

Annexure I

Course Specific Outcomes of Various courses offered by Department of Bioresources for Master's Programme

Name of the Course	Course Code	Activities with direct bearing on Employability/ Entrepreneurship/ Skill development
Bio medicine and Bio prospecting	BR15305GE	Identification, collection and processing of medicinal important plants of Himalayas. Utilization of traditional knowledge in Bioprospecting and its role in national food safety and security.
Microbial Resources	BR15105GE	Utilization of Microbes for production of food and beverages. Use of Microbes as Biosensors and in Bioremediation of environmental pollution.
Industrial Entomology	BR15205GE	Utilization of useful insects like bees, silk-moths etc and their products for food and pharmaceutical industry.
Wood Resource Utilization	BR15406GE	Identification and utilization of different woody species of Kashmir Himalayas and evaluation of various commercially important physical and chemical properties of wood.
Algal Resources	BR15106GE	Identification, collection and utilization of commercially important algal resources for food, fodder and energy.
Bioresource Management	BR15206GE	Management of Bioresources for the Sustainable development by monitoring biodiversity conserve-ation programmes, the acts and policies of the State/Nation.
Bioindustries	BR15407GE	Understand status and scope of various bio based industries and chances of employment and entrepreneurship opportunities in important of region.
Biocosmetics	BR15307OE	Utilization of Bioresources from animals, plants and microbes for use of cosmetic products.
Human Health and Plant Diet	BR15107OE	Plant based diet as neutraceuticals, functional food and Importance in disease management and prevention.
Organic Farming	BR15207OE	Scope and utility of organic agriculture for crop production, animal husbandry and vermiculture
Infectious Diseases and Livestock Health	BR15308OE	Various Bacterial, Fungal, Viral and protozoan diseases of livestock and their negative impact livestock production.
Green Technology	BR15408OE	Utilization of Bioresources from animals, plants and microbes for use of cosmetic products.
Infectious Diseases and Human Health	BR15208OE	Bacterial, Fungal, Viral and protozoan diseases and their impact on human health.
Plant Resources and Biotechnology	BR15401CR	Use of Biotechnology in production of different plant based products.
Microbial Technology	BR15403CR	Utilization of Microbes for production of food and beverages. Use of Microbes as Biosensors and in Bioremediation of environmental pollution.
Animal Resources	BR15103CR	Identification, collection and processing of animal and animal based products and their commercialization.
Bioenergy and Biofuels	BR15202CR	Utilization of plant and animal wastes for production of ecofriendly biofuels (biodiesel and bioethanol) and possibility of using microbes for the production of bio-hydrogen as a source of future fuel..
Bioinformatics	BR15404DCE	Impart know how of use of IT and utilization of web resources, biological databases for identification of biological resources, prediction of evolution and study structure and function of biomolecules.

Annexure II

Programme Outcomes of Masters of Sciences, Department of Bioresources

- Develop entrepreneurship skills to establish their own industries and to generate opportunities for employment in sectors viz., Apiculture, Aquaculture, Sericulture, Livestock and Aromatic units.
- Develop trained work force for various research organizations to conduct research pertaining to Immunology, Clinical Microbiology, Applied Fisheries, Applied Entomology and livestock.
- Work as consultants in various NGOs/Govt. organization pertaining to bio-trade and bio-prospecting of microbial/plant resources.

Annexure III



DEPARTMENT OF BIORESOURCES UNIVERSITY OF KASHMIR, SRINAGAR

MODIFIED CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME

Revised syllabi for M.Sc Bioresources as per the Modified Choice Based Credit System (CBCS) Scheme adopted by the University for implementation at Post-Graduate level from the academic session 2018 and onwards is as under:

Core Courses (CR): There are 4 Core Courses per semester i.e 16 courses for 4 semesters. There are three 4 credit courses and one 2 credit course per semester. A student has to obtain 14 credits from CR Courses per semester.

Discipline Centric Elective Courses (DCE): There are 7 Discipline Centric Elective Courses, each having 4 credits and Project Work of 4 credits. **Project Work** is to be taken by the students in 4th semester. A student has to obtain 8 credits per semester from DCE Courses.

The CR Courses and DCE Courses are exclusively meant for the Department's own students.

Generic Elective Courses (GE): There are 8 GE Courses, each course having 2 credits.

Open Elective Courses (OE): There are 4 OE Courses, each course having 2 credits.

