BHARTI VISHWAVIDYALAYA

DURG (C.G)

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SCHEME OF EXAMINATION

&

SYLLABUS

OF

Bachelor of Science (Honors) Microbiology

UNDER

FACULTY OF SCIENCE

Session: 2021-2022

(Approved by Board of Studies)

EXAMINATION SCHEME

B. Sc. (Honors) Microbiology

B. Sc. (Honors) examination will be conducted in six SEMESTER

SEMESTER– I

THEORY

PAPER CODE	SUBJECT	CREDIT	THEORY MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMB -101	Introduction to Microbiology and Microbial Diversity	4	70	30	100
BSHMB -102	Bacteriology	4	70	30	100
GE-I	A. Botany-I B. Zoology-I C. Chemistry-I	4	35	15	50
AECC	English Communication / MIL	2	35	15	50
ECA	Fundamentals of Bioinformatics	2	35	15	50

PRACTICAL

PAPER CODE	SUBJECT	CREDIT	PRACTICAL MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMBL -101	Introduction to Microbiology and Microbial Diversity	2	35	15	50
BSHMBL -102	Bacteriology	2	35	15	50
GEL-I	Generic Elective - Practical-I	2	35	15	50

B. Sc. (Honors) Microbiology

SEMESTER–II

THEORY

PAPER	COURSE	CREDIT	THEORY MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMB-201	General Microbiology	4	70	30	100
BSHMB-202	Virology	4	70	30	100
GE-II	A. Botany-II B. Zoology-II C. Chemistry-II	4	35	15	50
AECC	Environmental Science	2	35	15	50
ECA	Extracurricular activity/ Tour, Industrial training/ Field visit, NSS/ Swachhta/ vocational Training/ Sports/ others	2	35	15	50

PRACTICAL

PAPER	COURSE	CREDIT	PRACTICAL MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMBL-201	General Microbiology	2	35	15	50
BSHMBL-202	Virology	2	35	15	50
GEL-II	Generic Elective - Practical-II	2	35	15	50

B. Sc. (Honors) Microbiology

SEMESTER–III

THEORY

PAPER	COURSE	CREDIT	THEORY MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMB-301	Microbial Physiology and Metabolism	4	70	30	100
BSHMB-302	Cell Biology	4	70	30	100
BSHMB-303	Molecular Biology	4	70	30	100
GE-III	A. Botany-III B. Zoology-III C. *Chemistry-III	4	35	15	50
SEC - 1	Select one from the pool of sec courses offered by different department	2	35	15	50

PRACTICAL

PAPER	COURSE	CREDIT	PRACTICAL MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMBL-301	Microbial Physiology and Metabolism	2	35	15	50
BSHMBL-302	Cell Biology	2	35	15	50
BSHMBL-303	Molecular Biology	2	35	15	50
GEL-III	Generic Elective - Practical-III	2	35	15	50

***Students may Opt any one GE-III Chemistry as mention in syllabus**

B. Sc. (Honors) Microbiology

SEMESTER–IV

THEORY

PAPER	COURSE	CREDIT	THEORY MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMB-401	Microbial Genetics and Genomics	4	70	30	100
BSHMB-402	Environmental Microbiology	4	70	30	100
BSHMB-403	Food and Dairy Microbiology	4	70	30	100
GE-IV	A. Botany-IV B. Zoology-IV C. *Chemistry-IV	4	35	15	50
SEC -2	Select one from the pool of sec courses offered by different department	2	35	15	50

PRACTICAL

PAPER	COURSE	CREDIT	PRACTICAL MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMBL-401	Microbial Genetics and Genomics	2	35	15	50
BSHMBL-402	Environmental Microbiology	2	35	15	50
BSHMBL-403	Food and Dairy Microbiology	2	35	15	50
GEL-IV	Generic Elective - Practical-IV	2	35	15	50

***Students may Opt any one GE-IV Chemistry as mention in syllabus**

B. Sc. (Honors) Microbiology

SEMESTER–V

THEORY

PAPER	COURSE	CREDIT	THEORY MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMB-501	Industrial Microbiology	4	70	30	100
BSHMB-502	Immunology	4	70	30	100
DSE-l	DSE-l- Theory	4	70	30	100
DSE-2	DSE-2- Theory	4	70	30	100

PRACTICAL

PAPER	COURSE	CREDIT	PRACTICAL MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMBL-501	Industrial Microbiology	2	35	15	50
BSHMBL-502	Immunology	2	35	15	50
DSE-l	DSE-l- Lab	2	35	15	50
DSE-2	DSE-2- Lab	2	35	15	50

B. Sc. (Honors) Microbiology

SEMESTER–VI

THEORY

PAPER	COURSE	CREDIT	THEORY MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMB-601	Medical Microbiology	4	70	30	100
BSHMB-602	Recombinant DNA Technology	4	70	30	100
DSE-3	DSE-3-Theory	4	70	30	100
DSE-4	DSE-4-Theory	4	70	30	100

PRACTICAL

PAPER	COURSE	CREDIT	PRACTICAL MARKS	TEACHER ASSESSMENT	TOTAL MARKS
BSHMBL-601	Medical Microbiology	2	35	15	50
BSHMBL-602	Recombinant DNA Technology	2	35	15	50
DSE-3	Lab	2	35	15	50
DSE-4-Project	Dissertation/ Project work followed by seminar	2	35	15	50

* As per UGC CBCS guidelines, University / departments have liberty to offer GE and SEC courses offered by one department to students of other departments. The No. of GE course is four. One GE course is compulsory in first 4 semesters each.

Minimum One Skill Enhancement course shall be proposed by each department (4 credits) [4 L or 2 L+ 2 P or l L+3 P or 3L+ l T] 1P = 2 hours.

***Credit= L+T+P/2**

Where, **L-**Lecture**, T-**Tutorial and **P-** Practical

Total Credits=144

SCHEMEFORPRACTICALEXAMINATION

EXPERIMENT	MARKS
Experiment	25
Viva-voce	10
Teacher Assessment	15
TOTALMARKS	50

MICROBIOLOGY -DSE 1-4 (ELECTIVES)

DSE-1: BIOINFORMATICS

DSE-2: PLANT PATHOLOGY

DSE-3: INHERITANCE BIOLOGY

DSE-4: BIOMATHEMATICS AND BIOSTATISTICS

SKILL ENHANCEMENT COURSE (ANY TWO)

SEC-I: 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

NAME OF THE GENERIC ELECTIVE SUBJECTS OFFERED BY YOUR DEPARTMENT

1. GE-I: Introduction to Microbiology and Microbial Diversity
2. GE-II: General Microbiology
3. GE-III: Microbial Physiology and Metabolism
4. GE-IV: Microbial Genetics and Genomics

CORE SUBJECTS (HONOURS IN MICROBIOLOGY)
Semester I
INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (BSHMB-101)

CREDITS: 4

UNIT-I: 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-II: Diversity of Microbial World

Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's threekingdom classification systems and their utilit. Difference between prokaryotic and eukaryotic microorganisms.

General characteristics of different groups: **A cellular** microorganisms (Viruses,Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi andProtozoa) with emphasis on distribution andoccurrence, morphology, mode ofreproduction and economic importance.

