THE UNIVERSITY OF MELBOURNE

Response by the University of Melbourne to the

Victoria's Future Industries

Medical Technologies and Pharmaceuticals

Discussion paper

Executive summary

The University of Melbourne welcomes the opportunity to contribute to the Future Industries review of the Medical Technologies and Pharmaceuticals Industries currently being undertaken by the Victorian Government. We are Australia's premier university with particular strength in health and medical research, located in the greatest concentration of biomedical researchers and clinicians in Australia, the Melbourne Biomedical Precinct.

We educate more health professionals, graduate more research and higher degree students and attract more nationally competitive funding than any other Australian university.

We have world class people and facilities in physical, chemical and life sciences, engineering and health and medical research, all of which are critical to the development of strong MedTech and Pharma sectors in the State.

We are proud of our achievements in discovery research, translation and commercialisation that have made a difference to Australia and the world. Snapshots of these achievements and capabilities in drug development and medical technologies are presented at Attachment One.

We commend the Victorian Government for recognising that MedTech and Pharmaceuticals are key industry growth areas for the State. We are fully engaged in supporting this agenda.

Our response is broadly structured under four themes: 1) Realising opportunities across the global value chain – State and National setting; 2) Scale, Networks and Collaboration; 3) Convergence, ICT and Digital Health; and 4) Building capability through skills and enabling infrastructure. This response is complementary to our recent submission to the Health and Medical Research review to the Department of Health and Human Services.

We urge the State to continue to take a leading advocacy role in addressing national policy settings that have a direct impact on industry development and research in the State, in areas such as taxation reform, skills development, support for strategic research, proof of concept funding models and support for university-industry engagement.

A summary of our recommendations is provided below:

- Develop a Proof of Concept Fund with State investment provided for operational costs;
- Advocate to the Federal Government that further taxation incentives are required to stimulate R&D investment;
- Develop and operationally support Clinical Trial Centres of Excellence that are aligned with clinical need in priority areas;
- Provide strategic support for convergence science projects in biomedical engineering that fall into the crevice between ARC and NHMRC funding;
- Continue to fund strategic investments in Victoria that will result in Centres of Research and Innovation Excellence;
- Leverage existing initiatives and co-investment from Victorian-based CRC projects to stimulate SME engagement;
- Strategically implement transformative projects in ICT and Digital Health such as electronic health records and cognitive computing;
- Encourage skill development through postgraduate programs in key disciplines (e.g. bioinformatics, computational science, engineering);
- Foster internships, joint appointments between university and industry and attract entrepreneurs back to Australia through programs such as VESKI, which may be extended to a VESKI Entrepreneurs Program;
- Develop a global business-alumni network of ex-pat leaders that researchers, innovators and business entrepreneurs can access;
- Provide incentive for businesses to engage in skills and entrepreneurial development programs such as those run by the Centre for Workplace Leadership;
- Target infrastructure specialists that will have an integral role in areas key to MedTech and Pharma, for example, materials nano-fabrication, advanced characterisation, informatics and computation; and
- Continue to invest in industry attraction, jobs creation and world-class research through the provision of cutting-edge scientific infrastructure as an enabling mechanism.

1. Realising opportunities across the global value chain – State and National settings

Victoria aspires to be a major participant in the global value chain in medical technology, biotechnology and pharmaceutical industries. Given our leadership in health and medical research, our world-class hospitals and the location of two internationally recognised academic health precincts, this vision is fitting. Achieving it will deliver significant health and economic benefit to the State through access to the latest health technologies, new pharmaceutical treatments and local industry development.

Melbourne and Victoria have all of the makings of such an ecosystem, but we require judicious investment and policy settings to reach our potential. We will know when we have succeeded through a number of indicators, which include:

- Additional multinational corporations with major R&D centres of excellence in the State as well as regional headquarters and significant manufacturing;
- A vibrant entrepreneurial culture with significant capital flow from investment funds and industry to the higher education and research sector;
- Increased mobility of employees across university, research and industry sectors;
- An increase in the proportion of PhD qualified staff working in the MedTech and Pharmaceuticals sectors;
- Increased number of SMEs that are also engaged with the State's research and university sectors.

The Discussion Paper raises important points about incentives, regulation and mechanisms for industry growth and attraction. For some of the questions asked, it is appropriate that the primary responses are from industry; accordingly, the University of Melbourne responds to the Discussion Paper from a position of direct experience and research expertise involving many of Australia's leading researchers in their fields.

