensalism. Negative Interactions- Antagonism, Competition, Predation and Parasitism. **Biogeochemical cycles:** Nitrogen, Carbon, Sulphur and Phosphorous cycle.

Unit II: Microbiology of water and Waste water

16 hrs

Aquatic Microbiology: Water as a microbial habitat. Distribution of microorganisms in aquatic environment: Microorganisms of freshwater, marine water and brackish Water borne pathogen-sources and types, Significance of water borne disease. Biological indicators of faecal pollution. Microbiological analysis of water: SPC, Tests for coliform, MPN, IMViC reactions, membrane filter technique. Water purification in municipal water supply.

Sewage Microbiology: Sources of waste water. Physical, chemical and microbiological characteristics of waste water, BOD and COD. 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 (Reverse Osmosis and Electrodialysis). Methods of solid waste disposal (composting and sanitary landfill). Composition and strength of sewage (BOD and COD).

Unit III: Microbes in sustainable agriculture

16 hrs

Biofertilization: Biofertilizers- Definition, types- Nitrogen fixing, phosphate solubilizing and VAM. 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, Nematophagy and Mycophagy. Microbial herbicides. GM crops- advantages, social and environmental aspects of Bt crops. Approaches towards IPM (Integrated Pest Management).

Unit IV: **Plant Pathology**

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

Plant diseases: Study of symptoms, etiology, epidemiology and management of diseases caused by fungi (Tikka disease of groundnut, Downy mildew of grapes, blast disease of paddy, Red rot of sugarcane, Powdery mildew of mulberry and Rust of sorghum), bacteria (Citrus canker, Bacterial blight of rice, Angular leaf spot of cotton, Mycoplasma (Sandal spike), viruses (Bean Mosaic Virus, Tobacco Mosaic Virus, Bunchy top of banana, Papaya ring spot) and viroid (Potato spindle tuber disease).

SEMESTER - IV

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

PRACTICAL - IV

(4 hrs/week)

1. Isolation of air-borne microorganisms (bacteria and fungi) by petriplate exposure method.
2. Demonstration of air samplers-Gravity slide technique, equipment/photographs of vertical cylinder spore trap, Rotarod sampler, Hirst spore trap, Andersen sampler, bead bubbler, Membrane filter AGI 30.
3. Isolation and enumeration of bacteria and fungi from soil by serial dilution method.
4. Isolation of rhizosphere and rhizoplane microorganisms.
5. Standard analysis of water samples and Determination of MPN.
6. IMViC reactions.
7. Water quality testing by H₂S strip test.
8. Microscopic observation of water samples for biological indicator microorganisms of water pollution.
9. Display of photographs of water purification process (Baffles, Flocculator, Clarifier, Clariflocculator, Sand filter, Backwash, chlorinometer and chloroscope).
10. Determination of BOD of sewage.
11. Estimation of total solids of sewage.
12. Display of photographs-Septic tank, Trickling filter, activated sludge process, oxidation pond, sedimentation tank, anaerobic digester.
13. Study of antagonism between microorganisms.
14. Isolation and identification of *Azotobacter* from soil.
15. Isolation of actinomycetes from soil using glucose aspergine agar by plate methods.
16. Isolation and identification of *Rhizobium* from root nodules.
17. Study of VAM, Biofertilizer and Biopesticides samples.
18. Study of plant diseases: Gram staining of citrus canker specimen and mounting of fungal specimens-Downy mildew of grapes, powdery mildew of mulberry, rust of sorghum, blast disease of paddy and tikka disease of groundnut BMV and TMV.
19. Visit to water treatment plant/sewage treatment plant, industrial effluent treatment plant and agriculture research station.

SUGGESTED READINGS

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., New York.
3. Daniel Environmental Microbiology.
4. Grant, W.D. and P.E, Long: (1981). Environmental Microbiology, Thomson Litho Ltd.
5. Mehrotra, R.S., Plant Pathology, Tata Mc Graw Hill Publications Limited, New Delhi.
6. Michael, J. Pelczar, Jr.E.C.S. Chan, Moel: Microbiology, Mc Graw Hill Book Company, New York).
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8. Powar and Daginwala (1996). General Microbiology, Vol 1. Himalaya Publishing House, Bombay.
9. Powar and Daginwala (1996). General Microbiology, Vol 2. 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 Jhon Wiely and sons, New York.
13. Subba Rao, N.S. (2002). Soil Microorganisms and Plant Growth 4th ed., Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
14. Subha Rao, N.S. (1988). Biofertilizers in Agriculture, 2nd ed.Oxford and IBH Pub. Co., New Delhi.