UNIT-III: Algae

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. Type studies: *Chlamydomonas, Volvox* and *Spirogyra*. Applications of algae in agriculture, industry, environment and food.

UNIT-IV: Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallusorganization and aggregation, fungal wall structure and

synthesis, a sexual reproduction, sexual reproduction, heterokaryosis, heterothallism and para sexual mechanism. Type studies: *Rhizopus, Aspergillus, Saccharomyces* and *Agaricus*. Economic Importance of Fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins.

UNIT-V: Protozoa

General characteristics with special reference to *Amoeba, Paramecium and Plasmodium.*

References:

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. 5th Edition' Tata McGraw Hill Publishing Co., Ltd., New Delhi'
2. Stanier, R.Y., Adelberg, E.A. and Ingram, J.L. (1991)' General Microbiology, 5th Ed., Prentice Hall of India Prt. Ltd., New Delhi.
3. Madigan, M.T., Martinkl, J.M. and Parker, J' (2000). Brock Biology of Microorganisms, 9th Edition, MacMillan Press, England.

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY PRACTICAL (BSHMBL-101)

CREDITS: 2

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Sterilization of medium using Autoclave and assessment for sterility.
4. Sterilization of glassware using Hot Air Oven and assessment for sterility.
5. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
6. Demonstration of the presence of microflora in the environment by exposing nutrient agarplates to air.
7. Study of *Rhizopus*, *Penicillium*, *Aspergillus, Saccharomyces* using temporary mounts.
8. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporarymounts.
9. Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium* and *Plasmodium*.

SUGGESTED READING

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

BACTERIOLOGY (BSHMB-102)

CREDITS: 4

UNIT-I: 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, Archae bacterial 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-II: 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-culturablebacteria.

UNIT-III: Microscopy

Microscope: Principle and functions.

UNIT-IV: 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-V: Reproduction in Bacteria

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

References:

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M. T. Brown Publishers.
2. Black J G. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan M T, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.

BACTERIOLOGY (PRACTICAL) (BSHMBL-102)

CREDITS: 2

1. Preparation of different media: Synthetic Media, Complex media (Nutrient Agar, McConkey agar).
2. Simple staining.
3. Negative staining.
4. Gram's staining.
5. Acid fast staining (permanent slide only).
6. Capsule staining.
7. Spore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Estimation of CFU count by spread plate method/pour plate method.
10. Demonstration of Motility by hanging drop method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M. T. Brown Publishers.
2. Black J G. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan M T, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J.Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th editionMcMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition PearsonEducation.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. PearsonEducation Limited.

GE-I: CHEMISTRY: INORGANIC CHEMISTRY-I (BSHCY-101)

CREDITS: 4

UNIT– I: Atomic Structure

Bohr,s theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Shapes of *s, p, d* and *f* orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT –II: Periodicity of Elements

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block'

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends ofelectron gain enthalpy.

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-JafIe's electronegativity scales. Variation of electronegativity with bond order, pa(ial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

UNIT –III: Chemical Bonding

Ionicbond- General characteristics, types of *ions,* size effects, radius ratio rule and its limitations. Packing of ions in crystals. Bonn-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Bonn-Haber cycle and its application, Solvation energy.

Covalent bond- Lewis structure, Valence Bond theory (HeitIer-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCI, BeF_2, CO_2, (idea of *s-p* mixing and orbital interaction to be given). Formal charge, Valence shell electron

pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons.

UNIT –IV: Chemical Bonding-II

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electro-negativity difference.

Metallic Bond:Qualitative idea of valence bond and band theories. Semi-conductors and insulators, defects in solids.

Weak Chemical Forces.van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetic of dissolution process.

UNIT- V: Oxidation-Reduction

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford,1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.

GEL- I: CHEMISTRY: INORGANIC CHEMISTRY-I LAB

(BSHCYL-101)

CREDITS: 2

1. **Titrimetric Analysis**
   - (i) Calibration and use of apparatus
   - (ii) Preparation of solutions of different Polarity/Normality of titrants
2. **Acid-Base Titrations**
   - (iii) Estimation of carbonate and hydroxide present together in a mixture.
   - (iv) Estimation of carbonate and bicarbonate present together in a mixture.
   - (v) Estimation of free alkali present in different soaps/detergents
3. **Oxidation-Reduction Titrimetry**
   - (vi) Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.
   - (vii) Estimation of oxalic acid and sodium oxalate in a given mixture.
   - (viii) Estimation of Fe (II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

l. Vogegl, A.l. A Textbook of Quantitatlve I norgganic Analysis, ELBS.

GE-I: ZOOLOGY: ANIMAL DIVERSITY– I (NON-CHORDATES)
(BSHZO-101)

CREDITS: 4

UNIT I

Taxonomy: definition, taxonomic procedure, classification, systemic, taxonomic levels, taxa, hierarchy, species concepts, Zoological nomenclature: kinds of taxonomic characters (morphological, embryological, cytogenetic, and numerical characters).

UNIT II

Classification of multicellular animals: symmetry and early development (spiral and radial cleavage). Protostomes and Deuterostomes; body cavities: acoelomates, pseudocoelomates, coelomates.

UNIT III

General characters and classification up to classes with examples showing distinctive and adaptive features:

1. Protozoans (locomotion)
2. Poriferans (canal system and skeleton),
3. Platyhelminthes and Nematodes (parasitic adaptations),
4. Annelids (metamerism),
5. Arthropods (mouthparts),
6. Molluscs (modification of foot),
7. Echinodermata (water vascular system and larval forms).

UNIT IV

Overview of different patterns:

1. Digestion- intracellular, extracellular, feeding mechanisms (suspension, deposit, cropping, sucking, herbivorous and raptorial carnivorous)
2. Gas exchange and internal transport (structure and function of gills, trachea, book lungs)

UNIT V

Overview of different patterns:

1. Excretory organs - open tubular (metanephridia) and closed saccular (protonephridia and Malpighian tubules)
2. Pattern of nervous system in non-chordates.
3. Types of asexual reproduction: fission, regeneration and parthenogenesis; sexual reproduction: primary and accessory sex organs in non- chordates.

Books Recommended

1. Kotpal Series on Non-chordates (Rastogi Publications)
2. Nigam: Biology of Non-Chordates (1997, S. Chand)
3. Barnes: The invertebrate (3rd ed. 2001, Wiley-Blackwell)
4. Moore: An introduction to the invertebrates (2006, Cambridge)
5. Kotpal, Agarwal and Khetrapal: Modern Text Book of Zoology; Invertebrates. Edition, 6. Publisher, Rastogi Publications, 1990

GEL-I: ZOOLOGY: ANIMAL DIVERSITY– I (NON-CHORDATES) PRACTICAL (BSHZOL-101)

CREDITS: 2

Animal Diversity (Non-Chordates)

Study of transverse sections/chart of the following: Sycon, Hydra, Fasciola, Ascaris, Hirudinaria.

1. Study of salient features and classification up to classes of the following non-chordates: Amoeba, Euglena, Plasmodium, Paramecium, Euplectella, Physalia, Taenia, Ascaris (male and female), Nereis, Chiton, Mytilus, Octopus, Limulus, Sacculina, Asterias, Echinus, Holothuria.
2. External features of Earthworm.
3. Dissection of Earthworm showing alimentary canal, nervous system, reproductive system.
4. Dissection of snail showing radula, nervous system, Osphradium.
5. Culture of amoeba and paramecium.

