

Department of Biological Sciences, Aliah University, Newtown, Kolkata

Draft Syllabus for the 3 Years B.Sc. Honours Degree in Microbiology under the program of integrated Master Degree in Biological Sciences (Microbiology)

[Only for the first (2016-19) batch]

Overall Curriculum

Semester	Theory			Practical		
	Course Code	Course Title	Marks/Credits	Course Code	Course Title	Marks/Credits
I	BM101	Macromolecules	50/4	BM 191	Microbiology lab I	50/4
	BM103	Microbial nutrition and microbial growth	50/4			
II	BM102	Bacterial Morphology	50/4			
	BM104	Effect of drugs on microbes, bacterial culture and staining	50/4			
	BM106	History of microbiology and kingdoms of classification	50/4			
III	BM201	Biochemistry	50/4	BM 291	Microbiology lab II	50/4
IV	BM202	Bio-techniques and Cell & Molecular Biology	50/4	BM 292	Microbiology lab III	50/4
V	BM301	Microbial Genetics and Recombinant DNA Technology	50/4	BM391	Microbiology lab IV	50/4
	BM303	Immunology	50/4	BM393	Microbiology lab V	50/4
	BM305	Virology and Medical Microbiology	50/4			
VI	BM302	Environmental Microbiology	50/4	BM392	Microbiology lab VI	50/4
	BM304	Industrial Microbiology	50/4			
	BM306	Food and Dairy Microbiology	50/4			
	BM308	Bioinformatics and IPR	50/4			
				BM 382	Project Work	50/4
Total			700/56			350/28
Grand Total	1050 Marks / 84 Credits					

Detailed Syllabus

Semester I

BM101

Macromolecules

Total Marks 50, Credits 4

Unit 1. Stereochemistry:

General concepts on: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature; Projection formula (Fischer & Howarth); Isomers: anomers, epimers. Stereochemistry of cyclohexane: idea of axial & equatorial bonds (related to chair form conformation), Important chemical reactions relating to configurations, Mutarotation and its mechanism.

Unit 2. Carbohydrates:

Definition, classification and structural concept of: Monosaccharides: Hexoses (only Glucose), Pentoses (Ribose, Ribulose, Xylose) Disaccharides: Sucrose, Lactose, Maltose; Amino Sugars: Glucosamine, Muramic Acid Inversion (hydrolysis) of cane sugar. Chemical reactions of monosaccharides (glucose & fructose i.e., aldose and ketose) with HNO_3 , Br_2 -water, HIO_4 , Phenylhydrazine. Principle of chemical estimation of sugar. Anomeric effect (Methylation effect). Polysaccharides: Chemical structure of Starch (α -amylose, amylopectin), glycogen & cellulose. Smith degradation and enzymic hydrolysis of α -amylose & amylopectin.

Unit 3. Amino Acids:

Definition, classification, structure, stereochemistry of amino acids; Physico-chemical properties (Ionization & Biuret reaction) of amino acids. Amphoteric molecule, Zwitterion, pK values; Isoelectric point, Electrophoresis, Formol titration of Glycine (only reaction & principle). Reaction with Ninhydrin, FDNB, Dansyl & Dabsyl chloride, Fluorescamine, Van-slykes reaction. Reactions of carboxyl & amino groups. Synthesis of Glycine. Separation of amino acids by Ion-exchange, Gel filtration, Paper Chromatography and Thin layer Chromatography. Peptides: peptide bond, biologically important peptides (glutathione, oxytocin-important functions).

Unit 4. Proteins:

Classification (Primary, Secondary, Tertiary, Quaternary- definition, examples) Forces that stabilize structure of proteins: H-bonds, hydrophobic interaction, electrostatic attraction, Van der Waal's interaction, dipole-dipole interaction. Types of proteins: i) Fibrous (α -helix, β -sheet, e.g. collagen): definition and structure. ii) Globular (Haemoglobin, Myoglobin): definition & examples. iii) Simple proteins and conjugated protein: definition & examples—physical denaturation and renaturation.