R&D Incentives and Investment

The key challenges that Victoria faces in its health and medical innovation ecosystem are the lack of support at the early stages of the commercialisation pipeline and the need to build the base of entrepreneurial skills, in particular:

- Most of the investment that occurs at the pre-seed funding stage will never make a commercial return. But the provision of support at this early stage is absolutely critical to build the pipeline of potential businesses that can go on to bid for seed funding and venture capital. It is a classic example of market failure that requires State intervention.
- The problem most commonly encountered, when trying to commercialise researcher-generated intellectual property, is that the "invention" is at such an early stage that it cannot attract the dedication of a suitably skilled, experienced entrepreneur to plan and execute its commercial trajectory. At this early stage of product development there is little value in creating spin-off companies, as substantial work is usually required to establish the prima facie case for commercialisation.
- Innovation ecosystems thrive on activity density. Every successful innovation ecosystem around the world has, at its core, at least one world-class research institution and a number of successful multinational companies operating symbiotically. In Melbourne, we have world-class research institutions but we demonstrably lack engaged multinationals. Whilst this nucleus is not sufficient to generate a thriving innovation ecosystem, there can be no doubt that it is a necessary precursor that generates the environment in which start-ups and small business can also thrive.

Need for a Proof of Concept Fund

The Melbourne Accelerator Program[1] at the University of Melbourne has proven to be a successful model to nurture start-up businesses and develop an entrepreneurial culture in our next generation. Teams of potential start-ups from across the University of Melbourne work through a structured program to develop and grow their business, with top startups awarded access into the Startup Accelerator receiving $20,000 funding, office space, structured mentoring and networking opportunities. However, at the end of this development year, the teams still require more support and development before the idea is ready for seed funding.

This gap can be bridged by a "proof of commercial concept" fund. It fills the gap between a $20,000 grant under a MAP–styled accelerator program and a Uniseed or Medical Research Commercialisation Fund that undertakes investments starting at $250,000. We argue that for every major commercialisation success that reaches seed funding stage, there are at least 10 would-be successful ideas that never make it because of the gap in funding at the pre-seed funding stage. It is an example of market failure that exists at the early stage of the transition of technological breakthrough to a commercial product.

[1] http://themap.co/

The model for a Proof of Concept (PoC) fund is currently under investigation by the University of Melbourne in a number of contexts. The objective is to create a strong pipeline of proposals further along the value chain to the point where it becomes clearer whether or not there will be scope to secure seed funding towards a pathway of a licence, spin-out company, IP sale etc. Two funds are envisaged– one for the physical sciences and one for life sciences. These mechanisms will bring together the two established ingredients of human and financial capital and fill a long-standing gap in the research translation continuum.

The University of Melbourne is keen to partner with other key research institutions in order to build critical mass and ensure that this mechanism becomes an established piece of vital innovation infrastructure for Victoria. It is currently contemplated that the University of Melbourne (and select partners) will be responsible for raising the requisite capital. This funding will ensure that we can retain the best talent to manage the fund and so systematically generate high value jobs and export income for Victoria.

We recommend that the Victorian Government facilitate the development of a Proof of Concept activity by funding its operational costs.

Taxation

Taxation is an important policy instrument and lever for retaining and attracting companies, R&D and manufacturing investments into the State. The majority of corporate taxes operate under national programs, thus the State's role is one of influence and advocacy. We expect that many, if not all, of the University's industry collaborators would strongly support taxation instruments such as the R&D tax incentives scheme to encourage investment in innovation. Although the R&D tax incentive is important for Australia's research effort, we consider that it could be refined to better leverage the nation's public investment in research through universities and other public research organisations.

We recommend that the Victorian Government advocates to the Australian Government to consider additional taxation incentives that stimulate R&D investment and encourage research-industry engagement in Australia, such as:

Additional incentives where R&D leverages publicly supported research infrastructure

R&D tax incentives aimed at businesses and other eligible organisations could usefully be structured to offer additional incentives to leverage the significant public investment in research infrastructure in Australia. The R&D tax incentive could provide differential rates depending on the type and location of R&D activity, with greater incentive to invest in research leveraging publicly funded research infrastructure. While detailed and careful analysis and design is required to develop such as program, consideration might be given to the following:

- Incentives could be offered to larger companies (based on research and development spend) that engage with publicly funded research institutions and universities. Some examples of joint activity include internships, hosting PhD students, exchange programs, direct project support, university infrastructure access subsidies and workshops/events;
- In this situation, the onus could usefully be placed on the parties to develop relevant research projects and commit funds to underwrite industry relevance and focus;
- The rate of tax concession may be increased once aggregate spend exceeds a predetermined threshold, with the rate set with the overall objective being to grow a critical mass industry/academia engagement; and
- Such an initiative would likely only generate the critical mass of engagement where large companies were involved over the medium to long term.

Additional incentives for smaller businesses to invest in R&D to complement to tax incentive

At present, one per cent of Australian businesses currently account for two-thirds of non-government R&D spending. Adjusting government incentives to foster a greater R&D effort for the 99% of other businesses could broaden the sectoral base from which the Australian economy can benefit from innovation. This is particularly important for those 'micro' businesses with less than four employees that make up the majority of all Australian businesses but only undertake a very small fraction of the research activity (around five per cent).

