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IBS 8203 Methods in Molecular Biosciences (2 credits)
Spring 2017
Mondays, 11-12:40 pm, SSB 207A

Instructors:

Dr. Erin D. Sheets, Course Coordinator
Chemistry & Biochemistry
SCSE
Office: 329 Chem
Phone: 218-726-6046
Email: *edsheets@d.umn.edu*

Dr. Anne Hinderliter
Chemistry & Biochemistry
SCSE
Office: 152B SSB
Phone: 218-726-7062
Email: *ahinderl@d.umn.edu*

Dr. Steve Berry
Chemistry & Biochemistry
SCSE
Office: 152C SSB
Phone: 218-726-7087
Email: *smberry@d.umn.edu*

Dr. Joe Johnson
Chemistry & Biochemistry
SCSE
Office: 253B SSB
Phone: 218-726-8439
Email: *jljohns3@d.umn.edu*

Office Hours: Office hours will be by appointment.

Course Website: https://ay16.moodle.umn.edu/course/view.php?id=8691

Please note that the first class meeting will be Monday, January 23!

Course Overview:
Quantitative biology and biosciences dictate the need for quantitative methods and analytical tools under controlled biological conditions. Our knowledge in biosciences at the molecular, cellular and *in vivo* level is limited by the techniques being used and the awareness of users by the underlying fundamentals. As a result, this course will help students be aware of the rational choice of a given technique and its fundamentals to answer biological and biochemical questions with emphasis on proper usage, data analysis, and data interpretation.

Following the completion of this course, students will be able to:

- Design an experiment with the proper technique/method based on the biological questions of interest and the model system being used.
- Understand the underlying physical principles of a given technique, which will enhance their ability for experimental and control design as well as data interpretation while avoiding potential artifacts.
- Function in an interdisciplinary team with sound communication skills and comprehension of cross-disciplinary terminology/concepts.
- Comprehend current applications, experimental methods and the biological context in modern biosciences and contemporary scientific problems.

Assessment:
IBS 8203 is a team-taught course. Each instructor will evaluate students' performance in their section of the course (18.75% each; 75% total). The graded assignments may include (but are not limited to)

presentations, homework or quizzes. There will also be a final project (25%), due at the end of the semester that will integrate the sections of the course. Details on the project will be shared shortly after the beginning of the semester. Students' learning outcomes will be measured using homework, class participation, exams and project assignments, as described by each instructor at the beginning of their section.

Students who are unable to attend a class or to return assignment during the assigned class period must inform the instructor as soon as possible. Otherwise, a penalty (5% reduction) will be applied for every day an assignment is late. Make-up exam will be considered for medical reasons only.

Prerequisites:
Students are expected to enter the course with a basic knowledge of Organic Chemistry, Physical Chemistry, Biochemistry, Cell Biology and Molecular Biology.

Course Texts:
1. Recommended Textbook: Nadeau, *Introduction to Experimental Biophysics: Biological Methods for Physical Scientists*. CRC Press, 2012 (ISBN-13: 9781439829530); see http://www.crcpress.com/product/isbn/9781439829530 for purchasing paperback or electronic versions. This text will be a useful resource for one's research career. Instructors will teach from this text to varying extents. **We strongly recommend this text for the course.**

2. Recommended Textbook: Access to an excellent Biochemistry textbook such as Berg, Tymoczko, Gatto and Stryer. *Biochemistry*. 8th Edition, Freeman/Macmillian, 2015 (ISBN-13: 978-1-4641-2610-9) is **very strongly recommended and expected**.

3. Recommended Textbook: Access to an excellent Cell Biology textbook such as Alberts, Johnson, Lewis, Morgan, Raff, Roberts and Walter. *Molecular Biology of the Cell*. 6th Edition, Garland Science, 2015 (ISBN-13: 9780815344322) **is very strongly recommended and is expected**. The VitalBook e-book is available for purchase in its entirety or by chapter, or to rent for 1 year or 180 days, in the US and Canada from VitalSource (http://store.vitalsource.com/show/9781317563754).

In addition, scientific papers will be assigned from peer-reviewed journals to highlight the links between the course material and cutting-edge research. Supplemental material will be posted on the course website.

Attendance Policy and Disability Resources:
Students are expected to attend all scheduled class meetings. It is the responsibility of students to plan their schedules to avoid excessive conflict with course requirements. However, there are legitimate and verifiable circumstances that lead to excused student absences from the classroom. These are subpoenas, jury duty, military duty, religious observances, illness, bereavement for immediate family, and NCAA varsity intercollegiate athletics. For complete information, please refer to *http://www.d.umn.edu/vcaa/ExcusedAbsence.html* .

Individuals who have any disability or physical conditions, which might affect their ability to perform in this class, are encouraged to inform the instructor at the beginning of the semester. It is the policy and practice of the University of Minnesota Duluth to create an inclusive learning environment for all students, including students with disabilities. If there are aspects of this course that result in barriers to your inclusion or your ability to meet course requirements, please notify the instructor as soon as

possible. In addition, the student should contact the Office of Disability Resources (UMD for further information: 218-726-6130 (V); 218-726-6706 (Fax); e-mail *access@d.umn.edu*; or visit *www.d.umn.edu/access* for more information.

