P. G. PROGRAMME IN BIORESOURCES

DEPARTMENT OF BOTANY, UNIVERSITY OF KASHMIR, SRINAGAR

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER-WISE SCHEME FORMAT

SEMESTER I						
Course Code	**Course Name**	**Paper Category**	**Hours per week**			**Credits**
			L	**T**	**P**	
BR-01-CR	Plant Resources	Core	4	0	0	4
BR-02-CR	Animal Resources	Core	4	0	0	4
BR-03-CR	Practical-I (Based on BR-01-CR & BR-02-CR)	Core	0	0	8	4
BR-04-EA	Microbial Resources	Elective (Allied)	3	0	2	3+1=4
BR-05-EA	Biodiversity and Bioresources	Elective (Allied)	3	0	2	3+1=4
BR-06-EA	Biostatistics	Elective (Allied)	3	2	0	3+1=4
BR-07-EA	Industrial Entomology	Elective (Allied)	3	2	0	3+1=4
BR-08-EO	-	Elective (Open)	-	-	-	-
Credit =28	**Contact Hours = 36**		**20**	**4**	**12**	**28**

Credit Combinations could be: 12+12+0=24 or 12+8+4=24

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SEMESTER II						
Course Code	**Course Name**	**Paper Category**	**Hours per week**			**Credits**
			L	**T**	**P**	
BR-09-CR	Resource Regeneration	Core	4	0	0	4
BR-10-CR	Bioenergy and Biofuels	Core	4	0	0	4
BR-11-CR	Practical-II (Based on BR-09-CR & BR-10-CR)	Core	0	0	8	4
BR-12-EA	Biomedicine and Bioprospecting	Elective (Allied)	3	0	2	3+1=4
BR-13- EA	Biofertilizers and Organic farming	Elective (Allied)	3	0	2	3+1=4
BR-14- EA	Biocontrol and Biopesticides	Elective (Allied)	3	2	0	3+1=4
BR-15- EA	Biological Interactions	Elective (Allied)	3	2	0	3+1=4
BR-16-EO	Human Health and Plant Diet	Elective (Open)	3	2	0	3+1=4
Credit =28		**Contact Hours = 36**	**20**	**4**	**12**	**28**

Credit Combinations could be: 12+12+0=24 or 12+8+4=24

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SEMESTER III						
Course Code	**Course Name**	**Paper Category**	**Hours per week**			**Credits**
			L	**T**	**P**	
BR-17-CR	Biomolecules	Core	4	0	0	4
BR-18-CR	Secondary Metabolites	Core	4	0	0	4
BR-19-CR	Practical-III (Based on BR-17-CR & BR-18-CR)	Core	0	0	8	4
BR-20-EA	Bioinformatics	Elective (Allied)	3	0	2	3+1=4
BR-21- EA	Biotechniques	Elective (Allied)	3	0	2	3+1=4
BR-22- EA	Project Work	Elective (Allied)	0	0	16	8
BR-23-EO	Biocosmetics	Elective (Open)	3	2	0	3+1=4
Credit =28	**Contact Hours = 42**		**14**	**0**	**28**	**28**

Credit Combinations could be: 12+12+0=24 or 12+8+4=24

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SEMESTER-WISE SCHEME FORMAT

SEMESTER IV						
Course Code	**Course Name**	**Paper Category**	**Hours per week**			**Credits**
			L	**T**	**P**	
BR-24-CR	Plant Resources and Biotechnology	Core	4	0	0	4
BR-25-CR	Animal Cell and Tissue Technology	Core	4	0	0	4
BR-26-CR	Practical-IV (Based on BR-24-CR& BR-25-CR)	Core	0	0	8	4
BR-27-EA	Microbial Technology	Elective (Allied)	3	0	2	3+1=4
BR-28- EA	Bioresource Policy and Management	Elective (Allied)	3	0	2	3+1=4
BR-29- EA	Bioindustry and Trade Regulations	Elective (Allied)	3	2	0	3+1=4
BR-30- EA	Green Technology	Elective (Allied)	3	2	0	3+1=4
BR-31-EO	-	Elective (Open)	-	-	-	-
Credit =28	**Contact Hours = 31**		**17**	**2**	**12**	**28**

Credit Combinations could be: 12+12+0=24 or 12+8+4=24

SEMESTER I

BR-01-CR: Plant Resources

Unit: I

Plant resources: Utilization through ages and their domestication; Origin of agriculture; Centres of origin and domestication of cultivated plants as proposed by de Candolle and Vavilov.

