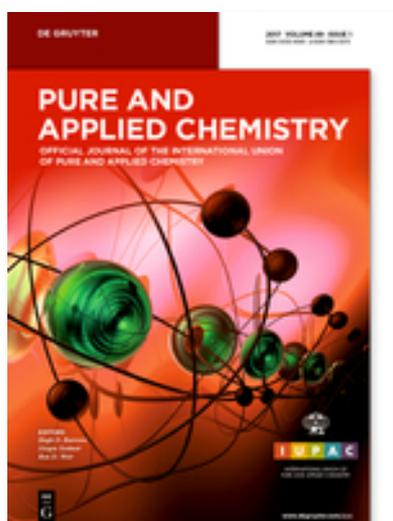


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Synthetic pathways and processes in green chemistry. Introductory overview

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Green Chemistry in the International Context

It has come to be recognized in recent years, that the science of chemistry is central to addressing the problems facing the environment. Through the utilization of the various subdisciplines of chemistry and the molecular sciences, there is an increasing appreciation that the emerging area of green chemistry¹ is needed in the design and attainment of sustainable development. A central driving force in this increasing awareness is that green chemistry accomplishes both economic and environmental goals simultaneously through the use of sound, fundamental scientific principles.

Recently, a basic strategy has been proposed for implementing the relationships between industry and academia, and hence, funding of the research that constitutes the engine of economic advancement; it is what many schools of economics call the "triple bottom line" philosophy, meaning that an enterprise will be economically sustainable if the objectives of environmental protection, societal benefit, and market advantage are all satisfied². Triple bottom line is a strong idea for evaluating the success of environmental technologies. It is clear that the best environmentally friendly technology or discovery will not impact on the market if it is not economically advantageous; in the same way, the market that ignores environmental needs and human involvement will not prosper. This is the challenge for the future of the chemical industry, its development being strongly linked to the extent to which environmental and human needs can be reconciled with new ideas in fundamental research. On the other hand, it should be easy to foresee that the success of environmentally friendly reactions, products, and processes will improve competitiveness within the chemical industry. If companies are able to meet the needs of society, people will influence their own governments to foster those industries attempting such environmental initiatives. Of course, fundamental research will play a central role in achieving these worthy objectives. What we call green chemistry may in fact embody some of the most advanced perspectives and opportunities in chemical sciences.

It is for these reasons that the International Union of Pure and Applied Chemistry (IUPAC)

has a central role to play in advancing and promoting the continuing emergence and impact of green chemistry. When we think about how IUPAC furthers chemistry throughout the world, it is useful to refer to IUPAC's Strategic Plan. This plan demonstrates the direct relevance of the mission of IUPAC to green chemistry, and explains why there is growing enthusiasm for the pursuit of this new area as an appropriate activity of a scientific Union. The IUPAC Strategic Plan outlines among other goals:

- IUPAC will serve as a scientific, international, nongovernmental body in objectively addressing global issues involving the chemical sciences. Where appropriate, IUPAC will represent the interests of chemistry in governmental and nongovernmental forums.
- IUPAC will provide tools (e.g., standardized nomenclature and methods) and forums to help advance international research in the chemical sciences.
- IUPAC will assist chemistry-related industry in its contributions to sustainable development, wealth creation, and improvement in the quality of life.
- IUPAC will facilitate the development of effective channels of communication in the international chemistry community.
- IUPAC will promote the service of chemistry to society in both developed and developing countries.
- IUPAC will utilize its global perspective to contribute toward the enhancement of education in chemistry and to advance the public understanding of chemistry and the scientific method.
- IUPAC will make special efforts to encourage the career development of young chemists.
- IUPAC will broaden the geographical base of the Union and ensure that its human capital is drawn from all segments of the world chemistry community.
- IUPAC will encourage worldwide dissemination of information about the activities of the Union.
- IUPAC will assure sound management of its resources to provide maximum value for the funds invested in the Union.

Through the vehicle of green chemistry, IUPAC can engage and is engaging the international community in issues of global importance to the environment and to industry, through education of young and established scientists, the provision of technical tools, governmental engagement, communication to the public and scientific communities, and the pursuit of sustainable development. By virtue of its status as a leading and internationally representative scientific body, IUPAC is able to collaborate closely in furthering individual national efforts as well as those of multinational entities.

