SEMESTER-I
CORE THEORY-I
CELL BIOLOGY AND GENETICS

Unit 1: Cell structure and Functions

1.1. Cell as basic unit of living organisms-bacterial, fungal, plant and animal cells
1.2. Ultrastructure of prokaryotic cell (cell membrane and plasmids, Nucleoid)
1.3. Ultrastructure of eukaryotic cell (cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles)
1.4. Fluid mosaic model, Sandwich model, Cell membrane permeability
1.5. Structure of chromosome-morphology, components of chromosomes (histones and non-histones), specialized chromosomes (Polytene, Lampbrush)
1.6. Chromosomal aberrations- structural and numerical

Unit 2: Cell cycle

2.1 Bacterial cell division
2.2 Eukaryotic cell cycle –phases
2.3 Mitosis - Stages (spindle assembly)-significance
2.4 Meiosis- Stages (synaptonemal complex)-significance
2.5 Senescence and necrosis
2.6 Apoptosis

Unit 3: Principles and mechanism of inheritance

3.1 Mendel's experiments- factors contributing to success of Mendel's experiments
3.2 Law of segregation- Monohybrid Ratio; Law of independent assortment- dihybrids, trihybrids
3.3 Deviation from Mendel's laws- partial or incomplete dominance (eg: Flower Color in Mirabilis jalapa), Co-dominance (eg: MN Blood groups), Non allelic interactions-types of epistasis, modification of dihybrid ratios
3.4 Penetrance and Expressivity (eg: polydactyly, waardenburg syndrome), pleiotropism, phenocopy- microcephaly, cleft lip
3.5 Multiple alleleism (eg: Coat color in Rabbits, eye color in Drosophila and ABO Blood groups)
3.6 X-Y chromosomes - Sex determination in Drosophila, Birds, Man, Bonellia, X-linked inheritance - Hemophilia, Color blindness, X-inactivation, Y-linked inheritance- Holandric genes

Unit 4: Linkage, Recombination and Extension to Mendel's Laws

4.1 Linkage and recombination- Cytological proof of crossing over, phases of linkage, recombination frequency, gene mapping and map distance
4.2 Non-Mendelian Inheritance – Maternal effect (Shell coilng in snail), variegation in leaves of Mirabilis jalapa
4.3 Cytoplasmic male sterility in Maize and Paramecium,
4.4 Mitochondrial inheritance in human and poky in Neurospora crassa
4.5 Chloroplast inheritance in Chlamydomonas
4.6 Hardy-Weinberg Equilibrium, allelic and genotypic distribution

CORE-I: PRACTICALS

1. Microscopic observation of cells: bacteria, fungi, plant and animal
2. Preparation of different stages of Mitosis (onion root tips)
3. Preparation of different stages of Meiosis (grasshopper testis)
4. Preparation of Polytene chromosome from Drosophila salivary gland
5. Identification, maintenance and culturing of Drosophila stock
6. Monohybrid and dihybrid ratio in Drosophila
7. Monohybrid and dihybrid ratio in Maize
8. Problems on co-dominance, epistasis, two point and three point test cross, gene mapping, Tetrad analysis
9. Statistical applications of t-test
10. Statistical applications chi square test
11. Statistical applications of Hardy-Weinberg Equilibrium

REFERENCE BOOKS

1. Cell & Molecular Biology. E.D.D De Robertis & E.M.F De Robertis, Waverly publication
2. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication
3. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York
4. The science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication
5. Principles of Genetics by R.H. Tamarin McGrawhill
6. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill
7. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel. American Scientific Books. W.H. Freeman, New York
8. The cell: A molecular approach. Geoffrey M Cooper, Robert E Hausman, ASM press
9. Cell and Molecular Biology, Concepts and Experiments – Gerald Karp, John Wiley & Sons, Inc

SEMESTER II
CORE THEORY II
NUCLEIC ACIDS & BIOINFORMATICS

Unit 1: Nucleic Acids and Genome organization

1.1 DNA as the genetic material- Griffiths experiments on transformation in Streptococcus pneumoniae, Hershey-Chase experiments with radio labeled T2 bacteriophage, Avery, MacLeod and McCarty's experiments
1.2 RNA as genetic material- Tobacco Mosaic Virus
1.3 Structure and forms of DNA (A, B and Z)
1.4 Genome organization in prokaryotes
1.5 Genome organization in eukaryotes, C-value and C-value paradox, Reassociation kinetics-cot curve, Denaturation, Reanturation, Tm curve
1.6 Kinetic classes of DNA- unique sequences, moderately repeated and highly repeated sequences; tandem repeats (satellite, minisatellite and micro satellites), interspersed repeats (SINES-eg: Alu repeats, LINES); palindromic sequences and transposable genetic elements

