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EDITORIAL

Analytical chemistry for a sustainable society – trends and implications

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Analytical chemistry plays an enormous role in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of great importance in different research areas. Analytical chemistry is a science that is directed towards creating new knowledge so that chemical analysis can be improved to respond to increasing or new demands—call it a "methods science" if you want.

Without analytical chemistry we could not make any important decisions about soil remediation or limit values for environmental pollution, choose the correct medical treatment for patients, etc. Over time, analytical chemistry has changed. Early on, the focus was very much on elemental analysis and speciation; for example the work of Torbern Bergman (stated to be the first "analytical chemist" in the world) in Uppsala in the late seventeenth century [1]. Analytical technologies and instruments were for hundreds of years developed in-house or in departmental tool shops. Nowadays instrument development is largely driven by instrument manufacturers. The perhaps only exception to this is the ongoing process of miniaturisation and integration of analytical platforms into complex systems. The research area of analytical chemistry has been migrating from earlier instrument construction and method development to the main focus being on method development and applications of analytical chemistry. Method development in itself involves obtaining faster, more sensitive, simpler, more complex/informative and/or more environmentally sustainable analytical methods. It can be purely curiosity driven or mature, for a specific analytical issue or task. For example, mass spectrometry is now an analytical tool for chemists, pharmacologists, medical practitioners and biologists but in the past was in the hands of pure ion physics. The major biological needs have driven the development with rocket speed. Activities in sustainable development as in chemical industry, where renewable resources are used more efficiently, also require greater efforts of analytical chemistry and chemistry at large. In collaborative projects, analytical chemistry often assists with methodology and experimental planning, method validation, quality control, multivariate data analysis and interpretation of results.

Analytical chemistry will continue to be an important part of undergraduate education in chemistry, not only for natural scientists and engineers but also for true translational and cross-disciplinary initiatives involving biologists and medical students and even within social science (e.g. economists within a circular economy and bioeconomy) and law (e.g. within environmental legislation and sustainable development, intellectual property protection).

There is also a need for educated analytical chemists in the future. Analytical chemistry is important as evidenced by a recent survey by the European Association for Chemical and Molecular Sciences (EuCheMS) that received responses from 4500 chemists and chemical engineers in Europe, of which 15% were analytical chemists. In response to the question, "I received my highest scientific/technical qualification in this chemical discipline", where 16 disciplines in chemistry were elective, analytical chemistry was in third place (after organic chemistry and chemical engineering) [2]. Hence, there is an obvious need to continue to take care of research and education in analytical chemistry, and to follow current trends and implications within the subject, as well as in cross-disciplinary efforts where analytical chemistry plays a significant role.

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One forum for discussing research and education in analytical chemistry is the Euroanalysis conference. The 19th edition of Euroanalysis was hosted in Stockholm, organised by the Swedish Chemical Society (Analytical Division) and supported locally by Stockholm University and globally by the EuCheMS Division of Analytical Chemistry (DAC). Euroanalysis is held every second year, and the conference covers all aspects where analytical chemistry plays a role, including fundamental and applied sciences.

More than 500 abstracts were submitted, of which 145 were given as oral presentations and 273 were given as poster presentations. In addition, 28 of the posters were pitched in special poster pitch sessions. Eighteen vendors participated in the conference, and six of them arranged vendors' lunch seminars. There were 10 plenary lectures and 32 keynote lectures. Three major awards were handed out during Euroanalysis XIX. The Robert Kellner Award was given to Luigi Mondello, University of Messina, Italy, who gave a lecture entitled "Different approaches to multidimensionality in chromatographic separations coupled to mass spectrometry detection to face challenging analytical tasks". The EuCheMS DAC Award was given to Lo Gorton, Lund University, Sweden, who gave a talk entitled "Analytical tools based on electrochemical communication between enzymes/cells and electrodes". Finally, the Heinrich Emanuel Merck Award for Analytical Chemistry was given to Francesco Ricci, and he gave a talk entitled "Nature-inspired DNA-based nanodevices for sensing applications". Overall, the conference had 509 participants from 53 different countries. The top ten countries were Sweden (138), Germany (43), Spain (27), the Czech Republic (26), Russia (24), Italy (22), Japan (16), the UK (15), the Netherlands (12) and Belgium (12).

The conference had seven invited plenary speakers, giving lectures about a wide range of topics—from a historical perspective of separation science to doping control and three-dimensional chromatography. Of note was the excellent (and very pedagogic) lecture given by the Nobel laureate Stefan Hell about microscopy with a resolution of the size of a molecule, demonstrated by doughnuts and devils [3]. Another interesting lecture was given by Lutgarde Buydens, talking about citizen science; that is the use of non-scientists (citizens) to gather evidence-based data, for instance, for statistical health monitoring [4]. Further, Mario Thevis gave an entertaining lecture about doping control and the difficulty of obtaining a correct urine sample and of following the trends of novel substances [5]. The conference also included a session about education in analytical chemistry, which had contributions about a new Erasmus Mundus programme, laboratory skills among chemical engineering students, formalisation of validation guidelines, how to introduce metrology concepts to students, problem-based learning in analytical chemistry and industry-supported education programmes, among others.

Some of the presentations at Euroanalysis XIX are represented in this topical collection of articles. For instance, one of the keynote speakers from one of the editorial sessions, Xiaohong Fang, has contributed "Single-molecule force spectroscopy study of interactions between angiotensin II type 1 receptor and different biased ligands in living cells". Overall, the contributions range from fundamentals in electroanalytical chemistry, mass spectrometry and NMR spectroscopy, to applications in forestry, plant and food analysis, as well as environmental, forensic and toxicological analysis. One contribution stems from one of the plenary speakers, also the recipient of the EuCheMS DAC Award, Lo Gorton: "The influence of pH and divalent/monovalent cations on the internal electron transfer (IET), enzymatic activity and structure of fructose dehydrogenase". Environmental applications are about organophosphorus pesticides and phthalates in baby food samples, chemicals diffusing from textiles into the skin, and proteinaceous aerosols in the Arctic atmosphere that have an impact in climate change research. Food and forest research contributions include, for instance, high-value phenols and carbohydrates in wood pyrolysis liquids and the phenolic profile and antioxidant activity of honey.

The strongest impression from the Euroanalysis conference programme and the *Analytical and Bioanalytical Chemistry* topical collection of articles is the breadth of analytical chemistry—from fundamentals to applications—demonstrating the impact of analytical chemistry in society especially regarding environmental and health aspects. The conclusion is that the future of analytical chemistry can be found in cross-disciplinary and interdisciplinary areas, focused on solving important societal challenges and engaging young and bright scientists.

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