

The University of Burdwan



**Syllabus for
B.Sc.(Hons.) in
Microbiology
Under Choice Based Credit System
w.e.f. 2017-2018 onward**

UG Course in Microbiology under CBCS Pattern, The University of Burdwan

Course Code	Course Title	Credit	Marks				No. of Hours	
			I.A. (Th +Prc)	ESE		Total	Lec/ week	Prc/ week
				Th	Prc			
CC-1	Introduction to Microbiology and Microbial Diversity (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-2	Bacteriology (Theory & Practical)	6	10+5=15	40	20	75	4	4
GE-1	Introduction and Scope of Microbiology OR Bacteriology&Virology (Theory &Practical)	6	10+5=15	40	20	75	4	4
AECC-1	ENVS	4				100	4	
Total in Semester I		22	45	120	60	325		
CC-3	Biochemistry (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-4	Virology (Theory & Practical)	6	10+5=15	40	20	75	4	4
GE-2	MicrobialMetabolism OR MicrobesinEnvironment (Theory &Practical)	6	10+5=15	40	20	75	4	4
AECC-2	English Communication/MIL	2				50	2	4
Total in Semester II		20	45	120	60	275		
CC-5	Microbial Physiology & Metabolism (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-6	Cell Biology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-7	Molecular Biology (Theory & Practical)	6	10+5=15	40	20	75	4	4
GE-3	Medical Microbiology&Immunology OR Industrial & FoodMicrobiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
SEC-1	Microbiological Analysis of Air and Water OR Microbial Diagnosis in Health Clinics	2	10	40		50	2	

Total in Semester III		26	70	280		350		
CC-8	Microbial Genetics (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-9	Environmental Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-10	Food and Dairy Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4

GE-4	Genetic Engineering & Biotechnology OR Microbial Genetics & Molecular Biology (Theory & Practical)	6	10+5=15	40	20	75	4	4
SEC-2	Bio-fertilizers and Bio-pesticides OR Food Fermentation Techniques	2	10	40		50	2	
Total in Semester IV		26	70	280		350		
CC-11	Industrial Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-12	Immunology (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-1	Microbes in Sustainable Agriculture and Development OR Bioinformatics (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-2	Instrumentation and Biotechniques OR Microbial Biotechnology (Theory & Practical)	6	10+5=15	40	20	75	4	4
Total in Semester V		24	60	160	80	300		
CC-13	Medical Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-14	Recombinant DNA Technology (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-3	Advances in Microbiology OR Term Paper & Its Power Point Presentation (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-4	Bio-safety and Intellectual Property Rights OR Plant Pathology (Theory & Practical)	6	10+5=15	40	20	75	4	4
Total in Semester VI		24	60	160	80	300		

MCBH = Subject Code, CC= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GE= Generic Elective, DSE= Discipline Specific Elective IA= Internal Assessment, ESE= End-Semester Examination, Lec.=Lecture, Tu.= Tutorial, Th= Theory and Prc.=Practical

Option each from GE, DSE and SEC may be selected only once by a candidate.

Core Course CC1 (Theory Paper)

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

4 Credits

Unit 1: History and Development of Microbiology:

Theory of Spontaneous generation, Germ theory of disease. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich Martinus

W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology. An overview of the Scope of Microbiology

Unit 2: Diversity of Microbial world:

Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese, General characteristics and representative members of different groups: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)
Acellular entity (Viruses, Viroids, Virusoids, Satellite viruses, Prions)

Unit 3 Microscopy

Principle and application of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope and Scanning Electron Microscope.

Unit 4 Phycology

General characteristics of algae including occurrence (habitat), thallus organization, cell ultra structure, pigments, flagella, eyespot, food reserves (reserve foods) and reproduction in Chlorophyta and Xanthophyta. Economic Importance of algae.

Unit 5 Mycology

General characteristics of fungi including habit, habitat, nutritional requirements, thallus organization and aggregation, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi

Unit 6 Protozoa

Life Cycle of *Amoeba*, *Paramecium*, *Plasmodium*. Economic importance of Protozoa.

Reference Books

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.

Core Course CC1 (Practical Paper):

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

2 Credits

1. Microbiology Laboratory Management and Bio-safety
2. To study the principle and applications of instruments (autoclave, incubator, hot air oven, centrifugation, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth and Nutrient 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 filtration
7. Isolation and enumeration of bacteria from air, water and soil.
8. Study of *Rhizopus*, *Penicillium* and *Aspergillus* from permanent slides.
9. Study of *Spirogyra* and *Chlamydomonas* from permanent slides.
10. Study of *Paramecium* and *Plasmodium* from permanent slides.

Core Course CC2 (Theory Paper)

BACTERIOLOGY

4 Credits

Unit 1: Cell Organization

Cell size, shape and arrangement; glycocalyx; capsule, flagella, endoflagella, fimbriae and pili.

Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls,

Archaeobacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the 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.

Unit 2: Bacteriological Techniques

Pure culture isolation: 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: Nutrition

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, acid-base indicator, enriched media

Unit 4: Control of Microorganisms

Physical methods of microbial control: heat, low temperature, filtration, desiccation, osmotic pressure, radiation
Chemical methods of microbial control: types and mode of action.

Unit 5: Growth & Reproduction in Bacteria

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Unit 6: Bacterial Systematics

Aim and principles of classification, taxonomy, concept of species, taxa, strain; Characters used in bacterial systematic.

Unit 7: Important Archaeal & Bacterial Groups

Archaea: Different physiological groups, suitable example and economic importance.

Bacteria: General characteristics & economic importance with suitable example of the following groups:

Gram Negative: Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Delta proteobacteria, Epsilon proteobacteria, Zeta proteobacteria.

Gram Positive: Low G+ C (Firmicutes), High G+C (Actinobacteria).

Cyanobacteria

Reference Books:

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 McGrawHill.

