Developing Biomedical Technology Talent in Hong Kong and The Greater Bay Area

Hong Kong BioMedical Technology Development Advisory Panel

CONTENTS

EXECUTIVE SUMMARY

Current Biomedical Technology Industry and Needs in GBA

Biomedical technology industry in the Greater Bay Area (GBA) is a key national development agenda. Endowed with advantages in its high-quality skilled labor force and large manufacturing capacity, the region is among the largest production and research base of medical devices in China. The number of new registration applications for biological and chemical drugs totaled 536 in 2019, with a compound annual growth rate of 44% since 2016.[1]

Being one of the most international economies in the GBA, Hong Kong has world-class universities, solid scientific research capabilities, a strong foundation in international business, competitive financial services, and robust legal and intellectual property system. In developing GBA into an international innovation and technology hub, Hong Kong is well positioned to be a R&D anchor to attract world-class talent and resources for innovations to the region and achieve synergistic development with neighboring GBA economies complementing each other's comparative strengths.

The Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area set out by the Central Government in 2019 clearly supported Hong Kong in nurturing innovations in science and technology and developing emerging industries.[2–5] The Plan has identified biomedical technology as a new pillar industry in the region and prioritizes major industry projects, such as biopharmaceuticals, high-end medical diagnostic equipment, as well as genetic testing. The Plan envisions closer cross-border co-operation in building up medical and healthcare resources, including encouraging talent exchanges and developing a regional healthcare cluster and medical centers.

The development of industries based on science and technology involves frontier basic research, technology translation and market adoption. It requires "multi-channel" capital, institutional and market mechanisms to encourage innovation and entrepreneurship, as well as sustained cultivation of talent.[6] Considering these key factors, the development of Hong Kong and GBA into an international biomedical hub faces both opportunities and challenges.

Analysis of Current Biomedical Talent Pool in GBA to Strengthen Biomedical Ecosystem

Numerous studies have identified the need to enhance talent development for GBA to reach its full potential. A survey showed a highly uneven distribution of high-end talent and digital talent in GBA cities.[7] Although Hong Kong's competitive advantage in innovation and technology lies in its basic research, there remains a strong demand for more researchers specifically for technology translation in Hong Kong.[8] According to the Global Innovation Index 2020, Hong Kong has approximately 4,000 researchers per million population, a ratio lower than that of other small economies such as Singapore and large countries such as the United States and the United Kingdom.[9]

Key Recommendations

In this context, this document from the *Hong Kong BioMedical Technology Development Advisory Panel* has gathered comments from a multidisciplinary group of professionals including leading academics, venture capitalists, legal experts and industry leaders. It intends to review current unmet needs in talent development and best practices and innovative approaches in other regions, and articulate recommendations on the strategy and provision of talent support, with a view to fostering the development of Hong Kong and Greater Bay Area into an international biomedical hub.

The Key Recommendations are Summarized as Below:

CULTIVATE BIOMEDICAL TECHNOLOGY TALENT IN GBA

Address current knowledge and skills gaps in biomedical research workforce, especially in technology translation to bridge bench science and clinical care, by rethinking graduate education and post-doctoral training programs

Establish a cross-institutional entity with a clear mandate in biomedical technology translation and talent cultivation in translational sciences

Establish public-private partnership to ensure long-term sustainability while leveraging the knowledge domain of the commercial sector

Mitigate the manpower shortage in medical service providers and position Hong Kong as a training hub. Training of medical service providers requires cooperation from the medical sector and also internship requirement for foreign trainees

Scale up initiatives to encourage primary and secondary students to pursue biomedical subjects and careers with an emphasis on entrepreneurship and understanding risks

Encourage a cultural change and facilitate the structured progression of researchers in the area of entrepreneurship, e.g., by providing more flexible policies on patent ownership, outside practice regulations and performance evaluations, etc.

ATTRACT INTERNATIONAL TALENT TO GBA

Improve alignment and complementarity of existing schemes to drive a holistic and even development of talent across the GBA region

摘要

现时粤港澳大湾区生物医学科技行业及需求

粤港澳大湾区（大湾区）的生物医学科技行业已经被列入国家重要发展项目。大湾区是中国最大的医疗器械生产和研究基地，拥有高素质和技术型的劳动力和巨大的制造能力。在2019年，生物及化学药物新注册申请总数为536项，自2016年以来年复合增长率达到44%[1]。

香港是大湾区内最具国际竞争力的经济体之一，备有世界级的大学、雄厚的科研能力、稳固的国际商业基础、高竞争力的金融服务，以及健全的法律和知识产权制度。在发展大湾区成为国际创新科技中心的进程中，香港有望进一步发展成为国际研发中心，吸引世界一流的人才和资源到这地区进行创新，推动粤港澳大湾区经济协同发展，发挥三地互补的优势。

