ROYAL SOCIETY OF CHEMISTRY

150 Years GDCh

Gesellschaft Deutscher Chemiker

Symposium Commemorating the 150th Anniversary of the Gesellschaft Deutscher Chemiker

25 October 2017
London, UK

Welcome Address

It is our great pleasure to welcome you to this symposium celebrating the 150th Anniversary of the Gesellschaft Deutscher Chemiker (GDCh, the German Chemical Society) and its longstanding relationship with the Royal Society of Chemistry (RSC), which celebrated its 175th Anniversary in 2016.

The GDCh brings together people working in chemistry and the molecular sciences and supports their striving for positive, sustainable scientific advance – for the good of humankind and the environment, and a future worth living for. With this goal in mind, it promotes chemistry in education, research and application, and seeks to deepen the understanding and knowledge of the general public about chemistry and its relevance to the world they live in. The many facets of the GDCh's promotion of chemistry find expression in the initiation and support of a number of projects and in the publication of highly esteemed professional journals, such as the internationally highly renowned journals Angewandte Chemie or Chemistry - A European Journal. The organization also confers important awards, such as the Karl Ziegler Prize and the Otto Hahn Prize (jointly with the City of Frankfurt and the Deutsche Physikalische Gesellschaft), which are among the most highly endowed German prizes in the natural sciences.

The GDCh has been marking their anniversary with a number of celebratory activities.

Today we are marking this occasion by celebrating something particularly special: the close relationship between our two societies and our respective chemistry communities. An appropriate way to do so, which forms our programme for the day, is to reflect on our shared history, celebrate the present, and look forward to the future.

We are delighted to start the day with talks on our common history from two illustrious experts. It is appropriate that we do so in Burlington House, home of the Royal Society of Chemistry since the mid-19th century (when it was the Chemical Society of London). Our common history is especially marked by August Wilhelm von Hofmann, who was President of the Chemical Society of London from 1861 to 1863 and, after his return to Berlin, founding President of the Deutsche Chemische Gesellschaft, in 1867. A marble bust of Hofmann welcomes you as you enter the doors of Burlington House, a photograph of him hangs on the wall of Past-Presidents of the Royal Society of Chemistry, while a portrait of his mentor and supervisor, Justus von Liebig, hangs in the Council Room. The Council Room is also where you can visit our special exhibition, with historical artefacts and information on Hofmann, Liebig and other figures in our Anglo-German story.

When we celebrate the contribution of the GDCh and RSC, we celebrate the contribution of chemistry and its transformative power in tackling many of the global challenges we face today. In the second part of our programme, it is our pleasure to have speakers from Germany and the UK discuss four of these vitally important challenges (food, water, energy and sustainability). We very much look forward to hearing from our expert speakers on how chemistry can play its part in helping deliver solutions to these issues.

This is followed by a very special presentation. The Alexander Todd - Hans Krebs Lectureship in Chemical Sciences is a reciprocal lectureship awarded alternately by the Gesellschaft Deutscher Chemiker and the Royal Society of Chemistry, for advances in chemistry made by a scientist while working and residing in Germany or the UK, respectively. It is our great pleasure to present this award as part of our anniversary celebration to our 2017 winner, Professor Thomas Carell from Ludwig Maximilians Universität München, and to hear his talk on DNA Bases beyond Watson and Crick.

The final part of our programme looks forward, with a panel discussion on the future of the chemical sciences. Along with our fellow chemical societies, the GDCh and RSC believe that chemistry has a vital role to play in a rapidly changing world. We are delighted to be joined by so many illustrious figures for this part of the day, and look forward to a fascinating discussion, full of different insights and perspectives.

Bringing together such an interesting programme would not be possible without the contribution of many people. We would therefore like to thank our contributors, speakers and panellists, for contributing their time, knowledge and expertise. We are grateful to our publishing colleagues at Wiley-VCH and the Royal Society of Chemistry for creating the joint collection of 150 papers, freely available online until the end of 2017, that celebrates many of the critical scientific advances made by German and UK chemists. In terms of the exhibition, the RSC and GDCh historical groups and library staff provided valuable expert advice and support, while many of the wonderful exhibits on display have been kindly lent to us by other institutions: we are grateful to the staff at Rothamsted Research and the Lawes Agricultural Trust for loan of the correspondence between Justus von Liebig and Robert Warrington, and to the staff of the Royal Institution for loan of John Tyndall's notebooks, Hofmann's model, and his Royal Institution lectures.

In closing, we would like to thank you again for joining us today in celebrating this milestone in the history of our two societies. We hope that you enjoy the programme.

Professor Dr. Thisbe K. Lindhorst
President
Gesellschaft Deutscher Chemiker

Professor Dr. Wolfram Koch
Executive Director
Gesellschaft Deutscher Chemiker

Professor Sir John Holman CChem FRSC
President
Royal Society of Chemistry

Dr Robert Parker CSci CChem FRSC
Chief Executive Officer
Royal Society of Chemistry

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European Chemical Sciences

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Chief Executive Officer
Royal Society of Chemistry

29 August 2017

Dear Thisbe, John, Wolfram and Robert

Joint Anniversary Celebration, GDCh - RSC

It is a great delight for us as President, Vice-President and General Secretary of EuCheMS to see that two of our largest and most successful Member Societies, the Gesellschaft Deutscher Chemiker (GDCh) and the Royal Society of Chemistry (RSC), are meeting together today jointly to celebrate significant milestones in their history. From the very earliest days post alchemy, the German and the British chemical communities have been connected. The most obvious link is provided by August Wilhelm von Hofmann, who having been the tenth President of the Chemical Society (1861-1863) returned to Germany to be the Inaugural President of the Deutsche Chemische Gesellschaft zu Berlin (1867). In addition, many renowned UK chemists can trace their chemical ancestry back to the great German chemists such as Justus von Liebig. Likewise, many famous German chemists have carried out some of their training in the UK. EuCheMS looks forward to seeing this strong relationship between the GDCh and RSC continue to grow and develop in future years.

Today's world faces many serious challenges, such as feeding and providing clean water for the expanding population, controlling climate change, tackling antibiotic resistance and, more generally, addressing the UN's 17 Sustainable Development Goals. We as citizens, but especially as chemists, have a role to play in achieving each and every one of these goals.

Scientists from Germany and the UK have been particularly successful in building and leading collaborations to the mutual benefit of academia and industry in both countries. EuCheMS urges Germany and the UK, two of the greatest scientific nations in Europe, to continue their strong collaborations and together with our colleagues across Europe and around the world to achieve our shared goals of supporting the next generation of researchers, and maximising the role that chemistry must play in scientific discovery to ensure a sustainable future for life on our wonderful planet, Earth.

Many congratulations to the GDCh and the RSC on these most significant anniversaries.

Yours sincerely

David Cole-Hamilton
EuCheMS President

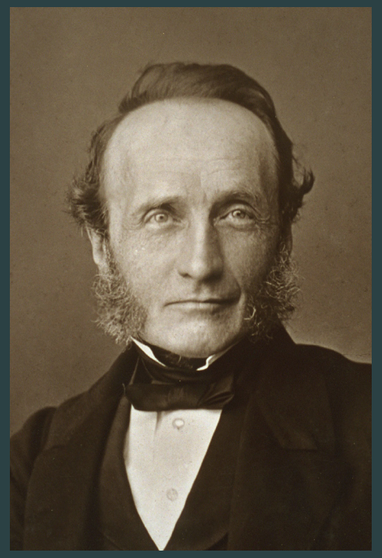
Nineta Hrastelj
EuCheMS General Secretary

Pilar Goya Laza
EuCheMS Vice-President

Programme

Time	Event	Chairs
9.00	Registration and coffee	
9.45	Welcome remarks	
	A Common History	
10.00	Anglo-German Chemistry 1821-1914 Professor William Brock	Professor Dr. Wolfram Koch and Dr Robert Parker
10.30	Searching for Traces of August Wilhelm von Hofmann Dr. Brigitte Osterath	
	Chemistry and Global Challenges	
11.00	The Role of Chemistry in the Development of Materials for Efficient, Safe and Low-Cost Rechargeable Batteries Professor Dr. Philipp Adelhelm	Dr Neville Compton and Dr Anna Simpson
11.30	The Role of Chemistry in Sustainable Wastewater Treatment Professor Elise Cartmell	
12.00	**Lunch and exhibition**	
14.00	Novel Developments in Food Chemistry to Ensure Safe, Healthy and Pure Food Professor Dr. Monika Pischetsrieder	Dr Neville Compton and Dr Anna Simpson
14.30	Chemistry: Towards a More Sustainable Future? Professor Pete Licence	
	Alexander Todd – Hans Krebs Award and Lecture	
15.00	DNA Bases beyond Watson and Crick Professor Dr. Thomas Carell	Professor Dr. Thisbe Lindhorst and Professor Sir John Holman
16.00	**Coffee break**	
	Future of the Chemical Sciences	
16.30	Panel Discussion Professor Dr. Thisbe Lindhorst, Professor Sir John Holman, Professor Pilar Goya, Dr Elizabeth Rowsell and Dr. Matthias Urmann	Mr Adam Brownsell
17.45	Closing remarks	
18.00	**Reception, including renewal of Memorandum of Understanding**	
20.00	**Close**	

A Common History



Robert Warington was the driving force behind the formation of the Chemical Society

Justus von Liebig was the first foreign member of the Chemical Society and published in the first edition of its Proceedings

Robert Warington, Justus von Liebig and the Chemical Society
by Anna Simmons

On 23 February 1841 a meeting was convened by Robert Warington of twenty-five London chemists at the Society of Arts in John Street, near the Strand. At this meeting a provisional committee was set up to consider forming a Chemical Society and a circular subsequently sent to potential members. On 30 March 1841 the Chemical Society of London was constituted with seventy-seven founder members, including forty from Scotland. Thomas Graham of University College, London was appointed President, with Robert Warington and Edward F. Teschemacher (a manufacturing chemist) as Secretaries. Soon a regular routine of meetings was established, Proceedings and Memoirs were published, and distinguished foreign members elected.

