

SHRI GURU RAM RAI UNIVERSITY

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act No. 03 of 2017)



Syllabus of B. Sc. (Hons.) Biotechnology

**Effective from Academic Session
2017-2018**

FINAL COURSE STRUCTURE-TOTAL CREDITS=148

Code	Course Content	L	P	T
Semester I				
HBTC 101	Biochemistry and Metabolism	4	0	4
HBTL 101	Lab course based on course HBTC 101	0	2	2
HBTC 102	Cell Biology	4	0	4
HBTL 102	Lab course based on course HBTC 102	0	2	2
HBTG 103	Generic Elective-Developmental Biology	4	0	4
HBTL 103	Lab course based on course HBTG 103	0	2	2
AECC 101/102/103	Environmental Science/ English / MIL Communication	4	0	4
Total		Credits=22		
Code	Course Content	L	P	T
Semester II				
HBTC 201	Mammalian Physiology	4	0	4
HBTL 201	Lab course based on course HBTC 201	0	2	2
HBTC 202	Plant Physiology	4	0	4
HBTL 202	Lab course based on course HBTC 202	0	2	2
HBTG 203	Generic Elective-Entrepreneurship Development	4	0	4
HBTL 203	Lab course based on course HBTG 203	0	2	2
AECC 201/202/203	Environmental Science/English/MIL Communication	4	0	4
Total		Credits=22		
Code	Course Content	L	P	T
Semester III				
HBTC 301	Genetics	4	0	4
HBTL 301	Lab course based on course HBTC 301	0	2	2
HBTC 302	General Microbiology	4	0	4
HBTL 302	Lab course based on course HBTC 302	0	2	2
HBTC 303	Chemistry-I	4	0	4
HBTL 303	Lab course based on course HBTC 303	0	2	2
HBTG 304	Generic Elective-Bioethics and Biosafety	4	0	4
HBTL 304	Lab course based on course HBTG 304	0	2	2
HBTS 305	Skill enhancement course- Industrial Fermentations	4	0	4
306	Molecular Diagnostics	Any one		
307	Basics of Forensic Science			
Total		Credits=28		
Code	Course Content	L	P	T
Semester IV (January to June)				
HBTC 401	Molecular Biology	4	0	4
HBTL 401	Lab course based on course HBTC 401	0	2	2
HBTC 402	Immunology	4	0	4
HBTL 402	Lab course based on course HBTC 402	0	2	2
HBTC 403	Chemistry-2	4	0	4
HBTL 403	Lab course based on course HBTC 403	0	2	2

HBTG 404	Generic Elective-Biotechnology and Human Welfare	4	0	4
HBTL 404	Lab course based on course HBTG 404	0	2	2
HBTS 405 496	Skill enhancement course- Enzymology Drug Designing	4	0	4
		Any one		
		Total	Credits=28	
Code	Course Content	L	P	T
Semester V				
HBTC 501	Bioprocess technology	4	0	4
HBTL 501	Lab course based on course HBTC 501	0	2	2
HBTC 502	Recombinant DNA Technology	4	0	4
HBTL 502	Lab course based on course HBTC 502	0	2	2
HBTD 503 504 505	Animal Diversity-I Animal Biotechnology Ecology and Environment Management	4	0	4
		Any one		
HBTL 503/504/505	Lab course based on course HBTD 503/504/505 (Any one)	0	2	2
HBTD 506 507 508	Plant Diversity I Plant Biotechnology Bioinformatics	4	0	4
HBTL 506/507/508	Lab course based on course HBTD 506/507/508 (Any one)	0	2	2
		Total	Credits=24	

Code	Course Content	L	P	T
Semester VI				
HBTC 601	Bio Analytical Tools	4	0	4
HBTL 601	Lab course based on course HBTC 601	0	2	2
HBTC 602	Genomics & Proteomics	4	0	4
HBTL 602	Lab course based on course HBTC 602	0	2	2
HBTD 603 604 605	603 Animal Diversity-II 604 Microbial Physiology 605 Biostatistics	4	0	4
		Any one		
HBTL 603/604/605	Lab course based on course HBTD 603/604/605 (Any one)	0	2	2
HBTD 606 607 608	606 Plant diversity-II 607 Medical Microbiology 608 Environment Biotechnology	4	0	4
		Any one		
HBTL 606/607/608	Lab course based on course HBTD 606/607/608 (Any one)	0	2	2
		Total	Credits=24	

Total Credits: 84 (Core Course) +8 (AECC) +8 (SEC) +24 (GE) +24(DSE) =148

BIOCHEMISTRY AND METABOLISM**CODE: HBTC-101****UNIT I: Introduction to Biochemistry (10 Periods)**

A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall **polysaccharides, Glycoprotein's and their biological functions.**

UNIT II (10 Periods)

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

UNIT III (20 Periods)

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD⁺, NADP⁺, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.

