CHEM-342
INTRODUCTION TO BIOCHEMISTRY
SYLLABUS - SPRING 2012

On-line at: http://www.udel.edu/chem/white/C342/342-SyllabusS11.html

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Administrative Information

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Office Hours: Normally, the hour after class will be available for office hours; however, you should feel free to contact me by phone or e-mail or to stop by my office at other times. If I do not have pressing business, I will be happy to meet on the spur of the moment. Please note that I do not do e-mail at home, so messages sent in the evening or on weekends likely will not be answered until the next working day.

Meeting Time and Place: 8:00 - 8:50, MWF in 205 Brown Laboratory. Normally, important announcements are made at the beginning of class, so don't be late. Similarly, homework is due at the beginning of class. The tentative course schedule is available on line and will be updated regularly as necessary through the semester.

Prerequisite: CHEM-331 or CHEM-321, Organic Chemistry or equivalent. Completion of or concurrent registration in introductory biology, physics, and calculus courses is assumed.

Course Reader and Texts: The Course Reader, which contains photocopies of all articles used in the course as well as some supplementary materials, is required. It and a three-ring, 2-inch loose-leaf binder to contain it can be purchased at the University Bookstore. The textbook for CHEM-641 & 643 is a useful optional, but highly recommended, reference book in CHEM-342, *Introduction to Biochemistry*. All students should have and use a good collegiate dictionary or be willing to make frequent use of Wikipedia. (There will be a variety of biochemistry texts available for loan during the course.) In addition, textbooks from introductory/prerequisite biology, chemistry, physics, and math courses come in handy for reviewing a variety of topics encountered in *Introduction to Biochemistry*, i.e. don't sell them.

Classroom Resources: A variety of biochemistry textbooks and other books will be available for loan from the course's classroom library.

Grading: There will be two examinations (midterm 20% and comprehensive final 30%). Individual and group assignments will constitute 40% of the final grade, of that 15% is a major individual writing assignment due the last Friday of the semester. Attendance, Preparation, Participation, and Attitude (APPA) are worth 10%. Unexcused absences and tardiness will detract from your final grade. Attendance is monitored. The comprehensive final will be administered during finals week. The midterm is scheduled in two parts for Wednesday and Friday before Spring Break. Grading will ***not*** be on a curve. If every student does excellent work, everyone will get an A in this class. (The converse is also true.)

Important General Information

Brief Course Description: This course uses series of 8 to 10 classic research articles on hemoglobin and sickle cell anemia to introduce sophomore biochemistry majors to the discipline of biochemistry. The course and its problem-based learning (PBL) format are non-traditional. Each article constitutes a rich multidisciplinary *problem* from which students identify and pursue those topics (learning issues) they need to learn or review outside of class in order to understand the article as a whole. Most classes are devoted to discussions of various learning issues within permanent groups of 4-5 students facilitated by a peer tutor-facilitator who has previously taken the course. Brief descriptions of the historical context of each article and follow-up lists of instructor-generated learning issues provide the intellectual continuity and assure that students address the major issues. These issues include topics relating to ethics in the conduct of science, philosophy of science, and experimental design in addition to issues of biochemical content and history. This course is not a survey course. Midterm and final essay examinations involve both individual and group assessments. Old exam files may be accessed from the course home page.

Course Objectives and Content: The ability to evaluate information within conceptual frameworks distinguishes practicing scientists from most undergraduate science majors. Through formal education and practical experience, biochemists come to "see" and interpret biological phenomena in molecular terms. A major objective of CHEM-342 is to initiate that transition in you through study of an important biochemical molecule (hemoglobin) in a variety of conceptual contexts (chemical, physical, functional, mathematical, genetic, historical, ethical, medical, etc.). Thus, while learning science content is important in this course, success depends on achieving a number of behavioral goals that address many of the Department’s Learning Goals and Outcomes and the University's General Education goals as well.