中央政府在2019年制定的《粤港澳大湾区发展规划纲要》（《规划纲要》）明确支持香港培育科技创新和发展新兴产业[2–5]。《规划纲要》确定生物医学行业为大湾区新的支柱产业，并优先培育一批重大产业项目，包括生物医药、高端医疗诊断设备以及基因测试等。《规划纲要》提出，支持推动优质医疗卫生资源更紧密的跨界合作，包括加强医疗卫生人才联合培养和交流，以及发展区域医疗联合体和区域性医疗中心。

科技产业的发展涉及前沿基础研究、技术转化和市场开拓。当中需要多渠道的资金、鼓励创新创业的体制和市场机制，以及培养充裕的创科人才[6]。综观以上关键因素，香港和大湾区发展成为国际生物医学中心既面临重大机遇，同时也充满挑战。

分析当前大湾区生物医学人才库以加强生物医学生态发展

许多研究指出大湾区需要加强人才发展，以充分发挥其潜力。据一项调查显示，大湾区各城市高端人才和科技人才分布非常不均匀[7]。受国内外认可的基础研究，是香港在创新科技方面的一大优势，唯目前香港面对研究人员严重不足的问题，特别是专门研究技术转化的人员[8]。根据2020年全球创新指数报告显示，香港每百万人口中约有4000名研究人员，比新加坡等小经济体以及美国、英国等大型经济体的研究人员比例要低[9]。

建议

在这基础下，香港生物医学科技发展顾问委员会收集了多方面的专业意见，包括顶尖学者、创业投资者、法律专家及业界领袖等，制定了这份详细的报告。报告旨在检视当前人才发展的需求和参考其他地区的模式，并就人才培育和汇聚的策略提出建议，以促进香港和大湾区发展成为国际生物医学中心。

建议摘要如下：

在大湾区培育生物医学技术人才

重新思考和定位生物医学技术人才的培育计划，包括研究生教育和博士后培训计划，以解决目前存在的知识和技能瓶颈，尤其是在技术转化方面，以衔接基础科学研究和临床护理的应用

成立一个跨机构的平台，专门负责生物医学技术转化和相关人才的培育

建立公私伙伴关系以确保可持续性发展，同时让商界的知识发挥其力量

改善医疗服务界的人力短缺问题，并定位香港为培训中心。医疗服务提供者的培训需要各医疗部门的通力合作，也需要订定海外实习生的实习要求

扩大现有的培育计划，鼓励中小学生攻读和从事生物医学的专业，并加入创业精神和其风险的元素

推动知识转移和创业文化，鼓励研究人员将科研成果商品化，例如提供更灵活的专利拥有权的政策、外部执业法规和绩效评估

吸纳全球专才到大湾区发展

优化现有计划的一致性和互补性，推动整个大湾地区人才的整体发展

摘要

現時粵港澳大灣區生物醫學科技行業及需求

粵港澳大灣區（大灣區）的生物醫學科技行業已經被列入國家重要發展專案。大灣區是中國最大的醫療器械生產和研究基地，擁有高素質和技術型的勞動力和巨大的製造能力。在2019年，生物及化學藥物新註冊申請總數為536項，自2016年以來年複合增長率達到44%[1]。

香港是大灣區內最具國際競爭力的經濟體之一，備有世界級的大學、雄厚的科研能力、穩固的國際商業基礎、高競爭力的金融服務，以及健全的法律和知識產權制度。在發展大灣區成為國際創新科技中心的進程中，香港有望進一步發展成為國際研發中心，吸引世界一流的人才和資源到這地區進行創新，推動粵港澳大灣區經濟協同發展，發揮三地互補的優勢。

中央政府在2019年制定的《粵港澳大灣區發展規劃綱要》（《規劃綱要》）明確支持香港培育科技創新和發展新興產業[2–5]。《規劃綱要》確定生物醫學行業為大灣區新的支柱產業，並優先培育一批重大產業項目，包括生物醫藥、高端醫療診斷設備以及基因測試等。《規劃綱要》提出，支持推動優質醫療衛生資源更緊密的跨界合作，包括加強醫療衛生人才聯合培養和交流，以及發展區域醫療聯合體和區域性醫療中心。

科技產業的發展涉及前沿基礎研究、技術轉化和市場開拓。當中需要多管道的資金、鼓勵創新創業的體制和市場機制，以及培養充裕的創科人才[6]。綜觀以上關鍵因素，香港和大灣區發展成為國際生物醫學中心既面臨重大機遇，同時也充滿挑戰。

分析當前大灣區生物醫學人才庫以加強生物醫學生態發展

許多研究指出大灣區需要加強人才發展，以充分發揮其潛力。據一項調查顯示，大灣區各城市高端人才和科技人才分佈非常不均勻[7]。受國內外認可的基礎研究，是香港在創新科技方面的一大優勢，唯目前香港面對研究人員嚴重不足的問題，特別是專門研究技術轉化的人員[8]。根據2020年全球創新指數報告顯示，香港每百萬人口中約有4000名研究人員，比新加坡等小經濟體以及美國、英國等大型經濟體的研究人員比例要低[9]。

