Chemistry 306 Spring, 2020 Course Guidelines

Flight Crew: Daniel Graham, Nick Kaley

DG: Flanner Hall Room 401, phone: 1-773-508-3169; dgraha1@luc.edu
AP: Flanner Hall Room 428, phone:1-773-508-2883; aorlof@luc.edu
GMR: Flanner Hall Room 106; gmartinezrameriz@luc.edu
NK: Flanner Hall Room 106; nkayley@luc.edu

Lab Times: T 0830 – 1220; Th 0830 – 1220; F 0830 – 1220; F 1340 – 1730. Four Sections!

Places: Flanner Hall Basement Biochemistry Lab. Some experiments will transpire in Flanner 315, the NMR Lab, and the Quantitative Analysis Lab.

DG Office Hours: T 1230– 1330; Th 1230 – 1330, or by arrangement.
AP Office Hours: M 1115 – 1220, or by arrangement

This course introduces techniques and analysis central to experimental biophysical chemistry. We will pursue the following activities over the semester:

(1) Information and Experimental Data. Information is the fruit of all biophysical inquiry, procedure, and experiment. Fundamental principles of information will be illustrated via electronic logic gates, radiometric functions, spectroscopy, genomic and protein sequence analysis.

(2) Information and Uncertainty. Experimental data invariably arrives with nagging Qs about uncertainty and reproducibility. This lab will focus on strategies for making the most of the imperfect situations imposed by analogue information. Principles and applications to biophysical chemistry will be illustrated via phase transition kinetics, electrochemical potentials, and reverse mitosis.

(3) Information and Models. Biophysical experiments and data are invariably complex. Models help us to sort through the complexity and illuminate the takeaways—or at least identify the most important Qs. Thermometric devices, Brownian motion and processing will be at center stage to illustrate time-honored models and applications.

(4) Analogue Information and Accumulation. Acquisition of biophysical information is not a one-and-done process. Rather it is highly accumulative over space and time. This lab will focus on techniques of experimental integration and differentiation. Applications will include thermodynamic isotherms, Monte Carlo techniques, electronic-vibrational spectroscopy, and electron paramagnetic resonance (EPR).

(5) Techniques and applications of Fourier spectral analysis. Biophysical structure data, e.g. X-ray diffraction, arrive in alternate domains. The data need to be "translated" into information we can understand. This requires experience and facility in Fourier spectral analysis. Two lab meetings will be devoted to Fourier principles, noise color analysis, infrared and laser light diffraction.

(6) Experimental measurements of π. The number 3.1415…. enters science in countless places, biochemistry matters included. And we usually take its value for granted. For this lab, the *transcendental* number π will be measured five or more ways. We will celebrate π-Day in the process!

(7) The growth of diffraction-grade protein crystals. The 3D structures of folded proteins are essential to biophysical chemistry. However, the structures can only be accessed by X-ray or neutron diffraction if crystalline order is imposed upon proteins. This lab focuses on the art and science of "growing" diffraction-grade protein crystals. It is not easy!

(8) Principles and applications of magnetic resonance. Magnetic resonance is the most powerful biophysical structure tool alongside X-ray diffraction. This lab will focus on Fourier transform *nuclear* magnetic resonance (NMR). Steroids and water molecules will be the systems of interest. This lab will echo and practice principles of the two Fourier analysis labs.

(9) Information, Protein Folding, and the Anfinsen Hypothesis. Anfinsen famously proposed that the primary structure of a protein contains the information required for folding and biological activity. This experiment dwells on a globular protein's capacity to refold given favorable electrolyte and thermal environment. Proteins unable to "fold on their own" require chaperones for assistance—other types of proteins.

(10) Principles and applications of phase transition order and kinetics. This lab focuses on the fluidity properties of model membrane systems. Such properties are essential to membrane structure and the transport of ions and proteins across membranes. We will examine melting and freezing thermodynamics of select systems.