If you are like most other students in this class, this will be your first biochemistry course. Because sound foundations in biology and especially chemistry support the discipline of biochemistry, courses in biochemistry usually are not offered to majors until their junior year after full-year courses in introductory chemistry, biology, and organic chemistry, as well as courses in calculus and physics. Consequently, many students who express an interest in biochemistry get no formal exposure to the subject until the second half of their college career. CHEM-342, *Introduction to Biochemistry*, attempts to alleviate this problem and to cultivate your interest by introducing biochemistry in nontraditional ways in the sophomore year. The objective is to enrich your appreciation for the discipline without preempting material from CHEM-641/642/643, a three-semester survey of biochemistry that you will probably begin next fall.

Introduction to Biochemistry differs from subsequent biochemistry courses in that it is not a lecture survey course and does not emphasize factual material per se. Rather, it emphasizes the nature of scientific investigation and problem solving, using biochemistry as the example. To convey this, you will read a series of research articles in a single research area spanning nearly 100 years. This approach provides the basis for discussions on the application of chemical principles to biochemistry, the history of biochemistry, experimental design, the role of publication, the language of science, and ethics in science.

Probably you will find CHEM-342 unlike any course you have taken before. In most courses, the goals are primarily on learning content. While certainly that is a significant goal in CHEM-342, it alone will not assure success. In fact, some students who are used to excelling academically find this course difficult because the “rules are different.” Successful students in this course can be compared to decathalon athletes who depend on a variety of skills. Students who excel in this course:

- work well with other students,
- communicate effectively,
- have or develop good information searching skills,
- remember what they learned in prerequisite courses,

- can relate and integrate information from various sources,
- are able to define what they don't know and need to learn, and
- know how to manage their time.

Society values these traits. CHEM-342 provides the opportunity to practice and enhance these traits in a low risk environment.

Pedagogy and Philosophy of Problem-Based Learning:

"Tell me, and I will forget.
Show me, and I may remember.
Involve me, and I will understand."

This perceptive Chinese proverb as translated by Ichiro Ochai, recognizes the limited effectiveness of lectures. How often do you discover what you don't know on an examination? Ignorance is not bliss! Successful students, like successful scientists, recognize and manage their ignorance. What ***don't*** you know? What do you ***need*** to know? What would you ***like*** to know? What is ***most important*** to learn first? These are ***learning issues***. While knowing facts may help you on an examination; understanding concepts, so that you can apply them to new situations and appreciate the facts, is as or more important in the long run. Cultivating the ability to confront your ignorance is an exercise in humility and in building competence and self-confidence. In CHEM-342, "***I don't know***," will point the direction for ***your*** learning.

How do you learn best? How can I enable you to achieve ***beyond*** your expectations? These questions challenge me as a teacher and are independent of the grade you will get. Learning is an active process. Each year I try new ways to facilitate that process based on my learning. In 1993, due to the dramatic increase in sophomore biochemistry majors, I dispensed with a lecture-discussion format and adopted a problem-based, group-learning format that encourages active participation and cooperation among ***all*** students.

While a lecture-survey course can expose students to lots of information, the students' role in class is basically passive. Learning is often superficial, and long-term retention for most students is poor. (How many final examinations from a year ago could you pass now?) This approach may "cover" the subject rather than "uncover" it. Many studies show that classroom activities that encourage active learning in groups lead to better understanding and greater retention. In such a learning environment the teacher becomes a coach who creates appropriate challenges (problems) and works to enable students to master the problems and use them to identify and eliminate areas of personal ignorance. Such problem-based approaches to learning emphasize analysis, synthesis, judgment, and communication. While learning and remembering facts are important in any science, those facts are useless and quickly forgotten unless they fit into a context where they have importance and are perceived as worth remembering beyond the next examination. In problem-based learning, the problem comes first and provides the incentive to learn and understand the concepts.

If you feel comfortable with rather focused "plug and chug" questions typically found at the end of chapters in many textbooks, you may be frustrated for a while by the real-world problems used in problem-based learning. Frequently, questions are open-ended and have no simple solution. You may need to consult several sources other than your textbook. Problem-based learning rewards students who pursue ***understanding*** beyond just the "right answer." Continuous effort (*preparation for **every** class*) rather than cramming is a necessity. On a regular basis, you will be expected to look up information in books and read journal articles available on-line. The student responses on the final course evaluation from past years may give you feel for how this course will be different from other courses you have taken.