建議

在這基礎下，香港生物醫學科技發展顧問委員會收集了多方面的專業意見，包括頂尖學者、創業投資者、法律專家及業界領袖等，制定了這份詳細的報告。報告旨在檢視當前人才發展的需求和參考其他地區的模式，並就人才培育和匯聚的策略提出建議，以促進香港和大灣區發展成為國際生物醫學中心。

建議摘要如下：

在大灣區培育生物醫學技術人才

重新思考和定位生物醫學技術人才的培育計畫，包括研究生教育和博士後培訓計畫，以解決目前存在的知識和技能瓶頸，尤其是在技術轉化方面，以銜接基礎科學研究和臨床護理的應用

成立一個跨機構的平台，專門負責生物醫學技術轉化和相關人才的培育

建立公私夥伴關係以確保可持續性發展，同時讓商界的知識發揮其力量

改善醫療服務界的人力短缺問題，並定位香港為培訓中心。醫療服務提供者的培訓需要各醫療部門的通力合作，也需要訂定海外實習生的實習要求

擴大現有的培育計劃，鼓勵中小學生攻讀和從事生物醫學的專業，並加入創業精神和其風險的元素

推動知識轉移和創業文化，鼓勵研究人員將科研成果商品化，例如提供更靈活的專利擁有權的政策、外部執業法規和績效評估

吸納全球專才到大灣區發展

優化現有計劃的以達致一致性和互補性，推動整個大灣地區人才的整體發展

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SECTION 1

Cultivate Biomedical Technology Talent in GBA

SECTION 1 CULTIVATE BIOMEDICAL TECHNOLOGY TALENT IN GBA

1.1 Introduction

Cultivating talent is one of the most critical elements for advancing translational medicine and developing Hong Kong and the Greater Bay Area into a biomedical hub. With the support of the Hong Kong Government, local universities have introduced a variety of new measures to ensure the competitiveness of talent over the years, including rolling out double major degrees, evidence-based learning, and new and enhanced funding schemes as detailed below. In view of increasing demands for technology translation and coordinated mode of coaching-based training, new education paradigms have developed around the world. It is worth reviewing and evaluating these schemes as a reference for Hong Kong and the GBA. Broadly speaking, strategic academic curriculum reform, collaborative research environment, and well-aligned reward and funding systems are important elements in building a high-quality and sustainable talent pipeline. This section provides an overview of the current GBA governmental and academic offerings and examples of global best practice that targets innovation and technology or biomedical development.

1.2 Train Cohorts of Translational Scientist with Curriculum Reform

The Clinical and Translational Science Awards (CTSA) Program[1] is one of the largest programs at the National Institutes of Health (NIH) in the US, featuring a national network of medical research institutions ("hubs") working together to advance translation of research discoveries into improved patient care and to speed up the entire process.

1.2.1 Case Study: CTSA

Established in 2006 under the NIH National Center for Research Resources initially, the CTSA became transitioned to National Centre for Advancing Translational Sciences and its implementation was in full swing in 2012. The program has since produced breakthrough innovations to address system-wide problems in clinical and translational research: the design, recruitment for and conduct of clinical trials, the use of informatics to advance research and health, and the inclusion of community partners as members of the research team.

- **FUNDING SOURCE**

  Currently, the program has reached capacity at 62 centers nationwide, with a total annual budget of US$578 million in fiscal year 2020 funded by the National Center for Advancing Translational Sciences. Virtually all centers leverage this public investment to attract substantial private investment from healthcare provider networks, global pharmaceutical and medical devices companies, and investors. This provides avenue for long-term sustainability, leveraging the knowledge domain of the commercial sector in a true public-private partnership.