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

Core Course CC2 (Practical Paper):

BACTERIOLOGY

2Credits

1. Preparation of different media: synthetic media (BG-11), Complex media- Tryptic soy agar, Differential and Selective media (McConkey agar, EMB agar).
2. Simple staining.
3. Negative staining.
4. Gram's staining.
5. Acid fast staining-permanent slide only.
6. Endospore staining.
7. Isolation of pure cultures of bacteria by streaking method.
8. Preservation of bacterial cultures (slant /stab).
9. Estimation of CFU count by spread plate method/pour plate method.
10. Motility by hanging drop method.

Core Course CC3 (Theory Paper)

BIOCHEMISTRY

4Credits

Unit1: Bioenergetics

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy; 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 and ATP.

Unit2: Carbohydrates

General properties and classification of carbohydrates, families of monosaccharides: structural

concept of aldoses and ketoses, trioses, tetroses, pentoses, and hexoses (glucose and fructose). Stereo isomerism of monosaccharides, epimers and anomers of glucose, Mutarotation, optical isomerism. Furanose and pyranose forms of glucose and fructose, sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides: concept of reducing and non-reducing sugars, occurrence; Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose and peptidoglycan.

Unit3: Lipids

Fatty acids: definition, types, structures and functions, essential fatty acids. Lipid: definition, nomenclature and classification (triacyl glycerols, phosphoglycerides, phosphatidylethanolamine, phosphatidylcholine, sphingosine with functions.

Unit4: Proteins

Functions of proteins, Primary structures of proteins: Amino acids- the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its significance, Classification, biochemical structure and notation of standard protein amino acids.

Ninhydrin reaction. Secondary structure of proteins: Peptide unit and its salient features.

The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins.

Unit5: Enzymes

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, specificity, enzyme kinetics, Michaelis-Menten equation and their transformations, Km and allosteric mechanism, Lock and key hypothesis, and Induced Fit hypothesis. Definitions – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature, substrate concentration, enzyme concentration, time on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts, uncompetitive.

Unit 6: Vitamins

Classification and importance.

Unit 7: Vitamins & Nucleic Acids

Purine, pyrimidine bases, nucleoside, nucleotide-structure, properties. Types of DNA and RNA.

Reference Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by CengageLearning.

2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
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., McGraw Hill.
7. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

Core Course CC3 (Practical Paper)

BIOCHEMISTRY

2Credits

1. Concept of pH and buffers, preparation of buffers – phosphate and acetate buffer.
2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars (DNS method)
3. Qualitative/Quantitative tests for proteins (Lowry method), amino acids (Ninhydrine), DNA (DPA) and RNA (Orcinol).
4. Qualitative/Quantitative assay of amylase.
5. Study the effect of temperature and pH on enzyme activity (amylase).
6. Estimation of Ascorbic acid.

Core Course CC4 (Theory Paper)

VIROLOGY

4Credits

Unit 1: Nature & Properties of Viruses

Introduction: Discovery of viruses, nature and general properties.

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses
Isolation, purification and cultivation of viruses

Viral taxonomy: Baltimore Classification

Unit 2: Bacteriophages

Diversity, classification, lytic and lysogenic cycle of lambda phage

Unit 3: Viral Transmissions, salient features of Viral Nucleic acids & Reproduction

Mode of viral transmission

Structure, Nucleic acid, Replication and Symptoms of : Adenovirus, Retrovirus, Hepatitis B

virus, Influenza virus, Assembly, budding and maturation of HIV

Unit 4: Viruses & Cancer

Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5: Prevention & Control of Viral Diseases Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination

Unit 6: Applications of Virology

Use of viral vectors in cloning and expression and Gene therapy.

Reference Books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc
3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
4. 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.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

Core Course CC4 (Practical Paper)

VIROLOGY

2 Credits

1. Study of TMV infection on Tomato plant induced by TMV infected tobacco extract.
2. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
3. Study of one step phage growth curve using isolated bacteriophages.
4. Isolation of Bacteriophage DNA and study of its HindIII digestion pattern.
5. Report writing: Educational tour to Institute/Industry.

Core Course (CC) 5 : MICROBIAL PHYSIOLOGY & METABOLISM **Credit :6** **Theory** **Credit:4** **Total no. of classes: 60**

Unit 1: Microbial Growth and Effect of Environment on Microbial Growth

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth

curve. Microbial growth in response to environment - Temperature (psychrophiles, mesophiles, thermophiles, thermotolerants, psychrotrophs), pH (acidophiles, alkaliphiles, neutrophiles), solute and water activity (halophiles, xerophiles, osmophiles), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobic, facultative anaerobic), barophilic. Microbial growth in response to nutrition and energy – Autotroph, Phototroph, Heterotroph (eg. Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph).

Unit 2: Nutrient uptake and Transport

Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake

Unit 3: Chemoheterotrophic Metabolism - Aerobic Respiration

Concept of aerobic respiration, Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, different types of phosphorylation, uncouplers and inhibitors

Unit 4: Chemoheterotrophic Metabolism - Anaerobic respiration and fermentation

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration)

Fermentation - Alcohol fermentation and Pasteur effect, Lactate fermentation (homofermentative and heterofermentative pathways).

Unit 5: Chemolithotrophic and Phototrophic Metabolism

Introduction to aerobic and anaerobic chemolithotrophy with an example of each, Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction)

Introduction to phototrophic metabolism - groups of phototrophic microorganisms, photosynthetic pigment apparatus, Photosynthesis in green bacteria, purple bacteria and

cyanobacteria

Unit 6 Nitrogen Metabolism - an overview

Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, Dissimilatory nitrate reduction, Denitrification

REFERENCE BOOKS:

1. Madigan MT and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Practical: MICROBIAL PHYSIOLOGY & METABOLISM

Credit:2

1. Study of growth curve of *E. coli* by turbidometric method, standard plate count method, Direct count method by phase contrast microscopy
2. Calculation of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of different concentration of glucose on growth of *E. coli*
6. Effect of salt on growth of *E. coli*
7. Determination of the thermal death point of *E. coli*
8. Demonstration of alcoholic fermentation