A student has to obtain 2 credits from GE and OE courses per Semester.

To obtain M.Sc degree in Bioresources a student has to obtain 96 credits i.e 56 credits from Core and 32 credits from DCE and 8 credits from GE/OE Courses in 4 semesters.

The Course Structure and credit break up has been given in tabulated form.

One credit means one hour of teaching/ tutorial or two hours of practical work/field work per week, for 16 weeks in a semester equivalent to 90 actual teaching days.

Abbreviations

L	Lecture
T	Tutorial
P	Practical
CR	Core Course
DCE	Discipline Centric Elective
GE	Generic Elective
OE	Open Elective



DEPARTMENT OF BIORESOURCES
UNIVERSITY OF KASHMIR, SRINAGAR

MODIFIED CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME AND COURSE STRUCTURE

SEMESTER I						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18101CR	Biodiversity and Bioresources	Core	4	0	0	4
BR18102CR	Plant Resources	Core	4	0	0	4
BR18103CR	Animal Resources	Core	4	0	0	4
BR18104CR	Lab Course I (Based on BR18101CR, BR18102CR, BR18103CR)	Core	0	0	4	2
BR18105DCE	Cellular & Molecular Biology	Discipline Centric Elective	3	0	2	4
BR18106DCE	Basic and Applied Immunology	Discipline Centric Elective	3	0	2	4

SEMESTER II						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18201CR	Plant Resource Regeneration	Core	4	0	0	4
BR18202CR	Animal Resource Regeneration	Core	4	0	0	4
BR18203CR	Bioenergy and Biofuels	Core	4	0	0	4
BR18204CR	Lab Course II (Based on BR18201CR, BR18202CR, BR18203CR)	Core	0	0	4	2
BR18205DCE	Inheritance Biology	Discipline Centric Elective	3	0	2	4

BR18206DCE	Biofertilizers & Biopesticides	Discipline Centric Elective	3	0	2	4
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SEMESTER III

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18301CR	Biomolecules	Core	4	0	0	4
BR18302CR	Secondary Metabolites	Core	4	0	0	4
BR18303CR	Biostatistics & Biotechniques	Core	4	0	0	4
BR18304CR	Lab Course III (Based on BR18301CR, BR18302CR, BR18303CR)	Core	0	0	4	2
BR18305DCE	Biological Interactions	Discipline Centric Elective	3	0	2	4
BR18306DCE	Wood Resource Utilization	Discipline Centric Elective	3	0	2	4

SEMESTER IV

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18401CR	Plant Resources and Biotechnology	Core	4	0	0	4
BR18402CR	Animal Cell and Tissue Technology	Core	4	0	0	4
BR18403CR	Microbial Technology	Core	4	0	0	4
BR18404CR	Lab Course IV (Based on BR18401CR, BR18402CR, BR18403CR)	Core	0	0	4	2
BR18405DCE	Bioinformatics	Discipline Centric Elective	3	0	2	4
BR18406DCE	Term Work	Discipline Centric Elective	-	-	-	4

SEMESTER IV

BR17406DCE: Project Work

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

GENERIC ELECTIVES (GE)						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18001GE	Industrial Entomology	Generic Elective	2	0	0	2
BR18002GE	Algal Resources	Generic Elective	2	0	0	2
BR18003GE	Microbial Resources	Generic Elective	2	0	0	2
BR18004GE	Bioresource Management	Generic Elective	2	0	0	2
BR18005GE	Biomedicine & Bioprospecting	Generic Elective	2	0	0	2
BR-18006GE	Biocontrol and Crop Management	Generic Elective	2	0	0	2
BR-18007GE	Biocosmetics	Generic Elective	2	0	0	2
BR18008GE	Organic Farming	Generic Elective	2	0	0	2

OPEN ELECTIVES						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18001OE	Human Health and Plant Diet	Open Elective	2	0	0	2
BR18002OE	Infectious Diseases and Human Health	Open Elective	2	0	0	2
BR18003OE	Infectious Diseases and Livestock Health	Open Elective	2	0	0	2
BR18004OE	Bioindustries	Open Elective	2	0	0	2



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			L	T	P	
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BR18102CR	Plant Resources	Core	4	0	0	4
BR18103CR	Animal Resources	Core	4	0	0	4
BR18104CR	Lab Course I (Based on BR18101CR, BR18102CR, BR18103CR)	Core	0	0	4	2
BR18105DCE	Cellular & Molecular Biology	Discipline Centric Elective	3	0	2	4
BR18106DCE	Basic and Applied Immunology	Discipline Centric Elective	3	0	2	4

CORE COURSES

SEMESTER I

BR18101CR: Biodiversity and Bioresources

Unit: I

Biodiversity and Bioresources: Concept and scope; Levels of biodiversity— organisational (genetic, species and ecosystem), spatial (alpha, beta and gamma); Valuing biodiversity— direct- and indirect use values; Concept and conservation of agro-biodiversity; Mega-biodiverse countries; Global biodiversity hotspots (criteria, distribution and conservation implications).

