

CHOICE BASED CREDIT SYSTEM

Scheme of Instruction & Syllabus for **B.Sc. MICROBIOLOGY**

2018 - 2019



JIS UNIVERSITY

| Credit Distribution across the Course | | | | |
|---|---------------------|--------------------|--------------------|---------------------|
| Course Type | Total Papers | Credit | | Total Credit |
| | | Theory | Practical | |
| CC | 14 | $14 \times 4 = 56$ | $14 \times 2 = 28$ | $56+28=84$ |
| DSE | 4 | $4 \times 4 = 16$ | $4 \times 2 = 08$ | $16 + 8 = 24$ |
| GE | 4 | $4 \times 4 = 16$ | $4 \times 2 = 8$ | $16+8=24$ |
| SEC | 2 | $2 \times 2 = 4$ | | 04 |
| AECC | 2 | $4 \times 2 = 8$ | | 08 |
| Total | | | | 144 |
| NON-CGPA | | | | |
| SEMINAR/MOOKS/OTHER ACTIVITIES | | | | 06 |
| SKILLX/NSS | | | | 06 |
| Grand Total Credit | | | | = 156 |
| Abbreviations used: | | | | |
| CC = CORE COURSES | | | | |
| DSE = DISCIPLINE SPECIFIC ELECTIVES | | | | |
| GE = GENERAL ELECTIVES | | | | |
| SEC = SKILL ENHANCEMENT COURSES | | | | |
| AECC = ABILITY ENHANCEMENT COMPULSORY COURSES | | | | |

| List of Core Courses (14 Papers for the Students of Biotechnology) | | Semester |
|--|--|-----------------|
| CORE I | INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY | I |
| CORE II | BIOCHEMISTRY | |
| CORE III | MICROBIAL PHYSIOLOGY AND METABOLISM | II |
| CORE IV | BACTERIOLOGY | |
| CORE V | MICROBIAL GENETICS | III |
| CORE VI | MOLECULAR BIOLOGY | |
| CORE VII | ENVIRONMENTAL MICROBIOLOGY | |
| CORE VIII | IMMUNOLOGY | IV |
| CORE IX | BIOINFORMATICS | |

| | | |
|-----------|-----------------------------|----|
| CORE X | MEDICAL MICROBIOLOGY | |
| CORE XI | INDUSTRIAL MICROBIOLOGY | V |
| CORE XII | RECOMBINANT DNA TECHNOLOGY | |
| CORE XIII | FOOD AND DAIRY MICROBIOLOGY | VI |
| CORE XIV | BIOSTATISTICS | |

| Choices for DSE | | Code |
|--|---|-------------|
| (2 Papers each to be selected by the Students of Biotechnology SemV and SemVI) | | |
| DSE_1 | Microbial Biotechnology | BMB-503 |
| DSE_2 | Inheritance Biology | BMB-504 |
| DSE_3 | Advances in Microbiology | BMB-505 |
| DSE_4 | Microbes in Sustainable Agriculture and Development | BMB-603 |
| DSE_5 | Plant Pathology | BMB-604 |
| DSE_6 | Biosafety and Intellectual Property Rights | BMB-605 |
| DSE_7 | Review Writing | BMB-606 |

| Choices for SEC | |
|---|---|
| (Any one per semester in semesters 3-4) | |
| SEC_1 | Microbial Quality Control in Food and Pharmaceutical Industries |
| SEC_2 | Microbial Diagnosis in Health Clinics |
| SEC_3 | Biofertilizers and Biopesticides |
| SEC_4 | Food Fermentation Techniques |
| SEC_5 | Management of Human Microbial Diseases |
| SEC_6 | Microbiological Analysis of Air and Water |

| Choices for AECC | |
|---|------------------------------|
| (Any one per semester in semesters 3-4) | |
| AECC_1 | English |
| AECC_2 | Environmental Science |
| AECC_3 | Entrepreneurship Development |
| AECC_4 | Values and Ethics |

| SEMESTER | COURSE OPTED | COURSE CODE | COURSE NAME | L | T | P | CREDIT | CONTACT HOURS | |
|----------|-----------------|-------------|--|---------------------------------|---|---|-----------|---------------|-----------|
| I | CORE I | BMB-101 | INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY | 3 | 1 | 0 | 4 | 4 | |
| | CORE I LAB | BMB-191 | INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE II | BMB-102 | BIOCHEMISTRY | 3 | 1 | 0 | 4 | 4 | |
| | CORE II LAB | BMB-192 | BIOCHEMISTRY LAB | 0 | 0 | 3 | 2 | 3 | |
| | GE I | BCS-101 | COMPUTER FUNDAMENTALS | 3 | 1 | 0 | 4 | 4 | |
| | GE I LAB | BCS-191 | COMPUTER FUNDAMENTALS | 0 | 0 | 3 | 2 | 3 | |
| | AECC I | BHU-101 | ENGLISH | 2 | 0 | 0 | 2 | 2 | |
| | TOTAL | | | | | | | 20 | 23 |
| | NON-CGPA | | | | | | | | |
| | | | BSD-101 | SEMINAR/ MOOKS/OTHER ACTIVITIES | 0 | 0 | 1 | 1 | 1 |
| | | BSD-102 | SKILLX/NSS | 0 | 0 | 1 | 1 | - | |
| | | | TOTAL | | | | 22 | 24 | |

| SEMESTER | COURSE OPTED | COURSE CODE | COURSE NAME | L | T | P | CREDIT | CONTACT HOURS | |
|----------|-----------------|--------------|---|---------------------------------|---|---|-----------|---------------|-----------|
| II | CORE III | BMB-201 | MICROBIAL PHYSIOLOGY AND METABOLISM | 3 | 1 | 0 | 4 | 4 | |
| | CORE III LAB | BMB-291 | MICROBIAL PHYSIOLOGY AND METABOLISM LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE IV | BMB-202 | BACTERIOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE IV LAB | BMB-292 | BACTERIOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | GE II | GCH-202 | BIO-ANALYTICAL TOOLS | 3 | 1 | 0 | 4 | 4 | |
| | GE II LAB | GCH-292 | BIO-ANALYTICAL TOOLS LAB | 0 | 0 | 3 | 2 | 3 | |
| | AECC II | EVS-201 | ENVIRONMENTAL SCIENCE | 2 | 0 | 0 | 2 | 2 | |
| | TOTAL | | | | | | | 20 | 23 |
| | NON-CGPA | | | | | | | | |
| | | | BSD-201 | SEMINAR/ MOOKS/OTHER ACTIVITIES | 0 | 0 | 1 | 1 | 1 |
| | | BSD-202 | SKILLX/NSS | 0 | 0 | 0 | 1 | - | |
| | | TOTAL | | | | | 22 | 24 | |

