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Chemistry and the Max Planck Society: A Stable Bond Resonating into the Future

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As one of the fundamental natural sciences, chemistry has long enjoyed a privileged position within the Max-Planck-Gesellschaft (MPG; Max Planck Society). More than 80 institutes and research facilities across the natural sciences, life sciences, social sciences, and humanities make up the MPG. They selectively focus on research topics that are especially new and promising. No fewer than three chemistry-oriented Max Planck Institutes (Max Planck Institute for Chemistry, Fritz Haber Institute, and Max-Planck-Institut für Kohlenforschung) were founded more than one hundred years ago as research institutions of the Kaiser-Wilhelm-Gesellschaft (KWG; Kaiser Wilhelm Society), the predecessor organization of the MPG. The Max Planck Institute for Chemistry and the Fritz Haber Institute, the oldest chemistry institutes of the KWG and the MPG, can trace their origins all the way back to the year 1911, when the KWG itself was established.

The 20th century can be viewed, above all, as the age of chemistry. Today, chemistry-based technology has taken on a preeminent role in everyday life, in parts it even provides the very foundation of our civilization. Both as a science and as a sector of industry, chemistry has rapidly become a key player in solving the most pressing tasks of the future. Whether it be meeting our energy needs, feeding the world's population, protecting our natural resources, or improving medical care, these global challenges can be met only by innovations in chemistry and the resulting developments in technology.

Overall, German chemistry finds itself in a very good position, with a considerable share of excellent chemical research taking place in non-university institutions. Not only century-old chemistry institutes but also younger departments in the MPG have made scientific history with groundbreaking discoveries and accomplishments, as borne out by the numerous Nobel Prizes in Chemistry that have been awarded to researchers of the KWG and the MPG. Seven of the fifteen Nobel Laureates from the KWG and eight of the eighteen Nobel Laureates from the MPG were recognized for their work in the field of chemistry. In addition, three Nobel Prizes in medicine and one Nobel Prize in physics originated at one of the chemistry institutes. Most recently, Stefan Hell, from the Max Planck Institute for Biophysical Chemistry, was awarded the coveted prize in 2014 for his pioneering work in the field of ultrahigh-resolution fluorescence microscopy.

Basic research in chemistry is carried out at more than 20 Max Planck Institutes. Modern chemistry, with its ability to manipulate the building blocks of the macroscopic world almost at will, appears primarily under three guises. On the one hand, it is a classical discipline, a fundamental science in itself. On the other hand, chemistry is an essential component of interdisciplinary research, for example, in its increasingly important contributions to the life sciences. Biology and medicine are becoming more "molecular", such that many open questions in those fields have morphed into chemical problems. Finally, chemistry has developed into a key branch of science for solving humanity's most urgent problems.

Although chemistry is now well recognized as an "enabling science", there are fundamental, profound issues within the discipline that are less visible both internally and externally. Precisely these intrinsic challenges must be identified so that chemistry remains a vibrant science with its own distinct identity.

Max Planck Institutes provide the necessary scope for such an evolution. The MPG's fundamental approach is to identify outstandingly creative scientists, often working on the boundary between disciplines, and to offer them a suitable foundation for independent scientific development. This so-called Harnack principle represents the traditional policy of the MPG to appoint the brightest minds as Scientific Members. But this principle is not applied only to the hiring of outstanding, exceptional researchers as departmental directors, for whom an environment is tailored to meet the needs of their particular research. The Harnack principle is also at the root of the great importance ascribed by the MPG to training of the next generation of scientists and to collaboration with universities.

The primordial question concerning the origin of life is in essence a chemical one. In the 1950s, scientists proved that amino acids and other organic compounds—the building blocks of life—can form in a "primordial soup". It took the discovery in 1995 of a planet outside our solar system, however, to reignite interest in determining the conditions

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necessary for life. This particular question appears to offer fertile ground for an interdisciplinary effort involving astrophysicists, planetary scientists, chemists, and biologists. The MPG is now considering just such an approach, in the hope of initiating a new golden age of research in this long-dormant field.

The significance of chemistry in biological systems is linked closely to synthetic biology (see also the Editorial by P. Schwille, *Angew. Chem. Int. Ed.* **2013**, *52*, 2616). The aim is not only to modify living systems, but also to construct new ones. Years ago, Richard Feynman coined the phrase: "What I cannot create, I do not understand". It is not sufficient to synthesize clean compounds; rather, the goal is complete, self-sustaining systems. The approach adopted by synthetic biology resembles that of chemical engineering, but, instead of assembling pumps, reactors, and filters into a functioning production facility, synthetic biologists work with a toolbox full of genes, proteins, and other biomolecules. The MPG has recently bundled its competencies in this area, forming the research network MaxSynBio out of nine Max Planck Institutes. The network will focus on synthesizing protocells, that is, searching for the minimal cell. In so doing, Max Planck researchers join a small number of colleagues from around the world who have been bold enough to tackle this exciting challenge.

The MPG, with financial resources comparable to the combined budgets of three to four large German universities, has always found itself in a process of thematic renewal. This is a particularly timely issue, since, as from 2016 on, the annual budgetary increases guaranteed by the Joint Initiative for Research and Innovation will no longer suffice to enable the founding of new institutes.

A natural starting point for reorientation is the retirement of a director of an institute. The challenge is to integrate new topics in a beneficial manner into the overall research portfolio of the MPG, either through the continuation of an existing field or, alternatively, by heading for an entirely new research direction. If several directors leave an institute, this creates the opportunity for innovative topical realignment at the institute level.

A successful example of the latter is the Max Planck Institute for Chemical Energy Conversion, which emerged in 2012 from a scientific reorientation of the Max Planck Institute for Bioinorganic Chemistry. The fundamental problem with renewable electrical energy is storage for later use independently of time and location. This new institute conducts basic research into chemical processes that are fundamental to the conversion of energy from electrical to chemical form and for energy storage. Obtaining the requisite knowledge for meeting this challenge is a task to which the MPG can make a valuable contribution, leveraging its proven expertise in interdisciplinary and flexible research. Solutions are needed for long-standing issues, such as the search for more efficient catalysts, which are essential to energy conversion, and an improved understanding of photosynthesis, by which plants and microorganisms convert solar energy into chemical form.

The challenge for chemistry is no longer just the synthesis of increasingly complex molecular structures, but to tailor functionalities, for example through the exploitation of intermolecular interactions within a system. The molecular alphabet is enormous; indeed, we are just now starting to explore the voluminous literature that can be written in this language. At the same time, other disciplines are moving toward the level of molecules. Chemistry is thus at the core of the molecular sciences, reaching out into many other areas. The MPG is committed to fostering progress in chemistry as one of the key scientific fields of the future.

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