Unit: II

Global, national and local magnitude of biodiversity: Floral, faunal and microbial diversity; Measurement of biodiversity— Methods of survey and inventorization of biodiversity, sampling procedures, biodiversity measures and indices, biodiversity surrogates; Biodiversity informatics— concept and applications; Biodiversity monitoring— global biodiversity targets and indicators.

Unit: III

Biodiversity loss and conservation: Factors of biodiversity loss— ultimate and proximate causes; IUCN threat categories and criteria; Biodiversity and climate change— concerns and challenges; *In situ* conservation strategies— Protected Area Network (National parks, Wildlife sanctuaries and Biosphere reserves); *Ex situ* conservation strategies (Botanical gardens, Zoos, Aquaria, Cryo-banks).

Unit: IV

Role of taxonomy in biodiversity studies; Role of Remote Sensing and Geographical Information System in biodiversity studies; Indian Bioresources Information Network— organisation and role; Biodiversity conservation policy and programmes— International and national efforts; National Biodiversity Action Plan (a brief summary).

SEMESTER I

BR18102CR: Plant Resources

Unit: I

Plant resources: Archeo-ethnobotany; Origin of agriculture; Centres of origin and domestication of cultivated plants as proposed by de Candolle and Vavilov; Green revolution— benefits and adverse consequences.

Cereals and pseudocereals: Cultivation and utility of rice (*Oryza sativa*), wheat (*Triticum aestivum*), maize (*Zea mays*), buckwheat (*Fagopyrum* spp.).

Unit: II

Fodder and oil crops: General account of fodder crops, methods of domestication and utility of alfalfa (*Medicago sativa*); Origin & evolution of *Brassica juncea* and *Brassica campestris*; Extraction and processing of mustard and sunflower oil.

Fibre crops: Plant fibres, types; Origin, evolution and processing of cotton and jute.

Fruits: Cultivation and commercial importance of some fruits grown in Kashmir (apple, pear, walnut, almond, apricot).

Unit: III

Vegetables, spices and condiments: Methods of cultivation of vegetables grown in Kashmir; Wild vegetables of Kashmir (overview); Spices and condiments; Origin, distribution, cultivation and importance of saffron.

Extractives: Gums and resins, classification, important sources and their commercial value; Dyes and tannins, extraction, processing and use.

Unit: IV

Medicinal plants: Morphology, ethnobotanical and medicinal importance of *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*.

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

SEMESTER I

BR18103CR: 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 I

BR18104CR: Lab Course I

(Based on BR18101CR, BR18102CR, BR18103CR)

Practical Work Based on BR18101CR

- Collection, description and herbarium preparation of various types of leaves, inflorescences and fruits.
- Types of quadrats and their utility.
- Determination of minimum size and number of quadrats for phytosociological studies.
- Computation of frequency, density, abundance and cover of constituent species of different communities.
- Field demonstration of Global Positioning System (GPS) and its utility in biodiversity studies.
- Role of Herbarium and its significance in biodiversity studies.
- Field study of various threatened endemic plants of Kashmir Himalaya.
- To prepare an inventory of economically important woody plants in KUBG.

Practical Work Based on BR18102CR

- Study the diagnostic features of some economically important angiosperm families (Asteraceae, Apiaceae, Brassicaceae, Fabaceae, Caryophyllaceae, Rosaceae, Lamiaceae and Poaceae).
- Study various types of plant fibres.
- Study the presence and structure of starch granules and oil bodies in various food crops.
- Study some commonly used spices and condiments.
- Pseudocereal- Buckwheat: Morphological features and seed structure; Test for presence of starch and proteins.
- Study the diagnostic features and medicinal importance of native medicinal plants of Kashmir Himalaya.

Practical Work Based on BR18103CR

- Study of modifications in legs of honey bees.