| SEMESTER | COURSE OPTED | COURSE CODE | COURSE NAME | L | T | P | CREDIT | CONTACT HOURS | |
|--------------|-----------------|-----------------|---|---|---|---|-----------|---------------|-----------|
| III | CORE V | BMB-301 | MICROBIAL GENETICS | 3 | 1 | 0 | 4 | 4 | |
| | CORE V LAB | BMB-391 | MICROBIAL GENETICS LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE VI | BMB-302 | MOLECULAR BIOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE VI LAB | BMB-392 | MOLECULAR BIOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE VII | BMB-303 | ENVIRONMENTAL MICROBIOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE VII LAB | BMB-393 | ENVIRONMENTAL MICROBIOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | GE III | GCH-301 | CHEMISTRY | 3 | 1 | 0 | 4 | 4 | |
| | GE III LAB | GCH-391 | CHEMISTRY LAB | 0 | 0 | 3 | 2 | 3 | |
| | SEC I | BMB-304/305/306 | SKILL ENHANCE COURSES (Microbial Diagnosis in Health Clinics /Microbial Quality Control in Food & Pharmaceutical Industries / Biofertilizers & Biopesticides) | 2 | 0 | 0 | 2 | 2 | |
| | AECC III | BHU-301 | ENTREPRENEURSHIP DEVELOPMENT | 2 | 0 | 0 | 2 | 2 | |
| | TOTAL | | | | | | | 28 | 32 |
| | NON-CGPA | | | | | | | | |
| | | BSD-301 | SEMINAR/ MOOKS/OTHER ACTIVITIES | 0 | 0 | 1 | 1 | 1 | |
| | | BSD-302 | SKILLX/NSS | 0 | 0 | 1 | 1 | - | |
| TOTAL | | | | | | | 30 | 33 | |

| SEMESTER | COURSE OPTED | COURSE CODE | COURSE NAME | L | T | P | CREDIT | CONTACT HOURS | |
|--------------|-----------------|-----------------|---|---|---|---|-----------|---------------|-----------|
| IV | CORE VIII | BMB-401 | IMMUNOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE VIII LAB | BMB-491 | IMMUNOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE IX | BMB-402 | BIOINFORMATICS | 3 | 1 | 0 | 4 | 4 | |
| | CORE IX LAB | BMB-492 | BIOINFORMATICS LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE X | BMB-403 | MEDICAL MICROBIOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE X LAB | BMB-493 | MEDICAL MICROBIOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | GE IV | GCS-401 | C PROGRAMMING | 3 | 1 | 0 | 4 | 4 | |
| | GE IV LAB | GCS-491 | C PROGRAMMING LAB | 0 | 0 | 3 | 2 | 3 | |
| | SEC II | BMB-404/405/406 | SKILL ENHANCE COURSES (Food Fermentation Techniques/ Management of Human Microbial Diseases/ Microbiological Analysis of Air & Water) | 2 | 0 | 0 | 2 | 2 | |
| | AECC IV | BHU-401 | VALUES AND ETHICS | 2 | 0 | 0 | 2 | 2 | |
| | TOTAL | | | | | | | 28 | 32 |
| | NON-CGPA | | | | | | | | |
| | | BSD-401 | SEMINAR/ MOOKS/OTHER ACTIVITIES | 0 | 0 | 1 | 1 | 1 | |
| | | BSD-402 | SKILLX/NSS | 0 | 0 | 1 | 1 | - | |
| TOTAL | | | | | | | 30 | 33 | |

| SEMESTER | COURSE OPTED | COURSE CODE | COURSE NAME | L | T | P | CREDIT | CONTACT HOURS | |
|----------|-----------------|-----------------|---|---|---|---|--------|---------------|-----------|
| V | CORE XI | BMB-501 | INDUSTRIAL MICROBIOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE XI LAB | BMB-591 | INDUSTRIAL MICROBIOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE XII | BMB-502 | RECOMBINANT DNA TECHNOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE XII LAB | BMB-592 | RECOMBINANT DNA TECHNOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | DSE I | BMB-503/BMB-505 | DISCIPLINE CENTRIC SUBJECTS I (Microbial Biotechnology/ Advances in Microbiology) | 3 | 1 | 0 | 4 | 4 | |
| | DSE I LAB | BMB-593/BMB-595 | DISCIPLINE CENTRIC SUBJECTS I LAB (Microbial Biotechnology Lab/ Advances in Microbiology Lab) | 0 | 0 | 3 | 2 | 3 | |
| | DSE II | BMB-504 | DISCIPLINE CENTRIC SUBJECTS II (Inheritance Biology) | 3 | 1 | 0 | 4 | 4 | |
| | DSE II LAB | BMB-594 | DISCIPLINE CENTRIC SUBJECTS II LAB (Inheritance Biology Lab) | 0 | 0 | 3 | 2 | 3 | |
| | TOTAL | | | | | | | 24 | 28 |
| | NON-CGPA | | | | | | | | |
| | | BSD-501 | SEMINAR/ MOOKS/OTHER ACTIVITIES | | 0 | 0 | 1 | 1 | 1 |
| | | BSD-502 | SKILLX/NSS | | 0 | 0 | 1 | 1 | - |
| | TOTAL | | | | | | | 26 | 29 |