Core Course (CC) 6 : CELL BIOLOGY

Credit : 6

Theory

Credit:4

Total no. of classes:60

Unit 1: Structure and organization of Cell

Cell Organization – Comparative account of Eukaryotic (Plant and animal cells) and prokaryotic Cell, Cell organelles, Cytoskeleton: Structure and organization of actin filaments, cell surface protrusions (Flagella, fimbriae, pilli), intermediate filaments,

microtubules

Unit 2: Nucleus

Nuclear envelope and nuclear pore complex, Chromatin – Molecular organization, Nucleolus

Unit 3: Protein Sorting and Transport

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, export of proteins, Golgi Apparatus – Organization, protein glycosylation and export from Golgi Apparatus, Lysosomes

Unit 4: Cell Signaling

Signaling molecules and their receptors, Function of cell surface receptors. Pathways of intra-cellular receptors – Cyclic AMP pathway and MAP kinase pathway

Unit 5: Cell cycle and cancer

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis, Development of cancer, causes of cancer

REFERENCE BOOKS

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons, Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Practical: CELL BIOLOGY

Credit :2

1. Study of a representative plant (epidermal cell of *Rheo* sp.) and animal cell (squamous epithelial cell) by microscopy
2. Study of the structure of cell organelles through electron micrographs (Mitochondria, Endoplasmic Reticulum, Ribosome, Chloroplast)
3. Cytochemical staining of DNA – Feulgen

4. Study of polyploidy in Onion root tip by colchicine treatment.
5. Identification and study of cancer cells by photomicrographs.
6. Study of different stages of Mitosis from permanent slide.
7. Study of different stages of Meiosis from permanent slide.

Core Course (CC) 7 : MOLECULAR BIOLOGY

Credit : 6

Theory:

Credit:4

Total no. of classes:60

Unit 1: Structures of DNA and RNA

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, T_m and C_o t curve, organization of DNA in Prokaryotes, Viruses and Eukaryotes, RNA types, function and Structure, Organelle DNA- mitochondria and chloroplast DNA.

Unit 2: 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, Topoisomerase, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair

Unit 3: Transcription in Prokaryotes and Eukaryotes

Transcription: Definition, difference from replication, promoter – concept. RNA polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors

Unit 4: Post-Transcriptional Processing

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, Polyadenylation and capping, RNA interference: siRNA, miRNA

Unit 5: Translation (Prokaryotes and Eukaryotes)

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.

Unit 6: Regulation of gene Expression

General concept of gene regulation- lac operon and tryptophan operon

REFERENCE BOOKS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab.Press, Pearson Publication
2. Becker WM, K leinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, SanFrancisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons.Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

Practical: MOLECULAR BIOLOGY Credit :2

1. Study of different types of DNA and RNA using micrographs and model
2. Study of semi-conservative replication of DNA through micrographs
3. Isolation of genomic DNA from *E.coli*.
4. Estimation of DNA and its purity check using UV spectrophotometer (A_{260} measurement).
5. Estimation of RNA using UV spectrophotometer (A_{260} measurement).
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Estimation of Proteins by using UV spectrophotometer (A_{280} measurement)

Core Course (CC 8):MICROBIALGENETICS

Credit : 6

Theory:

Credit:4

Total no. of classes: 60

Unit 1: Genome Organization and Mutations

Genome organization: *E. coli*, Mutations and mutagenesis, Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Applications of mutations. Reversion and suppression: True revertants; Ames test.

Unit 2: Plasmids

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, , yeast- 2 μ plasmid, plasmid- incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit 3: Mechanisms of Genetic Exchange

Transformation - Discovery, mechanism of natural competence. Conjugation - Discovery, mechanism, Hfr and F' strains. Transduction - Generalized transduction, specialized transduction.

Unit 4: Phage Genetics

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

Unit 5: Transposable elements

Basic idea of Prokaryotic and Eukaryotic transposable elements. IS an element, composite and non- composite, replicative and non-replicative transposition. Uses of transposons and transposition.

REFERENCE BOOKS

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
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. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings

7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

8. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

Practical :MICROBIALGENETICS

Credit :2

1. Preparation of master plates and replica plates
2. Study of the effect of physical (UV) mutagen on bacterial cells
3. Study of survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E. coli*
5. Study of different conformations of plasmid DNA through Agarose gel electrophoresis using DNA ladder.
6. Demonstration of Bacterial Conjugation through audio visual teaching aids.
7. Demonstration of bacterial transformation and transduction through audio visual teaching aids.
8. Demonstration of Ames test through audio visual teaching aids.

Core Course (CC 9) : EN VIRONMENTALMICROBIOLOGY Credit :6

Theory:

Credit:4

Total no. of classes:60

Unit 1: Microorganisms and their Habitats

Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Micro- flora of fresh water and marine habitats. Atmosphere: Aero- micro-flora: basic idea. Extreme Habitats: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity & low nutrient levels

Unit 2: Microbial Interactions

Microbe-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

Role of microbes in Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle.

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 organic (hydrocarbons, oil spills)

Unit 6: Water Potability

Treatment and safety of drinking water, methods to detect potability of water samples: (a) standard qualitative procedure: MPN test (presumptive test, confirmatory and completed test) for fecal coliforms (b) Membrane filter technique.

REFERENCE BOOKS:

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.

Practical :ENVIRONMENTALMICROBIOLOGY

Credit :2

1. Analysis of soil - pH, moisture content, water holding capacity
2. Isolation of cellulose degrading microbes by enrichment culture technique
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane
4. Assessment of microbiological quality of water by using bacterial filter disc method
5. Assessment of microbiological quality of water by MPN test
6. Study the presence of microbial activity by detecting enzymes (amylase) in soil
7. Isolation of *Rhizobium* from root nodules

Core Course (CC 10) : FOOD AND DAIRY MICROBIOLOGY

Credit :6

Theory:

Credit:4

Total no. of classes:60

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 and canned

Foods

Unit 3: Principles and methods of food preservation

Principles, physical methods of food preservation: temperature (low, high, canning and drying), irradiation, chemical methods of food preservation: salt, sugar, organic acids, SO₂, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit 4: Fermented foods

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kefir, dahi and cheese, other fermented foods: dosa, soy sauce, 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 *Aspergillus flavus*

Food infection: *Escherichia coli*, *Salmonella*, *Shigella*, and *Campylobacter jejuni*

Unit 6: Food sanitation

Indices of food sanitary quality and sanitizers

Unit 7: Rapid detection methods of food borne pathogens in foods

Basic concept of the rapid detection methods of food borne pathogens with examples

REFERENCE BOOKS

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, Gaithersberg, MD.