UNIT IV (20 Periods)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids.

PRACTICALS

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.

4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

SUGGESTED READING

1. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
3. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
4. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

CELL BIOLOGY**CODE: HBTC-102****UNIT-I (10 Periods)**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II (15 Periods)

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III (20 Periods)

Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT IV (15 Periods)

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

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

DEVELOPMENTAL BIOLOGY**SEMESTER-I (HBTG-103)****UNIT I: Gametogenesis and Fertilization (10 Periods)**

Definition, scope & historical perspective of development Biology, Gametogenesis– Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development (20 Periods)

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation (20 Periods)

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis (10 Periods)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

PRACTICALS

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
5. Study of different types of placenta.

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

UNIVERSITY GRANTS COMMISSION**Ability Enhancement Compulsory Course (AECC – Environment Studies)****Unit 1 : Introduction to environmental studies**

- Multidisciplinary nature of environmental studies;
 - Scope and importance; Concept of sustainability and sustainable development.
- (2 lectures)

Unit 2 : Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
 - a) Forest ecosystem
 - b) Grassland ecosystem
 - c) Desert ecosystem
 - d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
- (6 lectures)

Unit 3 : Natural Resources : Renewable and Non-renewable Resources

- Land resources and land use change; Land degradation, soil erosion and desertification.
 - Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
 - Water : Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
 - Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.
- (8 lectures)

Unit 4 : Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
 - India as a mega-biodiversity nation; Endangered and endemic species of India
 - Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
 - Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.
- (8 lectures)

Unit 5 : Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
 - Nuclear hazards and human health risks
 - Solid waste management : Control measures of urban and industrial waste.
 - Pollution case studies.
- (8 lectures)

Unit 6 : Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture

- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. (7 lectures)

Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

(6 lectures)

Unit 8 : Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

(Equal to 5 lectures)

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36-37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
8. McNeill, John R. 2000. *Something New Under the Sun: An Environmental History of the Twentieth Century*.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. *Environmental and Pollution Science*. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. Tripathi 1992.
14. Sengupta, R. 2003. *Ecology and economics: An approach to sustainable development*. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger: A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

MAMMALIAN PHYSIOLOGY
CODE: HBTC-201

UNIT I: Digestion and Respiration (15 Periods)

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice.

Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation (15 Periods)

Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III: Muscle physiology and osmoregulation (15 Periods)

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: Nervous and endocrine coordination (15 Periods)

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

PRACTICALS

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons, Inc.

PLANT PHYSIOLOGY
CODE: HBTC-202

UNIT I: Anatomy (10 Periods)

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II: Plant water relations and micro & macro nutrients (12 Periods)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III: Carbon and nitrogen metabolism (20 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development (18 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism

and vernalization

PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahh, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

ENTREPRENEURSHIP DEVELOPMENT

CODE: HBTG-203

UNIT I

INTRODUCTION (10 Periods)

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

UNIT II

ESTABLISHING AN ENTERPRISE (12 Periods)

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

UNIT III

FINANCING THE ENTERPRISE (15 Periods)

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

UNIT IV

MARKETING MANAGEMENT (13 Periods)

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

UNIT V

ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS (10 Periods)

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

Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

GENETICS
CODE: HBTC-301

UNIT I (12 Periods)

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics : **Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.**

UNIT II (18 Periods)

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

Genetic organization of prokaryotic and viral genome.

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III (15 Periods)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV (15 Periods)

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing

over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

PRACTICALS

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

SUGGESTED READING

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

GENERAL MICROBIOLOGY

CODE: HBTC-302

UNIT I (10 Periods)

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II (10 Periods)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III (20 Periods)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and

sporulation in bacteria.

UNIT IV (20 Periods)

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.

Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). *Introductory Mycology*. 4th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). *Introductory Phycology*. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). *Microbiology*. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). *General Microbiology*. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). *Microbiology: An Introduction*. 9th edition. Pearson
8. **Wiley JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.**

CHEMISTRY-I

CODE: HBTC-303

UNIT I (18 Periods)

Stereochemistry: Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformation: Restricted rotation about single bonds, Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all

these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/ Z notation along with CIP rules for geometrical isomers. Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R and S configuration (upto two chiral centres).