| SEMESTER | COURSE OPTED | COURSE CODE | COURSE NAME | L | T | P | CREDIT | CONTACT HOURS | |
|----------|-----------------|-----------------|---|---|---|---|--------|---------------|-----------|
| VI | CORE XIII | BMB-601 | FOOD AND DAIRY MICROBIOLOGY | 3 | 1 | 0 | 4 | 4 | |
| | CORE XIII LAB | BMB-691 | FOOD AND DAIRY MICROBIOLOGY LAB | 0 | 0 | 3 | 2 | 3 | |
| | CORE XIV | BMB-602 | BIOSTATISTICS | 3 | 1 | 0 | 4 | 4 | |
| | CORE XIV LAB | BMB-692 | BIOSTATISTICS LAB | 0 | 0 | 3 | 2 | 3 | |
| | DSE III | BMB-603/BMB-605 | DISCIPLINE CENTRIC SUBJECTS III (Microbes in Sustainable Agriculture and Development/ Biosafety and Intellectual Property Rights) | 3 | 1 | 0 | 4 | 4 | |
| | DSE III LAB | BMB-693/BMB-695 | DISCIPLINE CENTRIC SUBJECTS III LAB (Microbes in Sustainable Agriculture and Development Lab/ Biosafety and Intellectual Property Rights Lab) | 0 | 0 | 3 | 2 | 3 | |
| | DSE IV | BMB-604/BMB-606 | DISCIPLINE CENTRIC SUBJECTS IV (Plant Pathology/Review Writing) | 3 | 1 | 0 | 4 | 4 | |
| | DSE IV LAB | BMB-694/BMB-696 | DISCIPLINE CENTRIC SUBJECTS IV LAB (Plant Pathology/Review Writing) | 0 | 0 | 3 | 2 | 3 | |
| | TOTAL | | | | | | | 24 | 28 |
| | NON-CGPA | | | | | | | | |
| | | BSD-601 | SEMINAR/ MOOKS/OTHER ACTIVITIES | | 0 | 0 | 1 | 1 | 1 |
| | | BSD-602 | SKILLX/NSS | | 0 | 0 | 1 | 1 | - |
| | | TOTAL | | | | | | 26 | 29 |

CORE COURSES

CORE I: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (THEORY)

TOTAL HOURS: 60

CREDITS: 4

Unit 1: History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming; Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2: Diversity of Microbial World

Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms; General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Algae: History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

Fungi: Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

Protozoa: General characteristics with special reference to *Amoeba*, *Paramecium*, *Plasmodium*, *Leishmania* and *Giardia*

Unit 3 An overview of Scope of Microbiology

CORE I: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY LAB

TOTAL HOURS: 60

CREDITS: 2

Microbiology Good Laboratory Practices and Biosafety.

To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.

Preparation of culture media for bacterial cultivation.

Sterilization of medium using Autoclave and assessment for sterility

Sterilization of glassware using Hot Air Oven and assessment for sterility

Sterilization of heat sensitive material by membrane filtration and assessment for sterility

Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

Study of Rhizopus, Penicillium, Aspergillus using temporary mounts

Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts

Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium

SUGGESTED READING

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

Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T.Brown Publishers.

Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General

Microbiology. 5th edition. McMillan.

CORE II: BIOCHEMISTRY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Bioenergetics:

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

Unit 2 Carbohydrates:

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 3 Lipids:

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebroside and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Unit 4 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. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, 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. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Unit 5 Enzymes:

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double

reciprocal plots of enzyme activity, K_m , and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts

Unit 6 Vitamins:

Classification and characteristics with suitable examples, sources and importance

CORE II: BIOCHEMISTRY LAB

TOTAL HOURS: 60

CREDITS: 2

Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts

Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant

Standard Free Energy Change of coupled reactions

Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars

Qualitative/Quantitative tests for lipids and proteins

Study of protein secondary and tertiary structures with the help of models

Study of enzyme kinetics – calculation of V_{max} , K_m , K_{cat} values

Study effect of temperature, pH and Heavy metals on enzyme activity

Estimation of any one vitamin

SUGGESTED READING

Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning

Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone

Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman

Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company

Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,

Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill

Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

CORE III: MICROBIAL PHYSIOLOGY AND METABOLISM

TOTAL HOURS: 60

CREDITS: 4

Unit 1 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, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, 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, anaerobic respiration and fermentation 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, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism

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), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to 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

CORE III: MICROBIAL PHYSIOLOGY AND METABOLISMLAB

TOTAL HOURS: 60

CREDITS: 2

Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.

Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data

Effect of temperature on growth of *E. coli*

Effect of pH on growth of *E. coli*

Effect of carbon and nitrogen sources on growth of *E. coli*

Effect of salt on growth of *E. coli*

Demonstration of alcoholic fermentation

Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READINGS

Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons

Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India

Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

CORE IV: BACTERIOLOGY

TOTAL HOURS: 60

CREDITS: 4

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 Microscopy

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 4 Growth and nutrition

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media *Physical methods of microbial control*: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation *Chemical methods of microbial control*: disinfectants, types and mode of action

Unit 5 Reproduction in Bacteria No. of Hours: 3 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, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaeobacteria

Unit 7 Important archaeal and eubacterial groups

Archaeobacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens

(*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:
Gram Negative: Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples *Gram Positive*: Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples *Cyanobacteria*: An Introduction

CORE IV: BACTERIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.

Simple staining

Negative staining

Gram's staining

Acid fast staining-permanent slide only.

Capsule staining

Endospore staining.

Isolation of pure cultures of bacteria by streaking method.

Preservation of bacterial cultures by various techniques.

Estimation of CFU count by spread plate method/pour plate method.

Motility by hanging drop method.

SUGGESTED READINGS

Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.

Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall

Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.

Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.

Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht

Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.

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

Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

CORE V: MICROBIAL GENETICS

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Genome Organization and Mutations

Genome organization: *E. coli*, *Saccharomyces*, *Tetrahymena*; Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations; Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes

Unit 2 Plasmids

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

Unit 3 Mechanisms of Genetic Exchange

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

Unit 4 Phage Genetics

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

Unit 5 Transposable elements

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

CORE V: MICROBIAL GENETICS LAB

TOTAL HOURS: 60

CREDITS: 2

Preparation of Master and Replica Plates

Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells

Study survival curve of bacteria after exposure to ultraviolet (UV) light

Isolation of Plasmid DNA from *E.coli*

Study different conformations of plasmid DNA through Agarose gel electrophoresis.

Demonstration of Bacterial Conjugation

Demonstration of bacterial transformation and transduction

Demonstration of AMES test

SUGGESTED READING

Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings

Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning

Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings

Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

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

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

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

CORE VI: MOLECULAR BIOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Structures of DNA and RNA / Genetic Material

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, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA 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, 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 and strength of promoter 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, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

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 eukaryote

Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus*, Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

CORE VI: MOLECULAR BIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Study of different types of DNA and RNA using micrographs and model / schematic representations

Study of semi-conservative replication of DNA through micrographs / schematic representations

Isolation of genomic DNA from *E. coli*

Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A₂₆₀ measurement)

Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A₂₆₀ measurement)

Resolution and visualization of DNA by Agarose Gel Electrophoresis.

Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS

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

Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) *The World of the Cell*, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

De Robertis EDP and De Robertis EMF (2006) *Cell and Molecular Biology*, 8th edition. Lippincott Williams and Wilkins, Philadelphia

Karp G (2010) *Cell and Molecular Biology: Concepts and Experiments*, 6th edition, John Wiley & Sons. Inc.