Books Recommended

1. Kotpal Series on Non-chordates (Rastogi Publications)
2. Nigam: Biology of Non-Chordates (1997, S. Chand)
3. Barnes: The invertebrate (3rd ed. 2001, Wiley-Blackwell)
4. Moore: An introduction to the invertebrates (2006, Cambridge)

GE-I: BOTANY: PLANT DIVERSITY-I (VIRUS, BACTERIA, ALGAE & FUNGI) (BSHB-101)

CREDITS: 4

UNIT-I

Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

UNIT-II

Viruses: General characteristics, general account of Retrovirus, TMV; General characteristics, general structure with special reference to viroids and prions; replication (general account),

UNIT-III

Cyanobacteria: General characteristics; heterocystandakinetes; General account of *Nostoc*, *Oscillatoria* and *Scytonema*; Economic importance of cyanobacteria. General account of actinomycetes.

UNIT-IV

Algae: General characteristics; Chlorophyceae: *Volvox,* Xanthophyceae: *Vaucheria;* Phaeophyceae: *Sargassum;* Rhodophyceae: *Polysiphonia*; Singlecell protein, Economic importance of algae.

UNIT-V

Fungi: General characteristics; Mastigomycotina: *Phytophthora*; Zygomycotina: *Rhizopus* Ascomycotina: *Peziza;* Basidiomycotina: *Puccinia;* Deuteromycotina: *Alternaria.*

Suggested Readings:

1. Ananthanarayan and Paniker: 7th Edison. A text book of Microbiology, Orient Blackswan Publisher, Delhi
2. KumarHD,1990.IntroductoryPhycology.East-westPress,India
3. LeeR E.2008.IntroductiontoAlgae.CambridgeUniversityPress,UK.
4. PelczarMiJ.,Chan,E.C.S.,Krieg,NR,1972.Microbiology, McGraw-Hillpublisher, Columbus,OH
5. PrescottML,2000:Microbiology.McGraw-HillPublisher,Columbus,OH

GEL-I: BOTANY: PLANT DIVERSITY-I PRACTICAL

(BSHBL-101)

CREDITS: 2

1. Micro preparation observations of bacteria and viruses.
2. Gram staining of bacteria
3. Identification of cyanobacterial specimens
4. Identification of algal specimens
5. Identification of fungal specimens

Field trips: for habitat study & collection of samples

Suggested Readings:

1. Ananthanarayan and Paniker: 7th Edison. A text book of Microbiology, Orient Blackswan Publisher, Delhi
2. Kumar H D, 1990. Introductory Phycology. East-west Press, India
3. Lee R E. 2008. Introduction to Algae. Cambridge University Press, UK

ECA- FUNDAMENTALS OF BIOINFORMATICS

CREDITS: 2

UNIT- I: Introduction to Bioinformatics

Bioinformatics – Definition and Applications Information Flow in Biology, DNA Structure, RNA Structure, Protein Structure, Genomes (Prokaryotic and Eukaryotic), Genome sequencing

UNIT- II: Biological Databases

RDBMS, Biological databases - nucleic acid, genome, protein sequence and structure, geneexpression databases, Database of metabolic pathways Mode of data storage –

UNIT- III: File formats

FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, Uniprot, PDB

UNIT- IV: Sequence Alignments, Phylogeny and Phylogenetic trees

Local and Global Sequence alignment, pairwise and multiple sequence alignment. MolecularPhylogeny, Softwares for phylogeny

UNIT- V: Protein Structure Predictions

Hierarchy of protein structure - primary, secondary and tertiary structures, modelling (Homology) Structural Classes, Motifs, Folds and Domains. Protein structure and rational drug design

SUGGESTED READING

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

AECC- ENGLISH LANGUAGE

CREDITS: 2

UNIT I: COMMUNICATION

THEORY AND TYPES

Theory of Communication, Types and modes of Communication Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication

UNIT II: SPEAKING SKILLS

Monologue Dialogue Group Discussion Effective Communication/ Mis- Communication, Interview Public Speech.

UNIT III: READING AND UNDERSTANDING

Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation (from Indian language to English and vice-versa) Literary/Knowledge Texts.

UNIT IV WRITING SKILLS

Documenting Report Writing Making notes Letter writing.

UNIT-V FUNCTIOANL GRAMMAR

Parts of Speech, Word order / Types of Sentences, Questions (Affirmative and Negative),Present Perfect – Simple & Continuous, Present Perfect and Past Simple, Future Tense, Articles, Prepositions, Modals, Conjunctions, Quantifiers and Voice.

REFERENCE BOOKS:

English Language and Indian Culture - Published by M.P. Hindi Grant Academy Bhopal.

Semester II

BIOCHEMISTRY (BSHMB-201)

CREDITS: 4

UNIT-I: 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-II: 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-III: 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, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers andbilayers.

UNIT-IV: 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 andhydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and syntheticaspartame, 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.

UNIT-V: 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 hypothesisand Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme UNIT, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone.
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman.

BIOCHEMISTRY (BSHMBL-201)

CREDITS: 2

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems toexplain the concepts.
2. Handling of micropipettes and checking their accuracy.
3. Standard Free Energy Change of coupled reactions.
4. Qualitative tests for carbohydrates, reducing sugars, non reducing sugars.
5. Qualitative tests for lipids and proteins.
6. Study of protein secondary and tertiary structures with the help of models.
7. Study of enzyme kinetics – calculation of V_{max}, Km, Kcat values.

SUGGESTED READING

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

VIROLOGY (BSHMB-202)

CREDITS: 4

UNIT-I: Nature and Properties of Viruses

Introduction: Discovery of viruses, nature and definition of viruses, general properties, conceptof viroids, virusoids, satellite viruses and Prions. Theories of viral origin.

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

Viral taxonomy: Classification and nomenclature of different groups of viruses.

UNIT-II: Bacteriophages

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage.

UNIT-III: Viral Transmission, Salient features of viral nucleic acids and Replication

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna), Assembly with example of Polio virus and T4 phage, maturation and release of virions.

UNIT-IV: Viruses and Cancer

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

UNIT-V: Prevention & control of viral diseases

Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination.

Applications of Virology

Use of viral vectors in cloning and expression, Gene therapy, Phage display and phage therapy.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition,Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM pressWashington DC.

VIROLOGY PRACTICAL (BSHMBL-202)

CREDITS: 2

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B andretroviruses) using electron micrographs.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumbermosaic and alpha-alpha mosaic viruses) using electron micrographs.
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agarlayer technique.
5. Studying isolation and propagation of animal viruses by chick embryo technique by photographs.
6. Study of cytopathic effects of viruses using photographs.
7. Performing local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition,Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM pressWashington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, NewJersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

GE-II: CHEMISTRY: ORGANIC CHEMISTRY I (BSHCY-201)

CREDITS: 4

UNIT- I: Structure and Bonding

Classification, *nomenclature* and general structure *of* organic compounds. Hybridization.orbital representation of methane, ethane, ethylene, acetylene and benzene. Bond energy, bond length and bond angels. Polarity of covalent bonds-Inductive, resonance, hyper-conjugation and steric inhibition in resonance and its influence on acidity and basicity of organic compounds.