A business is usually required to invest a minimum of $20,000 in research to be eligible for the R&D tax incentive. This requirement means tax concessions alone are not an effective tool to encourage many small businesses that could benefit from R&D to do so. Even a small increase in research activity across the spectrum of small and medium businesses not engaged in R&D could pay big dividends for Australia. Several studies of other OECD countries have shown that appropriately targeted incentives can be attractive to SMEs. They have a stronger impact on SMEs than larger firms, particularly so for liquidity constrained firms[2].

To ensure maximum value from a targeted program, a requirement for accessing government support would be agreement where all parties share in underwriting costs for industry-academia exchanges or hosting PhD students. In addition, consideration should be given to providing quarterly tax credits under the R&D Tax Incentive to SMEs. The current approach of yearly returns can create significant cash flow difficulties for an early-stage start-up. The Australian Government, influenced by the Victorian Government, could introduce seed grants, coupled with an appropriate R&D tax incentive.

Australian Patent Box

The University of Melbourne considers an Australian Patent Box worthy of consideration. As other countries around the world have adopted similar or varying styles of the UK Patent Box, further investigation of an Australian style application would be supported.

Improving the regulatory environment

It is important that new health technologies and drugs are appropriately tested for efficacy and safety. However, excessive regulation can be an impediment to industry development. Commonly quoted reasons for excluding Australia in international clinical research programs are ethics and governance delays and high per patient costs as compared to not only the emerging clinical research markets but also the USA and Europe. Patient recruitment and quality of data are rarely stated as reasons why studies are not conducted in Australia. Processes to streamline the ethics and governance processes through the NHMRC Good Practice Process Pilot study and the Research Excellence Initiative (REx) are focused on streamlining the processes of ethics and governance review to reduce delays in study start-up. With regard to costs of clinical research in Australia, the NHMRC is looking at developing a guidance document on a standardised costs structure. Australian Investigators need to be realistic and transparent with study budgets, preferably using standardised costs. Through collaborative research networks it would be ideal to negotiate one cost structure that will apply to all participating Australian sites.

Many of these issues are systemic and are being addressed nationally. However, the State can play a role in terms of providing leadership in clinical trials and regulatory excellence. For example, the newly established Melbourne Children's Trials Centre (MCTC) offers clinical researchers assistance with trial start-up, feasibility assessment, ethics submissions, budgeting, contracting and sourcing / connecting with research coordinators/nurses for trial conduct. MCTC helps with endorsement for Investigator-Initiated studies whereby researchers can engage with senior clinical trial researchers and biostatisticians for help with protocol design and development in Paediatric Medicine. MCTC also coordinates clinical trials with Monash as well as the other major children's hospitals in Australia. It is the largest trial centre of its sort in the southern hemisphere. There is considerable scope for the State to invest in similar clinical trial centres of excellence in specialist areas.

The University of Melbourne Clinical and Translational Sciences Platform (CATS) has recently been established to work with the University's hospital partners to provide support in clinical trials – dealing with health economics, statistics and best practice. CATS is intended to eventually serve the whole of the Melbourne Health Science Precinct. Further initiatives intend to share translational resources from the University of Melbourne and Monash towards clinical research and development to attract funding from government and private partners. Such a critical mass is needed to attract international biotechnology and pharmaceutical companies to the Melbourne Biomedical Precinct.

We recommend that the State operationally support specialist Clinical Trial Centres in areas of medical research excellence that are aligned with clinical need and industry development potential, for example, cancer, neuroscience, cardiovascular disease, respiratory health and metabolic syndromes. The centres, overseen by the two Academic Health Science Centres, would provide whole of state coordination and support.

[2] Castellacci, Fulvio (2015) 'Do the effects of R&D tax credits vary across industries? A meta-regression analysis', In Research Policy, Vol 44