Unit 5. Nucleic acid:

Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). Chemical Properties: Hydrolysis (acid, alkali), enzymatic hydrolysis of DNA. General structure and types of RNA (tRNA, mRNA, rRNA). Viscosity, Buoyant density. Hyperchromic effect. Cot curve, T_m .

Unit 6. Lipids:

Definition, nomenclature, classification - (simple, complex, derived lipids - structure & example) phospholipids, glycolipids, - (structure, composition); hydrolysis, saponification, saponification number, I₂ number, acetylation, acetyl number, volatile fatty acid number - definition and related problems, Isomerism - cis-trans isomerism. Fatty acids: Saturated (palmitic acid, stearic acid), unsaturated (oleic acid): Structure of free fatty acids (example only). General chemical reaction of fatty acids - esterification. Hydrogenation and halogenations.

Annexure III

SUGGESTED READINGS:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

BM103

Microbial nutrition and microbial growth

Total Marks 50, Credits 4

Unit 1. Microbial Nutrition and media:

Nutritional types (definition and example) - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria); Chemoorganotrophs, Effect of oxygen on growth - classification on the basis of oxygen requirement and tolerance. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, acid-base indicator, enriched and enrichment media.

Unit 2. Bacterial Growth:

Growth phases - Generation time. Kinetics of growth, Batch culture. Continuous culture, Synchronous culture (definition and brief description). Physical factors influencing growth - Temperature, pH, osmotic pressure, salt concentration.

Unit 3. Eukaryotic microbes:

General characteristics, vegetative & reproductive structure of the following groups of microorganisms: Algae: Cyanophyta, Chlorophyta, Bacillariophyta, Phacophyta, Rhodophyta, Fungi: Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes; Protozoa: Giardia, Plasmodium & Entamoeba.

SUGGESTED READINGS:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Willey JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

BM 191
Microbiology lab I
Total Marks 50, Credits 4

1. Microbiology Good Laboratory Practices and Biosafety.
 2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
 3. Preparation of culture media (Nutrient broth/agar, Luria-bertini broth/agar) for bacterial cultivation.
 4. Sterilization of medium using Autoclave and assessment for sterility.
 5. Sterilization of glassware using Hot Air Oven.
 6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
 7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air and water.
 8. Operation of Light-Microscope; use of oil-immersion objective.
 9. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary/permanent mounts.
 10. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary/permanent Mounts
 11. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.
 12. Simple staining of Bacteria/Yeast and observation under Light Microscope.
-

Semester II

BM 102
Bacterial Morphology
Total Marks 50, Credits 4

Unit 1. Bacterial Morphology and subcellular structures:

Morphology of bacteria: shape, size and arrangement. Slime layer, Mycelial morphology: Actinomycetes, Capsule, Ribosome, Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic); Exospores & Cysts: types & structure; Endospore, Flagella, Pilus, Fimbriae (structure, composition and functions). Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome).

Unit 2. Bacterial cell wall biosynthesis and structure:

Detailed structure of cell wall of bacteria and archaea; biosynthesis of peptidoglycan

Suggested Readings:

1. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

BM 104

Effect of drugs on microbes, bacterial culture and staining

Total Marks 50, Credits 4

Unit 1. Control of growth of Microbes:

Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent (definition, application & examples); physical method of disinfection and sterilization - dry heat, moist heat, filtration, radiation (mode of action, applications); Chemical control – dye solutions, alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives, formaldehyde, ethylene oxide, detergents (mode of action, applications). Assessment of chemical disinfectant; phenol coefficient-definition and method of determination. Chemotherapeutic agents - sulphonamides, antibiotics, (definition types); mechanism of action and antimicrobial spectrum of penicillin, streptomycin, tetracycline, chloramphenicol, Nalidixic acid and metronidazole; drug resistance - phenomena and mechanism.

