2016 National Research Infrastructure Roadmap Capability Issues Paper

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Specific topic: Future stem cell capabilities

Status of stem cell research:

The central focus in infrastructure planning for stem cell research is the imminent wave of translational research. Australia is in a strong position to be pre-eminent in the development of clinical products based on stem cells. This submission will try to define the background on which we can build our capabilities and outline the scale of infrastructure necessary for its success.

Background and environment:

Our understanding of stem cells, their biology, behaviour, influences and possible roles in human therapeutics continues to grow exponentially. It is evident that there has been a profound shift in that understanding and hence the research and therapeutic platforms to which pluripotent cells may be applied. Whereas original applications focussed on replacement of tissues lost following disease or trauma with cells capable of restoring and renewing them, or the utilisation of stem cell paracrine functions (the effects of cell secretions on surrounding cells and tissues) to induce beneficial change in neighbouring cells, the development of new biological techniques and their application to controlling stem cell proliferation and differentiation has opened completely new potentials for the science.

Hence, future major advances will be grounded not only in growing and differentiating stem cells but in their use as cellular vehicles for therapeutic proteins, antibodies and metabolic mediators.

Questions from Capability Issues Paper:

Q.5 and Q.6 - Research workforce skills -Apart from the generally poor uptake of science subjects by high school and university students, the graduates that are produced are rarely work-ready. This can be attributed to a large extent to the diminishing time devoted to teaching practical laboratory techniques in tertiary institutions. Laboratory skills training is a high cost component of science training in universities. Current financial pressures on tertiary institutions will almost certainly worsen this deficiency in the short, medium and long term. Funding for NCRIS

resources should include a training moiety to ensure graduates gain sufficient bench skills to work effectively in their chosen field.

Q. 8 - Access to National Research infrastructure Q.8 - International models - This submission will put the case for a national collaborative network of stem cell laboratories, forming a national core platform technology provider. The system can be made “self-nourishing - users in turn become providers for subsequent applicants. Projects are developed among the new and old users and Australia’s capabilities in the field thereby develop exponentially. One does not have to seek international systems on which to model effective services in Australia.

Q. 18 - Are directions right? Any additional needs -The table on p. 20 identifies immediate needs in the current practice of stem cell science but the field needs to be viewed from a wider perspective. While elucidation of the physiology and chemistry of stem cells during differentiation and growth, and the application of induced pluripotent stem cells (iPSC) to research continue to be vital, the most important frontiers in stem cell research are the use of cutting edge techniques such as CRISPR gene editing and epigenetics. Added to increasing cross-disciplinary (nano-engineering, bio-informatics) activity, these techniques open a very different landscape for future research directions.

The dominant theme in these developments is the extension of stem cell use from replacement of cells and tissues lost by disease or injury to their use as vehicles for delivery of therapeutic molecules, genes and agents such as siRNAs. Possibly the most rapidly advancing therapeutic field is immuno-oncology, where immune cells are primed or induced to express specific tumour-arresting genes. Currently this is achieved by monoclonal antibodies that inhibit the natural arrest of killer T-cell attack on tumour cells. The use of stem cells opens up a much wider field where immune competent cells can be tailor-made to attack tumours defined either in tissue groups or by specific cell surface or cytoplasmic markers.

The list of points under 5.3.4 describes the necessary enabling technology to establish Australian leadership in this area, given the high standard of our existing stem cell facilities and personnel. The collaborative network we propose would maximise the efficiency of such facilities, affording stem cell research workers working on any cell type or tissue access to essential tools, run by experts at world’s best practice level.

Stem Cells Limited is developing a business plan that embeds the company within such a network. Several centres have established cell banking facilities of patient-derived iPSCs, bone marrow derived stem cells, human amniotic cells, and strains of embryonic stem cells - a necessary step given the fragile nature of living cells and the challenges of distribution chains for cellular therapeutic products. The benefits of capital and continuing investment in stem cell science are very considerable.