Unit 2: DNA Replication, Recombination and Repair

2.1 DNA replication- enzymes involved, semi conservative DNA replication-Messelson and Stahl experiment, Linear, Circular, Rolling circle, Theta, D loop
2.2 Mutation- spontaneous, induced (frame shift, transition, transversion)
2.3 Physical and chemical mutagens
2.4 DNA damage- intrinsic and extrinsic factors
2.5 DNA repair-Direct, Excision and methyl mediated mismatch, recombinational and SOS repair
2.6 DNA recombination-homologous, site specific recombination and NHEJ (Non-Homologous End Joining)

Unit 3: Concepts of Bioinformatics

3.1 Bioinformatics – a historical perspective
3.2 Internet and its role in bioinformatics
3.3 Bioinformatics Data: Genomes, nucleic acids, proteins, protein structures
3.4 Storage of databases in DNA (GenBank, EMBL, DDBJ)
3.5 Protein data banks (PDB, SWISS-PROT, UNIPROT, PIR) and their utilization
3.6 Data retrieval tools-BLAST, ENTREZ

Unit 4: Applications of Bioinformatics

4.1 Genome annotation: Gene identification tools
4.2 Basics of sequence alignment, Pairwise alignment (global and local)
4.3 Multiple sequence alignment and phylogenetic analysis
4.4 Structural classification of proteins and homology model building
4.5 Applications of Bioinformatics- drug targets, overview of drug designing
4.6 Concepts of Phramacogenomics

CORE-II: PRACTICALS

1. Isolation of DNA from Plant cells
2. Isolation of DNA from Animal cells
3. Estimation of DNA by Diphenylamine method
4. Estimation of RNA by Orcinol method
5. Exploring data bases: Genbank and Uniprot
6. Exploring the structural data bases: PDB, MMDB
7. Visualization of Protein structures-RASMOL
8. Database searching and downloading bioinformatics data- DNA (Gen bank, DDBJ, ENA) Protein (Uniprot)
9. Pairwise sequence alignment (global and local) of DNA and proteins
10. Multiple sequence alignment of DNA & protein sequences using ClustalW
11. Database searching with heuristic algorithms: BLAST

REFERENCE BOOKS

1. Genes VII. Benjamin Lewin, Oxford Univ. Press, Oxford
2. Molecular Biology by D, Freifelder Narosa Publishing house New York, Delhi
3. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel. American Scientific Books. W.H. Freeman, NewYork
4. Molecular Biology by Brown
5. Essentials of Molecular Biology. D. Freifelder, Panima Publishing Corporation.
6. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
7. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press
8. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
9. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

SEMESTER III
CORE THEORY III
BIOLOGICAL CHEMISTRY

Unit 1: Biomolecules-Carbohydrates and Lipids

1.1 Carbohydrates-Importance, classification, physical and chemical properties of carbohydrates
1.2 Structure, configuration and biochemical importance of monosaccharides (Glucose and Fructose) Oxidation, Reduction; Vitamins- classification, sources, functions and applications
1.3 Reducing and non-reducing sugars- structure, configuration and biochemical importance of disachharides and glycosidic bond (Sucrose, Lactose, Maltose, Isomaltose)
1.4 Structure and functions of polysachharides (Starch, glycogen, chitin)
1.5 Lipids, Fatty acids- importance, properties and classification, simple lipids- tag, complex lipids, derived lipids, sterols, fatty acids: saturated and unsaturated fatty acids with examples
1.6 Acids, Bases, acid-base interactions, pH, buffers, functional groups

Unit 2: Biomolecules-Proteins

2.1 Classification, structure, physical and chemical properties of amino acids
2.2 Characteristic properties of peptide bond and formation
2.3 Structure of proteins, primary, secondary, tertiary and quaternary
2.4 Enzymes-classification and nomenclature
2.5 Michaelis Menton equation-factors influencing the enzyme reactions and enzyme inhibition (competitive and non-competitive), role of co-enzymes.
2.6 Peptide-hormones, mode of action, thyroid gland, pancreatic hormones