The first foreign member to be elected on 1 June 1841 was the German chemist Justus von Liebig, in whose Giessen Laboratory many British students had received their training in chemistry. The first edition of Proceedings of the Chemical Society of London contained an abstract of Liebig's paper "On the Preparation and Formation of Yellow Prussiate of Potash", which had been read at the Society's meeting on 13 April 1841. The first edition of Memoirs of the Chemical Society of London contained Liebig's article "On the Preparation of Cyanide of Potassium and on its Applications", which had been read at the Society's meeting on 1 March 1842. When the Chemical Society was incorporated by royal charter in 1848 its membership numbered over two hundred.

The driving force behind the Chemical Society's foundation was Robert Warington (1807-1867), a London chemical consultant and key figure in the chemical community of the time who promoted chemistry on professional, educational and literary fronts. Warington's employment as a chemist to the brewers Truman, Hanbury and Buxton had ceased in 1839 and he was not appointed as chemical operator to the Society of Apothecaries until 1842. Without an official post, he could devote his energies during these years to the foundation of the Chemical Society. In his role as Secretary, Warington wrote to Liebig on 4 June 1841 informing him of his appointment as a foreign member of the Chemical Society. Liebig replied thanking the Society for conferring this distinction upon him and wishing it every success.

Further letters from Liebig survive in the collection of Warington's papers held by the library at Rothamsted, where Robert Warington's son, also Robert (1838-1907), was an agricultural chemist. The letters demonstrate the close friendship which developed between the two men, a relationship which was typical of the strong links existing between German and British chemists at this time. When one of Liebig's former pupils wanted information on soda and sulphuric acid production in England, Liebig introduced them with the promise that in return Warington would be told all about the experiments occurring in the Giessen laboratory.

The central role German chemists played in shaping chemical research and education in Britain was exemplified in the Royal College of Chemistry, founded in 1845, and another institution with which Warington was involved. In January 1845 he tried to persuade Liebig to become a member of the committee for the College, but Liebig declined. Nevertheless Liebig firmly supported the project, writing that he believed "its foundation will be followed by a new era in Chemistry in England" (see letter postmarked Giessen 3 February 1845). By this point Liebig and Warington had developed a close friendship, with Liebig sending Warington "a dozen bottles of genuine Rhein wine" and writing:

> "Regarding myself I like London perhaps more than any other place, I have in this town so many friends among whom, my dear Warington you are one of those I most esteem..."

August Hofmann and the 'chemists factory'
by Brigitte Osterath

In the mid-19th century, two Germans drastically accelerated Britain's development in chemical science and industry. Justus von Liebig and August Wilhelm Hofmann transformed chemical education and agriculture in England and helped initiate the country's organic chemistry boom.

Liebig was born in 1803 in the city of Darmstadt. At the age of 21, he was appointed chemistry professor at the University of Giessen. He later became famous for inventing meat extract after he founded a company that later trademarked the Oxo™ brand beef stock cube. He also discovered that yeast could be concentrated, which is why he is also credited with the invention of Marmite™.

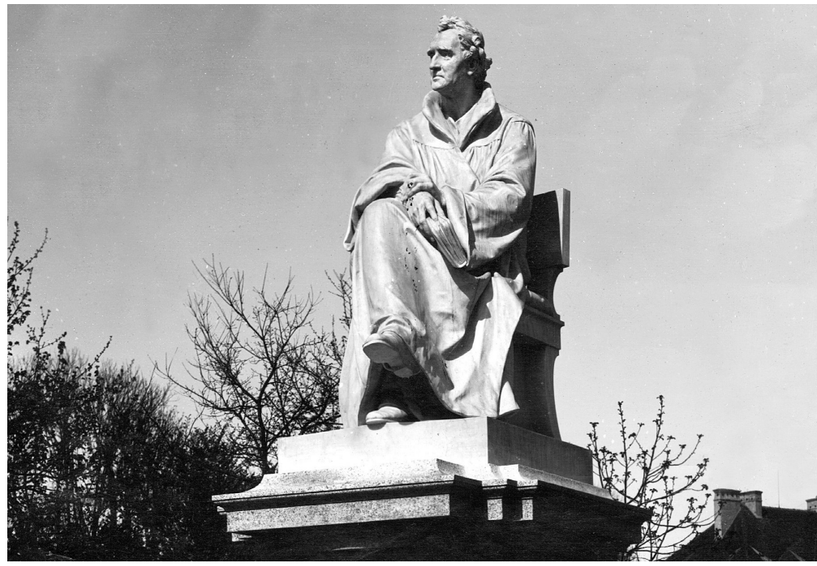
But his true achievements went much deeper: he is one of the founding fathers of organic chemistry. In the 1830s, Liebig had analysed parts of animals and plants in terms of their chemical composition and identified nitrogen, phosphorus and potassium as essential plant nutrients. He brought up the idea of supplying plants with those nutrients in the form of inorganic materials, inventing the concept of fertilising.

His ideas promised higher yields in agriculture, and plentiful food for a growing human population. The Brits were thrilled: between 1815 and 1846, the Corn Laws had imposed restrictions on importing grain to the UK. 'It became difficult to feed everyone,' says Peter Morris, science historian and research fellow emeritus at the Science Museum in London, UK. 'The key was to improve agriculture – and that is where Liebig came in.' Liebig's fertilising concept seemed to be the solution the UK had been looking for.

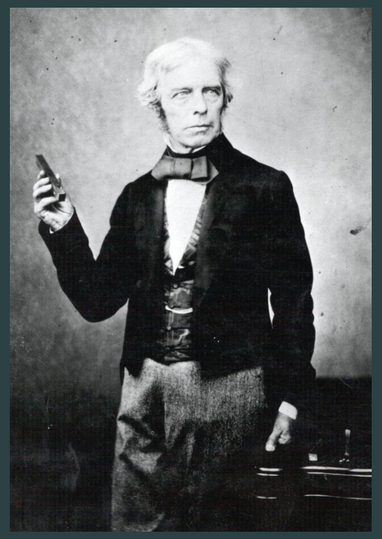
'Liebig was a big story in the UK in the 1840s,' says William Brock, emeritus professor of history of science at the University of Leicester, UK. 'The British loved him passionately.' A 2m^2 oil painting of Liebig still hangs in the Burlington House Council Room of the Royal Society of Chemistry in London.

The fascination was mutual, according to science historian Christoph Meinel at the University of Regensburg, Germany. During several trips to England, Liebig's interest in the country and its industrial revolution had been awakened. 'For a chemist, England seemed to be the land of boundless possibilities,' says Meinel. Liebig foresaw an exciting future for chemistry in the country, and even founded a fertiliser factory in Liverpool.

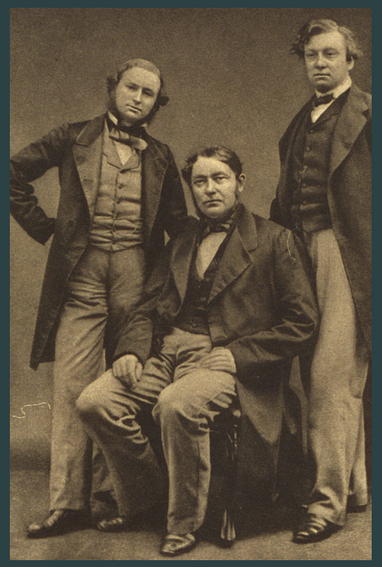
In 1852, Liebig left Giessen to become a professor at the Ludwig Maximilian University of Munich and scientific advisor to King Maximilian II of Bavaria. He died in 1873, and his grave in Munich is marked with a 2.5m high tombstone with a statue of Liebig atop.



Liebig's grave in Munich. A portrait of him also hangs in the Burlington House Council Room of the Royal Society of Chemistry in London



Michael Faraday "continually regret[ted] not being able to understand German"
Image reproduced by courtesy of the Royal Institution of Great Britain



Robert Bunsen, Gustav Kirchhoff and Henry Roscoe
© Royal Society of Chemistry

Michael Faraday and German-speaking chemists
by Frank James

In 1813, chemistry was very much a French science, its premier European journal being the Annales de Chimie. Its editorial policy derived entirely from the work of Antoine Lavoisier, who had sought to abolish the old phlogiston based chemistry by introducing terms such as oxygen and hydrogen. Such a major change in chemical theory did not happen quickly and indeed some, such as Humphry Davy (who lectured at the Royal Institution from 1801 to 1812), occasionally opposed Lavoisierian theory by showing, for example, that not all acids contained oxygen – one also suspects that by distancing himself from French chemistry, Davy was also disavowing any taint of Jacobin radicalism he might have shown in his youth. Faraday, on the other hand, never seems to have had any difficulty with accepting the basic ideas of Lavoisier's chemistry.

