Editorial Introduction: Ethical Case Studies of Chemistry, Part IV

Tom Børsen and Joachim Schummer

A unique analytical method that allows detecting a single molecule in a cup of water is currently performed at an unprecedented scale worldwide. Its main inventor, the US chemist Kary Mullis, who died last year in August from pneumonia, had originally developed it at a biotech start-up in 1983 as a diagnostic tool for sickle cell anemia, and would receive the Nobel Price in Chemistry for that method in 1993. It soon became part of the standard tool box of genetic engineering and molecular biology because it quickly and selectively multiplies any predefined DNA sequence, from a single molecule to bulk matter suitable for biochemical analysis, by polymerase chain reaction (PCR). In its modified form of Reverse-Transcription PCR, the method can detect (selected sequences of) RNA-viruses such as SARS-CoV-2 in the human body, in mucus, and even in sewage treatment plants at the earliest state of a local outbreak of the infectious disease.

In the absence of any medical cure against COVID-19, knowledge at various levels is the essential remedy to control the virus and to reduce harm, suffering, and death to a minimum. That makes the current pandemic an important case of ethics of science. Imagine a world without science but with a pandemic that rapidly spreads globally with a death toll of, say 1%. People were dying by the millions, and everybody would be afraid of being the next victim without having any clue of how to avoid that. As the dying just happens without any visible or tangible cause, rumors on supernatural causes and scapegoats would spread, pointing to the devil, the Anti-Christ, the World Health Organization (WHO), China, Bill Gates, you name it. Scientific knowledge that identifies the natural cause of a disease, disempowers the lunatics and those who seek benefit from unjustly harming others through false accusations. Hence, science enables justice and clear accountabilities by clarifying cause-effect relationships, which is no small, though frequently overlooked, contribution to ethics.

Once the cause is identified, scientists study how to detect it, how to avoid it, how to ban it, and how to extinguish it. This includes, among others, understanding the structure, reproduction cycle, and transmission ways of the virus, the effects of disinfectants and protective devices, and the devel-

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opment of tests, all of which have been researched early on for SARS-CoV-2 by the global community of scientists and shared publicly. Immediately after Chinese scientists had analyzed and published the virus' genome in early January 2020, research groups around the globe developed PCR test systems, some of which were distributed by the WHO when still few politicians had even heard of the new disease. The biotechnology industry quickly reorganized their business to produce millions of tests per week to be performed on thermal cyclers, the PCR instruments.

Next comes knowledge generation within the population, which requires widespread and generous testing for identifying and isolating infected people early on to control outbreaks and for understanding the actual dynamics and current dimension of the epidemic to inform political decisions on various measures. Knowledge on that level must be gathered by administrators in the public health sector. However, when governments try to save money on tests and when administrative staff do business as usual, the collected data rather describes the availability of tests over time or the weekly distribution of staff working hours, whatever is scarcer, which both are of no use for controlling an epidemic. Scientists, who with all ethical enthusiasm have done their part of the job of knowledge production at record time, might grow desperate if they see how careless society deals with knowledge, awaiting the wonder drug. Indeed, from the number of deaths to the numbers of the actually infected and recovered, our state of knowledge is so poor that even the mortality rate of the disease is largely unknown after more than five months.

The involvement of scientists in controlling COVID-19 could become an interesting ethical case for our collection because chemistry plays a crucial role therein, from PCR to the chemical synthesis of prospective drugs like remdesivir which requires at least 10 synthetic steps starting from ribose and alanine. The case might also illustrate the complex interdisciplinary and international collaboration of scientists required to successfully deal with a global challenge. For now suffice it in this editorial to point to some of the most obvious issues worth analyzing further.

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Instead, we present here the fourth and last part of our special series on Ethical Case Studies of Chemistry. Because the project aims at providing a canonical set of ethical cases for teaching ethics courses to chemistry students, it should ideally cover the full range of both ethics and chemistry fields. Three further studies supplement our collection by addressing the following questions. How can chemists consider global and intergenerational justice in their work (discussed on the example of rare earth elements and recycling research)? Do chemists have a special duty to foresee hazards they have not caused themselves (atmospheric chemistry)? Can one justly claim intellectual property rights on human DNA as on other molecules (biochemistry)?

Unlike compounds that can be produced in factories, elements have to be extracted from limited natural resources such as by mining, which frequently comes with huge local environmental damage. The present mining of rare earth elements, required for materials in numerous high-tech applications, unequally distributes benefits and harms in both space and time. It favors consumers in rich countries at the expense of the local population at mining sites, and it favors the present generation at the expense of future generations who might have no more access to these resources. Abigail Martin and Alastair Iles discuss the complex ethical issues that arise if dealing with global and intergenerational justice at the same time, which all chemists should be aware of if they consider applied research projects involving rare earth elements. The issues invite chemists to research both substitutes for rare earth elements in high-tech materials and effective recycling processes that would reduce the demand for mining.

Research of substitutes and recycling is one way of minimizing environmental harm, another one is researching possible hazards before they actually occur. The most prominent case of chemical hazard foresight is Molino and Rowland's 1974 prediction of stratospheric ozone depletion by human-made chlorofluorocarbons (CFCs), which would have threatened most terrestrial life. In this story, a post-doc project would trigger a revolution in global environmental politics, culminating in the Montreal Protocol of 1987 that banned CFCs worldwide. While Molino and Rowland are undoubtedly moral role models, Joachim Schummer discusses if and to what extent scientists have a special moral duty of hazard foresight based on their particular intellectual capacities.

Not all ethical issues of chemistry are a matter of life and death or concern physical harm, some arise from the way science questions and undermines traditional ways of thinking and valuing, thereby challenging human culture. Previous cases in our collection include the creation of life and human enhancement though drugs. Another such issue that has caused heated debates in society is if one can have intellectual property rights on human gene sequences. While this suggests to some the disturbing notion that one can own parts of the human body, for a chemist DNA is just a molecule. Saurabh Vishnubhakat takes the lawsuit of Myriad Genetics (2010-2013) to discuss the underlying scientific, legal, and ethical issues of patenting DNA. Rather than providing a simple answer, he argues for a procedural approach that mediates between specialist and generalist views and interests.

Finally, Janet Stemwedel's book review of Jeffrey Kovac's completely revised edition of *The Ethical Chemist* fits in well with the thematic focus of this issue.

This is not the end of our project. We will elaborate on a more detailed introduction that provides better guidance to teaching. Along with the case studies, this will be published in a book, still under negotiation with publishers, and on our project website where further material and information can be found:

http://www.hyle.org/journal/issues/special/ethical-cases.html

Moreover, further ethical case studies are welcome at any time because ethics of chemistry is now a fully established field of the philosophy of chemistry.

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We finish this editorial in memory of Rom Harré (1927-2019) who passed away last October after a longer period of illness with only temporary recoveries. His exceptionally broad interests and prolific scholarly activities made him famous in many different academic fields, such as philosophy of science and social psychology. Unlike the typical Cold War philosophers of science, who would muse about some isolated piece of theoretical physics for their entire career, Rom always saw science in its full diversity and in its practical and societal context. When we first distributed our Call for Paper to the Board Members of HYLE in 2015, he quickly and enthusiastically responded by suggesting to contribute with a paper on the environmental pollution of the River Thamse. Unfortunately he had to withdraw for health reasons.

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