- **TRAINING**

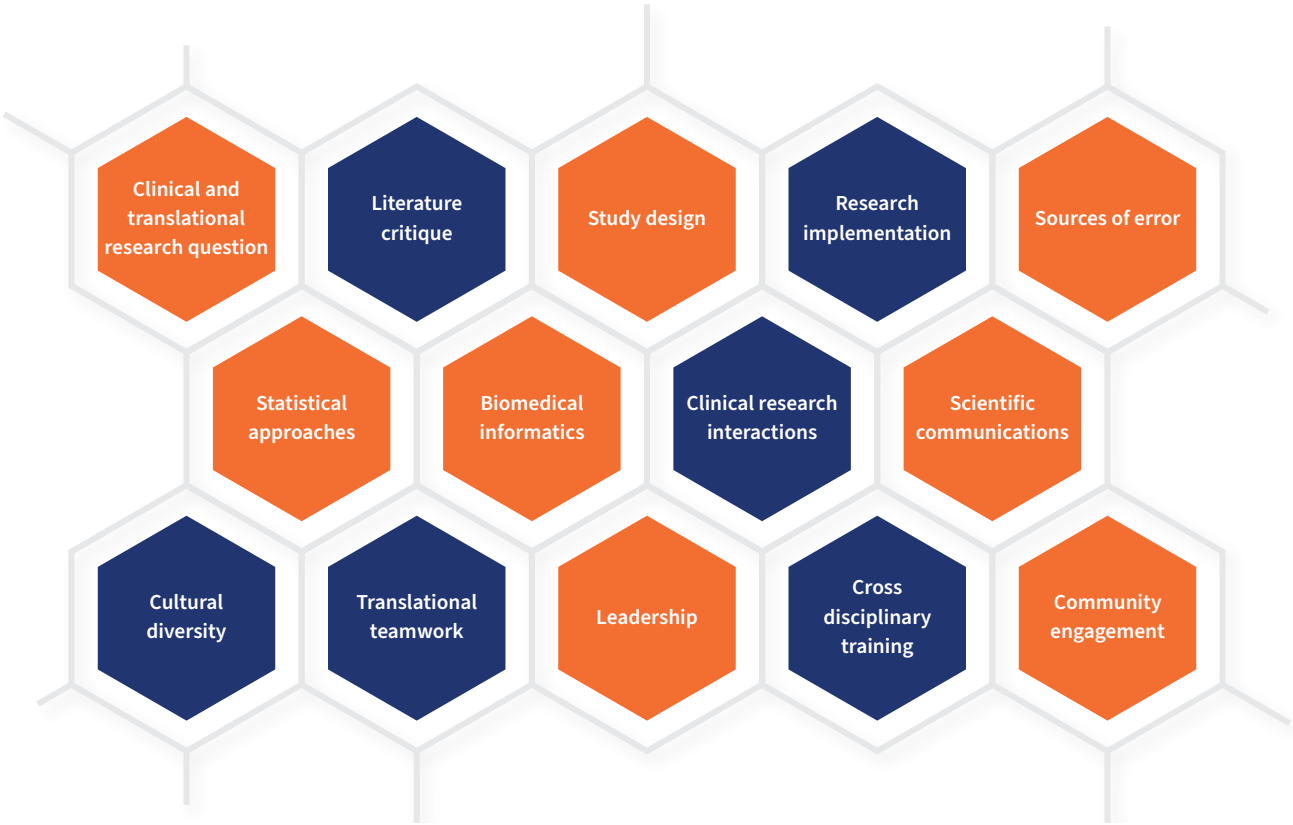
  From the start, training and cultivating the translational science workforce has been a key priority for the CTSA program. This is achieved through bringing together clinicians and scientists as an inter-disciplinary team under the guidance of experienced mentors. Since a major research-intensive comprehensive university functions as a hub for each CTSA center, an alignment of existing courses offered by various academic units (i.e., medicine, allied health, engineering, business, sciences, law, etc.) allows flexibility and efficiency to launch these training programs. An important attribute is mentorship. The KL2 and TL1 training awards have been an integral part of CTSA training programs.

The Institutional Career Development Awards (KL2) are required components of every CTSA Program hub award. This is a career development program that provides salary support and funds for protected training and research time for early career scholars (with MD, PhD or equivalent), allowing them to conduct research while being mentored by experienced investigators for up to 5 years. In the US, MD is a medical degree. In Hong Kong, MD is a different academic title. It is the highest academic degree for professionals who hold both a medical degree (MBBS) and a research doctorate degree.

The Institutional National Research Service Award (NRSA) Training Grants (TL1) are optional components of every CTSA Program hub award. The award offers pre- and post-doctoral researchers training in clinical and translational science research. This includes salary and educational support for up to 2 years for pre-doctoral research trainees. In addition to introducing trainees to various aspects of clinical and translational research through workshops and other training events, exposure to training in broad areas such as entrepreneurship, regulatory science and community-engaged research is encouraged.

To establish a more consistent approach to training, the CTSA Consortium has defined a set of 97 core competencies categorized into 14 domains for Master's degree program curricula (**Figure 1**). Certificate and PhD programs are available at individual CTSA hubs.

Figure 1. CTSA: 14 Domains of core competencies in clinical and translational research



KEY ACCOMPLISHMENTS

The KL2 awards support more than 350 scholars annually, and the TL1 awards, 500 trainees. The program has made significant contributions in accelerating the development of new therapeutics, facilitating disease-specific and child health research, and enhancing the integration of research funded by NIH institutes and centers. It has won the support from the Industry, with an externship program set up with Eli Lilly as an example.