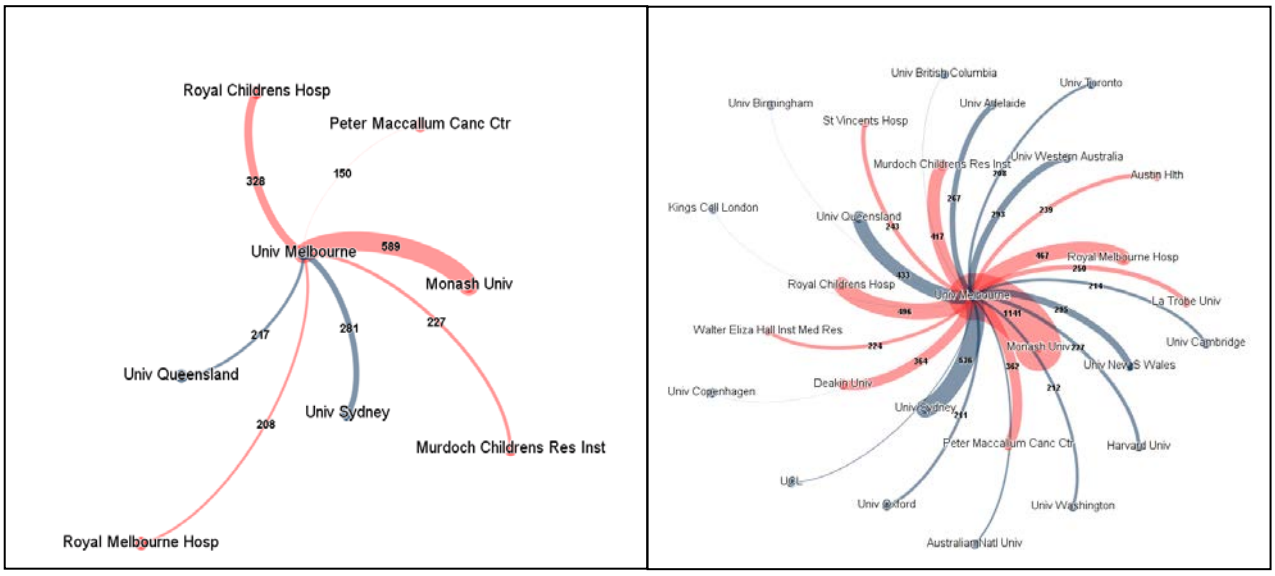
2. Scale, Networks and Collaboration

Victoria's biomedical and health sector has been established from a base of research excellence in the life, physical and medical sciences that has developed for over a hundred years. It is natural that within this ecosystem, concentrations of expertise and specialisation develop, clustered around core facilities and institutions. As a consequence, Victoria hosts a number of world-leading biomedical precincts.

However, the existence of these concentrations of excellence is not antithetical to collaboration and cooperation within and across precincts. Indeed the importance of collaboration has been recognised within the Melbourne Academic Health Science Centre which is nucleated around the Melbourne Biomedical Precinct.

Further, the University of Melbourne is an active collaborator with State, national and international partners. For example, network analysis demonstrates the growth in number and volume of co-authored, cross-institutional publications from 2010 (Figure 1) and 2014 (Figure 2).

2010 **2014**



In both of these network diagrams, Monash University is the University of Melbourne's major research collaborator. This collaboration is strategic as well as at the researcher level. Both institutions are involved, along with other universities, in major current and past research initiatives including NHMRC Program Grants in Dengue Fever Control and Antigen Presentation Recognition and the Immune System, the ARC CoE in Convergent Bio-Nano Science and Technology, the ARC CoE for Advanced Molecular Imaging, Victorian Life Sciences Computation Initiative (VLSCI), the Victorian Centre for Climate Change Adaptation Research, and the Defence Science Institute. Figure 2 also demonstrates the active collaborations with many of the State's medical research institutes and hospitals.

One of the obstacles to collaboration within and across institutions is the nature of the research funding system. Funding from ARC and NHMRC is highly competitive, reflected in low success rates. The ARC is reluctant to fund research that has near-term links to health and medical outcomes. These areas also do not fare well in regular NHMRC funding programs as they generally do not have enough of a health and medical research focus.

We recommend that the Victorian Government consider strategic support for convergence science projects in biomedical engineering that fall into the crevice between ARC and NHMRC funding.

Notwithstanding these challenges, there remains scope for greater collaboration and engagement across the health and medical technology value chain. Networks and associations such as the BioMelbourne Network, the Convergence Science Network, Biomedical Research Victoria, AusBiotech and AusMedTech are critical in this regard and should continue to be supported by the State (e.g. strategic event sponsorships).

Innovation Hubs and the value of Industry-Research Collaboration

University-industry collaboration is both a cause and a consequence of a healthy innovation ecosystem, which operates in a virtuous cycle, enabled by the right mix of settings, incentives, skills, people and infrastructure as discussed throughout this response. The University is proud of major research partnerships that are developing new intellectual property that is being taken up directly by industry, or is instrumental in the development of new

products, processes and services in health, wellbeing and related markets. Some key examples include our relationships with: i) CSL over many years at the Bio21 Institute, where CSL is currently expanding its footprint; ii) IBM R&D labs over the last five years, which has led to major advances in research for the State. Further, a substantial proportion of the IBM R&D highly skilled workforce consists of the University of Melbourne's PhD graduates who retain strong links with the University; iii) with Cochlear independently and via the Hearing CRC, to develop new algorithms and improve the function, safety and efficiency of the implant device. These collaborations have created hubs of medical and technological activity in Parkville. The University is seeking to develop this further through the Carlton Connect Initiative[3] at the site of the former Women's Hospital.

We also consider that there is scope for additional hubs, or major university-industry collaborations, in areas such as cognitive computing for health; cancer; neurosciences, biomedical engineering, regenerative medicine and infectious diseases and immunology, for example through the establishment of a new centre of excellence akin to the US Centres for Disease Control at the Doherty Institute for Infection and Immunity.