Agricultural biotechnology: Overview and applications in commercial productivity, adaptability and resistance to varied habitats; Green revolution— benefits and adverse consequences.

Unit: II

Cereals and Pseudocereals: Origin, evolution, domestication and utility of rice (*Oryza sativa*), wheat (*Triticum aestivum*), maize (*Zea mays*), amaranth (*Amaranthus* spp.), buckwheat (*Fagopyrum* spp.) and *Pennisetum* spp.

Fodder and Oil crops: General account of fodder crops with special reference to methods of domestication and utility of alfalfa (*Medicago sativa*); Vegetable oils; Extraction and processing of mustard and sunflower oil.

Unit: III

Fibre crops: Classification and types of plant fibres; Origin, evolution, and processing of flax and jute fibre.

Vegetables, Spices and Condiments: Methods of cultivation and commercial values of vegetables grown in Kashmir; Classification of spices and condiments; Distribution, cultivation and processing of saffron.

Fruits: General account of rosaceous fruits grown in Kashmir.

Unit: IV

Fumitories and Masticatories: Types and sources; Cultivation and processing of tobacco and betel nut.

Gums and Resins: Classification, important sources and their commercial values.

Dyes and Tannins: Dyes and tannins extracted from bark, stem, leaves, fruits and flowers; Extraction, processing and uses.

Non-woody forest products (NWFPs): General account and utilization.

BR-02-CR: Animal Resources

Unit: I

Livestock domestication: Brief history of domestication of livestock; 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 birds; Genetic and phenotypic consequences and applications of inbreeding and out-breeding; Genetic basis of heterosis and its use.

Unit: II

Aquaculture: Fish monoculture, polyculture and mixed culture; Pearl and shellfish farming; Integration of aquaculture with agriculture and animal husbandry— sewage-fed farming, organic aquaculture; Processing and preservation of fish and its products; Handling, canning, smoking and freezing of fresh water fish and its products.

Unit: III

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: an alternative sources of protein.

Unit: IV

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

BR-03-CR: Practical-I

- 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.
- Identification of various breeds of cattle, buffalo, sheep and goat.
- 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.
- Study of modifications in legs of honey bees.
- Quality analysis of honey.
- 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.
- Bacteriological examination of milk by clot on boiling test and methylene blue reduction MBR test.
- Structure of wool.

BR-04-EA: Microbial resources

Unit: I

Microbial resources: Historical perspective; Modern microbiology; 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; Planktonic protists as food; Microbes as sources of antibiotics and therapeutic agents; Major commercial microbial products (amino acids, enzymes, steroids and biopolymers).

Unit: III

Role of microbes in bioremediation— concept, types and scope; Microbes in bioleaching and biodegradation (heavy metals, hydrocarbons, xenobiotics) in soil and water; Role of protists in sanitation; Microbes as bioindicators; Phycoviruses and algal blooms; Biodefence and bioterrorism.

Unit: IV

Role of microbes in water quality and waste water treatment (processes based on attached microbial growth, activated sludge process); Microbes and biogeochemical cycles (carbon cycle, nitrogen cycle, sulphur cycle, phosphorus cycle).

Practical Work:

- Preparation of culture media.
- Study sterilization of equipment and materials.
- Study the preparation and use of disinfectants.
- Preparation of bacterial and yeast cultures.
- Preparation of mould cultures.
- Study the various morphological types of microbes (bacteria).

BR-05-EA: 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

Factors of biodiversity loss: ultimate and proximate causes; Species conservation status: 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 woody plants in KUBG, which are economically important.

BR-06-EA Biostatistics

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; Frequency and cumulative frequency distributions.

Graphical and diagrammatic representation of data: Histogram, frequency polygon, frequency curve; Line diagram, bar diagram (types), pie diagram; Significance and limitations of graphical and diagrammatic representation of data.