Unit 3: Metabolism and Cell Signaling

3.1 Basic concepts of metabolism, anabolic and catbolic pathways with examples.
3.2 Glycolysis, TCA Cycle, electron transport, Oxidative phosphorylation
3.3 Gluconeogenesis and its significance
3.4 β-oxidation of fatty acid, transamination and oxidative deamination reactions of amino acids
3.5 Basic characteristics of cell signaling- paracrine, endocrine, autocrine
3.6 Second messengers and their role in signal transduction

Unit 4: Bioanalytical techniques

4.1 Colorimetry: Beer and Lambert's laws and UV- Vis spectrophotometry
4.2 Principle and applications of Chromatography (Paper, thin layer, ion exchange and gel filtration, HPLC)
4.3 Principle and applications of Electrophoresis (Native gels and SDS-PAGE, Agarose)
4.4 Principle and applications of centrifugation (Preparative and Analytical)
4.5 Principle and applications of X-ray crystallography
4.6 Principle and applications of NMR

CORE-III: PRACTICALS

1. Preparation of normal, molar and molal solutions
2. Preparation of buffers (acidic, basic and neutral)
3. Qualitative tests of sugars, amino acids and lipids
4. Estimation of total sugars by Anthron method
5. Reducing sugars by DNS method
6. Separation of amino acids by paper chromatography, TLC
7. Estimation of proteins by Biuret method
8. Enzyme assay- catalase or invertase
9. Determination of acid value of fats
10. Amylase activity assay

REFERENCE BOOKS

1. Lehninger Principles of Biochemistry By: David L. Nelson and Cox
2. Biochemistry By: Rex Montgomery
3. Harper's Biochemistry By: Robert K. Myrray
4. Enzymes By:Trevor Palmer
5. Enzyme structure and mechanism By: AlanFersht
6. Principles of Biochemistry By: Donald J. Voet, Judith G.Voet, Charlotte W.Pratt
7. Analytical Biochemistry By Cooper
8. Principles and techniques of Biochemistry and Molecular Biology Edited By Keith Wilson and John Walker
9. Experimental Biochemistry: A Student Companion by Sashidhar Beedu et al
10. Practical Biochemistry By Plummer

SEMESTER IV
CORE THEORY IV
MICROBIOLOGY AND IMMUNOLGY

Unit 1: Fundamentals of Microbiology

1.1 Historical development of Microbiology and contributors of microbiology
1.2 Microscopy: Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Flourescent microscopy, scanning and Transmission Electron microscopy
1.3 Outlines of classification of Microorganisms
1.4 Structure and general characteristics of Bacteria
1.5 Structure and general characteristics of Virus
1.6 Structure and general characteristics of Micro algae and Fungi

Unit 2: Culture and Identification of Microorganisms

2.1 Bacterial nutrition, Nutritional types of Bacteria, Essential macronutrients, micronutrients and growth factors
2.2 Bacterial growth, factors influencing bacterial growth
2.3 Typical growth curve-batch and continuous cultures, synchronous cultures
2.4 Measurement of bacterial growth- measurement of cell number and cell mass
2.5 Culturing of anaerobic bacteria
2.6 Culturing of viruses

Unit 3: Basics of Immunology

3.1 Types of immunity-innate and adaptive immunity
3.2 Cells of the immune system: T-cells (helper and cytotoxic cells), B-cells, natural killer cells, macrophages, basophils and dendritic cells
3.3 Primary organs of immune system (thymus and bone marrow)
3.4 Secondary organs of immune system (Spleen and lymph nodes)
3.5 Complement system-functions and components of complement system
3.6 Cell mediated immunity and cytokines

Unit 4: Antigens and Antibodies

4.1 Antigens-Immunogenicity vs Antigenicity, factors affecting antigenicity, epitopes, haptens, adjuvants
4.2 Antibody structure, function and diversity, antigen-antibody reactions, complement activation
4.3 Antigen antibody interactions, principle and applications of precipitation and agglutination
4.4 Monoclonal antibodies, production and applications
4.5 Basic concepts of cell mediated immunity, autoimmunity and hypersensitivity
4.6 Major Histocompatibility Complex and its role in organ transplantation

