**P. G. DEPARTMENT OF BOTANY, UNIVERSITY OF KASHMIR, SRINAGAR**

**CHOICE BASED CREDIT BASED COURSE STRUCTURE TO BE IMPLEMENTED FROM ACADEMIC SESSION 2017 AND ONWARDS**

The revised syllabi for PG programme in Botany as per the Modified Choice Based Credit System (CBCS) Scheme adopted by the University for Implementation at Post-Graduate level from academic session 2017 and onwards is as under:

**Core Courses (CR)**: There are 3 Core Courses per semester i.e 12 courses for 4 semesters. Each course comprises 4 credits. A student has to take 3 Core courses per semester to obtain 12 credits per semester.

**Discipline Centric Electives Courses (DCE):** EachDiscipline Centric Electives course shall have 4 credits. A student has to obtain 8 credits per semester from DCE courses.

**The Core Courses (CR) and Discipline Centric Electives Courses (DCE) are exclusively meant for the Department’s own students.**

**Generic Elective Courses(GE):** General Elective Courses shall have two credits. The GE Courses are meant for the students of the sister departments under the school of Biological Sciences.

**Open Elective Courses (OE):** OE courses shall have 2 credits. OE courses are meant for students of all the other departments, except those falling under School of Biological Sciences. A student has to obtain 4 credits from GE and OE courses per semester. A student can take 2 or 4 credits from GE and 0 or 2 credits from OE courses.

The course structure and credit breakup has been given in tabulated form as foolows.

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

**Abbreviations:**

**L** **– Lecture**

**T** **– Tutorial;**

**P** **– Practical Work;**

**CR** **– Core Course;**

**DCE** **- Discipline Centric Elective**

**GE** **- General Elective**

**OE** **- Open Elective**

**Examination Scheme:** The examination in Core and Discipline Centric Electives shall constitute three components viz Assessment-I, Assessment-II and Practical Examination. Assessment-I is based on unit I & II will be held internally at the Departmental level and shall comprise of 25 marks, Assessment II is based on Unit-III & IV and will be an external examination and shall comprise of 50 marks. Practical examination shall comprise of 25 marks and will be held at the end at the Departmental level. In case of OE and GE there will be only one examination at the end of semester which shall comprise of 50 marks.

**Project work**: Project work **(Bot-Proj.)** worth **8credits** is compulsory for the studentsand will be allotted in 4th semester based on choice of the student and space availability in relation to his/her choice. The project has to be submitted prior to the conduct of 4th semester examination so that it can be evaluated and open viva voce be conducted prior to declaration of the results. The students for project work will be evenly distributed among faculty members of the Department.

**Botanical Trips**: To make on-field observations and impart on-site training in the subjectbotany, the Department will ensure that a minimum of one field trip is organized during each semester to acquaint the students with the flora of the region and also to collect, properly preserve, and prepare at least 50 plant specimens following standard herbarium techniques. The students will, however, avoid collection of rare and threatened plant species. The herbarium will have to be submitted at the end of the semester wherein Taxonomy is a core course.