- Study of life history of silk worm by rearing.
- Dissection of silk glands of the silk worm larva.
- Preparation of permanent slides of mouth parts, spiracles and appendages of larva.
- Identification of culturable fishes in Kashmir valley.
- Demonstration of induced-breeding technology in cultured fishes.
- Study of growth and age in fishes.
- Field trips to an organised fishery.
- Identification of various breeds of cattle, buffalo, sheep and goat.
- Quality analysis of honey.
- Bacteriological examination of milk by clot on boiling test and methylene blue reduction MBR test.
- Structure of wool.

DISCIPLINE CENTRIC ELECTIVE COURSES

SEMESTER I

BR18105DCE: 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.

Practical Work:

- Microscopy in study of cell structure.
- Comparative study of Prokaryotic & eukaryotic cells and Plant & animal cell.
- Study Membrane stability Index.
- Centrifugation for separation of cell organelles.
- Study of stages of Meiosis and Mitosis.
- Study pollen mother cell meiosis.
- Study meiotic stages during gamete formation in grasshopper
- Study stages of mitosis from root tips.
- Extraction of Nuclear DNA.

SEMESTER I

BR18106DCE: Basic and Applied Immunology

Unit: I

Immune System and its organs: Introduction to immune system, Immune system as defense, Timeline of immunology related developments, Overview of Infections and Diseases, Detailed overview of Immune organs, Composition of Blood and types of immune cells, Structure & function of Immune cells. Hypersensitivity and complement system.

Unit: II

Natural and acquired Immune Response: Immunity and types of Immunity, Natural Immunity (Physiological, anatomical and cellular barriers to infections), Cells and factors of natural immunity, Mechanism of Innate immunity, Acquired Immunity as second line of defense, Characteristics of Acquired immunity, Phagocytosis, opsonization and PAMPS, PRRs and TLRs

Unit: III

Antigen, antibody and cytokines: Definition and characteristics of an antigen molecule, Types of an antigens (Super antigens, TD and TI antigens), Immunogens, Haptens, Allergens, Tollerogens, allo-antigens, Tumor antigens, auto antigens, Antibody structure (regions, domains and various chains), Isoforms of antibodies, Types of Antibodies (Structure, presence and functions), Digestion of antibodies and antibody fragments, Mechanism of Inflammation, introduction to Cytokines and Interferon's.

Unit: IV

Serological techniques: Theory and principles of routine clinical immunology procedures; Serology, Materials and methods necessary for basic serology tests (Collection, preparation and preservation of specimen), Complement inactivation, Serial dilution, determinations of end point and titer. HCG and pregnancy, Pregnancy test, Factors affecting pregnancy tests; Disease characteristics, clinical manifestation and laboratory diagnosis of AIDS.

Practical Work:

- Determination of the bleeding time and TLC and DLC of human blood.
- Permanent mount preparation of parasitic Protozoa.
- Demonstration of phagocytosis.
- Demonstration of Haemagglutination.
- Demonstration of ELISA .
- MTT and Tryphon blue tests for viability of cells.



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SCHEME AND COURSE STRUCTURE

SEMESTER II						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18201CR	Plant Resource Regeneration	Core	4	0	0	4
BR18202CR	Animal Resource Regeneration	Core	4	0	0	4
BR18203CR	Bioenergy and Biofuels	Core	4	0	0	4
BR18204CR	Lab Course II (Based on BR18201CR, BR18202CR, BR18203CR)	Core	0	0	4	2
BR18205DCE	Inheritance Biology	Discipline Centric Elective	3	0	2	4
BR18206DCE	Biofertilizers & Biopesticides	Discipline Centric Elective	3	0	2	4

CORE COURSES

SEMESTER II

BR18201CR: Plant Resource Regeneration

Unit: I

Asexual reproduction in plants: Types of vegetative propagation; Importance of vegetative reproduction; Apomixes; Adventive embryony; Apospory and apogamy; Parthenocarpy.

Floral evocation: Transition to flowering; Homoeotic mutations; Floral organ development in *Arabidopsis* and *Antirrhinum*.

Unit: II

Sexual reproduction in angiosperms: Structure and development of anther; Role of tapetum; Structure and development of male gametophyte; Structure, development and types of ovules; Structure and development of female gametophyte; Types of embryosac in angiosperms.

