Molecular Design Research Network (MoDRN):

Educational Tools for Advancing 21st Century Chemistry

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4th Principle of Green Chemistry

Chemical products should be designed to preserve efficacy of function while reducing toxicity.

- Biology
- Pharmacology
- Computational Chemistry
- Toxicology
Molecular Design Research Network (MoDRN)
Multi-pronged Approach to Education

- Set of web modules designed for high school students in chemistry, biology and environmental science majors
- Inquiry-based learning workshop for high school teachers (2 weeks)
- Over 50 short videos in green chemistry with examples of industrial case studies for undergraduate level faculty
- On-line course focusing on mechanistic toxicology for undergraduates → MoDRN:U
- Combination of short courses and eLearning for practitioners in the field (e.g. certificate program)
MoDRN Modules: Next Generation Science Standards

- Developed and piloted MoDRN high school modules
- Concepts relevant to STEM education
- Easily integrated into any existing curriculum
- Available: http://modrn.yale.edu/education
- Curriculum includes:
  - Teacher’s Notes
  - Corresponding Next Generation Science Standard
  - Background/Real World Application/Materials & Method
  - Pre-Lab Questions (where applicable)
  - Experiment
  - Post-Lab Questions (where applicable)
MoDRN Inquiry-Based Learning Workshop for High School Teachers

Week 1: Baylor Science Building (Brooks Research Lab)

- Teachers design and conduct novel experiments to test teacher-generated hypotheses

Week 2: Baylor Research Innovation Collaborative (BRIC)

- Regional Education Service Center On-Site
- Classroom activities, and teacher produced lesson plans
Toxicity Experiments and Presentations

• Is there a difference in toxicity to *D. magna* for consumer products in four different categories between those marketed as green and those not marketed as green?

• Two of the four “green labeled” products were less toxic than conventional products and two were more toxic.
High School Students: Science Fair Ideas Database

- Developed several high school level science fair projects [green chemistry, toxicology, human health]
- Projects range in difficulty, time, and costs
- Additional questions to engage creativity
- Projects are tested and approved by high school science teachers
MoDRN: U

- Provides information on current topics that bridge Green Chemistry and Toxicology for undergraduates as they relate to the MoDRN project
- Freely available online as open access materials
- Each module includes learning outcomes, background information, video, assignment, and additional references.
- Each based on a key aspect of MoDRN research and key concepts for sustainable design
MoDRN:U Modules Introduction

Through a multidisciplinary collaboration between chemists, toxicologists, engineers and biologists from four different universities, MoDRN (Molecular Design Research Network) scientists aim to develop a systematic approach to understand and design chemicals that are both efficacious in their own right and chemically benign to the environment. The founding principle of MoDRN was derived from the 4th Principle of Green Chemistry, which states, “chemical products should be designed to preserve efficacy of function while minimizing toxicity”. With such strong collaborations with experts from different areas, it becomes possible to develop chemicals with the desired properties and predictable toxicity, and MoDRN serves as the important platform to achieve that goal.

The MoDRN team has developed a series of modules designed for undergraduate science and mixed-major/non-major classrooms to introduce concepts of green chemistry and sustainable chemical design. These are called the MoDRN:U Modules. The overall goal of these materials is to engage undergraduate students with educational concepts and activities that will aid dissemination of scientific principles relevant to the design of safer, next-generation molecules. Integrating MoDRN:U Modules into existing undergraduate lesson plans will allow students to make more connections with how interdisciplinary these topics truly are. The modules allow students to be introduced briefly to the relationship of physiochemical properties and toxicology, while providing faculty with resources for more information for their students. There are learning objectives for each module as well as a small assignment designed to be used in or out of class to assess comprehension (but not overwhelm time and syllabi schedules). The MoDRN:U Modules found by accessing the left menu are free to use and modify. Please return back frequently for new modules to come.

The MoDRN:U Modules were developed to introduce that concept that physicochemical properties and principles of toxicology are important aspects of consideration when designing safer chemicals. Undergraduate students will learn more about these topics by accessing each module and with small assignments associated with each module.

We value your feedback and will use it to help create more MoDRN:U Modules for use in your classroom. Please take a few minutes to fill out the evaluation form found at the end of each module. Or click here to access the evaluation through this homepage.
“...digital game-based learning has been recognized as a promising approach for motivating students to learn “

Green Chemistry and Safer Chemical Design Game

- Simulates decision making process to design safe chemicals in sustainable way
- Life Cycle Considerations: feedstock selection, cost of production and more
- Beta version available in Fall 2016
2-Day Course: Nexus of Toxicology and Chemistry

Target Audience: This workshop introduced chemists, toxicologists, material scientists and other scientists engaged in product design to systematic decision making about design and selection of safer commercial chemicals.

Collaboration: Northwest Green Chemistry and MoDRN

Supported by: EPA Region 1, EPA Region 10, University of OR, OHSU, Northwest Center for Occupational Health and Safety, UW DEOHS, and WA Dept of Ecology
Chemists, material scientists, regulators, teachers, and everyone who wants to learn about designing safer commercial products & industrial processes

Three courses:
1. Sustainability, Toxicology and Human Health
2. Principles of Green Chemistry
3. Assessment tools for Safer Chemical Decisions
Testimonial

• “I have the opportunity to pitch "sustainable product development" (cradle-to-cradle design, etc.) to our CEO and a board of Presidents. I plan to incorporate many bits of information & sustainable concepts I've learned throughout the course and show how those greatly align with [X]'s vision for the company in 2020.”

- 2016 Graduate of Green Chemistry and Chemical Stewardship Certificate Program
THANK YOU!

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