CORE-IV: PRACTICALS

1. Sterilization methods
2. Preparation of microbiological media
3. Isolation of bacteria by streak, spread, and pour plate method
4. Isolation of soil bacteria
5. Simple staining and differential staining (Gram's staining)
6. Bacterial growth curve
7. Replica plating
8. Microhaemagglutination (eg. ABO and Rh Blood grouping)
9. Viability tests of cells (Trypan blue test)
10. Differential leukocyte count
11. Single radial Immunodiffusion
12. ELISA

REFERENCE BOOKS

1. Brock, T.D. and Madigan, M.T. Biology of Microorganisms
2. Prescott, L.M., Harley, J.P. Klein, D.A. Microbiology
3. Pelczar, M.J, Chan, E.C.S., Ereig, N.R. Microbiology
4. Benson Microbiological applications
5. Freifelder, D Physical biochemistry: application to biochemistry and molecular biology
6. Wilson & Walker Practical biochemistry
7. Upadhyay and Upadhyay Physical Biochemistry
8. Essential Immunology - By I. Roitt, Publ: Blackwell
9. Immunology - By G. Reever & I. Todd, Publ: Blackwell
10. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Saunders Publication, Philadelphia
11. Golds by RA, Kindt TJ, Osborne BA. Kuby's Immunology. W.H. Freeman and Company, New York

SEMESTER V
CORE THEORY V
MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

Unit 1: Gene expression in prokaryotes and eukaryotes

1.1 Organization of prokaryotic and eukaryotic genes, gene families-homogenous, heterogenous gene families, pseudogenes, split genes
1.2 Transcription in prokaryotes: initiation, elongation, termination
1.3 Transcription in eukaryotes: initiation, elongation, termination
1.4 Processing and maturation of eukaryotic RNA (Splicing)
1.5 Genetic code, properties of genetic code, Wobble concept, aminoacylation
1.6 Translation in prokaryotes and eukaryotes

Unit 2: Regulation of Gene expression in Prokaryotes and Eukaryotes

2.1 Regulation in prokaryotes: general aspects of regulation
2.2 Transcription level regulation-positive, negative and coordinated regulation (inducible– lac operon and repressible operon concept – trp operon
2.3 Regulation in Eukaryotes: genome rearrangement for generation of functional protein sequences (immunoglobulin genes)
2.4 Transcriptional control by cis (enhancers, silencers) and Trans (transcription factors) regulatory elements
2.5 Translational regulation in prokaryotes
2.6 Translational regulation in eukaryotes

Unit 3: Introduction to Recombinant DNA Technology

3.1 Enzymes useful in molecular cloning: Restiction endonuclease, DNA ligases, Polynucleotide kinase, Klenow enzyme, DNA Polymerase I, reverse transcriptase, Alkaline phosphatase, terminal nucleotidyltransferase
3.2 Plasmids as cloning vehicles-pBR322, pUC 18 and pET
3.3 Cloning and expression of foreign genes in E.coli
3.4 Labeling nucleic acids and blotting techniques
3.5 Polymerase Chain Reaction and its applications
3.6 Applications of recombinant DNA technologies

CORE-V: PRACTICALS

1. Isolation of DNA from bacterial cells
2. Isolation of plasmid DNA
3. Agarose gel electrophoresis of DNA
4. Quantification of DNA by Spectrophotometer
5. Separation of proteins by SDS-PAGE
6. Bacterial Transformation (Selection of transformants with Blue-white selection)
7. Polymerase Chain Reaction
8. Restriction digestion of DNA

REFERENCE BOOKS

1. Molecular Biology of the cell. Alberts, B; Bray, D, Lews, J., Raff, M., Roberts, K and Watson, J.D. Garland publishers, Oxford
2. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)
3. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
4. Gene Structure & Expression - By J.D. Howkins, Publ: Cambridge
5. Test Book of Molecular Biology - By K.S. Sastry, G. Padmanabhan & C. Subramanyan, Publ: Macmillan India
6. Principles of Gene Manipulation - By R.W. Old & S.B. Primrose, Publ: Blackwell
7. Genes - By B. Lewin - Oxford Univ. Press
8. Molecular Biology &Biotechnol - By H.D. Kumar, Publ: Vikas
9. Methods for General & Molecular Bacteriology - By P. Gerhardf et al., Publ: ASM
10. Molecular Biotechnology - By G.R. Click and J.J. Pasternak, Publ: Panima
11. Genes and Genomes – By Maxine Singer and Paul Berg
12. Molecular Biology - By D. Freifelder, Publ: Narosa
13. Molecular biology. By;F.Weaver. WCB/McGraw Hill
14. Gene, Genomics and Genetic Engineering - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)