Unit: II

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

Correlation and regression: Basic idea of correlation; Simple correlation— calculation of correlation coefficient, significance tests for correlation coefficients; Simple linear regression-calculation of regression coefficients; Standard errors and significance tests.

Unit: III

Probability: Concept, laws of probability (multiplication law and addition law); Application of probability; Probability distribution (discrete and continuous distribution— concept); Normal distribution— properties and importance.

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.

Unit: IV

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

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.

BR-07-EA: Industrial Entomology

Unit: I

Apiculture: Importance and scope; Bee species, their biology, morphology, behaviour, habit and habitats; Bee keeping equipments, hives, bee pasturage and seasonal management; Honey extraction; Factors affecting honey yield; Honey, its properties and uses; Granulation, fermentation and storage of honey, uses of other bee products; Bee enemies including diseases and their control.

Unit: II

Sericulture: Silkworm species, their systematic position and salient features; Rearing techniques of mulberry, muga, eri and tassar silkworms; Nutritional requirements of silkworms; Sericulture rearing house and appliances, silkworm breeds, seed production and its economics; Enemies and diseases of silkworms and their management.

Unit: III

Lac culture: Lac insect, its biology, habit and habitats; 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 medicines; Use of insects in scientific investigations; Use of insects as food source.

P. G. PROGRAMME IN BIORESOURCES
UNIVERSITY OF KASHMIR, SRINAGAR

General Instructions for the Candidates

1. The two year (4 Semesters) P. G. Programme in Bioresources is of 96 credit weightage i.e. 24 credits per semester (24×4=96).

2. A candidate has compulsorily to opt for 12 credits from the core component in each semester.

3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied), except for semester III where a student can opt for 1 paper (4 credits) apart from the Project work (8 credits).In a particular semester a candidate is required to gain a minimum of 4 credits from Elective (Open) offered by any other Department /Faculty.

4. The P.G. Programme in Bioresources is offering Elective (Open) courses in semester II & III (4 credit each) for the students of other Departments.

5. A candidate has compulsorily to obtain a minimum of 4 credits from Elective (Open) from outside the Department in any of the semesters.

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Semester II

BR-09- CR: Resource Regeneration

Unit: I

Asexual reproduction in plants: Importance of vegetative reproduction, types and methods of vegetative propagation. Apomixes; Importance of apomictic seeds; Adventive embryony; Apospory and apogamy; Parthenocarpy— commercial utility of parthenocarpic fruits.

Unit: II

Sexual reproduction in angiosperms: Importance of sexual reproduction in plants.
Microsporangium and male gametophyte: Structure and development of anther; Role of tapetum; Structure and development of male gametophyte.
Megasporangium and female 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).

Unit: III

Plant tissue culture: Present concept and applications of plant tissue culture; Cellular totipotency; Micropropagation— regeneration through callus cultures, adventitious buds and non adventitious systems (apical and axillary buds); Production of somatic embryos; Methods and types of synthetic seed production.

Unit: IV

Sexual reproduction in animals: Introduction and significance; Basic concept of development- potency, commitment, specification, induction, competence determination and differentiation.
Gametogenesis and Fertilization: Production of male and female gametes and zygote formation; Mechanism of cleavage— Blastula formation, gastrulation and formation of germ layers; Environmental regulation of normal development; Regeneration in vertebrates.

BR-10-CR: 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; Current biodiesel technologies; Properties of biodiesel; Algae as a source of biodiesel; Production of bioethanol; Lignocellulosic biomass as feedstock for ethanol production; Ethanologens (modification for pentose utilisation); Transgenic feedstock for biofuel production— concept and achievements.

Unit: III

Gaseous biofuels: Biogas production; Aerobic and anaerobic conversion process; Biogas processing technologies for anaerobic digestion; Hydrocarbon biofuels; Bioenergy crops (Jatropa, Sugarcane, Sweet sorghum, Pongamia and Maize); Biohydrogen; Biohydrogen from biorenewable feedstocks; Green algae and cyanobacteria as powerhouses of biohydrogen; Artificial photosynthesis.

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.

