

SEMESTER III**BR15003DCE: Biological Interactions****Unit: I**

Plant interactions: Biotic community— structure and dynamics; Factors contributing to community stability (successional model and climax pattern model); Keystone species; Symbioses, mycorrhizal association; Plant defence and chemical warfare— plant-insect, plant-vertebrate and plant-plant interactions (brief concept); Parasitic and insectivorous plants; Pollination and seed dispersal by animals.

Unit: II

Social and community interactions of animals: Heritable basis of behaviour; Learned behaviour; Communication signals; Courtship, mating, parenting and individual reproductive success; Benefits and costs of living in a social group; Altruism; Migration and navigation; Factors affecting community structure— mutualism, commensalism, competitive interaction, predation, parasitic interactions; Co-evolution; Man animal conflict.

Unit: III

Biosignaling: General features of signal transduction pathways; Diversity of basic signaling cascades (brief idea) with emphasis on Protein kinases, Phosphoinositides, G-protein complex and Calcium mediated signaling; Two component sensor-regulator system in bacteria, plants and animals (one example each). Bacterial chemotaxis and quorum sensing.

Unit: IV

Applied Immunology: Immune system; antigens and antibodies; Types of immunoglobulins (overview); structure of antibody, Immune response system, antibody mediated responses; Allergic disorders (introduction, diagnosis and clinical manifestations); Aeroallergens (identification, isolation and impact on human health); Role of immunotherapy in allergic disorders.

Tutorials: 3 hours/week

SEMESTER IV**BR15004DCE: Bioinformatics****Unit: I**

Bioinformatics databases: Bioinformatics— concept and application; Types of databases- Genome (NCBI, EBI, TIGR, SANGER), Nucleic acid (EMBL, GeneBank, DDBJ), Protein (SwissProt, TrEMBL, PIR) databases; Structural classification of proteins (SCOP, CATH).

Unit: II

Sequencing: Conventional and next generation sequencing; Basic Concept of sequence similarity, identity and homology; Sequence based database searches (blast, fasta, gcg, msf, nbrf-pir etc.); Homologues, orthologues, paralogues; Sequence alignment (pair-wise and multiple); Gene finding and genome annotation; **Transcriptomics:** DNA Microarray, Serial analysis of gene expression, Qualitative RT PCR.

Unit: III

Emerging areas of bioinformatics: Computational systems biology, semantic web; Bioontologies (types, application, softwares), annotations; Proteomics— separation, identification of proteins, MS-MS, protein microarray, protein expression profiling, protein- protein interaction mapping; Metabolomics, cheminformatics, phenomics.

Unit: IV

Phylogenetics: Morphological & molecular phylogeny; Representation of molecular phylogeny; Methods of phylogeny— maximum parsimony, likelihood and Bayesian method; Distance methods (UPGMA, NJ); Softwares (PHYLIP, Tree base, Mesquite, NTSY Snp).

Tutorials: 3 hours/week

SEMESTER IV**BR-15005-DCE: Term Work**

Term work of 2 credits shall be taken by a student in 4th Semester. The Term work may be in the form of field surveys/practicals etc. A student is required to carry out term work under the guidance of a supervisor and submitted his work in the Department that shall be evaluated as per guidelines.

SEMESTER I**BR15001DCE: Cellular and Molecular Biology****Unit: I**

Membrane structure: Structure and composition of biomembranes (Fluid Mosaic Model); Membrane fluidity, membrane rafts; Cell adhesion molecules (overview), tight junctions, gap junctions and plasmodesmata; Extracellular matrix; Cytoskeleton—microtubules, actin filaments, intermediate filaments.

Unit: II

Intracellular organelles: Structural organization of nucleus (nuclear membrane and nuclear pore complex), mitochondria, chloroplast, golgi bodies, endoplasmic reticulum, ribosome, lysosomes, peroxisomes, vacuoles; Genome organization in mitochondria and chloroplast.

Cell division and cell cycle: Mitosis and meiosis; Phases of cell cycle, cell cycle check points and control of cell cycle.

