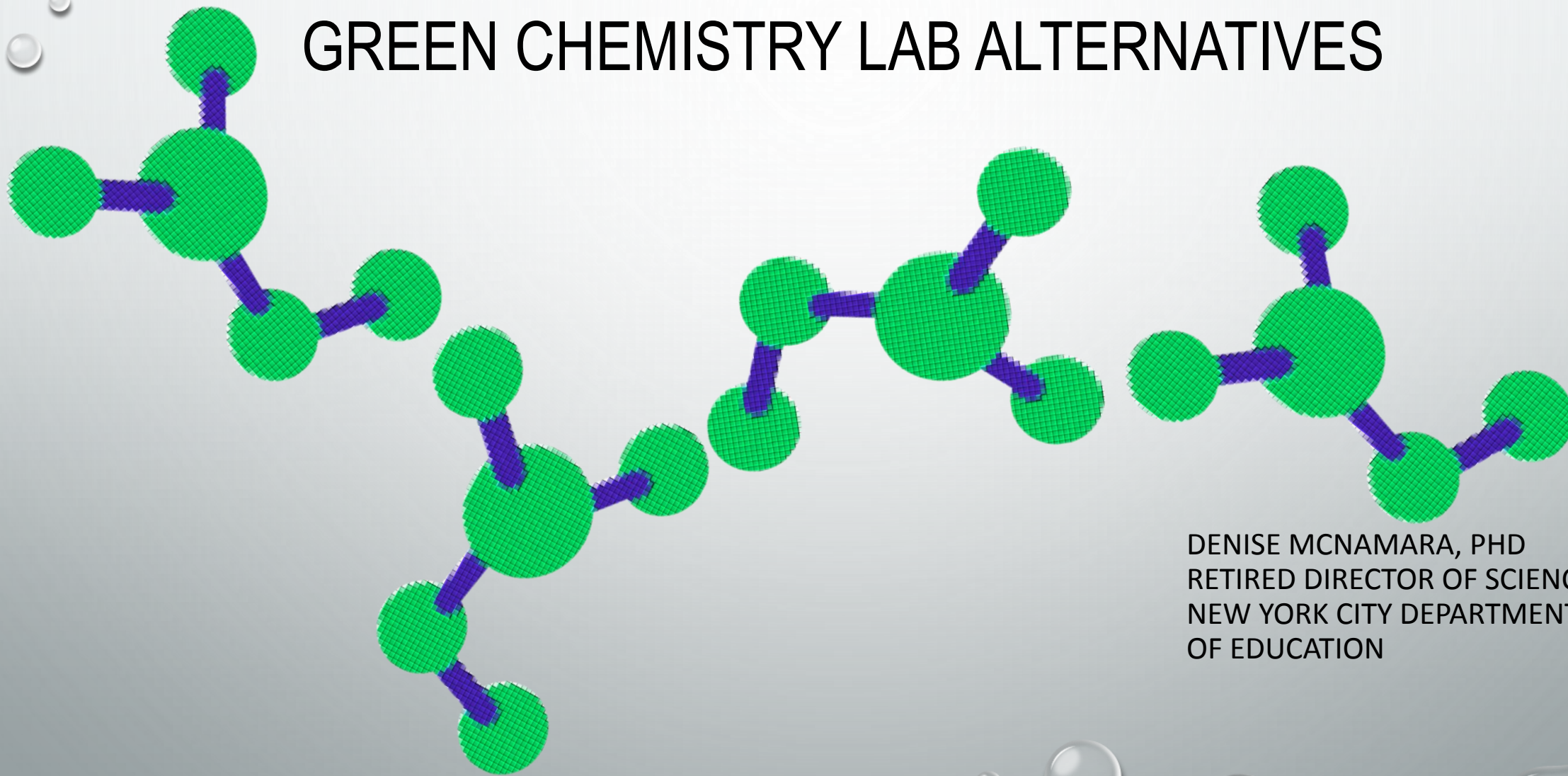


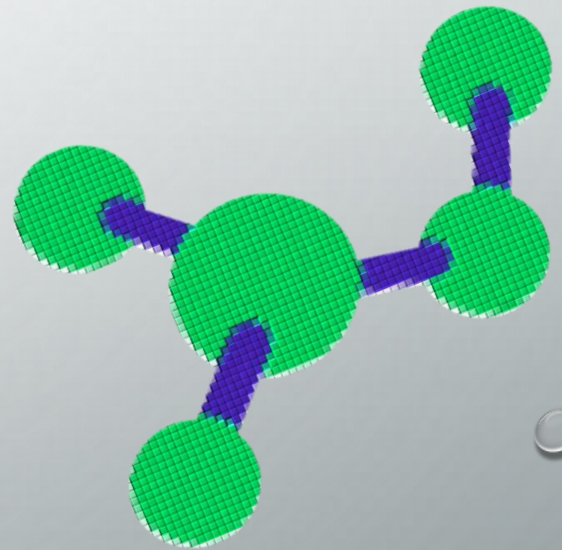
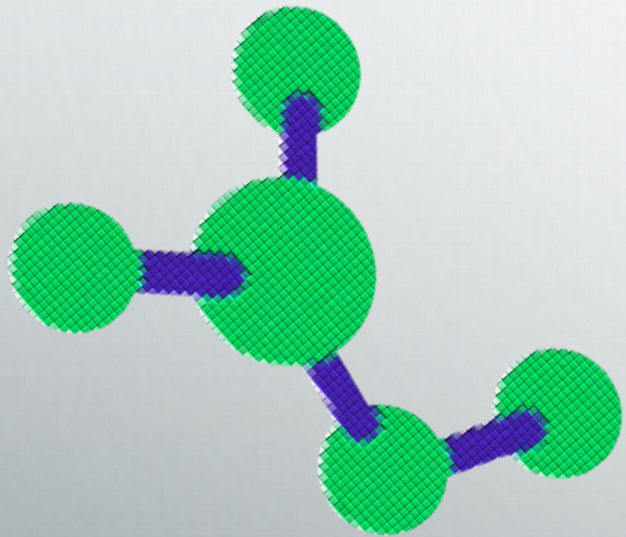
# GREEN CHEMISTRY LAB ALTERNATIVES




DENISE MCNAMARA, PHD  
RETIRED DIRECTOR OF SCIENCE  
NEW YORK CITY DEPARTMENT  
OF EDUCATION

# Defining Green Chemistry

What is Chemistry? What does Chemistry mean to you? Do you think of positive or negative things? What does it mean when companies go "green"?

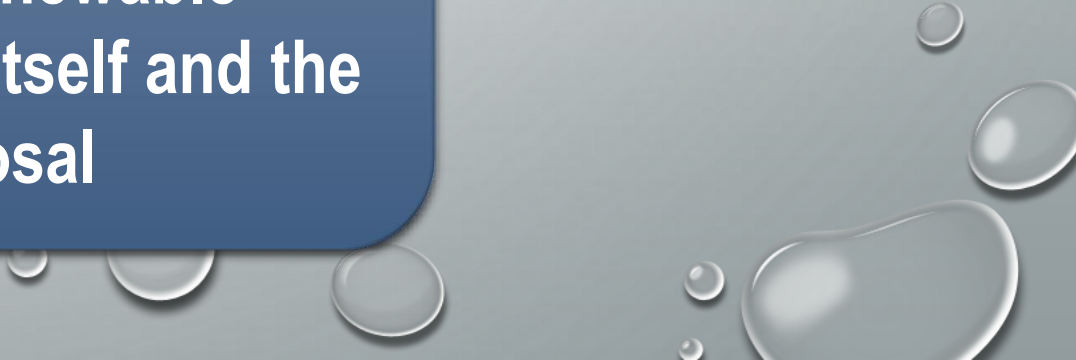




**Green Chemistry  
is pollution  
prevention at the  
molecular level**

**Traditionally chemists were not  
taught about the environmental  
impact of their work. We have had  
many advances and many helpful  
inventions but we have also  
caused harm to the environment.**

**Green Chemists design products  
taking into account the entire process,  
energy efficiency, renewable  
resources, the product itself and the  
product's disposal**





# Principles of Green Chemistry

## Prevention

It is better to prevent waste than to treat or clean up waste after it has been created.