BR-11-CR: Practical-II

- 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 pollen in-vitro germination.
- Demonstration of plant tissue culture technique (sterilization, media preparation and inoculation).
- Study the various stages of chick embryo (24 hrs, 48 hrs, 72 hrs and 96 hrs).
- 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 (as evidence to the utilization and synthesis of yolk proteins during differentiation and organogenesis).
- Study the meiosis in grasshopper.
- Study the bar body in buccal swab/drumstick in neutrophil.
- 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.
- Estimation of free fatty acids in biodiesel.
- Study the importance of jatropha, maize and sugarcane as major bioenergy crops.

BR-12-EA: Biomedicine and Bioprospecting

Unit: I

Biomedicine: Definition, historical perspectives and importance; Traditional knowledge about herbal medicine and its role in data compilation; Historical development and present status of (AYUSH):

i. Chinese system
ii. Ayurvedic system
iii. Unani system
iv. Sidha System
v. Homeopathic system

Unit: II

Ethnobotany: Concept, objectives and scope; Status assessment of important medicinal plants of Kashmir; Ethnobotanical importance and active principle of some important medicinal plants of Kashmir viz. *Arnebia*, *Aconitum*, *Atropa*, *Podophyllum*, *Saussurea*, *Rheum*, *Digitalis*, *Valeriana*, *Viola*, *Picrorhiza* and *Dioscorea* spp.

Unit: III

Herbal crude medicines: Introduction, classification, collection and processing; Herbal crude drugs— extraction, purification and characterization methods; Quality control and quality assurance of herbal drugs; Drug safety rules; Pharmaceutical Industries: Indian companies, multinational companies; Marketing policies in commercialization of herbal wealth.

Unit: IV

Bioprospecting: Introduction, global overview, ethics and benefits; Bioprospecting controversies; Role of Traditional Knowledge in biopropspecting; Traditional Knowledge Digital Library (TKDL); Biopiracy— introduction, threats posed by biopiracy to biological diversity, case studies of biopiracy (Basmati, Neem, Turmeric, Periwinkle, Enola bean, Colgate, Yoga); Criticism of biopiracy.

Practical Work:

- Taxonomy and identification of some important medicinal plants of Kashmir Himalaya.
- Preparation of crude extracts from medicinal plant parts by Soxhlet method.
- Study the distribution of active principle in different parts of some important medicinal plants of Kashmir Himalaya.
- Chromatography of herbal extracts using various solvent systems.

BR-13-EA: Biofertilizers and Organic farming

Unit: I

Biofertilizers: Concept, types and prospects; Bacterial biofertilizers— morphology, life cycle, isolation, cultivation, association, inoculation and method of application of *Azotobacter, Rhizobium* and *Beijerinckia*; Factors affecting biofertilizer efficiency of Azotobacter, *Rhizobium* and *Beijerinckia.*

Unit: II

Phosphorous solubilising microorganisms (PSMs): Introduction, isolation, culture, mass production and inoculation; Factors affecting biofertilizer efficiency of PSMs; Plant growth promoting rhizobacteria (PGPR)— role in sustainable agriculture.

Unit: III

Fungal biofertilizers: Morphology, association, cultivation, inoculation, role and application with particular reference to arbuscular mycorrhizas (AMs).

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

Unit: IV

Organic farming: Concept, principles, standards and certification; Role in soil fertility, crop agronomy and crop protection; Organic livestock husbandry and breeding.

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

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.

BR-14-EA: Biocontrol and Biopesticides

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

Biopesticides: Definition, history, types, advantages and limitations; Biofungicides— fungal fungicides, bacterial fungicides, fungal nematicides (role and application); Bioherbicides— concept, current status and prospects; Mass production and formulations.

Unit: III

Bioinsecticides: Bacterial insecticides- classification and mode of action with special reference to *Bacillus thuringenesis*; Fungal and viral insecticides— mode of action and commercial formulations; Entomopathogenic nematodes (EPN)- mode of action and field efficacy.

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; Role of biopesticides in sustainable agriculture; Preventive and safety measures required in using biopesticides.

BR-15- EA: Biological Interactions

Unit: I

Plant Interactions: Factors contributing to community stability (successional model and climax pattern model); Community instability and keystone species; Symbiosis; 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 travel; 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.