Unit: III

Nucleic acids: Structure of DNA double helix; Various forms of DNA (A, B, Z and H DNA); Packaging of genetic material (Nucleosome organization); DNA replication—enzymes, mechanism of DNA replication; RNA synthesis—promoters, transcription factors, mechanism of transcription; Structure of mRNA & tRNA.

Unit: IV

Protein synthesis: Genetic code; Aminoacylation of tRNA, initiation, elongation & termination of translation; Post translational modifications and protein trafficking.

Regulation of gene expression: Operon model in prokaryotes (lac operon, tryptophan operon and arabinose operon); Transcription attenuation; Regulation of transcription in eukaryotes—promoters and enhancers, activators and repressors, Role of chromatin in regulating gene expression; DNA methylation, miRNAs.

Tutorials: 3 hours/week

SEMESTER II**BR15002DCE: Inheritance Biology****Unit: I**

Laws of inheritance: Dominance, segregation and independent assortment; Types of dominance; Lethal alleles; Multiple alleles; Test of allelism; Gene interaction— complementation, epistasis and pleiotropy.

Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes; Maternal inheritance.

Unit: II

Linkage and Recombination: Linkage, linkage maps, 3 point test cross; Homologous and non homologous recombination; Gene mapping in prokaryotes through transduction and conjugation; Sex-linked inheritance— sex limited and sex influenced traits; Mechanism of sex determination.

Quantitative inheritance: Genes and environment— heritability, penetrance and expressivity.

Unit: III

Mutations: Spontaneous and induced mutations, molecular mechanism of mutations (chemical mutagens and physical mutagens); Suppressor, missense, nonsense and silent mutations.

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation; Auto- and allo-polyploidy and their genetic implications.

Unit: IV

Human genetics: Pedigree— gathering family history, construction of pedigree; Pedigrees of sex-linked, autosomal and mitochondrial traits; Genetic disorders (Klinefelter -, Turner-, Patau-, Down- & Edward's syndrome).

Population genetics: Gene pool; Hardy-Weinberg principle, factors affecting Hardy-Weinberg equilibrium (natural selection, migration and genetic drift); Molecular divergence and molecular clocks.

Tutorials: 3 hours/week

SEMESTER III**BR15006GE: Biomedicine and Bioprospecting****Unit: I**

Biomedicine: Introduction, present scenario & future prospectus; Sources of drugs (plants, animals, microorganism, drugs from organic synthesis); Historical development and present status of Chinese/ Amchi, Ayurvedic, Unani Sidha and Homeopathic systems of medicine.

Unit: II

Ethnobotany: Concept; Ethnobotanical and medicinal importance of some important medicinal plants of Kashmir viz. *Arnebia benthamii*, *Aconitum heterophyllum*, *Atropa acuminata*, *Podophyllum hexandrum*, *Saussurea costus*, *Rheum emodi*, *Digitalis purpurea*, *Valeriana jatamansii*, *Viola odorata*, *Picrorhiza kurroa*, *Dioscorea deltoidea* and *Hippophae rhamnoides*.

Unit: III

Herbal crude medicines: Classification, collection and processing; Various separation techniques for extraction of crude medicine, advantages and limitations; Plant drug standardization; Quality control and quality assurance of herbal drugs; Drug acts and rules.

Unit: IV

Bioprospecting: Concept and methods of bioprospecting; Role of traditional knowledge in bioprospecting; Biopiracy, case studies of biopiracy (Basmati, Neem, Turmeric, Periwinkle, Enola bean); Traditional Knowledge Digital Library (TKDL)— concept and importance.

Tutorials: 1 hour/week

SEMESTER I**BR15001GE: Microbial Resources****Unit: I**

Microbial resources— historical perspective; Types of microbial resources (algal, fungal, bacterial, viral); Approaches for the assessment of microbial diversity (culture dependent and independent); Morphology and ultrastructure of bacteria and viruses (bacteriophages); Microbial growth and growth curve.

Unit: II

Role of microorganisms in food production and beverages (wine, beer, bread, cheese); Single Cell Proteins— production and utility; Microbes as sources of antibiotics and therapeutic agents; Major commercial microbial products (amino acids, enzymes, steroids and biopolymers).