V SEMESTER

DSE-1.1: FOOD AND INDUSTRIAL MICROBIOLOGY

Paper - V

64 (4 hrs/week)

Unit I: Food Microbiology

16 hrs

Spoilage of food: Food as a substrate for growth of microorganisms. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods. Sources of contamination. Groups of bacteria important in food bacteriology. Microbial spoilage and preservation of fruits, vegetables, meat, poultry, 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), SO₂, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit II: Dairy Microbiology

16 hrs

Microbiology of milk: Sources of contamination of milk. Methods to detect microbial quality by SPC, Reductase test, Phosphatase test, clot on boiling 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.

Food infection and safety: Food infection (Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes*) **Food intoxication-** (Aflatoxin, Staphylococcal Intoxication, 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 of stock cultures. 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 state fermentation. 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 alcohol, wine, Penicillin, Lactic acid, Citric acid, Amylase, *Spirulina* and *Chlorella*. Mushroom cultivation- Oyster mushroom and its nutritional value.

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

V SEMESTER
FOOD AND INDUSTRIAL MICROBIOLOGY
PRACTICAL - V

(4 hrs/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 vegetables/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 of lipolytic microorganisms from butter.
10. Estimation of % of lactic acid present in given fermented dairy products.
11. Identification of *Aspergillus* on groundnut by Blotter's method.
12. Isolation of antibiotic producing microorganisms from soil by Crowded-Plate Technique.
13. Isolation and biochemical characterization of lactic acid bacteria from fermented milk products.
14. Preparation of wine from grapes.
15. Preparation of alcohol using jaggery/molasses.
16. Estimation of citric acid produced from *Aspergillus niger* by titrimetric method.
17. Estimation of % alcohol in a given sample by specific gravity bottle method.
18. Culturing of *Spirulina/Chlorella*.
19. Visit to food industries/ food research laboratories, dairy industries and distilleries.

SUGGESTED READINGS

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 Microbiology. New Age International Publishers.
5. Frazier & Westhoff, D. C. (1995). Food Microbiology Tata McGraw Hill Pub. Company Ltd., New Dehli.
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.
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12. R.P.Singh, (2007). Immunology and Medical Microbiology, Kalyani Publishers; 2nd edition
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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, New York.
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 (4 hrs/week)

Unit I: **Microbial Biotechnology and its Applications**

16 hrs

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. 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 production of bio-pesticides, 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, removal of heavy metals from aqueous effluents.

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 - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

Unit IV: **Applications of bioinformatics**

16 hrs

Sequence Alignments, Phylogeny and Phylogenetic trees: Local and Global Sequence alignment, pairwise and multiple sequence alignment. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood. Genome organization and analysis. Diversity of Genomes: prokaryotic & eukaryotic genomes Genome, transcriptome and proteome.

Protein Structure Predictions: Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains. Protein structure prediction in presence and absence of structure template.

SEMESTER - V

MICROBIAL BIOTECHNOLOGY AND BIOINFORMATICS

PRACTICAL - V

(4 hrs/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.
10. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool.
11. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK).
12. Prediction of different features of a functional gene.

SUGGESTED READINGS

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 Sinha Preeti, (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, Mc Graw 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 (2 hrs/week)

Unit I: Biosafety

16 hrs

Good laboratory practices: Good laboratory practices, Good microbiological practices Biosafety 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, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products 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- on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud 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 analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water-BIS standards for common foods and drinking water.

SUGGESTED READINGS

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 (2 hrs/week)

Unit I: Analytical Aeromicrobiology

16 hrs

Microflora of Air: Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact 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, water borne diseases, Control of water borne pathogens- Precipitation, chemical disinfection, filtration, high temperature, UV light.

SUGGESTED READINGS

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 Water A 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 (4 hrs/week)

Unit I: Immunity and Immune system

16 hrs

Introduction to immune system: History of immunology. Contributions of following scientists to 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 lymphoid organs (bone marrow, thymus), secondary lymphoid organs (spleen, lymph nodes and tonsils), Lymphoid tissues- MALT, GALT and CALT). B & T Lmphocytes. Antigens- Definition, nature(Foreignness, Molecular size and Heterogeneity) and types, Adjuvants.Antibodies-definition, sturcture, class- properties and functions of Immunoglobulins.Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic), VDJ rearrangements.