SEMESTER V
ELECTIVE THEORY (A)
PLANT BIOTECHNOLOGY

Unit 1: Basics to Plant Biotechnology

1.1 Introduction to plant tissue culture, totipotency of plant cells (dedifferentiation, redifferentiation, regeneration of whole plant)
1.2 Nutritional requirements for plant tissue culture: nutrient media – macronutrients and micronutrients, media additives (carbon source, vitamins, amino acids)
1.3 Plant growth regulators (cytokinins, auxins, gibberellins), gelling agents
1.4 Preparation of media, selection and surface sterilization of explants, inoculation, incubation (temperature and light regime), regeneration of plants
1.5 Initiation of callus cultures and cell suspension cultures
1.6 Regeneration of plants (Organogenesis and embryogenesis)

Unit 2: Applications of Plant Tissue Culture

2.1 Meristem culture and production of disease free plants
2.2 Micro propagation of elite ornamental, horticultural plants via organogenesis and somatic embryogenesis, Encapsulation and production of synthetics seeds
2.3 Cell suspension cultures (batch and continuous culture) for production of secondary metabolites
2.4 Embryo culture and embryo rescue; Protoplast culture and fusion, Development of somatic hybrids and Cybrids and their applications
2.5 Somaclonal variation and their applications; production of haploids, Isogenic lines, Anther and pollen culture
2.6 Methods of cryopreservation for conservation of plant germplasm

Unit 3: Techniques for production of transgenic plants and applications

3.1 Introduction to Agrobacterium tumifaciens, Features of Ti Plasmid, molecular mechanism of T-DNA transfer
3.2 Agrobacterium mediated gene transfer method
3.3 Direct gene transfer methods – Particle Bombardment (Gene Gun)
3.4 Production of transgenic plant for Biotic and Abiotic stresses
3.5 Molecular Farming – Production of biopharmaceuticals in transgenic plants
3.6 Improvement of nutritional quality of crops (vitamins, amino acids, oil, micronutrients)

Core-V (A): PRACTICALS

1. Preparation of media for tissue culture
2. Surface sterilization methods of explants (seed leaf, inter node and root) and inoculation
3. Seed culture
4. Establishment of callus cultures– from carrot
5. Cell suspension cultures
6. Protoplast isolation and culture
7. Protoplast fusion

REFERENCE BOOKS

1. Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture By Akio Fujiwara
3. Frontiers of Plant Tissue Culture By Trevor A. Thorpe
4. In vitro Haploid Production in Higher Plants by S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard

SEMESTER V
ELECTIVE THEORY (B)
MEDICAL BIOTECHNOLOGY

Unit 1: Methods for diagnosis of human diseases

1.1 Karyotyping of human chromosomes
1.2 Chromosome banding– G banding and R-banding technique
1.3 Inheritance patterns in Man– Pedigree analysis
1.4 Prenatal diagnosis - Invasive techniques– Amniocentesis, Chorionic villi sampling (CVS); Non-invasive techniques– Ultrasonography
1.5 Diagnosis using monoclonal antibodies- ELISA
1.6 DNA/RNA based diagnosis– HBV, HIV

Unit 2: Inherited disorders

2.1 Chromosomal disorders caused due to structural chromosomal abnormalities (Deletions, duplications, Translocations)
2.2 Chromosomal disorders caused due to numerical chromosomal abnormalities (autosomal and allosomal)
2.3 Monogenic disorders (autosomal and X-linked diseases)
2.4 Mitochondrial diseases – LHON, MERRF
2.5 Multifactorial conditions – Diabetes and Hypertension; Single Nucleotide Polymorphisms in common diseases: hypertension (Angiotensin Converting Enzyme gene)
2.6 Cancer – types, molecular basis of colon cancer and breast cancer

