Virtual laboratories in the life sciences

A new blueprint for reorganizing research at the European level

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In a few years, the European Union (EU) will have grown from its current 15 member states to 25 nations. At the same time, a truly European convention is being discussed that will give the EU a new legal basis for its business. These political developments will also have important implications for European scientists and researchers. Basically, we are at the crossroads where Europe as a whole has to decide whether it will invest more into scientific research—particularly in the life sciences—because it is no longer feasible to continue research with the modest funds that are now the case for many European states. The growing demand for large-scale experiments, expensive instrumentation, better coordination, and better access to data, technologies and interdisciplinary approaches makes the current situation untenable. To remain competitive on a global scale—scientifically as well as economically—we need to improve coordination and increase the financial support for all forms of research, be it at the university or at the institutional level.

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Some initiatives have already been implemented to improve the situation, but it is unclear if they will be sufficient. Nevertheless, their aim is to restructure the European research landscape, which, if successful, will have positive consequences for how scientists go about their daily lives. Given that funding will always be limited,

whereas the costs of research continue to increase, European research must indeed restructure, pool resources and increase international cooperation to use the available funds more efficiently. This article intends to point out limitations and suggest ways in which these problems can be solved.

In 2000, the EU seemed to be united around the political concept of a European Research Area (ERA)—to “make the EU the most competitive and dynamic knowledge-based society in the world.” Heads of state set a funding target for research and development of 3% of the EU Gross Domestic Product (GDP) by the year 2010—it is around 1.9% at present. Strikingly, the scientific community were given the task of coming up with proposals for how to implement the ERA concept. This is not an easy undertaking but one wrought with difficulties, uncertainties and responsibility. Fortunately, scientists are used to working in such *ad hoc* scenarios, where self-organization will eventually yield results; a few scientific organizations reconsidered their role in the new ERA and started making proposals for the future of research in Europe. The European Science Foundation (ESF), a pan-European association of 76 major national funding agencies from 29 countries, and the European Life Science Forum (ELSF), a coalition of independent life-science organizations, have willingly decided to lead a rigorous debate on how the ERA should be implemented (ESF, 2003: www.esf.org/; van Dyck & Peerenboom, *EuroBiotechNews*, 1, 33–35; 2003).

Emerging from these discussions is a clear consensus for a strategic reorganization of European research. There are, however, still major uncertainties. As alluded to by the ESF in their position paper, it is not clear what the concept of a new ERA really means (ESF,

2003). For scientists, it is obvious that long-term support of basic research is required and that this support needs to be allocated more efficiently to ensure high-impact research. However, the EU's interpretation may be different: “In essence the emphasis [by the EU] is on turning knowledge into wealth while the precursor of creating the required new knowledge through the provision of public funds is largely neglected” (ESF, 2003). But what is acutely needed is long-term support to “develop the underlying research base on which the more strategic and policy-driven research must rest” (ESF, 2003). This presents us with the first real problem: the absence of a clear emphasis on fundamental research at the EU level. The EU framework programmes, important as they are, only partly do this. In this context, support for fundamental research is allowed and supported, but formally, the Treaty of Amsterdam, which is the legal basis for EU action, dictates that EU research policy should increase economic competitiveness. Stated positively, we are therefore in uncharted waters and the course has not yet been set. On the one hand, we want to implement an ERA with a real focus on fundamental research. On the other hand, we rely on the EU to fund the new ERA. In the worst-case scenario, the EU may not be willing to support the scientists' view. In the best-case scenario, the EU will include in its new constitution a mandate to support fundamental research.

Although the situation may seem uncertain with regards to the final position of the EU, there has nevertheless been significant progress towards an ERA. During meetings

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held among various research organizations, a concept of a new and independent European Research Council (ERC) has emerged as the one and only solution to support fundamental research at the European level. This will represent the physical instrument to implement the new ERA and will function as the main funding body in Europe by "adding a clear European dimension to the competition for some of the most prestigious awards and grants" encompassing all scientific disciplines (ESF, 2003). Scientific quality alone should be the criterion for such awards. The funds for the ERC should come mainly from the EU, but a significant shift in the current Framework Programme budget towards the ERC would require a change in the legal basis. Other suggestions rely on part of the money coming from national funding schemes but, in general, everyone is of the opinion that the ERC should spend what is called 'new money'. In other words, the ERC should add to the existing national and EU framework funding schemes, not divert money away from them (van Dyck, *EMBO Rep.*, 4, 544–546; 2003).