However, by the time of Faraday's death in 1867, the centre of excellence in chemistry had shifted decisively to the German-speaking lands, with the Annalen der Physik und Chemie and the Annalen der Chemie being the premier journals. While Faraday was fluent in French (and to a lesser extent in Italian), he never mastered German. While he did try, unsuccessfully, to learn the language, he increasingly came to regret (as he recorded in his letters) being unable to read the ever increasing number of fundamental papers written in German. This process began comparatively early when in mid-1821 the editor of the Annalen der Physik, Ludwig Gilbert, complained (in French) to Faraday about British ignorance of 'discoveries sometimes of very great merit' that were published in his journal. Faraday replied tactfully, as was his wont, saying that he 'continually regret[ted]' not being able to understand German.

> // I have heard mathematical physicists deplore that Faraday's records of his labours were difficult to read and understand, that they often resembled rather abstracts from a diary. But the fault was their's, not Faraday's. To physicists, who have approached physics by the road of chemistry, Faraday's memoirs sound like an admirably beautiful music. //

On the other hand, until large numbers of British students started studying at German universities comparatively few understood the language; amongst the scientific community during the early nineteenth century, only Thomas Beddoes, William Brande and Samuel Coleridge immediately spring to mind with that skill. What happened was that German-speaking chemists such as Julius Plücker, Christian Schoenbein and Justus Liebig – with whom Faraday enjoyed decades long correspondences – wrote to Faraday either in French (as Gilbert did) or, more usually, in English.

Somewhat surprisingly one German chemist whom Faraday did not know particularly well was Robert Bunsen, Professor of Chemistry at Heidelberg from 1852. However, one of Bunsen's students, Henry Roscoe, who spent the summers of the 1850s conducting photochemical experiments in Heidelberg, came to know Faraday reasonably and indeed presented Faraday with a portrait of Bunsen. At the end of that decade and into the early 1860s, Bunsen, working with Gustav Kirchhoff, Professor of Physics at Heidelberg, invented the spectroscopic method of chemical analysis, in the process of which identifying two new chemical elements (caesium and rubidium). This work enjoyed spectacular success during the first half of the 1860s; for instance, August Hofmann, German-born professor at the Royal College of Chemistry on Oxford Street, lectured on the subject to various members of the Anglo-German royal family, including Queen Victoria. Roscoe kept Faraday fully informed of the developments in Heidelberg, including delivering a Friday Evening Discourse at the Royal Institution on the topic. When Bunsen and Kirchhoff visited London in 1862, Roscoe introduced them to Faraday at a garden party hosted by John Gassiot, but unfortunately nothing further has been found relating to this encounter.

Despite Faraday's inability to understand German, he nevertheless ascertained, through the agency of others, much of what was happening in German chemistry and in science more generally. To a large extent this can be attributed to his status as one of Europe's foremost natural philosophers and chemists of the day; it was worth the effort of keeping in contact with him. Such admiration was perhaps most succinctly summed up by Hofmann in his 1875 Faraday lecture to the Chemical Society, quoting the great organic chemist Liebig:

An 1842 engraving of Justus von Liebig's chemistry lab at the University of Giessen, Germany
© De Agostini Picture Library / Getty Images

A chemists factory

It wasn't just his chemistry ideas that made Liebig famous: the way he taught hands-on chemistry in his laboratory was revolutionary too. 'He produced huge numbers of future chemists in his labs in Giessen, and later in Munich, something which had never been done before,' says Frank James of the Royal Institution in London. Previously, academics had just a handful of students under their guidance. James and other science historians call Liebig's lab 'a factory for producing chemists'. His lab is considered the root of today's modern university lab, with students being introduced to ongoing research projects earlier than was previously typical.

From the 1830s onward, dozens of British students went to Germany to be trained in Liebig's lab, says Morris. 'People with a PhD from Germany were taken seriously.'

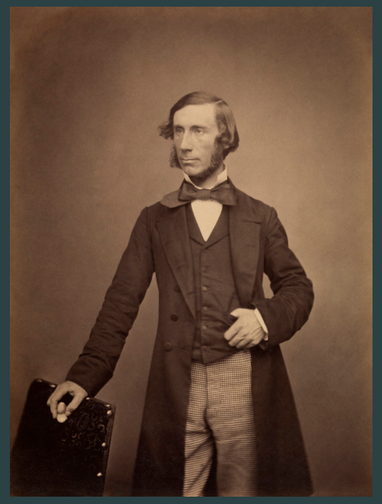
In 1844, two English businessmen who had previously worked in Liebig's lab – John Lloyd Bullock and John Gardner – proposed starting a private chemical research and education institute in London following the Giessen model. Landowners, ore mine operators, physicians and manufacturers as well as Prince Albert, Queen Victoria's German husband, all supported the idea of a British 'chemists factory' teaching practical chemistry. And, in 1845, the Royal College of Chemistry (RCC) was founded.

'It was determined that the director of the RCC should be a German,' says Brock. At that time Liebig had three possible candidates: Remegius Fresenius, Heinrich Will and Hofmann. Neither Fresenius nor Will wanted to go to London. That's how 28-year old Hofmann entered the picture.

A young German in London

Hofmann, born in 1818 in Giessen and the son of an architect, had travelled a lot with his father as a young man and was keen to learn and speak foreign languages. He had studied chemistry under Liebig and had been Liebig's assistant before he went to the University of Bonn as a lecturer.

When James Clark, physician to Queen Victoria, offered him the directorship of the RCC, Hofmann accepted. 'What a fantastic opportunity to make progress in science England does offer,' he wrote in a letter to Liebig. But he also made sure he could come back to Bonn, should the RCC fail to be successful.



John Tyndall "had greater regard for no other German man than Robert Bunsen"
Image reproduced by courtesy of the Royal Institution of Great Britain

Robert Bunsen's lectures were "superb"
Image reproduced by courtesy of the Royal Institution of Great Britain

John Tyndall and Robert Bunsen
by Roland Jackson

John Tyndall is known as a physicist rather than a chemist, but he had greater regard for no other German man than Robert Bunsen.

In October 1848, Tyndall travelled to Marburg with his friend and fellow teacher at Queenwood College, the chemist Edward Frankland. Following an invitation from Bunsen to Frankland, they had decided to study for their PhDs at the university where Bunsen (about ten years older than Tyndall) was a professor. They were the first from Britain to do so. Tyndall took lectures in physics from Christian Gerling (and later Hermann Knoblauch), mathematics from Friedrich Stegmann, chemistry from Bunsen, and spent time in the laboratory mastering qualitative and quantitative analysis. He thought the teaching impressive, and that it would take 'years of devoted effort to bring England up to the same standard'. He found Bunsen's lectures superb. His surprisingly neat notebooks from those days have recently been discovered in the Royal Institution's archive. Tyndall's German was not good before his arrival (he had bought Ollendorf's language teaching methodology the day before he left England, after some previous self-study). Nevertheless, the notebooks are predominantly in German, including substantial portions in Kurrentschrift, the old German form of handwriting.

Tyndall would later become known as one of the most engaging lecturers in England, and he was both inspired and influenced by Bunsen. When Tyndall finally got his big break—the offer of a professorship at the Royal Institution—it was to Bunsen that he turned for advice. Tyndall had to give four lectures 'On Air and Water' to qualify him formally for consideration. He wrote to Bunsen, who suggested the complete structure and experimental options for a lecture on water. Following this, Tyndall gave his second Friday Evening Discourse, the set-piece lecture to the RI's Society audience, 'On some of the eruptive phenomena of Iceland'. Again, he received advice from Bunsen, who had visited Iceland.

Over subsequent years the two men maintained a friendly correspondence. Tyndall was an important conduit between the German men of science (and particularly the physicists) and the British. In his role as an editor of the Philosophical Magazine, and of Taylor's Scientific Memoirs, he had many papers translated and made available in English. He also actively promoted their recognition by the Royal Society. He proposed Bunsen for the Copley Medal in 1857, and though he tactfully decided not to push Bunsen's claim against Charles Lyell that year, Bunsen received the award in 1860.

Tyndall was in turn supported by the Germans in his various arguments with the North British physicists. During the furore over Tyndall's advocacy of Robert Mayer's priority for calculating the mechanical equivalent of heat, Bunsen wrote with respect to Tyndall's altercation with William Thomson: 'Your response to Thomson's attacks is pretty devastating for him. May he take a lesson from it and stop arousing suspicion about the works of others, in fully unfounded ways and making sideswipes, as he has done so frequently in recent times'.

Tyndall made his career primarily in physics, and his discovery in 1868 that solar light could decompose the vapour of amyl nitrite, causing a chemical change, was ground-breaking. We do not know Bunsen's immediate response, but Rudolf Clausius, perhaps Tyndall's closest friend on the continent, thought he would probably open up a new field of research. Tyndall had arguably founded the field of chemical physics.

When Hofmann first arrived in London he lived and taught at 16 Hanover Square. In 1846, the college moved to cheaper rooms in Oxford Street. Hofmann then lived at 9 Fitzroy Square, now in the district of Fitzrovia, which today is marked with an English Heritage blue plaque. In 1853, the RCC merged into the Royal School of Mines and eventually became the Imperial College London chemistry department.

