

ACADEMIC AWARD

Winner: Peter J. H. Scott, Ph.D., University of Michigan Medical School

Contributors: Xia Shao, Ph.D.; Maria Fawaz; Keunsam Jang, Ph.D.

Ethanolic Carbon-11 Chemistry: The Introduction of Green Radiochemistry



In a novel application, Professor Scott's research team has found that the principles of green chemistry can be extended to the field of Nuclear Medicine. This work represents the first application of green chemistry to the preparation of radiopharmaceuticals for Positron Emission Tomography (PET) imaging. The use of PET imaging to non-invasively image biochemical processes in living human subjects is being increasingly applied to personalized medicine in the academic setting and to drug discovery in the pharmaceutical industry. Patients receive an injection of a radiopharmaceutical followed by PET imaging of the radioactivity distribution in the body. Reflecting the increasing global demand for access to PET imaging, sophisticated reactions for the synthesis of radiopharmaceuticals continue to be developed.

Professor Scott and his team have applied the principles of green chemistry to every aspect of their carbon-11 radiopharmaceutical manufacturing program, and now use ethanol as the only organic solvent for synthesis module cleaning and disinfection, radiopharmaceutical synthesis, purification, high performance liquid chromatography (HPLC), and reformulation. Eleven carbon-11 labeled radiopharmaceuticals have been prepared using ethanol as the only organic solvent throughout the entire manufacturing process. The removal of all other organic solvents from the process simplifies production and quality control testing. All radiopharmaceutical doses prepared are suitable for clinical use, and the methods developed are now in routine use at the University of Michigan. The result is a significantly cleaner radiopharmaceutical manufacturing process, cleaner analytical method, and a reduction in hazardous waste generated by the laboratory.

By applying the principles of green chemistry to its carbon-11 drug manufacturing program, the University of Michigan PET Center has become the first example of a green radiochemistry laboratory in the world. The PET Center has been inspected twice by the United States Food and Drug Administration, and no issues with the synthesis methods have been identified. The benefits of green radiochemistry are numerous to the extent that other PET Centers around the world have made contact looking to follow and implement this technology in their own radiochemistry laboratories. While the technology is applied in a radiochemistry setting, the green methods described are cost-effective and can be readily applied across all disciplines of organic chemistry.

Quote:

“At the University of Michigan PET Center we strive to provide the highest quality radiopharmaceuticals to patients receiving PET scans at University of Michigan Health System. Going green is therefore a priority for our drug manufacturing program, and is aligned with the campus-wide sustainability efforts ongoing at the University.” – Prof. Peter J.H. Scott

EDUCATION AWARD

Winner: Kathe Blue Hetter, Skyline High School

Contributor: Beyond Benign

Developing a Sustainable Green High School Chemistry Course

The year before Skyline High School opened Kathe was invited to be on the design team for developing a green chemistry curriculum for high school teachers. This was the spark that got her started in the development of Skyline's Sustainable Green Chemistry course. Skyline was to open with only a ninth grade class in the fall of 2008, and this gave Kathe time to work on the curriculum, because it would be an eleventh grade science course. During this time, she became a K-12 Curriculum Specialist for Beyond Benign, and she has had the opportunity to work on green chemistry curriculum with John Warner and Amy Cannon. Kathe has conducted workshops around the country to other high school teachers on how to introduce the 12 Principles of Green Chemistry into a high school setting.

The main component of the Sustainable Green Chemistry course developed at Skyline is to introduce students to the 12 Principles of Green Chemistry. Students do a project where they pick out an everyday item and follow its lifecycle from raw materials to disposal. The students draw the lifecycle, research to see ways that the 12 Principles could be incorporated, and then redraw the lifecycle. The first class of Sustainable Green Chemistry at Skyline was in the fall of 2010. Students were excited to learn about the 12 Principles of Green Chemistry, and posters were made for each of the principles and displayed around the school.

Students also do investigations looking at green chemistry practices in industry. Students have the opportunity to conduct labs that simulate some of these practices. Examples include, Essential Oil Extraction Using Liquid CO₂, TAML™ Industry Example, Petretec Industry Example, and Chemistry of Cosmetics. She has also incorporated green chemistry practices at Skyline by using non-toxic chemicals to show basic chemistry concepts. All the science teachers at Skyline use these practices and students are educated in the practices and the importance of green chemistry not just in industry, but also in a high school setting.