UNIT- II: Mechanism of Organic reactions

Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows.Homoljsis and heterolysis of carbon-carbon bonds; Reactive species e.g. Carbocations, carbanions, free radicals and their stability.Nucleophiles and electrophiles.

UNIT- III: Alkanes and cycloalkanes

Preparation and general reactions of alkanes and cycloalkanes, Bayer Strain theory of strain less ring; Conformation of ethane, *n*-butane and cyclohexane, chlorination of methane and side chain chlorination of toluene.

UNIT-IV: Alkenes

General methods for preparation of alkenes, Reactions of alkenes: Addition reactions (Electrophilic and free radical), Halogenation, Hydrohalogenation, Hydration, Hydroxylation, Hydroboration-oxidation, Mercuration-demercuration, Epoxidation and Ozonoloysis.

Dienes: Conjugated and isolated Dienes; 1,2- versus 1,4-addition. Diels-Alder reaction of dienes: Mechanism.

UNIT-V:Alkynes

Preparation of alkynes, acidity and metal acetylides, Electrophilic addition reactions viz.,Halogenation, Hydrohalogenation, Hydration. Hydroboration-oxidation, Mercuration-demercuration and Ozonoloysis.

Reference Books:

1. *"Organic Chemistry*", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P)Ltd., New Delhi.
2. *"OrganicChemistry",* S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, I st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
3. *"Organic Chemistry", I.* L. Finar, [Vol. 1, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.

4. *'Organic Chemistry - Structure and Reactivity", Seyhan N' Ege, 3rd Edition (1998),AITBS Publishers and Distributtors, Delhi'*
5. *-Organic Chemistry", Paula Y. Bruice, 2nd Edition, Prentice-Hall, lntemational Edition* (1998).
6. "Organic Chemistry",*",* G. Solomon, W illey India, Paper Back, 9" Edition.
7. *"Modern Organic Chemistry"*,M. K. Jain and S. C. Sharma, V ishal Publishing CO.Jalandhar, India. 4^{h} Edition (2012).

GEL-II: CHEMISTRY: ORGANIC CHEMISTRY-I LAB

(BSHCYL-201)

CREDITS: 2

1. Calibration of the thermometer
2. Purification *of organic* compounds by crystallization using the following solvents:a. Water b. Alcohol, c. Alcohol-Water
3. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point-mixed melting point of two unknown organic compounds.
5. Detection of special elements (N, S, C1. Br, I).

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemisstry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.: Smith, P.W.G.: Tatchell, A.R. *Practical OrganicChemistry, 5th Ed., Pearson (2012*

GE-II: ZOOLOGY: ANIMAL DIVERSITY–II (CHORADATES)
(BSHZO-201)

CREDITS: 4

UNIT I

Hemichordates: General characters and classification up to the order, Protochordates: Urochordates, Cephalochordates, Cyclostomes: General characters, Comparative account of Petromyzon and myxine.

UNIT II

General characters and classification of Pisces and Amphibians up to orders, Fishes: migration, Parental care, Amphibian: Parental care, Neoteny.

UNIT III

General characters and classification of Reptiles up to orders, Difference between poisonous and non-poisonous snakes with examples, Poison apparatus and biting mechanism of poisonous snakes. Snake venom, its uses and antivenin.

UNIT IV

General characters and classification of Aves up to orders, Migration and flight adaptation, Beaks and claws in birds, Ratitae, Archaeopteryx.

UNIT V

General characters and classification of Mammals up to orders,Receptors and Sense organs: Phonoreception and Photoreception, Oviparity, Ovoviviparity, Viviparity, Aquatic and Flying mammals.

Books Recommended

1. Cambell and Reece: Biology (7th ed. 2005, Pearson)
2. Nigam: Biology of Chordates (1997, Chand)
3. Kotpal Series of Chordates (Rastogi Publications)

GEL-II: ZOOLOGY: ANIMAL DIVERSITY– II -PRACTICAL (BSHZOL-201)

CREDITS: 2

Chordates

1. Study of museum specimens relevant to theory paper.
2. Study of models relevant to theory paper.
3. Dissection of fish showing digestive system.
4. Mounting of scales.
5. Fish dissection showing afferent and efferent cranial nerves.
6. Fish internal ear.

Books Recommended

1. Cambell and Reece: Biology (7th ed. 2005, Pearson)
2. Nigam: Biology of Chordates (1997, Chand)

GE-II: BOTANY: TAXONOMY AND EMBRYOLOGY OF ANGIO SPERMS (BSHB-201)

CREDITS: 4

UNIT-I

Structure and Development of Plant Body Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cyto differentiation and organogenesis during embryogenic development. Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspec:

UNIT-II

General feature and classification of Angiosperms, merits and demerits (Bentham and Hooker, Takhtajan); Modern trends in plants taxonomy.

UNIT-III

General features of the following families: Ranunculaceae, Malvaceae, Brassicaceae, Asclepiadaceae, Solanaceae, Asteraceae, Euphorbiaceae, Poaceae.

UNIT-IV

Embryology: structure of angio sperms flower, Androecium (stamens), pollenmorphology only, Gynoecium (Ovary, style and Stigma).Types of ovary, ovules and placentation, structure and main types.

UNIT-V

Pollination types, Double fertilization and triple fusion, Monocot and dicotembryo.Types of embryo sacs, organization and ultrastructure of mature embryo sac. Embryo endosperm relationship

Suggested readings:

1. Bhojwani S S and Bhatnagar S P, 2009. Embryology of Angiosperm, Vikas Publication House, NewDelhi.
2. Eames, A. J, 1961: Morphology of Angiosperms, McGraw Hill Publication, New Delhi.
3. PandeyB P, 2001: Plant Anatomy, S Chand and Company, New Delhi.
4. Sharma O P, 2005. Plant Taxonomy, Tata Mc Graw Hill, New Delhi.

GEL- II: BOTANY: TAXONOMY AND EMBRYOLOGY OF ANGIO SPERMS PRACTICAL (BSHBL-201)

CREDITS: 2

1. Study of Floral character sand Floral diagram of representative member of some families: Malvaceae, Brassicaceae, Asclepiadaceae, Solanaceae, Euphorbiaceae, Poaceae

2. Study of type of ovary, ovules, placentationt types, types of pollengrain sands tages of dicotembryo.

Fieldtrips: for habitat study & collection of samples.

Suggested readings:

1. Bhojwani S S and Bhatnagar S P, 2009. Embryology of Angiosperm, Vikas Publication House, NewDelhi.
2. Eames, A. J, 1961: Morphology of Angiosperms, McGraw Hill Publication, New Delhi.

AECC- ENVIRONMENTAL SCIENCE

CREDITS: 2

UNIT – I

General: Environmental segments, environmental degradation, environmental impact assessment. Concept of Ecosystem: Fundamental of Ecology and Ecosystem, components of ecosystem, food-chain, foodweb, trophic levels, energy flow, cycling of nutrients, major ecosystem types (forest, grass land and aquatic ecosystem).

UNIT – II

Air Pollution: Atmospheric composition, energy balance, classification of air pollutants, source and effect of pollutants – Primary (CO, SOx, NOx, particulates, hydrocarbons), Secondary [photochemical smog, acid rain, ozone, PAN (Peroxy Acetyl Nitrate)], green house effect, ozone depletion, atmospheric stability and temperature inversion, Techniques used to control gaseous and particulate pollution, ambient air quality standards.