University of Wisconsin Institute for Clinical and Translational Research (ICTR): An Exemplary Example of CTSA Training Program

The University of Wisconsin-Madison ranks high among the preeminent research institutions in the US, placing sixth in 2017 with research funding of US$1.2 billion. UW is home to the Institute for Clinical and Translational Research (ICTR)[2], one of the nation's federally awarded CTSA grantees. In addition to KL2 and TL1 career development awards, ICTR offers a graduate program in clinical investigation to effectively link bench science to clinical care. This program highlights investigations into patient populations or data, specific methods of treating patients, or the clinical tools used to provide treatments. Before enrolling into the Master or PhD program, students can start with a *Certificate in the Fundamentals of Clinical Research* as a core of foundational courses is shared. Research mentoring is another distinguished feature of ICTR training — useful training resources are available online on the Website for the UW Centre for the Improvement of Mentored Experiences in Research (www.cimerproject.org), including Mentor Training for Clinical and Translational Researchers curriculum, and three adapted versions for mentors in biomedical research, clinical and behavioral research and community engagement research.

1.3 Explore Support Model to Foster Cross-disciplinary Collaboration and Technology Translation

In tackling large-scale complex biomedical and genomic problems, broad collaboration across institutions and disciplines is necessary, and a new collaborative model of research institutes has arisen to provide researchers with extensive resources, shared facilities, and most importantly, a collaborative environment.

1.3.1 Case Study: Broad Institute

The Broad Institute represents the next-generation research institute designed to foster deep collaborations that transcend disciplinary and institutional boundaries. Founded under MIT in 2004 during the time of Human Genome Project, the Institute gradually evolved to become an independent research institute with talent pool of scientists from Harvard-University, MIT and Harvard-affiliated hospitals.[3,4] The overarching aim is to pursue fundamental changes in human healthcare by using genomics to advance the understanding of the biology and treatment of human disease. The Institute's key features are summarized in (**Figure 2**):

Figure 2. Key features of the Board Institute

In terms of the organization, there are 15 core members who have faculty appointments at MIT or Harvard and labs at "the Broad". The core members function as the Principal Investigators (PI) of the Institute, each leading a laboratory supported by a large team. There are also 300 associate members all of whom hold primary appointments at a home department in one of the partner institutions, but participate actively in one of the interdisciplinary teams. The Institute itself has professional scientific staff, operating core facilities and managing some of the interdisciplinary programs. The entire community has close to 2,000 direct employees (including labs of the associate members).

FUNDING SOURCE

The Institute has received generous endowments from the Broads and other philanthropists since its founding. In 2010, federal funding used to be the largest income source, accounting for 65% of the total income.[5] In the fiscal year 2020, the Institute's annual budget totaled US$529 million, with diversified sources of incomes generated from federal funding (35%), philanthropy (24%), industrial partnerships (20%), endowment incomes (6%) and other incomes (15%). With substantial financial resources and the ability to attract the world's top talent, the Broad Institute has been a flagship center for the genetic and molecular analysis of cancer and other common diseases. Outstanding achievements include the development of a new test for cancer early in 2007 that could detect 200 gene mutations using just one biopsy, to guide selection of the most effective treatment for an individual patient.

KEY ACCOMPLISHMENTS

Overall, cross-disciplinary research institutes provide a promising career pathway for researchers, and serve as a "magnet" to attract and retain local and overseas scientists. Institutes can also be a "magnet" for business partnership and spring broad for start-ups, thereby building up a regional biomedical hub.

The successes of the Broad Institute demonstrate that mega research institutes offer a collaborative model that works, leading many regions such as the UK, New York and Geneva to follow suit and set up their own institutes. For example, the New York Genome Centre is a multi-institutional hub for focusing on three main areas: cancer, neurodegenerative diseases and neuropsychiatric diseases.[6] The Center was founded in 2011 as a collaboration among 12 New York academic institutions, with funding from the founding institutions, philanthropic funds and local government initiatives (e.g., the New York City Economic Development Corp). Since its founding, the Centre has raised US$225 million from private grants and philanthropy funding, and close to US$100 million from government funding.[7] Currently, the Centre has grown to 20 member institutions and 9 research labs, providing genomics research facilities integrating next-generation sequencing services, bioinformatics and data management resources. Through this collaboration, scientists and clinicians from member institutions share diverse clinical and genomic expertise and data.

1.4 Foster Collaborations Among Institutions and Universities: Activities in Hong Kong and the Greater Bay Area

Similar to other OECD countries, Hong Kong also has several programs available to enhance collaborations among institutions locally and across the border, with the major funding schemes and initiatives highlighted as below. By strengthening R&D centers' links across, Hong Kong government aims to build an organic innovation system.

1.4.1 RGC Collaborative Research Schemes

The Research Grants Council (RGC) offers four existing collaborative research funding schemes, namely the Area of Excellence Scheme, Collaborative Research Fund, Theme-based Research Scheme, and Research Impact Fund.[8]

The Area of Excellence (AoE) scheme aims to support local universities to develop their strengths and nurture them into areas of international excellence. The scheme encourages collaborations to address complex problems and high-impact projects through pooling together talent from across the institutions and disciplines. Successful proposals need to involve both research and training, including a plan for the training of future research talent and a plan to transfer relevant research results to benefit education such as degree programs, course work, etc. For each AoE project, the funding of direct project cost is up to HK$60 million with a maximum project duration of 8 years.