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

Krebs J, Goldstein E, Kilpatrick S (2013). *Lewin's Essential Genes*, 3rd Ed., Jones and Bartlett Learning

Gardner EJ, Simmons MJ, Snustad DP (2008). *Principles of Genetics*. 8th Ed. Wiley-India

CORE VII: ENVIRONMENTAL MICROBIOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Microorganisms and their Habitats

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

Unit 2 Microbial Interactions

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

Unit 3 Biogeochemical Cycling

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

Unit 4 Waste Management

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

Unit 5 Microbial Bioremediation

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

Unit 6 Water Potability

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

CORE VII: ENVIRONMENTAL MICROBIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.

Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).

Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.

Assessment of microbiological quality of water.

Determination of BOD of waste water sample.

Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

Isolation of *Rhizobium* from root nodules.

SUGGESTED READINGS

Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/Benjamin Cummings

Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York

Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.

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. 9th edition. McGraw Hill Higher Education.

CORE VIII: BIOINFORMATICS

TOTAL HOURS: 60

CREDITS: 4

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 No. of Hours: 14 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 Toff 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

CORE VIII: BIOINFORMATICS LAB

TOTAL HOURS: 60

CREDITS: 2

Introduction to different operating systems - UNIX, LINUX and Windows

Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB

Sequence retrieval using BLAST

Sequence alignment & phylogenetic analysis using clustalW & phylip

Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool

Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)

Prediction of different features of a functional gene

SUGGESTED READING

Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House

Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications

Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition

Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

CORE IX: IMMUNOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Introduction

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

Unit 2 Immune Cells and Organs

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

Unit 3 Antigens

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

Unit 4 Antibodies

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

Unit 5 Major Histocompatibility Complex

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

Unit 6 Complement System

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

Unit 7 Generation of Immune Response

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

Unit 8 Immunological Disorders and Tumor Immunity

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

Unit 9 Immunological Techniques

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

CORE IX: IMMUNOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Identification of human blood groups.

Perform Total Leukocyte Count of the given bloodsample.

Perform Differential Leukocyte Count of the given bloodsample.

Separate serum from the blood sample(demonstration).

Perform immunodiffusion by Ouchterlony method.

Perform DOT ELISA.

Perform immunoelectrophoresis.

SUGGESTED READINGS

Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.

Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.

Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

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

CORE X: MEDICAL MICROBIOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Normal microflora of the human body and host pathogen interaction

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 Sample collection, transport and diagnosis No. of Hours: 5 Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, 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: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*
Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum*, *Clostridium difficile*

Unit 4 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

Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

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, Kala-azar

Unit 6 Fungal diseases

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention

Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

Unit 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 Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

CORE X: MEDICAL MICROBIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Identify bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests

Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS

Study of bacterial flora of skin by swab method

Perform antibacterial sensitivity by Kirby-Bauer method

Determination of minimal inhibitory concentration (MIC) of an antibiotic.

Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)

Study of various stages of malarial parasite in RBCs using permanent mounts.

SUGGESTED READING

Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication

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

Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier

Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

CORE XI: INDUSTRIAL MICROBIOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Introduction to industrial microbiology

Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media

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, sulphite waste liquor, whey, yeast extract and protein hydrolysates

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

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

Unit 4 Down-stream processing

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) No. of Hours: 18 Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12; Enzymes (amylase, protease, lipase) Wine, beer

Unit 6 Enzyme immobilization

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

CORE XI: INDUSTRIAL MICROBIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Study different parts of fermenter

Microbial fermentations for the production and estimation (qualitative and quantitative) of:

Enzymes: Amylase and Protease

Amino acid: Glutamic acid

Organic acid: Citric acid

Alcohol: Ethanol

A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited

Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA

Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell

Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company

Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

CORE XII: RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Introduction to Genetic Engineering

Milestones in genetic engineering and biotechnology

Unit 2 Molecular Cloning- Tools and Strategies

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering; DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases; Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs; Use of linkers and adaptors; Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 3 Methods in Molecular Cloning

Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral- mediated delivery, *Agrobacterium* - mediated delivery; DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit4 DNA Amplification and DNA sequencing

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

Unit 5 Construction and Screening of Genomic and cDNA libraries No. of Hours: 6 Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Unit 6 Applications of Recombinant DNA Technology

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

CORE XII: RECOMBINANT DNA TECHNOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Preparation of competent cells for transformation

Demonstration of Bacterial Transformation and calculation of transformation efficiency.

Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis

Ligation of DNA fragments

Cloning of DNA insert and Blue white screening of recombinants.

Interpretation of sequencing gel electropherograms

Designing of primers for DNA amplification

Amplification of DNA by PCR

Demonstration of Southern blotting

SUGGESTED READING

Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.

Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA

Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education

Brown TA. (2007). Genomes-3. Garland Science Publishers

Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

CORE XIII: FOOD AND DAIRY MICROBIOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Foods as a substrate for microorganisms

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

Unit 2 Microbial spoilage of various foods

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

Unit 3 Principles and methods of food preservation

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO₂, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 4 Fermented foods

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

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

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;

Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6 Food sanitation and control

HACCP, Indices of food sanitary quality and sanitizers

Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

CORE XIII: FOOD AND DAIRY MICROBIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

MBRT of milk samples and their standard plate count.

Alkaline phosphatase test to check the efficiency of pasteurization of milk.

Isolation of any food borne bacteria from food products.

Isolation of spoilage microorganisms from spoiled vegetables/fruits.

Isolation of spoilage microorganisms from bread.

Preparation of Yogurt/Dahi.

SUGGESTED READINGS

Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.

Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.

Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.

Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.

Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.

Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.

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

CORE XIV: BIOSTATISTICS

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Biomathematics

Sets. Functions and their graphs : polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc.

Simple observations about these functions like increasing, decreasing and, periodicity.

Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence.

Infinite Geometric Series. Series formulas for e^x , $\log(1+x)$, $\sin x$, $\cos x$. Step function. Intuitive idea of discontinuity, continuity and limits.

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions.

Integration as reverse process of differentiation.

Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations.

Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Product of matrices upto order 3.

Unit 2 Biostatistics

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences;

Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;

Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics;

Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom;

Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test;
Confidence Interval; Distribution-free test - Chi-square test;

Basic introduction to Multivariate statistics, etc.

CORE XIV: BIOSTATISTICS LAB

TOTAL HOURS: 60

CREDITS: 2

Word Problems based on Differential Equations

Mean, Median, Mode from grouped and ungrouped Data set

Standard Deviation and Coefficient of Variation

Skewness and Kurtosis

Curve fitting

Correlation

Regression

Finding area under the curve using normal probability

Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test

Confidence Interval

SUGGESTED READINGS

H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.

