Lahore University of Management Sciences

BIO 516 – Advances in Molecular and Cell Biology

Fall 2023-24

Instructor	Shaper Mirza & Zaigham Shahzad
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Course URL (if any)	

Course Teaching Methodology (Please mention following details in plain text)
Lecture based course with all in person lectures

Course Basics				
Credit Hours	Three (3)			
Lecture(s)	Nbr of Lec(s) Per Week	Two (2)	Duration	75 min
Recitation/Lab (per week)	Nbr of Lec(s) Per Week	One (1)	Duration-75 Min	Proteomics and phosphoproteomics case study (SM) Project presentation
Tutorial (per week)	Nbr of Lec(s) Per Week		Duration	

Course Distribution	
Core	Yes (for graduate Students)
Elective	No
Open for Student Category	Biology Minor and Major
Close for Student Category	Others

COURSE DESCRIPTION
This is an advanced course designed for incoming graduate students who wish to specialize in molecular biology. The first half of the course deals with basic concepts in molecular biology while the second half focuses on recent advances in molecular biology. Topics to be covered include DNA replication and repair, transcription, translation, regulation of gene expression in eukaryotes and prokaryotes.

COURSE PREREQUISITE(S)	
•	Molecular Biology
•	Cell Biology OR
•	Biochemistry

COURSE OBJECTIVES	
•	The course aims to:
•	▪ Solidify fundamental concepts of molecular biology
•	▪ Provide mechanistic details of cellular processes at the molecular level ▪ Impart recent developments in molecular biology ▪ Equip students with a holistic view of how different gears of the cellular machinery work together to keep a cell alive

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Learning Outcomes	
• • •	After taking this course students should: ▪ Be knowledgeable about various facets of molecular biology as it stands today ▪ Have a firm grasp of how different cellular processes work and respond to environmental factors at the molecular level ▪ Understand how signal transduction pathways work and how they influence cell structure as well as the overall intracellular milieu ▪ Develop a firm understanding of how gene expression is regulated in prokaryotes and eukaryotes ▪ Know some of the key questions in molecular and cell biology that remain unanswered

Grading break up: Component Details and weightages
Assignment(s): One assignment on a current problem in molecular and cell biology 5% Home Work: NONE Quiz(s): 4- 20% weightages Class Participation: 5% Attendance: Midterm Examination: 30% Paper review : 10% Final Examination: 35% (please add plain text)

Examination Detail	
Midterm Exam	Yes/No: Combine Separate: Duration: Preferred Date: Oct 27th Exam Specifications:
Final Exam	Yes/No: Combine Separate: Duration: Exam Specifications:

	COURSE OVERVIEW			
Week/ Lecture/ Module	**Topics**	**Instructor**	**Recommended Readings**	**Objectives/ Application**
Week 1	• DNA hereditary material, DNA structure/function • What are genes?	ZS	MCB, Lodish, 8th ed., chapter 5.1 & 8.1 Gerstein er al., (2007) Genome Research Genetics: A Conceptual	To develop understanding of Nucleic acid discovery, basic Structure, and equip students with understanding of chemical and physical nature of genes.