More active engagement and facilitation of university-research-health-industry engagement across the sector and at the University of Melbourne is desirable. The CIMIT model referred to in the Discussion Paper is an excellent example of what can be achieved, and is similar in many respects to the Defence Science Institute model which the University of Melbourne hosts. In this respect, the University of Melbourne, along with key partners, are currently identifying priorities for strategic activities in relation to research, development, innovation and industry engagement in the medical technologies and pharmaceutical sectors.

We recommend that the State continues to actively support and fund strategic investments in Victoria, such as those referred to above, that will result in centres of research and innovation excellence and improve industry engagement.

The State Government has a key role in exerting influence and leveraging Commonwealth investments such as the Medical Technologies and Pharmaceuticals Industry Growth Centre and CRC for Innovative Manufacturing (IMCRC). The University of Melbourne has been instrumental in the development of the IMCRC and has been a key research provider. The IMCRC is headquartered in Victoria, indeed at the University of Melbourne's innovation and industry engagement centre at Carlton Connect, yet there are many research organisations from across Australia involved. Further, other interstate Governments are exerting influence through the investment of millions over the life of the CRC. The CRC will benefit the State as it provides a mechanism for researchers to engage with local and interstate industrial R&D capability, for example, with the SME clusters in other geographies, such as the bionics hub at Macquarie University, which was established after Cochlear relocated from Melbourne in 2012.

We recommend that the Victorian Government leverages these initiatives through providing active financial and programmatic support, for example, through co-investments for Victorian-based CRC projects, and financial incentives for SME engagement.

Victoria also has world class engineering assets

The Discussion Paper recognises some of Victoria's world leading capabilities and key biomedical assets that can be used to attract international investment to the State, for example, at Peter Mac, the Florey, WEHI, ARMI and the Doherty Institute. While, naturally, the University of Melbourne considers that these are indeed world-class intellectual assets, we also note that in the context of MedTech industry development, it is important to also identify core engineering assets across Victoria.

Key assets in the Melbourne Biomedical Precinct and the Melbourne School of Engineering (MSE) include:

- **The Centre for Neural Engineering (CfNE):** An interdisciplinary centre embracing core disciplines of electrical engineering and neurosciences. Funding by Mr Leigh Clifford and Mrs Sue Clifford was recently provided to establish the endowment for the Clifford Chair in Neural Engineering. One of the key objectives is to facilitate the development of new point of care diagnostic devices that will enable more reliable diagnosis and better management of patients.
- **The Cell and Tissue Biomechanics Laboratory:** With a strong interdisciplinary team of maxillofacial surgeons, physiotherapists and material scientists, researchers designed and tested the world's first 3D-printed prosthetic total jaw joint replacement which was implanted in a patient to correct a congenital abnormality of the jaw. The Defence Science and Technology Group (formerly DSTO) has also selected MSE as the key research partner for evaluating battlefield injuries.
- **Therapeutic Technologies Hallmark Research Initiative:** This Initiative is focused on new applications of mechanobiology and organ-on-a-chip technology to transform drug screening technology and practice. The

[3] http://www.carltonconnect.com.au/

ultimate goal is to work with industry partners, such as CSL, to develop new drug screening technology. The multi- and inter- disciplinary collaboration with industry seeks to transform the efficiency of translation of promising new therapeutic targets into new medicines and therapies.

- **The Bionics Institute:** The Bionics Institute promotes multidisciplinary research that leads to clinical and commercial outcomes. Key commercial partners include Bionic Enterprises, Cochlear, GlaxoSmithKline and Pfizer. Research undertaken encompasses the biology, engineering and clinical study of cochlear implants (bionic ear), hearing aids, retinal prostheses (bionic eye), and brain implants for epilepsy, and intractable neurological and psychiatric disorders, with multidisciplinary research teams working to advance knowledge and capability in the areas of bionic hearing, bionic vision and neurobionics.
- **The Aikenhead Centre for Medical Discovery (ACMD):** ACMD, of which the University of Melbourne is a partner, will bring together medical practitioners with engineers, scientists and industry to solve real patient problems.

3. Convergence, ICT and digital health

The Convergence Science Agenda

The growing prevalence of chronic diseases and the changing constellation of disease patterns are contributing to mounting pressures, and costs, on health systems around the world. Further, new knowledge and the convergence of technologies are disrupting traditional approaches to the delivery of health services and the relationship of health services providers and healthcare consumers. Individuals are becoming increasingly empowered using their own personal data to inform decision making. The boundaries of health and wellbeing have already expanded beyond clinical care into exercise, mobility, preventative and lifestyle products.

The University of Melbourne welcomes the Victorian Government's recognition of the importance of convergence science in Victoria as part of the State's health and medical research strategy and as enabler for the development of new knowledge-intensive industries in the State.

As discussed already, Victoria's biomedical and health sector is state-of-the-art in many respects. The opportunity now presents for Victoria to exploit its potential and deliver economic outcomes by leveraging the convergence agenda in biomedical engineering and innovation. This is timely in an age where unprecedented technological advancement has led to greater demand for deep expertise. Biomedical science and engineering will play an instrumental role in addressing future health challenges. Melbourne has the right mix of research institutes, hospitals, a highly skilled workforce and strong translation capability to make it the MedTech and biomedical engineering leader in Australia and the Asia Pacific.