Unit: III

Bioremediation; Role of microbes in bioremediation of soil and water; Role of microbes in waste water treatment (processes based on attached microbial growth, activated sludge process).

Unit: IV

Role of microbes in biogeochemical cycles (carbon, nitrogen, sulphur & phosphorus cycle); Microbes as bioindicators; Phycoviruses and algal blooms; Biodefence and bioterrorism.

Tutorials: 1 hour/week

SEMESTER II**BR15003GE: Industrial Entomology****Unit: I**

Apiculture: Importance and scope; Bee species (biology, morphology, behaviour, and habitat); Bee keeping equipment, hives, bee pasturage and seasonal management; Honey extraction; Factors affecting honey yield; Properties and uses of honey; Granulation, fermentation and storage of honey; Uses of other bee products; Bee enemies including diseases and their control.

Unit: II

Sericulture: Silkworm species, systematic position and salient features; Rearing techniques of mulberry, muga, eri and tassar silkworms; Nutritional requirements of silkworms; Sericulture rearing house and appliances; Grainage technology and cocoon marketing; Enemies and diseases of silkworms and their management; By-products of sericulture.

Unit: III

Lac culture: Lac insect, biology and habitat; Host trees— pruning, inoculation, lac cropping techniques and harvesting; Enemies of lac insect and their control; Processing techniques of lac (traditional and modern); Physical and chemical characteristics of lac.

Unit: IV

Beneficial Insects: Insects as pollinators and biocontrol agents; Insects as soil fertility improving agents and scavengers; Use of insects and insect products in medicine; Use of insects in scientific investigations; Use of insects as food source.

Tutorials: 1 hour/week

SEMESTER III**BR15006GE: Biocontrol and Crop Management****Unit: I**

Biocontrol: Importance and scope; Biological control agents— predators, parasitoids and pathogens; Classical biological control— principles and procedures; Conservation biological control— conservation, habitat management and augmentation; Mass multiplication methods and effective evaluation techniques of biocontrol agents.

Unit: II

Plant disease management: Principles of plant disease management; Organic amendments and botanicals to control plant disease; Disease resistance and molecular approach for disease management; Fungicides, bactericides and antibiotics in disease management; Nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

Unit: III

Post harvest diseases: Concept of post harvest diseases; Importance with reference to environment and health; Postharvest management; Cultural practices in perpetuation of pathogens; Phytoextracts in controlling post-harvest diseases and improving the shelf life of produce.

Unit: IV

Integrated Pest Management (IPM): History, concept and principles; Components of IPM— host plant resistance, agronomic manipulations, mechanical, physical, chemical, biological, genetic and behavioural control methods; Economic Threshold Levels (ETL), Economic Injury Levels (EIL) and their determination.

Tutorials: 1 hour/week

SEMESTER IV**BR15007GE: Wood Resource Utilization****Unit: I**

Wood growth: Formation of wood cambium and its derivatives, growth rings, secondary xylem.

Wood anatomy: Soft wood and hard wood, sap wood and heartwood, knots; Reaction wood.

Unit: II

Physical properties of wood: Colour, luster, odour, weight, and density; Variation in density of early and late wood constituents, effect of growth rings on density.

Chemical properties of wood: Cellulose & hemi-cellulose— structure, chemical properties, effect of acids and bases; Lignin— structure and chemical properties; Wood extractives.

Unit: III

Wood deterioration and preservation: Wood boring insects— termites and carpenter ants; Wood destroying fungi; Wood preservation processes — non pressure and pressure processes; Wood preservative.

Wood seasoning: Concept & importance; Air seasoning— air drying, accelerated air drying; Special seasoning methods— drying by boiling in oily liquids and vacuum drying.

Unit: IV

Commercially important wood species in Kashmir: Description, habitat, type of wood and uses of pine, deodar, silver fir, willow, poplar and walnut; Wood as fuel; Saw dust and its uses, wood pellet technology.

Tutorials: 1 hour/week

SEMESTER I**BR15002GE: Algal Resources****Unit: I**

Algae: Introduction, habit and habitat, micro and macro-algae; Distribution in soil, freshwater and marine habitats; Contribution in primary productivity; Immobilized and inactivated algal biomass for metal and nutrient removal.