BR-16-EO: 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 (brief concept). Digestion, absorption and assimilation of proteins, carbohydrates, fats, vitamins and minerals.

Unit: II

Good things from plants in the diet: Fibre, Antioxidants (hydrophilic and lipophilic) Sterols; 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; Domestic and international hunger issues— malnutrition, world hunger and food security; Plant diets in pregnancy, lactation, infancy, childhood and adolescence.

Unit: IV

Plant diet and diseases: Chronic diseases— incidence and mortality; Impact of food matrix and phytonutrients against chronic diseases; Plant diet and diseases control— diabetes, heart disease, cancer, obesity; Plants in nutrition fitness and sports; Food safety; Food poisoning; Genetically modified crops, benefits and risks.

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4. The P.G. Programme in Bioresources is offering Elective (Open) courses in semester II & III (4 credit each) for the students of other Departments.

5. A candidate has compulsorily to obtain a minimum of 4 credits from Elective (Open) from outside the Department in any of the semesters.

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Semester III

BR-17-CR: Biomolecules

Unit: I

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

Biological membranes: The structure and composition of biomembranes (Fluid mosaic model); Solute transport across the membranes; Cell Adhesion Molecules (CAMs) and cell junctions (overview).

Unit: II

Carbohydrates: Introduction, classification, chemical and optical properties of carbohydrates; Role of monosaccharides in important biological reactions; Oligosaccharides and polysaccharides (sucrose, cellobiose, trehalose, lactose, maltose, cellulose, starch, pectins, hemicelluloses, fructans).

Lipids: Classification and properties of lipids; Functions of triacylgycerols, phospholipids, glycolipids, sphingolipids and cholesterol.

Unit: III

Amino acids & Proteins: Occurrence, structure and classification of amino acids; Properties of amino acids, stereoisomerism in amino acids; Protein structure, protein folding (concept of chaperones); Fibrous and globular proteins (α-keratin, collagen, haemoglobin); Actin, myosin and molecular motors (overview).

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

Unit: IV

Nucleic acids: Structure and function of nucleotides, Phosphoryl group transfer and ATP; Watson and Crick model of DNA double helix; Various forms of DNA (A, B, Z and H DNA); Packaging of genetic material (Nucleosome model); DNA replication; DNA dependent RNA synthesis; Types of RNA and their role in protein synthesis and reverse transcription; DNA damage and repair; RNA splicing.

BR-18-CR: Secondary Metabolites

Unit: I

Secondary metabolites: Introduction and classification; Phenolic compounds— introduction, occurrence and classification; Basic shikimic acid pathway for synthesis of phenolic compounds; Terpenes— introduction and occurrence; Classification based on isoprene rule; Biosynthesis of terpenes; Importance of rubber as a bioresource; Steroids-occurrence, basic 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 (general aspects of true, proto and pseudo-alkaloids); Biological functions of alkaloids; Non protein amino acids; Glycosylated N-containing toxins.

Unit: III

Plant pigments: Introduction, 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 biological function (napthquonones, anthraquinones, tannins, lignins); Indole derivatives— structure, occurrence and biological 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.

BR-19-CR: Practical-III

- 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.
- 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.

BR-20-EA: Bioinformatics

Unit: I

Bioinformatics: Concept and applications; Bioinformatics databases— Types of Biological databases, data representation and storage.

Nucleotide sequence databases: European Molecular Biology Laboratory (EMBL), GeneBank, DNA Data Bank of Japan (DDBJ) and Expressed Sequence Tags (ESTs) data bases.

Protein sequence databases: SwissProt, Protein Information Resource (PIR); Protein structure databases— structural classification of proteins (SCOP); Class Architecture, Topology Homologous Superfamily (CATH).

Unit: II

Sequence analysis: Genome sequencing (conventional and next generation sequencing).

Sequence alignment: Pair-wise and multiple sequence alignments; Gene finding and genome annotation.

Transcriptome analysis: DNA Microarray technology, serial analysis of gene expression, Quantitative Real Time PCR; Emerging areas in bioinformatics— computational systems biology, semantic web.

