



**P. G. PROGRAMME IN BIORESOURCES**  
**DEPARTMENT OF BOTANY**  
**UNIVERSITY OF KASHMIR, SRINAGAR**

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

**TO BE IMPLEMENTED FROM ACADEMIC SESSION 2015 AND ONWARDS**

The revised syllabi for P.G. Programme in Bioresources as per the Choice Based Credit System (CBCS) adopted by the University for implementation at Post-Graduate level from the academic session 2015 and onwards are as under:

- There are 3 **Core Courses** per semester i.e 12 courses for 4 semesters. Each course is of 4 credits. A student has to take 3 core courses per semester to obtain 12 credits from Core Courses per semester.
- **The Core Courses are exclusively for the Department's own students.**
- There are 3 **Discipline Centric Elective Courses**, each having 6 credits. There is 1 **Discipline Centric Elective Course** of 4 credits and **Term Work** of 2 credits. A candidate can take a maximum of 6 credits per semester from **Discipline Centric Elective Courses**.
- **Term Work** is to be taken by the students in 4<sup>th</sup> semester.
- **The Discipline Centric Courses are mainly meant for the Department's own students.**
- There are 8 **Generic Elective Courses**, each course having 3 credits and 4 **Open Elective Courses**, each course having 3 credits. The **Generic Elective Courses** are meant for the students of the Sister Departments and not for the for the Department's own students. **Open Elective Courses** are meant for students of all other Departments, except Biological Sciences.
- 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.
- In theory, continuous assessment shall carry 20% marks and 80% will be for end of the semester examination.
- Practical shall carry marks according to credit value.

**Abbreviations**

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



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<b>CORE COURSES</b>						
<b>SEMESTER I</b>						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
<b>BR15101CR</b>	Biodiversity and Bioresources	Core	3	0	2	4
<b>BR15102CR</b>	Plant Resources	Core	3	0	2	4
<b>BR15103CR</b>	Animal Resources	Core	3	0	2	4
<b>SEMESTER II</b>						
<b>BR15201CR</b>	Resource Regeneration	Core	3	0	2	4
<b>BR15202CR</b>	Bioenergy and Biofuels	Core	3	0	2	4
<b>BR15203CR</b>	Biofertilizers & Biopesticides	Core	3	0	2	4
<b>SEMESTER III</b>						
<b>BR15301CR</b>	Biomolecules	Core	3	0	2	4
<b>BR15302CR</b>	Secondary Metabolites	Core	3	0	2	4
<b>BR15303CR</b>	Biostatistics & Biotechniques	Core	3	0	2	4
<b>SEMESTER IV</b>						
<b>BR15401CR</b>	Plant Resources and Biotechnology	Core	3	0	2	4
<b>BR15402CR</b>	Animal Cell and Tissue Technology	Core	3	0	2	4
<b>BR15403CR</b>	Microbial Technology	Core	3	0	2	4



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<b>DISCIPLINE CENTRIC ELECTIVE COURSES</b>						
<b>Course Code</b>	<b>Course Name</b>	<b>Paper Category</b>	<b>Hours per week</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	
<b>SEMESTER I</b>						
<b>BR15001DCE</b>	Cellular & Molecular Biology	Discipline Centric Elective	3	3	0	6
<b>SEMESTER II</b>						
<b>BR15002DCE</b>	Inheritance Biology	Discipline Centric Elective	3	3	0	6
<b>SEMESTER III</b>						
<b>BR15003DCE</b>	Biological Interactions	Discipline Centric Elective	3	3	0	6
<b>SEMESTER IV</b>						
<b>BR15004DCE</b>	Bioinformatics	Discipline Centric Elective	3	1	0	4
<b>BR15005DCE</b>	Term Work	Discipline Centric Elective	-	-	-	2



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<b>GENERIC ELECTIVE COURSES</b>						
<b>Course Code</b>	<b>Course Name</b>	<b>Paper Category</b>	<b>Hours per week</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	
<b>SEMESTER I</b>						
<b>BR15001GE</b>	Microbial Resources	Generic Elective	2	1	0	3
<b>BR15002GE</b>	Algal Resources	Generic Elective	2	1	0	3
<b>SEMESTER II</b>						
<b>BR15003GE</b>	Industrial Entomology	Generic Elective	2	1	0	3
<b>BR15004GE</b>	Bioresource Management	Generic Elective	2	1	0	3
<b>SEMESTER III</b>						
<b>BR15005GE</b>	Biomedicine & Bioprospecting	Generic Elective	2	1	0	3
<b>BR-15006GE</b>	Biocontrol and Crop Management	Generic Elective	2	1	0	3
<b>SEMESTER IV</b>						
<b>BR-15007-GE</b>	Wood Resource Utilization	Generic Elective	2	1	0	3
<b>BR15008GE</b>	Bioindustries	Generic Elective	2	1	0	3