Unit II: Serological tests and Immunological disorders

16 hrs

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

Immunological disorders and Immunoprophylaxis: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - SCID, DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD-Types of tumors, tumor Antigens, causes and therapy for cancers. Immunoprophylaxis- Vaccines types- Killed, Live attenuated and Toxoid with an example each. National Immunization Schedule, MissionIndradhanush.

Immunotherapy– Anti Tetanus Serum (ATS). Hybridoma Technology: Monoclonal Antibodies.

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 of transmission, prophylaxis and control of Respiratory diseases (*Streptococcus pyogenes*, *Mycobacterium tuberculosis*). Gastrointestinal diseases: *Salmonella typhi*, *Helicobacter pylori* Others: *Bacillus anthracis*, *Treponema pallidum*.

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, Rabies). A brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis. Fungal diseases-transmission, symptoms and prevention of cutaneous mycoses (Athlete's foot), systemic mycoses (Histoplasmosis) and opportunistic mycoses (Candidiasis). Protozoan diseases (Malaria, Kala-azar).

Chemotherapy: General characteristics, types and of antibacterial agents. Mode of action of Antibacterial (Penicillin, Streptomycin) Antifungal (Nystatin), antiviral-Acycloguanosine. Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

SEMESTER-VI

IMMUNOLOGY AND MEDICAL MICROBIOLOGY

PRACTICAL - VI

(4 hrs/week)

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

SUGGESTED READINGS

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 Microbiology, Prentice Hall Inc, London.
10. Jayaram Panicker, C.K. (1993). Text Book of Medical Parsitology Jaypee Brothers, Medical Publishers, New Delhi.
11. Mackie and Mc catney, Medical Microbiology I and II. Charchill Livingston, 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's Immunobiology. 7th edition Garland Science Publishers, New York.
14. Nandhini Shetty 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 (4 hrs/week)

Unit I: Genomics and Metagenomics

16 hrs

Evolution of Microbial Genomes: Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics.

Metagenomics: Brief history and development of metagenomics, Understanding bacterial diversity 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 plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, 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, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses.

Unit III: Biostatistics

16 hrs

Introduction to biostatistics: Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions.

Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test.

Unit IV: Intellectual Property Rights

16 hrs

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications, importance of IPR, patentable and non patentables, patenting life-legal protection of biotechnological inventions, World Intellectual Property Rights Organization (WIPO).

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

SEMESTER - VI

ADVANCES IN MICROBIOLOGY, BIostatISTICS AND INTELLECTUAL PROPERTY RIGHTS

PRACTICAL - VI

(4 hrs/week)

1. Extraction of metagenomic DNA from soil.
2. Understand the impediments in extracting metagenomic DNA from soil.
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers.
4. Case study to understand how the poliovirus genome was synthesized in the laboratory.
5. Case study to understand how networking of metabolic pathways in bacteria takes place.
6. Mean, Median, Mode from grouped and ungrouped Data set.
7. Standard Deviation and Coefficient of Variation.
8. Skewness and Kurtosis.
9. Correlation.
10. Regression.
11. Filing primary applications for patents.
12. Study of steps of a patenting process 5.

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 Nelson 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. (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-Benjamin 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 Pvt. 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 Intellectual Property Rights: Legal and Social Implications, Springer India.
16. Voit, E. O. (2012). A First Course in Systems Biology, Ist edition, 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 (2 hrs/week)

Unit I: **Sample collection and Examination**

16 hrs

Collection of clinical samples: Importance of Diagnosis of Diseases Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis. 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.

Microscopic examination and culture: Direct Microscopic Examination and Culture. Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit II: **Pathogens detection and Antibiotic sensitivity test**

16 hrs

Detection of pathogens: Serological and Molecular Methods: Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Kits for Rapid Detection of Pathogens- Typhoid, Dengue and HIV, Swine flu.

Antibiotic sensitivity test: 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 READINGS

1. Ananthanarayan, R. and Paniker, C. K. J. (2009). Textbook of Microbiology, 8th edition, Universities Press Pvt. 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 (2 hrs/week)

Unit I: **Human diseases**

16 hrs

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

Microbial diseases: Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system 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 personal hygiene, 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.
5. 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

I. 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

Max. Marks: 20

Duration: 3 hours

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, Flocculator, 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 and labelled 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 / H₂S 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 alcohol, 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 vegetables/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 *Aspergillus niger* 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 pertaining 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 acids E 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 / NCBI PDB / 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, *Mycobacterium tuberculosis*, *Trypanema pallidum*, *Salmonella typhi*, Hepatitis virus, poliovirus, HIV, *Candida albicans*, *Tinea*, *Plasmodium*, *Trichomonas vaginalis*)

(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 / Isolation 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**