An Interdisciplinary Approach to Green Chemistry: Sustainable Biofuels Development

Monday and Wednesday 4-5:30 pm

Chem 234, SPH 234, CNR 234

3 Units

Project based course

Sustainability asks us to look broadly

Must Consider the Entire Product Cycle

BERKELEY CENTER FOR GREEN CHEMISTRY

Interdisciplinary Approach

Hass School of Business

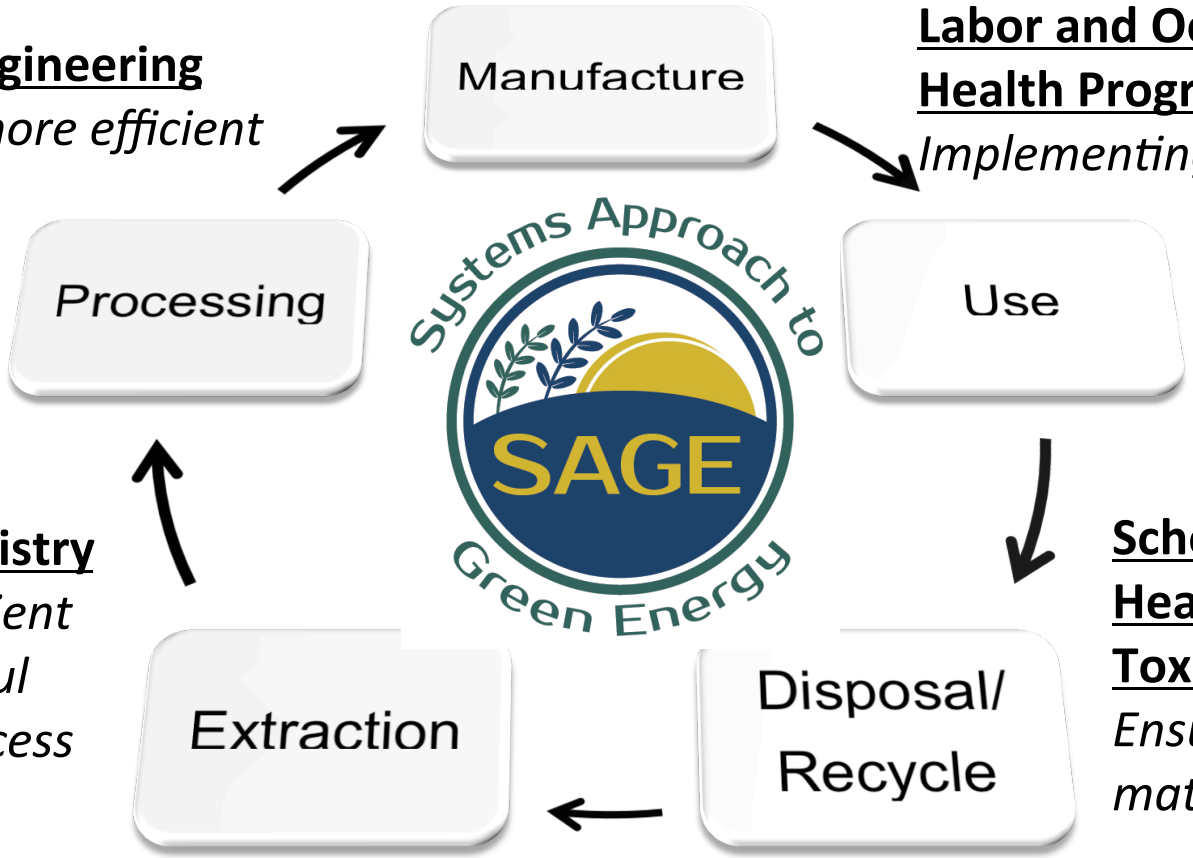
Characterizing the Business drivers

College of Engineering

Developing more efficient processes

Labor and Occupational Health Program

Implementing understanding



College of Chemistry

Using more efficient and less impactful chemicals & process

School of Public Health and Toxicology

Ensuring safer materials selection

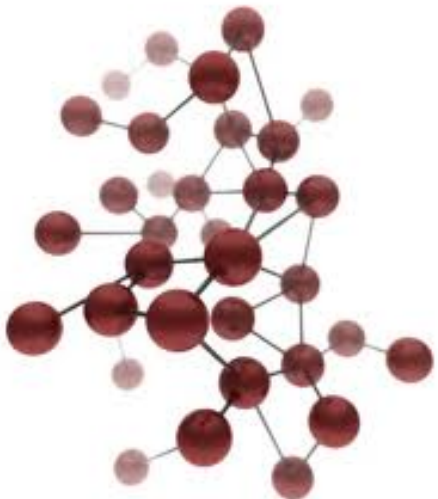
College of Natural Resources

Understanding the impacts of chemical products on the environment

Interactive Learning

Respect

Collaborate



Create

Course Details

B-Space:

Please mark the sign-in sheet if you received my B-Space announcements yesterday.