Unit: II

Algae as food and fodder: Algae as a source of vitamins, proteins, lipids, carbohydrates, minerals and iodine; Algae as fodder for cattle and poultry, seaweeds as animal feed; Agar agar, alginates and carrageenin.

Unit: III

Algae in pharmaceuticals: Algae as source of antimicrobials, antivirals and antifungals, neuroprotective proteins, therapeutic proteins and drugs; Use of algae in the light of modern research— as antioxidants and anticancer agents; Use of algae in forensic medicine research and HIV vaccine model.

Unit: IV

Algal biofuels and biofertilizers: Energy and chemicals; Biodiesel, hydrogen production-mechanism, progress and prospects; Mechanism of biological nitrogen fixation by cyanobacteria; Cyanobacteria as biofertilizers for paddy cultivation, reclamation of usar lands.

Tutorials: 1 hour/week

SEMESTER II**BR15004GE: Bioresource Management****Unit: I**

Bioresource management: Exploitation of bioresources and sustainable development; Forest resource management (social forestry, agro forestry and NWFPs); Grassland management; Freshwater & marine bioresource management; Wildlife management.

Unit: II

Monitoring biodiversity: Methods for monitoring biodiversity trends; Mega biodiversity zones and global biodiversity hotspots; Threats to biodiversity, species extinction; IUCN threat categories, Red data book.

Unit: III

Conservation programmes: Principles and strategies of biodiversity conservation; *In situ* and *ex situ* conservation strategies; Role of remote sensing and geographical information system in biodiversity studies; Principles and methodologies for soil conservation and restoration; Biovillages.

Unit: IV

Acts and policies: Forest Conservation Act 1981; Environment (protection) Act 1986; Hazardous waste (Management and Handling) Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Environmental Impact Assessment (EIA); Environmental Management Plan (EMP) and Environmental Clearance for Establishing Industry (ECEI); National Biodiversity Action Plan National Biodiversity Act 2002.

Tutorials: 1 hour/week

SEMESTER IV**BR15008GE: Bioindustries****Unit: I**

Industrial revolution: Causes and consequences; Industrial economic sectors: Primary, Secondary, Tertiary and Quaternary Sectors; Small scale industries and their importance; Entrepreneurship— concept, entrepreneurial skills; Self employment.

Unit: II

Bioindustries: Concept and scope; Role of natural resources in economic development.

Bioindustries in India: Status and scope of agriculture, fisheries, sericulture, forest and dairy industry.

Unit: III

Fruit industry in J & K: Status and scope; Fresh and dry fruits—harvest, processing & storage and marketing.

Potential bioindustries in J & K: Apiculture, tannery, pisciculture, ornamental horticulture and herbal drug industry.

Unit: IV

Sustainable development: Concept, indicators of sustainable development; Quality assurance and quality control; Policies responsible for development of bioindustries. Intellectual Property Rights— concept and importance.

Tutorials: 1 hour/week

SEMESTER III**BR15003OE: Biocosmetics****Unit: I**

Biocosmetics: History of biocosmetics; Importance of plant and animal resources in biocosmetics; Global market of biocosmetics; Manufacture and import of biocosmetics; Labelling, packaging and standardization of biocosmetics; Scope of biocosmetics industry in Jammu and Kashmir.

Unit: II

Skin cosmetics: Skin and hand creams; Facial skin care; Body lotions and bath time herbs; Sun screen products, skin tonics and anti-acne creams; Botanicals in skin care.

Unit: III

Hair cosmetics: Formulation of shampoos, surfactants and conditioners; Types of shampoos with emphasis on herbal shampoos; Hair colourants, fixers, sprays and gels; Botanicals in hair care.

Unit: IV

Perfumes and fragrances: Selection of fragrance; Raw material used in the preparation of fragrance; Fragrance and allergenicity, water soluble fragrances; Aromatherapy (Historical perspective, essential oils, aromatherapy for stress relief, weight loss and beauty aid).