In CHEM-342 you will be challenged to understand the actual work of research scientists whose curiosity about the chemistry of living systems could not be satisfied by a trip to the library. The problems they defined, studied, and described in research articles are your problems this semester. If you are interested in the educational ideas that motivate the use of research articles for learning science, they can be found in an article by Herman T. Epstein, *Nature* 235, 203-205 (1972) and his book ***A Strategy for Education***, Oxford University Press, 1970.

Group Formation and Function: An important element in the success of this problem-based course is the use of student groups and how they function. Use of cooperative working groups in a science class fosters the development of a learning community and lessens the sense of isolation that students may otherwise feel. Research has shown that student achievement is enhanced when students work together in a cooperative learning environment, as opposed to students who try to learn the same material individually. Cooperative learning also increases the motivation to learn, and the interest to solve more complex problems. Social and team skills learned in student groups are important for success in the working world today. If this is your first time working in a learning group, or even if you have had many previous experiences, you will probably have questions or reservations about the process. Find this paragraph and other information about working in groups by following the link.

During the second class meeting, you will be assigned to one of eight groups of four or five students each. These heterogeneous groups will function independently during class and outside of class. Each group will have a junior or senior biochemistry major as a tutor-facilitator who will attend every class and facilitate group discussions. The tutor-facilitators will be reassigned to different groups after Spring Break. The collective resources and effort of each group will be used to deal with each research article we study. As noted, part of your grade will depend on the performance of your group and your performance in the group. That portion of your grade associated with group work (10%) can be summarized in four words - **A**ttendance, **P**reparation, **P**articipation, and **A**ttitude - sometimes referred to as "APPA." You will evaluate yourself and the other members of your group in the middle and at the end of the course. How your peers evaluate you at the end of the semester constitutes half of your APPA grade, i. e. 5% of your overall grade.

In order for the groups to function well, each group should discuss and agree with signatures to a set of behavioral guidelines (**ground rules**) and consider the consequences to group members who do not follow them. Some guidelines that have served groups well in the past are listed below. Your group may change or add to the list. If your group has difficulties, you and the other group members may need to enforce or reevaluate your guidelines.

- **Come on time** to *every* class.
- **Be prepared** to discuss the assignment. (a *minimum* 2-3 hours preparation outside of class is expected for each class.)
- **Notify** other group members, your tutor, and the instructor in advance (when possible) if you must miss a class.
- Freely **share** the information you gather outside of class with other group members.
- **Use class time wisely**. (You can discuss soap operas, baseball, or organic exams before or after class, but not during class.)
- **Solicit and value** contributions from every group member.
- Group members who disrupt the group's function by ignoring the group's guidelines can be confronted by the other members of the group and suffer the following **consequences**: (e.g. have to take as an individual the group part of midterm and final examinations; bring food for the group for being late or having an unexcused absence.)

To assist your group in working well together, it is often useful to define **roles** and to rotate them on a weekly basis. Your tutor-facilitator (see below) will provide guidance. Some of the roles and responsibilities to consider in this course are:

- **Recorder** - This person keeps track of the learning issues in the group and who has responsibility for pursuing each learning issue.
- **Task Master** - This person keeps discussions on track. Class time may be the only convenient time your group can get together so you need to avoid digressions that are not related to the course.
- **Skeptic** - This person challenges the accuracy and reliability of information. The skeptic needs to make sure everyone in the group understands important concepts before going on.
- **Technical Advisor** - This person focuses on methodology and is the expert on questions of how things are done and the principles behind how things work.
- **Chemist** - This person finds out the chemical structures and properties of compounds mentioned in the articles.
- **Web-Scanners and Library Researchers** - Roles that everyone should assume between every class. These involve tracking down answers to group learning issues on the web and in the library.

Tutor-Facilitators - Roles and Responsibility: This year for the forteenth time and with the support of the Howard Hughes Medical Institute's (HHMI) Program on campus, each group will have a tutor. These students are mostly juniors who have taken CHEM-342 and who are interested in helping you succeed in this course. Each has taken or is taking a course (UNIV-460, Experiential Teaching, Section 044, Tutorial Methods of Instruction) specifically designed for tutor-facilitators who are helping in classes taught with a problem-based learning format. Because of the nature of the course, expect them to guide you to understanding rather than tell you "The Answer" to all of your questions. Their role is to help make the groups function effectively. **Tutor-facilitators will have no role in grading**. You should feel free to seek their advice in matters relating to the biochemistry major. You should take full use of e-mail to communicate with your tutor and other members of your group.