## Economy

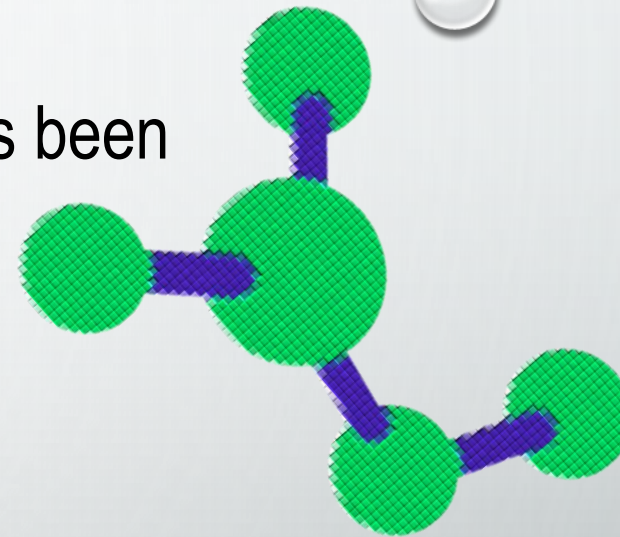
Synthetic methods should be designed to utilize all materials

## Less Hazardous Chemicals

Wherever practicable, utilize substances that possess little or no toxicity to human health and the environment.

## Designing Safer Chemicals

Chemical products should be designed to minimize their toxicity while achieving their use.



## **Design for Degradation**

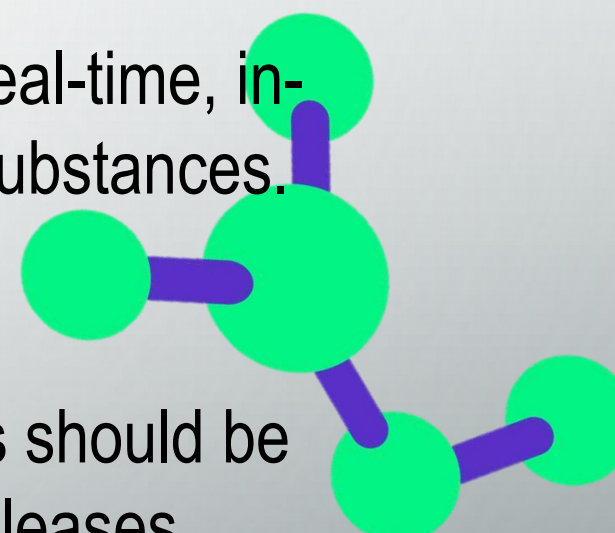
Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

