

CANCER IMMUNOTHERAPY IMAGING “CITI” PROGRAMME

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Executive Summary

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Cancer is the leading cause of deaths in Singapore today, accounting for 27.7% of total deaths. There is an urgent need for novel strategies to combat cancer as the number of cancer cases in Singapore is estimated to rise by 250% in the next 20 years¹. Cancer immunotherapy (CIT) holds promise as a breakthrough anti-cancer strategy wherein the patient's own immune system is harnessed for effective tumour control. In fact, CIT is projected to be the backbone of 60% of global cancer management by 2023², with an estimated market growth to over \$95B USD and annual growth rate of 14.6%.

Unmet Needs of CIT. A major challenge in CIT is that the average patient response rate is only 20%.^{2,3} This is mainly due to a dearth of accurate and reproducible biomarker(s) that allow physicians to select patients who are most likely (or least likely) to respond to treatment. The challenge is compounded by high treatment costs. This calls for the judicious selection of expensive therapy combinations that maximise patient outcomes, while reducing economic burden of cancer care spending. Therefore, it is crucial to identify biomarkers and monitor whole body immune system response to better predict: (i) types of patients to treat using CIT, (ii) methods to improve treatment responses, and (iii) selections of CIT combination treatments with the greatest likelihood of success, efficacy and safety.

The Singapore Solution: The Cancer Immunotherapy Imaging “CITI” Programme. **Non-invasive real-time *in vivo* imaging of immune cell-based biomarkers**, in conjunction with CIT, can provide a pivotal platform for validating treatment safety and efficacy of the deluge of CITs that are poised for clinical translation or already in clinical testing. However, translational imaging in the context of CIT is currently limited by the paucity of validated and clinically-proven imaging probes. The CITI Programme aims to overcome this by integrating cutting edge technologies in Immunology, Chemistry, and In Vivo Preclinical and Clinical Imaging, to take a systems biology approach for development of imaging probes and biomarkers in CIT. Efforts will be centred on the **discovery, validation, and clinical translation of novel peptide-based multimodal imaging probes** for optical and nuclear imaging, which specifically and sensitively target treatment-response relevant immune cell surface markers capable of defining tumour microenvironment status and guiding immunotherapeutic strategies.

Investments and industry partnerships. The CITI Programme is designed to target several value inflection points in the translational R&D continuum from CIT discovery to implementation. It is funded by a 5-year, S\$22 million Industry Alignment Fund-Pre-Positioning (IAF-PP) grant awarded by Singapore's Biomedical Research Council (BMRC). Strategic biopharma alliances are being sought for collaborative opportunities, including probe co-development, licensing, and clinical trial schemes relevant to the goals of the CITI Programme. Industry partners will also be able to immediately access programme infrastructure and resources to expedite translational and clinical applications for their in-house diagnostic/CIT candidates, regardless of the molecular/cellular format (e.g. Ab, small molecule, T Cell Therapy), and the molecular target.

Overview of goals:

- 1) Precision immunoimaging for precision immunooncology: Build a fully integrated platform to identify and validate prognostic and predictive *in vivo* imaging biomarkers for CIT to remove clinical uncertainty and improve patient response rates to CIT combination strategies.
- 2) Build a peptide-based “**ImmunoOncology Imaging Toolbox**”, a first-of-its-kind global initiative.
- 3) Establish strategic industry partnerships at any entry point of the CITI programme with any Rx/Dx (peptides, Abs, small molecules, T cells, etc.) as fits their interests and needs.

References. (1) Singapore Cancer Registry, Interim Annual Registry Report Trends in Cancer Incidence in Singapore 2010–2014 (2) Baum, A.S. Immunotherapy - The Beginning of the End for Cancer. (CITI GPS: *Global Perspectives & Solutions*, 2013). (3) Melero, I., et al. Evolving synergistic combinations of targeted immunotherapies to combat cancer. *Nat Rev Cancer* 15, 457-472 (2015).