Unit: III

Proteomics: Seperation and identification of proteins (mass spectroscopy); Protein Microarray; Protein expression profiling; Protein-protein interaction mapping. **Metabolomics and Metabolic Flux ontologies:** Types of bioontologies; Application of ontologies, software for assessing and analyzing ontologies and annotations.

Unit: IV

Phylogenetics: Concept and scope; Phenotypic and molecular Phylogeny; Representation of molecular phylogeny; Methods of phylogeny: maximum parsimony, maximum likelihood (Cladistic methods); Distance methods (Unweighted Pair Group Method with Arithmetic Mean (UPGMA) & Neighbor joining (NJ); Softwares for phylogenetic analysis— PHYLIP, Tree view, NTSYSpc.

Practical Work:

- Study the DNA databases: NCBI, EMBL, DDBJ.
- Study the protein databases: PIR and SwissProt.
- Study the particular gene using TAIR database.
- Study multiple sequence alignment using Clustal W.
- Study the BLAST.
- Study the Pub Med.
- Study the primer designing.
- Study the phylogenetic analysis using NTSYs.
- Construction of dendograms using cladistic methods.
- Construction of dendograms using distance methods.

BR-21-EA: Biotechniques

Unit: I

Light microscopy: Resolution and magnifying power of a microscope; Principle of working & application of Fluorescence, Phase contrast, Dark field and Confocal microscopy.

Electron microscopy: Principle and working of scanning electron microscope (SEM) and transmission electron microscope (TEM); Specimen preparation techniques for electron microscopy; Atomic force microscopy.

Unit: II

Chromatography: Principles of chromatography; Paper, thin layer, Gas-liquid, High Performance Liquid Chromatography (HPLC), ion exchange, adsorption, molecular exclusion, affinity chromatographic techniques and their applications.

Centrifugation: Principles of Sedimentation, Ultracentrifugation— Differential centrifugation; Density gradient centrifugation.

Unit: III

Spectroscopy: Various spectroscopic techniques (UV-visible, IR spectroscopy, NMR & Mass spectrometry) its applications; Principles, working and construction of a Spectrophotometer.

Radio labelling techniques: Properties of various radioisotopes and their applications in biology, safety guidelines. Immunological techniques— Immunoprecipitation; Immunoblotting; Immunoassays.

Unit: IV

Electrophoretic techniques: Principles of electrophoresis; Electrophoresis of nucleic acids (agarose gel electrophoresis); Electrophoresis of proteins (Native and SDS-polyacrylamide gel electrophoresis,).

Blotting techniques: Southern blotting, Northern blotting, Western blotting, Dot blots & Slot blots; Polymerase chain reaction (PCR).

Practicals Work:

- Demonstration of scanning electron microscopy (SEM).
- Use of paper and thin layer chromatography for the separation of plant pigments.
- Thin layer chromatography.
- Study the principal and working of colorimeter and UV- Visible spectrophotometer.
- Study the principal and working of centrifuge.
- Demonstration of Ultracentrifugation.
- Working of electrophoretic apparatus.
- SDS-PAGE.

BR-22-EA

Project Work

BR-23-EO: Biocosmetics

Unit: I

Biocosmetics: History and introduction about the use of cosmetics; Importance of plant and animal resources in biocosmetics; Global market of biocosmetics; Manufacture, sale and import of biocosmetics; Labelling, packaging and standardization of biocosmetics.

Unit: II

Skin cosmetics: Structure and functions of skin; 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; Evaluation and packaging of skin creams and lotions.

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).

P. G. PROGRAMME IN BIORESOURCES
UNIVERSITY OF KASHMIR, SRINAGAR

General Instructions for the Candidates

1. The two year (4 Semesters) P. G. Programme in Bioresources is of 96 credit weightage i.e. 24 credits per semester (24×4=96).

2. A candidate has compulsorily to opt for 12 credits from the core component in each semester.

3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied), except for semester III where a student can opt for 1 paper (4 credits) apart from the Project work (8 credits).In a particular semester a candidate is required to gain a minimum of 4 credits from Elective (Open) offered by any other Department /Faculty.

4. The P.G. Programme in Bioresources is offering Elective (Open) courses in semester II & III (4 credit each) for the students of other Departments.

5. A candidate has compulsorily to obtain a minimum of 4 credits from Elective (Open) from outside the Department in any of the semesters.

