

# Other Side Effects?

## Green Pharmaceuticals?

Millions of medications are sold around the world everyday. But what happens to these medicines when they are disposed of or processed through your system? Our water is showing more and more traces of these medications, from antibiotics to hormones. This is not good for us or the wildlife. Green chemists are at work now looking for answers. These include safer manufacturing of the medications, and better drug designs that metabolize safer in our bodies.

Many pharmaceutical manufacturers are looking for ways to lower Pharmaceuticals In the Environment or PIE for short.

## Cutting back on PIE:

Many companies are using new methods to help promote a better tomorrow these are just a few examples of what different manufacturers are doing. Other manufactures are also working on managing the waste produced in the production of pharmaceuticals. Some of note are Astra-Zeneca and Lily who continue to lead the research in reducing waste and environmental impact.

**Green Chemistry** is the *design* of chemical products and processes that reduce or eliminate the *use and/or generation* of hazardous substances.

## Pfizer:

Although Pfizer makes quite a few medications using green chemistry here is one sample:

Zoloft (Sertraline)

Treats depression

Doubles overall product yield

Ethanol replaced CH<sub>2</sub>Cl<sub>2</sub>, THF, toluene, and hexane

Eliminated use of 140 metric tons/year TiCl<sub>4</sub>

Eliminated 150 metric tons/year 35% HCl

Reduces raw material use by 20-60% by using a more selective palladium catalyst.

Eliminates the use of about 1.8 million pounds of hazardous materials per year.

