



A Perspective on Chemistry and Society

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SCS Division of Medicinal Chemistry and Chemical Biology

Medicinal Chemistry and Chemical Biology in the Age of the Pandemic

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The authors represent the board of the Division of Medicinal Chemistry and Chemical Biology (DMCCB) of the Swiss Chemical Society. The board is composed of representatives from Swiss universities, and Swiss pharmaceutical and agrochemical industries. Activities of the DMCCB include the organization of schools and scientific events and fostering an international network between scientists of different expertise.

In this perspective, we argue that the complexification of medicinal chemistry and the rise of chemical biology over the last 40 years, which has been a necessary step to produce better and safer drugs, has created the framework for a rapid and effective response to the challenge of the SARS-CoV-2 pandemic. Scientific societies such as ours have played an essential role in this process by cultivating information exchange and networking within and across disciplines and generations of scientists from multiple backgrounds. They must continue to do so in the future.

Why is it so hard?

Scientific understanding strives for simplicity and elegance.^[1] The natural world might indeed have seemed simple at the age of the scientific revolution, however since then we have learned to appreciate its extraordinary complexity, especially with regard to human health and disease and the action of drugs. While their chemical structure may be deceptively simple, how drugs act is often, if not always, extremely complex. This has been shown by the analysis of biological processes down to the molecular level, revealing not only multiple sites of action for any drug but also differential responses among patients.

One Health

It has also been realized that our health is closely related to the health and well-being of our environment. When the animals and plants in our ecosystem fare badly, it impacts us directly. In a globalized world with a population soon exceeding eight billions, these aspects, known under 'One Health',^[2]

become ever more important as is well illustrated by the recent corona virus pandemic.

Providing safe food and water to the growing population is a global imperative, considering that 600 million people still suffer every year from food-borne illnesses.^[3] Food safety must be ensured at all stages of the farm-to-fork path, starting from preventing crops from being contaminated by pathogens and potential toxins sources.

Crop science innovation is key for the reliable production of healthy food, but also to address threats to global agriculture such as deforestation, desertification, soil erosion and weather extremes. The international collaboration established to ensure food security on the planet in the current crisis, sets an example to address with a joint action other global issues such as climate change or biodiversity protection. This is the world we live in, which cannot be meaningfully understood and acted upon unless by large and interdisciplinary teams.



Fig. 1 highlights the importance of interdisciplinary approaches to address emerging diseases such as SARS-CoV-2, including wildlife health as a critical element of global disease prevention and management.

Creative Scientists

In our globalized culture of scientific publishing, conferences, and the internet, the scientific community operates at unprecedented scale almost as one very large team. As such, we can easily afford to not always follow the most probable path and to also explore daring hypotheses and ideas. These ideas are shared, critically evaluated, and further developed, feeding a reservoir of opportunities waiting for their day to shine. The fast response of the international scientific community to the SARS-CoV-2 pandemic exemplifies this inherent strength. For instance, mRNA and DNA-based vaccines were deemed an exotic, far too complex and costly technology until the change of tide triggered by the pandemic.^[4,5] Similarly, until a few years ago cryo-electron microscopy was considered a curiosity in front of X-ray crystallography, until it suddenly supplanted it as the workhorse of structural biology.^[6] Cryo-EM now enables rapid structural understanding of the SARS-CoV-2 and opens the door to discovering drugs that might soon emerge as first line of treatment.^[7]

The Role of Scientific Societies

Research organizations benefit from sharing their findings globally not only because they cannot compete in isolation, but

because the world is changing so fast that individual researchers must constantly challenge themselves. Scientific societies play a key role by providing the framework for this global exchange and continuing education in form of journals, conferences and workshops. The DMCCB and EFMC have recently intensified communication and created virtual events, mentoring programs and online symposia, to counteract the difficulty of maintaining active networks in this period of physical distancing. These events are of prime importance for all scientists, as the development of new concepts and technologies has markedly increased the remit of life sciences and drug discovery. In particular, the growing interest for multifunctional molecules, such as degraders and antibody-drug conjugates, has reshaped the understanding of what a drug actually looks like, and opened the path to completely new treatment modalities.

The value of the medicinal chemistry and chemical biology network is particularly important in the fight against SARS-CoV-2. The management of the current pandemic pins high hopes on vaccines, but these do not address all issues and might fail to treat emerging variants of the virus. In this sense, a multi-pronged approach drawing on the expertise of well-networked research groups is critical. Those have the best chance to discover drugs against conserved viral targets, with the potential to treat future pandemic-causing coronavirus infections, such as the COVID-19 main protease (Mpro).^[8]

Finally, scientific societies must provide multiple networking and training opportunities for the next generation of sci-

entists. These facilitate integration in the global community and provide exposure to the broad range of disciplines required for excellence in medicinal chemistry and chemical biology. Likewise, they facilitate academia-industry collaborations and active scientific exchange, minimizing the gap between academic and industrial research as well as encouraging international collaborations.

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- [1] R. Dotan, *Synthese* **2020**, <https://doi.org/10.1007/s11229-020-02773-2>.
- [2] J. S. Mackenzie, M. Jeggo, *Trop. Med. Infect. Dis.* **2019**, *4*, 88, <https://doi.org/10.3390/tropicalmed4020088>
- [3] https://www.who.int/foodsafety/publications/foodborne_disease/fergreport/en
- [4] N. Pardi, M. J. Hogan, D. Weissman, *Curr. Opin. Immunol.* **2020**, *65*, 14, <https://doi.org/10.1016/j.coi.2020.01.008>
- [5] M. A. Liu, *Vaccines* **2019**, *7*, 37, <https://doi.org/10.3390/vaccines7020037>
- [6] J. Dubochet, *Angew. Chem. Int. Ed.* **2018**, *57*, 10842, <https://doi.org/10.1002/anie.201804280>
- [7] G. U. Jeong, H. Song, G. Y. Yoon, D. Kim, Y.-C. Kwon, *Front. Microbiol.* **2020**, *11*, <https://doi.org/10.3389/fmicb.2020.01723>.
- [8] Z. Jin, X. Du, Y. Xu, Y. Deng, M. Liu, Y. Zhao, B. Zhang, X. Li, L. Zhang, C. Peng, Y. Duan, J. Yu, L. Wang, K. Yang, F. Liu, R. Jiang, X. Yang, T. You, X. Liu, X. Yang, F. Bai, H. Liu, X. Liu, L. W. Guddat, W. Xu, G. Xiao, C. Qin, Z. Shi, H. Jiang, Z. Rao & H. Yang. *Nature* **2020**, *582*, 289, <https://doi.org/10.1038/s41586-020-2223-y>