Lahore University of Management Sciences

Evolution (BIO 524)
Fall 2023

Instructors	**Zaigham Shahzad**
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Course URL (if any)	

Course Basics				
Credit Hours	**Three (3)**			
Lecture(s)	Nbr of Lec(s) Per Week	Two (2)	Duration	75 minutes
Recitation/Lab (per week)	Nbr of Lec(s) Per Week	none	Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week	none	Duration	

Course Distribution	
Core	No
Elective	Yes
Open for Student Category	Biology majors/Anyone interested
Close for Student Category	Others

COURSE DESCRIPTION
Evolutionary ideas link different fields of biology. This course provides an evolutionary context to understand biology. We will review the history of evolutionary thoughts, the forces of evolution, and the need for an extended evolutionary synthesis theory. We will also study the application of evolutionary studies to medicine and agriculture.

COURSE PREREQUISITE(S)	
	Students enrolled in this course are expected to have taken introductory level courses in biology.

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COURSE OBJECTIVES	
	The course aims to: ▪ Develop understanding of the major theories and hypotheses that have been proposed to describe the origin of life and the generation of biodiversity. ▪ Explain forces driving biological evolution. ▪ Illustrate the evidence supporting evolution. ▪ Show how evolutionary biology is related to other areas of biology.

Learning Outcomes	
	The course will enable students to: ▪ Accurately describe the concepts related to evolution, adaptation, and fitness. ▪ Explain the evolution of biological diversity at various levels of organization (gene to ecosystem). ▪ Understand the need of updating Modern Evolutionary Synthesis. ▪ Learn practical skills (constructing phylogenetic trees, calculating selection, finding fitness, quantitative genetics etc.). ▪ Work co-operatively as a member of a group to discuss future directions in evolutionary biology.

Grading Breakup and Policy
Midterm Examination: 25% Class participation and attendance: 5% Quiz: 20% Assignment(s): 20% Final Examination: 30%

Examination Detail	
Midterm Exam	Yes/No: Yes Combine/Separate: Combined Duration: 75 Minutes Preferred Date: 8th week Exam Specifications: Multiple choice, short question answers
Final Exam	Yes/No: Yes Combine/Separate: Combined Duration: 3 hours Exam Specifications: Short question answer

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COURSE OVERVIEW			
Weeks	**Topics**	**Recommended Books**	**Recommended papers**
Week 1	▪ **Introduction to the course** ▪ **How to study evolution**	**Book A: chapter 1**	
Week 2	▪ **History of evolutionary ideas** ▪ **Darwin's evolutionary theory**	**Book A: chapter 2**	
Week 3	▪ **Evidence supporting biological evolution** ▪ **Mendelian genetics & DNA as hereditary material**	**Book B: chapter 11** **Book C: chapter 3**	
Week 4	▪ **Modern synthesis of evolution** ▪ **Forces of evolution (Mutation)**	**Book A: chapter 5**	Mutation bias reflects natural selection in Arabidopsis thaliana. Monroe et al., Nature 602, 101–105 (2022). https://doi.org/10.1038/s41586-021-04269-6.
Week 5	▪ **Forces of evolution (Natural & artificial selection, Genetic drift, & Gene flow)** ▪ **Forces of evolution (Natural & artificial selection, Genetic drift, & Gene flow)**	**Book A: chapter 6** **Book A: chapter 13** **Book A: chapter 4**	Local adaptation and ecological differentiation under selection, migration, and drift in Arabidopsis lyrate. Hämälä et al., 2018. Evolution. 72(7):1373-1386. The effects of migration and drift on local adaptation to a heterogeneous environment. Blanquart et al., 2012. J. Evol. Biol. 25:1351–1363. Establishment and maintenance of adaptive genetic divergence under migration, selection, and drift. Yeaman et al., 2011. Evolution. 65:2123–2129.
Week-6	▪ **Forces of evolution (Natural & artificial selection, Genetic drift, & Gene flow)** ▪ **Quiz**	**Book A: chapter 6** **Book A: chapter 13** **Book A: chapter 4**	Local adaptation and ecological differentiation under selection, migration, and drift in Arabidopsis lyrate. Hämälä et al., 2018. Evolution. 72(7):1373-1386. Establishment and maintenance of adaptive genetic divergence under migration, selection, and drift. Yeaman et al., 2011. Evolution. 65:2123–2129.
Week 7	▪ **History in our genes** ▪ **Evolution in action- quantitative genetics**	**Book A: chapter 9** **Book A: chapter 7**	A potassium-dependent oxygen sensing pathway regulates plant root hydraulics. Shahzad et al., Cell. 2016. 167(1):87–98. Cryptic variation in RNA-directed