Tutorials: 1 hour/week

SEMESTER I**BR15001OE: Human Health and Plant Diet****Unit: I**

Introduction: Plants in the diet of hunter gatherers; Plants in modern western diet; Plants as sources of proteins, carbohydrates, fats, vitamins and minerals.

Unit: II

Good things from plants in the diet: Fibre, Antioxidants; Gut microbiotome; Role of phytonutrients in influencing gut microbiotome.

Unit: III

Plants as source of healthy diet: Natural health products; Algae and fungi as source of human food; Plant diet in pregnancy, lactation, infancy, childhood and adolescence.

Unit: IV

Plant diet and diseases: Impact of food matrix and phytonutrients against chronic diseases; Plant diet and disease management— diabetes, heart disease, cancer, obesity; Plants in nutrition fitness and sports; Food safety; Food poisoning.

Tutorials: 1 hour/week

SEMESTER II**BR15002OE: Organic Farming****Unit: I**

Organic agriculture: Principles of organic agriculture; Objectives and requirements of organic standards; Criteria for substances used in organic production and processing; Standard for organic production and processing; Organic certification; Organic farming and food security.

Unit: II

Organic crop production: Split production and parallel production; Crop production and conversion period; Diversity in crop production; Soil fertility and fertilization; Pest, disease and weed management; Breeding of organic varieties.

Unit: III

Organic animal husbandry: Animal management; Animal origin and conversion period; Breeds and breeding; Mutilations; Animal nutrition; Veterinary medicine; Transport and slaughter; Bee keeping.

Unit: IV

Vermiculture and vermicompositing: Species selection, environmental requirements; Vermicompositing—methods, materials and advantages; Role in soil fertility, plant growth promotion and disease management.

Tutorials: 1 hour/week

BR15003OE: Infectious Diseases and Livestock Health

Unit: I

Nature and Consequences of Parasitism: Parasitology, types of parasites, life cycle of different parasites, Host Parasitic associations; Parasitic adaptations; morphological and physiological adaptations; Host parasite interaction, Effects on the Parasite, Effects on the host; Zoonosis- Classification (reservoir host, etiological agent and type of life cycle).

Unit: II

Bacterial Diseases in Livestock: Anthrax Aetiology, Pathogenesis, Diagnosis and Control; Salmonellosis (Gastroenteritis) Pathogenesis, Diagnosis and Control; Avian Cholera Aetiology, Pathogenesis, Diagnosis and Control; Brucellosis, Pathogenesis, Diagnosis and Control.

Unit: III

Viral and Fungal Diseases in Livestock: Foot & Mouth Disease Distribution, Pathogenesis and Control; Bluetongue disease Distribution, Pathogenesis and Control; Bird flu Distribution, Pathogenesis and Control; Aspergillosis, Aetiology, Epidemiology, Pathogenesis, Diagnosis and Control.

Unit: IV

Protozoan And Helminth Diseases in Livestock: Parasitic protozoans of Livestock with special reference to Pathogenicity and Prophylaxis of Babesia; Nematode parasites of Sheep with special reference to life cycle, pathogenicity and control of *Haemonchus contortus*; Morphology life cycle, Pathogenicity, prophylaxis and control of *Fasciola hepatica*; Cestode parasites of ruminants with reference to the life cycle, pathogenicity, prophylaxis and control of *Moneiza expansa*.

SEMESTER IV**BR15004OE: Green Technology****Unit: I**

Environmental Health: Concept of environment, ecosystem, components of ecosystem; Environmental problems— global warming, ozone depletion and acid rain, water pollution and soil erosion.

Unit: II

Green energy: Solar, wind, geothermal, tidal, hydroelectric energy and biobased energy; Biofuels (concept and types); Alternative energy sources and their environmental impact.

Unit: III

Green concept in Biotechnology: Bioremediation— concept and types; Bioreactors; Biorefinery; Biopharmaceuticals; Bioplastics; White biotechnology.

Unit: IV

Green Building: Green construction and sustainable building, biomimetrics; Choice of building material and location of building; Green walls (vertical gardens); Carbon sequestration at landscape level; Greenwashing; Eco-labelling (concept and examples).