9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Practical : FOOD AND DAIRY MICROBIOLOGY

Credit :2

1. MBRT of milk samples.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk
3. Study of microorganisms from dahi
4. Isolation of spoilage microorganisms from spoiled carrot
5. Isolation of spoilage microorganisms from bread
6. Preparation of Yogurt/Dahi
7. Demonstration of cultivation of edible mushroom (*Pleurotus* sp)

Core Course (CC11) : INDUSTRIAL MICROBIOLOGY

Credit :6

Theory:

Credit:4

Total no. of classes: 60

Unit 1: Introduction to industrial microbiology

Brief history and developments in industrial microbiology

Unit 2: Isolation of industrially important microbial strains and fermentation media

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, crude and synthetic media, molasses, corn-steep liquor, and protein hydrolysates

Unit 3: Types of fermentation processes, bio-reactors

Types of fermentation processes – Outline of 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

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, penicillin, glutamic acid, amylase and beer

REFERENCE BOOKS

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 N ikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (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.

Practical :INDUSTRIALMICROBIOLOGY

Credit :2

1. Demonstration of different parts of a typical fermenter.
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
 - a. Enzyme: Amylase
 - b. Amino acid: Glutamic acid
 - c. Alcohol: Ethanol
3. Visit to any educational institute/industry to get an idea of industrial fermenter, and other downstream processing operations.

Core Course (CC 12):IMMUNOLOGY

Credit:4

Credit : 6 Theory:

Total no. of classes:60

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, 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,

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); Monoclonal and Polyclonal antibodies

Unit 5: Major Histocompatibility Complex

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules.

Unit 6: Complement System

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

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);

Unit 8: Immunological Techniques

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, Western blotting.

REFERENCE BOOKS:

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 Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Practical: IMMUNOLOGY

Credit :2

1. Identification of human blood groups
2. Total Leukocyte Count of the given blood sample
3. Differential Leukocyte Count of the given blood sample (demonstration)
4. Separation of serum from the blood sample (demonstration)
5. Immunodiffusion by Ouchterlony method
6. DOTELISA

Core Course (CC 13): MEDICAL MICROBIOLOGY

Credit :6

Theory:

Credit:4

Total no. of classes: 60

Unit 1: Normal micro-flora of the human body and host pathogen interaction

Normal micro flora of the human body and its importance: normal micro flora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Outline idea of -- Infection- Invasion, entry, colonization, Pathogenicity, Virulence, Bacterial toxins (Exotoxin-cholera toxin, botulinum toxin and endotoxins) and toxigenicity. opportunistic infections, nosocomial infections, transmission of infection.

Unit 2: Sample collection, transport and diagnosis

Collection, transport and culturing of clinical samples, Modern diagnostic tests

(Immunofluorescence, ELISA, PCR, DNA probes).

Unit 3: 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: Tuberculosis, Gastrointestinal Diseases: Cholera, peptic ulcer by *Helicobacter pylori*,

Others: Disease caused by *Staphylococcus aureus*, *Clostridium tetani*, *Treponema pallidum*

Unit 4: Viral 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, Rabies, Dengue, AIDS.

Unit 5: 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, Amoebiasis.

Unit 6: Fungal diseases

List of fungal diseases of various organ systems and their causative agents. Transmission, symptoms and control of Opportunistic mycoses: Candidiasis

Unit 7: Antimicrobial agents: Source, 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.

General idea of Antibiotic resistance (MDR, MRSA).

REFERENCE BOOKS:

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 JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Practical :MEDICALMICROBIOLOGY

Credit :2

1. Identify bacteria (*E. coli*, *Staphylococcus*, *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 bacterial flora of skin by swab method
3. Performantibacterial sensitivity by Kirby-Bauer method
4. Determination of minimal inhibitory concentration (MIC) of an antibiotic
5. Study using permanent mounts: stages of malarial parasite in RBCs

Core Course (CC 14) : RECOMBINANT DNA TECHNOLOGY

Credit :6

Theory:

Credit:4

Total no. of classes:60

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, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatase, and DNA ligases. Cloning Vectors: Definition and Properties; Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids. Use of linkers and adaptors.

Expression vectors for bacteria: *E. coli* lac and T7 promoter-based vectors

Unit 3: Methods in Molecular Cloning

Transformation of DNA: Calcium chloride method. Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery. DNA and Protein analysis: Agarose gel electrophoresis, SDS-PAGE

Unit4: DNA Amplification and DNA sequencing

PCR: Basics of PCR, Gradient PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing

Unit 5: Applications of Recombinant DNA Technology

Products of recombinant DNA technology: Products of human therapeutic interest - insulin,. Bt transgenic - cotton

REFERENCE BOOKS:

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning- A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Practical : RECOMBINANT DNA TECHNOLOGY

Credit :2

1. Demonstration of 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. Determination of molecular size of DNA fragment by agarose gelelectrophoresis
5. Interpretation of sequencing gel electrophoretograms
6. Designing of primers for DNA amplification
7. Demonstration of Southern blotting

GENERIC ELECTIVES : [For the Student(s) of any Discipline(s) other than Microbiology]

GENERIC ELECTIVE

Generic Elective GE1:

Introduction & Scope of Microbiology Or Bacteriology and Virology

Introduction & Scope of Microbiology (Theory Paper)

4

Credits Unit 1: History & Development of Microbiology

History and Development of microbiology

Theory of Spontaneous generation, Germ theory of disease

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner in the field of Microbiology

Scope of Microbiology

Unit 2: Diversity of Microorganisms

Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese

Basic idea of cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa) Basic idea of acellular microorganisms (Viruses, Viroids, Prions)

Unit 3: Microscopy

Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope, Scanning Electron Microscope

Unit 4: Sterilization

Moist Heat, Dry Heat, Hot Air Oven, Tyndallization, Filtration

Unit 5: Microbes in Human Health & Environment

Transmission, symptoms and treatment of Respiratory tract disease (*Mycobacterium tuberculosis*), Gastrointestinal disease (*Helicobacter pylori*), Cutaneous disease (*Candida albicans*)

Fundamental concept of Innate and Adaptive immunity; Definitions of Antigen, Hapten, Antibody, APC, ADCC.