Unit 2. Bacteriological culture Techniques

Concept of and isolation of Pure culture: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit 3. Stains & Staining techniques:

Definition of auxochrome; Chromophores; Acidic and Basic dyes; Classification of stains; Simple and differential staining: theories of staining, mordant and its function; Gram staining; acid fast staining; endospore staining; negative staining; capsule staining; flagella staining; mechanism of gram staining.

SUGGESTED READINGS:

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
12. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
13. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
14. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
15. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
16. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
17. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
18. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

History of microbiology and kingdoms of classification

Total Marks 50, Credits 4

Unit 1 History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, Germ theory of disease, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner. An overview of Scope of Microbiology.

Unit 2. Position of microorganisms in biological world:

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, Characters used in bacterial systematic: rRNA oligonucleotide sequencing, Signature sequences. Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaeobacteria (major difference within Eubacteria).

SUGGESTED READINGS:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Semester III

BM 201

Biochemistry

Total Marks 50, Credits 4

Unit 1. Bioenergetics

First and Second Laws of Thermodynamics. Definitions Of Gibb's Free Energy, Enthalpy, And Entropy And Mathematical Relationship Among Them, Standard Free Energy Change And Equilibrium Constant Coupled Reactions And Additive Nature Of Standard Free Energy Change, Energy Rich Compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP.

Unit 2. Biochemical Techniques

Paper and Thin-Layer Chromatography, Ion Exchange Chromatography, Gel Filtration and Affinity Chromatography, Electrophoresis (Agarose and PAGE)

Annexure III

Unit 3. Enzymes

Structure of Enzyme: Apoenzyme and Cofactors, Prosthetic Group-Tpp, Coenzyme NAD, Metal Cofactors, Classification of Enzymes, Mechanism Of Action Of Enzymes: Active Site, Transition State Complex And Activation Energy; Lock and Key Hypothesis and Induced Fit Hypothesis; Significance of Hyperbolic, Double Reciprocal Plots Of Enzyme Activity, Km, and Allosteric Mechanism; Definitions of Terms – Enzyme Unit, Specific Activity and Turnover Number, Multienzyme Complex: Pyruvate Dehydrogenase; Isozyme: Lactate

Dehydrogenase, Effect of pH And Temperature on Enzyme Activity. Enzyme Inhibition: Competitive- Sulfa Drugs; Non-Competitive-Heavy Metal Salts.

Unit 4. Amino Acid Metabolism

Transamination, Deamination, Transmethylation and Decarboxylation. Glucogenic and Ketogenic Amino Acids, Outline of Urea Cycle.

Unit 5. Carbohydrate Metabolism

Glycolysis, TCA-Cycle, Electron Transport Chain (In Brief) Photophosphorylation, Oxidative Phosphorylation (Chemiosmotic Theory); Anaerobic Respiration - Utilizing NO₂, Sulfur (SO₄), CO₂ As Electron Acceptors; Fermentation; Bacterial Photosynthesis (Cyanobacteria and Green-Sulphur Bacteria).

Unit 6. Purine and Pyrimidine Metabolism

Synthesis of Purines and Pyrimidines (Elementary Concept); Microbial Reduction of Purines to Deoxy-Purines

Unit 7. Lipid Metabolism

Oxidation of Even-And Odd-Carbon Numbered, Saturated And Unsaturated Fatty Acids; Brief Idea of Fatty Acid Biosynthesis; Metabolism of Triglycerides And Phospholipids.

Suggested Readings:

1. Campbell, M (2012) Biochemistry, 7th Ed., Published By Cengage Learning.
2. Campbell, P and Smith A (2011) Biochemistry Illustrated, 4th Ed., Published By Churchill Livingstone.
3. Tymoczko J, Berg J and Stryer L (2012) Biochemistry: A Short Course, 2nd Ed., W.H. Freeman.
4. Berg J, Tymoczko J and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
5. Nelson D and Cox M (2008) Lehninger Principles Of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Willey M, Sherwood, L and Woolverton C J (2013) Prescott, Harley and Klein's Microbiology 9th Ed., McGrawhill.
7. Voet D. and Voet J.G (2004) Biochemistry 3rd Edition, John Wiley and Sons.