Tutorials: 1 hour/week

BR17002OE: Infectious Diseases and Human Health

Unit: I

Introduction to Infectious Diseases: Basic concepts in pathophysiology of infectious diseases, Outline of physiological mechanisms leading to diseased state, Infectious disease transmission, Infection and immunity, Acute and chronic Infections, Major infectious diseases of humans.

Unit: II

Bacterial Infections: Pathogenesis, mechanisms of pathogenesis; transmission, epidemiology, public health implications, diagnosis, prophylaxis and treatment of major human infections (Tuberculosis, Cholera, Typhoid).

Unit: III

Viral Diseases: Pathogenesis, mechanisms of pathogenesis; transmission, life cycle, epidemiology, public health implications, diagnosis, prophylaxis and anti-retroviral therapy of Human immunodeficiency virus (HIV/AIDS); Sexually transmitted diseases.

Unit: IV

Fungal and Protozoan Diseases:

Pathogenesis, mechanisms of pathogenesis; transmission, life cycle, epidemiology, public health implications, diagnosis, prophylaxis and treatment of major Fungal human pathogens: (Dermatophytes, Candida, Aspergillus); Protozoal human pathogens (Plasmodia and Trypanosoma).

SEMESTER III**BR15301CR: Biomolecules****Unit: I**

Water: Properties of water and its role in the biological systems; pH and its significance in biological systems; Buffer systems and their importance.

Biological membranes: Solute transport across the membranes; Membrane potential; Vesicular transport— coat proteins, cargo selection, vesicle budding and vesicle fusion.

Unit: II

Carbohydrates: Classification, chemical and optical properties of carbohydrates; Role of monosaccharides in important biological reactions; Oligosaccharides and polysaccharides (sucrose, starch, cellulose, hemicelluloses, pectins).

Lipids: Classification; Biological functions of triacylglycerols, phospholipids, glycolipids, sphingolipids and cholesterol.

Unit: III

Amino acids: Occurrence, structure and classification of amino acids; Properties of amino acids, stereoisomerism in amino acids.

Proteins: Protein structure; Protein folding (concept of chaperones); Fibrous and globular proteins (α -keratin, collagen, haemoglobin); Actin, myosin and molecular motors (overview).

Unit: IV

Enzymes: Mechanism of enzyme action; Kinetics of single substrate enzyme catalyzed reactions— Michaelis-Menton equation; Enzyme inhibition and allosteric regulation.

Nucleic acids: Nucleotides, Phosphoryl group transfer and ATP; RNA splicing; DNA damage and repair mechanisms; Transposable elements in prokaryotes and eukaryotes (examples from bacteria and maize).

SEMESTER IV**BR15401CR: Plant Resources and Biotechnology****Unit: I**

Plant tissue culture: Concept and applications of plant tissue culture; Cellular totipotency; Cell culture and cell cloning; Micropropagation— regeneration through callus cultures, adventitious buds and non adventitious systems (apical and axillary buds); Production of somatic embryos; synthetic seeds (concept); Somatic hybrids & cybrids (Brief idea).

Unit: II

Genetic engineering: Introduction, scope and applications; Cloning vectors— Plasmids, cosmids, phages, artificial chromosomes; Expression vectors; Recombinant DNA technology— Restriction enzymes, ligation, transformation and selection; Construction of genomic and cDNA libraries; Gene transfer methods in plants— *Agrobacterium* mediated gene transfer; Physical methods of gene transfer; Reporter genes.

Unit: III

Molecular markers: PCR— principle and applications, RFLP, RAPD, AFLP, SSR, SNPs, SCARs & their applications; Molecular cytogenetic markers— FISH and GISH, their applications; Quantitative trait loci (QTL) mapping— introduction and types of mapping populations.

Unit: IV

Genetically modified crops: Transgenics for biotic and abiotic stress (insect resistance, virus resistance, herbicide resistance); Modification of plant nutritional content (vitamins, aminoacids, lipids, Iron); GMO's— ecological and ethical concerns.

Biotransformation: Plants as Bioreactors; Transgenic plants for biochemical production— edible vaccines, and secondary metabolites.