The Tutors for Spring 2012: Tim Gilpatrick, Amanda Grigoli, Monica Pirigyi, Matt Sciscione, Sharon Song, Matt White, and Jocelyn Zajac. Group tutors will change groups after midterm.

Assignments

Reading Assignments: The first paper you will read was published by the Royal Society of London in 1864. It is by G. G. Stokes and entitled "On the Reduction and Oxidation of the Colouring Matter of the Blood." We will spend two to three weeks discussing this single article. Progress toward understanding this article and those that follow will come from curiosity and communication. Because there will be many technical terms, do not expect to understand an article on the first or even the third reading. You will have many learning issues. **Learning Issues** are specific questions you or your group generate that define what you don't know but you think would help you understand the article, if you did know. For example, while reading the first article, you will ask, "What is protochloride of tin?" That may be followed by deeper learning issues such as, "What does the prefix 'proto' mean?" or "Why was this reagent used?" Each time you resolve one set of learning issues and reread an article, new and more probing learning issues will arise. Those unresolved personal learning issues are the basis of group discussion and the essence of your intellectual development in this course. The more **you** question, the deeper **you** probe, the more **you** will learn and understand. The discussions will help to define learning issues that need to be resolved by your whole group. You and your group should keep a record of your learning issues.

Writing Assignments: Writing is an essential skill in science, and most students could improve their writing. Therefore, you will hand in short written assignments most weeks due usually on Mondays. Remember, there is a major distinction between knowing an answer and understanding the basis of an answer. This course is about ***understanding***. Thus, grading will reflect how well your writing communicates your understanding. The **Hemoglobinopathy assignment** is a significant capstone assignment due on the last Friday of the semester.

Academic Honesty: I have assumed that students know the difference between acceptable and unacceptable academic behavior and that they conduct themselves accordingly. Unfortunately, that trust has been violated several times in the past with respect to plagiarism of unreferenced resources. Plagiarism or paraphrasing the work of others does not demonstrate understanding. Write-up ***your work*** in ***your own words*** on ***your own*** to show what ***you understand***. I look for well-thought-out responses that are clearly and neatly presented. I also expect your acknowledgment of the resources you use (books, articles, web sites, and people), i.e., if you received significant help from others, please list their names at the end of your assignments. If you are uncertain about what constitutes plagiarism or how the university deals with cases of academic dishonesty such as plagiarism, check out the **student handbook web-site** devoted to these issues. Cases of academic dishonesty will be reported.

While only individuals learn, interactions with others can enhance the learning process. Thus, I expect students to work together on solving problems and use a variety of resources. I encourage such interactions and do not consider it cheating unless specifically prohibited as on the individual part of an examination. However, "working together" here does not imply a divide-and-conquer approach in which students pool their individual work, but do not discuss it. Each student will be accountable for an entire assignment, so make sure you understand explanations that you get from others.

Examinations: Examinations serve many purposes only one of which is to rank students for grading. Examinations should also be learning experiences both for students and instructors--learning new information, learning how well you understand or discovering what you don't understand, learning what needs to be presented differently next time, learning who needs help. From my perspective, multiple choice and short answer examination questions have one advantage--ease of grading, which is often an important consideration in large classes. However, enrollment in CHEM-342 is relatively small and because I am personally interested in how you can use what you know to demonstrate your understanding, most examination questions will emphasize problem-solving (often involving new information and different situations) and require narrative responses. You can see **midterm and final examinations** from the past 16 years elsewhere on this web-site. I do not provide answers to the examinations because that short curcuits the thinking associated with problem-solving.

While learning is an individual activity, it can be facilitated by group activities. Being able to articulate what you know to others and modify your thinking from their responses (and vice versa) characterizes the way most people learn. Often, it is in discussions where we have to explain something when we discover whether or not we understand something. The ability to identify and remedy knowledge gaps through discussion is cultivated in this course and incorporated into midterm and final examinations. The group component of each examination will constitute 25% of your grade. Groups that don't work well together often have difficulty on group examinations where respect, clear communication, and cooperation are important.