Role of Microbes in Bioremediation, Biodegradation, Biopesticides and Biofertilizers

Unit 6: Food & Dairy microbiology

Prebiotics and Probiotics

Microorganisms in food fermentations (dairy and non dairy based fermented food products) Pasteurization

Microorganisms in spoilage of vegetables and meat.

Reference Books

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.

Introduction & Scope of Microbiology (Practical Paper) 2 Credits

1. Microbiology Laboratory Management and Bio-safety
2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth and Nutrient 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 filtration
7. Isolation and enumeration of bacteria from air
8. Isolation of spoilage microorganism from rotten bread

OR

Bacteriology and Virology (Theory Paper) 4 Credits

Unit 1 Cell organization

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram-positive and gram-negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes,

inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

Unit 2 Bacterial growth and control

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media

Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria

Growth: Binary fission, phases of growth

Unit 3 Bacterial Systematics and Taxonomy

Taxonomy, nomenclature, systematics, types of classifications

Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles

Eubacteria: Gram negative and Gram positive Gram negative:

Non-proteobacteria– *Deinococcus*, *Chlamydiae*,

Spirochetes Alpha proteobacteria- *Rickettsia*,

Rhizobium, *Agrobacterium* Gamma proteobacteria –

Escherichia, *Shigella*, *Pseudomonas*

Gram positive: Low G+C: *Mycoplasma*, *Bacillus*, *Clostridium*, *Staphylococcus*

High G+C: *Streptomyces*, *Frankia*

Unit 4 Introduction to Viruses

Properties of viruses; general nature and important features

Subviral particles; viroids, prions and their importance

Isolation and cultivation of viruses

Unit 5 Structure, and multiplication of viruses

Morphological characters: Capsid symmetry and different shapes of viruses with examples 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 (HIV & Hepatitis viruses)

Unit 6 Role of Viruses in Disease and its prevention

Viruses as pathogens: Role of viruses in causing diseases

Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan
4. Carter J and Saunders V (2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Control. 2nd edition. ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK

Bacteriology and Virology

(Practical Paper)

2 Credits

1. Preparation of different media: Nutrient agar, Nutrient broth.
2. To perform simple staining and Gram's staining of the bacterial smear.
3. To perform spore staining.
4. Isolation of pure cultures of bacteria by streaking method.
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate.
6. Study of the methods of isolation and propagation of plant viruses.
7. Study of cytopathic effects of viruses using photographs

Generic Elective GE2:

Microbial Metabolism OR Microbes in Environments

Microbial Metabolism (Theory Paper) 4

Credits Unit 1: Microbial Growth & Effect of Environment on

Microbial Growth

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate Temperature and temperature ranges of growth; pH and pH ranges of growth Effect of oxygen concentration on growth Nutritional categories of microorganisms (only definition and example)

Unit 2: Nutrient Uptake & Transport

Active, Passive and facilitated diffusion

Unit 3: 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: components of respiratory chain, electron transport phosphorylation.

Unit 4: Chemoheterotrophic Metabolism: Anaerobic Respiration & Fermentation

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways).

Unit 5: Chemolithotrophic & Phototrophic Metabolism

Introduction to aerobic and anaerobic chemolithotrophy with example. Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria.

Unit 6: Nitrogen Metabolism: An

overview Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction

Reference Books:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingraham JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Microbial Metabolism (Practical Paper)

2 Credits

1. Study of growth of *E. coli* by turbidometric method.
2. Effect of temperature on growth of *E. coli*
3. Effect of pH on growth of *E. coli*
4. Effect of salt on growth of *E. coli*
5. Demonstration of alcoholic fermentation
6. Demonstration of the thermal death time of *E. coli*.

OR

Microbes in Environments (Theory Paper)

4

Credits 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: Aero microflora 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.

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.

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.

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, hydrocarbons (oil spills).

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.

Reference Books

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/ BenjaminCummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, AcademicPress
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, NewYork

5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, BerlinHedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford,England.
7. CoyneMS.(2001)..SoilMicrobiology:AnExploratoryApproach.DelmarThomson 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. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9thedition.

Microbes in Environments (Practical Paper)

2 Credits

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water by filter disc method.
5. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase, urease) in soil.
6. Isolation of *Rhizobium* from root nodules.

Generic Elective (GE 3) : Medical Microbiology and Immunology

OR

Industrial and Food microbiology

GE 3 : Medical Microbiology and Immunology

Credit :6

Theory:

Credit:4

Total no. of classes:60

Unit 1 Normal micro-flora of the human body and host pathogen interaction

Normal micro- flora 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, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection,

Unit 2 Sample collection, transport and diagnosis

Collection, transport and culturing of clinical samples and their identification characteristics.

Unit 3 Bacterial diseases

List of common diseases of various organ systems and their causative agents.

Unit 4 Viral diseases

List of common diseases of various organ systems and their causative agents.

Unit 5 Protozoan diseases

List of common diseases of various organ systems and their causative agents.

Unit 6 Fungal diseases

List of Common fungal diseases & their causative agents.

Unit 7 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 Griseofulvin

Antiviral agents: Mechanism of action of Acyclovir

Unit 8 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

Unit 9 Antigens and Antibodies

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

Unit 10 Generation of Immune Response

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

Unit 11 Immunological Disorders and Tumor Immunity

Brief idea of Autoimmunity and Hypersensitivity.

Unit 12 Immunological Techniques

Principles of Precipitation, Agglutination, Immunodiffusion, ELISA.

REFERENCE BOOKS:

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 JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
6. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Richard C and Geffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Practical: Medical Microbiology and Immunology

Credit :2

1. Identify bacteria 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: EMB Agar, McConkey agar and Blood Agar.
3. Study of bacterial flora of skin by swab method
4. Performantibacterial sensitivity by Kirby-Bauer method
5. Identification of human blood groups.