UNIT II (10 periods)

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (**Markovnikov's and anti-Markovnikov's addition**), hydration, hydroxylation (cis and trans), oxymercuration-demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes. Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives Name reactions: Aldol, cross Aldol, Claisen, Knoevenagel, Cannizzaro, cross Cannizzaro

UNIT III (15 Periods)

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes. Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group) Benzene diazonium chloride: Replacement of diazo group Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl₅, SOCl₂ and HI) Carboxylic acid derivatives: Hydrolysis Ethers: Cleavage by HI Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

UNIT IV (17 Periods)

Elimination Reactions: Alkyl halides (dehydrohalogenation, **Saytzeff's rule**), vicinal dihalides (**dehalogenation**), alcohols (**dehydration**), **Quaternary ammonium salts (Hofmann's elimination)**.

Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Oxidation Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2-diols with periodic acid and lead tetraacetate. Aldehydes: **Oxidation with potassium permanganate, chromic acid and Tollen's reagent** Ketones: Oxidation with

potassium permanganate, sodium hypiodite (iodoform reaction) and Baeyer–Villiger oxidation
Reductions Aldehydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction. Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

PRACTICALS:

1. Purification of organic compounds by crystallization using the following solvents: (a) Water (b) Alcohol
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
3. Determination of optical activity by using polarimeter Organic preparations: Carry out the following preparations using 0.5 - 1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample.
4. To prepare acetanilide by the acetylation of aniline.
5. To prepare p-bromoacetanilide.
6. Benzoylation of **aniline** or **β -naphthol** by Schotten-Baumann reaction
7. Hydrolysis of benzamide or ethyl benzoate.
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methylketone, diethylketone, cyclohexanone, benzaldehyde.
9. Nitration of nitrobenzene.
10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

SUGGESTED READING

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Longman, London & New York.
3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. College Practical Chemistry, Universities Press.
4. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
6. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
7. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
8. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
10. **T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.**
11. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.
12. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.

BIOETHICS & BIOSAFETY**CODE: HBTG-304****UNIT-I (15 Periods)**

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II (20 Periods)

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III (10 Periods)

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International.

Ethical issues against the molecular technologies.

UNIT IV (15 Periods)

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

PRACTICALS

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

INDUSTRIAL FERMENTATIONS**CODE: HBTS-305****UNIT I (12 Periods)**

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II (15 Periods)

Microbial products of pharmacological interest, steroid fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III (13 Periods)

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT IV (20 Periods)

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (K_a) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

PRACTICALS

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

MOLECULAR DIAGNOSTICS**CODE: HBTS-306****UNIT I (15 Periods)****Enzyme Immunoassays:**

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal

or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT II (15 Periods)

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology
Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III (18 Periods)

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno fluorescence. Radioimmunoassay.

UNIT IV (12 Periods)

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial Culture.
3. A kit-based detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. **Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical**
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). **Mims' Medical Microbiology**. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Century-Crofts publication.
8. **Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's** Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

BASICS OF FORENSIC SCIENCE**CODE: HBTS-307****Unit I (15 Periods)**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II (15 Periods)

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III (15 Periods)

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV (15 Periods)

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

PRACTICALS

1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.
b. To lift footprints from crime scene.
3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001). _
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002). _
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005). _
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. **W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation**, CRC Press, Boca Raton (2013).

MOLECULAR BIOLOGY**CODE: HBTC-401****UNIT I: DNA structure and replication (15 Periods)**

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II: DNA damage, repair and homologous recombination (10 Periods)

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III: Transcription and RNA processing (17 Periods)

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: **5' cap formation, polyadenylation, splicing**, rRNA and tRNA splicing.

UNIT IV: Regulation of gene expression and translation (18 Periods)

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation., Posttranslational modifications of proteins.

PRACTICALS

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

IMMUNOLOGY
CODE: HBTC-402

UNIT I (20 Periods)

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II (15 Periods)

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III (13 Periods)

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing.

Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV (12 Periods)

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.

Introduction to immunodiagnostics – RIA, ELISA.

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

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

CHEMISTRY-II**HBTC-403****UNIT I (10 Periods)**

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of isachharides (sucrose, maltose, lactose) and polysachharides (starch and cellulose) excluding their structure elucidation.