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<b>OPEN ELECTIVE COURSES</b>						
<b>Course Code</b>	<b>Course Name</b>	<b>Paper Category</b>	<b>Hours per week</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	
<b>SEMESTER I</b>						
<b>BR15001OE</b>	Human Health and Plant Diet	Open Elective	2	1	0	3
<b>SEMESTER II</b>						
<b>BR15002OE</b>	Organic Farming	Open Elective	2	1	0	3
<b>SEMESTER III</b>						
<b>BR15003OE</b>	Biocosmetics	Open Elective	2	1	0	3
<b>SEMESTER IV</b>						
<b>BR15004OE</b>	Green Technology	Open Elective	2	1	0	3



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<b>CORE COURSES</b>						
<b>SEMESTER I</b>						
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			<b>L</b>	<b>T</b>	<b>P</b>	
<b>BR15101CR</b>	Biodiversity and Bioresources	Core	3	0	2	4
<b>BR15102CR</b>	Plant Resources	Core	3	0	2	4
<b>BR15103CR</b>	Animal Resources	Core	3	0	2	4

## **SEMESTER I**

### **BR15101CR: 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).

**Practical Work:**

- 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.



## SEMESTER I

### BR-15102-CR: 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.

**Practical Work:**

- 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.

**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.

**Practical Work:**

- 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.



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<b>SEMESTER II</b>						
<b>BR15201CR</b>	Resource Regeneration	Core	3	0	2	4
<b>BR15202CR</b>	Bioenergy and Biofuels	Core	3	0	2	4
<b>BR15203CR</b>	Biofertilizers & Biopesticides	Core	3	0	2	4

**SEMESTER II****BR15201CR: Resource Regeneration****Unit: I**

**Asexual reproduction in plants:** Importance of vegetative reproduction, types and methods of vegetative propagation; Apomixis; Adventive embryony; Apospory and apogamy; Parthenocarpy.

**Floral evocation:** Transition to flowering; 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.

**Pollination and fertilization:** Pollination mechanisms and vectors; Double fertilization; Endosperm and embryo development (monocot and dicot embryos); Fruit development; Seed dispersal; Importance of sexual reproduction in plants.

**Unit: III**

**Principles of animal development:** Basic concepts of development— potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients; Cell fate and cell lineages; Genomic equivalence and the cytoplasmic determinants; Imprinting; Mutants and transgenics in analysis of development; Production of male and female gametes; Zygote formation.

**Unit: IV**

**Early embryonic development:** Mechanism of cleavage; Blastula formation; Gastrulation and formation of germ layers.

**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.

**Practical Work:**

- 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.
- 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.

## **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.



**Practical Work:**

- 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.

## SEMESTER II

### BR15203CR: 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.



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<b>SEMESTER III</b>						
<b>BR15301CR</b>	Biomolecules	Core	3	0	2	4
<b>BR15302CR</b>	Secondary Metabolites	Core	3	0	2	4
<b>BR15303CR</b>	Biostatistics & Biotechniques	Core	3	0	2	4

**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 ( $\alpha$ -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).

**Practical Work:**

- 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.

**SEMESTER III****BR15302CR: 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.

**Practical Work:**

- 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 radicle scavenging activity of plant extract.
- Study the effect of pH on the anthocyanins from fruit extracts.



## **SEMESTER III**

### **BR15303CR: 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.

**Practical Work:**

- 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 principal and working of colorimeter and UV- Visible spectrophotometer.



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<b>SEMESTER IV</b>						
<b>BR15401CR</b>	Plant Resources and Biotechnology	Core	3	0	2	4
<b>BR15402CR</b>	Animal Cell and Tissue Technology	Core	3	0	2	4
<b>BR15403CR</b>	Microbial Technology	Core	3	0	2	4

## 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.

**Practical Work:**

- 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.

