

TIGP - CBMB

1142 Semester

Experimental Molecular Biophysics

實驗分子生物物理學

Time: 2:00 pm ~ 5:00 pm on Tuesdays

Place: R123, the Institute of Molecular Biology, Academia Sinica

Credit: 3 credits

Coordinator: Dr. Wei-Yuan Yang

Instructors:

Dr. Hsin-Yung Yen (IBC), hsinyungyen@as.edu.tw

Dr. Shang-Te Danny Hsu (IBC), sthsu@as.edu.tw

Dr. Su-Chang Lin (GRC), tomlin@as.edu.tw

Dr. Wei-Yuan Yang (IBC), weiyang@as.edu.tw

TA: Chia Yee Goh, goh0002@as.edu.tw

Perspective:

A holy grail in biology is to modulate the functions of bio-molecules. For example, one wants to design small compounds to perturb the form and activities of bio-molecules for disease intervention (*e.g.*, inhibition of protein aggregation for treating neurodegenerative diseases). These pursuits will not be possible without proper knowledge (*e.g.*, structure, function, composition, interactome, localization) of the bio-molecules at hand. This course will give you a first-hand look at the many biophysical techniques that allow you to characterize your biomolecule of interest through lectures, facility visits, hands-on sessions, and designed presentations.

Grading scheme:

25% for each module (Details will be announced at each module)

- ◆ Topic A: Mass Spec
 - ◆ Class participation: 15%
 - ◆ Presentation: 10%
- ◆ Topic B:
 - ◆ Attendance accounts for 2 pt per class (8 pt in total)
 - ◆ Quiz account for 5 pt (two quizzes will take place in the second and last week of part B)
 - ◆ Data analysis accounts for 3 pt per class (12 pt in total)
- ◆ Topic C: Crystallography
 1. Accomplishments in hands-on training and finish the oral presentation in the week 4: a max of 5 of final grade/week

2. Responding to teacher's questions: a max of 1 of final grade/week
3. Hard worker or good results in hands-on training: a max of 1 of final grade
4. No-shows get 3 of the final grade/week. (You will not have a second chance)
5. COVID, RSV, or Flu positive (Please do not come. You need a proof.) get 5 of final grade for that week.

- ◆ Topic D: Imaging
 - ◆ 15% in-class participation
 - ◆ 5% quiz
 - ◆ 5% oral presentation

Attendance:

Students who need to take leave should contact the course TA and the program secretary, Ms. Vicki Huang (vicki0315@as.edu.tw) with proper reason and proof before the lecture starts. If not, will be considered an unexplained absence and may cause a deduction from the grade.

Schedule

Date	<p>Topic A: Mass Spec</p> <p>The goal of this module is to introduce the principle of mass spectrometry (MS) and the progress made in technological development. The application of MS for a range of biology/pharmaceutics studies and its emerging utility in investigating protein structures and dynamics will be further discussed.</p>	Instructor
2/24	D1: History and basis of mass spectrometry	Dr. Hsin-Yung Yen
3/3	D2: The application of mass spectrometry in “mocis” studies	
3/10	D3: State-of-the-art mass spectrometry in investigating structural and dynamical property of protein molecules	
3/17	D4: Student presentation	
Date	<p>Topic B: Molecular spectroscopy & light scattering</p> <p>Teaching design: Hands-on tutorial of data processing will require the use of personal computers/laptops. Real sample measurements will be covered in UV-Vis, CD and fluorescence spectroscopy.</p>	Instructor

3/24	<p>B1: UV-Vis spectroscopy & circular dichroism (CD) spectroscopy</p> <p>Absorbance spectroscopy can be used to determine biomolecular concentrations based on Beers Law. It is an essential technique to define the quantity (and purity) of your samples of interest. CD spectroscopy provides quantitative measures of molecular chirality. We shall discuss how basic UV-Vis spectroscopy is used to analyze protein samples and how CD spectroscopy can be used to define the higher order structures, eg, secondary structures in proteins.</p>	Dr. Shang-Te Danny Hsu
3/31	<p>B2: Intrinsic and extrinsic fluorescence spectroscopy</p> <p>Fluorescence spectroscopy is exquisitely sensitive to molecular structures around the chromophores. It is routinely used to probe molecular structures at an ensemble and single molecule levels. We shall discuss different applications of intrinsic and extrinsic fluorescence spectroscopy are applied to characterize molecular structures under equilibrium and in a time-resolved manner.</p>	
4/7	<p>B3: Nuclear magnetic resonance (NMR) spectroscopy</p> <p>NMR spectroscopy is fundamental in molecular structure determination, ranging from chemical structure configurations to three dimensional structures. It is particularly powerful in elucidating molecular dynamics and interactions at atomic resolution. We shall cover the basics of NMR spectroscopy and its applications in studying biomolecular structures and dynamics.</p>	
4/14	<p>B4: Dynamic light scattering (DLS), static light scattering (SLS) and small-angle X-ray scattering (SAXS)</p> <p>DLS, SLS and SAXS are different tools to examine molecular sizes. When coupled with UV-Vis and refractive index analysis, multiangle static light scattering (MALS) can further dissect the molecular composition of protein conjugates such as PEGylation, glycosylation or lipid/nucleic acid binding. Additionally, SAXS can provide molecular structure envelope details at nm resolution. We</p>	

	shall cover the basic principles of these light scattering techniques and how they can be integrated into the structural biology toolkit.	
Date	Topic C: Crystallography This module is to lecture on the techniques for single-crystal X-ray diffraction and limitations. We will also use lysozyme as a model protein to go through the steps from protein crystallization to X-ray data collection.	Instructor
4/21	C1: Protein crystallization Hands-on training: Hanging-drop protein crystallization	Dr. Su-Chang Lin
4/28	C2: Why X-ray crystallography? Hands-on training: Crystal mounting	
5/5	C3: Principle of X-ray diffraction Hands-on training: Manual X-ray diffraction	
5/12	C4: How X-ray crystallography may help your research? (Student presentation)	
Date	Topic D: Imaging This module will take you into the world of bio-imaging. We will help develop your intuition on bio-imaging, show you what microscopes there are on campus, and go through various imaging tricks that can help advance your research.	Instructor
5/19	A1: (A) Why imaging? (B) Contrast mechanisms.	Dr. Wei Yuan Yang
5/26	A2: (A) Resolution. (B) Intro to the many types of fluorescence microscopes (Hands-on session: using a confocal microscope).	
6/2	A3: (A) Optical-control of biomolecules. (B) Inside image quantification (Hands-on session: playing with ImageJ. //personal laptop required)	
6/9	A4: Case study: Expansion microscopy (in class quiz; short student presentations)	