An important example of such collaboration in the area of green chemistry is that of IUPAC with the Organization for the Economical Cooperation and Development (OECD) in the project on "Sustainable Chemistry", aimed at promoting increased awareness of the subject in the member countries. During a meeting of the Environment Directorate (Paris, 6 June 1999), it was proposed that United States and Italy co-lead the activity, and that implementation of five recommendations to the member countries be accorded the highest priority, namely:

- research and development
- awards and recognition for work on sustainable chemistry
- exchange of technical information related to sustainable chemistry
- guidance on activities and tools to support sustainable chemistry programs
- sustainable chemistry education

These recommendations were perceived to have socio-economic implications for worldwide implementation of sustainable chemistry. How IUPAC and, in particular, its Divisions can contribute to this effort is under discussion. IUPAC is recognized for its ability to act as the scientific counterpart to OECD for all recommendations and activities. Although the initiatives being developed by the OECD are aimed primarily at determining the role that national institutions can play in facilitating the implementation and impact of green chemistry, it is recognized that each of these initiatives also has an important scientific component. Whether it is developing criteria or providing technical assessment for awards and recognition, identifying appropriate scientific areas for educational incorporation, or providing scientific insight into the areas of need for fundamental research and development, IUPAC can play and is beginning to play an important role as an international scientific authority on green chemistry.

Other multinational organizations including, among others, the United Nations, the European Union, and the Asian Pacific Economic Community, are now beginning to assess the role that they can play in promoting the implementation of green chemistry to meet environmental and economic goals simultaneously. As an alternative to the traditional regulatory framework often implemented as a unilateral strategy, multinational governmental organizations are discovering that green chemistry as a nonregulatory, science-based approach, provides opportunities for innovation and economic development that are compatible with sustainable development. In addition, individual nations have been extremely active in green chemistry and provide plentiful examples of the successful utilization of green chemistry technologies. There are rapidly growing activities in government, industry, and academia in the United States, Italy, the United Kingdom, the Netherlands, Spain, Germany, Japan, China, and many other countries in Europe and Asia, that testify to the importance of green chemistry to the

future of the central science of chemistry around the world.

Organizations and Commissions currently involved in programs in green chemistry at the national or international level include, for example:

- U.S. Environmental Protection Agency (EPA), with the "Green Chemistry Program" which involves, among others, the National Science Foundation, the American Chemical Society, and the Green Chemistry Institute;
- European Directorate for R&D (DG Research), which included the goals of sustainable chemistry in the actions and research of the European Fifth Framework Programme;
- Interuniversity Consortium "Chemistry for the Environment", which groups about 30 Italian universities interested in environmentally benign chemistry and funds their research groups;
- UK Royal Society of Chemistry, which promotes the concept of green chemistry through a "UK Green Chemistry Network" and the scientific journal Green Chemistry;
- UNIDO-ICS (International Centre for Science and High Technology of the United Nations Industrial Development Organization) which is developing a global program on sustainable chemistry focusing on catalysis and cleaner technologies with particular attention to developing and emerging countries (the program is also connected with UNIDO network of centers for cleaner production); and
- Monash University, which is the first organization in Australia to undertake a green chemistry program.

Footnotes:

1. The terminology "green chemistry" or "sustainable chemistry" is the subject of debate. The expressions are intended to convey the same or very similar meanings, but each has its supporters and detractors, since "green" is vividly evocative but may assume an unintended political connotation, whereas "sustainable" can be paraphrased as "chemistry for a sustainable environment", and may be perceived as a less focused and less incisive description of the discipline. Other terms have been proposed, such as "chemistry for the environment" but this juxtaposition of keywords already embraces many diversified fields involving the environment, and does not capture the economic and social implications of sustainability. The Working Party decided to adopt the term green chemistry for the purpose of this overview. This decision does not imply official IUPAC endorsement for the choice. In fact, the IUPAC Committee on Chemistry and Industry (COCI) favors, and will continue to use sustainable chemistry to describe the discipline.

2. J. Elkington, < <http://www.sustainability.co.uk/sustainability.htm>

↓ About the article

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