Unit: III

Pollination and fertilization: Pollination mechanisms and vectors; Double fertilization; Endosperm development, types of endosperm; Embryo development (monocot and dicot embryos); Fruit development; Seed dispersal; Importance of sexual reproduction in plants; Self incompatibly, molecular basis of self incompatibility; Male sterility.

Unit: IV

In-vitro regeneration: Cellular totipotency; Micro propagation- cell and organ differentiation, Somatic embryos, synthetic seeds; Advantages of Micropropagation; Somaclonal variation; Production of haploids (anther and ovule culture); protoplast culture, cytoplasmic hybrids or cybrids; Plant growth regulators in tissue culture.

SEMESTER II

BR18202CR: Animal Resource Regeneration

Unit: I

Principles of animal development: Basic concepts of development— potency, commitment, specification and its types, induction, competence, determination and differentiation; Morphogenetic gradients; Cell fate and cell lineages; Genomic equivalence and the cytoplasmic determinants; Genomic Imprinting; Mutants and transgenics in analysis of development.

Unit: II

Early embryonic development: Gametogenesis (Production of male and female gametes) Spermatogenesis and Oogenesis; Types of eggs, Fertilization and Zygote formation, Mechanism of cleavage; Blastula formation; Gastrulation and formation of germ layers. Fat maps of germinal layers.

Unit: III

Morphogenesis and organogenesis: Axis and pattern formation in *Drosophila* and amphibia; Organogenesis—vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; Environmental regulation of normal development.

Unit: III

Hormones in Embryonic Development: Reproduction and hormonal functions of the male and female: physiologic anatomy of the male and female sexual organs. Testosterone and other male sex hormones, abnormalities of the male sexual function (Prostrate, hypogonadism), Pineal gland. Ovarian cycle and functions of the ovarian hormones. Abnormalities of secretion by ovaries. Hormonal factors in pregnancy.

SEMESTER II

BR18203CR: 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.

SEMESTER II

BR18204CR: Lab Course II

(Based on BR18201CR, BR18202CR, BR18203CR)

Practical Work Based on BR18201CR

- Study the types of placentation.
- Study the types and structure of ovule in angiosperms.
- Study the pollen mother cell meiosis.
- Study the structure of dicot and monocot embryos.
- Test for seed and pollen viability.
- Study the *in vitro* pollen germination.

Practical Work Based on BR18202CR

- Permanent slides of mammalian gametes.
- Study the various stages of chick embryo (24 h, 48 h, 72 h and 96 h).
- Comparative estimation of soluble and structural proteins in embryonic and extra embryonic layers of different stages (48, 72, and 96 hours) of development in chick.
- Study the meiosis in grasshopper.
- Study the bar body in buccal swab/drumstick in neutrophil.

Practical Work Based on BR18203CR

- Determination of saponification value of fat/oil.
- Preparation of biodiesel from various oils.
- Comparison of time of flow and density of biodiesel and vegetable oils.
- Determination of iodine number of oil/fat and biodiesel.
- Study of some important algal sources of biofuel.
- Study the importance of jatropha, maize and sugarcane as major bioenergy crops.
- Demonstrate the fermentation process for ethanol production.

DISCIPLINE CENTRIC ELECTIVE COURSES

SEMESTER II

BR18205DCE: 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.

Practical Work:

- Karyotype study of mammals using permanent slides.
- Carryout karyotype analysis and develop a karyogram of onion.
- Construction of Linkage maps from given data.
- Study sex chromatin in somatic cells.
- Study of giant chromosomes (polytene chromosomes and lampbrush chromosomes).
- Determining allele frequencies using *Hardy-Weinberg principle*.
- Use χ^2 test to compare obtained phenotype ratio in F2 generation with expected ratio.
- Study cases of aneuploidy and polyploidy.

SEMESTER II

BR18206DCE: Biofertilizers and Biopesticides

Unit: I

Biofertilizers: Concept, types and prospects; Bacterial biofertilizers— morphology, life cycle, isolation, cultivation, association, inoculation and methods of application of *Azotobacter*, *Rhizobium* and *Frankia*.

Phosphorous Solubilising Microorganisms (PSMs): Introduction, isolation, culture, mass production and inoculation.

Unit: II

Cyanobacteria and Azolla as Biofertilizers: Morphology, life cycle, association, cultivation and inoculation; Factors affecting biofertilizer efficiency; Mass production and quality control of biofertilizers.

Arbuscular Mycorrhizas (AM): Morphology, association, cultivation, inoculation, role and application.