To achieve this, the blueprint that has been successful in other biomedical domains should be applied to biomedical engineering to link fundamental research with technology capability, clinical and general health practice and an entrepreneurial culture. In doing so, Victoria will build a vibrant economy underpinned by jobs growth in knowledge-intensive industries.

Thus it is imperative that critical mass in biomedical engineering and innovation is developed in areas of existing clinical and research concentration across the State. It is important that the University of Melbourne, with its record in health, biomedical research, science and engineering, also contributes to the biomedical engineering and medical technology agenda by coalescing, catalysing and leveraging our substantial, multidisciplinary research strengths, clinical leadership and networks for the benefit of Victoria. To this end, the University of Melbourne is developing an Institute in biomedical engineering research and innovation, which will have its geographic focus in the Melbourne Biomedical Precinct at Parkville, with RMH, the Women's, and the Children's Hospital at its core, but also extending via the Western Health network and the Austin Hospital.

We expect that the Institute will deliver health and medical technology innovations that will help transform Victoria and Australia's approach to healthcare and contribute to the development of future knowledge-intensive industries and jobs for Victoria. The Institute will be aligned with other biomedical engineering initiatives and precincts across the State, in particular networking and activities such as the Convergence Science Network and the establishment of the complementary Monash Institute of Medical Engineering (MIME) at Monash University's Clayton campus. The programs and activities of the Institute will also be aligned and integrated with the $180M capital works program of the Aikenhead Institute for Medical Discovery focussed on the Eastern Medical Precinct.

ICT and Digital Health

Over the past decade, the Victorian State Government has made strategic investments in ICT including the Victorian

Life Sciences Computation Initiative (VLSCI), a $50M State investment with $80M accompanying cash and in-kind contributions from the Victorian university sector. An independent report has recently found that the initial government investment has generated a three to five fold increased spending in life sciences research. The VLSCI has also been the foundation for an enduring partnership between the University of Melbourne and IBM Research Australia, which now have a major health focus.

Similarly, the Victorian Government invested in the NICTA Victoria Research Laboratories to stimulate applied ICT R&D resulting in similar ROIs, research, health and other industry focussed achievements. For example, NICTA VRL has been critical in building enduring capability in Victoria which is driving much of the University's biomedical engineering innovation and industry engagement agenda. This is underpinned by world class research in nanoelectronics that is currently leading to the development of new innovative point of care health diagnostic devices. We commend these investments.

We also note the recent announcement that Queensland Health has developed a 20-year health ICT and e-Health strategy with an anticipated investment of $1.2 billion. We believe that it is important that the State demonstrate leadership in health and industry development, through a whole of government approach to health reform. This should be driven by strategic investments and procurements in e-health/ ICT infrastructure, for example, through the delivery of a State wide electronic health record system, and other important initiatives such as cognitive computing for health.

We consider that cognitive computing, that is the next generation of computing that can process and synthesise vast masses of data via sophisticated algorithms through machine learning, will be critical in delivering health outcomes and stimulating industry development for Victoria. For example, in the field of cancer genomics, the wealth of research and medical literature in relation to the molecular subtypes of cancer mutations can be rapidly analysed to support diagnosis, clinical decision making and research.

Major investments in digital health are also likely to stimulate the development of health technology and analytics focussed SMEs that are able to leverage these major platforms and a more sophisticated approach to health data management.

We recommend that the State continue to adopt a strategic approach to ICT and Digital Health through transformative projects in ICT and Digital Health such as electronic health records and cognitive computing.

4. Building capability through skills and enabling infrastructure

Skills

Victoria has a world-class, post-secondary education and training system in both VET and higher education sectors. However, gaps remain and it is important that skills development responds to emerging industry needs and trends.

As discussed in Section 1, it is critical that an entrepreneurial culture is encouraged. Further, a STEM-literate society is necessary for future social and economic benefit. We consider that key priority areas for skills development are:

- Developing science, research and technical skills in bioinformatics, computational biology, genomics, medicinal chemistry, neuroscience and electrical engineering;
- Skills in clinical trial management and drug development;
- Increasing STEM awareness and literacy across business, government and the community; and
- Developing entrepreneurial and business skills;

As part of its contribution to Victorian skills development in the MedTech and Pharma areas, the University of Melbourne currently offers the following programs:

- Master of Biotechnology (Faculty of Science), which provided education in scientific technologies at the forefront of the emerging biotechnology industries, and knowledge in areas of science commercialisation, biotechnology regulation, scientific leadership and decision making.
- Master of Science (Faculty of Science) with a focus on the BME related fields of Bioinformatics, Biosciences (Genetics, Genomics and Development) and Mathematics and Statistics (Biostatistics).
- Master of Engineering (Biomedical) and Master of Engineering (Biomedical with Business) program (both offered through the Melbourne School of Engineering). The Master of Engineering (Biomedical) is accredited by Engineers Australia and EUR-ACE.
- Master of Bioinformatics program through the Department of Computing and Information Systems.
- The Faculty of Medicine, Dentistry and Health Sciences offers subject specialisations in its degree programs including through the Bachelor of Biomedicine. Third year majors include Bioengineering Systems,

Biotechnology and Health Informatics.

