Strategic Review Submission

Strategic Review of Health and Medical Research

30 March 2012

1. Why is it in Australia's interest to have a viable, internationally competitive health and medical research sector?

Throughout the world, countries have realised that their future growth and prosperity relies heavily on innovation arising from key areas of research and development. The three R&D areas most likely to drive progress in the first half of this century are information and communication technology, nanotechnology and the life sciences. If Australia is to remain competitive in these fields, it is critical that we invest our limited resources where they have the greatest impact and obtain the best possible return.

A nation with a proud history of research achievement in the life sciences, Australia's prospects for progress in the health and medical research sectors have never been better. Emerging relatively unscathed from the continuing global financial crisis, Australia is poised to attract and retain the world's best research talent in the field. Advances in health and medical practice, both traditional strengths of this country, rely critically on the funding of world-class basic life science research and the infrastructures that support it. Virtually every recent medical breakthrough Australia has arisen from discoveries in basic research: this is a proven avenue to gain the understanding we need for progress in promoting health and treating illness, and a key to innovation.

2. How might health and medical research be best managed and funded in Australia?

A key to achieve maximum return on research funding is to invest in the young. The most creative and agile minds are often the youngest, yet an ever-lowering percentage of the Australian youth sector is choosing the hard sciences as a career path. At a time when the explosion of biological data being generated in virtually every aspect of life science research demands computational analysis, the number of students choosing to study mathematics is at an all-time low. Faced with a choice between an uncertain future in research funding and more lucrative prospects in medicine, banking or marketing, many talented young would-be scientists in Australia are distracted or discouraged from entering a research career.

How can we change perception? As a scientist trained in the US and recently recruited to Australia after a decade of leading an biomedical research institute in Europe, I bring an international perspective to the question. Although Australia boasts an impressive track record of superb scientific achievement, there is an unspoken sentiment in the academic sector here as elsewhere that aspiring young researchers have to earn their place in the scientific hierarchy. With fewer Australian students are entering the sciences, the current career paths for those that do are littered with unnecessary obstacles. To attract personnel and financial support in competition with the seasoned scientific community, a beginning scientist spends most of her time worrying about the future: how to position herself for promotion in her academic institute, how to attract good students who invariably gravitate towards the more established labs, how to gain funding in a national scheme where the most successful grants are those where most of the work has already been done. It's not a recipe for innovation.

There's another way to fund research, and I've experienced it. In the 1970s, Europe was faced with just such a brain drain and did something about it by forming the European Molecular Biology Laboratory. EMBL is a remarkable success story, and a tribute to the vision of both the scientists who conceived the Laboratory and to the member states that have guided and supported its development for the last four decades. With just 95 research groups working in five locations across Europe, EMBL is recognised as a world leading research institution (ranked fourth in

citations globally).

At the heart of EMBL's success is the nurturing of their young. At EMBL, the most promising scientists right out of their postdoctoral training are awarded generous, fixed-contract research packages guaranteed for up to nine years, access to the brightest students, close mentoring from a small cohort of experienced senior staff and some of the best research facilities in the world. The fixed-term contract system ensures that independent researchers, having established themselves and their scientific reputations, move on to enrich the scientific community as the future's leaders. It's a tried and true example of how limited R&D investment can be employed effectively and with broad impact. And it can work in Australia.

I've spent the last five years talking to governments, universities and research institutions around Australia to convince them that this nation would benefit profoundly from the EMBL model. It's worked: the Australian government and interested universities have now invested in a small number of EMBL Australia Partner Laboratories around the country where beginning scientists can concentrate on doing their best, riskiest and most original work. In Melbourne, the two first EMBL Australia groups hosted by the Australian Regenerative Medicine Institute at Monash University have already started their cutting-edge research. Challenging the prevailing culture by promoting the young as the driving force of progress has been difficult for some to accept, but if the experiment is successful it could change young Australian minds about a career in research, and convince the nation to support them.