Unit 3: Therapeutic approaches for human diseases

3.1 Gene therapy – exvivo and *invivo* gene therapy; somatic and germline gene therapy;
3.2 Strategies of gene therapy: gene augmentation – ADA deficiency; Prodrug therapy/ suicide gene – glioma
3.3 Stem cells – potency definitions; embryonic and adult stem cells; applications of stem cells – cell based therapies and regenerative medicine
3.4 Encapsulation technology and therapeutics-Diabetes
3.5 DNA based vaccines, subunit vaccines – Herpes Simplex Virus, Recombinant attenuated vaccines– Cholera
3.6 Nutrigenomics and Pharmacogenomics

ELECTIVE (B): PRACTICALS

1. Karyotyping of normal and abnormal human chromosome sets
2. Human pedigree analysis
3. Estimation of C-reactive protein
4. Dot ELISA
5. Genotyping of candidate genes for diseases by RFLP
6. Detection of DNA damage by comet assay
7. Encapsulation of mammalian cells

REFERENCE BOOKS

1. Medical Biotechnology-Pratibha Nallari, V.Venugopal Rao-Oxford Press
2. Introduction to Human Molecular Genetics – J.J Pasternak, John Wiley Publishers
3. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scxientific Publishers
4. Human Genetics Molecular Evolution, Mc Conkey
5. Recombinant DNA Technology, AEH Emery
6. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery
7. Molecular Biotechnology, Glick and Pasternak

SEMESTER-VI
CORE THEORY VI
MICROBIAL TECHNOLOGY

Unit 1: Introduction to Microbial technology

1.1. Introduction to industrial biotechnology, scope and applications
1.2. Principles and exploitation of microorganisms and their products
1.3. Isolation and screening of microorganisms for industrial products
1.4. Strategies for Strain improvement (mutation, selection, recombination)
1.5. Preservation of industrial microorganisms
1.6. Good manufacturing practices and Intellectual Property Rights and Patenting issues

Unit 2: Microbial fermentation

2.1 Principles of Fermentation technology
2.2 Fermentation concept and Design
2.3 Types of Fermentation
2.4 Formulation and Design of fermentation Media
2.5 Substrates used as Carbon and Nitrogen Inoculum development.
2.6 Factors affecting fermentation process

Unit 3: Microbial technology products and applications

3.1 Microbial production of Organic acids (Lactic acid, citric acid)
3.2 Microbial production of Amino acids (Glutamic acid ,Aspartic acid, Lysine)
3.3 Fermentation by microbes for food additives: dairy products (Cheese, Yogurt, Bread, Vinegar, SCP), beverages (Beer, Wine) and antibiotics (Penicillin, Streptomycin, Erythromycin)
3.4 Food quality and Control
3.5 Therapeutic drugs: Recombinant vaccines, monoclonal antibodies, insulin, vitamins
3.6 Biofuel: Hydrogen, Alcohol, Methane

CORE-VI: PRACTICALS

1. Screening of Microorganisms (primary selection, secondary selection)
2. Production of Citric acid
3. Screening of amylase producing microorganisms
5. Production of wine using common yeast
6. Production of alcohol by fermentation and Estimation of alcohol by colorimetry
7. Production of hydrogen or biogas using cow/cattle dung
8. Production of Penicillin/Ampicillin

REFERENCE BOOKS

1. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
2. Biotechnology -By H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology - By b.T. Nijaguna
4. Biotechnology - By K. Trehan
5. Industrial Microbiology - By L.E. Casida
6. Food Microbiology - By M.R. Adams and M.O. Moss
7. Introduction to Biotechnology - By P.K. Gupta
8. Essentials of Biotechnology for Students - By Satya N. Das
9. Bioethics – Readings and Cases - By B.A. Brody and H. T. Engelhardt. Jr. (Pearson Education)
10. Biotechnology, IPRs and Biodiversity - By M.B. Rao and Manjula Guru (Pearson Education)
11. Bioprocess Engineering - By Shuler (Pearson Education)
12. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)
13. Gene, Genomics and Genetic Engineering - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)

