Introduction to Evolutionary Biology and Evolutionary Genetics

Department:	**Department of Zoology**
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Duration:	**90 hrs.**
Credits:	**3**

Course Fee: 4000 INR

Rationale

Evolution is a fundamental process that generates biological diversity from molecules to organisms. Evolutionary biology has been elevated from a controversial, esoteric topic of the past, and is now being applied to understanding the evolution of human health and disease. As such, every student of biology must understand what evolution is, why it occurs, and how it occurs to make sense of the diversity of life. Apart from educating students to answer these questions, this course is designed to foster critical thinking by specifically focusing on 1) evidence-based learning of evolution as a process and 2) hands-on training on how to study evolution using molecular and morphological information. Students will critically analyze and explore multiple case studies to learn how evolution informs our understand of organismal diversity as well as human health and disease.

Eligibility: 1, 2, and 3rd Year Biology students.

Course components

Theory of key topics.

Workshop on molecular analyses to study evolution.

Student project.

Course Objective

At the end of the course, students will be able to

1) Demonstrate what evolution is and explain the processes of evolution by providing multiple lines of evidence.
2) Demonstrate and differentiate between Natural selection and Sexual selection, and how they operate in populations.

3) Conduct literature search, develop valid hypothesis, gather, and analyze information to test hypotheses.
4) Gain an understanding of the fundamental principles of molecular evolutionary analyses through hands-on analyses of molecular data.
5) Construct phylogenetic trees for molecular systematics. Analyze molecular data to differentiate between adaptive evolution and neutral evolution.

Syllabus

Theory

Unit 1 – Understanding Evolution

A brief history of life. History of Evolutionary Thought. What is Evolution? How Scientists study Evolution – using evidence from multiple sources to understand the process of Evolution.

Unit 2 - Key Ingredient for Evolution

Why does evolution occur?

Mutations and Heritable Variation. Appreciating the variety and complexity of molecular variation.

Basic population genetics: Good, bad, neutral, and ugly mutations. Exploring the fate of mutations in populations. The importance of genetic variation in populations.

Case studies: Exploring mutations rates and variation in genes and genomes. How do we measure genetic diversity in populations?Why is genetic structure important in populations? Exploring disease variants and their frequencies across human populations.

Unit 3 - Natural Selection; struggle for survival.

What is Natural Selection and how does it work? Exploring paleontological, morphological, and molecular evidence. *Case studies:*Darwin's finches. Stickleback fish. Whales and dolphins.

How genes and environments interact to produce phenotypes. The importance of climate change on phenotypic evolution.

*Case studies:*Evolution of coat color in mice. Evolution of skin color and height in humans. Applying evolutionary genetics to discuss the misconception of Race in Humans.

Unit 4 - Sexual Selection; struggle for reproduction.

Why did sex evolve? What are the consequences of sex? What is sexual selection and how does it work? Evolution of Ornaments: Color and plumage in birds, e.g. the peacock's train. Evolution of Armaments: Deer antlers, canine teeth, male size. How sexual selection shapes genes and genomes.

Unit 5 - Speciation and macroevolution

How is biodiversity generated? Exploring the 'mother of all questions in biology'. Species concepts and evidence. Adaptive radiations. Scouring the genome for 'Speciation genes' – what have we found so far?

Unit 6 - Coevolution

Host-pathogen coevolutionary arms race. Tracing evolution of Ebolaand SARS, including SARSCov2 (Covid19) evolution.

Unit 7 - Human Evolution

Paleontological, Archeological, and molecular evidence.

Interactive Workshop (Practical)

Tracing evolution using molecules

Genomes contain signatures of the past. How do we uncover them? How did scientists construct the tree of life? An introduction to molecular systematics.

1. *Introduction to Tree-thinking.* A brief introduction to phylogenetics. Constructing morphological phylogenies and molecular phylogenies. Exploring SARSCov2 population structure.
2. *Not everything is adaptation* - Differentiating between adaptive and neutral evolution in genes and genomes. The utility of neutrally evolving genes in phylogenetics.

Student Project: List of topics will be provided. Students may seek permission for their own topic.

Course Evaluation:

Quizzes:	20%.	Quizzes on each topic.
Assignments:	20%.	Summarizing research papers. Critical evaluation of information.
Workshop:	20%.	Successfully completing workshop activities.
Project:	40%.	