Unit: III

Biopesticides: Definition, types, merits and demerits; Biofungicides— fungal fungicides, bacterial fungicides, fungal nematicides (role and application).

Bioherbicides: Concept, current status and prospects; Mass production and commercial formulations; Role of biocontrol in Integrated Pest Management.

Unit: IV

Bacterial insecticides: Classification and mode of action with special reference to *Bacillus thuringensis*; Methods of uses and symptoms of infection.

Fungal and viral insecticides: Biology and their use in insect control; Commercial formulations; Entomopathogenic nematodes and protozoans— mode of action and field efficacy; Preventive and safety measures required in using biopesticides.

Practical Work:

- Preparation of Potato Dextrose Agar (PDA), medium for fungal growth.
- Preparation of Yeast Extract Mannitol Agar (YEMA), medium for bacterial growth.
- Isolation and study of the root nodule bacteria.
- Preparation of a water squash mount of a living mosquito fern (*Azolla*) and to study its symbiotic association with cyanobacteria (*Anabaena*).
- Preparation of vermicompost.



DEPARTMENT OF BIORESOURCES

UNIVERSITY OF KASHMIR, SRINAGAR

MODIFIED CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME AND COURSE STRUCTURE

SEMESTER III						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18301CR	Biomolecules	Core	4	0	0	4
BR18302CR	Secondary Metabolites	Core	4	0	0	4
BR18303CR	Biostatistics & Biotechniques	Core	4	0	0	4
BR18304CR	Lab Course III (Based on BR18301CR, BR18302CR, BR18303CR)	Core	0	0	4	2
BR18305DCE	Biological Interactions	Discipline Centric Elective	3	0	2	4
BR18306DCE	Wood Resource Utilization	Discipline Centric Elective	3	0	2	4

CORE COURSES

SEMESTER III

BR18301CR: 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 III

BR18302CR: Secondary Metabolites

Unit: I

Phenolic compounds and isoprenoids: Phenolic compounds— occurrence and classification; Shikimic acid pathway for synthesis of phenolic compounds; Terpenes— Occurrence; Classification based on isoprene rule; Biosynthesis of terpenes; Importance of rubber as a bioresource;

Steroids: Occurrence, structure and biological functions of major plant and fungal steroids.

Unit: II

Alkaloids: Introduction, occurrence, classification based on nitrogen heterocyclic ring; Use of alkaloids by humans from historical perspective; Nomenclature (true, proto and pseudo-alkaloids); Biological functions of alkaloids; Non protein amino acids; Glycosylated N-containing toxins.

Unit: III

Plant pigments: Classification; Chlorophyll— structure, biosynthesis and properties; Carotenoids— structure, occurrence and biological function of carotenes and xanthophylls; Flavonoids— structure, occurrence and biological function of anthocyanins, flavonols, flavones; Phenolics and Quinoids— structure, occurrence and function (naphthaquinones, anthraquinones, tannins, lignins); Indole derivatives— structure, occurrence and function (betalains, phytomelanins, indigo).

Unit: IV

Importance of secondary metabolites: Perspectives in human health; Effect of biotic and abiotic stresses on secondary metabolites in plants; Allelopathic effects of secondary metabolites; Taxonomic significance of secondary metabolites.

SEMESTER III

BR18303CR: Biostatistics and Biotechniques

Unit: I

Data types and collection: Data on ratio, interval, ordinal and nominal scales; Continuous and discrete data; Methods of primary and secondary data collection and their limitations.

Processing and analysis of data: Measures of Central Tendency— arithmetic mean, mode, median; Measures of dispersion— mean deviation, variance, standard deviation, coefficient of variation.

Unit: II

Testing of hypothesis: Basic concept, procedure for hypothesis testing, test of difference between means— independent and paired samples, test of proportions and test of goodness of fit.

Sampling techniques: Principles and steps in sample survey; Procedures and practices involved in simple random sampling, systematic, stratified and cluster sampling.

Unit: III

Design and analysis of experiments: Principles of experimentation; Experimental designs— layout, analysis of variance and comparison of treatments in completely randomised design, randomised complete block design and factorial experimental designs.

Correlation and regression: Basic idea of correlation; Simple correlation— calculation of correlation coefficient; Simple linear regression— calculation of regression coefficients.