E. Batschelet : Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)

A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.

W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

DISCIPLINE SPECIFIC ELECTIVES

DSE-I: MICROBIAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Microbial Biotechnology and its Applications

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology; Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology

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

Unit 3 Applications of Microbes in Biotransformations

Microbial based transformation of steroids and sterols; Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit 4 Microbial Products and their Recovery

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

Unit 5 Microbes for Bio-energy and Environment

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

Unit 6 RNAi

RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

Unit 7 Intellectual Property Rights, Patents, Copyrights, Trademarks

DSE-I: MICROBIAL BIOTECHNOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Study yeast cell immobilization in calcium alginate gels

Study enzyme immobilization by sodium alginate method

Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)

Isolation of xylanase or lipase producing bacteria

Study of algal Single Cell Proteins

SUGGESTED READING

Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.

Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.

Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,

Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press

Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science

Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

DSE-II: INHERITANCE BIOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit I: Science of Genetics – an overview of modern history of Genetics before 1860, 1860-1900, 1900-1944, 1944-Present, about 3 general areas of Genetics (Classical, Molecular & Evolutionary).

UNIT II: Mendelism & Chromosome Theory – Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal, Mitochondrial, Unifactorial, Multi-factorial). Pedigree analysis – Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance.

UNIT III: Extension of Mendelism – Deviation from Mendel's Dihybrid phenotype, Linkage, Sutton's view on linkage, Morgan's view on linkage, Bateson & Punnett's Coupling & Repulsion hypothesis.

UNIT IV: Linkage & Crossing over - Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Allelic Variation & Gene function – Multiple allele, Genetic interaction, Epistatic interactions, Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.

UNIT V: Non-Mendelian inheritance – Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance.

UNIT VI: Chromosomal variation in Number & Structure – Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytenic chromosome in Diptera, Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric & Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution.

UNIT VII: Chromosome Mapping - Haploid mapping (2 point & 3 point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.

UNIT VIII: Human Cyto-Genetics – Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, Chromosomal abnormalities in spontaneous abortions, viable monosomies & trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions & translocations, human traits, Genomic position effects on Gene expression.

DSE-II: INHERITANCE BIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

PRACTICALS

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -Rhoeo translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

DSE-III: ADVANCES IN MICROBIOLOGY

TOTAL HOURS: 60

CREDITS: 4

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), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

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 viral metagenome, 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 Systems and Synthetic Biology

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

DSE-III: ADVANCES IN MICROBIOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Extraction of metagenomic DNA from soil

Understand the impediments in extracting metagenomic DNA from soil

PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers

Case study to understand how the poliovirus genome was synthesized in the laboratory

Case study to understand how networking of metabolic pathways in bacteria takes place

SUGGESTED READING

Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press

Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press

Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press

Sangdun C. Introduction to Systems Biology, 2007, Humana Press

Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag

Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons

Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings

Wilson BA, Salyers AA Whitt DD and Winkler ME (2011) Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,

Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International

Voit EO (2012) A First Course in Systems Biology, 1st edition, Garland Science

DSE-IV: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

TOTAL HOURS: 60

CREDITS: 4

Unit I: Soil Microbiology No of Hours: Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit II: Mineralization of Organic & Inorganic Matter in Soil No of Hours: Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit III: Microbial Activity in Soil and Green House Gases, Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit IV: Microbial Control of Soil Borne Plant Pathogens, Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit V: Biofertilization, Phytostimulation, Bioinsecticides, Plant growth promoting bacteria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Unit VI: Secondary Agriculture Biotechnology, Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Unit VII: GM crops, Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

DSE-V: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT LAB

TOTAL HOURS: 60

CREDITS: 2

1. Study soil profile
2. Study microflora of different types of soils
3. Rhizobium as soil inoculants characteristics and field application
4. Azotobacter as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

SUGGESTED READINGS

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 Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

DSE-V: PLANT PATHOLOGY

TOTAL HOURS: 60

CREDITS: 4

Unit 1 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, Burrill, E. Smith, 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 No. of Hours: 5 Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit 4 Host Pathogen Interaction

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).

Genetics of Plant Diseases

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance— horizontal & vertical, apparent resistance.

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), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

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

genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit 6 Specific Plant diseases

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

Important diseases caused by fungi White rust of crucifers - *Albugo candida*

Downy mildew of onion - *Peronospora destructor* Late blight of potato - *Phytophthora infestans* Powdery mildew of wheat - *Erysiphe graminis* Ergot of rye - *Claviceps purpurea*

Black stem rust of wheat - *Puccinia graminis tritici*

Loose smut of wheat - *Ustilago nuda*

Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici*

Red rot of sugarcane - *Colletotrichum falcatum*

Early blight of potato - *Alternaria solani*

Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn

Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadang

DSE-V: PLANT PATHOLOGY LAB

TOTAL HOURS: 60

CREDITS: 2

Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo*, *Puccinia*, *Ustilago*, *Fusarium*, *Colletotrichum*.

SUGGESTED READINGS

Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,

Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.

Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.

Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.

Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

DSE-VI: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

TOTAL HOURS: 60

CREDITS: 4

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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

Unit 6

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

DSE-VI: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS LAB

TOTAL HOURS: 60

CREDITS: 2

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

Suggested Reading

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.

SKILL ENHANCEMENT COURSES

SEC-I: Microbial Quality Control in Food and Pharmaceutical Industries

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Microbiological Laboratory and Safe Practices

Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL- 1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples No. of Hours: 10 Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products; Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar; Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

SUGGESTED READING

Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press

Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

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

Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

SEC-II: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

TOTAL HOURS: 30

CREDITS: 2

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, Ziehl-Neelson staining for tuberculosis, Giemsa- stained thin blood film for malaria

Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit 4: Serological and Molecular Methods

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Unit 5: Kits for Rapid Detection of Pathogens

Typhoid, Dengue and HIV, Swine flu

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

SUGGESTED READING

Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.

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

Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd

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.

SEC-III: BIOFERTILIZERS AND BIOPESTICIDES

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Biofertilizers

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, Alder, 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.

SUGGESTED READINGS

Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.

Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.

Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.

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

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

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

SEC-IV: FOOD FERMENTATION TECHNIQUES

TOTAL HOURS: 30

CREDITS: 2

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

Pickels, Saeurkraut: 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

SUGGESTED READINGS

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

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

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

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

SEC-V: MANAGEMENT OF HUMAN MICROBIAL DISEASES

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Human Diseases

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Unit 2 Microbial diseases

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

Unit 3 Therapeutics of Microbial diseases

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides.

Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.

Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit 4 Prevention of Microbial Diseases

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

SUGGESTED READINGS

Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication

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

Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier

Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Editi

SEC-VI: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Aeromicrobiology

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology

Water borne pathogens, water borne diseases

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

SUGGESTED READING

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

Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

GENERAL ELECTIVES

GE-I: COMPUTER FUNDAMENTALS

Unit 1: Introduction of computer and Basic computer organization (3L)

Introduction of computer: Characteristics of Computer, Evolution of Computer, Generations of Computer (I, II, III, IV, V), Classifications of Computer (2L)

Basic computer organization : Input Unit, Output Unit, Storage Unit, Arithmetic & Logic Unit, Control Unit, Central Processing Unit, The system concepts (1L)

Unit 2: Number System, Binary Arithmetic, Codes & Logic Gates (9L)

Number System: Digit Concept, Bit, Byte, Nibble, Word, Weights, Base and Fractions, Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System (1L)

Conversion (Number & Fraction): Decimal to Binary, Decimal to Octal, Decimal to Hexadecimal, Binary to Decimal, Binary to Octal, Binary to Hexadecimal, Octal to Decimal, Octal to Binary, Octal to Hexadecimal, Hexadecimal to Decimal, Hexadecimal to Binary, Hexadecimal to Octal (4L)

Binary Arithmetic: Binary Addition, Binary Subtraction, Binary Multiplication, Binary Division, Concepts of 1's complement and 2's complement, Binary Subtraction using 1's complement and 2's complement (2L)

Computer Codes: Weighted code (BCD, EBCDIC, ASCII, 8421, 2421, 84-2-1, Excess-3), Non-weighted code (Gray Code), Conversion from Binary to Gray code, Conversion from Decimal to BCD, Conversion BCD to Decimal (1L)

Logic Gate: Rules, symbol, truth table and circuit diagrams of NOT, OR, AND, NOR, NAND, XOR, EX-NOR, BUFFER and Negative-OR, Universal Gate, NOT, OR & AND using Universal Gates (1L)

Unit 3: Storage and Input/output Devices, Computer Hardware & Software, Computer Language, Program Planning and Language Processor (8L)

Primary Storage: RAM (SRAM, DRAM), ROM (MROM, PROM, EPROM, EEPROM), Cache Memory, Register, Motherboard and Memory unit (1L)

Secondary Storage: Sequential & Direct Access devices, Punched Paper Tape, Magnetic Tape, Tape Cassettes & Cartridges, Magnetic Disk, Floppy Disk, Winchester Disk, Magnetic Drum, Magnetic Bubble Memory, Optical Disk, Flush Drives (2L)

Input Devices: Keyboard, Mouse, Joy Stick, Light pen, Track Ball, Scanner, Graphic Tablet, Microphone, Magnetic Ink Card Reader (MICR), Optical Character Reader (OCR), Bar Code Reader (BCR), Optical Mark Reader (OMR) (1L)

Output Devices: Monitor (Cathode-Ray Tube (CRT), Flat Panel Display (LCD, LED, Plasma, 3D)), Printer (Impact (Character (Dot-matrix, Daisy Wheel), Line (Drum, Chain)), Non-impact (Laser, Inkjet)), Plotter (Drum, Flatbed) (1L)

Computer Hardware & Software: Port, Hardware, Relation between hardware and software, Software (System Software and Application Software) (1L)

Programming Planning: Purpose, Algorithm, Flowcharts, Decision Tables, Pseudo code (1L)

Computer Language & Language Processor: Low level (Machine level, Assembly level), High level (Procedure-oriented, Object-oriented), Assembler, Compiler & Interpreter (1L)

Unit 4: Introduction to Microsoft Paint & Microsoft Office (16L)

Microsoft Paint: Opening, Drawing & Erasing, Creating a shape, adding text, Opening, cropping, rotating, resizing image, save project (1L)

Microsoft Word: Introduction, Entering text, Editing Document, Formatting Text, Formatting Page, Working with Tables, Mail Merge & Macro (6L)

Microsoft Excel: Introduction, Editing Worksheet, Formatting Cells, Formatting Worksheets, Formulae, Pivot Table (5L)

Microsoft PowerPoint: Introduction, Editing Presentation, Formatting Presentation, Working with multimedia (2L)

Microsoft Access: Overview, Object, Data Type, Create Database, Create Table, Adding Data, Query Data, Action Query (2L)

Unit 5: Basic concepts of Operation System, Data Processing, Database System, Data Communication & Network, Internet and Computer Virus (12L)

Operating System: Definition, Function, Evolution, Single User OS, Multiuser OS, Batch Processing, Spooling, Multiprogramming, Multiprocessing, Time sharing, On-line processing, Real time processing, Disk Operating System (DOS), Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers (3L)

Data Processing: Definition, Data Storage Hierarchy, File Organization (Sequential, Direct, Indexed, Index-sequential), File Utilities (Sorting, Searching, Merging, Copying, Printing, Maintenance) (1L)

Database System: Concepts, DBMS, Shortcomings of File Management Systems, Database Structure (List, Hierarchical or Tree, Network, Relational), Advantage & Disadvantages of Database (1L)

Data Communication & Network: Basic Elements, Data Transmission Modes (Simplex, Half Duplex, Full Duplex), Data Transmission Speed (Narrowband, Voice band, Broadband), Transmission Media (Twisted Pair, Coaxial Cable, Microwave system, Communications Satellite, Optical Fibbers), Digital and Analog Transmission (Amplitude Modulation, Frequency Modulation, Phase Modulation), Switching Techniques

(Circuit, Message, Packet), Network Topologies (Star, Ring, Mesh, Hybrid), PAN, LAN, MAN, WAN, World Wide Web (WWW), Network Security, Firewall (5L)

Internet: Definition, Search engines, E-mail, Chat (1L)

Computer Virus: Overview, Symptoms, Effect, Precautions (1L)

Text / Reference Books:

1. Computer Fundamentals – P K Sinha, BPB
2. Xavier C Introduction to Computers, New Age International
3. Computer Today by S. K. Basandra, Galgotia Publications, New Delhi
4. Rajaraman V. Fundamental of Computers
5. M.M.Oka Computer Fundamentals, EPH
6. Leon – Fundamental of Information Tchnology, Vikas
7. Ram B. Computer Fundamentals, New Age International

GE-I: COMPUTER FUNDAMENTALS LAB

TOTAL HOURS: 60

CREDITS: 2

1. Operation of several Windows desktop elements, Start menu, Taskbar, working with files, Notepad, WordPad, setting up and maintain new printer.
2. Different steps and operation of Microsoft Calculator and Microsoft Paint, Microsoft DOS Commands.
3. Getting started and File management of Unix/Linux.
4. Directory management and File permission / access mode of Unix/Linux.
5. Getting started with Microsoft Word, Entering text, editing document, working with tables.
6. Formatting text and formatting pages of Microsoft Word, Mail merge & macros
7. Introduction of Microsoft Excel, editing worksheets, formatting cells.
8. Formatting worksheets, formulae and pivot table of Microsoft Excel.
9. Introduction of Microsoft PowerPoint, Editing presentation.
10. Formatting presentation of Microsoft PowerPoint, Working with Multimedia.