UNIT II (12 Periods)

Amino Acids, Peptides and Proteins: Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT III (20 Periods)

Enzymes and correlation with drug action: Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition). Drug action – receptor theory. Structure - activity relationships of drug molecules, binding role of –OH group, -NH₂ group, double bond and aromatic ring. Concepts of Energy in Biosystems: Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells: Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy: Outline of catabolic pathways of Carbohydrates - Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of fats and proteins. Interrelationships in the metabolic pathways of proteins, fats and carbohydrates.

UNIT IV (18 Periods)

Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation. Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

SUGGESTED READING

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. **Lehninger's Principles of Biochemistry 7th Ed.**, W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.

PRACTICALS:

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

SUGGESTED READING

1. **Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.**
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

BIOTECHNOLOGY AND HUMAN WELFARE**CODE: HBTG-404****UNIT I (10 Periods)**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, Alcohol and antibiotic formation.

UNIT II (10 Periods)

Agriculture: N₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III (15 Periods)

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

UNIT IV (12 Periods)

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V (13 Periods)

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentation **using Baker's yeast**
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

ENZYMOLOGY
CODE: HBTS-405**UNIT - I (20 Periods)**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of K_m and V_{max} and their

physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT – II (15 Periods)

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of K_i , suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT – III (13 Periods)

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding,

measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV (12 Periods)

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes. Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution. Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & *invivo*.

PRACTICALS

1. Purification of an enzyme from any natural resource
- 2. Quantitative estimation of proteins by Bradford/Lowry's method.**
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as K_m , V_{max} , K_{cat}

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
- 2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition,McGrawHill, 2009.**
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons,1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004

7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

DRUG DESIGNING

CODE: HBTS-406

UNIT I (12 Periods)

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization.

UNIT II (12 Periods)

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.

UNIT III (12 Periods)

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotypic vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.

UNIT IV (12 Periods)

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation.

UNIT V (12 Periods)

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.

BIOPROCESS TECHNOLOGY
CODE: HBTC-501

UNIT I (10 Periods)

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II (20 Periods)

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes.

Principles of upstream processing – Media preparation, Inoculation development and sterilization.

UNIT III (15 Periods)

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa.

Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV (15 Periods)

Introduction to downstream processing, product recovery and purification. Effluent treatment.

Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

PRACTICALS

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

RECOMBINANT DNA TECHNOLOGY
CODE: HBTC-502

UNIT I (15 Periods)

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase.

Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II (20 Periods)

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT III (10 Periods)

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV (15 Periods)

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

PRACTICALS

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

ANIMAL DIVERSITY-I
CODE: HBTD-503

UNIT I (15 Periods)

- a) Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.
- b) Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans
- c) Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II (15 Periods)

- a) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
- b) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
- c) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III (15 Periods)

- a) Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
- b) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT IV (15 Periods)

- a) Mollusca : general features, Outline of classification, Shell Diversity; Torsion in gastropoda.
- b) Echinodermata: General features, Outline of Classification Larval forms
- c) Hemichordata: Phylogeny: Affinities of *Balanoglossus*

PRACTICALS

1. Identification and Classification of Any these of the following – Porifera: *Scypha*, , *Leucosolenia*, *Euspongia*, *Hylonema*, *Euplectella* Cnidaria: *Medrepora*, *Millepora*, *Physalia*, *Porpita*, *Varella*, *Aurelia*, *Metridium* Platyhelminthes: *Taenia*, *Fasciola*, Aschelminthes: *Ascaris*, *Ancylostoma*, *Enterobius* Annelida: *Pheretima*, *Hirudinaria*, *Chaetopterus*, *Nereis*, *Aphrodite* Arthropoda: *Julus*, *Scolopendra*, *Peripatus*, *Carcinus*, *Limulus*, *Lepisma*, *Dragonfly*, *Musca*, *Acheta* Mollusca: *Pila*, *Unio*, *Mytilus*, *Loligo*, *Sepia*, *Octopus*, *Solen* Echinodermata: *Asterias*, *Ophiothrix*, *Echinus*, *Holothuria*, *Astrophyton* Hemichordata: *Balanoglossus*

2. Identification of slides with two points of identification. *Amoeba*, *Paramecium*, *Ceratium*, *Plasmodium*, *Opalina*, L.S. Sponge, Spicules of sponges, L.S. *Hydra*, *Obelia*, *Bougainvillia*, Larvae of *Fasciola*, Seta of Earthworm, Radula
3. Ecological Note – On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach Earthworm: Digestive, Nervous System, Cockroach: Digestive Reproductive, Nervous System.