- All readings, resources and assignments will be posted to B-Space.

Grading:

(1) Class Participation: 20%

(2) Critical Review of a Biofuel: 80%

- Peer evaluation will be used to evaluate contributions to group work.

Biofuel Review

3-5 students from different disciplines produce a critical review of a biofuel technology and outline the barriers to broad adoption of the technology.

Biofuels

- Ethanol from cellulosic biomass
- Biodiesel from plant oils (FAME diesel)
- Biodiesel from algae (isoprinoid diesel *Amyris* or FAME like from extracted oils)
- Other Algae Biofuels (Butanol, Methanol, Ethanol (seawater and cyanobacteria), BioGasoline (Hexane through dodecane)
- Biomass gasification to Methane
- Syngas (H2 + CO) from biomass
- gamma-valerolactone from biomass as liquid fuel and feedstock
- Biomass to Electricity by burning or co-burning with coal

Timeline

Jan. 30th give preference and groups assigned

Reading Week Presentations

May 10th Final Draft

Teaching Team

Sasha Harris-Lovett,
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Dr. Meg Schwarzman,
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Professor Tom McKone,
LBNL and SPH
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Professor Alastair Iles,
ESMP
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Professor Chris Rosen,
Business
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Professor Chris Vulpe,
Nutrition and Toxicology
Vulpe@berkeley.edu

Dr. Marty Mulvihill,
Chemistry and COEH
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Dr. Joe Guth,
COEH
jguth@berkeley.edu