11. Overview, Objects, Data types of Microsoft Access, Create Database, Create Tables, adding data to the tables.

12. Query Data and action queries of Microsoft Access.

GE-II: BIO-ANALYTICAL TOOLS

TOTAL HOURS: 60

CREDITS: 4

UNIT 1:

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT 2:

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT 3:

Introduction to the principle of chromatography . Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT 4:

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

GE-II: BIO-ANALYTICAL TOOLS LAB

TOTAL HOURS: 60

CREDITS: 2

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.

7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

GE-III: CHEMISTRY

TOTAL HOURS: 60

CREDITS: 4

Unit 1: Inorganic Chemistry

Ionic Bonding: General characteristics of ionic bonding, lattice energy, solvation energy, Born- Haber cycle and its applications, polarizing power, polarizability: Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage of ionic character.

Covalent bonding: Shapes of inorganic molecules with suitable examples, MO of diatomic molecules, concept of resonance and resonating structures in various inorganic and organic compounds.

Van der Waals interactions, hydrophilic and hydrophobic interactions, importance of hydrogen bonds in biomolecules, directionality of hydrogen bonding.

Unit 2: Organic Chemistry

Fundamentals, electronic displacements: Inductive Effect, Electromeric effect, Resonance Hyper-conjugation and their applications, Dipole moment, Reactive intermediates: carbocations, carbanions, carbene, free radical, and benzyne, Aromaticity.

Nucleophilic substitution reactions, Elimination reactions: Saytzeff's and Hoffmann rule, addition reactions to alkene and alkyne: Markownikoff's and anti-Markownikoff's addition, Hydration, Ozonolysis, oxymercuration-demercuration.

Stereochemistry: conformations with respect to ethane and butane, Inter conversion of Wedge Formula, Newmann, Sawhorse and Fischer representations, Concept of chirality, Configuration: Geometrical and Optical isomerism, Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro, D and L, cis–trans nomenclature, CIP Rules: R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C=C systems).

Unit 3: Physical Chemistry

Chemical Energetics: Laws of Thermodynamics and their applications, thermochemistry and its applications.

Chemical Equilibrium: Equilibrium constants, relationships between K_p , K_c and K_x for reactions involving ideal gases. Le Chatelier's principle, free energy change in a chemical reaction.

Ionic Equilibrium: Classifications of electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant, ionic product of water, p^H scale, Solubility product: principle and its applications, salt hydrolysis, buffer, buffer capacity, Henderson equation and related problems, principle of choice of indicators for acid-base titration with examples.

GE-III: CHEMISTRY LAB

TOTAL HOURS: 60

CREDITS: 2

Inorganic Chemistry

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.

Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements).

Physical Chemistry

1. Determination of heat capacity of calorimeter for different volumes
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH- meter.

4. Preparation of buffer solutions: Sodium acetate-acetic acid.

SUGGESTED READINGS

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
3. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
4. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
5. R. G. Mortimer, Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
6. P.C. Rakshit, Physical Chemistry 7th Ed. Sarat book distributors, Calcutta (2001)

GE-IV: C PROGRAMMING

TOTAL HOURS: 60

CREDITS: 4

Unit 1: C Variable, Data type, Operator, Expressions

Variable and Data Types: The C character set identifiers and keywords, data type & sizes, variable names, declaration, Statements

C Operators & Expressions: Arithmetic operators, relational operators, logical operators, increment and decrement operators, bitwise operators, assignment operators, conditional operators, special operators - typeconversion, C expressions, precedence and associativity.

Input and Output: Standard input and output, formatted output - printf, formatted input scanf

Unit 2: Branching and Loop Statements:

Statement and blocks, if - else, switch, goto and labels

Loops - while, for, do while, break and continue

Unit 3: Array. Character Array & Strings

One dimensional arrays, Two-dimensional arrays, Multidimensional arrays. Passing an array to a function

Character array and string, array of strings, Passing a string to a function, String related functions

Unit 4: Function, Structure, Union & Pointers

auto, external, static and register variables. Functions, function types, function prototypes, functions returning values, functions not returning values, scope rules, recursion

Basic of structures, arrays of structures, structures and pointers, structures and functions, Basics of Unions.

Pointers, Pointer and Array, Pointer and String, Pointer and functions

Unit 5: File I/O, Preprocessor, Error Handling, Command-Line Arguments

formatted and unformatted files, Command line arguments, fopen, fclose, fgetc, fputc, fprintf, fscanf
function typedef, preprocessor, header file, type casting, Error handling

Variable arguments, Memory Management, Dynamic memory allocation

GE-IV: C PROGRAMMING LAB

TOTAL HOURS: 60

CREDITS: 2

1. Writing C Programs on variable, expression, operator and type-casting.
2. Writing C Programs using different structures of if-else statement and switch-case statement.
3. Writing C Programs demonstrating use of loop (for loop, while loop and do-while loop) concept and use of break and continue statement.
4. Writing C Programs demonstrating concept of Single & Multidimensional arrays.
5. Writing C Programs demonstrating concept of Character Array & Strings and several build-in string functions.
6. Writing C Programs demonstrating concept of Function and Recursion.
7. Writing C Programs demonstrating concept of Pointers, address of operator, declaring pointers and operations on pointers.
8. Writing C Programs demonstrating concept of structures, union and pointer to structure.
9. Writing C Programs demonstrating concept of String and command line arguments.
10. Writing C Programs demonstrating concept of dynamic memory allocation
11. Writing C Programs demonstrating concept of File Programming.
12. Writing c programs demonstrating preprocessor, error handling, variable-length arguments.