SUGGESTED READING

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) *The Invertebrates: A New Synthesis*. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) *Invertebrate Structure and Functions*. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
4. Bushbaum, R. (1964) *Animals without Backbones*. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.

ANIMAL BIOTECHNOLOGY **CODE: HBTD-504**

UNIT I (10 Periods)

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II (10 Periods)

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III (20 Periods)

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV (20 Periods)

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

PRACTICALS

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

ECOLOGY AND ENVIRONMENT MANAGEMENT**CODE: HBTD-505****UNIT-I (12 Periods)**

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT-II (20 Periods)

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

UNIT-III (18 Periods)

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations, Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup : Case studies

UNIT-IV (10 Periods)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quadrat **rate method and calculation of the Simpson's and Shannon- Weiner diversity index** for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.

5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmental pollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.

PLANT DIVERSITY-I

CODE: HBTD-506

UNIT I

Algae: (20 Periods)

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – *Volvox*, *Oedogonium*

Xantho phyceae – *Vaucheria*

Phaeophyceae – *Ectocarpus*

Rhodophyceae-*Polysiphonia*

UNIT II

Fungi: (20 Periods)

General characters, classification & economic importance. Life histories of Fungi:

Mastigomycotina- *Phytophthora*

Zygomycotina-*Mucor*

Ascomycotina- *Saccharomyces*

Basidomycotina-*Agaricus*

Deutromycotina-*Colletotrichum*

UNIT III

Lichens : (10 Periods)

Classification, general structure, reproduction and economic importance. Plant diseases:

4 of 36 Casual organism, symptoms and control of following plant diseases.

Rust & Smut of Wheat.

White rust of Crucifers.

Late blight of Potato.

Red rot of Sugarcane.

Citrus Canker.

UNIT IV

Bryophytes: (10 Periods)

General characters, classification & economic impotence. Life histories of following:

Marchantia.

Funaria.

PRACTICALS

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory

2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4 th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 Th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2 nd Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.
10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3 Rd edition, Cambridge University Press, Cambridge.
11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

PLANT BIOTECHNOLOGY

CODE: HBTD-507

UNIT I (15 Periods)

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II (20 Periods)

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT – III (15 Periods)

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

UNIT – IV (10 Periods)

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

PRACTICALS

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

BIOINFORMATICS
CODE: HBTD-508**UNIT I (10 Periods)**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II (20 Periods)

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III (20 Periods)

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV (10 Periods)

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.

6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) *Bioinformatics: Principles and Applications*. Oxford University Press.
2. Pevsner J. (2009) *Bioinformatics and Functional Genomics*. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) *Discovering Genomics, Proteomics and Bioinformatics*. II Edition. Benjamin Cummings.

BIO-ANALYTICAL TOOLS
CODE: HBTC-601

UNIT I (10 Periods)

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

UNIT II (15 Periods)

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

UNIT III (15 Periods)

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

UNIT IV (20 Periods)

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

PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. **To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.**

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

GENOMICS & PROTEOMICS
CODE: HBTC-602

UNIT I (15 Periods)

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II (10 Periods)

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III (20 Periods)

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV (15 Periods)

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

PRACTICALS

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *iGenetics- A Molecular Approach*. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

ANIMAL DIVERSITY-II
CODE: HBTD-603

UNIT I: Proto-chordates, Pisces and Ambhibia (15 Periods)

Proto-chordates: Outline of classification, General features and important characters of *Herdmania*, *Branchiostoma*. Origin of Chordates. Pisces: Migration in Pisces, Outline of classification.

Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT II: Reptilia, Aves and Mammalia (15 Periods)

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration.

Mammalia: Classification, Origin, dentition

UNIT III: Comparative anatomy of vertebrates I (15 Periods)

Comparative anatomy of various systems of vertebrates: Integumentary, digestive, respiratory systems.

UNIT IV: Comparative anatomy of vertebrates II (15 Periods)

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear.

