Course title: Molecular Cell Biology: From Genes to Communities			
Course code: BBP 114	**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 2	

Course description:

This course will highlight the physiological versatility that underlies the ability of organisms to adapt to varying needs of their respective developmental stages, environmental stimuli and ecological niches. Advanced and contemporary themes in molecular and cell biology will be highlighted as indicated. The course is divided into three modules to facilitate the analysis of living systems at progressively more complex levels. This course will help students gain new knowledge in, and develop their own perspectives on the rapidly expanding field of modern biology.

Course objectives:

1. To present an integrative view of cellular processes at progressively complex levels.
2. To enable synthesis of isolated information in order to analyze biological phenomena in a contextually relevant manner.
3. To delineate the overarching role of evolutionary considerations at multiple levels of complexity.

Course contents

S.No	Topic	L	T	P
Module 1	**The genetic material**			
1	The evolution of complexity.	3	0	0
2	The dynamic nature of the genome Recombination, gene conversion, extrachromosomal elements, horizontal gene transfer, transposition, transduction, phase variation, DNA rearrangements and the vertebrate adaptive immune system	3	0	0
3	Epigenetics Epigenetic mechanisms of gene regulation, non-coding RNAs in gene regulation and cellular defence.	3	0	0
Module 2	**Cellular processes – from molecules to cells**			
1	Model organisms – overview of *E. coli*, *S. cervisiae* (yeast), *C. elegans*, *D. melanogaster*, and *A. thaliana*	2	0	0
2	Spatio-temporal gene regulation Molecular processes underlying the eukaryotic cell cycle,cell signalling and responses, regulatory networks and cross-talk between cellular pathways, protein secretion and localization.	5	0	0
3	A systems view of regulatory processes in biology. Types of regulatory mechanisms, bistabilty, intrinsic and extrinsic noise, synthetic biology.	3	0	0
Module 3	**Organisms to ecosystems**			
1	Microbial interactions Gene transfer, barriers to gene transfer, quorum sensing, host-microbe interactions, symbiosis and pathogenesis.	5	0	0
2	Microbial communities and the microbiota – an evolutionary-ecological synthesis. The self versus non-self recognition conundrum.	6	0	0
	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. Detailed knowledge of specific aspects of model living systems in consonance with topics in the outline (Minor test 1, Minor test 2 and Major test).
2. Ability to critically analyze and synthesize primary data to develop coherent models (Minor test 1, Minor test 2 and Major test).
3. Understanding implicit evolutionary arguments underlying the analysis of organisms from the genetic to community levels (Minor teset 1, Minor test 2 and Major test).

Pedagogical Approach:
Classroom 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 design and results.
3. Formulation of experimental strategies for molecular genetic studies of simple model organisms.
4. Analysis and design of complex regulatory networks.

Employability:
1. Academic and industrial research involving molecular biology approaches.
2. Intellectual property firms.
3. Life science teaching at school and undergraduate levels.
4. Management and/or supervision of laboratory research in academic/industrial settings.

Materials:
Required texts

1. J. D. Watson., *et al.* Molecular Biology of the Gene. Pearson, Cold Spring Harbor, ed. 7, 2014.
2. S. Brenner. *Phil. Trans. R. Soc. B*, 365, 207–212 (2010).
3. M. W. Gray *et al. Science*, 330, 920-921 (2010).
4. A. Rokas. *Nature*, 443,401-402 (2006).
5. T.D.P. Brunet, W.F. Doolittle. *Biol Philos* 33, 2 (2018). doi: 10.1007/s10539-018-9614-6.
6. I. R. Henderson, S. E. Jacobsen. *Nature* 447, 418-424 (2007).
7. V.L. Chandler. *Cell*, 128 (4), 641-645 (2007).
8. B. Alberts, *et al.* Molecular Biology of the Cell. Garland Science, New York, ed. 5, 2008.
9. D. G. Gibson *et al. Science*, 329, 52-56 (2010).
10. R.J. Hall, *et al*. *Front Microbiol* 11:1569. doi: 10.3389/fmicb.2020.01569 (2020).
11. J. -H. Hehemann et al. *Nature*, 464, 908-912 (2010).
12. N. C. Reading, V. Sperandio. *FEMS Microbiol Lett*, 254, 1-11 (2006).
13. O.P. Duddy, B.L. Bassler. *PLOS Pathogens* 17(1): e1009074. doi: 10.1371/journal.ppat.1009074 (2021).
14. E. K. Costello et al. *Science*, 336, 1255-1262 (2012)

Case studies

Suggested readings

1. J. E. Krebs *et al.* Lewin's GENES XII. Jones and Bartlett Publishers, Inc., Burlington, ed. 12, 2017

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. 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

2. Dr. S. Ramachandran, Chief Scientist, Professor of the AcSIR in the Faculty of Biological Sciences, Room 130, CSIR-Institute of Genomics and Integrative Biology, Mathura Road, Near Sukhdev Vihar Bus Depot
   New Delhi 110 025