SUGGESTED READING

1. Kerninghan B.W. & Ritchie D.M. - The C Programming Language

2. Gottfried - Programming with C Schaum
3. Kanetkar Y. - Let us C
4. Balaguruswamy - Programming in C
5. Pohl and Kelly - A Book on C
6. Kerninghan, B.W. - The Elements of Programming Style
7. Schied F.S. Theory and Problems of Computers and Programming
6. Ravichandran D. Programming in C, New Age International

ABILITY ENHANCEMENT COMPULSORY COURSES

AECC_1: ENGLISH

Unit 1: Communication: Interface in a Globalized World

- a. Definition of Communication & Scope of Communication
- b. Process of Communication—Models and Types
- c. Verbal—Non-Verbal Communication, Channels of Communication
- d. Barriers to Communication & surmounting them [to be delivered through case studies involving intercultural communication]

Unit 2: Vocabulary and Reading

- a. Word origin—Roots, Prefixes and Suffixes, Word Families, Homonyms and Homophones
- b. Antonyms and Synonyms, One-word substitution
- c. Reading—Purposes and Skills
- d. Reading Sub-Skills—Skimming, Scanning, Intensive Reading
- e. Comprehension Practice (Fiction and Non fictional Prose/Poetry)

Texts:

- (i) Isaac Asimov, I Robot (“Robbie” OR “Little Lost Robot”)
 - (ii) George Orwell, “Shooting an Elephant”
 - (iii) Ruskin Bond, “The Cherry Tree” OR “The Night Train at Deoli”
 - (iv) Robert Frost, “Stopping by the Woods on a Snowy Evening.”
- f. Precis Writing (Use of daily newspapers for reading practice is recommended)

Unit 3: Functional Grammar and Usage

- a. Articles, Prepositions, Verbs
- b. Verb-Subject Agreement
- c. Comparison of Adjectives
- d. Tenses and their Use
- e. Transformation of Sentences (Singular-Plural, Active-Passive, Direct-Indirect, Degrees of Comparison)
- f. Error Correction

Unit 4: Business writing [10L]

- a. Business Communication in the Present-day scenario
- b. Business Letters (Letters of Inquiry, Sales Letters, Complaint and Adjustment Letters, Job Application Letters)
- c. Drafting of a CV and Résumé
- d. Memo, Notice, Advertisement, Agenda, Minutes of Meetings

e. E-mails (format, types, jargons, conventions)

AECC_2: ENVIRONMENTAL SCIENCE

UNIT 1. General

1.1 Natural Resources: Forest Resource, water resource, mineral resource, energy resources (renewable, non-renewable, potentially renewable)

1.2 Population Growth: Exponential Growth, logistic growth, Maximum sustainable yield

1.3 Disaster Management: Types of disasters (Natural & Man-made), Floods, Earthquake, Tsunamis, Cyclones, landslides (cause, effect & control)

1.4 Ecology & Ecosystem: Elements of ecology, definition of ecosystem- components types and function, Food chain & Food web,

Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems

1.5 Environmental Management: Environmental impact assessment, Environmental laws and protection act of India, Different international environmental agreement.

UNIT 2. Air pollution and control

2.1 Sources of Pollutants: point sources, nonpoint sources and manmade sources primary & secondary pollutant

2.2 Types of air pollutants: primary & secondary pollutant ; Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN, Smog (Photochemical smog and London smog),

2.3 Effects on human health & climate: Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion

2.4 Air pollution and meteorology: Ambient Lapse Rate, Adiabatic Lapse Rate, Atmospheric stability & Temperature inversion

2.5 control of air pollution (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury),

UNIT 3. Water Pollution

3.1 Classification of water (Ground & surface water)

3.2 Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, heavy metals, pesticides, volatile organic compounds.

3.3 Surface water quality parameters: pH, DO, 5 day BOD test, BOD reaction rate constants, COD. Numerical related to BOD Lake: Eutrophication [Definition, source and effect].

3.4 Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only), ground water pollution (Arsenic & Fluoride; sources, effects, control)

3.5 Quality of Boiler fed water: DO, hardness, alkalinity, TDS and Chloride

3.7 Layout of waste water treatment plant (scheme only).

UNIT 4. Land Pollution

4.1 Types of Solid Waste: Municipal, industrial, commercial, agricultural, domestic, hazardous solid wastes (bio-medical), E-waste

4.2 Solid waste disposal method: Open dumping, Land filling, incineration, composting, recycling (Advantages and disadvantages).

UNIT 5. Noise Pollution

5.1 Definition of noise, effect of noise pollution on human health,

5.2 Average Noise level of some common noise sources

5.3 Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L10 (18 hr Index) .

5.4 Noise pollution control.

AECC_3: ENTREPRENEURSHIP DEVELOPMENT

UNIT I: INTRODUCTION

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II: ESTABLISHING AN ENTERPRISE

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III: FINANCING THE ENTERPRISE

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV: MARKETING MANAGEMENT

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product life cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V: ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

AECC_4: VALUES AND ETHICS

Unit – 1: Ethics and Human Values – Definition – Good Behaviour, Conduct and Character; Importance, Respects for Elders, Use and Relevance in Present-day Society.

Unit – 2: Indian Constitution and Values – Fundamental Rights and Duties -Freedom, Equality, Fraternity, Justice; Directive Principles of State Policy; Our National Emblem.

Unit – 3: Individual and Society – Desirable Basic Human Characters - Honesty, Truthfulness, Respect, Punctuality, Responsibility, Courtesy, Discipline, Kindness, courage, Character, Forgiveness, Friendship, Compassion, Consideration, Contentedness, Simplicity, Empathy, Avoiding Greed; Family responsibilities; Duties as a Member of the Society; Social Concerns – Evils of Dowry, Caste System, Racial Discrimination; Participation in NCC, NSS, Scouts & Guides, NGC.

Unit – 4: Life Skills – Goal-setting; Self-esteem and Self-Confidence; Problem Solving; Decision Making; Time Management; Stress Management; Positive Thinking; Assertiveness; Teamwork; Interpersonal Relationships; Coping with Life Stresses; Suicidal Tendencies; Peer Pressure; Substance Abuse and Addiction.

Unit – 5: Environmental Concerns – Respect for Natural Environment – Land, Trees, Air, Water, Animals; Unethical Practices – Depletion of Natural Resources (Soil Erosion, Pollution, Mining, Deforestation); Use of Plastics and Pesticides; EcoClubs.

Unit – 6: Professional Ethics–Need and Importance – Goals – Dignity of Labour – Ethical Values in Different Professions – Management, Business, Teaching, Civil Services, Politics, Medicine, Policing, Judiciary.

Unit – 7: Ethics, Values and Thinking–Right Thinking, Right Understanding, Reflective Thinking, Rational / Critical Thinking, Creative Thinking.