- Master of Biomedical Science (MDHS), which provides students with skills in the conduct and design of research in biomedical and health sciences and offers specialist projects in biomedical science, pharmacology, therapeutics and engineering.

The University is also developing a postgraduate course in BioDesign Innovation, modelled on the Stanford University BioDesign course. Over one academic year, teams of students selected for the course will receive instruction in innovation and entrepreneurship and complete a significant project, during which they will identify a need or opportunity for a new or improved medical instrument or device; devise a concept solution for the new instrument or device; develop an engineering prototype for the new instrument or device; test the prototype invention; file a provisional patent application; and develop a business plan to take the new medical device toward commercialisation.

In addition to technical and innovation skills for the future, Victoria needs people who are networked. Mobility across industry, government and research sectors is critical - Australia has one of the lowest proportions of PhD graduates employed in industry relative to leading knowledge economies in Europe and the US.

The importance of better leveraging existing relationships and connections is recognised by the State in the Discussion Paper. We support this approach and consider that it is vital that connections are retained and actively cultivated with offshore business alumni, that is, key personnel from firms that have moved offshore wholly or in part, or Australian leaders now working in internationally based corporations.

In summary, the University considers that there is substantial scope to develop workforce relevant technical skills, increase industry-university mobility and create vibrant international networks of business alumni.

We recommend that the State provide financial support and actively encourage:

- **Postgraduate programs in Bioinformatics and Computational Biology that emphasise interdisciplinary training and include embedded research placements - one example of this approach is the University's successful MSc (Bioinformatics);**
- **Software engineering skills development programs to create a workforce that can develop bespoke software solutions for data capture and facilitate access that are ready-made to integrate with existing State and National health e-platforms;**
- **Short course skills training in genomic methods for current practitioners (both technical and clinical);**
- **Internships, joint appointments between university and industry, and attraction of entrepreneurs back to Australia. For example, the VESKI program could be extended to include a VESKI Entrepreneurs program and a VESKI Industry Fellows for two-way fellowships between industry and research sectors;**
- **Development of a global business-alumni network of ex-pat leaders that Victorian researchers, innovators and business entrepreneurs can access both formally and informally.**

It is also essential that entrepreneurial and innovation skill development occurs across the State's existing and future businesses. The Centre for Workplace Leadership (CWL)[4] at the University of Melbourne collaborates with a wide range of organisations on workplace projects to improve the quality of leadership and management in Australian business organisations by undertaking research, industry outreach and delivering education and training programs. The Centre delivers knowledge, resources and tools to strengthen and drive inter-organisational collaboration and productivity and in turn, lead to high performance organisations. The Centre works with a wide range of organisations on workplace projects to address actual problems that impact on their capacity to innovate and grow. It is currently developing an online toolkit for business managers.

The State Government can assist activities such as those undertaken by CWL by encouraging participation in these absorptive capacity building and skills development activities.

We recommend that the State Government provide incentive for businesses to engage in skills and entrepreneurial development programs such as those run by the Centre for Workplace Leadership.

Infrastructure

Victoria has a number of key infrastructure assets that support health and medical research and new industry development. In addition to the assets referred to in the Discussion Paper, other core facilities with significant cutting-edge infrastructure include the Bio21 Institute, the Doherty Institute, the Melbourne Brain Centre, the Melbourne

[4] http://www.workplaceleadership.com.au/

Centre for Nanofabrication, the 7Tesla MRI Scanner, and a number of technology platforms at the University of Melbourne[5]. The Victorian Platform Technologies Network portal is a valuable mechanism to access facilities across the State. While these and other assets are highly valued by Victorian researchers, there is substantial scope for increased industry use.

One of the key challenges for establishing effective research infrastructure is limited funding available for technical specialists. Technical specialists are deeply engaged with their technology domain, allowing instrument capabilities to be maximised towards new applications in academic and industry settings. And yet, there is no dedicated funding stream for this unique workforce within NHMRC or ARC (the Commonwealth NCRIS scheme does provide some valuable funding to select research infrastructure). Therefore, the State Government has the opportunity to intervene by provision of funding for this critical workforce, for whom there will be global competition.

We recommend that the State target those specialists that will have an integral role in areas key to MedTech and Pharma, for example, materials nano-fabrication, advanced characterisation, informatics and computation.