OR

GE 3 : Industrial and Food microbiology

Credit : 6

Theory:

Credit:4

Total no. of classes: 60

Unit 1 Introduction to Industrial microbiology

Brief history and developments in industrial microbiology

Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous.

Components of a typical continuously stirred tank bioreactor

Unit 2 Isolation of Industrial Strains and Fermentation Medium

Primary and secondary screening. Criteria for selection of industrially important strains.

Preservation and maintenance of industrial strains. Ingredients used in fermentation medium - corn steep liquor, whey & Yeast extract

Unit 3 Microbial fermentation processes

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.

Microbial production of industrial products - Ethanol and penicillin. Industrial production and uses of amylases.

Unit 4 Food as a substrate for microbial growth

Intrinsic and extrinsic parameters that affect microbial growth in food.

Microbial spoilage of food - milk, egg, bread and canned foods

Unit 5 Principles and methods of food preservation and food sanitation

Physical methods - high temperature, low temperature, irradiation, aseptic packaging.

Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite

Unit 6 Dairy products, probiotics and Food-borne Diseases

Fermented dairy products - Dahi and Cheese

Probiotics definition, examples and benefits

Food intoxication by *Clostridium botulinum*

Food infection by *Salmonella*

REFERENCE BOOKS:

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, NewDelhi
2. Patel AH. (1996). Industrial Microbiology .1 st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi,India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. PearsonEducation
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Highereducation
5. Casida LE. (1991). Industrial Microbiology. 1 st edition. Wiley EasternLimited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier ScienceLtd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New AgeInternational (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi,India.
9. Frazier WC and Westhoff DC.(1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi,India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi,India.

Practical :Industrial andFoodmicrobiology

Credit :2

1. Microbial production and estimation of amylase
2. Microbial fermentation for the production and estimation of ethanol
3. Determination of the microbiological quality of milk sample by MBRT

4. Isolation of fungi from spoiled bread/fruits/vegetables
5. Study of Microorganisms present in Dahi.

Generic Elective (GE) 4 :Genetic Engineering & Biotechnology

OR

Molecular Genetics & Molecular Biology

GE 4 : Genetic Engineering & Biotechnology

Credit :6

Theory:

Credit:4

Total no. of classes:60

Unit 1 Introduction to genetic engineering

Milestones in genetic engineering and biotechnology

Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases.

Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases. Cloning: general concept & application. Transformation of DNA: Chemical method, Electroporation.

Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, SDS-PAGE and Western blotting.

Unit 2 Vectors

Cloning Vectors: Definition and Properties. Plasmid vectors: pBR and pUC series

Expression vectors: *E.coli* lac and T7 promoter-based vectors

Unit 3 DNA Amplification and DNA sequencing

PCR: Basics of PCR, RT-PCR

Genomic and cDNA libraries: Brief idea & application.

Sanger's method of DNA Sequencing: Basic Principle.

Unit 4 Application of Genetic Engineering and Biotechnology

Gene delivery: Microinjection, electroporation, biolistic method (gene gun) and *Agrobacterium* - mediated delivery

Products of recombinant DNA technology: Products of human therapeutic interest - insulin. Bt transgenic – cotton.

Unit 5 Intellectual Property Rights

General concept: Patents, Copyrights, Trademarks

REFERENCE BOOKS:

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford,U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press,USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford,U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning- A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford,U.K.

Practical : Genetic Engineering&Biotechnology

Credit :2

1. Isolation of Plasmid DNA from *E.coli*
2. Isolation of genomic DNA from bacteria by standard method.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Interpretation of sequencing gel electropherograms

OR

GE 4 : Molecular Genetics & Molecular Biology Credit :6 Theory:

Credit:4

Total no. of classes: 60

Unit 1 Structures of DNA and RNA / Genetic Material

DNA structure, Salient features of double helix, Types of DNA. Organization of DNA in Prokaryotes, Viruses, Eukaryotes. RNA: Types & Function

Unit 2 Prokaryotic DNA Replication

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

Unit 3 Transcription in Prokaryotic

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

Unit 4 Translation in Prokaryotic

Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

Unit 5 Regulation of gene Expression

Principles of transcriptional regulation, regulation with examples from *lac* operon.

Unit 6 Mutations

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations. Ames test & its significance.

Unit 7 Mechanisms of Genetic Exchange

Transformation - Discovery, mechanism of natural competence

Conjugation - Discovery, mechanism, Hfr and F' strains

Transduction - Generalized transduction, specialized transduction

Unit 8 Plasmids and Transposable Elements

Property and function of plasmids, Types of plasmids. Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition.

REFERENCE BOOKS:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons, Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition,

Cold Spring Harbour Laboratory press.

6. Krebs J, Goldstein E, Kilpatrick S (2013). *Lewin's Essential Genes*, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). *Principles of Genetics*. 8th Ed. Wiley-India
8. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). *Concepts of Genetics*, 10th Ed., Benjamin Cummings
9. Maloy SR, Cronan JE and Friefelder D (2004) *Microbial Genetics* 2nd EDITION., Jones and Barlett Publishers.
10. Russell PJ. (2009). *Genetics- A Molecular Approach*. 3rd Ed, Benjamin Cummings

Practical : Molecular Genetics & Molecular Biology

Credit :2

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent)
4. Estimation of rRNA by using colorimeter (Orcinol reagent).
5. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
6. Study of survival curve of bacteria after exposure to ultraviolet (UV) light.
7. Demonstration of Bacterial Transformation and calculation of transformation efficiency.