SEMESTER IV

BR17403CR: Microbial Technology

Unit: I

Microbial genome: Bacterial genome structure, replication (DNA and plasmid); Genetic exchange (transformation, transduction and conjugation); Recombination (hosts, vectors and mechanism); Replication of Bacteriophages: Viral multiplication (lytic and lysogenic).

Unit: II

Culturing of microbes: Isolation and screening of microorganisms; Cultivation of microbes- nutritional requirements and factors affecting microbial growth (pH, temperature, water, oxygen, CO₂); Culture types— static cultures, suspension cultures; synchronous cultures, growth curve, generation time, growth kinetics; Storage and transportation of microbes.

Unit: III

Fermentation technology: Introduction; Types of fermentation (aerobic, anaerobic), fermentors and their types, substrates for fermentation; Role of enzymes in various fermentation processes; Microbial chemostat cultures; Scale-up of cultivation of microorganisms; Microbes in beverages and food production (wine, beer, bread, cheese); Advantages of fermented foods.

Unit: IV

Economic importance of microbes: Major commercial microbial products (amino acids, enzymes, steroids, therapeutic agents and biopolymers); Single Cell Proteins; Role of microbes in bioremediation; Microbes as bioindicators; Biodefence and bioterrorism; Role of microbes in waste water treatment.

SEMESTER I**BR15103CR: Animal Resources****Unit: I**

Insect resources: Importance and scope of insect based industries; Silkworm breeds, synthesis of silk and cocooning, harvesting and grainage; Apiculture products and apitherapy (honey, beeswax, bee pollen, propolis, royal jelly, bee venom); Lac products, properties and their uses (lac dye, lac wax, shellac, bleached shellac, dewaxed bleached shellac, aleuritic acid); Edible insect industry.

Unit: II

Aquaculture: Fish monoculture, polyculture and composite culture; Pearl and shellfish farming; Integration of aquaculture with agriculture and animal husbandry; Natural and artificial breeding in fish; Genetic approach to fisheries; Fish as a food commodity; Fish by-products; Processing and preservation of fish and its products.

Unit: III

Livestock domestication: History of domestication; Important breeds of livestock (cow, sheep, goat, buffalo) and poultry with special reference to economic characters; Important methods of selection and systems of breeding in farm animals and poultry birds; Genetic and phenotypic consequences and applications of inbreeding and outbreeding; Genetic basis of heterosis and its use.

Unit: IV

Animal products and processing: Principles and practices for production of high quality milk; Pasteurization and sterilization; Utilization of various animal and poultry by-products: blood, fat, hides, bones, wool, hair, and feather; Use of biotechnological tools in improving animal productivity; Scope of meat, fish and poultry processing industry in India.

SEMESTER II**BR15202CR: Bioenergy and Biofuels****Unit: I**

Introduction: Concept of bioenergy; Biomass as energy source; Biomass feedstocks and biomass feedstock characterization; Biomass fuel analysis; Wood pellet technology; Pyrolysis and gasification of biomass; History and classification of biofuels (first, second, third and fourth generation biofuels).

Unit: II

Liquid biofuels: Vegetable oils as fuels; Biodiesel, concept & history; Biodiesel production by transesterification; Properties of biodiesel; Algae as a source of biodiesel; Production of bioethanol; Lignocellulosic biomass as feedstock for ethanol production; Ethanologens.

Bioenergy crops: Jatropha, Sugarcane, Sweet sorghum, Pongamia and Maize.

Unit: III

Gaseous biofuels: Biogas production process; Biogas processing technologies for anaerobic digestion; Biohydrogen; Green algae and cyanobacteria as powerhouses of biohydrogen; Biohydrogen from biorenewable feedstocks; Artificial photosynthesis; Hydrocarbon biofuels.

Unit: IV

Biofuel economy and policy: Estimation of biofuel prices; Biodiesel and bioethanol economy; Current status of biodiesel production in India; Biorenewable energy costs and biohydrogen economy; Bioenergy policy and impact of bioenergy programmes in India (Overview); Global biofuel projections.