There are also discussions about the actual level of funding that is required for the proposed ERC. Some fear that it may be too high. Most research in Europe is funded by taxes and charities. As such, politicians have a duty to ensure that this money is well spent. The real problem here is how to determine what is useful. At a practical level, how can a politician assess the real value of research? Ask the scientist? Count the number of publications in *Nature* or *Science*? Neither provides a clear measure for quality or innovation, nor do they provide a solid justification for funding in the eyes of the taxpayer. A high level of funding could therefore translate into a higher demand for more product-orientated science, which is easier to justify. If this were to happen, it would undoubtedly undermine the long-term health and prosperity of the ERA.

Another question raised during these discussions is whether there will be one ERC or several smaller ERCs, each reflecting different areas of basic research. There are both advantages and disadvantages with either scenario but given that basic research is becoming increasingly multidisciplinary, one central ERC may be the way forward. We should embrace the opportunity to remove inhibitory borders that still exist between different disciplines and to stimulate interdisciplinary research on a large scale. To give an example, classical approaches in biology are increasingly blended with physics, mathematics and

chemistry. This has resulted in many new possibilities and will ultimately yield important discoveries. A strengthening of interdisciplinary research should take place if we are to make significant progress in Europe.

I think it is safe to say that we all want to see a better scientific environment than the one that is now in place. Having said that, one should be aware that we are actually not so badly off. We always tend to look across the Atlantic and assume that science there is much better. In fact, Europe as a whole is doing pretty well, we just spend less money than the USA. This has been due to our ability to do more with less, by sharing information and giving open access to infrastructure. Nevertheless, there are growing requirements for significant increases in funding. To meet these, Europe needs a restructuring of existing national funding schemes, ideally working towards a central ERC in which most implementation and coordination can take place at the European level.

However, a focused funding system at the European level—much in line with the National Institutes of Health and the National Science Foundation system in the USA—will have some disadvantages. With the criteria of rewarding only excellence, some may lose out unless funding is increased to the level at which everyone gets sufficient money. Then we will rise above the 'event horizon' in terms of visibility, thus potentially putting free and unrestricted basic research at risk. Instead, funding levels should be kept within limits with a long-term focus on sites and groups of excellence. The consequence then is that universities and institutes that are not at the forefront of research may face increasing difficulties in securing funding, not only at the European but also at the national level. This inevitably creates concerns, particularly in those countries that are not able to invest the same amount of money into research than do the economically stronger states. But there is another important issue at stake here: education and training. Research in universities should ensure that students receive the most up-to-date education and give them direct exposure to a research environment. A healthy education system is also vital for industry. High-technology companies usually cluster in close proximity to institutes and universities where excellent basic research is conducted. For them, this only makes sense as long as the education is of high quality. A decrease in funding or even a lack of increase will undoubtedly undermine this relationship. An ERC must therefore balance scientific excellence with what can only be expressed as 'social responsibility'; that is, to promote and elevate research in all areas within Europe. Another point is that innovations and discoveries do not come only from well-funded labs and institutes. Many fundamental discoveries are made by good scientists who work in universities and institutes across Europe. A refocusing of funds must therefore at the same time safeguard our existing diversity in basic European science. This may seem contradictory at first glance.

A large part of today's research costs goes into instrumentation platforms. To be competitive, institutes and universities need to invest vast amounts of money in new technology and development programmes. We therefore face a technology race in which investment in infrastructure will further increase the financial burden we already feel. There is no way to escape this, as a higher degree of sophistication requires