Science history books describe Hofmann as 'likeable', 'full of humour' and with 'a wit that never offended'. 'He was very popular, very outgoing and charismatic,' agrees Bill Griffith, emeritus chemistry professor at Imperial College London. 'People spoke very highly of him, his students and his colleagues. He must have been a nice chap.' Brock adds that Hofmann 'got on with everybody, all shapes and sizes'.

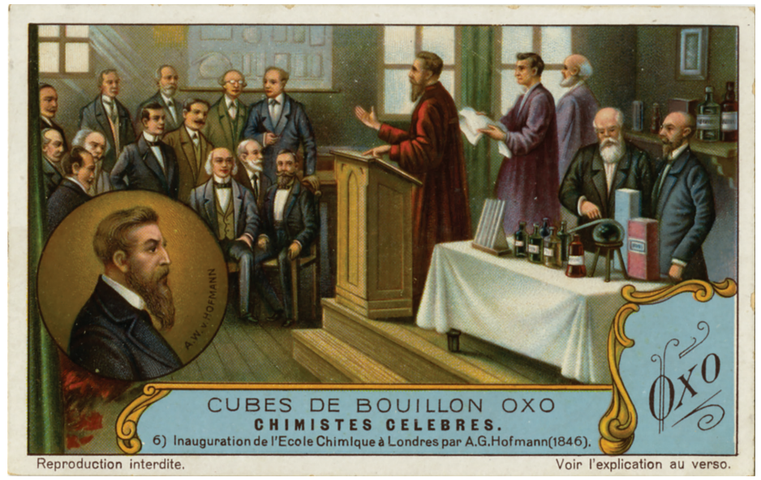
His strengths were his negotiating skills, diplomacy and integrity. 'He was a master in converting tensions into a common identity with unbroken self-confidence and in preventing open conflicts,' writes Meinel. In contrast, Liebig was known to be quite aggressive at times, writing vicious denunciations about science in Prussia and Austria, which he found to be of low quality.

Hofmann fitted well into life in London. 'He was respected,' says science historian Robert Bud of the Science Museum in London. 'You never get the sense of him being talked about as a foreigner.' Given Germany's reputation for chemistry research, it was entirely fitting for Hofmann to be appointed the director. For a chemist at that time, it was 'natural to be a German', Bud says. Hofmann also joined the Chemical Society (a precursor of the Royal Society of Chemistry) in 1845 and was elected its president in 1861. He had become a fellow of the Royal Society in 1851.

Frederick Abel, one of Hofmann's students, once said that Hofmann was homesick for London when visiting Germany on a summer vacation. Hofmann reportedly claimed: 'I am dying to get back. Germany no longer feels like home to me'.

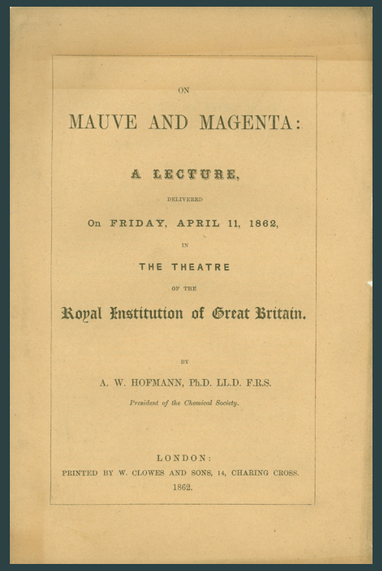
Chemistry on a large scale

Hofmann successfully achieved what he had come to England for: he implemented the country's first institute for producing chemists. But while it is often said that Hofmann established an exact London-based replication of the University of Giessen in London, Bud disagrees.



Liebig company trading card advert showing Hofmann giving a lecture at the opening of the Royal College of Chemistry
Image reproduced by courtesty of the Chemical Heritage Foundation

Obverse of the Albert Medal, which was awarded to Hofmann in 1881
Image reproduced by courtesy of the RSA, London. Photography by Maxwell Hodgetts


ON

MAUVE AND MAGENTA:

A LECTURE,

DELIVERED

On FRIDAY, APRIL 11, 1862,

IN

THE THEATRE

OF THE

Royal Institution of Great Britain.

BY

A. W. HOFMANN, Ph.D. LL.D. F.R.S.

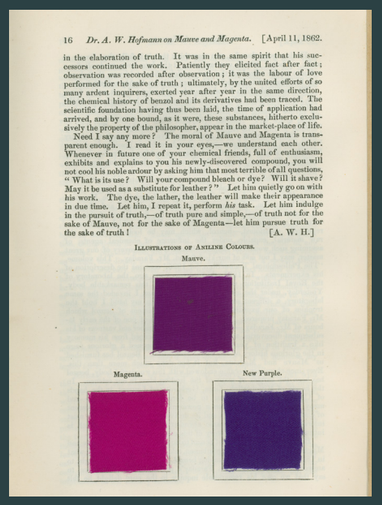
President of the Chemical Society.

LONDON:

PRINTED BY W. CLOWES AND SONS, 14, CHARING CROSS.

1862.

First page of Hofmann's Friday evening lecture to the Royal Institution in 1862
Image reproduced by courtesy of the Royal Institution of Great Britain


16 *Dr. A. W. Hofmann on Mauve and Magenta.* [April 11, 1862.

in the elaboration of truth. It was in the same spirit that his successors continued the work. Patiently they elicited fact after fact; observation was recorded after observation; it was the labour of love performed for the sake of truth; ultimately, by the united efforts of so many ardent inquirers, exerted year after year in the same direction, the chemical history of benzol and its derivatives had been traced. The scientific foundation having thus been laid, the time of application had arrived, and by one bound, as it were, these substances, hitherto exclusively the property of the philosopher, appear in the market-place of life.

Need I say any more? The moral of Mauve and Magenta is transparent enough. I read it in your eyes,—we understand each other. Whenever in future one of your chemical friends, full of enthusiasm, exhibits and explains to you his newly-discovered compound, you will not cool his noble ardour by asking him that most terrible of all questions, "What is its use? Will your compound bleach or dye? Will it shave? May it be used as a substitute for leather?" Let him quietly go on with his work. The dye, the lather, the leather will make their appearance in due time. Let him, I repeat it, perform *his* task. Let him indulge in the pursuit of truth,—of truth pure and simple,—of truth not for the sake of Mauve, not for the sake of Magenta—let him pursue truth for the sake of truth! [A. W. H.]

ILLUSTRATIONS OF ANILINE COLOURS.

Mauve.

Magenta. New Purple.

Last page of Hofmann's lecture, with the dye samples
Image reproduced by courtesy of the Royal Institution of Great Britain

Albert Medal 1881
by William Brock

The Albert Medal of the Royal Society for the Encouragement of Arts, Manufactures and Commerce was struck in 1863 to commemorate the long Presidency of the Society by Prince Albert between 1843 and his death in 1861. It was awarded annually from 1864 "for distinguished merit in promoting Arts, Manufactures, and Commerce". The medal's obverse portrays Prince Albert; the reverse three allegorical figures representing the areas promoted by the Society since its foundation in 1754. In 1881 Hofmann was awarded the medal by the Society's President, Edward Prince of Wales (later King Edward VII) for "eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England." The award, therefore, reflected Hofmann's contributions to the creation of the British dyestuffs industry, and the training of chemists at the Royal College of Chemistry between 1845 and 1865. The medal had previously been presented to Justus von Liebig in 1869 for his "contributions to the development of food economy and agriculture". The only other German chemist ever to have received the medal was Robert Bunsen in 1898.

Hofmann's Friday evening discourse at the Royal Institution on 11 April 1862
by William Brock

In his penetrating report on the chemical exhibits at the 1862 London International Exhibition at South Kensington, Hofmann foresaw that coal was destined to be the primary source of colours and that synthetic dyestuffs would soon entirely replace natural dyes. This would be achieved through chemists' ability to substitute amino and phenyl groups in aniline and other organic bases derived from coal-tar distillation and by forging academic-industrial alliances. This was the theme of a remarkable illustrated lecture that Hofmann gave to members of the Royal Institution on Friday 11 April 1862 when he was President of the Chemical Society. The lecture, entitled "On Mauve and Magenta, and the Colouring Matters derived from Coal", opened with a diagram of a gasworks and a practical demonstration of the destructive distillation of coal. Arguing that coal was "a sort of magazine of several elements", he claimed these elements could be shuffled into four "types of construction" or templates, namely hydrogen, water, ammonia and methane. He proceeded to illustrate this "type theory" (as historians call it) with wire cubes into which blocks of zinc, each painted in colours representing hydrogen (white), carbon (black), oxygen (red), nitrogen (blue), chlorine (green), etc, could be lowered. He then showed how "compound" hydrocarbon molecules could be exchanged or substituted for hydrogen atoms equivalent for equivalent and so derive substituted ammonias like ethylamine, diethylamine, etc, or benzol (benzene), phenol and aniline using the "phenyl" group, C_6H_5, as the substituent. He emphasized that the two-volume weight system recommended by Cannizzaro was essential in representing "the vast and daily multiplying class of substitution changes" and later called the volume of space his lattice wire cubes occupied a "crith"; in the hands of Ostwald, this became the chemists' "mole". In a further dazzling sequence of aids and practical demonstrations Hofmann reached the aniline dyes that he and his pupils had prepared, samples of which were shown to the audience and accompanied the printed version of the lecture in the RI's Proceedings. Although he confessed that the exact chemical nature of mauve, magenta and other dyes was not yet known, he convincingly showed what a powerful conceptual tool the type theory could be for synthesis in the days before the theory of structure was introduced by Kekulé.

