Course Syllabus and Informational Outline
Green Chemistry (Chemistry 393-0), Spring 2003

M,W & F: 9 – 9:50am, Tech A110
See the BlackBoard course website for more information.

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Introduction: "Green chemistry or environmentally benign chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances."[1] Green chemistry places equal importance on the development of science with the effects the development has on the environment and the global population. Green chemistry breaks away from the traditional methods that solely considered the treatment or abatement of pollution after it was created, and considers alternative routes obviating the need to produce the waste. The "command and control" laws enacted following the formation of the EPA in 1970 have focused on diminishing the risk to the environment by limiting the acceptable levels of disposal. Since the passing of the Pollution Prevention Act in 1990, green chemistry became a formal focus of the EPA.

Green chemistry embodies the concept of "benign by design" and involves tailoring or modifying chemical processes to minimize or eliminate hazardous waste from being produced during a chemicals generation, use, and eventual degradation. Green chemistry need not be more difficult or costly than existing technologies and can even be significantly cheaper when waste disposal and remediation are factored into a product's cost analysis. Green chemistry encompasses all chemical related disciplines and provides a method to evaluate and examine all existing processes and products currently being used or created.

Course Objectives: This course will

- introduce the concept and discipline of green chemistry and place its growth and expansion in a historical context from its birth in the early 1990's through the most recent Presidential Green Chemistry awards of 2001.
- further demonstrate the necessity and viability of the methods of green chemistry to the chemical sciences and related disciplines.
- introduce the 12 principles of green chemistry as well as the tools of green chemistry including the use of alternative feedstocks or starting materials, reagents, solvents, target molecules, and catalysts.
- demonstrate how to evaluate a reaction or process and determine "greener" alternatives.
- focus heavily on the application of innovative technology the development of "greener" routes to improve industrial processes and to produce important products.
- introduce the chemistry awarded or considered for the "Presidential Green Chemistry Awards."

Prerequisites: Green Chemistry is an advanced level course designed for junior or senior level undergraduate students and graduate students in Chemistry, Biochemistry, Civil, Environmental and Chemical Engineering, Materials Science and related fields. Successful completion of a year of general chemistry and organic chemistry are the only specific prerequisites for the course. Concurrent registration in the third quarter of sophomore-level organic chemistry is acceptable.

Course Structure: Green Chemistry will be a lecture-based course that meets M,W & F 9 – 9:50am in the Spring 2003 quarter. The class will be in a discussion format. Please read all required reading prior to coming to each class and be prepared to participate in an open discussion of the material. Your grade

[1] Anastas, P. T.; Warner, J.C. Green Chemistry Theory and Practice, Oxford University Press, New York, 1998.

will strongly reflect your preparation for and participation in class. Other class performance assessments will include weekly homework assignments, a 6 page typed midterm paper and a 15 minute final presentation to the class.

Textbook and Course Material: There will be two required textbooks for the course. Also, some of the material will be taken from current literature:

1. Lancaster, M.; *Green Chemistry an Introductory Text,* Royal Society of Chemistry, Cambridge, UK 2002. ISBM 0-85404-620-8.
2. Cann, M.C.; Connelly, M.E. *Real World Cases in Green Chemistry,* American Chemical Society: Washington DC. 2000. ISBN 0-8412-3733-6 (Paperback) (RWCGC). $16.00

Additional reference books available in instructor's office:

1. Tufte, E.R. *The Visual Display of Quantitative Information,* Graphics Press, Connecticut, 1983.
2. Tufte, E.R. *Envisioning Information,* Graphics Press, Connecticut, 1990.
3. Matlack, A.S., *Introduction to Green Chemistry,* Marcel Dekker, Inc., New York, 2001.
4. Tundro, P.; Anastas, P., *Green Chemistry Challenging Perspectives,* Oxford Press, Oxford, 2000.
5. Anastas, P.T.; Williamson, T.C., *Green Chemistry, Frontiers in Benign Chemical Syntheses and Processes,* Oxford University Press, Oxford, 1998.
6. Anastas, P.T.; Bickart, P.H.; Kirchhoff, M.M., *Designing Safer Polymers,*Wiley Interscience, NY.
7. *Green Chemical Syntheses and Processes, ACS Symposium Series 767,* Anastas, P.T.; Heine, L.G.; Williamson, T.C. (Editors), American Chemical Society, Washington, D.C., 2000.
8. Anastas, P.T.; Warner, J. C., *Green Chemistry, Theory and Practice,* Oxford University Press, Oxford, 2000. ISBN: 0 19 850698 8 (Paperback)

Course Evaluation:

Weekly Assignments:

The assignments for the class will focus on developing good presentation skills and developing the ability to critically evaluate the literature. Detailed descriptions of the assignments will be posted on the course website.

Literature Summaries:

Every Monday, one quarter of the class will be expected to turn in a *typed* summary of one of the journal articles assigned for the prior week and to lead the discussion of the articles during Monday's class. These summaries will follow an online discussion outside of the classroom, using the Blackboard environment as a tool to facilitate discussion during the previous week. Please refer to the handout 'Literature_Summary_Guidelines' (on the website in the 'Class 1: 03.31.03' folder in 'Course Materials') for a description of what you are expected to do for the summaries and for the online discussion. *Everyone* is expected to come to class prepared to discuss the journal articles assigned for that week.

Midterm Paper:

A 4 page midterm paper critiquing a specific recent development in green chemistry will be due at the end of the midterm week (May 2nd.) Students are encouraged to refer to *Real World Cases in Green Chemistry* for an example on how to structure the paper. The paper can be written as if it were an additional chapter in the book. Topics are easily found from other or more recent Presidential Green Chemistry Awards that are not covered in the text. For more information please refer to the handout 'Midterm_Paper' (on the website in the 'Class 1: 03.31.03' folder in 'Course Materials') for a detailed

description.) A topic should be chosen BEFORE April 11, 2003. An updated sign-up for the Midterm paper will be posted on the course website, as topics are chosen. Topics cannot be duplicated.

Final Project:

The final project for the course will be a 15 minute in class presentation of your critical evaluation of a green chemical process or procedure that was recently developed. These critiques should closely follow the outline used in each Chapter of *Real World Cases in Green Chemistry*. Homework assignments throughout the course will be geared towards helping you to assemble and prepare this 15 minute PowerPoint presentation.

Please see the 'Detailed Schedule' (on the website in the 'Class 1: 03.31.03' folder in 'Course Materials') for due dates for specific homework assignments. Late assignments will be graded, however 10% of the grade will be deducted for each day it is late. The maximum grade that can be awarded on an assignment that is received two days late will be 80%.