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**GREEN CHEMISTRY  
Train the Facilitator Workshop**

**Dates:** …………, **Venue:** ………………….

**PROGRAMME**

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| **DAY 1** | |
| **08:00-08:30** | **Registration** |
| 08:30 - 09:00 | **Welcome**  Welcome by Representatives of National Cleaner Production Center, Brazil  Dr. Karolina Mellor, Center for Green Chemistry & Green Engineering at Yale |
| 09:00 – 10:30 | **Morning Session I: Sustainability 1**   1. Sustainability – Myths and Facts 2. Society, Economy, and the Environment |
| **10:30 - 10:45** | **Tea/ Health Break** |
| 10:45 - 12:15 | **Morning Session II: Sustainability 2**   1. Business and Sustainability    1. Applying Green Chemistry to Management 2. Different Models of Sustainability 3. Case Study: The Interface Company 4. In-Class Discussion |
| **12:15 – 13:15** | **Lunch** |
| 13:15 – 14:45 | **Afternoon Session I: Sustainability 3**   1. Describe Processes for Reporting and Measuring Sustainable Actions 2. Life Cycle Assessment 3. Definitions & Examples 4. In-Class Exercise |
| **14:45 -15:00** | **Tea / Health Break** |
| 15:00 – 16:30 | **Afternoon Session II: Disasters and Unintended Consequences**   1. Chemical and Industrial Accidents    1. Union Carbide, 1984    2. Cuyahoga River, 1969    3. 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? |
| **16:30** | **Break for the day** |
| **DAY 2** | |
| 09:00 – 10:30 | **Morning Session I: Definitions & Benefits of Green Chemistry**   1. What is Green Chemistry 2. Twelve Principles of Green Chemistry 3. Chemical and Green Chemistry Design 4. The Market and Demand for Green Chemistry 5. Examples of the Twelve Principles |
| 10:30 - 10:45 | **Tea/ Health Break** |
| 10:45 - 12:15 | **Morning Session II: Definitions & Benefits of Green Chemistry; Metrics**   1. Examples of the Twelve Principles 2. Conventional Chemistry Metrics 3. Why do we need Metrics in Green Chemistry? 4. Metrics used in Green Chemistry    1. Atom Economy    2. Environmental (E) Factor    3. Process Mass Intensity 5. In Class Discussion |
| **12:15 – 13:15** | **Lunch** |
| 13:15 – 14:45 | **Afternoon Session I: Waste**   1. Appraoches to deal with Environmental Challenges 2. The Waste Treatment Pyramid 3. Reduced Solvent Use 4. Waste as a Feedstock 5. Biodegradation of Waste 6. Biodegradation Demonstration |
| **14:45 -15:00** | **Tea / Health Break** |
| 15:00 – 16:30 | **Afternoon Session II: Renewable Feedstocks for Energy**  1. Energy from Fossil Feedstocks 2. First, Second, and Third Generation Feedstocks 3. The Advantages and Drawbacks of Biofuel |
| **16:30** | **Break for the day** |
| **DAY 3** | |
| 09:00 – 10:30 | **Morning Session I: Renewable Feedstocks for Molecules**   1. Petroleum Chemistry 2. The Biorefinery 3. Renewable Feedstocks    1. Biomass Feedstocks    2. Carbohydrate Feedstocks    3. Triglycerides Feedstock    4. Lignocellulosic Feedstock    5. Protein Feedstocks 4. Renewable Feedstocks as a Source of Molecules    1. A Little History of Vanillin    2. Platform Molecules    3. Advantages & Drawbacks of bio-based Molecules |
| **10:30 - 10:45** | **Tea/ Health Break** |
| 10:45 - 12:15 | **Morning Session II: 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 |
| **12:15 – 13:15** | **Lunch** |
| 13:15 – 14:45 | **Afternoon Session I: Solvents**   1. What are solvents and how are they used? 2. Conventional Solvents 3. Alternative Solvents 4. Solvent Selection 5. In-Class Exercise |
| **14:45 -15:00** | **Tea / Health Break** |
| 15:00 – 16:30 | **Afternoon Session II: Solvents; Energy Delivery in Chemistry**   1. Solvent Replacement 2. Role of Energy in a Chemical Process 3. Microwaves 4. Flow Chemistry 5. Photochemistry 6. Electrochemistry 7. Mechanochemistry |
| **16:30** | **Break for the day** |
| **DAY 4** | |
| 09:00 – 10:30 | **Morning Session I: Designing for Reduced Hazard 1**   1. Hazard and Risk – Past and Present 2. Toxicology 3. In-Class Discussion 4. Assessing Hazards and Exposure    1. What Happens When You’re Exposed? |
| **10:30 - 10:45** | **Tea/ Health Break** |
| 10:45 - 12:15 | **Morning Session II: Designing for Reduced Hazard 2**   1. In-Class Exercise 2. Hazard Minimisation Through Molecular Design 3. QSAR-Quantitative Structure Activity Relationship |
| **12:15 – 13:15** | **Lunch** |
| 13:15 – 14:45 | **Afternoon Session I: Innovation**   1. Transformative Innovation    1. What is it that we really want? 2. Nature as Inspiration    1. Design Challenges 3. Biomimicry    1. Colour    2. Adhesives    3. Self-Cleaning 4. There is Still More We Can Learn from Nature |
| **14:45 -15:00** | **Tea / Health Break** |
| 15:00 – 16:30 | **Afternoon Session II: From Theory to Practice**   1. Implementation: Why, What, and How 2. Understanding Context    1. Green Chemistry in the Marketplace 3. Identify Opportunities    1. Life Cycle and Green Chemistry Principles as a Guide to Finding Opportunity 4. Delivering Innovation 5. Green Chemistry Strategies at All Stages    1. Green Chemistry Assessment Tool 6. How to Proceed: Moving Forward |
| **16:30** | **Break for the day** |

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| **DAY 5** | |
| 09:00 – 10:30 | **Morning Session I:**  Learning about Green Chemistry Landscape  Discuss Challenges and Opportunities |
| **10:30 - 10:45** | **Tea/ Health Break** |
| 10:45 - 12:15 | **Morning Session II:** |
| **12:15 – 13:15** | **Lunch** |
| 13:15 – 14:45 | **Afternoon Session I:** |
|  | **Closing Remarks** |