(11) Protein-Ligand Interactions. This lab focuses on the affinity of globular proteins for select ligands. Almost all drugs of modern day are protein inhibitors. However, a given drug can "target" more than one protein, giving rise to deleterious side effects. This lab directs modern qPCR techniques to globular proteins and ligands to assess protein-ligand specificity.

Course Structure:

Chemistry 306 will consist of experiments, analysis, and oral and written presentations. Consultations with the flight crew will part of every lab meeting. Lab quizzes will transpire at the start of four meetings early in the semester. A mid-term exam will occupy one lab meeting. One meeting will focus on the measurement of π and celebration of π–Day. The last several meetings will concentrate on protein crystal growth, magnetic resonance, protein folding and unfolding, protein-ligand affinity, and the phase transitions of model membrane systems. To close the semester, a research-format paper will be written by each student on the experiment of his or her choice.

Students will work individually and in pairs. Teams are fluid throughout the semester. Work with people you like!

If you have a laptop computer and flash drive, please bring them to lab meetings. These will greatly assist in the experiments and data analysis.

Grading:

Grades will be determined on the basis of four areas with equal weight factors:

Lab Consultation Points: 25%
Lab Quizzes: 25%
Mid-term exam: 25%
Completion of protein crystallization and rotation experiments plus independently-written research-format paper: 25%

The following scale will be used:

A: 90 – 100	A-: 89	
B+: 86 – 88	B: 81 – 85	B-: 76 – 80
C+: 71 – 75	C: 64 – 70	C-: 59 – 63
D+: 55 – 58	D: 50 – 54	
F < 50		

Team work is essential to Chemistry 306 (and life in general). Points and grades, however, will be grounded upon individual effort and achievement. As with science across disciplines, the Chemistry 306 curriculum is neither easy nor quick to learn, but the process is rewarding if good-faith effort is made. Students are urged to consult the flight crew to discuss problems before they become serious.

And please consult DG when and where there are Qs about grades, computations, and standing in Chemistry 306.

First Meeting: Logistics and handouts. See Sakai for pdf versions. Important: all postings will be in the **Resources Section** of the course website.

Second Meeting: Information and experimental data.

Third Meeting: Quiz on second meeting material followed by a study of analogue information and uncertainty.

Fourth Meeting: Quiz on third meeting material followed by a study of information and models.

Fifth Meeting: Quiz on fourth meeting material followed by a study of analogue information and accumulation techniques.

Sixth Meeting: Quiz on fifth meeting material (last quiz!) followed by techniques and applications of Fourier analysis.

Seventh Meeting: More Fourier analysis!

Eighth Meeting: Celebration of π-Day.

Ninth Meeting: Mid-Term Exam. The exam will address essential material of previous lab meetings.

Tenth Meeting: The growth of diffraction-grade protein crystals.

The eleventh–thirteenth meetings will follow a rotation format of three experiments chosen from a menu of four: magnetic resonance, protein folding/unfolding, protein-ligand specificity, and model

membrane phase transition order specificity.

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The Ten Commandments of Lab Work (adapted from SU handout)

I. Thou Shalt maintain an open mind.

II. Thou shalt never take anything for granted; thou shalt check up early and often and make sure of absolutely everything.

III. Thou shalt have a pretty good time and thy work shall be interesting.

IV. Thou shalt respect the intelligence of others.

V. Thou shalt not gather in small and divisive groups.

VI. Thou shalt fear no experiment. Yet shall thee fear and despise sloth, dullness, and gutlessness, for these will bring bad Karma.

VII. Thou shalt hack away at things with dignity and help associates to do likewise.

VIII. Thou shalt bend over backwards to record data and questions that come to mind.

IX. Thou shalt admit thy mistakes, for they shall be forgiven.

X. Thou shalt roll and bounce over the inevitable potholes.

The Chemistry 306 Motto: No lies, no hate, no fear.