# POOL OF DISCIPLINE SPECIFIC ELECTIVES

**DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -1): Evolutionary Biology of Plants**

**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 | | |
| **Evolutionary Biology of Plants**<br><br>**DSE-1** | **4** | **2** | **0** | **2** | Class XII pass | **Nil** |

**Learning Objectives:**

- This course builds on the fundamental points introduced in the core course on Plant Diversity and Evolution and presents a synthesis of various theories, concepts, evidence and methods to study evolution.

**Learning Outcomes:**

At the end of this course the students will be able to:

- understand the essential theories in evolution
- differentiate between micro and macroevolution and the forces shaping evolution
- construct phylogenetic trees based on morphological and molecular data
- understand evolution of life.

**Unit 1: Historical Perspective of Eevolutionary Cconcepts** **4 hours**

Pre-Darwinian ideas, Lamarckism, Darwinism, Post-Darwinian era – Modern synthetic theory, Neo-Darwinism

**Unit 2: Origin of Life** **3 hours**

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Evolution of eukaryotes from pprokaryotes

**Unit 3: Evidences of Evolution** **4 hours**

Paleobiological– Concept of Stratigraphy and geological timescale; fossil study
Anatomical & Embryological – Vestigial organs; homologous and analogous organs (concept of parallelism and convergence in evolution)
Taxonomic –Transitional forms/evolutionary intermediates, living fossils
Phylogenetic – morphology, protein (Cytochrome C) and gene (Globin gene family) based

**Unit 4: Microevolution and Macroevolution** **8 hours**

Hardy Weinberg equilibrium; Founder effect, Natural and artificial selection. Levels of selection.

Inferring phylogenies- Gene trees, species trees; Patterns of evolutionary change; Adaptive radiation, Evolution and development (evo-devo); Biodiversity- Estimating changes in biodiversity; Taxonomic diversity through the Phanerozoic era.

**Unit 5. Forces of Evolution** **3 hours**

Mutation, Geneflow, Selection, Genetic Drift, Co-adaptation and co-evolution, Anthropogenic activities, Extinction (in brief)**-** Periodic and Mass-scale – Causes and events.

**Unit 6. Speciation** **4 hours**

Species concept, Modes of speciation – Allopatric; sympatric; peripatric; Patterns of speciation – Anagenesis and Cladogenesis; Phyletic gradualism and Punctuated eequilibrium (Quantum evolution); Basis of speciation – Isolating mechanisms.

**Unit 7. Evolution of Land Plants** **4 hours**

Origin of land plants – Terrestrial algae and Bryophytes; alternation of generations. Early vascular plants – Stelar evolution; Sporangium evolution; seed habit and evolution of seed. Angiosperms – Phylogeny of major groups.

**Practicals** **60 hours**

1. Study of different types of fossils, connecting links/transitional forms and Living fossils (Specimens/slides/photographs)
2. Sampling of quantitative characters (continuous and discontinuous) in a population(height, weight, number of nodes etc)
3. Study of adaptive strategies (colouration, co-adaptation and co-evolution); (Specimens/photographs)
4. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
5. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies
6. To study and interpret Phylogenetic trees (reading and using trees) - minimum of three examples.

**Suggested Readings:**


1. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
2. Ridley, M. (2004). Evolution. III Edn. Blackwell Pub., Oxford.
3. Hall, B. K., Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett.
4. Zimmer, C., Emlen, D. J. (2013). Evolution: Making Sense of Life. Roberts & Co.
5. Futuyma, D. (1998). Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
6. Barton, Briggs, Eisen, Goldstein and Patel. (2007). Evolution. Cold Spring Harbor Laboratory Press.
7. Nei, M., Kumar S. (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Futuyma, J. D., Kirkpatrick, M. (2017). Evolution, 4th Ed. Sinauer, Sunderland, MA: Sinauer Associates.

**DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -2): Biostatistics & Bioinformatics for Plant Sciences**

**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 | | |
| **Biostatistics & Bioinformatics for Plant Sciences**<br><br>**DSE-2** | **4** | **2** | **0** | **2** | Class XII pass | **Nil** |

**Learning Objective:**

- To train students in using computational and mathematical tools to solve biological problems.

**Learning Outcomes:**

At the end of this course students will be able to:

- use the various online databases and resources for accessing biological data.
- use the different methods of alignment of DNA, RNA and protein sequences and interpret the significance of the same.
- understand the descriptive and inferential statistical tests for interpretation of experimental data.

**Unit 1- Introduction to Bioinformatics** **3 hours**

Historical background; Aims and scope; Bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics; Applications of bioinformatics in crop improvement

**Unit 2- Biological databases** **4 hours**

Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (GenBank, PubChem, PubMed and its tools (only BLAST)), introduction to UniProt, PDB, PlantPepDB.

**Unit 3- Basic concepts of Sequence alignment** **4 hours**

Similarity, identity and homology. Concepts of alignment (gaps and penalty); Alignment – pairwise and multiple sequence alignments

**Unit 4- Molecular Phylogeny** **4 hours**

Introduction, methods of construction of phylogenetic trees: maximum parsimony (MP), maximum likelihood (ML) and distance (Neighbour-joining) methods.

**Unit 5- Introduction to Biostatistics** **2 hours**

Definition, Basics of descriptive and inferential statistics; Limitations and applications.

**Unit 6- Data and sampling methods** **3 hours**
Primary and secondary data; Sampling methods (in brief); tabulation and presentation of data.

**Unit 7- Measures and deviations of central tendencies** **4 hours**
Dispersion - range, standard deviation, mean deviation, standard error, skewness and kurtosis, quartile deviation –merits and demerits; Coefficient of variation.

**Unit 8-Correlation and Regression** **3 hours**
Correlation - types and methods of correlation (I. E. Karl Pearson and Spearman Rank method), Introduction to simple regression equation; similarities and dissimilarities between correlation and regression.

**Unit 9- Statistical tests** **3 hours**
Statistical inference - hypothesis – (simple hypothesis), student's t test, chi-square test.

**(Note: Numerical based questions of unit 7, 8 and 9 should be covered only in practical)**

**Practicals** **60 hours**

1. Biological databases (NCBI, UniProt, PlantPepDB)
2. Literature retrieval from PubMed
3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank and GenPept formats)
4. Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol)
5. Multiple sequence alignment (MEGA/Clustal omega)
6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega).
7. Calculation of standard deviation and coefficient of variation through manual calculation and using Microsoft Excel, using only ungrouped data)
8. Calculation of correlation coefficient values by Karl Pearson's /Spearman Rank methods (through manual calculation and using Microsoft Excel)
9. Student's t-test (using Microsoft Excel), chi square test (Manual and using Microsoft Excel)

**Suggested Readings:**


1. Ghosh, Z., Mallick, B. (2008). Bioinformatics – *Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2. Baxevanis, A.D., Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3. Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
4. Zar, J.H. (2012). Biostatistical Analysis, 4th edition. London, London: Pearson Publication.
5. Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

**Additional Resources:**


1. Pevsner J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
3. Mount, D.W. (2004). Bioinformatics: Sequence and Genome analysis 2nd edition, Cold Spring Harbor Laboratory Press, USA.
4. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning.
5. Khan, I.A., Khanum, A., Khan S., (2020). Fundamentals of Biostatistics, 6th edition. Ukaaz Publications, Hyderabad, India.


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