The Collaborative Research Fund (CRF) offers the basis for initiating collaborations among researchers, targeting medium-scale, team projects of 3–5 years. The funding covers procurement of major research facilities or equipment to support collaborative research, or group research activities that operate across disciplines or institutions. The funding for each project ranges from HK$2 million to HK$10 million. For both AoE and CRF, the research topics are determined by the applicants.

The Theme-based Research Scheme aims to focus academic research efforts of universities on pre-defined themes of strategic importance to the long-term development of Hong Kong. One of the pre-defined themes is "Promoting Good Health", which includes four grand challenge topics: infectious diseases, understanding disease mechanisms to improving health, stem cells and regenerative medicine, and wellness enhancement. The funding ceiling is HK$75 million per project and the maximum project duration is 5 years.

The Research Impact Fund aims to encourage more impactful and translational research projects, and more collaborations beyond academia with stakeholders including government departments, business sector, the industry and research institutes. This is a matching fund of 70% (RGC)/30% (university or organization partners). Each successful application will receive a funding amount of up to HK$10 million.

In the 2020/21 round of the AoE Scheme, four proposals were awarded and their total budget exceeded HK$304 million with around HK$277 million to be funded by the RGC and about HK$27 million to be matched by the universities concerned.[9] As for the other schemes, totally HK$121 million was awarded for Collaborative Research Fund (and an additional HK$150 million for one-off CRF COVID-19 Research Exercises), HK$230 million for Theme-based Research Scheme (of which HK$87 million devoted for the theme of "Promoting Good Health") and HK$75 million for Research Impact Fund.

1.4.2 State Key Laboratories

The State Key Laboratory (SKL) Scheme is one of the major national science and technology development schemes managed by the Ministry of Science and Technology (MOST). They are the major innovation bases and serve as major initiatives in nurturing basic and applied technology R&D in Mainland China.[10]

In Hong Kong, Partner State Key Laboratories were established in 2007 and were recognized by MOST as R&D partners of corresponding Mainland's SKLs for their research excellence in a particular technology area. These Partner State Key Laboratories went through a vigorous admission process to demonstrate that they possessed high quality research capabilities. In 2018, Partner State Key Laboratories were renamed to State Key Laboratories, following the agreement by MOST and the Innovation and Technology Fund (ITF) on commencing joint-funded projects. This allows more flexibility to collaborate with different R&D institutions. The Innovation and Technology Commission (ITC) currently provides an annual funding of up to HK$10 million to each SKL in Hong Kong, so as to build up the necessary infrastructural support, strengthen their research capability and explore new technology areas.

There are currently 16 SKLs in Hong Kong, covering areas including emerging infectious diseases, neurosciences, translational oncology, liver research, and digestive diseases. Outstanding R&D achievements include: confirming that the plasma analysis is useful for screening early asymptomatic nasopharyngeal carcinoma and completing the first whole-genome sequencing study on Alzheimer's disease in the Chinese population, to name a few. The SKLs provide a conductive environment to foster cross-institution partnerships, e.g., SKL of Translational Oncology at CUHK is a multidisciplinary group of clinical and basic cancer researchers within CUHK and Sun Yat-sen University, and the SKL of Digestive Disease at CUHK has partnered with the Fourth Military Medical University.

The SKLs serve as the research base for attracting and retaining talent, each led by prominent experts in the field and supported by a team of research, technical and management staff. Team dynamics and mobility is further enhanced with the presence of visiting scholars and post-doctoral fellows.

1.4.3 Chinese Academy of Sciences

The Chinese Academy of Sciences (中国科学院, CAS) is the national academy for natural sciences in China. CAS holds 104 research institutes throughout China, with a staff of 71,000 people.[11] In 2018, the Hong Kong Government has signed a Memorandum of Understanding with CAS, to set up an affiliated institution in Hong Kong, with a view to facilitating its Guangzhou Institutes of Biomedicine and Health and Institute of Automation to respectively establish their presence in the research clusters on healthcare technologies and on artificial intelligence and robotics technologies at the Hong Kong Science and Technology Park.[12] The institution completed registration as a Hong Kong non-profit organization in 2020.[13] Future activities may include technology translation, research collaboration with local universities, and outreach and education activities.

1.5 Comparisons

To better understand the potential shortfall of Hong Kong's programs and what can be learned from global best practice, a topline comparison of the various programs might be worthwhile. Most of the programs in Hong Kong are PI-focused and research-based unlike CTSA and Broad Institute that are multi-institutional and highly collaborative in nature with a clear mandate in technology translation and talent cultivation through curriculum development (**Table 1A and 1B**). Also, the funding scale and the operating budget of the Hong Kong PI-based schemes are considerably less than that of CTSA and Broad Institute. This poses additional challenges for late-stage translational projects which generally require more time and funding. Under this situation, researchers will need to spend extra time to secure sufficient resources for their research. For attracting talent, funding availability is potentially an important consideration factor. A centralized framework with a clear mandate to harness and to leverage the collective knowledge base and the translational potential of these projects is also missing under the current set-up in Hong Kong.