**CORE COURSES (Bot-CR) SEMESTER WISE**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course** | **Course Name** |  | **Hours** |  | **Credits** |
| **Code** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |
|  |  | **L** |  | **T** |  | **P** |  |
|  |  |  |  |  |  |
|  | **SEMESTER 1st**  |
|  |  |  |  |  |  |  |  |
| **BOT-17101CR** | Plant Taxonomy | 3 |  | 0 |  | 2 | **3+1** |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| **BOT-17102CR** | Microbiology, Fungi and | 3 |  | 0 |  | 2 | **3+1** |
|  | Plant Pathology |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| **BOT-17103CR** | Algae and Bryophyta | 3 |  | 0 |  | 2 | **3+1** |
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|  | **SEMESTER 2nd** |
|  |  |  |  |  |  |  |
| **BOT-17201CR** | Pteridophyta and | 3 |  | 0 |  | 2 | **3+1=4** |
|  | Gymnosperms |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| **BOT-17202CR** | Ecology | 3 |  | 0 |  | 2 | **3+1=4** |
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| **BOT-17203CR** | Cell and Molecular Biology | 3 |  | 0 |  | 2 | **3+1=4** |
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|  | **SEMESTER 3rd** |
|  |  |  |  |  |  |  |
| **BOT-17301CR** | Reproductive and | 3 |  | 0 |  | 2 | **3+1=4** |
|  | Developmental Biology of |  |  |  |  |  |  |
|  | Angiosperms |  |  |  |  |  |  |
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| **BOT-17302CR** | Cytogenetics and Genetics | 3 |  | 0 |  | 2 | **3+1=4** |
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| **BOT-17303CR** | Plant Metabolism | 3 |  | 0 |  | 2 | **3+1=4** |
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|  | **SEMESTER 4th** |
| **BOT-17401CR** | Plant Physiology | 3 |  | 0 |  | 2 | **3+1=4** |
|  |  |  |  |  | 2 |  |  |
|  |  |  |  |  |  |  |  |
| **BOT-17402CR** | Plant Tissue Culture and | 3 |  | 0 |  | 2 | **3+1=4** |
|  | Genetic Engineering |  |  |  | 2 |  |  |
|  |  |  |  |  |  |  |  |
| **BOT-17403CR** | Plant Resource Utilization | 3 |  | 0 | 2 | 2 | **3+1=4** |
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**Discipline Centric Elective Courses For Semester 1st**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Code** | **Course Name** | **Total hours** |  |  **Credits**  |
| L | T |  |  | P |  |  |
| **BOT-17104DCE** | Biostatistics and Biotechniques | 3 | 0 |  |  | 2 |  |  | **4** |
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| **BOT-17105DCE** | Mushroom Cultivation | 3 | 0 |  |  | 2 |  |  | **4** |
|  | Technology  |  |  |  |  |  |  |  |  |  |  |
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| **BOT-17106DCE** | Medicinal Plants and Herbal Resource Management | 3 | 0 |  |  | 2 |  |  | **4** |
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**General Elective Courses For**

**Semester 1st**

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| --- | --- | --- | --- | --- |
| **Course Code** | **Course Name** | **Total hours** |  |  **Credits**  |
| L | T |  |  | P |  |  |
| **Bot-17001GE** | Principals of Genetics | 2 | 0 |  |  | 0 |  |  | **2** |
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| **Bot-17002GE** |  | 2 | 0 |  |  | 0 |  |  | **2** |
|  | Urban Ecology |  |  |  |  |  |  |  |  |  |  |
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**Open Elective Courses For**

**Semester 1st**

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| --- | --- | --- | --- | --- |
| **Course Code** | **Course Name** | Total hours |  |  **Credits**  |
| L | T |  |  | P |  |  |
| **Bot-17001OE** | Biogeography | 2 | 0 |  |  | 0 |  |  | **2** |
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**Examination Scheme**

**4 Credit Courses with Credit breakup 3L+1P**

1. Continuous Assessment 25 Marks
2. End of Semester Examination 50 Marks
3. Practical 25 marks

**4 Credit Courses with Credit breakup 3L+1T**

1. Continous Assessment I 25 Marks
2. Continuous Assessment II 25 Marks
3. End of Semester Examination 50 Marks

**2 Credit Course (GE and OE)**

1. End of Semester Examination 50 Marks

**Examination with Max. Marks = 25**

Section A:Question carrying one mark each- 08 objectives questions=08 marks

Section B:Question carrying 04 mark each- 02 questions=08 marks

Section C:Question carrying 09 mark each- 02 questions –only one to be attempted=09 marks

**Examination with Max. Marks = 50**

Section A:Question carrying one mark each- 16 objectives questions=16 marks

Section B:Question carrying one mark each- 04 questions=16 marks

Section C:Question carrying one mark each- 02 questions –only 2 to be attempted=18 marks

**CORE COURSES EACH WORTH 4 CREDITS**

**SEMESTER 1ST**

**Bot-1701CR: PLANT TAXONOMY (4 credit)**

**Unit: I**

**Introduction to taxonomy**: taxonomy, systematics, classification; role of taxonomy in

biodiversity science; taxonomic impediment and global taxonomic initiative

**Unit: II**

**Approaches to plant classification**: artificial, natural and evolutionary approaches

(historical account); phenetics (principles, selection of characters, character x taxon matrix, similarity matrix, phenogram construction and classification); cladistics (concept, terminology, taxon and character selection, character analysis, cladogram construction and classification)

