Semester	JAN 2022
Open to semester	6,8,12,14,22
Course code	**BI3444/BI6444**
Course title	**Genome Biology & Epigenetics**
Credits	4 /4
Course Coordinator & participating faculty (if any)	Krishanpal Karmodiya*, Kundan Sengupta
Nature of Course	Lectures
Pre-requisites	Introductory Biology
Objectives (goals, type of students for whom useful, outcome etc)	To introduce students to basics concepts in gene regulation, chromatin biology, genome-environment interaction, epigenetics and its applications in genomics and disease biology. The human genome sequence was released in 2003 and has paved the way for path breaking discoveries and brought unprecedented cutting-edge technological breakthroughs, which are enabling us to address the mechanistic underpinnings of genome organization and function. The goals of this course are: i) To introduce the recent and ongoing excitement in Genome Biology through a confluence of high-resolution imaging and genomics-based approaches. ii) This course would be useful to any student with an interest to understand the basic workings of our genomes and epigenomes and how recent findings are being applied using interdisciplinary approaches to address fundamental biology of normal and diseased cells. This is now paving the way for the diagnosis and treatment of complex human diseases such as cancers. An ability to design novel strategies and assays to harness the power of genomics to study both fundamental and applied questions in biology. The discussions will encompass biochemistry, bioinformatics, genomics, proteomics, computational biology and systems biology.
Course contents (details of topics /sections with no. of lectures for each)	Module:1: Biology of the nucleus – Nuclear envelope, Nuclear pore complexes (Nups), Nuclear bodies, nuclear speckles and their functional significance, Mechanobiology, Phase separation in the nucleus (8)

	Module:2: Advanced chromatin biology - Molecular Cytogenetics, FISH methods, Single molecule FISH (smFISH), Crispr based imaging, latest developments in high resolution chromatin imaging and its applications (10) Module:3: Structural Genomics: Chromosome conformation capture assays, 3C, 4C and Next Gen Sequencing and Hi-C to address chromatin organization and associations (6) Module:4: Functional Genomics: RNA Sequencing technologies, Chip-Seq, Transcriptomics, Proteomics, Epigenomics, Single cell omics technologies, Bioinformatics, Applications of systems & computational Biology in genomics (12) Module:5: Genome Biology & Disease: Inherited diseases,, Metabolomics, Stem cells & genomics, Cancer Genomics (4) Module:6:. In the nucleus, the genome is packaged by association with a number of basic proteins to form chromatin with nucleosomes as its repeating structural units. However, chromatin is highly heterogeneous at both micro and macro levels due to differential chemical modifications of DNA and histones, which can mark various functional states of chromatin. Distinct functional states ranging from 'highly active' to 'completely silenced' can be associated with specific nucleosome rearrangements, histone variants, histone post-translational modifications, and interactions of non-histone regulators. Module: 7: A dynamic scenario in which the environmental and cell-type specific signals can inflate the finite coding capacity of the genome into an epigenome with virtually infinite possibilities of combinations and regulation. Thus, chromatin structure has emerged as a key player in the transmission of heritable gene expression patterns. Mechanisms underlying the roles of epigenetic mechanisms in development, differentiation and complex diseases will be discussed using specific examples.
Evaluation /assessment	End-Sem Examination-40% Mid-Sem Examination-40% Others-20 % (Paper presentation and assignment)%
Suggested readings (with full list of authors, publisher, year, edn etc.)	1) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular Biology of the Cell, 5th Edition, 2007 (Sections: 1-3, Chapters: 1-8).

2) Gibson et al, Science 2 2010: 329, 52 – 56
3)http://cshperspectives.cshlp.org/cgi/collection/the_nucleus
4) Shivashankar GV Nuclear mechanics and genome regulation, Methods Cell Biol. 2010;98:xiii
5) Vorsanova SG et al Human interphase chromosomes: a review of available molecular cytogenetic technologies, Mol Cytogenet. 2010 Jan 11;3:1
6) Padilla-Nash HM et al Spectral karyotyping analysis of human and mouse chromosomes. Nat Protoc. 2006;1(6):3129-42
7) http://my5c.umassmed.edu/welcome/welcome.php
8) Metzker ML, 2010, Nature Reviews Genetics 11, 31-46
9) http://www.nature.com/omics/index.html
10) Finn EH, Misteli T. Molecular basis and biological function of variability in spatial genome organization. Science. 2019 Sep 6;365(6457). pii: eaaw9498. doi: 10.1126/science.aaw9498. Review.
11. Histone variants – ancient wrap artists of the epigenome. Talbert P. B. and Henikoff, S. Nat. Rev. Mol. Cell Biol., 2010 doi:10.1038/nrm2861
12. Divide and (epigenetic) rule: Chromatin domains as functional and structural units of genomes. Mishra RK and Galande S. Journal of Indian Academy of Sciences, Platinum Jubilee issue, 2009, pp 211-224.
13. The mammalian epigenome. Berstein et al., Cell 2007, 128: 669-681.
14. Linking DNA methylation and histone modification: patterns and paradigms. Cedar H, Bergman Y. Nat Rev Genet. 2009, 10(5):295-304.
15. Boundaries. Boundaries...Boundaries??? Lunyak VV. Curr Opin Cell Biol. 2008, 20(3):281-7.
16. Transgenerational Epigenetic Inheritance: Myths and Mechanisms. Heard E and Martienssen R, Cell 2014, 157(1):95–109.