The lecture ended with the moral: when Faraday had first prepared benzene at the RI in 1825, he had never intended to find something "useful". Chemists should be free to pursue pure synthetic research for its own sake and allow economic and commercial applications to emerge in the course of time. Privately, however, Hofmann's own experience with his pupils William Perkin and Edward C. Nicholson demonstrated that progress would be even more rapid when there was a symbiosis between pure science and trade – a view that he did much to encourage on his return to Germany in 1865.

Instead, Bud says Hofmann adapted Liebig's training methods to what was needed in London – giving an even greater emphasis to learning practical techniques. 'Hofmann didn't have a German university in London in the Humboldtian sense. Instead, he had a British college,' he explains. Most of Hofmann's students became farmers, pharmacists or consultants working for the chemical industry, rather than professors. About half of the students stayed only for one semester, learning to use a specific analytical technique that was important for their profession.

In addition to its role as a teaching institute, the RCC was also an analytical service carrying out testing and providing expertise for its private investors. 'There wasn't any room in London for the primacy of pure solely knowledge-driven science,' according to Meinel.

As well as being the first person in the country to formally teach chemists how to work at a bench, Hofmann is also credited with initiating chemistry's role as a large-scale discipline. 'Hofmann had a huge number of successors as chemists on these islands, and that was really important in getting chemistry going in a big way. Hofmann's impact on chemistry in this country is really significant,' says James. Chemists frequently track back their 'academic family tree', looking at who was a teacher of whom and determining which chemist appears on the top of their tree, he explains. 'In the UK, you always get back to Hofmann – and thus to Liebig.'

From coal to colour

During his time in Giessen, Hofmann had started to examine organic bases of coal tar. His research on aniline later became the basis for the chemistry of dyes, thus converting a black, rather displeasing byproduct into bright colours and founding a new sector of the chemical industry.

While Liebig became famous for analysing substances, Hofmann pushed forward the era of synthesis, converting his research lab into a workshop to produce new compounds and derivates. He was the first to convert ammonia into ethylamines and to synthesise quaternary amines. The Hofmann rearrangement from amides into amines is named after him. In 1866, he also invented the Hofmann voltameter, an apparatus for electrolysing water.

Hofmann had good connections with the chemical industry throughout his career, but always remained an academic and retained the title 'herr doktor professor', says Bud. He never yielded to the start-up fever of that time to try his luck in industry like so many other chemists did, including Liebig.

Some of Hofmann's students – or rather their research – gained enormous importance for Britain later on. One of them is William Henry Perkin, who accidentally discovered mauveine, the first aniline dye. Charles Mansfield distilled benzole from coal tar. Tragically, Mansfield died in an accident at the age of 35 when preparing benzole specimens for the Paris international exhibition of 1855. Abel became an expert in explosives and helped to safely manufacture guncotton.

Leaving England

In 1865, after 20 years in London, Hofmann returned to Germany. The Prussian government had offered him a chair at the Friedrich Wilhelms University in Berlin. This opportunity was simply too exciting to turn down, says Brock. 'I wouldn't want to decline the opportunity of a chair in Berlin with no monetary restrictions at all [either].'

Morris thinks Hofmann's decision might also have been motivated by the fact that Germany was on the up again. After the failed German revolution of 1848, many Germans had left the country – now they were coming back. 'Things were moving in Germany, both in chemistry, the chemical industry and in Germany in general,' says Morris. The unification of the German states was in the air. 'People like Hofmann wanted to be part of the new Germany.'

Hofmann held his British farewell lecture in the Royal Institution. He showed molecular models for the first time, using croquet balls of different colours, bolted together and set up on tripods. 'He had got the idea of trying to demonstrate the atomic and molecular structure of organic compounds,' says Brock. 'And of course we are still doing it.'

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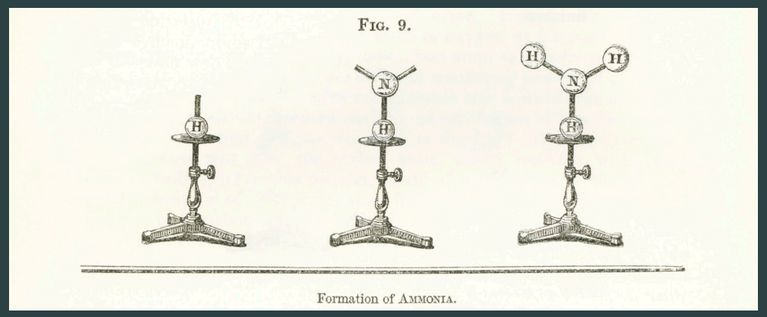
Hofmann and chemical models

by William Brock

In his 1862 RI lecture Hofmann had introduced wires shaped into a cube into which different coloured zinc cubes representing hydrogen, carbon, nitrogen, chlorine, etc could be placed and substituted. This was purely an architectural visual aid to help understand substitution and how chemists could build larger molecules from the basic types of hydrogen, water, methane and ammonia. It was never meant to represent chemical reality. It was about this time that, exploiting the new concept of valence, the Scots chemist Alexander Crum Brown introduced graphic formulae. Hofmann immediately saw that these line formulae could be built in three dimensions by bolting the coloured zinc cubes he had hitherto used together and assembling them on a tripod. For ease of manipulation ceramic balls instead of zinc cubes were used. Again, these models were not in any way representative of real chemical structures, but instead visual aids of how chemists had the ability to assemble complex molecules by means of substitution and elimination reactions. With the aid of his Royal College of Chemistry (RCC) assistant, Herbert McLeod, he assembled models using miniature billiard or croquet balls, using the same coloured signatures he had used previously. These "croquet" models were first demonstrated in another public lecture to the RI in 1865, and by 1866 chemical supply companies like J. J. Griffin were selling sets of these "glyptic" (sculpted) models.

Curiously, there is no evidence that Hofmann used these molecular kits after his return to Germany, though they continued to be used by Edward Frankland (Hofmann's successor at the RCC), and by Henry Roscoe's German colleague, Carl Schorlemmer, at Manchester. Their use in teaching was strongly objected to by Benjamin Collins Brodie, the professor of chemistry at Oxford, on the grounds that there was no evidence that atoms existed and that the use of such kits misled young minds. His intervention led to a series of debates at the Chemical Society (1867-69) about whether matter really was made up of atoms. Ironically, in his own mathematical operational system of chemistry that he used to replace atomism, Brodie used the same wire cubes that Hofmann had introduced as a visual aid. Meanwhile, in Germany, in the hands of August Kekulé at the University of Bonn, the exploitation of molecular models was transformed into a research tool – a process completed by J. H. van't Hoff in the Netherlands and J. A. le Bel in Paris with the concept of tetrahedral carbon bonding in 1874. This beautiful explanation of stereochemistry put pay to Brodie's objections to molecular modelling, which became an essential teaching and research aid in the twentieth century.

Although Hofmann appears not to have viewed his models as literal images of molecules, historians have noted that he inherited an interest in architecture from his father (who designed the enlargement of Liebig's laboratories at Giessen in 1839). Attention has also been drawn to the fact that the founder of the Kindergarten movement, Friedrich Froebel (who had worked as a crystallographer at Jena before turning to children's educational development), had introduced and popularised wooden block construction kits whose geometric assembly possibilities bear a remarkable resemblance to R. J. Haüy's diagrams of crystal structures made up from cubic blocks. It has also been noted that the adult game of croquet, which was first introduced to England in 1856, quickly led to table croquet sets that young children could play with in middle-class homes. Such sets used ceramic balls. Hofmann would undoubtedly have been familiar with these cultural and recreational developments, though whether they directly influenced his modelling of molecules in the 1860s has yet to be convincingly demonstrated.



A diagram on the formation of ammonia from Hofmann's Friday Evening Discourse write up "On the Combining Power of Atoms", 7 April 1865
Image reproduced by courtesy of the Royal Institution of Great Britain

Hofmann and 150 Years of the GDCh

With thanks to Christoph Meinel

The Deutsche Chemische Gesellschaft (DChG) was founded in Berlin in 1867 by a group of chemists around August Wilhelm Hofmann, who was elected first president. The constitution of the Deutsche Chemische Gesellschaft was similar to the one of the Chemical Society, founded in London in 1841. Hofmann had been living and working in London since 1845, chairing the Royal College of Chemistry in London. During this time he lived at 9 Fitzroy Square, now in the district of Fitzrovia, which today is marked with an English Heritage blue plaque. In 1861 Hofmann had become president of the Chemical Society of London.

In 1868 the newly founded Deutsche Chemische Gesellschaft published its first scientific journal, Berichte der Deutschen Chemischen Gesellschaft (Reports from the German Chemical Society): its successor publications today are the European Journal of Inorganic Chemistry and the European Journal of Organic Chemistry. The most recent predecessor to today's GDCh, the Verein Deutscher Chemiker (VDCh) (Association of German Chemists), was founded twenty years later, in 1887. The journal it produced for its members is still published today: Angewandte Chemie. The DChG membership was drawn primarily from the universities, while the VDCh addressed persons working in the chemical industry.