6. A candidate can earn more than minimum required credits (i.e., more than 96 credits) for 4 Semester programme which shall be counted towards the final result of the candidate.

Semester IV

BR-24-CR: Plant Resources and Biotechnology

Unit: I

Biotechnology: Introduction, scope and applications; Cloning Vectors— Plasmids, cosmids, phages, artificial chromosomes; 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; Use of reporter genes in transformed plant cells.

Unit: II

Molecular markers: RFLP, RAPD, AFLP, SSR, SNPs; applications of molecular markers; Molecular cytogenetic markers— FISH and GISH, their applications; Quantitative trait loci (QTL) mapping— introduction and types of mapping populations; Polyploidy— role of polyploidy in crop improvement (biotechnological approach).

Unit: III

Genetically modified crops: Insect resistance, virus resistance, herbicide resistance; Modification of plant nutritional content (vitamins, aminoacids, lipids); Modification of food plant taste and appearance— sweetness, starch and preventing discoloration; Genetically modified crops— ecological and ethical concerns.

Unit: IV

Biotransformation: Transgenic plants for biochemical production, edible vaccines, and secondary metabolites; Plants as Bioreactors; Bioreactors and bioprocessors for large scale production of bioactive compounds; Immobilization of cells and use of bioreactors; Enhancement of plant yield: Increasing Iron content, altering lignin content, increasing oxygen content; Phytoremediation- transgenic approach (Brief idea).

BR-25-CR: 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

Immunodiagnostics: Lymphocytes, antibodies and antigens– brief concept; Molecular diagnostics– ELISA and Immunoprecipitation.

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.

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 – applications and limitations; Cloning livestock by nuclear transplantation, scope and applications; Production of transgenic animals with special reference to transgenic mice, cow and sheep; Identification and transfer of genes influencing milk quality and disease resistance; Applications of animal biotechnology in genetic counselling, forensic medicine and gene therapy.

BR-26-CR: Practical IV

- Preparation of chemical competent cells for transformation.
- Transformation of plasmid into competent cells (*E. coli*).
- Small scale plasmid preparation from *E. coli.*
- Visualization of DNA by Agarose Gel Electrophoresis.
- Restriction digestion of total genomic DNA.
- Mobilization of recombinant Ti plasmid from common laboratory host (*E. coli*) to an *Agrobacterium tumefaciens* strain.
- *Agrobacterium tumefaciens*-mediated plant transformation.
- Isolation of plant genomic DNA by CTAB method.
- Amplification of DNA by Polymerase Chain Reaction.
- Transfer of DNA fragments from Agarose gel to Nitrocellulose membrane (Southern blotting).
- To make mitotic chromosome preparation from root tips.
- 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.

BR-27-EA: Microbial Technology

Unit: I

Microbial genome: Bacterial replication (DNA replication and plasmid replication); Genetic exchange (transformation, transduction and conjugation); Recombination (hosts, vectors and mechanism); Gene regulation: Lac-operon, Tryptophan operon, Attenuation; Replication of Bacteriophages: Viral multiplication (lytic and lysogenic).

Unit: II

Isolation and screening of microorganisms; Cultivation of Microbes- nutritional requirements and factors affecting microbial growth (temperature, water, pH, presence of oxygen, availability of CO_2); Culture types- static, suspension cultures (batch and continuous culture); synchronous cultures, growth curve, generation time, growth kinetics; Storage and transportation of microbial resources.

Unit: III

Fermentation technology- introduction, evolution, application; types of fermentation (aerobic, anaerobic); fermentors and their types; substrates for fermentation; role and kinetics of enzymes in various fermentation processes; microbial chemostat cultures; Scale-up of cultivation of microorganisms; Advantages of fermented foods.

Unit: IV

Importance of microbes in biotechnology (*E. coli*, *A. rhizogens*, Bacteriophages (Lambda Phage, M13), *Adenovirus*, *CaMV*, *Saccharomyces* spp., *Aspergillus nodulans;* Microbes as biosensors- basic features and applications; Microbes of extreme environment.

Practical Work:

- Estimation of CO_2 in water samples obtained at different stages of Sewage Treatment Plant (STP).
- Estimation of dissolved oxygen in given water sample.
- To test the quality of water using standard physical and chemical methods.
- 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.