Table 1. Research Funding Programs in Hong Kong and Overseas[14–16]

(A) Comparison of mainstream funding programs that are PI-based

	Hong Kong	Mainland China	United States
Major funding program (PI-focused)	**UGC/RGC General Research Fund (GRF)** (accounts for 71% of RGC's funding on research)	**National Natural Science Foundation of China (NSFC) — General Program 国家自然科学基金 — 面上项目** (accounts for over 60% of NSFC's funding, and supports the largest number of projects of NSFC)	**NIH Research Project Grant (R01)** (largest single category of support provided by the NIH & most common source of NIH funding for independent investigators)
Funding amount per project	Max HK$1,200,000 per project in Biology & Medicine	Life Sciences: Average RMB580,000 per project Medical Sciences: Average RMB550,000 per project	Max US$ 250,000 per year per project for Modular Budget format; can apply even higher amount based on non-modular budget format (HK$1,937,776 per year)
Project duration	2–3 years	Max 4 years	Max 5 years

(B) Comparison of funding programs for collaborative research[2,3,17,18]

	Hong Kong	Mainland China	US — CTSA	US — Broad Institute
Funding program	**ITC Midstream research program** (encourages universities to collaborate with research institutes worldwide to conduct theme-based inter-disciplinary and translational R&D work)	**National Natural Science Foundation of China (NSFC) — International (Regional) Joint Research Programs 国家自然科学基金 — 国际(地区)合作研究与交流项目** (encourages Chinese scientists to join internal cooperation to enhance the innovation capability of the country)	**NIH — Clinical and Translational Science Awards (CTSA) Program** (one of the largest programs at the NIH, featuring a network of medical research institutions working together to advance translation of research discoveries into improved patient care and speed up the entire process)	**Broad Institute** (a new-generation research institute designed to foster deep collaborations that transcend disciplinary and institutional boundaries, for tackling large-scale complex biomedical and genomic problems)
Funding amount	Max HK$5,000,000 per project	Average: RMB2,427,000 per project	NA	NA
	Annual program funding: HK$31,300,000 in 2020	Annual program funding: RMB250,000,000 in 2019	Annual budget: US$578,000,000 in FY 2020	Annual budget: US$529,000,000 in FY 2020
Project duration	3 years	5 years	KL2 (5 years) TL1 (2 years)	NA
Curriculum development	No	Yes	Yes	Yes
Clinical components	No	NA	Yes	Yes

1.6 Address the Manpower Shortage of Medical Service Providers

When discussing biomedical technology development and translation in GBA, it is imperative to include the practitioners as a critical stakeholder. Medical service providers and physician-scientists play a critical role in the biomedical ecosystem as they bridge the clinical and research domains and help accelerate the translation of basic discoveries into clinical practice. With a rapidly aging population, Hong Kong is currently facing an acute shortage of doctors.[19] Per capita doctor ratio in Hong Kong was 2.0 per 1,000 people in 2019, one of the lowest amongst OECD countries (**Figure 3**).[20,21] The latest projection by the Hong Kong Government is that the annual shortfall would be 1,610 doctors by 2030, 1,700 doctors by 2035 and 1,949 doctors by 2040.[22]

Figure 3. Total number of doctors per 1,000 inhabitants (2019 or latest available figures)[20,21]

As for allied healthcare professionals, the forecast was that by 2030 there would be a shortage of 1,669 nurses, 933 physiotherapists, 497 optometrists, 222 Chinese Medicine Practitioners, 186 occupational therapists, 127 dentists, 106 radiographers and 49 medical laboratory technologists.[23]

While the public hospitals in Hong Kong account for over 80% of all inpatient bed days for the entire population and over 90% for those aged 65 years or above, only half of the doctors are working in the public sector. The growth rate of public hospital doctors is not catching up with the upsurge in service demand and workload. As public hospitals continue to be overloaded and the 'pull factors' from the private sector increase, it is likely that the doctor shortage situation will persist or even worsen, especially in the public sector.[24]

1.6.1 Admission of Non-locally Trained Professionals

One approach to addressing this manpower shortage is to admit overseas-trained professionals. Currently, there are two routes for overseas trained doctors to apply to practice in Hong Kong:[25] (i) obtain full registration through passing the licensing examination, and, either completing a 6- to 12-month internship assessment in public hospitals, or having worked in the public healthcare segment for 3 years; (ii) register under the limited registration scheme, which specified institutions (e.g. HA, Department of Health and two local medical schools) may apply on behalf of those overseas trained doctors with proven experience and knowledge for teaching, conducting research or clinical work for a period up to 3 years.

