

YALE – UNIDO TRAIN THE FACILITATOR WORKSHOP

DAY 1

LEARNING OBJECTIVES

- Describe historical and current view of the society, economy and environment with sustainability
- Define Sustainability and its role as a business driver.
- Describe myths for businesses when integrating sustainability into their organizations.
- Recognize tools to measure sustainability.
- Understand the role of chemicals in the society, economy and environment.
- Recognize how chemicals can positively and negatively impact the world.

9.00 – 10.30 AM Morning Session I – Sustainability I (1.5h)

1. Sustainability – Myths and Facts
2. Society, Economy, and the Environment

Break

10.45 – 12.15 PM Morning Session II – Sustainability II

3. Business and Sustainability
 - a. Applying Green Chemistry to Management
4. Different Models of Sustainability

5. Case Study: The Interface Company
6. In-Class Discussion

Lunch

1:15 – 2:45 PM Afternoon Session I - Sustainability III

7. Describe Processes for Reporting and Measuring Sustainable Actions
8. Life Cycle Assessment
9. Definitions & Examples
10. In-Class Exercise

Break

3:00 – 4:30 PM Afternoon Session II – Disasters and Unintended Consequences

1. Chemical and Industrial Accidents
 - a. Union Carbide, 1984
 - b. Cuyahoga River, 1969
 - c. Port of Tianjin, 2015
2. Unintended Consequences
3. Green Chemistry is Everybody's Job
4. Perspective and Context
5. Green Chemistry – Where do we go from here?

DAY 2

LEARNING OBJECTIVES

- Review the definition and the Twelve Principles of Green Chemistry.
- Describe the benefits of green chemistry in society, economy and environment.
- Analyze the efficiency of various approaches to chemical design.
- Identify the advantages and disadvantages of various process feedstocks.

9.00 – 10.30 AM Morning Session I – Definition & Benefits of Green Chemistry

1. Green Chemistry and Design Criteria
2. Chemical Design
 - a. Current Innovations in Chemical Design
3. Green Chemistry Design in Other Fields
4. The Market for Green Chemistry
5. Green Chemistry Benefits are In Demand
6. Applications of Green Chemistry - Examples

Break

10.45 – 12.15 PM Morning Session II – The 12 Principles of Green Chemistry I

1. The Twelve Principles of Green Chemistry
2. Industrial examples of Green Chemistry

Lunch

1:15 – 2:45 PM Afternoon Session I - The 12 Principles of Green Chemistry II

3. The Twelve Principles of Green Chemistry
4. Industrial examples of Green Chemistry
5. In-Class exercise

Break

3:00 – 4:30 PM Afternoon Session II – Renewable Feedstocks

1. Energy and Feedstock Consumption
2. Petroleum
3. Renewable Feedstocks
 - a. Biomass Feedstocks
 - b. Carbohydrate Feedstocks
 - c. Lipid Oils and Terpenes as Feedstocks
 - d. Protein Feedstocks
4. Renewable Feedstocks as a Source of Energy
5. First, Second, and Third Generation Feedstocks
6. The Advantages and Drawbacks of Biofuel

DAY 3

LEARNING OBJECTIVES

- Explain transformational role of catalysis on industry and the associated material and energy benefits, including biocatalysts.
- Assess impacts of solvent usage and identify green chemistry alternative solvent systems and the subsequent benefits.
- Discuss the ways to process waste and identify its potential as a feedstock.
- Identify different metrics in green chemistry for implementing best practices.

9.00 – 10.30 AM Morning Session I – Catalysis

1. Activation Energy for Reaction
2. What is a Catalyst?
3. Types of Catalysts
4. Catalysts and Sustainability
5. Important Improvements Using Catalysts
6. Enzymatic Reactions
7. Examples and Considerations

Break

10.45 – 12.15 PM Morning Session II – Solvents

1. What are solvents and how are they used?
2. Conventional Solvents
3. Alternative Solvents
4. Solvent Selection
5. In-Class Exercise
6. Solvent Replacement

Lunch

1:15 – 2:45 PM Afternoon Session I - Waste Prevention

1. The Waste Treatment Pyramid
2. Reduced Solvent Use
3. Waste as a Feedstock
4. Biodegradation of Waste
5. Designing Processes to Include Biodegradation of Waste
6. In-Class Exercise

Break

3:00 – 4:30 PM Afternoon Session II – Metrics

1. Why do We Need Metrics in Green Chemistry?
2. Established Metrics in Green Chemistry
 - a. Atom Economy
 - b. Environmental (E) Factor
 - c. Atom Utilization
 - d. Reaction Mass Efficiency
3. Additional Metrics Used in Green Chemistry
 - a. Process Mass Intensity
 - b. Life Cycle Assessment
 - c. Ecological Indicator/Ecological Footprint
4. In-Class Discussion

DAY 4

LEARNING OBJECTIVES

- Identify estimation tools that integrate the chemical properties and toxicological data for chemical design.
- Recognize role of green chemistry in innovation, both incremental and transformational.
- Review the path from theory to practice.
- Discuss a successful case study examples of green chemistry in industry and small businesses.

9.00 – 10.30 AM Morning Session I – Designing for Reduced Hazard I

1. Hazard and Risk – Past and Present
2. Toxicology
3. In-Class Discussion
4. Assessing Hazards and Exposure
 - a. What Happens When You're Exposed?

Break

10.45 – 12.15 PM Morning Session II - Designing for Reduced Hazard II

5. In-Class Exercise
6. Hazard Minimization Through Molecular Design
7. QSAR - Quantitative Structure Activity Relationship
8. Molecular Design Research Network (MoDRN)

Lunch

1:15 – 2:45 PM Afternoon Session I – From Theory To Practice

1. Implementation: Why, What, and How
2. Understanding Context
 - a. Green Chemistry in the Marketplace
3. Identifying Opportunities
 - a. Life Cycle and Green Chemistry Principles as a Guide to Finding Opportunity
4. Delivering Innovation
5. Green Chemistry Strategies at All Stages
 - a. Green Chemistry Assessment Tool
6. How to Proceed: Moving Forward

Break

3:00 – 4:30 PM Afternoon Session II – Innovation

1. Transformative Innovation
 - a. What is it that we really want?
2. Nature as Inspiration
 - a. Design Challenges
3. Biomimicry
 - a. Color
 - b. Adhesives
 - c. Self-Cleaning
4. There is Still More We Can Learn from Nature

DAY 5 Partnering Country

LEARNING OBJECTIVES

- Learn about Green Chemistry Challenges and Opportunities in Partnering Countries

9.00 – 10.30 AM Morning Session I

- Learning about Green Chemistry Landscape
- Discuss Challenges and Opportunities
- Partner's Case study

Break

10.45 – 12.15 PM Morning Session II

- Partner's Case study

Lunch

1:15 – 2:45 PM Afternoon Session I (1.5h)

- Lessons Learned and the Path Forward

Closing Remarks