UNIT – III

Water Pollution: Hydrosphere, natural water, classification of water pollutants, trace element contamination of water, sources and effect of water pollution, types of pollutants, determination and significance of D.O., B.O.D.,C.O.D. in waste water, Eutrophication, methods and equipment used in waste water treatment preliminary, secondary and tertiary.

UNIT – IV

Land Pollution & Noise Pollution: Lithosphere, pollutants (agricultural, industrial, urban waste, hazardous waste), their origin and effect, collection of solid waste, solid waste management, recycling and reuse of solid waste and their disposal techniques (open dumping, sanitary land filling, thermal, composting).Noise Pollution: Sources, effect, standards and control.

UNIT – V

Environmental Biotechnology: Definition, current status of biotechnology in environmental protection, bio-fuels, bio-fertilize, bio-surfactants, bio-sensor, bio-chips, bio-reactors. Pollution Prevention through Biotechnology: Tannery industry, paper and pulp industry, pesticide industry, food and allied industry.

TEXT BOOKS:

1. Environment and Ecology by Piyush Kant Pandey and Dipti Gupta (Sum India Publication)
2. A Textbook of Environmental Chemistry and Pollution Control by S.S. Dara (S. Chand and Company)

REFERENCE BOOKS:

1. Masters, G.M. Introduction to Environment Engineering and Science (Prentice Hall of India).
2. Environmental Chemistry by A.K. Dey (Eastern Ltd.).
3. Environmental Chemistry by B.K. Sharma (Krishna Prakashan).
4. Nebel B.J. Environmental Science (Prentice Hall of India-1987).
5. Environmental Biotechnology by S.N. Jogdand (Himalaya Publishing House).
6. Introduction to Environmental Biotechnology by A.K. Chatterji (Prentice Hall of India).

Semester III

MICROBIAL PHYSIOLOGY AND METABOLISM (BSHMB-301)

CREDITS: 4

UNIT-I: Microbial Growth and Effect of Environment on Microbial Growth

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate Effect of temperature and pH on microbial growth. Effect of solute and water activity on growth. Effect of oxygen concentration on growth. Nutritional categories of microorganisms.

UNIT-II: Nutrient uptake and Transport

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

UNIT-III: Chemoheterotrophic Metabolism - Aerobic Respiration

Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathwayTCA cycle.

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterialETC, electron transport phosphorylation, uncouplers and inhibitors.

UNIT-IV: Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate

/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction).

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

UNIT-V: 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 and cyanobacteria.

SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.

MICROBIAL PHYSIOLOGY AND METABOLISM LAB (BSHMBL-301)

CREDITS: 2

1. Study and plot the growth curve of *E. coli* by tubidometric method.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with thegiven data.
3. Effect of temperature on growth of *E. coli*.
4. Effect of pH on growth of *E. coli*.
5. Demonstration of alcoholic fermentation.
6. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SUGGESTED READINGS

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

CELL BIOLOGY (BSHMB-302)

CREDITS: 4

UNIT-I: Structure of Cell

Plasma membrane: Structure and transport of small molecules. Cell Wall: Eukaryotic cell wall, Extracellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects). Mitochondria, chloroplasts and peroxisomes. Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasmamembrane, cell surface protrusions, intermediate filaments, microtubules.

UNIT-II: Nucleus

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

UNIT-III: Protein Sorting and Transport

Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from GolgiApparatus. Lysosomes.

UNIT-IV: Cell Signalling

Signalling molecules and their receptors. Function of cell surface receptors. Pathways of intracellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.

UNIT-V: Cell Cycle, Cell Death and Cell Renewal

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis. Development of cancer, causes, types, Diagnosis and therapy. Programmed cell death. Stem cells. Types: Embryonic stem cell, induced pluripotent stem cells.

SUGGESTED READING

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley &Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. LipincottWilliams and Wilkins, Philadelphia.

CELL BIOLOGY LAB (BSHMBL-302)

CREDITS: 2

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs.
3. Cytochemical staining of DNA – Feulgen.
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell usingvital stain Janus Green B.
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis by permanent slides.

SUGGESTED READING

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

MOLECULAR BIOLOGY (BSHMB-303)

CREDITS: 4

UNIT-I: 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 DNAProkaryotes, Viruses, Eukaryotes. RNA Structure,

UNIT-II: 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) modeof replication and other accessory protein, Mismatch and excision repair.

UNIT-III: 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-IV: 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,mRNA and its significance.

UNIT-V: 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.

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of theGene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition,Pearson Benjamin Cummings Publishing, San Francisco.
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. LippincottWilliams and Wilkins, Philadelphia.

MOLECULAR BIOLOGY LAB (BSHMBL-303)

CREDITS: 2

1. Study of different types of DNA and RNA using micrographs and model/schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of genomic DNA from *E. coli*.
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) and UV spectrophotometer (A260 measurement).
5. Estimation of RNA using colorimeter (orcinol reagent) and UV spectrophotometer (A260 measurement).
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS

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

*GE-III: CHEMISTRY: Choose from scheme

CREDITS: 4

*GEL-III: CHEMISTRY: Choose from scheme

CREDITS: 2

GEL-III: ZOOLOGY: GENETICS AND EVOLUTION

(BSHZO-301)

CREDITS: 4

UNIT- I

Elements of heredity and variation: Mendel's laws of inheritance; Chromosomal basis of inheritance. Extension of Mentalism: dominance relationships,Multiple allelism, Leathalalleles', Pleiotropy, Epistasis, Complementary, Supplementary inheritance; Cytoplasmic inheritance.

UNIT-II

Linkage and crossing-over, Sex-linkage; Sex chromosome systems,Sex determination; Structural and numerical alterations of chromosomes, Pedigree analysis: symbols of pedigree, Pedigrees of sex linked and autosomal inheritance.

UNIT- III

Human genetics: Karyotype, banding, nomenclature of chromosome subdivisions and genetic map. Genetic disorders: Chromosomal aneuploidy (Down, Turner and Klinefelter syndromes), Chromosome translocation (chronic myeloid leukemia) and deletion ("cry of cat" syndrome), Gene mutation (cystic fibrosis);Genetic counselling.

UNIT -IV

Concept of organic evolution, Evidences of organic evolution from comparative anatomy, embryology, palaeontology, Theories of organic evolution: Lamarckism, Darwinism, Modern synthetic theory, natural selection in action.

UNIT- V

Gene frequency in Mendelian population, Hardy-Weinberg equilibrium; major evolutionary forces; isolating mechanisms, modes of speciation (allopatric and sympatric).