Course Evaluation: From 1994 through 1997, CHEM-342 was part of a project, "*Problem-Based Learning in Introductory Science Across Disciplines*" funded by the National Science Foundation's (NSF) Division of Undergraduate Education, the first PBL grant to the University of Delaware. As a consequence of its role in that grant, this course required more documentation and evaluation than most courses and hosted guest observers from time to time. These activities will continue and I hope you will welcome them as your contribution to efforts to improve the quality of science education here and elsewhere. Among these are the initial survey administered on the first day of class, the peer-self-group evaluation near the middle and at the end of the course, and the final course evaluation. All of the **course evaluations since 2001** are on line linked to the course home page.

Distinguished Visitors and Guests: As perhaps the longest running and most distinctive Problem-Based Learning courses at the University of Delaware, CHEM-342, *Introduction to Biochemistry*, is frequently observed (1-4 times each semester) by faculty visitors from other schools who are interested in implementing problem-based learning. Visitors are invited to join groups and participate in group discussions. After class, a few students will accompany a visitor for breakfast and debriefing at Kent Dining Hall. In addition to these visitors and other University of Delaware faculty, several distinguished invited guests have participated in CHEM-342 and have met with students. They include:

1993 John Edsall, (1902-2002), Physical biochemist and professor emeritus at Harvard University, member of the National Academy of Sciences, and author of several articles on the history of biochemistry and the study of hemoglobin.

1994 Shiela Tobias, Sociologist and university administrator, nationally known scholar and author of several widely acclaimed books on reforming science and mathematics education.

1994 Todd Savitt, Medical historian at East Carolina University School of Medicine, who tracked down the identity and medical history of the first two reported patients with sickle cell anemia.

1995 Vernon Ingram, (1924-2006), Professor of Biology at the Massachusetts Institute of Technology and author of two of the articles in our course reader, visited this class. Dr. Ingram's classic articles reported the very first chemical characterization of a structural change in a protein (hemoglobin) associated with a genetic disease (sickle cell anemia).

1996 Anne Riley, M.D., Physician at the Alfred I. DuPont Hospital whose patients include children who have sickle cell disease.

1996 Michael Cox, Professor of Biochemistry, University of Wisconsin and coauthor of a major biochemistry textbook.

1997 Rosemary Dews, Director of the Delaware Sickle Cell Foundation and two patients who had Sickle Cell Disease.

1998 Ross Hardison, Professor of Biochemistry and Molecular Biology, Penn State University, who studies the regulation of hemoglobin gene expression.

1999 Thomas G. Spiro, Professor of Chemistry, Princeton University, who studies CO binding to the iron in heme proteins.

2000 John Jungck, Chair of Biology, Beloit College, Director of the BioQuest Curriculum Consortium.

2000 Sheldon McBee, Graduate student with a family history of sickle cell disease.

2001 John Wriston, (1926-2004), University of Delaware faculty member who, as a graduate student, worked with David Shemin on Heme biosynthesis.

2002 John Wright, Professor of Chemistry, University of Wisconsin.

2003 Dr. Kwaku Ohene-Frempong M.D., Director of the Comprehensive Sickle Cell Center at the Children's Hospital of Philadelphia

2003 Frank Ferrone, Professor of Biophysics at Drexel University, who studies hemoglobin S polymerization.

2003 Anthony Allison, M.D., Author of the classic article that demonstrates malaria resistance among human

2004 Lois W. Dow, M.D., Local retired hematologist who helped isolate human hemoglobin mRNA and knew Lemuel Diggs.

2005 Jumy Fadugba, former tutor-facilitator in the course who described her recent experience with malaria.

2006 Howard Dintzis, Johns Hopkins University, Author of classic article determining the direction of protein synthesis.

2007 Penny Gilmer, Florida State University biochemist and science educator.

2008 Eric Mazur, Harvard Unniversity, Physics Professor and nationally known for work in active learning in lectures.

2009 Howard Dintzis, Johns Hopkins University, Author of classic article determining the direction of protein synthesis.

2009 Carlton Rodney Cooper, University of Delaware Department of Biological Sciences, Discussed sickle cell disease in the context of health care disparities.

2009 Kathleen Cornely, Providence College, Visiting faculty observer.