## **Real-time analysis for Pollution Prevention**

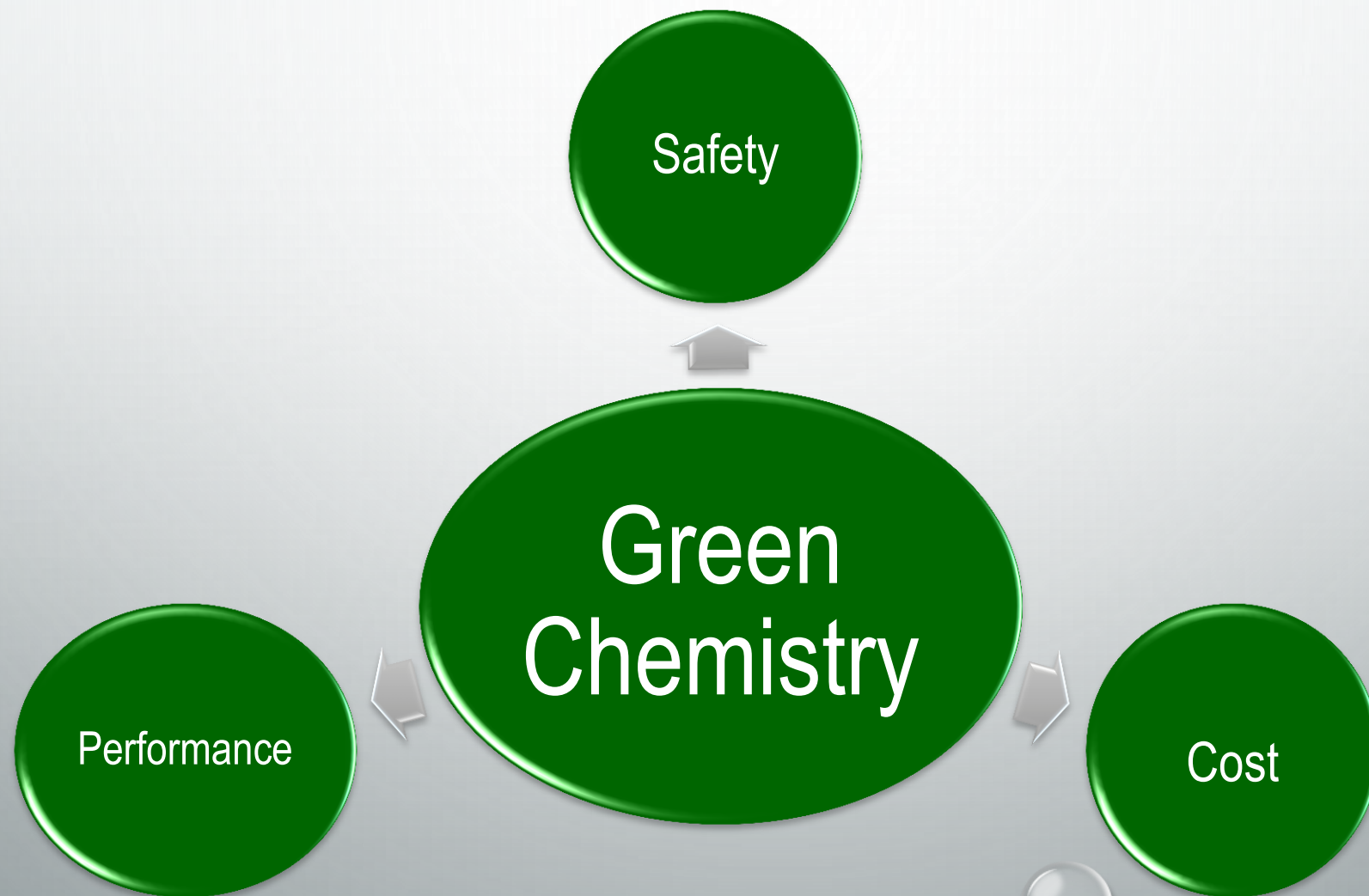
Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

## **Inherently Safer Chemistry for Accident Prevention**

Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.



# THREE FACTORS FOR SUCCESSFUL GREENING OF CHEMISTRY





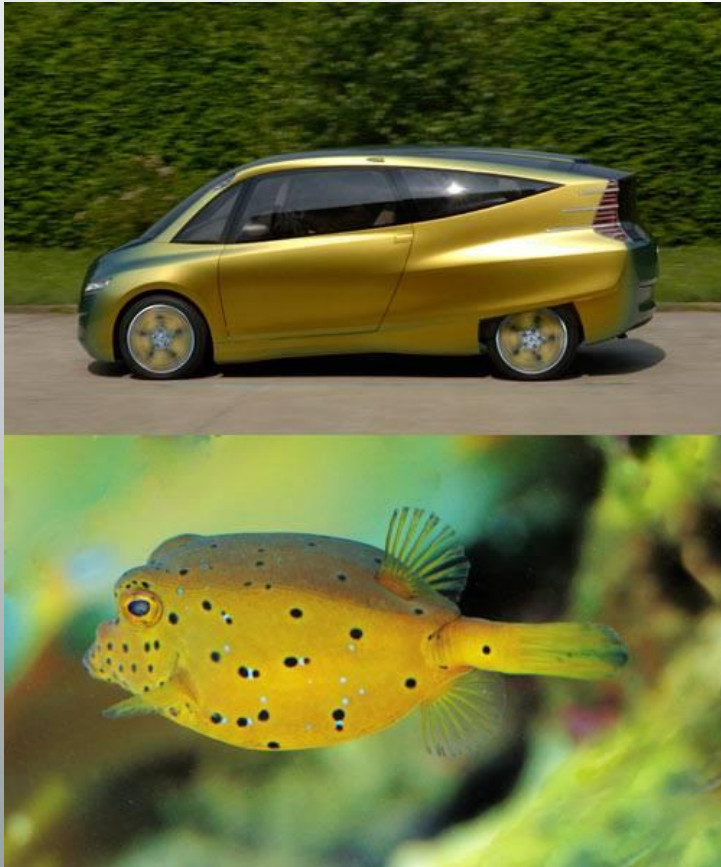
# Biomimicry



Scientists have discovered that the natural world has the most efficient processes on Earth. Learning how to manufacture or create products that mimic how nature operates is called biomimicry.