**Unit: III**

**Taxonomic characters and sources**: characters (kinds and criteria); sources(morphology, cytology, palynology, phyto-chemistry, molecular biology)**;** taxonomic categories (supra-specific, species &infra-specific); taxonomic hierarchy (structure & properties)

**Taxonomic tools and institutions**: herbarium (collection, preparation and role); botanicgarden (concept & importance); taxonomic literature (an overview); Botanical Survey of India (organization & role).

**Unit: IV**

**Plant identification**: methods of identification; dichotomous keys (kinds andconstruction); polyclaves (a brief account); cybertaxonomy (concept and scope), e-floras and e-herbaria

**Scientific nomenclature**: brief overview of various nomenclature codes - Viral,Bacteriological, International Code for Nomenclature of Cultivated Plants (ICNCP), International Code for Nomenclature of algae, fungi and plants (ICN); principles of ICN; type method (concept and kinds); author citation; effectiveand valid publication; basionyms and synonyms; homonyms; autonyms and tautonyms.

**Laboratory Exercises:**

* Preparation of herbaria of different types of leaves, flowers, inflorescences and fruits.
* Taxonomic description of various botanical families: Ranunculaceae, Brassicaceae, Fabaceae, Rosaceae, Malvaceae, Asteraceae, Apiaceae, Solanaceae, Poaceae, Liliaceae.
* Study of various placentation types.
* Comparative morphology of different species of a genus and different genera of a family.
* Construction of dichotomous keys for identification.
* Preparation of similarity matrix and construction of dendrograms.
* Preparation of character-taxon matrix and construction of cladograms.

**Bot-17102CR: MICROBIOLOGY, FUNGI AND PLANT PATHOLOGY**

**Unit I**

i.Eubacteria: Origin and evolution, diversity assessment and classification criteria; bacterial growth and nutrition, ultrastuctural details; types of reproduction; ecological and economic importance;

ii. Archaebacteria: general account, major types of archaebacteria (methanogens, extreme halophiles, extreme thermophiles); structural variations (comparison with eubacteria and eukaryotes); evolutionary significance

iii.Cyanobacteria: salient features, cyanobacterial symbiosis, endosymbiotic evolution, biological and ecological importance

**Unit** **II**

i. Fungi: general characteristics, cell ultrastructure; unicellular and multicellular organization; cell wall composition; nutrition (saprobic and biotropic); reproduction (vegetative, asexual and sexual ); heterothallism; heterokaryosis, parasexual life cycle; recent trends in classification of fungi

ii.Structural diversity and mode of reproduction in Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; Role of fungi with respect o food and medicine; mycorrhizae-types and role

**Unit** **III**

i. Viruses: general characteristics. Origin of viruses; chemical nature and ultrastructure.

ii. Replication, tansmission and isolation: replication (mechanisms of viral replication); difference between DNA and RNA viruses); transmission (ways and vectors); isolation and purification of plant viruses;

iii. Virus-like agents: virions, viroids and prions- concept, structural aspects and evolutionary importance; economic importance of viruses.

**Unit** **IV**

i.Plant Pathology- Introduction, definition of terms used in plant pathology; plant diseases: concept, nature and classification of plant diseases

ii. Symptoms, etiology, epidemiology and control of following plant diseases: paddy blast, powdery mildew of cucurbits, black stem rust, apple scab, peach leaf curl, damping off seedlings, black rot of crucifers, angular leaf spot of cotton, Cauliflower mosaic virus disease; Phytoplasma: general characteristics and role in causing plant diseases; use of fungi as biocontrol agents

