



## Green Chemistry

The University of Toledo  
Department of Chemistry and Biochemistry  
College of Natural Science and Mathematics  
CHEM 8200, CRN 47313, Section 001

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<b>Instructor:</b>	Dr. Mark R. Mason	<b>Offered:</b>	Fall 2021
<b>Email:</b>	mark.mason5@utoledo.edu	<b>Class Location:</b>	1049 Bowman-Oddy Labs
<b>Office Hours:</b>	T, Th 1:00-3:00 pm	<b>Class Day/Time:</b>	Tuesday, Thursday 5:30 – 6:50 pm
<b>Office Location:</b>	3260 Wolfe Hall	<b>Credit Hours:</b>	3
<b>Instructor Phone:</b>	419-530-1532		

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### CATALOG/COURSE DESCRIPTION

Advanced topics in green chemistry, including industrial applications, atom economy, safer solvent substitutions, alternatives assessment, green metrics (PMI, E-factor), basic life cycle analysis, and an introduction to chemical toxicology.

### COURSE OVERVIEW

Green chemistry is the utilization of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products, including fuels, plastics, polymers, synthetic fibers, pharmaceuticals, food additives, fragrances, pesticides, herbicides, detergents and cleaning supplies. This course will introduce the principles and fundamental concepts of green chemistry, and provide examples of commercial applications of green chemistry. The course will be especially pertinent for students studying chemistry, medicinal chemistry, chemical engineering, and environmental sciences.

### STUDENT LEARNING OUTCOMES

Upon completion of this course, students will be able to:

1. Apply the principles of green chemistry to chemical-related problems and waste reduction.
2. Apply the principles of green chemistry to improve chemical manufacturing processes.
3. Calculate atom economy, process mass intensity, and E-factor.
4. Analyze toxicology data, materials properties, and regulatory requirements to choose safer chemicals for product formulations and process chemistry.
5. Understand the fundamentals of chemical alternatives assessment using QCAT and Green Screen.
6. Search authoritative lists for data required to perform a chemical alternatives assessment using QCAT.
7. Utilize EPA software packages to predict physical, chemical, and toxicological properties of chemical substances
8. Explain how green chemistry principles can be used to advance UN Sustainable Development Goals.



## TEACHING METHODOLOGY

Course material will be presented in a traditional lecture style using Power Point slides. Slides will be posted on Blackboard for your convenience. Since I also teach a distance learning version of this course, those lecture modules will be accessible to you to supplement my in-class lectures. *These are not comprehensive and are not a substitute for attending lectures.* Students should keep up with assigned reading and ask questions in class or by email.

## PREREQUISITES AND COREQUISITES

Organic Chemistry II (CHEM 2420 or equivalent).

## REQUIRED INSTRUCTIONAL MATERIALS (TEXTS AND ANCILLARY MATERIALS)

Course material will be taken from the text by Lancaster, supplemented with material from texts by Anastas and Warner, Baird and Cann, and Manahan. Additional examples will be taken from scientific articles and reviews which will be posted as pdf files on the Blackboard site for this course.

### Recommended Textbook

Lancaster, M. *Green Chemistry: An Introductory Text*, Third Edition; RSC Publishing; 2016.  
ISBN: 978-1-78262-294-9

### Supplementary Texts

Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press, Oxford; 1998.  
ISBN: 0-19-850234-6

Baird, C.; Cann, M. *Environmental Chemistry*, Fifth Edition; W. H. Freeman and Company, New York; 2012.  
ISBN-13: 978-1-4292-7704-4. (Toxicology, Chapters 13-15)

Manahan, S. E. *Environmental Chemistry*, Eighth Edition; CRC Press, 2005.  
ISBN: 1-56670-633-5. (Toxicology, Chapters 22-23)

### Blackboard

Lecture slides, handouts, problem and exam keys, and pdf versions of pertinent scientific articles will be posted on the Blackboard site for this course. You can login to Blackboard using your UTAD credentials at <https://blackboard.utdl.edu/webapps/login/>. Your course grade book is also located on Blackboard.

## UNIVERSITY POLICIES

### Institutional Classroom Attendance Policy

Please be aware that the university has implemented an attendance policy, which requires faculty to verify student participation in every class a student is registered at the start of each new semester/course. For this course, if you have not attended/participated in class (completed any course activities or assignments) within the first 14 days, I am required by federal law to report you as not attended. Unfortunately, not attending/participating in class impacts your eligibility to receive financial aid, so it is VERY important that you attend class and complete course work in these first two weeks. Please contact me as soon as possible to discuss options and/or possible accommodations if you have any difficulty completing assignments within the first two weeks.