Books Recommended

Genetics

1. Gardner et al: Principles of Genetics (2006, John Wiley)
2. Griffith et al: An Introduction to Genetic Analysis (2008, Freeman)
3. Hartl & Jones: Essential Genetics - A Genomic Perspective (2009, Jones & Bartlet)

4. Pierce: Genetics – A Conceptual Approach (W. H. Freeman, 12-Apr-2011)
5. Russell: I Genetics (2009, Benjamin Cummings)
6. Snustad & Simmons: Principles of Genetics (2012, John Wiley)

Evolution

1. P A Moody: Introduction to Evolution
2. Rastogi: Organic Evolution (2007, Kedarnath& Ramnath)
3. Strickberger: Evolution

GEL-III: ZOOLOGY: GENETICS AND EVOLUTION-III LAB (BSHZOL-301)

CREDITS: 2

Genetics and Evolution

1. Application of probability in the law of segregation with the coin tossing
2. Frequency of following genetic trait in human attached ear lobe, widow's peak, dimple in chin mid-digital Hair, Thumb, hypertrichosis, color blindness, PTC (phenyl thiocarbamide)
3. Study of mode of inheritance of the following traits by pedigree charts – attached ear lobe, widow's peak
4. Familiarization with techniques of handling Drosophila, identifying males and females; observing wild type and mutant (white eye, wing less) flies, and setting up cultures.

5 Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs.

6. Study of human karyotypes and numerical alterations (Down, Klinefelter and Turner syndrome).
7. Preparation of temporary slide of Barr body by own cheek epithelium or hair root.

Books Recommended

Genetics

1. Gardner et al: Principles of Genetics (2006, John Wiley)
2. Griffith et al: An Introduction to Genetic Analysis (2008, Freeman)

Evolution

1. P A Moody: Introduction to Evolution
2. Rastogi: Organic Evolution (2007, Kedarnath& Ramnath)

GE-III: BOTANY: PLANT PHYSIOLOGY-I (BSHB 301)

CREDITS: 4

UNIT-I

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

UNIT-II

Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, Electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

UNIT-III

Photosynthesis: role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction photo phosphorylation, C_3, C_4 and CAM pathways of carbon fixation,photo respiration.

UNIT-IV

Respiration: Glycolysis, TCA cycle, electron transport, oxidative phosphorylation, alpha and betaoxidation off attyacid.

UNIT-V

Plant growth hormones: Physiological role of auxins, gibberellins, cytokinins, abscisic acid and ethylene, Phytochrome: Structure and function; Photoperiodism; Vernalization; Seeddormancy

Suggested Books:

1. Devlin Robert M. 1983. Plant Physiology, Prindle Weber and Schmidt Publisher; 4thedition. UK
2. Hopkins, W.G.1995.Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
3. Moore, T.C.1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, New York, USA.

GEL-III: BOTANY: PLANTPHYSIOLOGY-I LAB

(BSHBL-301)

CREDITS: 2

1. Determination of diffusion pressure deficit (DPD)
2. Study of transpiration rate
3. Transpiration rate by Ganong' spotomter
4. Study of effect of different light on photosynthetic rate
5. Separation of plant pigments by paper chromatography
6. Demonstration of osmosis phenomenon
7. Role of plant growth hormones

SuggestedBooks:

1. Devlin Robert M. 1983. Plant Physiology, Prindle Weber and Schmidt Publisher; 4th edition. UK
2. Hopkins, W.G.1995.Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
3. Pandey S Nand Sinha B K.2009.Plantphysiology: VikasPublishing,NewDelhi
4. Singh G S. Renger G, Sopory, S K, Irrganag K D, Govindjee; 1999. Conceptsin Photobiology, Photosynthesis and Phytomorphognesis, Narosa Pub.House, NewDelhi.
5. TaizLandZeigerE.2010.Plantphysiology.SinauerAssociates, UK.

Semester IV

MICROBIAL GENETICS AND GENOMICS (BSHMB-401)

CREDITS: 4

UNIT-I: Genome organization and mutations

Genome organization: *E. coli*, *Saccharomyces*, *Tetrahymena*. Organelle genome: Chroloroplast and Mitochondria. 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-II: 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-III: 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 byrecombination and co-transduction of markers.

UNIT-IV: Phage genetics

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

UNIT-V: 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.

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed.,Benjamin Cummings.
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and BartlettLearning.

MICROBIAL GENETICS AND GENOMICS LAB

(BSHMBL-401)

CREDITS: 2

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

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed.,Benjamin Cummings.
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and BartlettLearning.
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher EducationLearning.
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., BenjaminCummings.
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings.
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, ColdSpring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd Edition., Jones and BarlettPublishers.

ENVIRONMENTAL MICROBIOLOGY (BSHMB-402)

CREDITS: 4

UNIT-I: 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-II: Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non symbiotic interactions. Microbe-animal interaction: Termites gut microflora, nematophagus fungi and symbiotic luminescentbacteria.

UNIT-III: Bio-geochemical 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-IV: 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-V: Microbial Bioremediation

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

Water Potability

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

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition.Benjamin/Cummings Science Publishing, USA.
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition.Pearson/ Benjamin Cummings.
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, AcademicPress.
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,New York.
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17,Springer-Verlag, Berlin Hedeilberg.

ENVIRONMENTAL MICROBIOLOGY LAB

(BSHMBL-402)

CREDITS: 2

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

SUGGESTED READINGS

1. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.
2. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
3. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
4. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in MicrobialEcology. Blackwell Scientific Publication, U.K.
5. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. NewYork & London.
6. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
7. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.

FOOD AND DAIRY MICROBIOLOGY (BSHMB-403)

CREDITS: 4

UNIT-I: Foods as a substrate for microorganisms

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

UNIT-II: Microbial spoilage of various foods

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

UNIT-III: Principles and methods of food preservation

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processingand aseptic packaging, chemical methods of food preservation: salt, sugar, organicacids, SO_2, nitrite and nitrates, ethyleneoxide, antibiotics and bacteriocins.

UNIT-IV: Fermented foods

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

UNIT-V: Food borne diseases (causative agents, foods involved, symptoms and preventivemeasures)

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*.

SUGGESTED READINGS

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

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

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

4.Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and FoodPreservation. CABInternational, Wallingford, Oxon.

FOOD AND DAIRY MICROBIOLOGY LAB

(BSHMBL-403)

CREDITS: 2

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation and detection of food borne bacteria (*Staphylococcus* or *Salmonella*) from different foodsamples.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

SUGGESTED READINGS

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

*GE-IV: CHEMISTRY: Choose from scheme

CREDITS: 4

*GEL-IV: Choose from scheme

CREDITS: 2

GE-IV: ZOOLOGY: COMPARATIVE ANATOMY OF VERTEBRATES (BSHZO-401)

CREDITS: 4

UNIT- I

Origin of vertebrates, Integument and its derivatives, Structure of integument, scales, feathers, hair, beak, claw, nail, hoof, horn, antler, gland, Endoskeleton: Pectoral, Pelvic, Hindlimb, Forelimb.

UNIT- II

Digestive system: Modifications in relation to feeding habits, digestive glands, Oesophagus, Stomach; Dentition, dental formula in mammals.

UNIT- III

Respiratory System: Aquatic respiration, Aerial respiration, Circulatory system: Heart, Aortic arches,

UNIT- IV

Nervous system: Brain, Chemoreceptors, Photoreceptors, Photoreceptors of vertebrates, Cranial and spinal nerve.

UNIT -V

Urinogenital system: Excretory system- Types and evolution of kidney tubules, Urinary duct and bladder. Reproductive system- General plan of gonads, Accessory reproductive organs.