BM 291

Microbiology lab II

1. Concept of molarity, normality, percentage, dilutions, pH and buffers, Preparation of buffers and Numerical problems to explain the concepts.
 2. Qualitative tests for the detection of biomolecules: Glucose, Fructose (Benedict's Test); Sucrose (Acid hydrolysis & Benedict's Test); Starch (Iodine Test), Proteins (Biuret method); Amino acids (Ninhydrin); Lipids (Grease Spot Test, Red Test).
 3. Study of enzyme kinetics – calculation of V_{max}, Km, K_{cat} values
 4. Estimation of amino acid (glycine) by formol titration.
 5. Study of protein secondary and tertiary structures with the help of models
-

Semester IV

BM 202 Bio-techniques and Cell & Molecular Biology

Total Marks 50, Credits 4

Bio-techniques:

Unit 1. Microscopy: Principles and applications.

Principles and applications of - Light microscopy: brightfield and darkfield, Phase contrast microscopy, Fluorescence Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy); Micrometry.

Unit 2. Electromagnetic radiation and Spectrophotometry.

Basic principles of electromagnetic radiation: Energy, wavelength, wave numbers and frequency, review of electronic structure of molecules.

UV-visible spectrophotometry: Beer Lambert law, light absorption and its transmittance, factors affecting absorption properties of a chromophore, Principle and use of study of absorption spectra of biomolecules; structural analyses of DNA/ protein using absorption of UV light. Colorimetry and turbidometry

Fluorescence spectroscopy: Theory of fluorescence, static and dynamic quenching, resonance energy transfer, fluorescent probes in the study of protein and nucleic acids.

Mass spectrometry (MALDI-TOF): Physical basis and uses of MS in the analysis of proteins/ nucleic acids.

Unit 3. Radiation Biology.

Concept of radioisotopes, types of radioactive decay (gamma and beta emitter), half-life, detection and measurement of radioactivity: methods based upon ionization (GM counter), methods based upon excitation (scintillation counter). Autoradiography, radioisotopes in diagnosis and radiotherapy. Effect of radiations (ionizing and non-ionizing) on living systems, precautions and safety measures in handling radioisotopes.

Unit 4. Hydrodynamic methods.

Viscosity: Methods of measurement of viscosity, specific and intrinsic viscosity, relationship between viscosity and molecular weight, measurement of viscoelasticity of DNA.

Sedimentation: Principle of centrifugation; Svedberg equation, RCF and sedimentation coefficient; relationship between RPM and RCF; differential and density gradient centrifugation, preparative and analytical ultracentrifugation techniques, fractionation of cellular components using centrifugation with examples.

Flow Cytometry: Basic principle of flow cytometry and cell sorting, detection strategies in flow cytometry.

Unit 5. Biostatistics.

Introduction to biostatistics & its use. Basic idea on variables, frequency distribution and sampling. Measures of central tendency: mean, median, mode. Measures of distributions: variance, range, quartile deviation. Standard deviation and standard error - problems and application. Student's t-test and Chi square test - problems and application. Correlation and Regression.

Cell & Molecular Biology:

Unit 1 Structure of Cell

Plasma membrane: Structure and transport of small molecules; Cell Wall: Eukaryotic cell wall, Extracellular matrix; Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

Unit 2 Cell Organelles and Cell Cycle

Annexure III

Mitochondria, chloroplasts, lysosomes and peroxisomes; Nucleus: Nuclear envelope, nuclear pore complex, nucleolus and nuclear lamina; Chromatin; Endoplasmic Reticulum and Golgi Apparatus. Cell cycle, Mitosis and Meiosis; Brief idea about Development of cancer and Programmed cell death.

Unit 3 Structures of DNA and RNA / Genetic Material

DNA structure: Salient features of double helix, Types of DNA, denaturation and renaturation, cot curves. DNA topology: linking number, twist and writhe. RNA Structure.