			Approach (pp 279-285)	
Week 2- **Quiz1**	• DNA packaging in prokaryotes and eukaryotes.	ZS	MGB, Watson, 7th ed., chapter 9 Massachio & Salmon, Nat. Rev. Mol. Cell Biol. 8:379 2007 Cheeseman & Desai, Nat. Rev. Mol. Cell Biol. 9:33, 2008 Hirano T, Genes Dev. 13:11-19, 1999	Present an overview of how DNA is packaged in different organisms. Complex process of DNA packaging in eukaryotes.
Week 3	• Morphology and functional elements of eukaryotic chromosomes • DNA replication and Nucleosome assembly post replication	ZS	MCB, Lodish, 8th ed., chapter 8.6 MGB, Watson, 7th ed., chapter 8 & 9 Almouzni and Cedar, 2016, Cold Spring Harb Persp Biol	Provide detailed understanding of chromosome morphology and functional elements. Present mechanistic details of DNA replication. Discuss recent advancement in histone synthesis transport and assembly of Role of Nucleosomes in regulation of DNA replication
Week 4 - **Quiz2**	• DNA mutability and repair • Homologous and site-specific recombination, mismatch repair.	ZS	MGB, Watson, 7th ed., chapter 10 & 11	Mechanistic insights into DNA damage repair mechanisms.
Week 5	• Gene transcription in prokaryotes. • Overview of gene transcription in eukaryotes.	ZS	MCB, Lodish, 8th ed., chapter 9.1 & 9.2	Provide detailed description of transcriptional control of genes in prokaryotes and present an overview of this process in eukaryotes.
Week 6	• RNA Pol II and general transcription factors • Regulatory sequences in protein coding genes.	ZS	MCB, Lodish, 8th ed., chapter 9.3 & 9.4	To develop a deep understanding of basal gene transcription in eukaryotes.
Week 7	• Molecular mechanisms of transcription repressors and activators including epigenetics regulation and long non-coding RNAs.	ZS	MCB, Lodish, 8th ed., chapter 9.5, 9.6 & 9.7	Provide detailed description of regulatory mechanisms influencing gene transcription.
Week 8-**Mid term**	• Small RNA and Long Non-coding RNA	SM	Molecular Biology of the gene Watson	Detailed discussion on smallRNA/lncRNA. Cross talk between two RNA and regulation of Oncogenesis
Week 9	• Translation • Translation overview prokaryotes (cap-independent) vs eukaryotes • Overview of Translation in eukaryotes • Non-AUG initiations • Translation and dysregulation and chronic diseases	SM	Pg 509-569 Pg 701-727 Molecular Biology of the Gene Watson Research papers	To understand the diversity and flexibility of processes of Translation in prokaryotes (in particular viruses) and eukaryotes Dysregulation in translation and associated mechanisms of disease.
Week 10- **Quiz 3**	• Post-translational modification and quality control in Rough endoplasmic reticulum	SM	Molecular Biology of Gene Watson and Research papers	• Objective is to develop deeper appreciation of post translational modifications and their role in biological functions.

	• Ubiquitin Network			• Lectures supported by current literature will also highlight challenges that are faced by cell biologist in analysis of post translational modification. • Use of proteomics in identification and mapping of post translational modifications . Understanding of the ubiquitin writes, erasers and readers.
Week 11-12 **Quiz 4**	• Protein Basics / Proteins at work • Protein Folding /Protein Evolution • Prions •	SM	Reading material will be provided in class. Research papers Review articles (Vijay Jayaraman,2022- Protein Sciences. Andreas Sebastian Bommarius 2008 protein science	To review basics of protein structure Discuss theories in Protein evolution Protein evolution, protein folding and function and form relationship To understand dominant principals of protein evolution using enzyme-substrate relationship as a model Introduction to PRIONS- the Dangerous Bend
Week 13-14	▪ Paper (Biochemistry 2006, 45, 14129-14139)/ • Paper (Nature 2000, 407, 477-483)	SM	Reading material will be provided in class Research articles and review papers	Classical papers on discovery of PRIONS Useful prions in both prokaryotic and Eukaryotic world Recent direction of research in PRIONs
Week 14-16	• Methods in Molecular and Cell Biology	SM	Lecture	

Textbook(s)/Supplementary Readings

- Molecular Biology of the Gene (MBG) (Watson et al. 2014 - 7th Edition).
- Molecular cell biology (MCB) (Lodish. et al. 2016 8th addition
- Genetics: A Conceptual Approach (Benjamin A. Pierce, 2012 – 4th edition)
- Research Papers will be provided in the class.
- Links to videos shown in class will be provided in the lecture power point