Course title: Conceptual Foundations of Molecular Biology			
Course code: BBP 158	**No. of credits:** 2	**L-T-P:** 30-0-0	**Learning hours:** 30
Pre-requisite course code and title (if any): None			
Department: Department of Biotechnology			
Course coordinator(s): Prof. Ramakrishnan Sitaraman	**Course instructor(s):** Prof. Ramakrishnan Sitaraman		
Contact details: rkraman@terisas.ac.in			
Course type: Core	**Course offered in:** Semester 1		

Course description: The objective of this foundational course is to familiarize students of varied academic backgrounds (including non-biology degree holders) with the interdisciplinary knowledge that underlies molecular biology. The approach will not only ensure the transmission of this knowledge, but also emphasize the scientific method, creative thought processes, fortuitous discoveries and elegant experimental approaches that led to classic insights and discoveries in this field. The course will be taught with a special focus on the overarching framework of evolutionary theory that underlies all of biology. Original research articles, book excerpts and reviews highlighting seminal insights in the field will be discussed in detail. Finally, the value of this information will be underscored by a detailed description of instances of gene regulation.

Course objectives:

1. To provide students of varied backgrounds the history of ideas in, and the theoretical bases of molecular biology.
2. To highlight the interdisciplinary nature of major advances in molecular biology.
3. To present an overview of gene regulation.
4. To emphasize the importance of evolutionary theory in the understanding of biological phenomena.

Course contents

S.No	**Topic**	**L**	**T**	**P**
Module1	**The Importance of Evolutionary Theory to all Biology**			
	Early evolutionary ideas; Darwin, Mendel and the modern synthesis; symbiosis and evolution; natural selection across scales – from molecules to complex systems	3		
	Beyond dichotomies – evolution and molecular phylogeny, formulation of the three-domain system of classification by Woese and Fox, gene transfer and role of viruses in evolution.	3		
Module2	**The Development of Molecular Biology**			
1	Historical background The scientific method, vital force theory, classic experiments related to vital force theory and spontaneous generation	3		
2	Physico-chemical approach to biology The influence of *What is life* by Schrodinger on molecular biology	3		
3	The nature and mutability of the genetic material The chromosomal location of genes, DNA as the genetic material, DNA structure, semi-conservative replication of DNA, the Luria-Delbruck fluctuation test.	4		

4	The flow of genetic information The central dogma and its continuing relevance, sequence hypothesis, adaptor hypothesis, messenger RNA	4		
5	The physical nature and universality of Mendel's 'genes' Benzer's experiments on phage T4, the existence and nature of the triplet code	6		
6	Gene expression and control Positive and negative control of gene expression, considerations in the global regulation of gene expression	4		
	Total	**30**	**0**	**0**

Evaluation criteria:
Minor test 1 – 30% weightage
Minor test 2 – 30% weightage
Major test (end semester) – 40% weightage

Learning outcomes:
1. Understanding of essential evolutionary concepts and their application to molecular biology (Minor test 1, Minor test 2 and Major test).
2. Recognition of crucial advances in molecular biology based on model systems. (Minor test 2 and Major test).
3. Knowledge of different modes and levels of the regulation of gene regulation (Major test).
4. Critical analysis of primary scientific literature (Minor test 1, Minor test 2 and Major test).
5. Problem-solving skills (Minor test 1, Minor test 2 and Major test).

Pedagogical Approach:
Offline lectures emphasizing the detailed discussion of research/review articles from scientific journals in class.

Skill Set:
1. Design of molecular biology/genetic engineering experiments.
2. Critical analysis of molecular biology/genetic engineering experimental results.
3. Formulation of experimental strategies for molecular genetic studies of simple model organisms.

Employability:
1. Academic and industrial research involving molecular biology approaches.
2. Intellectual property firms.
3. Life science teaching at school and undergraduate levels.

Materials:
Required texts

1. E. Schrödinger. What Is Life? : The Physical Aspect of the Living Cell with Mind and Matter and Autobiographical Sketches (Cambridge University Press, Canto series, Cambridge, 11th reprint, 2004).
2. J.C. Herron, S. Freeman. Evolutionary Analysis. Pearson Education, India. ed. 5, 2013.
3. J. D. Watson, F. H. C. Crick. *Nature*, 3, 737-738 (1953).
4. M. Messelson, F. W. Stahl. *Proc. Natl. Acad. Sci. USA*, 44, 671-682 (1958).
5. F. H. C. Crick. *Nature*, 227,561-563 (1970).
6. F. H. C. Crick *et al. Nature*, 192, 1227-1232 (1961).
7. S. Benzer. *Proc. Natl. Acad. Sci. USA*, 45, 1607-1620 (1959).

8. S. Benzer. *Proc. Natl. Acad. Sci. USA*, 47, 403-415 (1961).
9. S. Brenner. *Proc. Natl. Acad. Sci. USA*, 43, 687-693 (1957).
10. S. Brenner *et al. Nature*, 190, 576-581 (1961).
11.G. W. Beadle, E. L. Tatum. *Proc. Natl. Acad. Sci. USA*, 27, 499-506 (1941).
12.O. T. Avery *et al. J. Exp. Biol.*, 79, 137-158 (1944).
13.S. E. Luria, M. Delbrück. *Genetics*, 28, 491-511 (1943).
14.B. Magasanik. *Proc. Natl. Acad. Sci. USA*, 97, 14044-14045 (2000).
15.C. R. Woese, G. E. Fox. *Proc. Natl. Acad. Sci. USA*, 74, 5088-5090 (1977).
16. T.H. Morgan. Sex-limited inheritance in Drosophila, *Science*, 32, 120-122 (1910).

Suggested readings

1. J. D. Watson., *et al.* Molecular Biology of the Gene. Pearson, Cold Spring Harbor, ed. 7, 2014.
2. B. Alberts, *et al.* Molecular Biology of the Cell. Garland Science, New York, ed. 5, 2008.
3. J. E. Krebs *et al.* Lewin's GENES XII. Jones and Bartlett Publishers, Inc., Burlington, ed. 12, 2017
4. T. H. Morgan *et al.* The Mechanism of Mendelian Heredity. Henry Holt and Company, New York, 1915.

Case studies
Websites
Journals
Other readings

Additional information (if any):

Student responsibilities:
1. Class attendance (online/offline).
2. Study/self-study of course materials as specified by the instructor.
3. Ensuring functionality of essential IT hardware & software at their preferred location(s).

Course reviewers:

1. Dr. Neel Sarovar Bhavesh, Group leader (equivalent to Professor), International Centre for Genetic Engineering and Biotechnology, Aruna Asaf Ali Marg, New Delhi – 110067, India.

2. Prof. Vijaya Satchidanandam, Department of Microbiology and Cell Biology, Indian Institute of Science, Bengaluru (superannuated) and Adjunct Professor, St. John's Medical College, Sarjapur Road, Bengaluru – 560034