**Laboratory Exercises**

1. Learning methods of sterilization and techniques of inoculation.

2. Preparation of culture media and aseptic transfer of pure cultures.

3. Differential staining of microorganisms to study their morphology and staining reactions.

4. Demonstration of the presence of nitrogen fixing organisms (*Rhizobium* sp.) in root nodules of legumes.

5. Morphological study and identification of the following representative members of fungi: *Perenospora, Albugo, Mucor, Rhizopus, Ustilago, Polyporus, Morchella, Sacharomyces, Aspergillus, Penicillium, Alternaria, Clletotrichum and Fusarium*

*6.* Preparation of fungal cultures of *Rhizopus, Mucor, Aspergillus, Penicillium, Trichoderma, Alternaria,Verticillium*

7. Sterilization methods (physical and radiation), Preparation of media (PDA, Soil extract Agar, Richards solution, peptone dextrose agar medium.

8. Symptomology and studies of some diseases of Plants: White rust, downy mildew, Powdery mildew, rusts, smuts, wilts, rice blast, apple scab, citrus canker, peach leaf curl, tomato mosaic virus, cauliflower mosaic virus.

**Bot-17103 CR: ALGAE AND BRYOPHYTA**

**Unit: I**

1. **Algae:** diverse habitats (terrestrial, freshwater, marine); thallus organization;evolutionary relationships; cell ultrastructure; reproduction (vegetative, asexual, sexual); criteria for classification of algae ( pigments, reserve food, flagella).

 **Unit: II**

1. **Origin of Bryophytes-** evolution of gametophyte and sporophyte

**Liverwort and Hornworts:** classification, morphology, anatomy and reproduction ofMarchantiales, Metageniales and Jungermanniales.

**Unit: IlI**

1. **Classification and salient features**: Protochlorophyta, Chlorophyta, Charophyta,Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

**Algal blooms**: causal factors and dynamics of freshwater algal blooms; physical andchemical means and bio-manipulation (top- down and bottom-up) for controlling nuisance blooms; role of phycoviruses in algal bloom control; algal bio-fouling of ships and its control.

**Unit IV**

1. **Hornworts:** classification, morphology, anatomy and reproduction of Anthocerotales.

**Mosses:** classification, morphology, anatomy and reproduction of Funariales,Sphagnales and Polytrichales,

**Bryophytes in bioindication:** direct and indirect biomonitoring**.**

Ecologicaland microbial importance of bryophytes

**Laboratory Exercises:**

* Morphological study of the representative members of Algae: *Anabaena, Nostoc,* *Pediastrum, Volvox, Hydrodictyon, Ulva, Clostridium, Chara, Botrydium, Enteromorpha, Padina, Bulbochaete, Ceramium* and *Batrachospermum*.
* Study of morphological, anatomical and reproductive structures of various bryophytes viz: *Riccia, Marchantia, Pellia, Porella, Anthoceros, Polytrichum,* *Andreaea, Bryum, Mnium* and *Funaria*.

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**DISCIPLINE CENTRIC ELECTIVE COURSES EACH WORTH 4 CREDITS**

**Bot-17104DCE: BIOSTATISTICS AND BIOTECHNIQUES**

**Unit: I**

**i. Data types and collection:** data types- 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.

**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.

**Unit: II**

**i. Sampling techniques:** principles and various steps in sample survey; procedures and practices involved in simple, systematic, stratified, cluster and multistage random sampling.

**ii. Biophysical methods:** concepts of spectroscopy, laws of photometry, Beer-Lambert's law, use of various spectroscopic techniques like UV-Visible, NMR, and Mass spectroscopy in biology

**Radio-labeling Techniques**: Properties of different radio-isotopes and their applications in biology, Safety guidelines.

**Unit: III**

**i. Testing of hypothesis:** basic concepts, procedure for hypothesis testing; test difference between two means (-independent and paired samples); test of proportions and test of goodness of fit.

**ii. Simple correlation and regression:** basic idea, scatter diagram, calculation of an estimated correlation coefficient, significance tests for correlation coefficients; simple linear regression- calculation of regression coefficient, standard errors and significance test.

**Unit: IV**

**i. Design and analysis of experiments:** principles of experimentation; experimental designs- layout, analysis of variance and comparison of treatments in completely randomized design, randomized complete block design and factorial experiments.