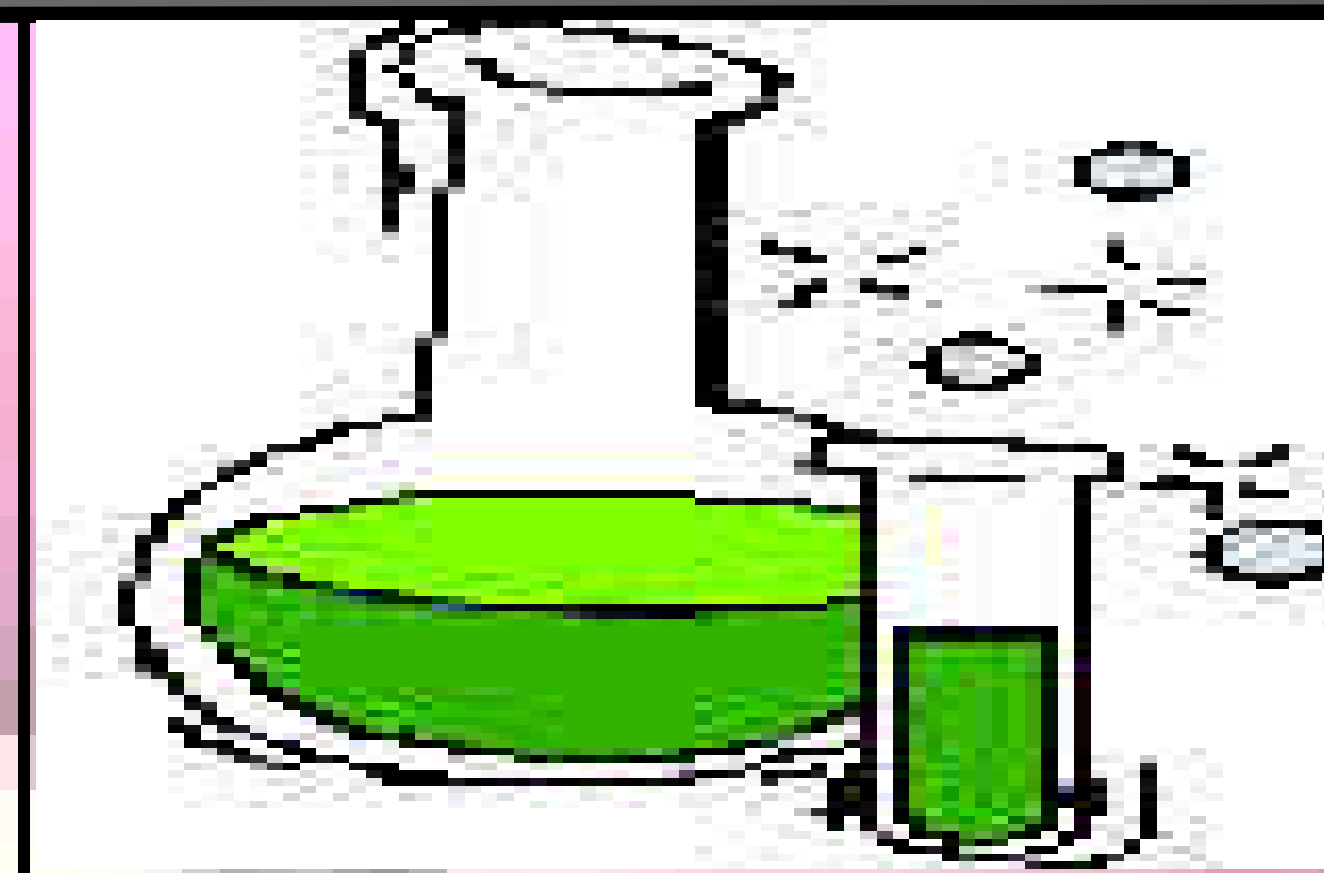
Reduces energy and water use

## A breath of fresh air!

HFA Inhalers

Previously, albuterol inhalers contained chlorofluorocarbons (CFCs). As of 2009, albuterol CFC inhalers will no longer be available. CFCs are used as sprays to transport the albuterol medicine out of the inhaler into the lungs. However, CFCs are harmful to the environment, but not to the human body. CFCs have been found to be harmful to the environment because they decrease the protective ozone layer above the Earth. Hydrofluoroalkanes (HFAs), are another type of propellant and will now be used to propel the medicine out of inhalers. HFA inhalers will not affect the treatment or prevention of bronchospasm, but may taste and feel different than CFC inhalers. Proper cleaning and priming of inhalers are also important to receive the best results from the inhaler. HFA inhalers may feel different because the spray of CFC inhalers often hits the back of the mouth, while the HFA inhaler sprays a fine mist. However, there is no difference in the amount of medication distributed in each spray.

The FDA phased out the CFC inhalers due to an international agreement called the Montreal Protocol on Substance that Deplete the Ozone Layer. Current albuterol inhalers available include, Proair HFA, Ventolin HFA, and Flovent HFA.



### Principles of Green Chemistry

- Minimize waste.
- Minimize the spread of toxic materials.
- Promote non-persistent chemicals in the environment.
- Minimize the potential for accidents.
- Maximize the percentage of incorporation of materials used into the final product.
- Preserve the efficiency of function while reducing toxicity.
- Minimize the use of auxiliary substances.
- Minimize energy requirements.
- Use renewable feed stocks where possible.
- Minimize the use of derivatives.
- Maximize the use of catalytic processes.
- Develop appropriate analytical methodology.

## Go Green at Bristol-Myers Squibb

Bristol-Myers Squibb pharmaceutical use Green Chemistry to develop innovative, cost effective medicines that extend and enhance human life by:

- minimizing the use of regulated materials
- Minimizing environmental impact.
- promoting the recovery and recycling of solvents
- reducing waste generation (1)

By implementing Green Chemistry principles in the manufacturing process, Bristol-Myers Squibb is reducing energy consumption, hazardous materials use and waste generation. (2)

Two of the medications that are made by Bristol-Myers Squibb by using the Green chemistry method are Avapro (Irbesartan) and Taxol (paclitaxel).

- AVAPRO is a brand medication and its genetic is Irbesartan which is used to treat hypertension and renal disease in Type 2 diabetes. This pharmaceutical started recycling the primary chlorinated solvent used in the bromination step during synthesis of AVAPRO. Also they eliminated the aqueous extraction step and reduced the amount of crystallization solvent required. These changes have increased the yield of Avapro while reducing waste and increasing workplace health and safety. (3)

- TAXOL is an anticancer drug with genetic name is Paclitaxel. Bristol-Myers Squibb has been working on the Paclitaxel Greenness Project during the manufacturing process. This pharmaceutical switched production to the latest Plan Cell Fermentation (PCF) technology, which has improved the sustainability of the supply of paclitaxel while reducing the amount of waste and pollutants. Paclitaxel is being made using only plant cell cultures through the application of the PCF technology. (3)

In 1991, the Taxol was manufactured from the bark of a yew tree. Under agreement with the National Cancer Institute, Bristol-Myers Squibb pharmaceutical developed Paclitaxel. In 1994, this pharmaceutical made this drug from cultivated yew shrub twigs and needles. Cells are extracted from yew tree twigs and needles, which are then reproduced to create Taxol. Making drugs by using twigs and needles from shrubs instead of bark, trees are unharmed when harvesting the raw material. This new process requires fewer raw materials than the original process and the habitat of the spotted owl is not compromised.

## Industry thoughts

"Pharmaceutical companies have become much more aware of eco-friendly manufacturing practices within the last few years --an example of this new consciousness is the switch from CFC's to HFA's as the propellant in inhalers."

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