The first job placement service for chemists was launched under the aegis of the VDCh in 1900. At the same time, the VDCh's first specialist groups came into being. These subsidiary organizations largely shape the character of the GDCh to this day. The fiftieth anniversary of the DChG coincided with the 100th birthday of its founding president, August Wilhelm von Hofmann, on April 18, 1918. In the early years of the 20th century, the first internationally recognized scientific awards were established. These included the Liebig-Denkmünze (the Liebig Memorial Medallion) and the Emil Fischer Medaille, which are conferred on outstanding chemists to this day. In 1921, the DChG, the VDCh and the predecessors of today's VCI joined to found Verlag Chemie (Chemical Publishing).

The National Socialist era in Germany did not leave the GDCh's predecessor organizations unscarred. Application of the so-called Führerprinzip (top-down governance), which implied the firing of Jewish colleagues, was made obligatory, as was incorporation of the chemical organizations into the NS-Bund Deutscher Technik (the National Socialist Federation of German Technology). After the war, the DChG and the VDCh were both dissolved, and both organizations were merged to form the Gesellschaft Deutscher Chemiker, first founded in the British zone in 1946 and then in West Germany as a whole in 1949. The first chairman and president of the GDCh was Karl Ziegler, later a winner of the Nobel Prize.

In the 1950s, membership in the GDCh passed the 5,000 mark. In 1953, the Chemische Gesellschaft was founded in the German Democratic Republic. By 1958, the GDCh had more than 10,000 members, and in 1962 the organization moved into its present home in Frankfurt. In the 1960s, the focus was on probing more deeply into the chemical sciences. In the 1970s and 1980s internationalization became a priority, and ecology came to be written large with, for example, the establishment of the Beratergremium für umweltrelevante Altstoffe (BUA), an advisory committee on chemical substances that impact the environment. By its 125-year anniversary celebrations in 1992, the GDCh could boast a brisk business in publications and one successful conference after another. Integration of the former members of the GDR's Chemische Gesellschaft raised GDCh membership to over 25,000.

In the second half of the 1990s, the GDCh brought about a reformation in the landscape of the continental European chemical journals. Under GDCh leadership, the national journals of the European chemical societies were melded into new, pan-European journals. Prominent among the large number of very successful journals, Chemistry - A European Journal merits special mention.

Together with other chemical organizations and the German Federal Ministry of Education and Research (BMBF), GDCh orchestrated the national Year of Chemistry in 2003 on the occasion of the 200th anniversary of the birth of Justus von Liebig. With the new millennium the GDCh sought to foster both greater merging of the European chemical societies into a common European research area and close cooperation with non-European partners, like the International Union of Pure and Applied Chemistry, IUPAC. In 2004 GDCh was one of the leading forces in converting the former Federation of European Chemical

Hofmann's house in London is marked with an English Heritage blue plaque
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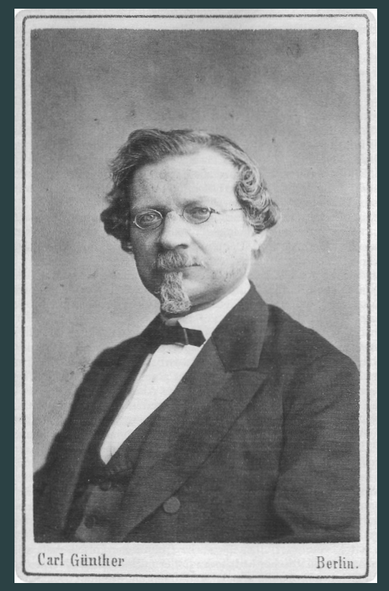
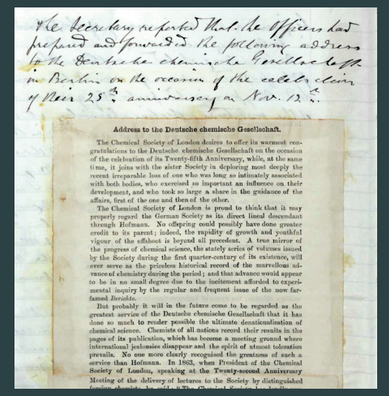


Portrait of Hofmann in 1871, after his return to Berlin
Image reproduced with kind permission from: Christoph Meinel and Hartmut Scholz (eds.), Die Allianz von Wissenschaft und Industrie: August Wilhelm Hofmann (1818-1892). Zeit, Werk, Wirkung (Weinheim/New York: VCH, 1992), p. 54.


Address to the Deutsche chemische Gesellschaft.

Address to the Deutsche chemische Gesellschaft from the Chemical Society of London, congratulating them on their 25th anniversary and celebrating the contribution of Hofmann
© Royal Society of Chemistry

Societies (FECS) into the European Association of Chemical and Molecular Sciences (EuCheMS). In 2010 the GDCh was organizer of the 3rd EuCheMS Chemistry Congress in Nürnberg with some 2,500 participants. In 2011 GDCh played a key role in the organization of the International Year of Chemistry launched by the United Nations and IUPAC.

The GDCh is a member of ChemPubSoc Europe, an organization of 16 European chemical societies, founded in the late 1990s as a consequence of the amalgamation of many chemical journals owned by national chemical societies into a number of high-quality European journals with ChemistryOpen as the first Open-Access-Society journal in 2011. ChemPubSoc Europe's journals are all published with Wiley-VCH.

Since 1996 eleven bilateral cooperation alliances have been signed with Chemical Societies around the world, focusing on cooperation in organizing scientific events and enabling the members to access conferences of the partner society with reduced conference fees. The most recent Memorandum of Understanding was signed with the Israeli Chemical Society on the occasion of a recent symposium in Tel Aviv, Israel.

Aside from these activities, the attention of the GDCh has focused on the ethical commitment and responsibility of its members as chemist scientists. In 1998 the GDCh code of honour was drawn up. All members pledge to act in a responsible and sustainable way and to oppose strictly any misuse of chemical weapons and illegal drugs. In 2015 a more than 700-page survey about chemists in the so-called Third Reich was published, set off by the GDCh. With this extensive and detailed study, the GDCh committed the responsibility of its predecessor organizations. And it was in 2015 also, when, 100 years after the first use of chemical weapons in warfare, then GDCh president Thomas Geelhaar and other representatives of chemistry organizations gathered in Ypres to commemorate those who died as a result of chlorine gas and other chemical weapons.

In 2013 the number of GDCh's members exceeded 30,000. With members from academia, industry and the professions, the GDCh represents a large and socially important community of experts. Although the huge majority of members are chemists or chemistry students, everyone who accepts GDCh's code of honour is invited to join the GDCh. The organization's 150-year history, global network and high scientific and social standards form the foundation for future-oriented activities in pursuit of a world that can sustain human life at a level worth living.

Celebrating 150 years of history at the GDCh Scientific Forum Chemistry (Berlin, September 2017)

Speaker abstracts and biographies

Anglo-German Chemistry 1821-1914

William Brock
University of Leicester, UK

In 1821 Edward Turner, the future professor of chemistry at University College London, studied analytical chemistry with Friedrich Stromeyer at the University of Göttingen. In the succeeding decades scores of other British students flocked to chemistry courses at Giessen (Liebig), Heidelberg (Bunsen), Göttingen (Wöhler), Berlin (Hofmann) and other centres. What did these German laboratories have to offer that was not available in Great Britain from at least 1845 onwards when Hofmann established the Royal College of Chemistry? The phenomenon was largely destroyed by the First World War, which stimulated British universities to create a system of postgraduate education between 1917 and 1919 that culminated in the very Germanic PhD degree.

William Hodson Brock read chemistry at University College London. On graduating in 1959 he studied the history and philosophy of science at the University of Leicester and was appointed a lecturer in the subject in 1960. Apart from visiting appointments at Toronto (1977), Melbourne (1985 and 1989), and as Edelstein International Fellow in History of the Chemical Sciences at the Chemical Heritage Foundation in Philadelphia (1990-91), Brock remained at Leicester for the whole of his teaching career. He retired in 1998 and moved back to the south coast of England where he continues to write. Following a visit to Germany in 1973, he became interested in the careers of Justus Liebig and his pupil, August Wilhelm Hofmann. The edition of their correspondence, Liebig und Hofmann in ihren Briefen (1841-1873), was published in German in 1984, and the biography Justus von Liebig: The Chemical Gatekeeper appeared in English in 1998 and in German two years later. His best-known work, The Fontana History of Chemistry (1992/1993), has been translated into Spanish, Polish, German and Japanese. His History of Chemistry: A Very Short Introduction was published by OUP in 2016. Brock recently completed a 50-year long association with the Society for the History of Alchemy and Chemistry, as editor of its journal Ambix (1968-83), its Chairman (1993-2006) and member of Council (1967-2016). He was awarded the ACS's Dexter Prize for the History of Chemistry in 1995.

Searching for traces of August Wilhelm von Hofmann

Brigitte Osterath
Am Kalkofen 2, 53347 Alfter (bei Bonn), Germany

August Wilhelm von Hofmann spent 20 years in London before returning to Germany and founding the German Chemical Society. What signs of his life and work still remain today? Science reporter Brigitte Osterath went to look for Hofmann's traces in London and Berlin.

Brigitte Osterath is a freelance science writer and editor based in Bonn, Germany. In addition, she works for the German Chemical Society's magazine "Nachrichten aus der Chemie" and for Deutsche Welle, Germany's international broadcaster. She holds a diploma in chemistry from the University of Bonn and completed her PhD thesis at the Institute of Biotechnology at Research Center Juelich.

