CHEM 341—Physical Chemistry for Life Sciences, Spring 2016

Instructor: **Tyler Meldrum,** ISC 1060, 221-2561 *tkmeldrum@wm.edu*
Office hours: Tuesdays 1:00 – 2:30 pm; Thursdays 10:30 – 11:30 am; or by arrangement
Class times: Tuesdays, Thursdays 9:30 – 10:50 am, Millington 305

Course Description:
This course discusses principles of physical chemistry applied directly to biological systems. Topics include structure of nucleic acids and proteins, thermodynamics, molecular recognition, and kinetics, as well as many techniques used in biophysical research. Please note: this course does NOT count towards the chemistry major; however, it does count towards the chemistry and biochemistry minors. Prerequisites include two years of chemistry (through Organic II and General II) and integral calculus (MATH 112/132). Students who have taken differential calculus (MATH 111/131) and are currently enrolled in MATH 112/132 are probably sufficiently prepared for this course—they should see the instructor to discuss their math background and, if appropriate, to receive a course override.

Texts:
Kuriyan, J.; Konforti, B.; Wemmer, D. *The Molecules of Life: Physical and Chemical Principles;* Garland Science: New York, 2013. ISBN: 978-0-8153-4188-8.

[Optional] Dill, K. A.; Bromberg, S. *Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience;* Garland Science: New York, 2011. ISBN: 978-0-8153-4430-8.

Course Structure and Grading:

Attendance and participation:	5%
Homework assignments:	25%
Paper:	20%
Midterm exam:	20%
Final exam:	30%

Attendance and participation: Students are expected to be present and to contribute to the class. I will not take attendance and do not record "participation activities;" rather, these are discretionary points for the instructor. Everybody receives full credit for participation unless there is a demonstrated lack of participation.

Homework: Ten (10) weekly homework assignments will be posted to Blackboard to be turned in on Tuesday mornings at the beginning of class. Each is worth 2.5% of the course grade, for a total of 25% of the course grade. Due dates are listed on the tentative course schedule.

Paper: An original paper will be based on current research in the literature that incorporates topics discussed in class. Each student is required to get instructor approval for their topic, and may (but is not required to) submit one outline and one draft of their paper before submitting the final version. The paper may be submitted at any time during the semester, but no later than the last day of class. Chosen topics must be approved by the instructor no later than Thursday, April 7. I expect high-quality writing of my students. Further details will be distributed during the semester. The paper will count for 20% of the total course grade.

Midterm exam: One midterm exam will be given on Thursday, March 3. It will be worth 20% of the course grade.

Final exam: A final exam will be given on **Wednesday, 4 May 2015, from 9:00 am – 12:00 pm,** location to be announced. The final exam will be worth 30% of the course grade and will be comprehensive.

Grading policy: To receive a grade in the A range in this course, you must have at least 90% of the points; the B range is at least 80%; the C range is at least 70%, and the D range is at least 60%. These thresholds may be lowered (i.e., it may become easier to get a higher grade), but they will not be raised. These absolute thresholds are designed to allow you to collaborate and work with others without fear of getting a lower grade if a peer performs well. Please teach one another and, while submitting only your own work, collaborate with your colleagues.

CHEM 341—Physical Chemistry for Life Sciences, Spring 2016

TENTATIVE COURSE SCHEDULE

Dates	Topics	Reading *[Kuriyan et al.]*
R, 1/21	Course intro, overview of intermolecular forces	5–15
T, 1/26	Structure of nucleic acids	15–25, 51–87
R, 1/28	Structure of lipids *Technique: RCSB Protein Data Bank, Molecular Visualization*	108–126
T, 2/2	**Homework Assignment 1 due**	
T, 2/2	Structure of amino acids and proteins	25–34, 131–150
R, 2/4	Structural motifs, membrane proteins, sequence and structure *Technique: X-ray diffraction*	150–187, 191–195
T, 2/9	**Homework Assignment 2 due**	
T, 2/9	Intro to thermodynamics, math for physical chemistry	Posted online
R, 2/11	Energy, the first law, ideal gases *Technique: Mass spectrometry*	239–253
T, 2/16	**Homework Assignment 3 due**	
T, 2/16	Work, heat, heat capacity, Boltzmann, and protein melting	253–265
R, 2/18	Classical entropy, thermodynamic cycles *Technique: Calorimetry*	Posted online 446–452, 573–576
T, 2/23	**Homework Assignment 4 due**	
T, 2/23	Coin flips, counting, and distributions	293–317
R, 2/25	Statistical definition of entropy *Technique: Computational methods*	317–336
T, 3/1	**Homework Assignment 5 due**	
T, 3/1	Statistical entropy, the second law	
R, 3/3	**MIDTERM EXAM**	
T, 3/8	*SPRING BREAK*	
R, 3/10	*NO CLASSES*	
T, 3/15	Entropy, energy, and temperature	341–379
R, 3/17	Entropy, energy, and temperature *Technique: Nuclear magnetic resonance*	
T, 3/22	**Homework Assignment 6 due**	
T, 3/22	Free energy	383–409
R, 3/24	Free energy *Technique: Library techniques*	
T, 3/29	**Homework Assignment 7 due**	
T, 3/29	Chemical potential and equilibrium	413–428, 438–446
R, 3/31	Chemical potential, protein folding *Technique: Atomic force microscopy*	
T, 4/5	**Homework Assignment 8 due**	
T, 4/5	Chemical kinetics, rate laws, activation energy	673–718
R, 4/7	Chemical kinetics, transition state theory *Technique: FRET*	
T, 4/12	**Homework Assignment 9 due**	
T, 4/12	Diffusion, transport, and stochastic processes	787–826
R, 4/14	Diffusion, transport, and stochastic processes *Technique: Circular dichroism*	
T, 4/19	**Homework Assignment 10 due**	
T, 4/19	Intro to quantum mechanics, math, particles and waves	Posted online
R, 4/21	Particle in a (3D) box	Posted online
T, 4/26	Partition functions	Posted online
R, 4/28	**Last day to submit papers** Classical and statistical approaches: energy of an ideal gas	Posted online
T, 5/4	**FINAL EXAM 9:00 am – 12:00 pm**	