### **Policy Statement on Non-Discrimination on the basis of Disability (ADA):**

The University is an equal opportunity educational institution. Please read [The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance](#). Students can find this policy along with other university policies listed by audience on the [University Policy webpage](#) (<http://www.utoledo.edu/policies/audience.html/#students>).

### **Academic Accommodations**

The University of Toledo embraces the inclusion of students with disabilities. We are committed to ensuring equal opportunity and seamless access for full participation in all courses. For students who have an Accommodations Memo from the Office of Accessibility and Disability Resources, I invite you to correspond with me as soon as possible so that we can communicate confidentially about implementing accommodations in this course.

For students who have not established accommodations with the Office of Accessibility and Disability Resources and are experiencing disability access barriers or are interested in a referral to health care resources for a potential disability, please connect with the office by calling 419.530.4981 or sending an email to [StudentDisability@utoledo.edu](mailto:StudentDisability@utoledo.edu).

### **ACADEMIC AND SUPPORT SERVICES**

Please follow this link to view a comprehensive list of [Student Academic and Support Services](#) (<http://www.utoledo.edu/studentaffairs/departments.html>) available to you as a student.

### **SAFETY AND HEALTH SERVICES FOR UT STUDENTS**

Please use the following link to view a comprehensive list [Campus Health and Safety Services](#) available to you as a student.

### **INCLUSIVE CLASSROOM STATEMENT**

In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, gender identity/expression, socioeconomic background, and a myriad of other social identities and life experiences. We will encourage and appreciate expressions of different ideas, opinions, and beliefs so that conversations and interactions that could potentially be divisive turn, instead, into opportunities for intellectual and personal development.

### **ACADEMIC POLICIES**

**Academic Dishonesty:** The University Policy on Academic Dishonesty will be strictly enforced. See: <http://www.utoledo.edu/dl/students/dishonesty.html>.

### **Drop, Withdrawal and Incomplete Grades**

Course drop and withdrawal procedures have been set by the University faculty. Dropped courses do not appear on your transcript. The deadline for dropping a course is **September 13**. If you are in a course after that date, there will be a grade on your transcript. You may withdraw from the course and receive a grade of W. The deadline for withdrawal is **November 5**. Grades of W do not affect your GPA. You do



not need your instructor's permission for either process. *Note that course registration changes might change your financial aid.*

A course grade of Incomplete (I) is given only to those who have completed all but a small percentage of course requirements for an acceptable reason. If you have a serious problem near the end of the course, communicate with me as soon as possible. You will retain all of your previously determined grades.

### Copyright Notice

The materials in the course website and presentation slides are only for the use of students enrolled in this course for purposes associated with this course, and may not be further disseminated.

### COURSE EXPECTATIONS

Students are expected to attend all lectures, arrive on time, and be prepared to take notes on lecture material and ask questions/discuss reading materials.

### OVERVIEW OF COURSE GRADE ASSIGNMENT

Final grades will be based on three exams (100 points each), four quizzes (15 points each), an in-depth project/presentation (50 points), and a comprehensive final exam (140 points). The following final grading scale (out of a possible 550 points) will be applied:

A	495 points	B	446	C	385	D	336
A-	479	B-	429	C-	369	D-	319
B+	462	C+	413	D+	352		

Exam and quiz dates are provided below:

Exam 1	Tuesday, September 21		
Exam 2	Tuesday, October 19		
Exam 3	Tuesday, November 16		
Final Exam	Tuesday, December 14	5:00-7:00 pm	
Quizzes	Thursday, September 9		
	Thursday, October 7		
	Thursday, November 4		
	Thursday, December 2		

Midterm grades will be assigned based on student performance on the first exam and the first two quizzes.

**Homework:** Problem sets will be distributed periodically. These will not be collected or graded. Answer keys will be discussed in class and posted online.