Books Recommended

• Hildebrand: Analysis of Vertebrate Structure (1995, John Wiley)

• Kotpal: Modern Text Book of Zoology Vertebrates (2003, Rastogi)

• Nigam: Biology of Chordates (1983, S Chand)

GEL- IV: ZOOLOGY: COMPARATIVE ANATOMY OF VERTEBRATES IV-LAB (BSHZOL-401)

CREDITS: 2

Comparative anatomy of vertebrates

- Study of histological slides of Pisces.
- Study of histological slides of Amphibians.
- Study of histological slides of Reptiles.
- Study of histological slides of Aves.
- Study of histological slides of Mammals.
- Dissection of Afferent and efferent arteries of available fish/ amphibia
- Dissection of Cranial nerve of fish

Books Recommended

- Hildebrand: Analysis of Vertebrate Structure (1995, John Wiley)
- Kotpal: Modern Text Book of Zoology Vertebrates (2003, Rastogi)

GE-IV: BOTANY: PLANT PATHOLOGY (BSHB-401)

CREDITS: 4

UNIT-I

History of plant pathology, classification of plant diseases, general symptoms of plant diseases.

UNIT-II

Mode of infection and role of enzymes and toxins in plant disease, defense mechanisms of plants against infection: Pre-existing structural and chemical defense, Host pathogen interactions, PR proteins.

UNIT-III

Control of plant diseases: biological, chemical, physical; bio-pesticides, plant quarantine, integrated pest management.

UNIT-IV

General account of some plant diseases: Late blight of Potato, Tikka disease of groundnut, Blackrust of wheat, Redrotof sugarcane, leaf spot of rice, Citruscanker; Yellow veinmosaic of hindi.

UNIT-V

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

Suggested Readings:

1. Agrios G N, 2000. Plant Pathology, Academic press, London
2. Bilgrami K .H. & Dube H. C... 1976. A textbook of Modern Plant Pathology. International Book Distributing Co. Lucknow.
3. Dubey H. C. 2009. An introductionto Fungi, Vikas Publisher New Delhi

4. R. S. Mehrotra and A. Agrawal, 2005.Plant Pathology, Tata McGraw New Delhi
5. Sharma P. D. 2004. Plant Pathology, Rastogi Publishers, Meerut

GEL-IV: BOTANY: PLANT PATHOLOGY LAB

(BSHBL-401)

CREDITS: 2

1. To demonstrate control of plant diseases.
2. Symptomology of some viral disease specimens: Yellow veinmosaic of hindi
3. Symptomology of some bacterial disease specimens: Bacterial blight of rice, Citruscanker
4. Symptomology of some fungal disease specimens: Late blight of Potato, Tikka disease of groundnut, Black rust of wheat, Red rot of sugarcane.

Suggested Readings:

1. Agrios G N, 2000. Plant Pathology, Academic press, London
2. Bilgrami K .H. & Dube H. C... 1976. A textbook of Modern Plant Pathology. International Book Distributing Co. Lucknow.
3. Dubey H. C. 2009. An introduction to Fungi, Vikas Publisher New Delhi

Semester V

INDUSTRIAL MICROBIOLOGY (BSHMB-501)

CREDITS: 4

UNIT-I: Introduction to industrial microbiology and fermentation processes

Brief history and developments in industrial microbiology. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations.

UNIT-II: Types of bio-reactors and measurement of fermentation parameters

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-III: 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-IV: Down-stream processing

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

UNIT-V: Microbial production of industrial products (micro-organisms involved, media,fermentation conditions, downstream processing and uses)

Citric acid, ethanol, , glutamic acid, Vitamin B12. Enzymes (amylase, protease, lipase).Wine, beer. Antibiotics – Penicillin, Streptomycin.

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios ScientificPublishers Limited. USA.
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition, Wiley – Blackwell.

INDUSTRIAL MICROBIOLOGY LAB (BSHMBL-501)

CREDITS: 2

Study different parts of fermenter.

1. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
   (a) Enzymes: Amylase and Protease.
   (b) Amino acid: Glutamic acid.
   (c) Organic acid: lactic acid/ Acetic Acid
   (d) Alcohol: Ethanol.
2. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

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

IMMUNOLOGY (BSHMB-502)

CREDITS: 4

UNIT-I: Introduction

Concept of Innate and Adaptive immunity; Contributions of following scientists to the developmentof 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-II: 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 – BoneMarrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

UNIT-III: Antigens

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

UNIT-IV: Antibodies

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

UNIT-V: 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).

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th editionSaunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman andCompany, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland SciencePublishers, New York.

IMMUNOLOGY LAB (BSHMBL-502)

CREDITS: 2

Identification of human blood groups.

1. Perform Total Leukocyte Count of the given blood sample.
2. Perform Differential Leukocyte Count of the given blood sample.
3. Separate serum from the blood sample (demonstration).
4. Perform immune diffusion by Ouchterlony method.
5. Perform DOT ELISA.
6. Perform immune electrophoresis.

SUGGESTED READINGS

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

Semester VI

MEDICAL MICROBIOLOGY (BSHMB-601)

CREDITS: 4

UNIT-I: 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-II: Sample collection, transport and diagnosis

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immuno fluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

UNIT-III: 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-IV: 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-V: Protozoan diseases

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

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, UniversityPress Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick andAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier

MEDICAL MICROBIOLOGY LAB (BSHMBL-601)

CREDITS: 2

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

1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
2. Study of bacterial flora of skin by swab method.
3. Perform antibacterial sensitivity by Kirby-Bauer method.
4. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox,HPV warts, AIDS (candidiasis), dermatomycoses (ring worms).
5. Study of various stages of Malarial parasite in RBCs using permanent mounts/Photomicrographs.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, UniversityPress Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition.

RECOMBINANT DNA TECHNOLOGY (BSHMB-602)

CREDITS: 4

UNIT-I: Introduction to Genetic Engineering

Milestones in genetic engineering and biotechnology.

UNIT-II: 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-III: 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, Gel Shift Assay and Western blotting.

UNIT-IV: DNA Amplification and DNA sequencing

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

UNIT-V: Construction and Screening of Genomic and cDNA libraries

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

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford,U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. ElsevierAcademic Press, USA.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition.Blackwell Publishing, Oxford, U.K

RECOMBINANT DNA TECHNOLOGY LAB

(BSHMBL-602)

CREDITS: 2

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

SUGGESTED READING

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

MICROBIOLOGY-DSE I-IV (ELECTIVES)

DSE-I: BIOINFORMATICS

CREDITS: 4

UNIT-I: Introduction to Computer Fundamentals

RDBMS - Definition of relational database.

Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.

UNIT-II: Introduction to Bioinformatics and Biological Databases

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

UNIT-III: 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-IV: Genome organization and analysis

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

UNIT-V: 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.

SUGGESTED READING

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House.
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications.
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International StudentEdition.

PRACTICALS-DSE-I LAB: BIOINFORMATICS

CREDITS: 2

1. Introduction to different operating systems - UNIX, LINUX and Windows.
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB.
3. Sequence retrieval using BLAST.
4. Sequence alignment & phylogenetic analysis using clustalW & phylip.
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool.
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK).
7. Prediction of different features of a functional gene.

SUGGESTED READING

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

DSE-II: PLANT PATHOLOGY

CREDITS: 4

UNIT-I: 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 (K.C.Mehta, Mundkur, Dastur and Sadasivan).