Unit 4 Replication of DNA (Prokaryotes and Eukaryotes)

Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends, and other accessory protein. Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication. Inhibitors of DNA Replication.

Unit 5 Transcription in Prokaryotes and Eukaryotes

Concept of Operon (lac and trp), Promoter and Operator; Mechanism of Transcription; RNA polymerase, transcription unit; Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Inhibitors of Transcription.

Unit 6 Post-Transcriptional Processing

Concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping.

Unit 7 Translation (Prokaryotes and Eukaryotes)

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Translational machinery, charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation; Inhibitors of protein synthesis in prokaryotes and eukaryotes.

SUGGESTED READINGS:

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. David Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2nd Ed., W.H. Freeman and Company.
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Daniel : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.
5. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
6. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
7. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
8. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
9. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
10. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

Microbiology lab III
Total Marks 50, Credits 4

Unit I. General Microbiology

1. Simple staining.
3. Negative staining.
4. Gram's staining.
5. Acid fast staining-permanent slide only.
6. Capsule staining.
7. Endospore staining.
2. Preparation of different media: Synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar, Endo agar.
8. Isolation of pure cultures of bacteria by streaking method.
10. Preservation of bacterial cultures by various techniques.
11. Estimation of CFU count (serial dilution of soil and water sample) by spread plate method/pour plate method.
12. Motility by hanging drop method.

Unit II. Bio-techniques

1. Effect of different solvents on UV absorption spectra of proteins.
 2. Study of structural changes of proteins at different pH using UV spectrophotometry.
 3. Study of structural changes of proteins at different temperature using UV spectrophotometry.
 4. Determination of melting temperature of DNA.
 5. Study the effect of temperature on the viscosity of a macromolecule (Protein/DNA).
 6. Use of viscometry in the study of ligand binding to DNA/protein.
 7. Study of fluorescent micrographs to visualize bacterial cells.
 8. Ray diagrams of phase contrast microscopy and Electron microscopy.
 9. Determination of λ_{max} for an unknown sample and calculation of extinction coefficient.
 10. Separation of components of a given mixture using a laboratory scale centrifuge.
 11. Understanding density gradient centrifugation with the help of pictures.
-

Semester V

BM 301 Microbial Genetics and Recombinant DNA Technology Total Marks 50, Credits 4

Microbial Genetics:

Unit 1. Mutations and Repair.

Experimental evidence for DNA as genetic material (Experiments of Griffith, Avery and MacLeod; Hershey and Chase); Experimental evidence for RNA as genetic material (TMV), 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. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes. Repair: Reversal of UV damage in prokaryotes : photoreactivation, base excision and nucleotide excision repair, post replicational repair, mismatch repair, SOS repair, error prone repair.

Unit 3. Plasmids:

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Unit 4. Mechanisms of Genetic Exchange

Transformation - Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.

Unit 5. Phage Genetics

Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda

Unit 6. Transposable elements

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon; Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds); Uses of transposons and transposition.

Recombinant DNA Technology:

Unit 1. Introduction to Genetic Engineering

Milestones in genetic engineering and biotechnology

Unit 2. Molecular Cloning- Tools and Strategies

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering; DNA modifying enzymes and their applications: DNA polymerases. 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; Use of linkers and adaptors; Expression vectors: *E. coli* lac and T7 promoter-based vectors, yeast YIp, YE μ p and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.

Unit 3. Methods in Molecular Cloning

Isolation and purification of nucleic acid; Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, Agrobacterium mediated delivery. Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, Western blotting.

Unit 4. DNA Amplification and DNA sequencing

Annexure III

PCR: Basics of PCR, RT-PCR, Real-Time PCR; Sanger's method of DNA Sequencing: traditional and automated sequencing; Primer walking and shotgun sequencing.