**ii. Chromatography:** principles and applications of paper, thin layer, column chromatography, HPLC, ion exchange, affinity and gas liquid chromatographic techniques;

**Electrophoretic and Centrifugation Techniques:** gel electrophoresis; ultra centrifugation

**BOT-17105DCE: MUSHROOM CULTIVATION TECHNOLOGY**

**Unit: I**

**Mushroom**: introduction; general morphology of mushrooms; magnitude of mushroomspecies; mushroom biology: components of applied mushroom biology: mushroom science, mushroom biotechnology and mushroom mycorestoration

**Nutritional and medicinal value of mushrooms**: poisonous and non-poisonousmushrooms; edible mushrooms and cultivation in India and world; Medicines from mushrooms; mushroom production and consumption; world mushroom development industry movements

**Unit: II**

**Mushroom cultivation technology**: steps in mushroom cultivation: compost: materialsused in composting and different formulation used in composting; compost preparation, methods of compost preparation

**Spawn**: definition, kinds of spawn, spawning and spawning technique, spawn running,post spawning management and handling during spawn running; equipment used for spawn production laboratory; Preservation and maintenance of mushroom culture

**Unit: III**

**Casing**: raw materials used for casing, preparation and sterilization of casing materials,qualities of an ideal casing material, care after casing, mushroom crop management: management at different stages of crop

**Pests and pathogens of mushrooms and their management**: management of pestsand diseases of button mushroom and Oyster mushroom; important sanitation during various stages of mushroom cultivation

**Unit: IV**

**Cultivation of important mushrooms**: general process for the cultivation of the whitebutton mushroom (*Agaricus bisporus*), the oyster mushroom (*Pleurotus sajor-caju*), paddy straw mushroom (*Volvariella* sp.), black ear mushroom (*Auricularia* sp.)

**Medicinal mushrooms**: general process for the cultivation of shitake mushroom(*Lentinus* sp.) and reishi mushroom (*Ganoderma lucidium);* harvesting, postharvest handling, preservation and processing of mushrooms, and marketing of mushrooms

**Laboratory Exercises:**

* Morphological studies and identification of the local mushroom flora and of preserved specimen of mushrooms
* Sterilization of media and glass ware, preparation of culture of some local mushroom fungal species
* Preparation of culture media/substrate: Potato dextrose agar(PDA), Rice bran medium**,** Richard’s solution, Grain spawn substrate, Sawdust spawn substrate, preparation of Agar slants
* Preparation of different types of compost and some compost formulations.
* Preparation of different types of spawns
* Cultivation procedures for Button mushroom and Oyster mushroom
* Picking and haunting of Mushrooms.
* Study of fungal pathogens and nematode pests of mushrooms

**BOT-17106DCE:** **MEDICINAL PLANTS AND HERBAL RESOURCE MANAGEMENT**

**Unit: I**

**History of herbal medicine**: documentary and archaeological evidences supporting thetraditional theme of plants as a natural herbal resource

**Herbal systems of medicine**: world scenario with emphasis on- concept, status andpotential at Regional, National and International level:

****European

****American

****African

****Chinese and Tibetan

****Unani

****Ayurvedic

****Sidhi

**Traditional usage of ethno-medicine in Jammu and Kashmir**: history, status andpotential

**Unit: II**

**Diversity and distribution** ofmedicinal plants (MP’s) in J & K

**Different threats:** causes and concerns of Kashmir Himalayan MP diversity

**Assessment of population status:** MP’s of J & K in accordance with IUCN guidelines

**Data collection**: methods, documentation and exchange, importance of threat assessmentof MP’s

**Unit: III**

**Commercial potential of** MP’s in Kashmir Himalaya

**Role of MP’s** in World pharmaceutical industry

**Assessment of** status of genetic diversity and its role in conservation of MP’S

**Linkage between traditional knowledge holders, policy makers and industry**: NGO’sand their role in commercialization of MP’s based on traditional knowledge

**Unit: IV**

**Spices and condiments**: medicinal aspects in relation to modern theme of herbalism **Economic valuation:** techniques used to estimate the monetary values and to educatethe tribals and locals for facilitating herbal medicine commercialization