SEMESTER VI
ELECTIVE THEORY (A)
ANIMAL BIOTECHNOLOGY

Unit 1: Animal diversity and Cataloguing of germplasm

1.1 Conventional methods of Animal Breeding: Selective and Cross breeding
1.2 Embryo Biotechniques for augmentation of replication efficiency and faster Multiplication of superior germplasm
1.3 Cryopreservation of germplasm
1.4 Artificial insemination: Super ovulation, Oestrus synchronization, embryo collection and transfer
1.5 In vitro maturation of Oocytes, In vitro fertilization, embryo culture, preservation
1.6 Economically important livestock, Conservation of genetic resources

Unit 2: Animal Improvement for desired traits by biotechnology Interventions

2.1 Scope for biotechnological interventions (Buffalo as multipurpose livestock)
2.2 Model organisms and their significance (Cattle, Rodents and Fish)
2.3 DNA Micromanipulation
2.4 Somatic cell nuclear transfer
2.5 Embryo sexing
2.6 Gene mapping and Identification of genes of economic importance in farm Animals

Unit 3: Developments in molecular markers in Livestock and Transgenic Animals

3.1 Developments in livestock genomics (estimated breeding value, ebv)
3.2 Molecular markers and applications
3.3 Development of transgenic animals
3.4 Applications of transgenic animals in milk production, meat production and aquaculture
3.5 Transgenic technology for development of animals as bioreactors
3.6 Ethical considerations for transgenic animals

ELECTIVE (A): PRACTICALS

1. Preparation of media
2. Isolation of cells from Chicken Liver
3. Isolation of cells from Chick Embryo
4. Preparation of somatic metaphase chromosomes
5. Karyotyping- banding procedures for comparing the chromosomal complement
6. Screening of chromosomal abnormalities

RECOMMENDED BOOKS

1. Lasley JF. Genetics of Livestock Improvement
2. Text book of Animal Biotechnology by B Singh. The Energy and Resources Institute (teri)
3. Ross CV. Sheep Production and Management. Prentice Hall
4. Schmidt GM & Van Vleck LD. Principles of Dairy Science. WH Freeman
5. Turner HN & Young SSY. Quantitative Genetics in Sheep Breeding. MacMillan
6. Van Vleck LD, Pollak EJ &Bltenacu EAB. Genetics for Animal Sciences. WH Freeman
7. Crawford RD. Poultry Breeding and Genetics. Elsevier
8. Singh RP &KumarJ. Biometrical Methods in Poultry Breeding. Kalyani

SEMESTER-VI
ELECTIVE THEORY (B)
ENVIRONMENTAL BIOTECHNOLOGY AND BIODIVERSITY

Unit 1: **Environmental Pollution**

1.1 Introduction to environment and pollution
1.2 Types of pollution- air, water and land pollutions
1.3 Types of pollutants– inorganic, organic and biotic sources
1.4 Sources of pollution – domestic waste, agricultural waste, industrial effluents and municipal waste
1.5 Climate change, greenhouse gases and global warming
1.6 Impact of pollution on environment and measurement methods

Unit 2: Bioenergy and Bio-fuels

2.1 Renewable and non- renewable energy resources
2.2 Fossil fuels as energy source and their impact on environment
2.3 Non-conventional source – biomass as source of bioenergy
2.4 Types of biomass – plant, animal and microbial biomass
2.5 Production of biofuels: bioethanol
2.6 Production of biomethane, biohydrogen

Unit 3: Bioremediation and Restoration of Environment

3.1 Microbial treatment of waste water (sewage of industrial effluent)- aerobic and anaerobic methods
3.2 Solid waste and management; Bioremediation– concepts and types (in-situ and ex-situ); Bioremediation of toxic metal ions– biosorption and bioaccumulation
3.3 Composting of organic wastes
3.4 Microbial bioremediation of pesticides and Xenobiotic compounds
3.5 Phytoremediation- concepts and application
3.6 Conservation of biodiversity

ELECTIVE (B): PRACTICALS

1. Estimation of BOD in water samples
2. Estimation of COD in water samples
3. Estimation of Total dissolved solid in water samples
4. Isolation of microorganisms from soil/industrial effluents
5. Production of hydrogen or biogas using cow/cattle dung

RECOMMENDED BOOKS

1. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
2. Biotechnology -By H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology - By B.T. Nijaguna
4. Biotechnology - By K. Trehan
5. Industrial Microbiology - By L.E. Casida
6. Food Microbiology - By M.R. Adams and M.O. Moss
7. Introduction to Biotechnology - By P.K. Gupta
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