new technologies. If we wish to invest in instrumentation platforms, retain our broad and diversified base in fundamental research and, at the same time, promote excellence, we need to come up with a formula that allows for all three. I believe that this is possible without excessive increases in funding. In fact, there was a similar situation in the early 1970s, when Europe faced the potential threat of losing out on the emerging molecular biology technology being developed mainly in the USA. Realizing that this would become a whole new research field, a few prominent scientists in Europe lobbied governments to create a pan-European Molecular Biology Organization (EMBO). Resources were pooled to launch EMBO and shortly thereafter the European Molecular Biology Laboratory (EMBL). While EMBO supports research at a European level through various programmes, such as long- and short-term fellowships, workshops and courses, EMBL is a research institute hosting some 700 scientists mainly from its European member countries. The laboratory's aims include the training of scientists and to serve as an infrastructure resource for scientists in its member states. Both EMBO and EMBL have been successful and cost-effective ventures that have helped to secure a level of research in Europe that still remains on a par with the USA and Japan. Other success stories in which resources were pooled are the Laboratory for Molecular Biology (LMB) in Cambridge, UK, and the former Basel Institute of Immunology (Switzerland), perhaps best exemplified by the number of Nobel-Prize-winning discoveries made there. My suggestion is that we use the same formula—pooling resources—to counter today's demand for increased investments, but I wish to take it a bit further. To do that, we need to change the way we think about and conduct our research at present. What I propose could in many ways serve as a subtitle for the new ERA: a pan-European virtual laboratory. Make no mistake, there is nothing virtual in what I am proposing, it is just a label used to illustrate a new way to perform basic research. I wish to illustrate what I mean by outlining what has recently happened in the field of light microscopy.

In 1997, a few scientists at the EMBL explored possible partnerships with leading microscopy companies to establish a centralized instrument platform in the form of a facility. Several companies enthusiastically participated in what has become a joint venture in cellular imaging. The Advanced

Light Microscopy Facility (ALMF) at the EMBL is now one of the most sophisticated imaging facilities in Europe. The centralization of sophisticated microscopy platforms into one facility is, of course, not unique—several excellent microscopy units exist across Europe. What was new in this regard is ALMF's emphasis on being a resource not just for scientists at the EMBL, but for anyone in Europe and beyond. The benefits of such centralized technology platforms are quite obvious. First, they are much more cost-effective at a national or even European level, given that many universities are not able to afford such expensive instruments—an advanced laser scanning confocal microscope costs somewhere around €0.3–0.5 million, not including the salary of the person who maintains and operates it. Equally, centralizing such technology in one place with sufficient technical staff ensures a critical mass of knowledge and experience. The most important benefit is the fact that both the instruments and the know-how are accessible to all scientists.

The next step was then to link several facilities across Europe to establish a network that has now existed for three years as the European Light Microscopy Initiative (ELMI). Its aim is to promote light microscopy through integration and coordination, and its facilities contribute to a great diversity of microscopy techniques, platforms and expertise across Europe. The main criterion to qualify as a member is that microscopy is organized as a facility that is accessible to every interested scientist. ELMI increases the level of interaction by holding frequent workshops and encourages the exchange of scientists between centres. It is through such networking that we can create a 'virtual lab' that becomes far greater than the sum of its parts. The added value of a virtual lab, to name just one, is the possibility for scientists to travel to a particular site and to learn a particular technique or use an instrument. This is of great benefit, not just for scientists from countries that spend less on infrastructure.

The physicists and the astronomers have shown that cooperation at an international level and pooling resources at a small number of facilities is an effective way to both generate results and to efficiently use the available money. But to implement such a development for the life sciences, a larger proportion of national and European funding needs to be set aside to allow researchers from all over Europe to visit facilities. The EU,

ESF, EMBO and the Federation of European Societies of Biochemistry and Molecular Biology (FEBS) already support this by providing funds for workshops and short-term fellowships. But this needs to increase significantly if we wish to implement a larger and more powerful virtual laboratory in all disciplines. There are also other important aspects to consider. If resources are pooled into centres, these should be located at institutes and universities that can ensure long-term support, technical know-how and research. These should go hand-in-hand with a focus on scientific excellence; a well-functioning facility requires a high level of expertise and research. Nevertheless, trans-mobility and centralization ought to work at all organizational levels, be it at the university, regional, national or European level. The key to success will be to guarantee access to infrastructure for everyone. This will ensure maximum use of resources and provide much needed training and education. If this is implemented correctly, we should be able to shoulder the ever-increasing demands for funding at the same time as ensuring that the ERC will have a certain dimension of 'social responsibility'.

In summary, I wish to see the concept of 'virtual laboratories' implemented as an overall aspect of the new ERC to afford the expensive infrastructure that is needed in the near future. How this is organized depends very much on the willingness of scientists to collaborate and to share resources in an intelligent way. If given the right type of financial incentives, I think it will add a positive and important dimension to European research.

The views expressed are the opinions of the author.

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