Currently, the degree of access to university platform technologies by industry is reasonable. For example, there is approximately 30% access by industry of the specialist equipment at the Bio21 Institute. However, there is room for improvement, including developing the technical specialist workforce to be literate in business needs and expectations (as opposed to academic), and further incentivising industry to access platform technologies through linkages with R&D tax credits and simplification of the existing voucher programs. The State Government invariably has the opportunity to contribute on both fronts.

The acquisition of new cutting-edge technology is challenging, especially when the capital investment required and subsequent operational costs are substantial. State investment in assets will drive future growth in the sector and will ensure enabling of research excellence that will attract industry. Therefore the University of Melbourne will look to partner with industry, the State and peer institutions to make strategic investments in new landmark, cutting-edge technology, such as a new medical beam line for the Australian Synchrotron, the proposed proton beam therapy facility in Parkville, for which we commend the current feasibility study, and cryo-electron microscopy for the Bio21 Institute. It is worth noting that cryo-EM is revolutionising drug discovery through characterisation of small molecules and will be instrumental in future drug discovery.

We recommend that the State continue to invest in industry attraction, jobs creation and world-class research through the provision of cutting-edge scientific infrastructure as an enabling mechanism.

[5] See http://research.unimelb.edu.au/research-infrastructure.html

Attachment One: Achievements in drug development and medical technologies by University of Melbourne researchers

Drug development

New vaccines to improve child health: In 1973, Professors Ruth Bishop and Ian Holmes discovered rotavirus, a leading cause of child death. The MHP rotavirus vaccine development team in Parkville has recently developed the RV3-BB vaccine, which, unlike current vaccines, can be administered at birth. It is currently in Phase III efficacy trials in Indonesia, funded by the Gates Foundation.

Anti-thrombotic agents: Cellular biomechanics sits within the discipline of mechanobiology, a science that underpins the emerging utility of cell- and organ-on-a-chip technologies to the pharmaceutical industry. Cell-on-a-chip microfluidics technology has recently matured sufficiently for application in drug screening in limited areas, such as the evaluation of anti-thrombotic agents. This technology has been used to facilitate the development of AZD6482, an anti-thrombotic agent discovered in Melbourne and now being evaluated in clinical trials by Astra-Zeneca.

Nanomedicine: Recent developments in materials engineering allow the design of nanoengineered materials with precise architecture and function. "Smart" micro/nanoparticles that are capable of triggered response to specific stimuli including pH, light, and protein concentration are ideal for biomedicine. Breakthrough research by the University of Melbourne and Baker IDI has resulted in the development of a drug-loaded nanocapsule, that when it reaches the site of blood clots, releases a clot-busting drug to destroy the blockage. There is significant opportunity to commercialise the invention here in Australia through commercial partnerships with companies such as Sanofi Aventis.

Treating fibrosis: Clinically focussed bio-organic chemistry is also leading to breakthrough drug development: for example, the company Fibrotech, using University-created intellectual property, has developed a new class of agents with potential to treat excess deposition of fibrous tissue (fibrosis), prevalent in chronic kidney disease and chronic heart failure as well as other diseases. Fibrotech was recently acquired by the global specialty biopharmaceutical company, Shire, for $75million.

First vaccine against periodontitis: Led by Eric Reynolds, the CRC for Oral Health and the pharmaceutical company, CSL, have developed the first ever candidate vaccine to prevent periodontitis. Now in partnership with Sanofi Pasteur, the vaccine is currently preparing for clinical trials.

Medical technologies

Medical bionics: The University of Melbourne has a pre-eminent role in the field of neural-bionics based on the development of the bionic ear, resulting from the pioneering work of Graeme Clark. Dedicated research on the bionic ear continues today and is focused on improving the performance of the cochlear implant in patients. The group has expanded their research to develop new neural prostheses including bionic eyes and neurobionics devices for application in a variety of neurological disorders.

Epilepsy seizure detection: Epilepsy is the world's most common brain disorder. Researchers at the University of Melbourne and St Vincent's Hospital have developed a device that can detect seizures as they are evolving and rapidly respond with a counter-stimulation to stop it in its tracks. The end-goal is to create an implant for people with epilepsy to prevent seizures. Its present development received the 2015 Epilepsy Foundation (USA) prize for most promising technology in epilepsy treatment.

Innovations in prosthetics: The advent of new production technologies for biomedical materials is expected to revolutionise healthcare. Already, the University of Melbourne is leading the way. In June 2015, in an Australian first procedure, a rare congenital jaw deformity was corrected, using a 3D printed jaw joint that was designed and created by the University. 3-D printing is also being applied to create artificial bone implants that will be inserted advanced surgery aided by robotics.

Point of care diagnostics: Clinicians are often challenged by access to the information they require for timely, accurate decision making, while there is also substantial opportunity to improve the quality of care given through technology innovation in nursing care. The goal is to develop tools and systems for health practitioners, be they clinicians, nursing or allied health professionals, that are low-cost, easy to use and deliver the best patient treatment and care. University of Melbourne intellectual property is expected to lead to the development of new point of care nano-sensors that will make diagnostic tests available to everyone.