Policies Related to the Student Conduct Code, Academic Integrity and Other UMD Policies:

1. Students are expected to follow the University's Student Conduct Code (*http://www.d.umn.edu/conduct/*) to promote an environment of mutual respect and academic integrity. The instructor will enforce and students are expected to follow the University's Student Conduct Code: (see *http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf*). Appropriate classroom conduct promotes an environment of academic achievement and integrity. Disruptive classroom behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning is prohibited. Disruptive behavior includes, but is not limited to, inappropriate use of technology in the classroom. Examples include ringing cell phones, text messaging, watching videos, playing computer games, writing email or surfing the Internet.

2. UMD is committed to providing students every possible opportunity to grow in mind and spirit. As a result, academic dishonesty is regarded as a serious offense by all members of the academic community. This course will adhere to UMD's Student Academic Integrity Policy (*http://www.d.umn.edu/vcaa/StudentAcademicIntegrity.html*), which sanctions students who are engaged in academic dishonesty. This policy sanctions students engaging in academic dishonesty with penalties up to and including expulsion from the University for repeat offenders. Each student is bound by the following specific provisions as part of the honor code: Academic misconduct is an unauthorized act which may give a student an unfair advantage over other students, including but not limited to falsification, plagiarism, misuse of test materials, receiving or giving unauthorized assistance, and the misuse of clickers. This includes programming calculators with exam information. Each student will be asked to sign a cover sheet on tests, quizzes and major assignments that reaffirms the honor code as it applies to this course and confirms that the work turned in represents their individual effort. Violation of these policies will result in a failing grade on the exam/assignment and possibly for the course.

3. Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. For additional information, please see *http://www.d.umn.edu/vcaa/ClassNotesAppropriateUseof.html* .

Other Course Policies and Information*:*

The course syllabus is subject to change. Any changes to the syllabus will be communicated to the students via their UMD email address and/or during scheduled lecture times. You are responsible for all course material and administrative announcements, including problem assignments and syllabus changes.

Tentative

IBS 8203 Methods in Molecular Biosciences: Topics and Instructors

Dr. Joseph Johnson (Jan 23–Feb 6):
We will explore the power of RNA-based methods in biology. Specifically, we will focus on two methods of post-transcriptional control of gene expression. RNA interference (RNAi) is a powerful and versatile technique for inhibiting gene expression in a highly specific and controlled manner. A second rapidly emerging approach has recently been discovered in bacteria and archaea that appears to be the RNAi equivalent in these organisms. It is based on short, repetitive DNA sequences called Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) that bind to Cas9 proteins. The CRISPR-Cas9 system is being used to control gene expression in systems ranging from bacteria and archea to mammals. We will review these techniques and explore recent examples of how RNAi and CRISPR-Cas9 are being used to control gene expression in both *in vivo* and *in vitro* studies.

Dr. Steve Berry (Feb 13–Mar 13; no meeting on Mar 6 due to Spring Break):
We will cover the technique of protein X-ray crystallography. We will begin by discussing general properties of crystal systems, space groups and symmetry. The practical aspects of how to identify conditions and grow X-ray diffraction quality crystals of proteins, how to improve their order and size, and how to analyze their quality will be covered. A field trip to the X-ray diffractometer in MWAH will be included. Finally, we will review the basics of solving a structure with readily available freeware, using the molecular replacement method.

Dr. Anne Hinderliter (Mar 20–Apr 3):
We will discuss metal-ion detection assays using ion-specific molecular probes combined with optical detection (e.g., absorption and emission spectra). The chelation of metal ions is a potent form of signaling in biological systems. Detection of or defining concentrations of metal ions in solution is necessary to quantitatively define these signals. An array of molecules, such as BAPTA, Br-BAPTA, FURA, etc. have been synthesized for detection of metal ions that exhibit changes in signal such as in UV/Vis absorbance or in fluorescence intensity upon their binding. These same molecules are also used to buffer and set the working concentrations of metal ions in solution. Practical application of how to use these chromophoric metal ion chelators including theory, experimental design, data acquisition and analysis will be featured. Students will apply their coursework to data they collect, and they will be assessed based upon their experimental design, quality of data collected, design of controls, analysis and conclusions based upon their data.

Dr. Erin Sheets (Apr 10–24):
In this section, we will begin with a brief discussion about fluorescence fundamentals. The cellular and biomolecular contexts will include molecular structure and dynamics, molecular interactions, binding kinetics, diffusion and cellular biomolecules. Then we will cover mammalian cell culture and transient and permanent transfection strategies. We will also discuss strategies for labeling cells and tissues for bioimaging (fluorescence and electron microscopies), necessary controls and troubleshooting of issues. If there is time, we will also discuss some practical aspects of light microscopy for quantitative imaging.