**SEMESTER IV****BR15402CR: 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.

**Practical Work:**

- 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.

**SEMESTER IV****BR15403CR: 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, CO<sub>2</sub>); 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.



**Practical Work:**

- Estimation of CO<sub>2</sub> 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.



## P. G. PROGRAMME IN BIORESOURCES

DEPARTMENT OF BOTANY, UNIVERSITY OF KASHMIR, SRINAGAR

### CHOICE BASED CREDIT SYSTEM (CBCS)

#### SCHEME AND COURSE STRUCTURE

TO BE IMPLEMENTED FROM ACADEMIC SESSION 2015 AND ONWARDS

<b>DISCIPLINE CENTRIC ELECTIVE COURSES</b>						
Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
<b>SEMESTER I</b>						
<b>BR15001DCE</b>	Cellular & Molecular Biology	Discipline Centric Elective	3	3	0	6
<b>SEMESTER II</b>						
<b>BR15002DCE</b>	Inheritance Biology	Discipline Centric Elective	3	3	0	6
<b>SEMESTER III</b>						
<b>BR15003DCE</b>	Biological Interactions	Discipline Centric Elective	3	3	0	6
<b>SEMESTER IV</b>						
<b>BR15004DCE</b>	Bioinformatics	Discipline Centric Elective	3	1	0	4
<b>BR15005DCE</b>	Term Work	Discipline Centric Elective	-	-	-	2

**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****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 Spc).

**Tutorials: 3 hours/week**

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

**Term work of 2 credits shall be taken by a student in 4<sup>th</sup> 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.**



## P. G. PROGRAMME IN BIORESOURCES

DEPARTMENT OF BOTANY, UNIVERSITY OF KASHMIR, SRINAGAR

### CHOICE BASED CREDIT SYSTEM (CBCS)

#### SCHEME AND COURSE STRUCTURE

TO BE IMPLEMENTED FROM ACADEMIC SESSION 2015 AND ONWARDS

<b>GENERIC ELECTIVE COURSES</b>						
<b>Course Code</b>	<b>Course Name</b>	<b>Paper Category</b>	<b>Hours per week</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	
<b>SEMESTER I</b>						
<b>BR15001GE</b>	Microbial Resources	Generic Elective	2	1	0	3
<b>BR15002GE</b>	Algal Resources	Generic Elective	2	1	0	3
<b>SEMESTER II</b>						
<b>BR15003GE</b>	Industrial Entomology	Generic Elective	2	1	0	3
<b>BR15004GE</b>	Bioresource Management	Generic Elective	2	1	0	3
<b>SEMESTER III</b>						
<b>BR15005GE</b>	Biomedicine & Bioprospecting	Generic Elective	2	1	0	3
<b>BR-15006GE</b>	Biocontrol and Crop Management	Generic Elective	2	1	0	3
<b>SEMESTER IV</b>						
<b>BR-15007-GE</b>	Wood Resource Utilization	Generic Elective	2	1	0	3
<b>BR15008GE</b>	Bioindustries	Generic Elective	2	1	0	3



**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 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****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 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 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 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 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**





## P. G. PROGRAMME IN BIORESOURCES

DEPARTMENT OF BOTANY, UNIVERSITY OF KASHMIR, SRINAGAR

**CHOICE BASED CREDIT SYSTEM (CBCS)**

**SCHEME AND COURSE STRUCTURE**

**TO BE IMPLEMENTED FROM ACADEMIC SESSION 2015 AND ONWARDS**

<b>OPEN ELECTIVE COURSES</b>						
<b>Course Code</b>	<b>Course Name</b>	<b>Paper Category</b>	<b>Hours per week</b>			<b>Credits</b>
			<b>L</b>	<b>T</b>	<b>P</b>	
<b>SEMESTER I</b>						
<b>BR15001OE</b>	Human Health and Plant Diet	Open Elective	2	1	0	3
<b>SEMESTER II</b>						
<b>BR15002OE</b>	Organic Farming	Open Elective	2	1	0	3
<b>SEMESTER III</b>						
<b>BR15003OE</b>	Biocosmetics	Open Elective	2	1	0	3
<b>SEMESTER IV</b>						
<b>BR15004OE</b>	Green Technology	Open Elective	2	1	0	3

**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**

**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 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**