Unit 5. Construction and Screening of Genomic and cDNA libraries

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

Unit 6. Applications of Recombinant DNA Technology

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

SUGGESTED READINGS:

1. Larry Snyder, J. E. Peters, Tina M. Henkin, Wendy Champness (2013) Molecular Genetics of Bacteria, 4th Ed., ASM Press.
2. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers
6. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
7. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
8. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
9. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

BM 303

Immunology

Total Marks 50, Credits 4

Unit 1 Introduction

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

Unit 2 Immune Cells and Organs

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

Unit 3 Antigens

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants.

Unit 4 Antibodies

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

Unit 5 Major Histocompatibility Complex

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways).

Annexure III

Unit 6 Complement System

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co-stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

Unit 8 Immunological Disorders and Tumor Immunity

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit 9 Immunological Techniques

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.

SUGGESTED READINGS:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

BM 305

Virology and Medical Microbiology

Total Marks 50, Credits 4

Unit 1. Virology and Viral diseases

(a) Nature and Properties of Viruses

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses; Isolation, purification and cultivation of viruses; Viral taxonomy: Classification and nomenclature of different groups of viruses.

(b) Viral multiplication in the Cell:

Lytic and lysogenic cycle. Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (Replication and Symptoms of: Adenovirus, Retrovirus, Hepatitis viruses, Influenza virus; Assembly, budding and maturation of HIV).

(c) Role of Viruses in Disease and its prevention

Viruses as pathogens: Role of viruses in causing diseases; Prevention and control of viruses: Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination.

(d) Viral Diseases

Annexure III

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

Unit 2. Normal microflora of the human body and host pathogen interaction.

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxicogenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2. Bacterial diseases

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control-Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*. Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*. Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum*, *Clostridium difficile*.

Unit 4. Protozoan diseases

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar.

Unit 5. Fungal diseases

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis; Opportunistic mycoses: Candidiasis

Unit 6. Antimicrobial agents: General characteristics and mode of action

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

SUGGESTED READINGS:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.
7. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
8. 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
9. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
10. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
11. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Microbiology lab IV
Total Marks 50, Credits 4

Unit I. Microbial Genetics

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of Genomic DNA from *E.coli*.
5. Isolation of Plasmid DNA from *E.coli*.
6. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
7. Demonstration of Bacterial Conjugation.
8. Demonstration of bacterial transformation and transduction.
9. Demonstration of AMES test.

Unit II. Recombinant DNA Technology

1. Preparation of competent cells for transformation.
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
4. Ligation of DNA fragments.
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms.
7. Designing of primers for DNA amplification.
8. Amplification of DNA by PCR.
9. Demonstration of Southern blotting.

BM393

Practical V: Immunology, Virology and Medical Microbiology
Total Marks 50, Credits 4

Unit I. Immunology and Virology

1. Identification of human blood groups.
2. Perform Agglutination test.
3. Perform Total Leukocyte Count of the given blood sample.
4. Perform Differential Leukocyte Count of the given blood sample.
5. Separate serum from the blood sample (demonstration).
6. Perform immunodiffusion by Ouchterlony method / Radial Immunodiffusion method.
7. Perform DOT ELISA/Indirect ELISA.
8. Perform immunoelectrophoresis.
9. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B and retroviruses) using electron micrographs.
10. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
11. Study of the structure of important bacterial viruses (ϕ X 174, T4, λ) using electron micrograph.
12. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique (plaque assay).

Unit II. Medical Microbiology

1. 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
2. Study of composition and use of important differential media for identification of bacteria: EMBAgar, Endo agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method

Annexure III

5. Antibiotic sensitivity test by agar-cup and paper disc methods of commonly used antibiotics.
 5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
 6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
 7. Study of various stages of malarial parasite in RBCs using permanent mounts.
-

Semester VI

BM 302 Industrial Microbiology Total Marks 50, Credits 4

Unit 1. Introduction to industrial microbiology

Brief history and developments in industrial microbiology

Unit 2. Isolation of industrially important microbial strains and fermentation media No. of Hours: 12

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphitewaste liquor, whey, yeast extract and protein hydrolysates.