Professor John Arnold,
Chemistry
arnold@berkeley.edu

Quick Introductions

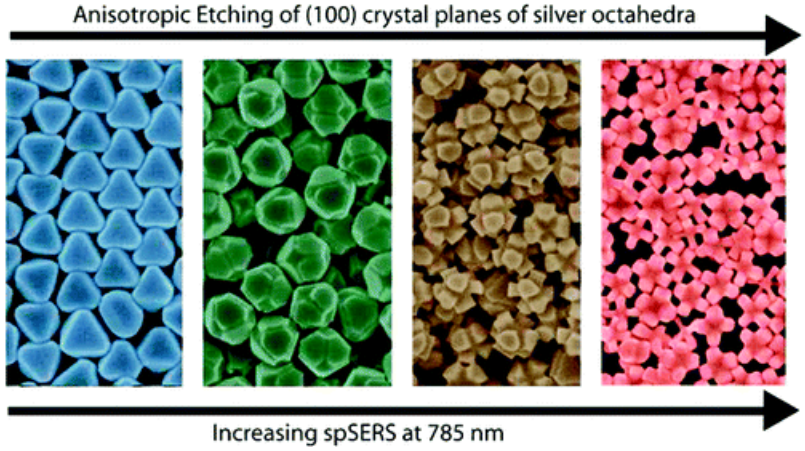
Name,

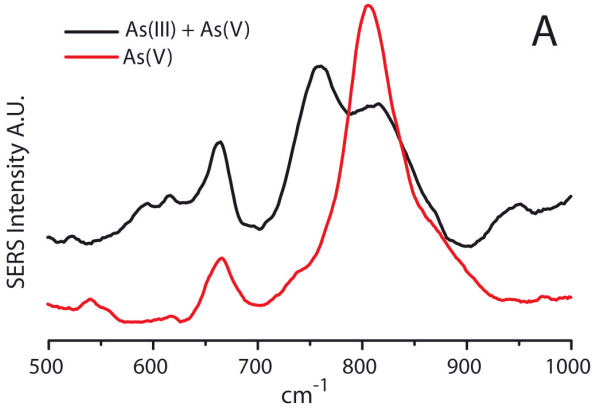
Department,

Research Area or Interest

Green Chemistry is a design strategy

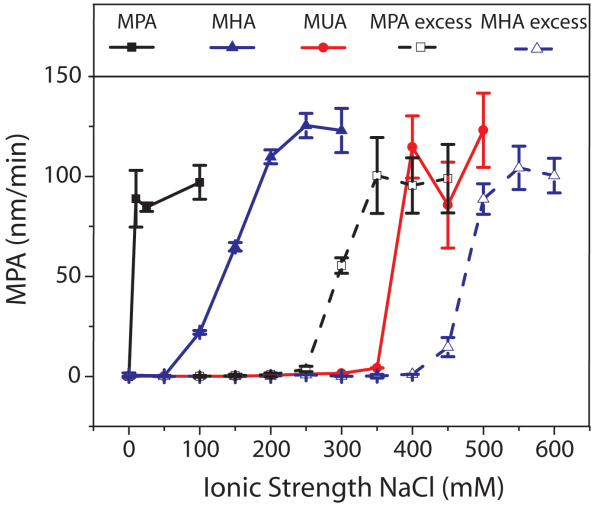
Marty_m@berkeley.edu





Greener Synthesis

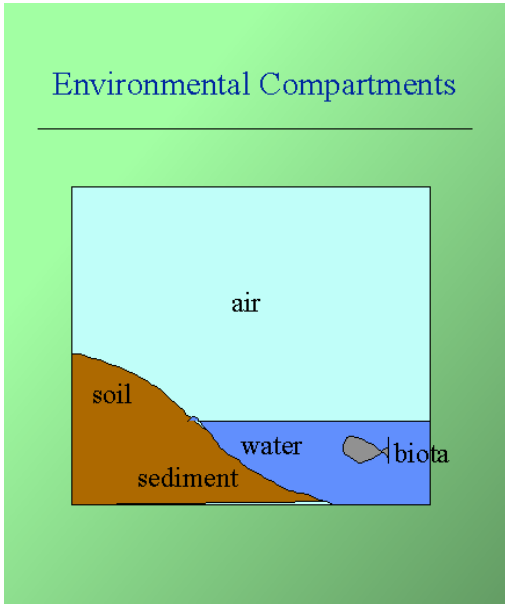
Environmental Applications



Understanding

Environmental

Fate and Toxicity



Sasha Harris-Lovett
sharrislovett@berkeley.edu

Sign up on bSpace for office hours:
Mon. 9:30-4:00
or Wed. 5:30-6:30

Business Dimension – Commercialization of Biofuels

- Chris Rosen
  - Haas School of Business
  - crosen@haas.berkeley.edu
  - F577 Haas

EUROPEAN ALGAE BIOMASS

24-25 APRIL VIENNA, AUSTRIA

Accelerating the Commercialisation of Algal Biomass Through Applied R&D and Business Strategy

Key Topics

- Commercial Market Analysis & Forecasts
- Strain Selection & Genetic Engineering
- The Future for European Algae Biomass: View from Diverse Markets
- Algal Culture Systems: Latest Developments from Laboratory & Field
- Harvesting, Dewatering, Drying & Oil Extraction: Maximising Efficiency & Reducing Cost
- Commercial Algae Production: Case Study Examples
- Biofuel Production & Biorefining
- Algae-Based CO2 Capture
- Algae as an Investment Opportunity: An Investor's Viewpoint

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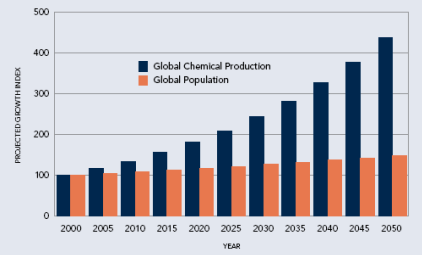
- $ Commercial Algae Production: Case Study Examples
- Biofuel Production & Biorefining
- Algae-Based CO2 Capture
- $ Algae as an Investment Opportunity: An Investor's Viewpoint

Key themes

- Market structure & competition
- Drivers and barriers
  - Private and public investment
  - Regulatory policies
  - Technological breakthroughs & challenges
  - Scaling up challenges
  - Internal organizational barriers & dynamic capabilities
- Risks and risk management

Key Issues in Environmental Health

- Synthetic chemicals and pollutants are ubiquitous in the environment and in people