UNIT-II: Stages in development of a disease

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

UNIT-III: Plant disease epidemiology

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

UNIT-IV: Host Pathogen Interaction

A. Microbial Pathogenicity

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

B. Genetics of Plant Diseases

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

C. Defense Mechanisms in Plants

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological- cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

UNIT-V: 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.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. BlackwellScience, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hallof India Pvt.Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, NewDelhi.

DSE-II LAB: PLANT PATHOLOGY

CREDITS: 2

Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.

1.Study of important diseases of crop plants by cutting sections of infected plantmaterial - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

2.Study of following diseases through photographs: bacterial leaf blight of rice, Angular leaf spot of cotton, crown galls, bacterial cankers of citrus, Aster yellow, citrus stubborn, Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro disease, Potato spindle tuber, coconut cadang cadang disease.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. BlackwellScience, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hallof India Pvt.Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, NewDelhi.

DSE-III: INHERITANCE BIOLOGY

CREDITS: 4

UNIT-I: Introduction to Genetics

Historical developments

Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis elegans Drosophila melanogaster, Arabidopsis thaliana*.

UNIT-II: Mendelian Principles

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance,Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance,Multiple alleles, Epistasis, penetrance and expressivity.

UNIT-III: Linkage and Crossing over

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strandstage, Molecular mechanism of crossing over, mapping.

UNIT-IV: Characteristics of Chromosomes

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes,Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

UNIT-V: Recombination

Homologous and non-homologous recombination, including transposition, site-specific recombination.

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education.
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed.Benjamin Cummings.

DSE-III LAB: INHERITANCE BIOLOGY

CREDITS: 2

1. Mendelian deviations in dihybrid crosses.
2. Studying Barr Body with the temporary mount of human cheek cells.
3. Studying *Rhoeo* translocation with the help of photographs.
4. Karyotyping with the help of photographs.
5. Chi-Square Analysis.
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chironomus /Drosophila* larvae.
7. Study of pedigree analysis.
8. Analysis of a representative quantitative trait.

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education.
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed.Benjamin Cummings.
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9thEd. W.H.Freeman and Co., New York.
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers.
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings.

DSE-IV: BIOMATHEMATICS AND BIOSTATISTICS

CREDITS: 4

UNIT-I: Biomathematics-I

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.

UNIT-II: Biomathematics-II

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 ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

UNIT-III: Biomathematics-III

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 Produce of matrices upto order 3.

UNIT-IV:

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;

UNIT-V:

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.

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

DSE-IV LAB: BIOMATHEMATICS AND BIOSTATISTICS

CREDITS: 2

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

SUGGESTED READINGS

5. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
6. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
7. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
8. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

SKILL ENHANCEMENT COURSE (ANY TWO)

(SEC-I TO SEC-IV)

SEC-I: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICALINDUSTRIES

CREDITS: 2

UNIT- I: Microbiological Laboratory and Safe 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- II: Determining Microbes in Food / Pharmaceutical Samples

Culture and microscopic methods - Standard plate count, Most probable numbers,Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, geldiffusion, sterility testing for pharmaceutical products. Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

UNIT- III: Pathogenic Microorganisms of importance in Food & Water-I

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, SalmonellaShigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar.

UNIT- IV: Pathogenic Microorganisms of importance in Food & Water-II

Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological qualityof milk at milk collection centres (COB, 10 min Resazurin assay).

UNIT-V: 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 drinkingwater.

SUGGESTED READING

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control inPharmaceutical and Medical Devices, Taylor and Francis Inc.

SEC-2: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

CREDITS: 2

UNIT- I: Importance of diagnosis of diseases

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, clinical samples fordiagnosis of infectious disease.

UNIT- II: 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- III: Microscopic examination and culture methods.

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- IV: Serological and Molecular methods

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

UNIT- V: Kits for rapid Detection of Pathogens

Typhoid, Dengue and HIV, Swine flu.

Testing for Antibiotic sensitivity in Bacteria

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilutionmethod.

SUGGESTED READING

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, UniversitiesPress Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick andAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2ndedition, Elsevier India Pvt Ltd.
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical MedicalMicrobiology, 14th edition, Elsevier.

SEC-3: BIOFERTILIZERS AND BIOPESTICIDES

CREDITS: 2

UNIT- I: 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, Cropresponse, field application.

UNIT- II: Non - Symbiotic N_2 fixers

Free living *Azospirillum, Azotobacter* - free isolation, characteristics, mass inoculum production andfield application.

UNIT- III: Phosphate and silicate solubilizers

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

UNIT- IV: Mycorrhizal biofertilizers

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculumproduction of VAM, field applications of Ectomycorrhizae and VAM.

UNIT- V: Bioinsecticides

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

Suggested Readings

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial Biofertilizers, The Haworth Press, Inc. NewYork.
3. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, ScientificPublishers.
4. Subba Rao N.S (1995) Soil Microorganisms and Plant Growth, Oxford and IBH publishing co. Pvt.Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert AcademicPublishing GmbH KG.
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

SEC-4: FOOD FERMENTATION TECHNIQUES

CREDITS: 2

UNIT- I: Fermented foods

Definition, types, advantages and health benefits.

UNIT- II: Milk based fermented foods

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

UNIT- III: Grain based fermented foods

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

UNIT- IV: Vegetable based fermented foods

Pickles, Saeurkraut: Microorganisms and production process.

UNIT- V: Fermented meat and fish

Types, microorganisms involved, fermentation process.

Probiotic foods

Definition, types, microorganisms and health benefits.

Suggested Readings

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food andfermentation technology, CRC Press.
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

SEC-5: MANAGEMENT OF HUMAN MICROBIAL DISEASES

CREDITS: 2

UNIT- I: Introduction to Human Microbial Diseases

Definition and concept of health, disease, Infection and Pathogen. Types of human microbial diseases and their transmission, causative agents and symptoms of human microbial diseases: Respiratory microbial diseases, gastrointestinal microbial diseases, nervous system diseases, skin diseases, eye diseases, urinary tract diseases, sexually transmitted diseases, mosquito borne disease, Microbial mediated cancers and Nosocomial infections. Recent outbreaks of human microbial diseases (SARS/ Swine flu/Ebola) – causes, spread and control.

UNIT- II: Diagnosis of Human Microbial diseases

Various serological and molecular methods for diagnosis of microbial diseases. Detection by diagnostic kits based on ELISA, Immunofluorescence, Agglutination tests, PCR, DNA probes (illustrate each with one example).

UNIT- III: Therapeutics of Microbial diseases-I

Treatment using antibiotics: Mechanism of action of antibiotics belonging to different classes: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.** Judicious use of antibiotics, importance of completing antibiotic regimen,

UNIT- IV: Therapeutics of Microbial diseases-I

Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

UNIT- V: Prevention of Microbial Diseases

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

Suggested Readings

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, UniversityPress Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz,

Melnick andAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition.

SEC-6: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

CREDITS: 2

UNIT- I: 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- II: Air sample collection and analysis

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

UNIT- III: Control measures

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

UNIT- IV: Water Microbiology

Water borne pathogens, water borne diseases.

UNIT- V: Microbiological analysis of water

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

Suggested Reading

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