DISCIPLINE SPECIFIC ELECTIVE

Discipline specific Elective (DSE 1) :

MICROBES IN SUSTAINABLE AGRICULTURE

OR BIOINFORMATICS

DSE 1: Microbes in Sustainable Agriculture

Credit :6

Theory:

Credit:4

Total no. of classes:60

Unit 1 Soil Microbiology

Soil as Microbial Habitat, Soil profile and properties, Soil formation, General idea of diversity of microorganisms in soil

Unit 2 Microbial Activity in Soil and Green House Gases

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 3 Microbial Control of Soil Borne Plant Pathogens No of Hours:8

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit 4 Biofertilization, Phytostimulation

Plant growth promoting bacteria, bio-fertilizers – symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), Non Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, Mycorrhization Helping Bacteria (MHBs), Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Unit 5 Secondary Agriculture Biotechnology

Biotech feed, Silage, Biomanure, biogas, biofuels – general idea and advantages

Unit 6 GM crops

General idea, Advantages and disadvantages, Bt-cotton and Golden rice.

REFERENCE BOOKS:

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego.
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, 1st edition, Marcel decker Inc.

10. Mahendra K. Rai (2005). Hand Book of Microbial Bio- fertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bio- inoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bio- insecticide, Lap Lambert Academic Publishing GmbH KG.

Practical: Microbes in Sustainable Agriculture

2 Credits

1. Study soil profile (Water holding capacity, pH, total organic carbon content)
2. Enumeration of bacterial load of barren and fertile soil
3. Preparation of *Rhizobium* as soil inoculants and application (pot based experiment)
4. Preparation of *Azotobacter* as soil inoculants and application (pot based experiment)
5. Design and functioning of a biogas plant – model study.
6. Isolation of cellulose degrading organisms using CMC as substrate

OR

DSE 1: BIOINFORMATICS

6 Credits

Theory:

4 Credits

Total no. of classes: 60

Unit 1 Introduction to Computer Fundamentals

RDBMS - Definition of relational database. Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

Unit 2 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 3 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 4 Genome organization and analysis

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Genome, transcriptome, proteome, 2-D gel electrophoresis, MALDI-TOF spectroscopy. Major features of completed genomes: *E. coli*, *S. cerevisiae*, *Arabidopsis*, Human

Unit 5 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. Energy minimizations and evaluation by Ramachandran plot. Protein structure and rational drug design.

REFERENCE BOOKS:

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House.
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications.
3. Lesk M.A. (2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition.
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication.
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell.

Practical: Bioinformatics

2 Credits

1. Introduction to operating system - Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using ClustalW
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Primer designing.
6. Prediction of different features of a functional gene.

Discipline specific Elective (DSE 2) :

**INSTRUMENTATION AND BIOTECHNIQUES OR MICROBIAL
BIOTECHNOLOGY**

DSE2: Instrumentation and Biotechniques

Credit :6

Theory:

Credit:4

Total no. of classes:60

Unit 1 Microscopy

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2 Chromatography

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography, GLC

Unit 3 Electrophoresis

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing and Agarose gel electrophoresis.

Unit 4 Spectrophotometry

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Unit 5 Centrifugation

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

REFERENCE BOOKS:

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7thEd., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5thEd., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's

Microbiology. 9thEd., McGraw Hill.

4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons.Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins,Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5thEdition. ASM Press & Sunderland, Washington D.C., Sinauer Associates,MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual inBiochemistry, Immunology and Biotechnology. Tata McGrawHill.

Practical : Instrum ntationandBiotechniques

Credit :2

1. Ray diagram ofphase contrast microscopy
2. Separationofmixturesofamino acidsand sugarsbypaperchromatography
3. Separationofmixturesofaminoacidsandsugarsbythinlayerchromatography
4. Demonstration of column packing in gel filtrationchromatography
5. Separation of protein mixtures by gelfiltration
6. Separation of protein mixtures byPolyacrylamide Gel Electrophoresis (PAGE)
7. Determination of λ_{\max} for an unknown sample and calculation of extinction coefficient
Separation of components of a given mixture using a laboratory scalecentrifuge
8. Demonstration of density gradient centrifugation with the help ofpictures

OR

DSE 2:MICROBIALBIOTECHNOLOGY

Credit :6

Theory:

Credit:4

Total no. of classes: 60

Unit 1 Microbial Biotechnology and itsApplications

Microbial biotechnology: Scope and its applications inhuman therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology

Use ofprokaryotic and eukaryotic microorganisms inbiotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides, Microbial production of bio-pesticides, bioplastics

Unit 3 Applications of Microbes in Biotransformations

Microbial based transformation of steroids

Bio-catalytic processes and their industrial applications: Production of high fructose syrup

Unit 4 Microbial Products and their Recovery

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

Unit 5 Microbes for Bio-energy and Environment

Bio-ethanol: commercial production from lignocellulosic waste , Biogas production:

Methane and hydrogen production using microbial culture. Microorganisms in bioremediation:

Degradation of xenobiotics (aromatic hydrocarbons), removal of heavy metals from aqueous effluents

Unit 6 RNAi

RNAi and its applications in silencing genes

Unit 7 Intellectual Property Rights

Patents, Copyrights, Trademarks

REFERENCE BOOKS:

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and N ikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science.
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

Practical :Microbial Biotechnology

Credit :2

1. Study of yeast cell immobilization in calcium alginate gels
2. Study of enzyme immobilization by sodium alginate method
3. Pigment production from fungi
4. Isolation of lipase producing bacteria
5. Demonstration of cultivation of edible Mushroom (*Pleurotus* sp.)

Discipline specific Elective (DSE 3) :

ADVANCES IN MICROBIOLOGY OR TERM PAPER & ITS POWER POINT PRESENTATION

DSE 3 : Advances in Microbiology

Credit :6

Theory:

Credit:4

Total no. of classes:60

Unit 1 Evolution of Microbial Genomes

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT),

Unit 2 Metagenomics

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of, metatranscriptomics, metaproteomics and metabolomics.

Unit 3 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

Unit 4 System and Synthetic Biology

General concept of System and synthetic Biology Networking in biological systems, Quorum sensing in bacteria, e Concept of artificial cell, Future implications of synthetic biology with respect to bacteria and viruses

REFERENCE BOOKS:

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press.
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press.
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press.
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press.
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley – VCH Verlag

Practical : Advances in Microbiology

Credit :2

1. Extraction of metagenomic DNA from soil
2. Quantification and purity checking of extracted metagenomic DNA
3. Demonstration of PCR amplification of metagenomic DNA using universal 16S ribosomal gene primers
4. Demonstration of networking of metabolic pathways in bacteria using audiovisual aids

OR

DSE 3 : TERM PAPER & ITS POWER POINT PRESENTATION

Term Paper & Its Power Point Presentation

6 Credits

Each student will prepare a term paper under the guidance of a specified teacher within the stipulated period. Evaluation of term paper will be carried out by a panel of examiners including one external examiner.