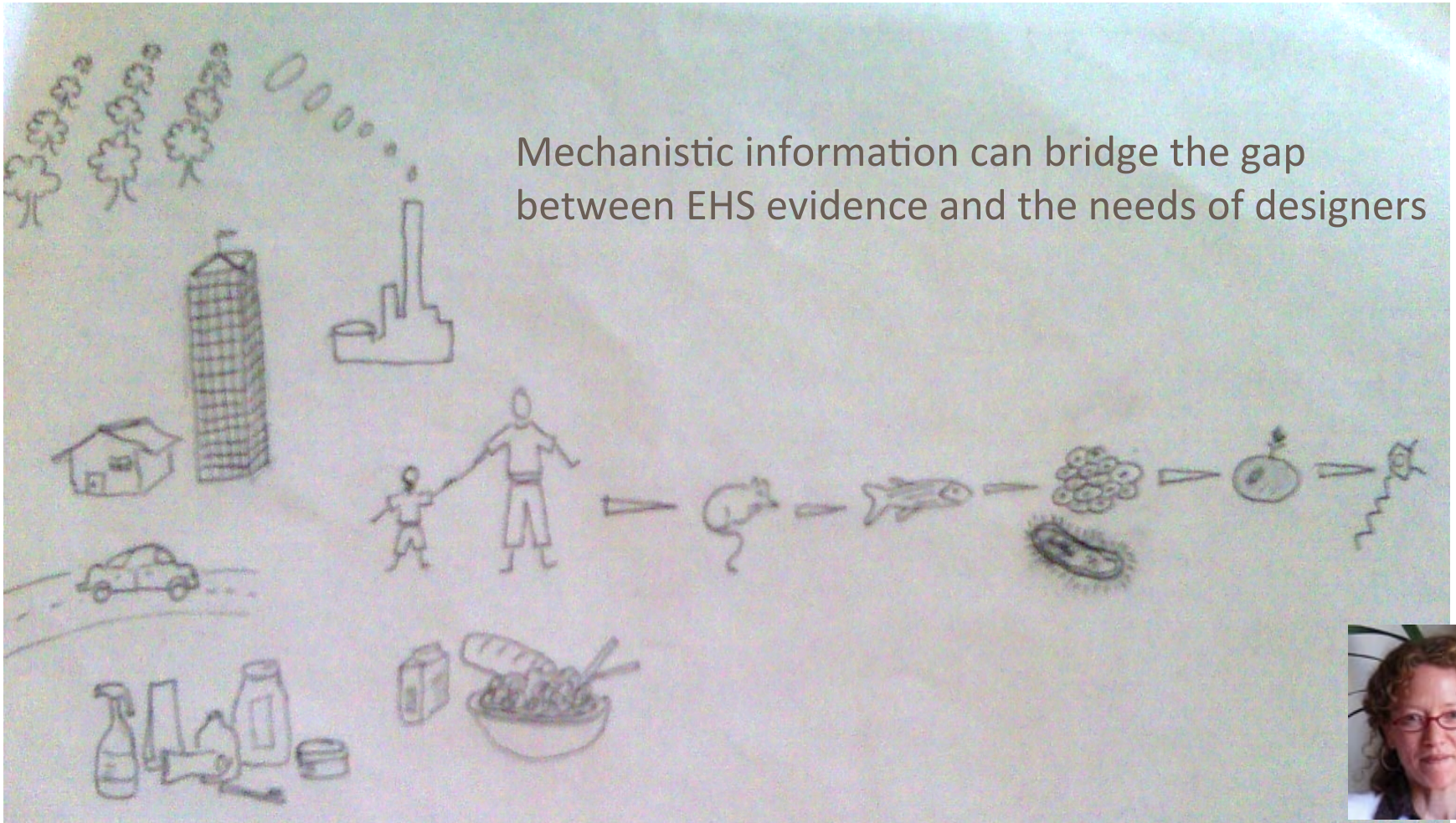
- Chemical exposure is known or suspected to contribute to a wide range of common diseases

Cancer	Infertility	Asthma & allergies
Obesity	Heart disease	Neurodevelopmental problems

- All is not lost! A basic understanding of what drives toxicity (e.g., hazard, exposure, vulnerability) can:
  - Help set priorities (in research, policy)
  - Guide selection of alternatives
  - Inform design of safer substances

Key Issues in Environmental Health

Goal: Make human health and environmental impacts design criteria not obstacles



Introduction

UC BERKELEY

Legal Director, Science & Environmental Health Network (www.sehn.org)

Berkeley Center For Green Chemistry (http://bie.berkeley.edu.cgc.home)
jguth@berkeley.edu

SEHN is a member of:
CHANGE: Californians for a Health ANd Green Economy (changecalifornia.org)
Safer Chemicals, Healthy Families Coalition (www.saferchemicals.org/)

Currently appointed member of Cal/EPA's:
Cumulative Impacts and Precautionary Approaches Workgroup
Green Ribbon Science Panel

- Former member of U.S. EPA's National Pollution Prevention and Toxics Advisory
Committee (NPPTAC)

Three major topics to be presented and integrated into the projects by Joseph Guth

1) Overview of environmental law, particularly the role of ethics in environmental decision-making, and comparison of utilitarian/cost-benefit analysis with deontological/precautionary approaches.

