Course title: Molecular Cell Biology – from Genes to Communities			
Course code: BBP114	**No. of credits:** 3	**L-T-P:** 28-14-0	**Learning hours:** 42
Pre-requisite course code and title (if any): BBP 151			
Department: Department of Biotechnology			
Course coordinator: Dr. Ramakrishnan Sitaraman	**Course instructor** Dr. Ramakrishnan Sitaraman		
Contact details: rkraman@teriuniversity.ac.in			
Course type: Core	**Course offered in:** Semester 2		

Course description:

Developing on the material presented in Conceptual Foundations of Molecular Biology (BBP 151), this course will highlight the biochemical 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 integrativeview 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
Module1	**The genetic material**			
1	Evolution at multiple levels Phylogeny and evolutionary relationships, the evolution of multisubunit molecular complexes.	3	1	0
2	A systems view of regulatory processes in biology. Types of regulatory mechanisms, the *lac* operon, sporulation in *B. subtilis*, bistabilty, intrinsic and extrinsic noise, the emergence of synthetic biology.	3	1	0
3	The dynamic nature of the genome Recombination, gene conversion, extrachromosomal elements, horizontal gene transfer, transposition, transduction, phase variation, the generation of antibody diversity.	5	1	0
4	Organellar genetics and epigenetics Chloroplast and mitochondrial genomes, cytoplasmic male sterility in plants, epigenetic mechanisms of gene regulation, non-coding RNAs in gene regulation and cellular defense (CRISPR/Cas systems).	3	2	0
Module 2	**Cellular processes – from molecules to cells**			
1	Model organisms and their utility for the study of cellular processes – overview of *E. coli*, *S. cervisiae* (yeast), *C. elegans*, *D. melanogaster*, and *A. thaliana* Insights from yeast as a model organism, the mating type switch as a model for cell polarization and differentiation, post-transcriptional mechanisms of gene regulation.	4	3	0
2	Spatio-temporal gene regulation The eukaryotic cell cycle, cell signalling and responses, regulatory networks and cross-talk between cellular pathways, protein secretion and localization.	5	3	0
Module 3	**Organisms and their interactions**			
1	Bacterial interactions	3	1	0

	Gene transfer, barriers to gene transfer (restriction enzymes and CRISPRs), quorum sensing, host-bacterial interactions (pathogenic and non-pathogenic).			
2	Microbial communities and the microbiota – an evolutionary-ecological synthesis	2	2	0
	Total	**28**	**14**	**0**

Evaluation criteria:

1. 2 minor tests : 30% each
2. 1 major test (end semester) : 40%

Learning outcomes:

1. Detailed knowledge of specific aspects of model living systems in consonance with topics in the outline.
2. Ability to critically analyze and synthesize primary data to develop coherent models.
3. Understanding implicit evolutionary arguments underlying the analysis of organisms from the genetic to community levels.

Pedagogical Approach:

Classroom lectures and tutorials, with a major emphasis on the detailed discussion of original research papers and 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. IPR firms.
3. Management and/or supervision of laboratory research in academic/industrial settings.

Materials:

Required text

Suggested readings

1. J. D. Watson., *et al.* Molecular Biology of the Gene. (Benjamin Cummins, Cold Spring Harbor, ed. 6, 2008).
2. D. G. Gibson *et al. Science*, 329, 52-56 (2010).
3. M. W. Gray *et al. Science*, 330, 920-921 (2010).
4. A. Rokas. *Nature*, 443,401-402 (2006).
5. R. Jensens *et al. Proc. Natl. Acad. Sci. USA*, 80, 3035-3039 (1983).
6. E. J. Parnell, D. J. Stillman. *PLoS Biol*, 6, e229 (2008).
7. M. P. Cosma. *EMBO Reports*, 5, 953-957 (2004).
8. J. M. Jansen *et al. J Cell Biol* 175, 755-766 (2006).
9. G. Tebb *et al. Genes Dev*, 7, 517-528 (1993)..
10. M. C. Gustin. *Microbiol Mol Biol Rev* 62, pp1264-1272 (1998).
11. G. W. Beadle, E. L. Tatum. *Proc. Natl. Acad. Sci. USA*, 27, 499-506 (1941).
12. I. R. Henderson, S. E. Jacobsen. *Nature* 447, 418-424 (2007).
13. S. Fujii, K. Toriyama. *Plant Cell Physiol*, 49, 1484-1494 (2008).
14. H. R. B. Pelham. *Phil Trans R Soc Lond*, 354, 1471-1478 (1999).
15. J. -H. Hehemann *et al. Nature*, 464, 908-912 (2010).
16. N. C. Reading, V. Sperandio. *FEMS Microbiol Lett*, 254, 1-11 (2006).
17. S. Raghavan *et al. Nature;* 454, 717–721 (2008).
18. E. K. Costello *et al. Science*, 336, 1255-1262 (2012).

Case studies

Websites

1. S. Brenner. The next 100 years of biology (Discovery Lecture delivered at the Vanderbilt University Medical Centre, September 14, 2006). http://www.mc.vanderbilt.edu/discoveryseries/speaker.html?sid=1

Journals

Other readings **Required reading** **Suggested readings**
Additional information (if any):
Student responsibilities: 1. Class attendance. 2. Study of course materials as specified by the instructor.

Course reviewers:

1. Dr. Rup Lal, Professor, Delhi University
2. Dr. Anjan Banerjee, Associate Professor, IISER, Pune