Discipline specific Elective (DSE 4):

**BIO-SAFETY & INTELLECTUAL PROPERTY RIGHTS OR PLANT
PATHOLOGY**

DSE 4 : Bio-safety & Intellectual Property Rights

Credit : 6

Theory:

Credit:4

Total no. of classes:60

Unit1

Bio-safety: Introduction; bio-safety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Bio-safety Levels of Specific Microorganisms

Unit 2

Biosafety Guidelines: Biosafety guidelines and regulations (National); GMOs/LMOs- Concerns and Challenges

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; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; Indian Patent Act 1970 & recent amendments.

REFERENCE BOOKS:

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Practical : Bio-safety & Intellectual Property Rights

Credit :2

1. Study of components and design of a BSL-III laboratory using audio-visual aids.
2. Filing applications for approval from bio-safety committee
3. Filing primary applications for patents
4. Study of steps of a patenting process
5. A case study

OR

DSE4: PLANT PATHOLOGY

Credit :6

Theory:

Credit:4

Total no. of classes: 60

Unit1 Introduction and History of plant pathology

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Unit 2 Stages in development of a disease

Infection, invasion, colonization, dissemination of pathogens and perennation.

Unit 3 Plant disease epidemiology

Concepts of monocyclic, polycyclic diseases, disease triangle & disease pyramid.

Forecasting of plant diseases and its relevance in Indian context.

Unit 4 Host Pathogen Interaction

A. Microbial Pathogenicity

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

B. Genetics of Plant Diseases

Concept of resistance (R) gene and avirulence (avr) gene;

C. Defense Mechanisms in Plants

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), phytoalexins]

Unit 5 Control of Plant Diseases

Principles & practices involved in the management of plant diseases by different methods, viz. regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material

cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches

chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants

Unit 6 Specific Plant Diseases

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control

A. Important diseases caused by fungi

1. Late blight of potato - *Phytophthora infestans*
2. Brown spot of rice by *Helminthosporium oryzae*.

3. Black stem rust of wheat - *Puccinia graministritici*.
4. Loose smut of wheat - *Ustilagonuda*

B. Important diseases caused byviruses:

Banana bunchy Top, Rice Tungro

C. Important disease caused byViroids:

Coconut Cadang Cadang

REFERENCE BOOKS:

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, SanDiego.
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-HillLimited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., NewDelhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford &IBH, NewDelhi.

Practical :PlantPathology

Credit :2

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material- *Puccinia*, *Colletotrichum*.
3. Study of plant pathogens using permanent slides (Late blight of potato, Citrus canker, Brown spot of rice, Red rust of *Magnolia*).

SKILL ENHANCEMENT COURSE

Skill Enhancement Course (SEC) 1 :

MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

OR

MICROBIAL DIAGNOSIS IN HEALTH CLINICS

SEC 1 : Microbiological Analysis of Air and Water 2Credits Total no. of classes: 30

Unit 1 Aeromicrobiology

Bio-aerosols, Air borne microorganisms (bacteria and fungi) and their impact on human health

and environment, significance in food and pharma industries and operation theatres, allergens.

Unit 2 Air Sample Collection and Analysis

Bio-aerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.

Unit 3 Control Measures

Fate of bio-aerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology

Water borne pathogens, water borne diseases (Cholera, Typhoid; Amoebiasis)

Unit 5 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

Unit 6 Control Measures

Precipitation, chemical disinfection, filtration, high temperature, UV light

REFERENCE BOOKS

- 1 da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water A Laboratory Manual, CRC Press.
- 2 Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
- 3 Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
- 4 Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press.

OR

SEC 1: Microbial Diagnosis in Health Clinics 2 Credits Total no. of classes: 30

Unit 1 Importance of Diagnosis of Diseases

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease

associated clinical samples for diagnosis.

Unit 2 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.

Unit 3 Direct Microscopic Examination and Culture

Examination of sample by staining - Gram stain, Acid fast staining for tuberculosis, Geimsa – stained thin blood film for malaria. Preparation and use of culture media- Blood agar, Chocolate agar, and MacConkey agar. Distinct colony properties of various bacterial pathogens

Unit 4: Serological and Molecular Methods

Serological Methods - Agglutination, ELISA. Nucleic acid based methods - PCR

Unit 5: Kits for Rapid Detection of Pathogens

Typhoid and Dengue

Unit 6: 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

REFERENCE BOOKS:

1. Ananthanarayan R and Paniker CKJ (2009). Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Randhawa, VS, Mehta G and Sharma KB (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
Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and McCartney Practical Medical Microbiology, 14th edition, Elsevier.

Skill Enhancement Course (SEC 2):

BIO-FERTILIZERS AND BIO-PESTICIDES

OR

FOOD FERMENTATION TECHNIQUES

SEC 2: Bio-fertilizers and Bio-Pesticides **2 Credits** **Total no. of classes: 30**

Unit 1 Bio-fertilizers

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N₂ fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants

Frankia - Isolation, characteristics, Alnus, Casurina plants, non- leguminous crop symbiosis. Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2 Non - Symbiotic Nitrogen Fixers

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Unit 3 Phosphate Solubilizers

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Unit 4 Mycorrhizal Biofertilizers

Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*- production, Field applications, Viruses – cultivation and field applications.

REFERENCES

1. Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al.(2002). Bioinoculants for sustainable agriculture and forestry,

Scientific Publishers.

4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. New Delhi.

5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

OR

SEC 2 : Food fermentation Techniques

2 Credits

Total no. of classes: 30

Unit 1 Fermented Foods

Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable Based Fermented Foods

Pickles, Sauerkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish

Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods

Definition, types, microorganisms and health benefits

REFERENCES:

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press

2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.

3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan

4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

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