2) Regulation of chemicals in the US under the Toxic Substances Control Act.

3) Regulation of chemicals under emerging more precautionary legal institutions, particularly the European Union's recent law known as REACH.

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John Arnold, Chemistry

Synthetic Chemistry

- Catalysis
  - Alternatives to Pt in fuel cell catalysis
  - Non-precious metal replacements for existing catalytic processes
- Alternatives to Fossil Fuels
  - Fundamental chemistry of *f*-element compounds

- Catalysis - a bed-rock principle of Green Chemistry
- Sustainable materials
- Efforts to tie in with toxicity research, training

Tom McKone, School of Public Health,
Lawrence Berkeley National Laboratory

Sustainable Energy Systems Research

- Energy and health
- Emerging energy technologies total cost (price and externalities)
- Life-cycle impact assessment for biofuels
  - carbon footprint
  - health burden
  - water footprint

- Framing energy-health research questions
- Quantifying and valuing life-cycle impacts for all SAGE technologies
- Can provide support broadly for biofuels projects

Photo is from WW Nazaroff

Chris Vulpe, Nutritional Sciences and Toxicology

Conserved cellular response to chemicals

Functional Toxicology
Predict chemical reactivity in organisms

High throughput toxicity assays
Enable rapid screens of chemicals

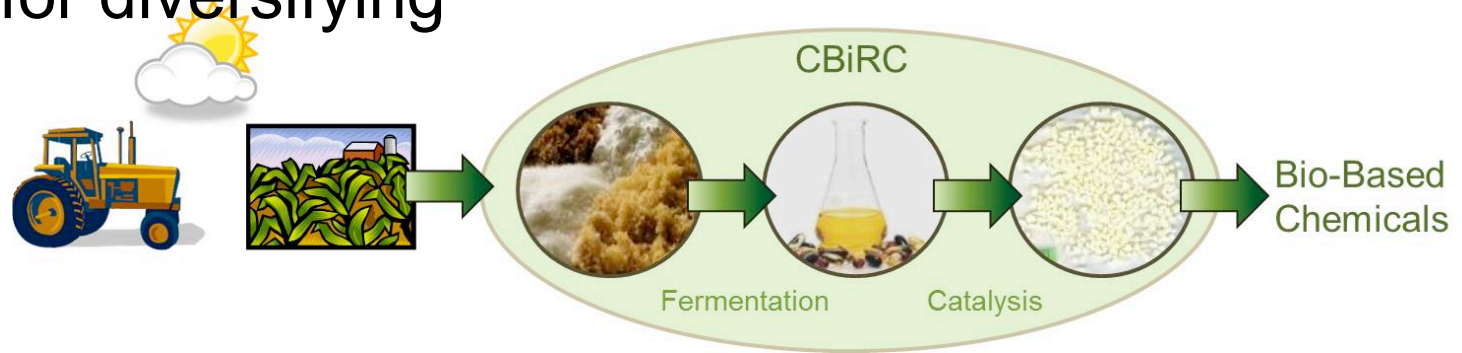
Genetic diversity in toxicant response
Consider variability in chemical effects

Eco-indicator genomics
Screen chemicals for effects to environmentally relevant organisms

Green Chemistry & Sustainable Materials research

- Green chemistry policies and regulation
  - US versus Europe
  - Biobased chemicals
- Environmental justice in emerging technologies like biofuels and biomonitoring
- Sustainable farming systems (agroecology, policies for diversifying farms)

- For SAGE: I'm interested in the development of a systems approach that integrates GC principles, public policies, processes for evaluating materials, environmental health, and upstream inputs (e.g., agriculture) into technology design



Group Discussion Based on NY Times Reading

Some of the people who may be affected by the decisions that we make in terms of biofuels, feedstock, and production methods

Biofuels are not all the same.

What trade-off would you make?

Globalized feedstock and food distribution cross nation boundaries and carry different burdens locally.

Questions to mull in your small groups

- What should be the role of ethics in helping guide chemists, engineers, toxicologists, policy-makers, and business leaders in deciding how to develop biofuels?

- What, if anything, *can* these actors achieve by trying to act more ethically?

- At what point in the life cycle should we consider ethics?