Unit: IV

Microscopy & spectroscopy: Principle, working & application of fluorescence, phase contrast, scanning electron and transmission electron microscopy; Principle and working of a spectrophotometer; Application of spectroscopic techniques (UV-visible, IR, NMR).

Chromatography: Paper, thin layer, Gas-liquid chromatography; Ion exchange, adsorption and molecular exclusion chromatography; High performance liquid chromatography (HPLC); Radioisotopes— applications in biology.

SEMESTER III

BR18304CR: Lab Course III

(Based on BR18301CR, BR18302CR, BR18303CR)

Practical Work Based on BR18301CR

- Extraction and estimation of total titrable acidity in plant extract.
- Effect of various physical and chemical treatments on membrane permeability.
- Preparation of calibration graph for the estimation of starch and proteins.
- Determination of the time course of diastase action on starch.
- Determination of polyphenol oxidase activity.
- Extraction of proteins from fresh material.

Practical Work Based on BR18302CR

- Separation of pigments from leaf extract using phase separation method.
- Detection of presence of phenolics, alkaloids and flavonoids in plant material.
- Preparation of calibration graph for the estimation of total phenols.
- Estimation of free radical scavenging activity of plant extract.
- Study the effect of pH on the anthocyanins from fruit extracts.

Practical Work Based on BR18303CR

- Collection of data from field and construction of frequency tables.
- Diagrammatic and graphical representation of data.
- Comparison of populations on the basis of mean value of parameters, standard deviation and standard error.
- Analysis of variance (one way).
- Demonstration of scanning electron microscopy (SEM).
- Use of paper and thin layer chromatography for the separation of plant pigments.
- Study the principle and working of colorimeter and UV- Visible spectrophotometer.

DISCIPLINE CENTRIC ELECTIVE COURSES

SEMESTER III

BR18305DCE: 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.

Practical work:

- Field exercises to study various types of behaviour in animals
- Collection and identification of different types of insects and their larvae.
- Study of different casts in Honey bee, Ants and Termites
- Study of various types of bird nests.
- Collection of hives of different social insects (Bees and Wasps).
- Study ammensalism using bacterial cultures.
- Computation of frequency, density, abundance and cover of constituent species of different communities.
- Visit to local National park for the study of behavior in different captive and wild animals.
- Use of GPS and its use in Biodiversity studies.

SEMESTER III

BR15306DCE: Wood Resource Utilization

Unit: I

Introduction: Wood as a resource; Wood Structure- Wood elements in gymnosperms, monocots and dicots; Formation of wood in gymnosperms and dicots.

Wood growth: Formation of wood cambium and its derivatives, secondary xylem; Growth rings, Properties of secondary xylem; 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 products: Wood as fuel; Saw dust and its uses, wood pellet technology, Wicker works and their importance as sources of income in Kashmir; Wood resources and sports items; Water resistant woods, Wood as timber, Plywood.

Practical Work:

- Morphology of important wood species of Kashmir Kashmir Himalayas.
- Study stem anatomy hard and soft wood species.
- Study various types of wood elements in gymnosperms and angiosperms.
- Study resin canals in gymnosperms.
- Study Physical properties of wood.
- Extraction of cellulose from a given sample of plant material.
- Proximate analysis of various samples wood.



DEPARTMENT OF BIORESOURCES
UNIVERSITY OF KASHMIR, SRINAGAR

MODIFIED CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME AND COURSE STRUCTURE

SEMESTER IV						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18401CR	Plant Resources and Biotechnology	Core	4	0	0	4
BR18402CR	Animal Cell and Tissue Technology	Core	4	0	0	4
BR18403CR	Microbial Technology	Core	4	0	0	4
BR18404CR	Lab Course IV (Based on BR18401CR, BR18402CR, BR18403CR)	Core	0	0	4	2
BR18405DCE	Bioinformatics	Discipline Centric Elective	3	0	2	4
BR18406DCE	Term Work	Discipline Centric Elective	-	-	-	4

CORE COURSES

SEMESTER IV

BR18401CR: 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

BR18402CR: Animal Cell and Tissue Technology

Unit: I

Animal cell and tissue culture: History, scope and applications; Culture media, culture procedures and techniques; Transfection, targeted transfection, transient and stable transfections; Large scale culture of cell lines for production of biomolecules (viral vaccines, interferons, recombinant proteins and hybrid antibodies).

Unit: II

Culture products: Somatic cell fusion, hybridoma technology and production of monoclonal antibodies.

