جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Contemporary Topics in Bioscience - B 394B

Division	Biological and Environmental Sciences & Engineering Division
Course Number	B 394B
Course Title	Contemporary Topics in Bioscience
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	05:30 PM - 07:00 PM | Sun Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Lukasz Jaremko	LUKASZ.JAREMKO@KAUST.EDU.SA			To be estimated upon request.

Teaching Assistant(s)

Name	Email
N/A	N/A

Course Information

Comprehensive Course Description	This course aims at deepening the understanding of the synergism among the contemporary structural biology high-resolution techniques, i.e. high-resolution multidimensional nuclear magnetic resonance (NMR) spectroscopy and single crystal X-ray crystallography and cryogenic electron microscopy (cryoEM). The course introduces students to the modern concepts of biomacromolecular dynamic structures, molecular mobility, thus their functioning and dynamic integrated structural biology. The contemporary high-resolution biophysical techniques used to study the biomacromolecular matter in the different forms, solutions, precipitates, aggregates, phase-separated entities, hydrogels, etc. will be widely discussed and analysed in terms of current cutting edge spectroscopic techniques and prominent examples from the literature and ongoing own studies at the university.
Course Description from Program Guide	
Goals and Objectives	Students will recognize the importance of modern dynamic integrated approaches in structural biology that allow to decipher the biomacromolecular function and connect it directly to the molecular architecture and move towards applications, e.g. drug design, metabolomics, protein engeniering, medical diagnostics. Students will govern the technical and practical knowledge to design, set up and run the advanced bioNMR expriments on their samples, integrate them with results coming from X-ray crystallography and cryoEM. Setudents will learn how to prepare the valuable biomaterial for their studies and make decisions of the labeling strategies and spetroscopic techniques selection that will yield answers for their research specific questions. Students will learn basics of pulse programming and setting up their own NMR experiments on the top-end NMR spectrometers.
Required Knowledge	Advanced knowledge in Chemistry, Physics and substantiall interest in biomacromolecules, proteins and nucleic acids. Solid bases with Linux environment.

Reference Texts	Positions in **BOLD** are mandatory and constitute the integral core of the course. **Structural Biology: Practical NMR Applications 2nd ed. 2013 Edition** by Quincy Teng Single-particle Cryo-electron Microscopy: The Path Toward Atomic Resolution/ Selected Papers Of Joachim Frank With Commentaries (Series in Structural Biology) by Joachim Frank, Nuclear Spin Relaxation in Liquids: Theory, Experiments, and Applications, Second Edition 2nd Edition by Jozef Kowalewski , Lena Maler **A Primer of NMR Theory with Calculations in Mathematica 1st Edition** by Alan J. Benesi **NMR: THE TOOLKIT: How Pulse Sequences Work (Oxford Chemistry Primers) 2nd Edition** by Peter Hore , Jonathan Jones , Stephen Wimperis Protein NMR Spectroscopy: Principles and Practice 2nd Edition by Arthur G. Palmer III, Wayne J. Fairbrother, John Cavanagh, Nicholas J. Skelton, Mark Rance Structure And Mechanism In Protein Science: A Guide To Enzyme Catalysis And Protein Folding (Series in Structural Biology) Reprint Edition by Alan R Fersht Textbook of Structural Biology (Series in Structural Biology) 2nd Edition Edition by Anders Liljas, Lars Liljas, Miriam-Rose Ash, Göran Lindblom, Poul Nissen, Morten Kjeldgaard **Isotope Labeling of Biomolecules – Labeling Methods, Volume 565 (Methods in Enzymology) 1st Edition** by Zvi Kelman (Editor) **Isotope Labeling of Biomolecules – Applications, Volume 566 (Methods in Enzymology) 1st Edition** by Zvi Kelman (Editor) Protein NMR Techniques (Methods in Molecular Biology) 3rd ed. 2012 Edition by Alexander Shekhtman (Editor), David S. Burz (Editor) NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry 3rd Edition by Harald Günther Practical Nuclear Magnetic Resonance Relaxation for Chemists 1st Edition by Vladimir I. Bakhmutov NMR Spectroscopy in Inorganic Chemistry (Oxford Chemistry Primers) 1st Edition by Jonathan A. Iggo
Method of evaluation	**100.00**% - Final exam
Nature of the assignments	Practical exam with the NMR spectometer and biomacromolecular sample.
Course Policies	All lectures/trainings are mandatory to attend.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Sun 08/26/2018 Thu 08/30/2018	Principles of classical biomacromolecular structures: proteins, nucleic acids, lipids and all "hybryds". Molecular and statistical thermodynamics
2	Sun 09/02/2018 Thu 09/06/2018	*Omne trinum perfectum* - NMR, X-ray, cryoEM - why and when to use all of that?
3	Sun 09/09/2018 Thu 09/13/2018	Stable isotopes and isotope labelling strategies for small, medium sized and large macromolecular assemblies.
4	Sun 09/16/2018 Thu 09/20/2018	Classical NMR - from Bloch equations to 1D specrum, chemical structure and dynamics and...
5	Sun 09/23/2018 Thu 09/27/2018	Quantuum NMR - from Schroedinger equation to single and multiple coherences
6	Sun 09/30/2018 Thu 10/04/2018	NMR spectrometer - what is inside and how does it work?
7	Sun 10/07/2018 Thu 10/11/2018	Pulse programing and several useful 1D experiments, like how to supress the water resonance and decouple spins?
8	Sun 10/14/2018 Thu 10/18/2018	Multidimensionality of NMR experiments, how to? What for? Practical and applications of 2D spectroscopy. COSY, TOCSY, NOESY, ROESY.
9	Sun 10/21/2018 Thu 10/25/2018	Heteronuclei, adding another dimension - triple resonance 3D and 4D experiments for sequence specific resonance assignment of proteins and J-coupling measurements and applications.
10	Sun 10/28/2018 Thu 11/01/2018	Resonance assignment of proteins below 20 kDa, up to 30-40 kDa and beyond. Yes, we can!
11	Sun 11/04/2018 Thu 11/08/2018	Structure calculations, molecular dynamics, defining the various experimental NMR constraints, integration of NMR, X-ray, cryoEM data sets - examples. Validation of the structural models.
12	Sun 11/11/2018 Thu 11/15/2018	Spin relaxation in solution - principles
13	Sun 11/18/2018 Thu 11/22/2018	Pulse programs to detect various relaxation observables for small <15 kDa and larger systems. Scope and practical aspects.
14	Sun 11/25/2018 Thu 11/29/2018	Spin relaxation data analysis - revealing the biomacromolecular dynamics, thus functioning.
15	Sun 12/02/2018 Thu 12/06/2018	Towards the 4D dynamic structural biology - struture with dynamics as the only way to reveal the biomolecular mechanisms of action
16	Sun 12/09/2018	Final Exam

Note

The instructor reserves the right to make changes to this syllabus as necessary.