Biomimicry is learning from nature how to design products that are sustainable. This aligns with green chemistry because this is what green chemists are trying to do.

# Examples of Biomimicry



Mercedes-Benz looked toward the boxfish for their bionic car concept. Noting the aerodynamics and efficiency of the boxfish shape, the engineers decided to apply the characteristics of the fish to the car. The result is a very streamlines vehicle with a 65% lower drag coefficient than other compact cars at the time (2005).



# Examples of Biomimicry



What better example to use for underwater turbine design than the flora and fauna of the oceans? Biopower Systems did just that. Looking at the way sea plants move in currents and the efficient movements of fish like sharks and tuna. BioPower used evolution as its role model for designing turbines for effective tidal power generation.

# Examples of Biomimicry



If you have ever tried to pick a mussel off a rock or pier piling, you've likely noticed that they sure know how to stick to something. Columbia Forest Products looked at the natural adhesive abilities of the blue mussel and came up with a way to use soy-based formaldehyde-free technology in the construction of hardwood plywood products.

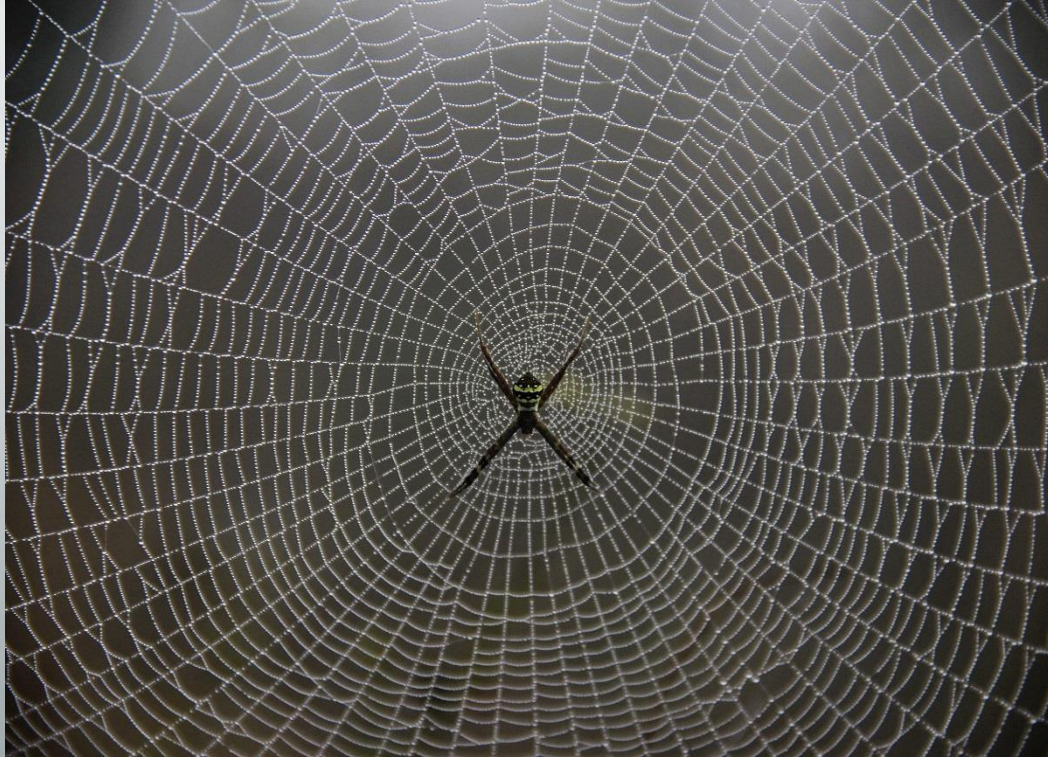


# Examples of Biomimicry



The goal was to cut out the extremely loud claps that occurred when Japan's bullet train emerged from tunnels. Engineers looked toward the kingfisher, which dives seamlessly into water. A nosecone designed after the bird's beak solved the issue.





