CHAPTER 19

Because We Can Expand the Scope of Research with "Open Science," Bringing an Improved Future for Society

The term *open science* is recent. It has arisen as a policy push of the funding agencies to realise science advances quicker when meeting directed science challenges set by the agencies themselves. The urgency often arises from a health or disease emergency that requires concerted research by the relevant scientific community to find possible solutions rapidly. Of course, concerted efforts are in themselves not new. World War II brought concerted efforts to bring about large-scale production

of the antibiotic penicillin. Open science today arises in the frame of being able to share raw scientific data more or less as soon as they are measured (i.e., well before publication). Thus, large teams can be in contact even whether they are on opposite sides of the world. The Internet, invented at the European Organization for Nuclear Research (CERN) in Geneva, is key to this approach. The particle physicists saw the need for both remote access to the CERN particle accelerators and for the sharing of data between collaborating research groups. Such an approach is now applicable to emergency disease challenges. The sense here is that there should be openness between collaborating research groups that may ordinarily be competitors. That does not necessarily mean that the raw experimental data are immediately open to the public. Another version of open science is what is termed *citizen science,* where members of the public can lodge their own observations at a centralised website. Thus, large-scale, geographically disparate observations can be gathered.

Open science also can (indeed should) be a key feature of regular scientific research. The results of publicly funded science should be openly available to the taxpayers who funded it. This is termed *open access.* The data that underpin research publications funded by taxpayers also should be openly available. Published results, of course, appear at the end of a research project or an identifiable milestone of a larger research project. Such open science is with a research team working on its own, whereas the previous discussion focussed on the sharing of raw scientific data as soon as it is measured to allow very broadly based collaborations to develop.

There are interesting exceptions to the open science approach. Closed science, as one might call it, is not automatically bad. One can cite several generic examples. Single individuals working alone can undertake research stemming from their own imagination. In the early stages, this is very likely to be unfunded. Results can be written up and submitted for publication. Often, these studies can be the most innovative and unusual. There are no monies,

however, for research assistants or for publication fees to make the publications open access.

This emphasises the need for researchers to keep their skills up to date so that they can work on their own on such ideas. It also illustrates that subscribers to journals cover the publication costs of such unfunded research, although it does put the research publication behind a paywall. Some journals have been established by research communities (namely, the learned societies). Such is the case with my own research area of crystallography, as the International Union of Crystallography runs its own journals and is a not-for-profit science publisher. Another approach is that of the Wellcome Trust, which has its own journal called *eLife*. It finances the journal completely, without subscriber fees or article processing charges; it is free to readers and free to authors.

Open science is practical in the situations that I describe here, which we as scientists engage with wherever possible.