The Role of Chemistry in the Development of Materials for Efficient, Safe and Low-Cost Rechargeable Batteries

Philipp Adelhelm
Institute of Technical Chemistry and Environmental Chemistry, Friedrich-Schiller-University Jena, Germany

The average daily energy need of a person living on "western living standards" amounts to about 125 kWh per day. In other words, we live in a "5 kW society". Compared to the present world average (56 kWh/day, 2.34 kW) and considering the rising world population, these numbers undoubtedly illustrate that the transition to a renewable energy supply is a major challenge. Moreover, Europe is highly dependent in its energy supply and imports more than half of all the energy it consumes at a cost of more than one billion EUR per day. The efficient use of wind and solar energy seems the only viable option for the future but the unsteady supply is already challenging electricity grids. The realization of large scale grid storage in the range of GW (power) and TWh (energy) is therefore considered a decisive factor for the future within the EU and worldwide. Without doubt, chemistry is of central relevance to this and the development of materials for efficient, safe and low-cost rechargeable batteries is an important task. Lithium-ion battery technology is at the forefront of this development but a massively growing market will likely put severe pressure on resources and supply chains. Recently, sodium-ion batteries are being reconsidered with the aim of providing a lower-cost alternative that is less susceptible to resource and supply risks. On paper, the replacement of lithium by sodium in a battery seems straightforward at first but unpredictable surprises are often found in practice. The presentation will therefore address the following aspects: (1) How big is the energy challenge? (2) What is the state-of-the art in lithium-ion batteries and where are the limits? (3) Are sodium-ion batteries an alternative and how can chemists contribute to their development?

Philipp Adelhelm is a materials scientist and received his education at the University of Stuttgart and the Max-Planck-Institute for Metals Research. After graduation in 2004, he joined the group of Prof. Markus Antonietti at the Max-Planck-Institute of Colloids and Interfaces in Potsdam, Germany, and worked on the synthesis and characterization of carbon materials with tailored porosity. He received his PhD in physical chemistry in 2007 and continued his academic career as a postdoc at the Debye Institute of Nanomaterials Science in Utrecht, The Netherlands, under supervision of Prof. Petra de Jongh and Prof. Krijn de Jong studying sodium and magnesium based hydrogen storage materials. During his stay as group leader at the Justus-Liebig-University Giessen, Germany (Institute of Physical Chemistry, RG Prof. Juergen Janek) his research was aimed at exploring the cell chemistry of sodium based battery systems with the focus on carbon materials, conversion reactions, sodium/air and low temperature sodium/sulfur systems. In April 2015, he was appointed professor at the Institute for Technical Chemistry and Environmental Chemistry (ITUC) at the Friedrich-Schiller-University Jena where he is heading a group on functional materials / electrochemistry. He is also part of the Jena Center for Energy and Environmental Chemistry (CEEC Jena).

The Role of Chemistry in Sustainable Wastewater Treatment

Elise Cartmell
Scottish Water, Bullion House, Mill Road, Invergowrie, Dundee, UK

Wastewater treatment has a vital role in protecting human and environmental health. But what is the future role of chemistry as wastewater treatment increasingly now transitions towards treatment processes that also recover valuable resources and support wider sustainable water management approaches? This presentation will examine how chemistry can be applied both now and in the future to support resource recovery options for energy, metals, nutrients, salts, wider chemicals (including bioplastics) and of course water. How chemistry can support wider developments including the sustainable management of contaminants by catchment management approaches and process optimisation for a chemically diverse range of chemicals, from conservatively biodegradable organics to non-biodegradable inorganic species will also be addressed. Chemistry can have a significant role to play in future wastewater treatment, especially if more integrated ways of working and greater collaboration are embraced.

Elise Cartmell is the Chief Scientist at Scottish Water responsible for their sampling, laboratory and scientific services. Elise joined Scottish Water in April 2016 following a career in academia at Cranfield University where she was Professor of Water Technology and Director of Environmental Technology. Here she specialised in wastewater treatment with particular reference to trace contaminants and anaerobic processes. Elise is a chemist with a BSc (Hons) from The University of Edinburgh and PhD from Imperial College, London. Prior to joining Cranfield in 2000 she was a research scientist at WRc plc. She is a Fellow of the Royal Society of Chemistry.

Novel Developments in Food Chemistry to Ensure Safe, Healthy and Pure Food

Monika Pischetsrieder
Department of Chemistry and Pharmacy, Friedrich Alexander University Erlangen-Nürnberg, Schuhstraße 19, 91052 Erlangen, Germany

One of the most important global challenges is the supply of a sufficient amount of healthy and safe food to a growing population. Provision of energy is a fundamental prerequisite for food security. However, not only the quantity, but also low quality of food leads to malnutrition. Thus, severe health problems occur, when insufficient amounts of nutrients or toxic contaminants are consumed. This presentation will discuss how novel developments in food chemistry can help to improve food security, quality and safety. In particular untargeted profiling methods promise fundamental improvement to detect unsafe food and food fraud. In Europe, food items are regularly tested for several hundred contaminants. Consequently, common contaminations can be routinely kept to a minimum. Severe risk however appears, when toxic components are overlooked because their presence in food is not expected. The same is true for food adulteration. Whereas common food frauds can be easily discovered, criminal ideas beyond the imagination of food control can stay undetected for too long. For both applications, untargeted profiling methods are a good way to detect suspicious samples, which differ in their composition and which can be subjected to further analysis. The emerging application of untargeted profiling in food analysis is greatly based on the latest progresses in mass-, but also NMR-spectrometry. Most important here are developments that allow the transfer of cutting-edge techniques to routine analysis. A further challenge is the translation of a huge amount of data, generated by profiling methods, into knowledge. Moreover, profiling methods can greatly accelerate the search for bioactive food components. In order to understand the physiological activity of a food or a particular diet, it is not sufficient to glimpse their effect on a selected single cellular target. Instead, a view on their influence on metabolic networks is desired to fully understand and predict the physiological activity of a food molecule. Some examples from our own work will illustrate how untargeted MS-based profiling methods can be applied for food authentication and the search for novel bioactives in food.

Monika Pischetsrieder is a food chemist and received her PhD from the University of Munich, Germany. After a postdoctoral stay at the Institute of Pathology at the Case Western Reserve University in Cleveland, Ohio, USA with Prof. Vincent Monnier, she returned to the University of Munich to build up her own research group. In parallel, she held a position as Visiting Assistant Professor at the College of Physicians & Surgeons of Columbia University, New York, USA in the wok group of Prof. Ann-Marie Schmidt. Since 1999 she has been Associate Professor and since 2004 Full Professor and Chair of Food Chemistry at the University of Erlangen-Nürnberg, Germany. Her research interests focus on the identification of novel bioactive food components with a special focus on neuroactive compounds. For this purpose, novel mass spectrometry-based strategies for targeted and non-targeted peptide and protein profiling are developed and applied. These methods are further used to find novel approaches for food authentication. For her achievements, she received for example the Forprion Research Award or the Cofresco Research Prize. Since 2011, she has been Board Member and since 2011 Board Chairwoman of the Society of Food Chemistry in Germany, the largest division of the GDCh. Among numerous activities in the scientific community, Monika Pischetsrieder served on the Review Board of the German Research Foundations and is currently Member of the Scientific Advisory Board of the German Federal Ministry of Food and Agriculture.

Chemistry: Towards a More Sustainable Future?

Pete Licence
School of Chemistry, University Park, Nottingham, NG7 2RD, UK

As we celebrate significant milestones in the heritage of our national societies we can reflect upon the greatness of the collective past of our discipline. Chemistry and chemistry related activities have driven development and introduced opportunity into the lives of many. We now live in a fast-moving consumer society with an insatiable demand for smarter, better, higher performance products. Our population is larger and the demands on our environment are becoming more apparent. There is a pressing and urgent need to develop new chemical and manufacturing solutions that are safe, efficient and, above all, sustainable! In this short presentation, I will attempt to showcase some of the best examples of chemistry providing impacts that span the needs and wants of our modern society whilst striving for increased efficiency. I will explore the impacts of chemistry based research in terms of both reaction metrics and indeed the environment in which we do our science, i.e. the broader aspects of our laboratories.

Pete Licence is Professor in Chemistry at the University of Nottingham where he is also inaugural Director of the GSK Carbon Neutral Laboratories for Sustainable Chemistry, a new-build facility focused on the delivery of sustainable chemistry solutions for the fine chemicals and pharmaceuticals sectors. A synthetic organic chemist by training, Licence offers experience in the design and preparation of ultra-high purity functionalised ionic liquids that are bespoke for a specific task. The key driver that underpins much of Licence's research is the development of an in-depth knowledge of interactions and processes at interfaces and discontinuities. Interfaces are crucial regions in most processes spanning extraction, catalysis and small molecule sensing. Licence is Adjunct Professor in Chemistry at Addis Ababa University in Ethiopia, Co-Director of the recently awarded EPSRC Centre for Doctoral Training in Sustainable Chemistry (CDT-SusChem) and Co-I of the BBSRC/EPSRC Multidisciplinary Synthetic Biology Research Centre (SBRC-Nottingham). Pete is author of > 120 peer-reviewed articles in the field of Green and Sustainable Chemistry (h = 33), a founding presenter in the acclaimed YouTube channel PeriodicVideos.com and Associate Editor of the American Chemical Society journal; ACS Sustainable Chemistry and Engineering.