			DNA-methylation controls lateral root development when auxin signaling is perturbed. Shahzad et al., Nature Communications. 2020. 11:218.
Week 8	▪ **Mid-term exam** ▪ **The evolution of genome size**	**Book D: chapter 1** **Book D: chapter 2**	Genome size evolution: towards new model systems for old questions. J. Blommaert. The Proceedings of the Royal Society. 2020. https://doi.org/10.1098/rspb.2020.1441.
Week 9	▪ **Transposable elements** ▪ **Small-scale gene duplications**	**Book D: chapter 3** **Book D: chapter 5**	Ten things you should know about transposable elements. Bourque et al., Genome Biology. 2018. 19, 199. https://doi.org/10.1186/s13059-018-1577-z.
Week 10	▪ **Large-scale gene duplications** ▪ **Evolutionary fates of gene duplicates**	**Book D: chapter 6**	The Evolutionary Fate and Consequences of Duplicate Genes. Lynch M. and Conery J.S. Science. 2000. 290: 1151-1155.
Week 11	▪ **Polyploidy in plants and animals** ▪ **Quiz plus assignment**	**Book D: chapter 7** **Book D: chapter 8**	Plant Polyploidy: Origin, Evolution, and Its Influence on Crop Domestication. Kang et al., Horticultural Plant Journal. 2019. 5(6): 231-239. https://doi.org/10.1016/j.hpj.2019.11.003. Polyploidy: A Biological Force from Cells to Ecosystems. Fox et al., Trends in Cell Biology. 2020. 30(9): 688-694. https://doi.org/10.1016/j.tcb.2020.06.006.
Week 12	▪ **Beyond DNA sequence variation (DNA methylation and histone modifications)** ▪ **Epigenetics and evolution**		Epigenetic modifications in plants: an evolutionary perspective. Feng S. and Jacobson S.E., Curr Opin Plant Biol. 2011, 14(2):179-86. doi: 10.1016/j.pbi.2010.12.002. Epigenetic inheritance and plant evolution. Miryeganeh M. and Saze H., Population Ecology. 2020. 62(1) doi.org/10.1002/1438-390X.12018. Epigenetic inheritance mediates phenotypic diversity in natural populations. Shahzad et al., 2022. bioRxiv, https://doi.org/10.1101/2021.03.1

			5.435374.
Week 13	▪ **Applications of evolutionary biology in medicine** ▪ **Applications of evolutionary biology in agriculture**		The great opportunity: Evolutionary applications to medicine and public health. Nesse R.M. and Stearns S.C., Evolutionary Applications. 2008. 1(1):28-48. doi: 10.1111/j.1752-4571.2007.00006.x. Evolution in agriculture: the application of evolutionary approaches to the management of biotic interactions in agro-ecosystems. Thrall et al., Evolutionary Applications. 2011. 4(2): 200-15. doi: 10.1111/j.1752-4571.2010.00179.x.
Week 14	▪ Student presentations		

Textbook(s)/Supplementary Readings

A) Evolution: Making sense of life. C. Zimmer and D. Emlen. ISBN: 978-1-936221-55-4.
B) Concepts of Biology. S. Flower, R Roush, and J. Wise. ISBN-13: 978-1-938168-11-6.
C) Genetics: A conceptual approach. Benjamin A. Pierce. ISBN-13: 978-1-4292-3250-0.
D) The Evolution of the Genome. T. Ryan Gregory. ISBN: 0-12-301463-8.