Chemistry 63400
Biochemistry: Structural Aspects

Instructor: Chittaranjan Das
Office: BRWN 3185
Phone: 4-5478
Email: cdas@purdue.edu
Office Hours: by appointment

Course Information
Fall
MWF 10:30-11:20

Course description

Graduate level introduction to – or review of – biomolecules, their structure and function.

Prerequisites

none

Learning objectives: practical aspects

- To understand the basics of molecular biology techniques, including PCR, cloning, and restriction digestion
- To know how to clone, express, and purify a protein
- To become familiar with basic bioinformatics techniques (sequence alignment).
- To be able to view and analyze the 3D-structure of a protein or RNA molecule using Pymol.

Course requirements

Homework	40 pts each (120 total)
Three exams:*	100 pts each (300 Total)
Report**	150 pts
Presentation***	150 pts
Total	720 pts
Bonus homework	extra credit

* Each exam covers its own portion of the course. The last of the three exams is the open-notebook exam based on students' presentations in class

** To be e-mailed to Dr. Das at least 24 hrs before in-class presentation

*** 20 min powerpoint presentation followed by 5 min question period

Texts (optional)

Biochemistry, 5th Edition
Reginald H. Garrett & Charles M. Grisham
On reserve in the Chemistry Library (3rd floor WTHR)

Biochemistry: Concepts and Connections, 1st Edition
Dean R. Appling, Spencer J. Anthony-Cahill & Christopher K. Mathews
On reserve in the Chemistry Library (3rd floor WTHR)

Course materials available on BB Learn (lecture outline + powerpoint slides will be posted after class), homework, etc.

Grading policies

These cutoffs serve as a guide and may be adjusted

90 +	A
85 – 90	A-
80 – 85	B
75 – 80	B-
55 – 75	C

Course content

Primer on protein sequence / structure
Protein Databank
Pymol
An example of proteins at work: muscle contraction
Strong interactions: covalent bond
Weak interactions: van der Waals
Weak interactions: hydrogen bond
Chemical equilibrium. Equilibrium constants
pH
Adjusting pH of the sample. Titration of ionizable groups in protein (histidine)
pKa
Buffers
Henderson-Hasselbalch equation
Boltzmann distribution
Entropy, enthalpy, Gibbs free energy, and heat capacity

Populations of conformational species
Hydration of non-polar molecules
Factors behind protein folding (protein stability)
Estimating transition rates
Mechanism of chymotrypsin catalysis
Michaelis-Menten equation
Ramachandran map
α-helix (example – keratin)
3_{10} helix
PPII helix (example – collagen)
β-sheet (example – amyloids)
monoclonal antibodies (example – solanezumab)
Immunoglobulin (antibody)
Generating antibodies
Phage display cycle
Immunoglobulin fold
Protein architectures and folds
BLAST alignment
DNA structure
DNA translation
tRNA
Structure and function of chromatin
Cloning of α-spectrin SH3 domain
PCR reaction
Mechanism of DNA extension
Vectors and plasmids
Protein expression (Lac suppressor control and IPTG induction)
Protein purification (cation exchange and Ni^{2+}-affinity chromatography)
Protein structure determination by NMR – brief overview
Multiple topics in biochemistry & molecular biology (student presentations)

Missed or Late Work

Late homework will be accepted with 1-day extension, subject to a 4 pt deduction. Special arrangements will be made in the case of an illness or unavoidable conflict with the scheduled exams.

Ethical standards

Usual standards of academic behavior apply. When working on your report, the text should represent your original thought process. If you quote the literature source verbatim (even half-sentence) use quotation marks and provide the reference.

Additional notes on the final report & presentation

This is a literature-based report + presentation addressing a specific research question in modern biochemistry. I suggest that you attend at least several Biochemistry Division seminars (J. Foster Memorial Seminar series) to get an idea of how a good research talk in this area may look like.

The choice of topic. By and large, this is your call. You may want to talk to your advisor and see if he/she has any suggestions (it can be a topic related to your future research). Alternatively, it may be related to biochemistry research that you have done in the past. Otherwise it can be a problem that you have been curious about or you feel strongly about (e.g. something that is related to disease). You can also talk to Dr. Das and ask for suggestions.

The range of subjects can be very broad – from core structural biology to biotechnology to drug design to computational methods to analytical techniques in life science, etc. <u>It is extremely important, though, that there is a big element of structural biology in what you discuss (since structural biology is the core content of this course)</u>. It is also desirable that your report is discovery-based, rather than descriptive.

After you have chosen a topic, please send an e-mail to Dr. Das with (1) the proposed title of your report, (2) the desired dates of your presentation, and (3) the .pdf of the research paper which is one of your 'core' sources. In most cases I'll just approve your request and add your talk to the presentation schedule. Sometimes I ask for clarification or make suggestions (e.g. alert you to the fact that someone has already chosen a very similar topic, etc.). The sign-up process begins at the middle of the semester (the exact date will be announced).

Written report. It needs to contain a discussion of the problem which is both deep and clear. There are no requirements associated with structure of the document –it is your call (most people, of course, prefer to begin with an introduction, etc.). I expect to see ca. 15 pages, but do not care about margins, line intervals, etc. – the important thing is that you deliver your message clearly and effectively. The pictures and graphs are expected to be copy-pasted from the original research articles, texts, etc. – but it is mandatory that complete references are provided every time.

Presentation in class. There is a 20-min in-class presentation, followed by 5 min question period. This is essentially a miniature research talk (except it is based on literature results rather than your own results). It is expected to be a PowerPoint presentation, where you first introduce the problem to the audience, then present the research results (ideally, centered on a certain discovery or innovation that you find exciting), then possibly discuss potential applications, etc. Again, there are no rigid requirements as to the structure of the talk, it is your call.

Grading is based on the following rubrics

- There should be 'meat' in your talk – a substantial and interesting scientific content with a strong connection to structural biology. Ideally, you should be yourself excited about the research that you present and you should make the audience excited.

- You should really know what you are talking about. It is usually rather obvious from the report, the talk, and the answers to questions that the person has a good grasp of the problem.

- You should explain things well, both in your report and in your presentation, so that the readers (Dr. Das) as well as the listeners (the entire class) effectively get the message.

Presentation-based exam. One of the three exams in the course is presentation-based. The entire class is expected to be in attendance for all presentations and take notes. During the final exam you are allowed to use your notebook (but no electronic or printed materials). The questions asked at the exam are based on the presentations, but they are of general nature – they seek to confirm that you understand the essence of the talk (it does not test your memory for technical details).