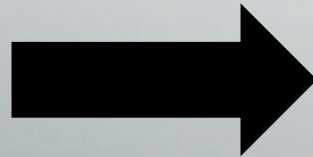
How do spiders catch their food? They use a “glue” to coat their webs to catch their prey. Scientists are studying the process of the natural glue for human use.

# Polymerization



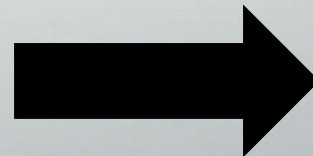
$C_4H_6O_2$   
Polyvinyl Acetate

Monomer  
+  
Solvent



Heat

Polymerization



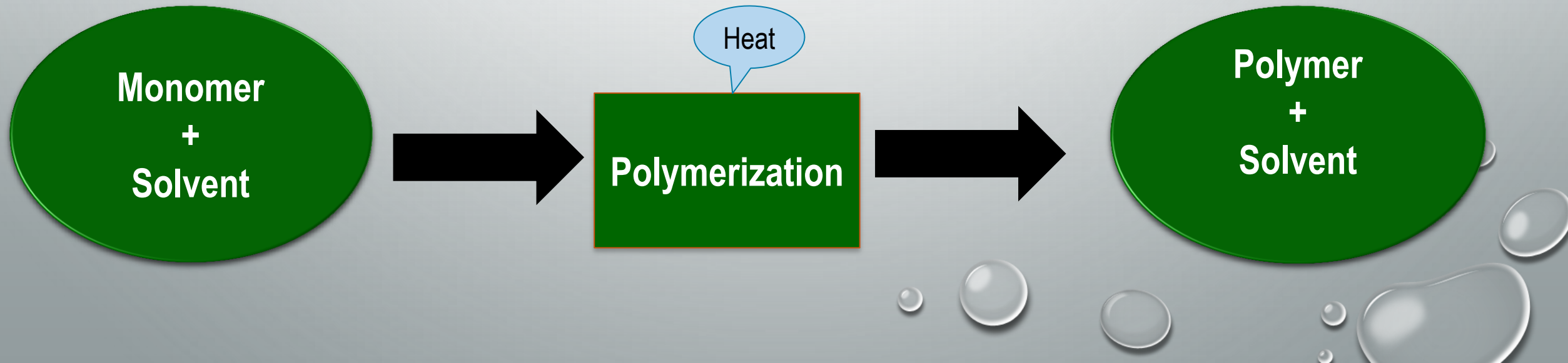
$(C_4H_6O_2)_n$   
Polyvinyl Acetate

Polymer  
+  
Solvent

# Polymerization



The protein **casein** found in milk produces the glue







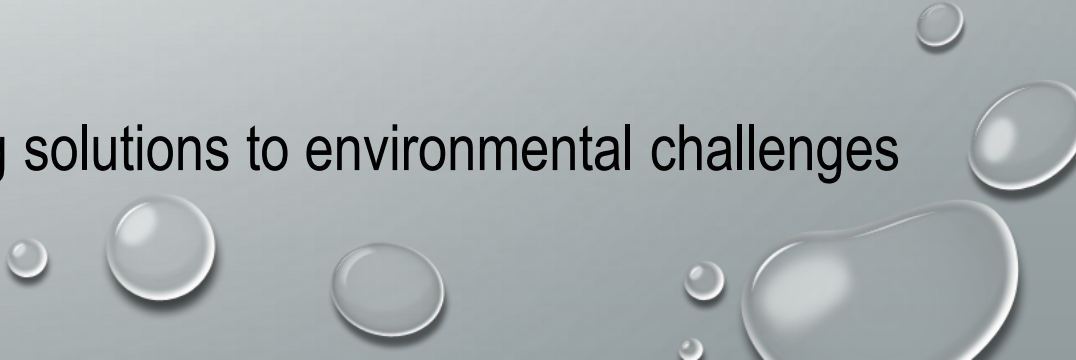
**You can create glue that follows the three criteria for a Green Chemistry Technology:**