BR-28-EA: Bioresource Policy and Management

Unit: I

Status and strategies for bioresource management: Exploitation of bioresources and sustainable development, Forest resource management (social forestry and agro forestry management), Grassland management, Cropland management, Freshwater Bioresource management, Marine Bioresource management, Wetland Bioresource management, Microbial resource management, Wildlife management.

Unit: II

Monitoring biodiversity: Methods for monitoring biodiversity trends, mega biodiversity zones and global biodiversity hotspots (criteria, distribution and conservation implications); Biodiversity valuation and services provided by biodiversity; Threats to biodiversity, major causes, extinctions, vulnerability of species to extinction; IUCN threat categories, Red data book; Principles and strategies of biodiversity conservation.

Unit: III

Conservation programmes: Factors of biodiversity loss; Biodiversity and climate change— concerns and challenges; *In situ* conservation strategies; *Ex situ* conservation strategies; Role of remote sensing and geographical information system in biodiversity studies; Technologies for restoration of degraded soils; Principles and methodologies for soil conservation and restoration.

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.

Practical Work:

- Visiting of national parks/ wildlife sanctuaries of the region to acquaint students with various *In situ* conservation measures.
- Visiting of forest/grassland ecosystems.
- Visiting of botanical gardens/zoos to apprise students about their importance and role.

BR-29-EA: Bioindustry and Trade Regulations

Unit: I

Industrial revolution— causes and consequences; Industrial economic sectors: Primary, Secondary, Tertiary and Quaternary Sectors; Small scale industries and their importance; Product development; Quality management.

Entrepreneurship- Concept and scope; Qualities and role of entrepreneur in economic development; Entrepreneurial skills; Market plan- characteristics, steps and elements; Business plans- steps and types; Self employment- concept and scope.

Unit: II

Bioindustries- Concept and scope; Role of natural resources in economic development; Major Bioindustries in India- status and scope (Agriculture, Fisheries, Forest and Diary industry); Status of fruit and sericulture industry in India with special reference to Kashmir; Entrepreneurship in vermiculture; Policies for agricultural growth.

Unit: III

Scope of potential bioindustries in Kashmir (apiculture, leather, pisciculture and ornamental horticulture); Herbal drug industry- status & scope with reference to Kashmir; Biotechnology in Entrepreneurship Development; Business opportunities in the field of Bioinformatics sector; Biotechnology in agriculture and healthcare industry.

Unit: IV

Wild life trade- costs and benefits; Scale of international wildlife trade; CITES and illegal wildlife trade; Wildlife crime as a legal concept (the role of criminal sanctions, effective law enforcement).

Evolution, impact and effectiveness of domestic wildlife trade bans in India; Regulatory design (the vertical axis – implementation of international policy; the horizontal axis – cohesion of international policy).

BR-30- EA: Green Technology

Unit: I

Green energy: Introduction; Quest for clean energies- concept, current status and future prospects; Renewable energy (solar, wind, geothermal, tidal, hydroelectric energy); The development of alternative fuels (Biobased Energy- Biofuels concept and types), energy efficiency, storage and distribution, modeling and waste management.

Unit: II

Green concept in Biotechnology: Biopharmaceuticals, biorefinery, bio-inorganics, fermentation—types and importance; Bioreactors; Organic synthesis using supported microbes and enzymes.

Unit: III

Green Chemistry: Introduction, invention, design and application of chemical products for reducing and eliminating the use and generation of hazardous substances. Nanotechnology: Green synthesis- concept and its applications; Bio-fuel cells and applications; Photovoltaics (Silicon and non silicon based Photovoltaic cells); Biopolymers and Electronic ceramics; Biosensors and Biochips.

Unit: IV

Green Building: Green construction and sustainable building; Choice of building material and the location of the building; Energy efficiency: Low energy/zero energy buildings; Green walls (vertical gardens); Carbon sequestration at Landscape Level; Greenwashing; International laws, Eco-labeling, Examples from Pharmaceuticals, Foods, Cosmetics, Packaging, Computers, Polymers, Automobiles, and Electronics Industry.

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