Unit 3. Types of fermentation processes, bio-reactors and measurement of fermentation parameters

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

Unit 4 Down-stream processing

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spraydrying.

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)

Citric acid, acetic acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase), Wine, beer, champagne.

Unit 6 Enzyme immobilization

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

SUGGESTED READINGS:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaïdo H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida L.E. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

BM 304

Food and Dairy Microbiology
Total Marks 50, Credits 4

Unit 1 Foods as a substrate for microorganisms

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various foods

Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

Unit 3 Principles and methods of food preservation

Principles, 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, SO₂, nitrite and nitrates, ethyleneoxide, antibiotics and bacteriocins.

Unit 4 Fermented foods

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit 5. Food borne diseases (causative agents, foods involved, symptoms and preventive measures)

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*.

Unit 6. Food sanitation and control

HACCP, Indices of food sanitary quality and sanitizers.

Unit 7. Detection of Pathogenic Microorganisms 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).

SUGGESTED READINGS:

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

Environmental Microbiology

Total Marks 50, Credits 4

Unit 1. Microorganisms and their Habitats

Structure and function of ecosystems: Terrestrial Environment: Soil profile and soil microflora; Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter.

Unit 2. Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.

Unit 3. Biogeochemical Cycling

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese.

Unit 4 Waste Management

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

Unit 5 Microbial Bioremediation

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.

Unit 6 Water Potability

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

SUGGESTED READINGS:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

BM 308

Bioinformatics, Biosafety and IPR

Total Marks 50, Credits 4

Bioinformatics

Unit 1. 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. Human Genome Project.

Unit 2. Sequence Alignments, Phylogeny and Phylogenetic trees

Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction-UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood.

Unit 3. 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; Protein structure and rational drug design.

Biosafety and IPR

Unit 1

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

Unit 2

Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit 3

AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

Unit 4

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).

Unit 5

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.

Unit 6

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

Suggested Readings:

1. Bioinformatics: Sequence and Genome analysis, 2nd edition (2004), David W. Mount, ColdSpring Harbour Laboratory Press. ISBN-13: 978-0879697129.
2. Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition (2004), Andreas D. Baxevanis and B.F. Francis Ouellette, John Wiley and Sons. ISBN-13: 978-0471478782.
3. Introduction to Medicinal Chemistry, 4th edition (2009), Graham I. Patrick, Oxford University Press

Annexure III

4. The Process of New Drug Discovery and Development, 2nd edition (2006), C.G. Smith and J.T.O'Donnell, InformaHealthcare, ISBN-13: 978-0849327797.
5. Cheminformatics (2003), J. Gasteiger, Thomas Engel; Wiley-VCH. ISBN: 9783527618279.
6. Molecular modeling - Principles and Applications, 2nd edition (2003), A. R. Leach, Pearson Education Limited, UK. ISBN 13: 9780582382107.
7. Cheminformatics in Drug Discovery (2006), edited by. T.I. Opera; Wiley Publishers, ISBN: 9783527604203.
8. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
9. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

BM392

Practical VI: Applied Microbiology and Bioinformatics

Total Marks 50, Credits 4

Unit I. Food, Industrial and Environmental Microbiology

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.
7. Study different parts of fermenter
8. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
9. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
10. Isolation and enumeration of microbes (bacteria & fungi) from rhizospheric soil and rhizoplane.
11. Assessment of microbiological quality of water (Presumptive test, Confirmatory test, Completed test for coliform; IMVIC reactions)
12. Determination of BOD of waste water sample.
13. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase) in soil.
14. Isolation of Rhizobium from root nodules.

Unit II. Bioinformatics

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. 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
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene

BM 382

Project Work / Review Work

A student has to do a project work / review work in a topic given by his/her supervisor (to be decided by lottery amongst all the teachers present for that Semester) and submit the report/review within a stipulated time. During examination the work has to be presented before an evaluation team (one external member may be invited) and the student will be credited based on the quality of the report and presentation.

