Life science infrastructures are different

There are several basic components required for a successful scientific programme: sufficient funds, good people, a well-equipped laboratory and research infrastructure. But the last requirement does not normally receive much attention, particularly in the life sciences. This is a bit surprising, given that, in other disciplines, it is nearly impossible to conduct an experiment without special equipment. Life sciences are different. In many fields of biology, it is possible to envisage significant research in the absence of any non-routine infrastructure. Much of microbiology, virology, biochemistry, immunology, plant science and developmental biology research are performed with affordable and readily available equipment. The requirements of structural biology, such as X-ray sources or computing resources, are more significant and reflect the physical nature of this field. Some other areas of the life sciences also need more sophisticated equipment, but these are often shared between research groups at a university or research institute. All of this seems to indicate that, for the most part, the life sciences do not need any large-scale research infrastructure, unlike disciplines that cannot function without particle accelerators, observatories or satellites.

But what exactly does infrastructure mean in the context of research? As defined on Wikipedia, it is "a set of interconnected structural elements that provide the framework for supporting the entire structure". Hmm. That does not help too much, but it shows that when discussing research infrastructure, we are usually talking about an analogy rather than a strictly defined entity. But the word, and hence its consequences, has been hijacked by those who require large pieces of equipment for their research. It has also attracted the invisible adjective 'expensive', which inevitably has political implications. This combination—big and expensive—points to infrastructure as something that can be provided only by the

cooperation of various well-funded partners. This is true if we are discussing particle physics, climate research or astronomy, but we should clarify that this interpretation of infrastructure excludes very important and pervasive, although smaller, frameworks that support the entire structure of research. Unlike other activities, biological infrastructure is not extremely expensive, but research can only progress if, for example, all of the current information on genomes, transcriptomes, proteomes and so forth is centrally stored and made available to every biologist who needs it. It is as much an infrastructure as is a particle accelerator—a framework on which research is based.

And it is not only genome or proteome databases that are required by life scientists. As biological research increasingly achieves medical relevance, those working to translate basic research into therapies need access to collections of biological samples and associated clinical information. The same can be said of animals. Because of their size and ease of storage, some model systems, such as *Drosophila* or zebrafish, can be made easily available to researchers even if the animals are stored in a dispersed manner—if the data are centrally kept and accessible to everyone. Conversely, the storage of transgenic mice, a favourite model system in biology, creates more challenges. As the number of transgenic animals and new combinations of altered genomes grows exponentially, a complete collection of transgenic mice strains becomes essential. Such a widely used infrastructure must be supported by the total funding system, not by individual laboratories.

Biological infrastructures have other notable differences from more traditional scientific infrastructures. They are usually relatively cheap and easy to set up, and may even be virtual—but they need ongoing financial support. Buying a number of computers with terabytes of storage capacity and broadband access is not a massive investment. But even

the best database is useless without skilled personnel to annotate and curate the data, perform quality control and ensure its peak performance. Life sciences infrastructure must therefore include personnel and maintenance costs. This applies equally to tissue collections and mutant animal archives.

But all of these advantages and special needs are usually overlooked when the topic is examined at the political level through the prism of the physics paradigm. It seems that politicians understand research infrastructure as something that has to be big, expensive and therefore financed by various nations—they are more interested in capturing a large piece of capital expenditure than in addressing the needs of the life sciences community. And their advisors on these issues come predominantly from those sectors that need big and expensive infrastructure. Although it is surely within the financial capacity of a single nation to establish and run a biological database, it may not be fair to leave it to one country, particularly as they rarely earn the political kudos associated with the investment. A significant financial investment for the physical sciences ensures competition for the honour of hosting the infrastructure and offers great possibilities for photographers and reporters at the opening ceremony. Fewer trumpets are blown for databases. More often, discussions centre on the need for such resources, and whether they should be supported by infrastructure funds.

This editorial reflects the perspective of the life sciences, but is equally relevant to other disciplines—most obviously the social sciences and humanities. However, there are also areas in chemistry, physics and environmental research where it would be timely to take a fresh look at the cost-benefit ratio of investment in research infrastructure frameworks and at the various types of infrastructure that are needed today.

Frank Gannon

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