3. What are the health and medical research strategic directions and priorities and how might we meet them?

Of the many positive aspects of increased research funding in Australia over the past decade, strategic investment in national research infrastructure has been a globally recognised hallmark of Australian governmental foresight. Now a shift is required towards funding key aspects of infrastructural operation, if Australia's distinctive edge in the international life sciences landscape is to be maintained. Perhaps the greatest challenge facing the contemporary life sciences is how to enable the medical research community to make optimal use of the avalanche of biological data being produced to support research and promote health and innovation. We have now reached the stage where data production is no longer the bottleneck and the challenge has moved to the analysis and integration of large heterogeneous datasets, and exploiting this complex data to gain new insight into biological processes and perturbations in disease.

In both Europe and the US, large-scale projects are being launched to plan and construct the next generation of bioinformatic data resources, with hubs that will host the major biomolecular datasets and provide the connectivity needed for integration and interoperability of the distributed information. It is essential that Australia take a leading role in this international effort.

An equally critical component of this paradigm shift in biomedical research is the requirement for trained bioinformatics and computational scientists required to translate the encroaching deluge of data into tractable, useable information. Despite the impressive generation of medically relevant datasets around Australia, there is a serious dearth of human capital capable of analysing, integrating and exploiting quantitative data.

Formed through collaboration between EMBL Australia, Bioplatforms Australia and CSIRO, the Australian Bioinformatics Network has been recently convened to tackle these issues, developing and maintaining an active and nationally inclusive membership base, providing an effective

training program for bioinformaticians and life science researchers through Winter and Summer Schools, facilitating specialist bioinformatics training to further develop computational skills and expertise in Australia through interactions with international bioinformatics centres of excellence, and developing key links with stakeholders including government and funding agencies. Realisation of these initiatives will require a significant increase in funding but is critical for the Australian health and medical research community to set trends and push the limits of technology in this exploding field.

4. How can we optimise translation of health and medical research into better health and wellbeing?

The current calls by both the public and funding agencies for an increased emphasis on so-called translational research arise from a general misconception that basic life scientists have reached a sufficient level of understanding of living systems and their inherent complexity to move this knowledge directly into clinical application. Having lived through the disappointment and sometimes tragic consequences of pushing gene therapy and more recently stem cell therapy too rapidly into the clinic, I would urge a realistic assessment of claims by over-eager bench scientists and physicians alike that their research is "bedside" ready. Our effective promotion of human health and treatment of disease can only be improved by systematic analysis of the biological systems involved, the interactions of their components and the structural and functional properties that emerge from these interactions. History bears out the futility of seeking a fast track to a cure.

And progress is being made. Medicine and basic molecular biology have already started to converge, with diagnosis increasingly moving from the phenotypic description of symptoms towards the molecular characterisation of pathology. The elucidation of the human genome, its variations and interactions with the environment, has provided an unprecedented advance in the capture of data on genetic variation between patients. Enabling techniques for systems biology computational methods and aids must now be developed to allow adequate analysis of the large amounts of biological data being generated, modelling networks of gene and protein interaction and simulating complex biological systems and their defects in disease states.

Without experimentally accessible biological systems to make considerable progress in understanding how genotype leads to phenotype, and how DNA sequence variation leads to phenotypic variation to determine susceptibility to disease or to rare drug side effects, we will not be in a position to exploit these data to human benefit. With few exceptions, the current intense focus on stem cells and induced pluripotency technologies is more likely to generate new platforms for drug discovery, personalised pharmaceutical testing and tissue engineering strategies than provide direct therapeutic solutions in the short to medium term. We must apply new sophisticated genetic and biochemical methods to engineer increasingly more accurate animal models of human disease, exploiting advances in computational biology and bioinformatics to devise better ways to integrate and compare data from model cells and organisms with human biology.

The next steps in translational research are difficult, costly and labour intensive, but are unavoidable if we are to develop, test, modify and improve our predictions to the point where they can be safely applied to patients. They are not likely to produce cures tomorrow, but their support is crucial to ensure that Australia realises the potential of its current advantageous position in biomedical research, and produces world-leading breakthroughs in medical practice over the next decade.