Stem cells: Stem cell lines– origin and types, stem cell therapy and its applications.

Immunodiagnosics: Blood grouping; Rh typing; Immuno electrophoresis; Enzyme linked Immuno Sorbent Assay (ELISA); Radio Immuno Assay (RIA).

Unit: III

Tissue engineering: Concept, approaches, prospects and limitations; Biomaterials for tissue engineering; Tissue engineering of skin and haemoglobin-based blood substitutes; Artificial womb technology.

Unit: IV

Animal cloning: *In vitro* fertilization and embryo transfer; Cloning livestock by nuclear transplantation; Production of transgenic animals with special reference to transgenic mice, cow and sheep; Identification and transfer of genes influencing milk quality and disease resistance.

SEMESTER IV

BR18403CR: 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 IV

BR18404CR: Lab Course IV

(Based on BR18401CR, BR18402CR, BR18403CR)

Practical Work Based on BR18401CR

- Demonstration of plant tissue culture technique (sterilization, media preparation and inoculation).
- Isolation of plant genomic DNA by CTAB method.
- Visualization of DNA by Agarose Gel Electrophoresis.
- Demonstration of Polymerase Chain Reaction.
- Preparation of mitotic chromosome preparation from root tips.

Practical Work Based on BR18402CR

- Preparation of culture media for animal cells by filter sterilization methods.
- Establishment of primary cell culture - chick embryo.
- Study the antigen-antibody reactions to determine blood groups.
- Study the differential morphology of human leucocytes.
- Study the cell count using a haemocytometer.
- Comparative studies of haemin crystal in mammals: humans, cow and goat.
- Demonstrate phagocytic activity (phagocytosis) in the insect cells.
- Demonstrate the presence of natural biomaterial chitin in the insect integument.

Practical Work Based on BR18403CR

- Estimation of CO₂ in water samples obtained at different stages of Sewage Treatment Plant (STP).
- Estimation of dissolved oxygen in given water sample.
- Check the efficacy of antibiotics on a given microbial sample.
- To grow bacteria from cheek sample of mouth on nutrient medium.
- Study the preparation of yogurt.
- Study the procedure to ascertain the milk quality.

DISCIPLINE CENTRIC ELECTIVE COURSES

SEMESTER IV

BR17405DCE: 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 Spc).

Practical Work:

- Role of NCBI, EBI, TIGR and SANGER in maintaining sequence data.
- Demonstration of BLAST and FASTA.
- Study Pairwise and Multiple sequence alignments.
- Demonstration of MSA.
- Construction of Phylogenetic trees using morphological and molecular data.
- Tools for obtaining information about primary structure of proteins.

SEMESTER IV**BR17406DCE: Project Work**

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



DEPARTMENT OF BIORESOURCES
UNIVERSITY OF KASHMIR, SRINAGAR

MODIFIED CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME AND COURSE STRUCTURE

GENERIC ELECTIVES (GE)						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18001GE	Industrial Entomology	Generic Elective	2	0	0	2
BR18002GE	Algal Resources	Generic Elective	2	0	0	2
BR18003GE	Microbial Resources	Generic Elective	2	0	0	2
BR18004GE	Bioresource Management	Generic Elective	2	0	0	2
BR18005GE	Biomedicine & Bioprospecting	Generic Elective	2	0	0	2
BR-18006GE	Biocontrol and Crop Management	Generic Elective	2	0	0	2
BR-18007GE	Biocosmetics	Generic Elective	2	0	0	2
BR18008GE	Organic Farming	Generic Elective	2	0	0	2

BR18001GE: 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.

BR18002GE: 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.

BR18003GE: 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.

BR18004GE: 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.

BR18005GE: 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.

BR18006GE: 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.

BR18007GE: 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).

BR18008GE: 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.



DEPARTMENT OF BIORESOURCES
UNIVERSITY OF KASHMIR, SRINAGAR

MODIFIED CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME AND COURSE STRUCTURE

OPEN ELECTIVES						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
BR18001OE	Human Health and Plant Diet	Open Elective	2	0	0	2
BR18002OE	Infectious Diseases and Human Health	Open Elective	2	0	0	2
BR18003OE	Infectious Diseases and Livestock Health	Open Elective	2	0	0	2
BR18004OE	Bioindustries	Open Elective	2	0	0	2

BR18001OE: 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.

BR18002OE: 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).

BR18003OE: 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*.

BR18004GE: 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.