Autonomic Nervous system in Mammals

PRACTICALS

1. Identification & Classification upto order of the following: Proto-chordata: *Salpa*, *Doliolum*, *Herdmania*, *Branchiostoma* Cyclostomata: *Myxine*, *Petromyzon* Chondrichthyes: *Scoliodon*, *Zygnaea*, *Pristis*, *Trygon*, *Raja*, *Chimaera* Osteichthyes: *Labeo*, *Mystus*, *Catla*, *Hippocampus*, *Anabas*, *Echeneis*, *Lophius*, *Polypeterus* Amphibia: *Rana*, *Hyla*, *Amblystoma*, *Necturus*, *Proteus*. Reptiles: *Hemidactylus*, *Calotes*, *Draco*, *Phrynosoma*, *Naja* *Vipera*, *Bungarus* Aves: *Columba*, *Alcedo*, *Passer* Mammalia: *Ornithorhynchus*, *Macropus*, *Didelphes*, *Dasybus*
2. An Ecological Note on any one of the specimens in Experiment 1
3. Identification of the following slides:
 4. Preparation of a permanent mount of *Salpa*, Placoid scales, spicules of *Herdmania*, Pharynx of *Amphioxus*, Tadpole Larva of frog
 5. Identification of endoskeletons of frog and rabbit.

SUGGESTED READING

1. Hall B.K. and Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
2. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
3. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
4. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
5. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

MICROBIAL PHYSIOLOGY**CODE: HBTD-604****UNIT I (12 Periods)**

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT II (13 Periods)

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity

UNIT III (15 Periods)

Effect of the environment on microbial growth

Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism,

Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT IV (20 Periods)

Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

PRACTICALS

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READING

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

2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms. 10th edition. Pearson/ Benjamin Cummings.
3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
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. (2008). Prescott, Harley and Klein's** Microbiology. 7th edition. McGraw Hill Higher Education.

BIOSTATISTICS

CODE: HBTD-604

UNIT I (12 Periods)

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II (18 Periods)

Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III (18 Periods)

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV (12 Periods)

Correlation and Regression. Emphasis on examples from Biological Sciences.

PRACTICALS

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

PLANT DIVERSITY-II**CODE: HBTD 606****UNIT I: (10 Periods)****Pteridophytes**

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia*.

UNIT II: (20Periods)**Pteridophytes: Type studies**

Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum*, *Pteris*, *Lycopodium*.

UNIT III: (20 Periods)**Gymnosperms**

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia* & *Glossopteris*, telome and stele concept.

UNIT IV: (10 Periods)**Gymnosperms: Type studies**

Life histories of *Cycas* & *Pinus*, economic importance of gymnosperms.

PRACTICALS

1. Examination of morphology and anatomy of vegetative and reproductive parts of *Selaginella*, *Equisetum* & *Pteris*.
2. Examination of morphology and anatomy of vegetative & reproductive parts of - *Cycas* & *Pinus*
3. Plant collection (pteridophytes & gymnosperms)

SUGGESTED READING

1. Bhatnager, S.P. and Moitra, A. 1996 Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi.
2. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
3. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
4. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

MEDICAL MICROBIOLOGY**CODE: HBTD-607****UNIT I (18 Periods)**

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus*, *S.pyogenes*, *B.anthraxis*, *C.perferinges*, *C.tetani*, *C.botulinum*, *C.diphtheriae* *M.tuberculosis*, *M. leprae*.

UNIT II (15 Periods)

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*, *T. pallidum* *M. pneumoniae*, *Rickettsiaceae*, *Chlamydiae*.

UNIT III (12 Periods)

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV (15 Periods)

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton*, *Microsporum* and *Epidermophyton*) Subcutaneous infection (*Sporothrix*, *Cryptococcus*), systemic infection (*Histoplasma*, *Coccidioides*) and opportunistic fungal infections (*Candidiasis*, *Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

PRACTICALS

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of *Aspergillus* and *Candida* by appropriate staining.
5. **Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.**

SUGGESTED READINGS

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). **Jawetz, Melnick and Adelberg's Medical Microbiology**. 24th edition. McGraw Hill Publication.
2. **Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology**. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). **Prescott, Harley and Klein's Microbiology**. 7th edition. McGraw Hill Higher Education.

ENVIRONMENTAL BIOTECHNOLOGY
CODE: HBTD-608

UNIT I (18 Periods)

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas.
Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen
Production, Conversion of sugar to alcohol Gasohol

UNIT II (20 Periods)

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents.
Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides
and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons
and petroleum products.

UNIT III (12 Periods)

Treatment of municipal waste and Industrial effluents. Bio-fertilizers. Role of symbiotic and
asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV (10 Periods)

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental
significance of genetically modified microbes, plants and animals.

PRACTICALS

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Josef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy