Budget wars in genomics

Should large-scale functional genomics and proteomics be funded by the public or the private sector?

Fighting for more research money is nothing new in science. But recently these debates have reached a higher level in Europe, where many scientists working in basic biological research feel that their work is endangered by the politicians' current love of big facilities. In particular, the critics from the laboratory benches feel that the strategy of the European Commission (EC) to support and establish 'networks of excellence' in functional genomics and other platform technologies funnels away euros that are sorely needed for 'small' basic science. On the other hand, these platform technologies churn out data on which scientists are increasingly dependent in order to effectively perform their research. Both are needed, but, as the money is limited, the dilemma is that supporting one will inevitably create financial strains for the other.

Functional genomics and proteomics are evidently not mere fads but research areas into which companies and public funding agencies are pouring money in order to stay on top of these rapidly emerging fields. And there is no doubt that the huge amount of data generated is highly beneficial for biological research, while, at the same time, making it much more effective. As sequencing and structure prediction are now performed on a large scale, scientists can concentrate on the more interesting experiments rather than wasting their time with these purely technical tasks. Furthermore, researchers are able to define and refine their theories at the computer before they embark on an actual experiment, thus saving time and money.

This is one view, but it is not shared by all. Many scientists, particularly in Europe, see a danger in the emphasis that the EC in particular is placing on

functional genomics and other technologies in anticipation of future applications, as they believe this will eventually hurt the curiosity-based research that is necessary to make sense of it all. Some fear that this will lead to a situation where all the data are available but the scientists and the funding to integrate it and eventually produce a useful application are missing. '[...] a strategy that prioritises large infrastructures might not meet the

'I believe that [...] European research needs more and better small university-based laboratories dedicated to carrying out "avant-garde" basic science.' His fear is shared by many other scientists working in academia.

'I think we are at a potential crossroads in Europe,' said Tommy Nilsson, a cell biologist and group leader at the European Molecular Biology Laboratory, about the relationship between product-oriented technology and basic research. 'If we put too much emphasis on either one, we are likely to lose out.' Critics like to compare this situation with the war on cancer declared by US President Richard Nixon in

1971, to which he devoted all the efforts of the National Institutes of Health (NIH), and they fear that Europe is falling into the same trap. But the facilities that were established or extended for the human genome project are now busy sequencing the genomes from many other scientifically important species. Moreover, there is no sign that the US, Europe or Japan are likely to dismantle their genomics facilities and send all the scientists and

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real demands of biological research in Europe,' wrote André Goffeau from the Laboratoire Génétique Moléculaire at the École Normale Supérieure in Paris, France, in his critique of the EC's research policy (*EMBO reports*, December, 2001).

technicians home, as they are actually expanding these investments. Last year, the EC rushed to include functional genomics into the Fifth Framework Programme (FP5) and awarded €39.4 million to large research projects as a

prelude to the €2.2 billion earmarked for 'genomics research for human health' in the upcoming FP6.

The heart of the debate, therefore, is whether large-scale data generation is still 'science' and how public funds should be divided between data generation and the creation of knowledge. But biologists are not the first to face this problem. In fact, there are many parallels with physics. Although physicists at the beginning of the 20th Century, such as Robert Millikan, Otto Hahn, Ernest Rutherford and Marie Curie, made their discoveries in small laboratories using home-made equipment, many of their successors now work in large teams and use the most expensive scientific equipment to produce data. Building and designing particle accelerators, fusion reactors or neutrino detectors is engineering rather than science; the real

But the price tag on these facilities is in a different league to the budget of an average research laboratory. The investment required to establish and manage a

Inside Celera Genomics, Rockville, MD.

facility for genome sequencing or large-scale protein analysis is so major that only well-funded institutions or companies can afford them. And to effectively run such a facility and churn out data needs a high

approach. That does not mean 'small' science, according to Nilsson, who thinks that this undertaking needs to bring together mathematicians, biologists and physicists in order to integrate all the information gathered into complex biological systems.

Others regard expensive platform technologies as an increasingly essential part of modern biology that needs to be supported adequately. 'If you want to get somewhere and you want to develop technologies, then you need to provide critical mass in funding,' said Kurt Vandenberghe, head of the cabinet of Philippe Busquin, European Commissioner for Research, about the EC's rationale to allocate funds

for functional genomics. Relying solely on industry to generate the data needed in academia is not a feasible solution, he thinks. 'It is difficult to know what industry will fund in research and what it will not fund,' he said. 'There may be scientific tasks that are too large for industry to take on.' Ploegh agrees: 'Yes, industry certainly has a role to play, but you have to have an assurance that necessary data are generated.' That is why the EC plans to create the 'networks of excellence' in functional genomics and other areas in order to establish the infrastructure needed. 'For us, post-genomics research has a definite European value,' said Vandenberghe, explaining the political rationale for supporting these areas. 'Europe cannot afford to be absent from that science.' He maintains that the EC's

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science only starts when the experiment has been completed and the scientists begin to make sense of the data collected.

Thus, the question is whether biology is heading in the same direction. 'I think that the nuclear physics analogy is a good one. The future will see less emphasis on the cottage industry approach to data generation,' said Peter N. Goodfellow, Senior Vice President for Discovery and Research at GlaxoSmithKline, about the developments in molecular biology. His view is shared by Hidde Ploegh, Professor of Immunopathology at Harvard Medical School's Department of Pathology: 'At some point, people have to pay attention to the fact that the scale of the project is becoming important.' And this is not limited to any one technology. 'It's all in the eye of the beholder what is functional genomics,' said Ploegh. 'What you see is the formation of the new umbrella programmes called proteomics, functional genomics, etc., that no single academic institution could afford.'

degree of parallelisation, sufficient computing power and industry-like management to be effective—something that is clearly not high on the priority list of many scientists. Furthermore, genomics or proteomics are not really science if science is defined as an undertaking to search for knowledge—'omics' creates data but not knowledge.

For these reasons, many scientists think that the challenge of functional genomics and proteomics should be met by both academia and industry working together. 'Let the person who does it best do it. And in many cases, the industry seems better suited to do at least the data gathering much more effectively,' said Nilsson. Furthermore, this will be a temporary undertaking, as the number of genomes to sequence and the number of proteins to investigate is basically finite. 'At some point, we need to make sense of all the new information and this will not be solved by an emphasis on sophisticated technology alone,' said Nilsson. This will be tackled by the traditional reductionist

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proposed network of excellence programme is not geared towards applied research, as many critics maintain, but that the main goal is to create the European Research Area. 'We open the door much more to strategic-oriented research in the future.'

This does not exclude the private sector; on the contrary, industry has a vested interest in academia producing

effective research. Indeed, the public and the private sector have been of mutual benefit in many areas—The SNP Consortium, where companies and academia make single nucleotide polymorphisms (SNP) data freely available, being an example. But, although there are many areas where both can co-operate, there are also areas where each sector must go its own way and therefore have the required infrastructure. ‘If the public sector wants to have data freely available, then the public sector will have to pay for it—either directly or indirectly,’ said Goodfellow. ‘It would be unsustainable for commercial companies to conduct basic research if they could not commercially exploit the results.’ Ploegh agrees: ‘Certain things won’t get done [in industry] for economic reasons [...] but that doesn’t mean that the basic scientists have stopped working on it.’ As an example, he cites the work on the anthrax

edema factor that was of purely academic interest until the bioterrorist attacks with anthrax-contaminated letters in the US.

Perhaps the debate about what to support—large-scale data generation or curiosity-based research—is a sign that biological research itself is changing as it

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comes to rely increasingly on expensive technology. Again, physicists went through a development of this kind decades ago and eventually were able to convince politicians to provide the money for their expensive equipment. There is a solution to this, and that is simply increasing the money for research. Interestingly, the debate that is taking

place in Europe is not mirrored in the US, where spending for biological and biomedical research remains at an all-time high and Congress has no objection to increasing the NIH’s budget further. European policy makers are not oblivious to this solution either; in fact, at the recent summit in Barcelona, Spain, the Heads of States endorsed a proposal to increase the investments into research and development from 1.9 to 3% by 2010. Compared to what countries spend on defence or social security, this is only a minute amount of money to come up with. ‘If you double the spending on science, it would not even register as a blip on people’s tax forms,’ said Nilsson.

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DOI: 10.1093/embo-reports/kvf105

Growing greener

The impact of integrated pest management

In the fierce debate about genetically modified (GM) crops, both sides claim to protect the environment. Proponents of pesticide- and herbicide-resistant plants maintain that their use will actually decrease the need for chemicals in agriculture. Opponents claim that GM crops themselves endanger the environment and say that growers should adopt less toxic alternatives rather than rely on untested technology.

The fact is, however, that most farmers have already progressed from the indiscriminate use of chemicals in the 1950s and have adopted ‘greener’ alternatives. Many of these techniques form part of the increasingly popular integrated pest management (IPM) approach. In its broadest sense, IPM promotes action against pests only when necessary, choosing the most effective option with the least risk to people and the environment, and applying knowledge about pest biology to create long-term, prevention-based solutions. ‘Growers have been very willing

to adopt IPM programs since they see the value both in the marketplace and to the environment as well,’ said Lorianne Fought, a plant pathologist with Bayer in Leverkusen, Germany, at the American Phytopathological Society meeting in Salt Lake City, UT, in August 2001. Most studies acknowledge that the use of IPM

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in general has clear economic benefits. But, although its use is widespread, IPM may be very expensive to administer and its long-term effectiveness is still unproven, she said. Furthermore, many critics and ecologists maintain that IPM is more a tool to increase farmers’ returns than one to improve the environment. This calls for more research on IPM to identify potential weak spots and improve effectiveness if farmers are to continue to use this approach.

The idea of combining traditional means of pest control with those that aim for prevention rather than cure dates back to the late 1950s, but it gained momentum only after Rachel Carson’s *Silent Spring* was published in 1962, which described how chemical pesticides cause serious harm to humans, wildlife

and the environment. In addition, there was growing evidence of resistance to these and other chemicals in common pests, so many small and medium-sized farmers came to believe that the indiscriminate use of toxic chemical pesticides was not sustainable. IPM over the next 30 years became widely practiced and evolved from alternative to mainstream. A recent survey from the US Department of Agriculture (USDA) found that, on 70% of land used for farming in