DEPARTMENT OF ENVIRONMENTAL STUDIES

Category-I

SEMESTER - IV

BSC (H) ENVIRONMENTAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 10 (DSC-EVS-10): SYSTEMATICS AND BIOGEOGRAPHY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-EVS-10: SYSTEMATICS AND BIOGEOGRAPHY	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the principles and methods of systematic biology for determining evolutionary relationships among organisms
- Describe major biogeographic regions of the world and identify underlying factors responsible for their formation and evolution
- Familiarize with the different types of molecular and morphological characters used in systematic analysis
- Interpret phylogenetic trees constructed using molecular and morphological data in an evolutionary context
- Evaluate literature in systematics and biogeography and critically assess research questions and methods

Learning outcomes

After this course, students will be able to:

- Identify and classify different taxa using morphological and molecular characters
- Construct and interpret phylogenetic trees based on molecular and morphological data
- Analyze biogeographic patterns and use them to make inferences about evolutionary history

- Apply the principles and methods of systematics and biogeography to practical problems in conservation biology, ecology, and biotechnology
- Communicate effectively about the principles and methods of systematics and biogeography, and their applications to various areas of research and practice

SYLLABUS OF DSC-EVS-10

Theory (02 Credits: 30 lectures)

UNIT – I Concept, systematics approaches and taxonomic hierarchy (3 Week) (6 lectures)
Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; evidence from anatomy, palynology, ultrastructure, cytology, phyto-chemistry, numerical and molecular methods; taxonomy databases.

Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); categories and taxonomic hierarchy

UNIT – II Nomenclature and systems of classification (2½ Week) (5 lectures)
Principles and rules (International Code of Botanical and Zoological Nomenclature); ranks and names; types and typification; author citation; valid publication; rejection of names; principle of priority and its limitations; names of hybrids; classification systems of Bentham and Hooker; Angiosperm Phylogeny Group (APG III) classification.

UNIT – III Numerical and molecular systematics (1½ Week) (3 lectures)
Characters; variations; Operational Taxonomic Units; character weighting and coding; phenograms; cladograms; DNA barcoding; phylogenetic tree (rooted, unrooted, ultrametric trees); clades: monophyly, paraphyly, polyphyly; homology and analogy; parallelism and convergence.

UNIT – IV Biogeography, Speciation and extinction (3½ Week) (7 lectures)
Genes as unit of evolutionary change; mutation; genetic drift; gene flow; natural selection; geographic and ecological variation; biogeographical rules – Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species.

Types and processes of speciation – allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

UNIT – V Historical and ecological Biogeography (3½ Week) (7 lectures)
Earth's history; paleo-records of diversity and diversification; continental drift and plate tectonics and their role in biogeographic patterns – past and present; biogeographical dynamics of climate change and Ice Age.

Species' habitats; environment and niche concepts; biotic and abiotic determinants of communities; species-area relationships; concept of rarity and commonness; Island Biogeography theory; Equilibrium Theory of Insular Biogeography; geography of

diversification and invasion; phylogeography.

UNIT – VI Conservation Biogeography (1 Week) (2 lectures)
Application of biogeographical rules in design of protected area and biosphere reserves; use of remote sensing in conservational planning.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Construct and compare phylogenetic trees based on morphological and molecular data
2. Extract and quantify DNA from various organisms
3. Conduct PCR and amplify a specific gene using a target primer
4. Identify different taxa using morphological and molecular characters
5. Construct, analyze and infer phylogenetic trees based on molecular data by using software like PAUP*, RAxML, and MrBayes
6. Use and construct a phylogenetic tree based on morphological characters
7. Molecular Characters: Students should learn how to use molecular characters to construct a phylogenetic tree
8. Compare and contrast the anatomy of different organisms to understand their evolutionary relationships
9. Map and identify the distribution of organisms across the world and the factors that influence their distribution
10. Analyze the factors explaining biogeographic patterns of distribution of a target species using hypothesis of vicariance and dispersal
11. Estimate the timing of evolutionary events based on molecular clocks
12. Identify and analyze different biogeographic regions of the world and the unique flora and fauna found in each
13. Estimate divergence times between different lineages using molecular data

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Essential/recommended readings

- Baum, D. A., & Smith, S. C. (2013). Systematic Biology. John Wiley & Sons.
- Briggs, C. J. (2016). Biogeography: An ecological and evolutionary approach. Wiley-Blackwell.
- Cox, L. R., & Moore, P. D. (2010). Biogeography: An introduction to the study of plants and animals in time and space. Wiley-Blackwell.
- Heads, M. (2019). Biogeography and evolution. New Zealand. CRC Press.
- Lieberman, B. S., & Garland, R. L. (2020). Phylogenetic trees made easy: A how-to manual. Sinauer Associates.
- Lomolino, I., Riddle, B. R., & Whittaker, R. J. (2016). Biogeography: Principles and Practice. Sinauer Associates.

- Pressey, R. L., Anderson, M. B., & Groves, R. G. (2019). Systematic conservation planning. Oxford University Press.
- Wiley, E. H., & Lieberman, B. S. (2011). Systematics and evolution: Theory and practice. Wiley-Blackwell.

Suggestive readings

- Antonelli, A. (2019). Historical biogeography: An introduction. Princeton University Press.
- Dayrat, B. H. E. W. (2005). Phylogenetic systematics. University of Kansas Press.
- Guglielmino, A. G., & Barbujani, A. V. (2017). Biogeography: A natural science of human diversity. Cambridge University Press.
- Hennig, P. (1966). Systematics: A course of lectures. Columbia University Press.
- Nei, M., & Kumar, S. (2020). Molecular evolution and phylogenetics. Oxford University Press.
- Revell, L. V. (2020). Phylogenetic comparative methods: A guide for ecologists. Princeton University Press.
- Wiley, E. O. (2020). Phylogenetics: Theory and practice of phylogenetic systematics. John Wiley & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.