## COURSE SCHEDULE

<b>Week</b>	<b>Date</b>	<b>Topics</b>	<b>Notes</b>
1	August 31 & Sept 2	Introduction, Atom Economy, Principles of Green Chemistry, UN Sustainable Development Goals	
2	September 7 & 9	Alternative Solvents/Energy Efficiency	Quiz 1, Sept. 9
3	September 14 & 16	Catalysis, Abiotic Depletion of Elements	
4	September 21 & 23	Renewable Feedstocks	Exam 1, Sept. 21
5	September 28 & 30	Biodegradation	
6	October 5 & 7	Introduction to Toxicology	Quiz 2, Oct. 7
7	October 12	Toxicology, Designing Safer Chemicals	<b>No class Oct. 14</b>
8	October 19 & 21	Metrics: E-Factor and PMI	Exam 2, Oct. 19
9	October 26 & 28	Commercial Examples of PMI Life Cycle Analysis	
10	November 2 & 4	Triple Bottom Line, Supply Chain Issues, Business Considerations	Quiz 3, Nov. 4
11	November 9	Risk vs. Hazard Assessment, Chemical Alternatives Assessment	<b>No class Nov. 11</b>
12	November 16 & 18	Environmental Laws, Policies, Regulations	Exam 3, Nov. 16
13	November 23	Inherently Safer Design Emerging Green Technologies	<b>No class Nov. 25</b>
14	November 30 & Dec 2	Presidential Green Chemistry Award Winners	Quiz 4, Dec. 2
15	December 7 & 9	Graduate Student Presentations	
16	December 14	Final Exam, 5:00 – 7:00 pm	<u>Cumulative</u>



## **SPECIAL COURSE EXPECTATIONS DURING COVID-19**

Maintaining a safe campus during the ongoing COVID-19 pandemic remains a top priority. UToledo continues to follow the guidance of the U.S. Centers for Disease Control and Prevention and Ohio Department of Health to keep our campus safe.

### **ATTENDANCE**

The University of Toledo has a missed class policy. It is important that students and instructors discuss attendance requirements for the course. Before coming to campus each day, students should take their temperature and complete a self-assessment for symptoms of COVID-19, such as cough, chills, fatigue or shortness of breath. Anyone with a temperature at or above 100.0 degrees Fahrenheit or who is experiencing symptoms consistent with COVID-19 should not come to campus and should contact their primary care physician or the Main Campus Health Center at 419.530.3451 or Health Science Campus Student Health and Wellness Center at 419.383.5000. For more information on the symptoms of COVID-19, please go to <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>

COVID-19 testing for sick students is available on both Main Campus and Health Science Campus. Call 419.383.4545 for an appointment. Absences due to COVID-19 quarantine or isolation requirements are considered excused absences. Students should notify their instructors and follow the protocols summarized in this document on [Navigating COVID-Related Course Concerns](#).

In the event that you have tested positive for COVID-19 or have been diagnosed as a probable case, please review the [CDC guidance](#) on self-isolation and symptom monitoring, and report the disclosure to the Division of Student Affairs by emailing [StudentAffairs@utoledo.edu](mailto:StudentAffairs@utoledo.edu) or by connecting with their on-call representative at 419.343.9946. Disclosure is voluntary and will only be shared on a need to know basis with staff such as in the Office of Student Advocacy and Support, The Office of Residence Life, and/or the Office of Accessibility and Disability Resources to coordinate supportive measures and meet contact tracing requirements.

### **FACE COVERINGS**

Face coverings are required while on campus, except while eating, alone in an enclosed space, or outdoors practicing social distancing. Students will not be permitted in class without a face covering. If you have a medical reason preventing you from wearing a face covering due to a health condition deemed high-risk by the CDC, submit an [online application](#) to request an accommodation through the Office of Accessibility and Disability Resources. Students will need to provide documentation that verifies their health condition or disability and supports the need for accommodations. Students already affiliated with the Office of Accessibility and Disability Resources who would like to request additional accommodations due to the impact of COVID-19, should contact their accessibility specialist to discuss



their specific needs. You may connect with the office by calling 419.530.4981 or sending an email to [StudentDisability@utoledo.edu](mailto:StudentDisability@utoledo.edu).

### **VACCINATION**

Doctors and other health care professionals agree that the best way to protect ourselves and each other is to get vaccinated. Case data clearly show that vaccines remain highly effective at preventing serious illness from COVID, including the highly contagious delta variant. If you have not yet received your COVID vaccine, the University encourages you do so as soon as possible. No appointment is needed to get the shot at the UTMC Outpatient Pharmacy, University Health Clinic or Main Campus Pharmacy. Once you receive the COVID vaccination, please register on the COVID Vaccine Registry site at: <https://utvaccinereg.utoledo.edu/>.

### **SPECIAL NOTES**

It is important to note, that based on the unpredictability of the COVID-19 virus, things can change at any time. So please be patient and understanding as we move through the semester. Please refer to <https://www.utoledo.edu/coronavirus/> on a regular basis for updates to current requirements or mandates. I also ask that you keep me informed of concerns you may have about class, completing course work/assignments timely and/or health concerns related to COVID.