**1. Safe for you and the environment**

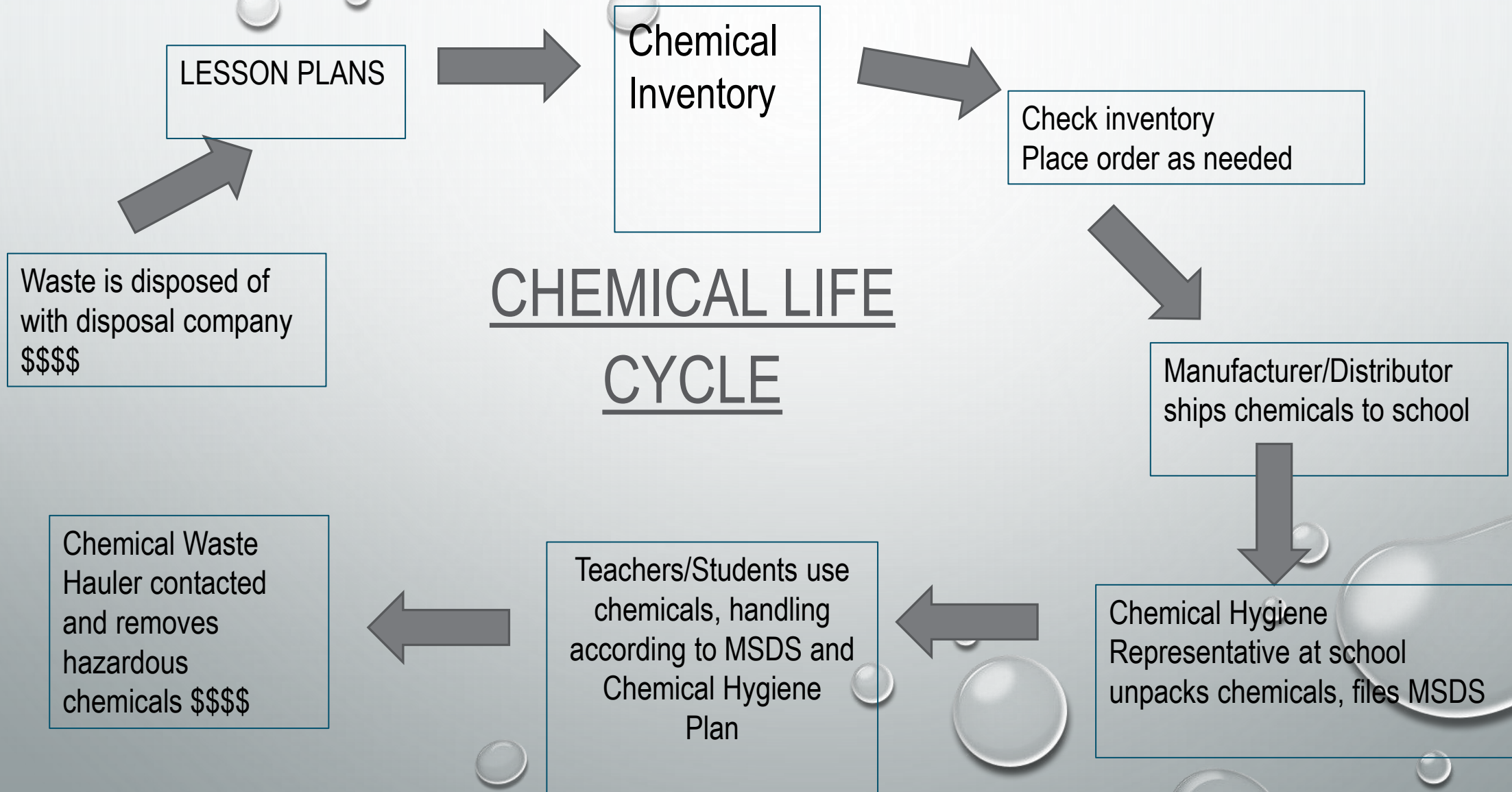
**2. Cost Efficient**

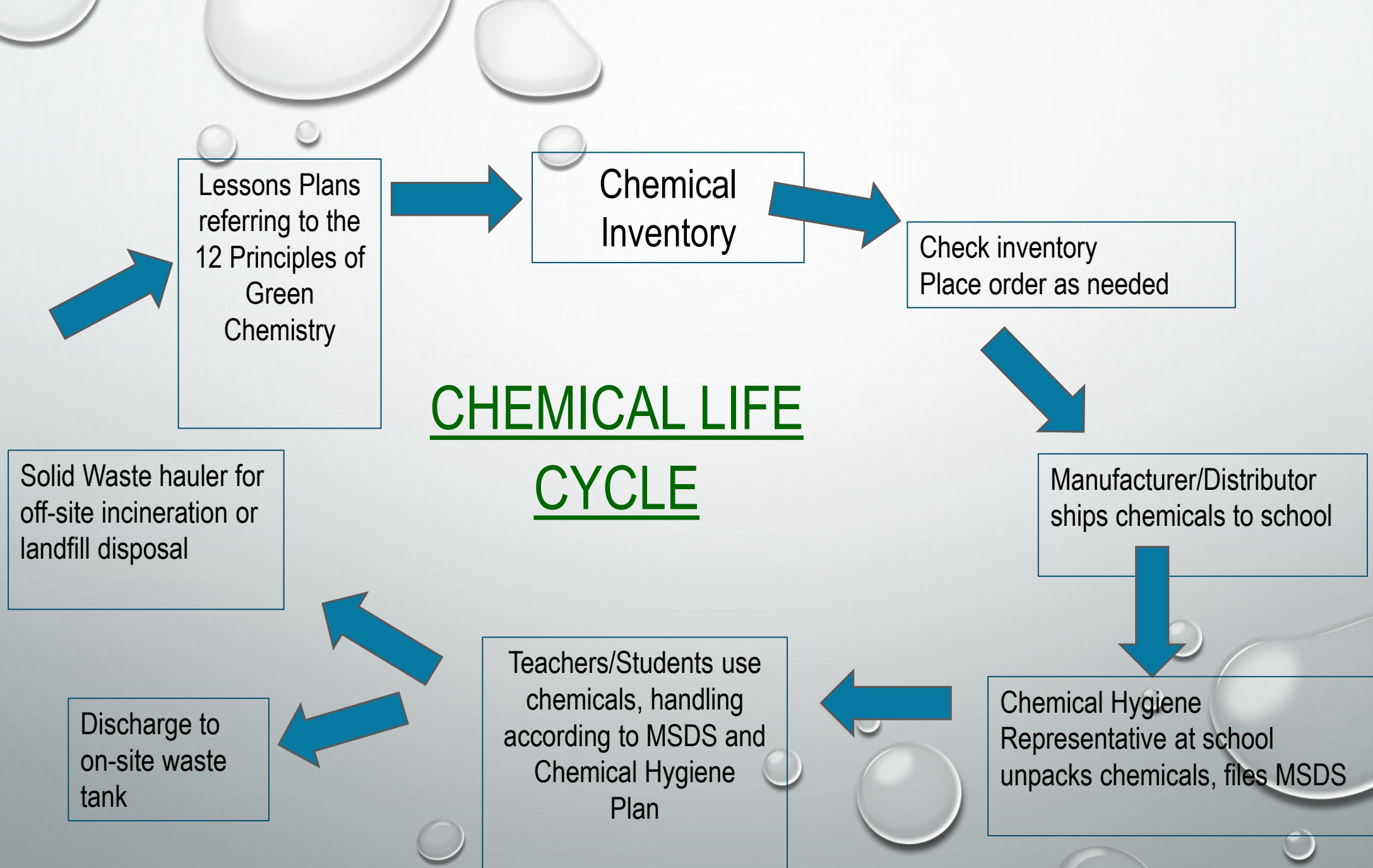
**3. Works**

Green Chemistry provides the tools needed for creating solutions to environmental challenges



# CHEMICAL LIFE CYCLE







# **STEPS NEEDED FOR A GREEN CHEMISTRY PILOT**

- 1. Buy in from District Leadership**
- 2. Pilot High Schools – varied of models**
- 3. Inventory Checklist**
- 4. Alignment of the Laboratory Activities to the Chemistry syllabus**
- 5. Rewriting of the laboratories activities to address CCLS and NGSS as well as NYSED Standards**
- 6. Disposal of unwanted/unneeded chemicals**
- 7. Purchase of materials and supplies needed for the revised Chemistry laboratory activities**
- 8. Creation of set-ups for each of the newly designed labs**

**Does not address:**

- Advanced Placement Chemistry Laboratory Activities**
- Classroom Demonstrations**