DNA Bases beyond Watson and Crick

Thomas Carell
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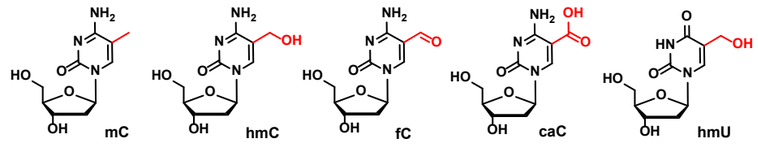
Epigenetic information is stored in the form of modified bases in the genome. The positions and the kind of the base modifications determine the identity of the corresponding cell. The setting and erasing of epigenetic imprints control the complete development process starting from an omnipotent stem cell and ending with an adult specialized cell. I am going to discuss results related to the function and distribution of the new epigenetic bases 5-hydroxymethylcytosine (hmC), 5-formylcytosine (fC), 5-carboxycytosine (caC) and 5-hydroxymethyluracil (Scheme 1).[1] These nucleobases seem to control epigenetic programming of cells and establish genetic programmability. Synthetic routes to these new bases that enable the preparation of oligonucleotides will be discussed. The second part of the lecture will cover mass spectroscopic approaches to decipher the biological functions of the new bases.[2] In particular, results from quantitative mass spectrometry, new covalent-capture proteomics mass spectrometry and isotope tracing techniques will be reported.[3] Finally I will be discussing potential präbiotic origins of modified bases.[4]



Scheme 1: Depiction of the new epigenetic bases.

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4. S. Becker, I. Thoma, A. Deutsch, T. Gehrke, P. Mayer, H. Zipse, T. Carell, *Science* **2016**, *352 (6287)*, 833-836. A high-yielding, strictly regioselective prebiotic purine nucleoside formation pathway.

Thomas Carell was raised in Bad-Salzuflen (Germany). He studied chemistry at the Universities of Münster and Heidelberg. In 1993 he obtained his doctorate with Prof. H. A. Staab at the Max Planck Institute of Medical Research in Heidelberg. After postdoctoral training with Prof. J. Rebek at MIT (Cambridge, USA) in 1993-1995, Thomas moved to ETH Zürich (Switzerland) as an assistant professor to start independent research. He obtained his habilitation (tenure) in 2000. He subsequently accepted a full professor position for Organic Chemistry at the Philipps-Universität in Marburg (Germany). In 2004 Thomas moved to the Ludwig-Maximilians-Universität (LMU) in Munich (Germany), where he now heads a research group centered around chemical biology. His current focus is to analyze the chemistry of epigenetic programming in DNA and RNA; Thomas founded the company Baseclick GmBH in 2008. He is a member of the National German Academy, Leopoldina and of the Berlin-Brandenburg Academy of Arts and Sciences. He is a recipient of the Cross of Merit from the Federal Republic of Germany. Thomas obtained the Leibniz award from the DFG in 2003 (comparable to an HHMI investigator in the USA) and an ERC advanced grant in 2017. He is the speaker of the Excellence Cluster (EXC114) on protein chemistry and of the collaborative research center (SFB749) on Chemical Dynamics.

Adam Brownsell

Publisher, Royal Society of Chemistry

Adam Brownsell is a Publisher at the Royal Society of Chemistry and Editor of Chemistry World magazine. He was previously Head of Publishing and Marketing at the Royal College of Surgeons and has worked in scholarly communications covering medical, educational and professional fields.

John Holman

President, Royal Society of Chemistry, UK

John Holman is President of the Royal Society of Chemistry, Emeritus Professor in the Chemistry Department, University of York, UK, and adviser in Education at the Wellcome Trust and the Gatsby Foundation. He was the founding Director of the National Science Learning Centre from 2004 until September 2010, and adviser to the English government as National Science, Technology, Engineering and Mathematics (STEM) Director from 2006 until September 2010. He was re-appointed a Trustee of the Natural History Museum (2015), he is Chair of the Salters' Institute Board (from 2013) and Chair of the Teacher Development Trust (from 2014). After studying Natural Sciences at Cambridge, John taught in a range of secondary schools and in 1994 he became principal of Watford Grammar School for Boys, an all-ability state school. From 2000 to 2004 he was Salters' Professor of Chemical Education at the University of York. John has taught learners of chemistry and science at all levels from 11 year olds to undergraduates and currently teaches chemistry to undergraduates at York. He has created curricula and written books for science learners of most ages in the UK and overseas and was the founding director of the Salters Advanced Chemistry programme. John was named in 2014 by the Science Council as one of UK's 100 leading practising scientists, and was awarded in 2014 the Royal Society of Chemistry's Lord Lewis Prize and the Royal Society's Kavli Education Medal. He was knighted in 2010, for services to education.

Pilar Goya

Vice-President, European Association for Chemical and Molecular Sciences

Pilar Goya Laza is currently Vice-President and President Elect of EuCheMS (European Association for Chemical and Molecular Sciences). She received her PhD in Chemistry from the Universidad Complutense Madrid and had a postdoctoral stay with Prof. W. Pfleiderer in Konstanz, Germany, financed by the Alexander von Humboldt Foundation. She is research professor of the Spanish Research Council (CSIC) and from 2005 to 2011 she was the Director of the Instituto de QuímicaMédica. From 1991 to 1996 she was Head of International Affairs of CSIC. Former representative in HCM and TMR programmes of the EU, she has participated in evaluation panels of the Framework Programmes of the EU, having chaired the Chemistry Committee of the Marie Curie grants. Her research deals with different aspects of medicinal chemistry and drug design, and is currently focused on cannabinoids and PPAR ligands targeting the CNS and obesity. She is author of over 150 scientific publications and holds a dozen international patents in these disciplines. She has directed 10 PhD theses. She was Vice President of the Royal Society of Chemistry of Spain, RSEQ, and is currently the President of the Spanish Society of Medicinal Chemistry, SEQT

Thisbe Lindhorst

President, Gesellschaft Deutscher Chemiker. Germany

Thisbe Lindhorst has been full professor at the Faculty of Mathematics and Natural Science of Christiana Albertina University of Kiel since 2000. She studied chemistry at the Universities of München and Münster, received her diploma in chemistry/biochemistry in 1988 and her PhD in Organic Chemistry in 1991 at the University of Hamburg (Prof. Thiem). After a postdoctoral stay at the University of British Columbia (Prof. Withers) she worked on her habilitation and became Private Docent in 1998 at the University of Hamburg. In 1997 she was a Visiting Professor at the University of Ottawa in Canada (Prof. R. Roy) and in 2014 and 2015 Visiting Professor at the University of Orléans in France. Since 2000 she has held a chair in Organic and Biological Chemistry in Kiel.

Her scientific interests are in the field of synthetic organic chemistry and in biological chemistry, especially in glycochemistry and glycobiology. Her current research is focussed on the study of glycosylated surfaces and control of cell adhesion. She is the author of over 130 publications and of the text book "Essentials in Carbohydrate Chemistry and Biochemistry", amongst others. Her most important awards are 'Förderpreis der Karl-Ziegler-Stiftung award', 'Chemiepreis der Akademie der Wissenschaften zu Göttingen award', and 'Carl-Duisberg-Gedächtnispreis award'. Her activities and professional responsibilities comprise several positions in advisory and editorial boards. She has been an elected member of the DFG Forschungsforum for 8 years and in 2016 she was elected president of the German Chemical Society, GDCh, for 2016 and 2017. She has two grown-up children.

Elizabeth Rowsell

Director, Johnson Matthey Technology Centres, UK

Liz joined the Johnson Matthey Technology Centre in 1993 as a Research Scientist working in Biomedical Research where the focus was the use of inorganic complexes as therapeutics. Her main area of research was the use of ruthenium complexes as nitric oxide scavengers for use in the treatment of sepsis. In 2000 Liz became manager of the Liquid Phase Catalysis Group looking at the development of homogeneous and heterogeneous catalysts for use in the pharmaceutical and fine chemical industry. The group applied high throughput screening techniques to discover new catalysts for use in carbon-heteroatom coupling, carbonylation, hydrosilation, selective oxidation and chiral chemistry. In 2004 Liz moved into the development of new technologies based on the properties of platinum group metals. Liz and her team have developed technologies in low temperature catalysis, thermochemical biomass processing, mercury removal from gas streams, and new materials for energy production. Liz is now the Director of the Johnson Matthey Technology Centres, Johnson Matthey's corporate R&D facilities, with locations in the UK, USA and South Africa. The site at Sonning Common houses the advanced materials characterisation facilities and works closely with scientists at Harwell in the Diamond Light Facility.

Matthias Urmann

Sanofi-Aventis Deutschland GmbH

Matthias Urmann studied chemistry at Heidelberg University. After a post-doctorate at Harvard University, he began his industrial career in pharmaceutical research at Hoechst AG ¬(Frankfurt) in 1993. Here, he worked mainly in the research of new drugs for the treatment of the metabolic diseases, diabetes and adiposity, but he was also able to contribute to several drug candidates in the areas of arteriosclerosis and thrombosis. In the role of Associate Vice President, he has been responsible for managing an R&D Department within the Diabetes Division of Sanofi in Frankfurt since the beginning of 2010. He is a board member of the GDCh and has been elected as GDCh President for 2018/19.

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