**Bio-prospecting**: the systematic search for new sources of chemical compounds, genes,proteins, microorganisms that have potential medicinal value as a biotic resource

**Laboratory Exercises:**

* Studies on MP’s of Kashmir with respect to status, distribution pattern, adaptability and threats, if any
* Survey of various tribal areas of Kashmir valley to compile an inventory of important medicinal plant species of the region (name, local name, part used, uses, method of use, degree of popularity and precautions, if any)
* Assessment of resource allocation and resource partitioning of important MP’s of Kashmir Himalaya
* Assessment of reproduction biology as a means of domestication and conservation of MP’s
* Analysis of active components in relation to commercial usage of important MP’s of Kashmir
* Developing vegetative and sexual parametres for commercialization of important

MP’s of Kashmir

* Preparing a herbarium of atleast 30 important medicinal plants with all detailes related to habit, habitat, density and diversity and status

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**GENERIC ELECTIVE COURSES EACH WORTH 2 CREDITS**

**BOT-17001GE: PRINCIPLES OF GENETICS**

**Unit: I**

**Beginning of genetics:** cell cycle–mitosis and meiosis, difference between mitosis andmeiosis.

**Concepts of inheritance**- chromosomal theory of inheritance

**Mendel's laws of inheritance** - principle of segregation and independent assortment,concept of monohybrid and dihybrid cross

**Multiple alleles**- gene interactions (complimentary, duplicate, epistatic interactions **Concept of linkage**- sex linked traits.

**Structural and numerical changes in chromosomes** –brief concept

**Unit: II**

**Morphology and organization** of eukaryotic chromosome **Genetic material:** DNA as genetic material (experimental proof)

**Structure of DNA** (Watson & Crick model), mechanism of DNA replication (Semi-conservative).

**Concept of gene and allele**, euchromatin and heterochromatin, genetic code and itsproperties

**Gene mutations** –concept and types of point mutations, molecular basis of gene

mutation

**C-value paradox** and its significance.

**BOT-17002GE: URBAN ECOLOGY**

**Unit: I**

**Terrestrial urban ecosystems**: Urban green spaces meaning and types, composition anddiversity of vegetation in urban green spaces (Patterns and controlling processes) land use and surface cover as urban ecological indicators, urban soils characterization and biodiversity in small designed landscapes.

**Aquatic and wetland urban ecosystems**: Hydrology of urban environments, plantcommunities of urban wetlands and water bodies (Patterns and controlling processes) **Ecological processes and social drivers**: Human impact, spatial and meta-communityprocesses on biodiversity and community composition. Urban climate, urban impacts on global and regional sustainability.

**Unit: II**

**Types of ecosystem services:** Types of ecosystem services provided by urbanecosystems, global effects of urbanization on ecosystem services, role of ecosystem services in contemporary urban planning.

**Urbanization and citizen science**: public perception, social-ecological perspective onurban biodiversity.

**Approaches towards a sustainable city:** Multifunctional green infrastructure planningto promote ecological services in the city, building urban biodiversity through financial incentives, regulation and targets, conservation in an urbanising world.

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**OPEN ELECTIVE COURSES EACH WORTH 2 CREDITS**

**BOT-17001OE: BIOGEOGRAPHY(2 credit)**

**Unit: I**

**Fundamentals of biogeography:** historical perspective of biogeography; principles of biogeography;rules of biogeography; components of geographic template (climate, soil, aquatic environment)

**Geological processes**: theory of continental drift; plate tectonics; glaciation andbiogeographic responses.

**Ecological and evolutionary processes:** habitat and ecological niche; plant-animalassociations; speciation, diversification and extinction; dispersal (mechanisms, routes and barriers).

**Unit: II**

**Biogeographic patterns**: cosmopolitanism and endemism; disjunctions and relicts; rangesize and shape; species-area relationship; theory of island biogeography.

**Biogeographic classification**: terrestrial biomes; phytogeographic and zoogeographic realms; biogeographic classification of India.

 **Biodiversity**- definition, components and levels; magnitude ofbiodiversity; gradients in biodiversity (latitudinal, elevational); biogeographic surveys and monitoring.