In February 2021, the Hong Kong Government announced the plan to table a proposal to change the Medical Registration Ordinance to facilitate the return of doctors abroad and help alleviate the manpower shortage in public hospitals, while upholding the quality of healthcare services.[26] The proposal would include three main criteria for applicants under the new scheme: they must be permanent residents; graduates of recognized foreign medical schools already registered as doctors or holders of specialist qualifications outside Hong Kong; and willing to work in the Hong Kong public health care system for 5 years after obtaining their specialist qualifications. After 5 years, the doctor could obtain full registration in Hong Kong, without the need to pass the licensing exam, and would have the option to work in the private sector.

Similarly for other healthcare professionals such as dentists and nurses, measures have been put in place to increase the frequency of licensing examinations and refine the exam arrangement, e.g., allowing retaining partially pass results. There were suggestions to introduce additional measures to facilitate overseas-trained professionals to practice in Hong Kong.[23]

1.6.2 Strengthening Healthcare-related Manpower Training in HK and the GBA

As the long-term solution, there is a strong need to continuously increase the number of healthcare-related training places in Hong Kong, providing funding for universities to upgrade and increase their healthcare training capacities, as well as supporting the manpower initiatives of the Hospital Authority to retain existing healthcare professionals.[27] The Government has progressively expanded the number of annual entry of students to the two local medical schools, from 470 during 2016–2019, and further to 530 during 2019–2022,[19] yet more is needed to meet the ever-increasing service demands. It was recommended that the Government further leverage the self-financing sector to help meet part of the increasing demand for healthcare professionals (notably nurses, occupational therapists, physiotherapists, medical laboratory technologists, optometrists and radiographers) and provide the necessary support to the self-financing sector in terms of infrastructural and funding support.[23]

The *Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area* released in 2019 provides two clear directions favoring the development of Hong Kong as a training hub for medical service providers:[28]

- ***Shaping a Healthy Bay Area*** *"To step up cooperation in medical and healthcare services. To foster close cooperation in quality medical and healthcare resources, support medical and healthcare service providers from Hong Kong and Macao to set up healthcare facilities through sole proprietorship, joint-venture, cooperation, etc. in the nine PRD municipalities in accordance with regulations, and develop a regional healthcare cluster as well as regional medical centres."…"To strengthen the joint nurturing of and exchanges among medical and healthcare talents, take forward joint consultations on infectious diseases, and encourage medical and healthcare professionals from Hong Kong and Macao to visit the nine PRD municipalities for academic exchanges and short-term private practice."*

Since the release of the *Outline Development Plan*, a number of new measures have been introduced.[29] For example, under the Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA), statutory healthcare professionals who are registered to practice in Hong Kong are allowed to provide short-term services in the Mainland, without the need for going through Mainland's qualification examinations. Use of Hong Kong-registered drugs and common medical devices is allowed in designated Hong Kong-owned healthcare institutions in the GBA, specifically for Hong Kong residents working and living in the GBA to seek healthcare services.

To support medical education in the GBA, the University of Hong Kong and the Chinese University of Hong Kong are working with their counterparts in Mainland China to introduce the models of their Faculties of Medicine to the GBA in training healthcare professionals and assisting in raising the professional healthcare standards in the Mainland.[30] Under the Guangdong-Hong Kong-Macao Greater Bay Area Health Cooperation Consensus signed in 2019, health cooperation projects to be launched include the construction of the Chinese University of Hong

Kong-affiliated hospital and medical school in Shenzhen.[31] Various universities in Hong Kong will initiate collaborations with hospitals across the Guangdong Province, in providing clinical services and medical education and training. Collaborations also include training post-graduates, conducting scientific research projects and setting up new laboratories.

On the training and development of doctors in the GBA, the Hong Kong Academy of Medicine and the Hong Kong College of Family Physicians have launched systematic training and exchange programs in the GBA to facilitate understanding of and making reference to Hong Kong's established specialist training system.[32] Through exchanges including visits, lectures and short-term training programs, the health authorities in Mainland at provincial and municipal level as well as universities have been fostering cooperation in the medical field with various stakeholders in the healthcare system in Hong Kong including the Hospital Authority, Department of Health, medical schools and healthcare organizations.

1.7 Augment Funding for Talent Development in Biomedical Technology at Primary, Secondary, Tertiary and Post-grad Levels: Activities in Hong Kong and the Greater Bay Area

Education starts at a young age in fostering genuine curiosity, responsible risk taking, and technical competency. 百年树人. The Government has set a target in the 2017 Policy Address to double total R&D expenditure to approximately HK$45 billion, or from 0.73% of GDP to 1.50%, by 2022. Our neighboring economies such as Shenzhen and Singapore are aggressively investing into R&D, with an R&D spending reaching 4.0% and 2.1% of their GDP in 2015, respectively.[33] With recent influx of total research supports by all industries through various initiatives, the current R&D investment in Hong Kong has increased from 0.8% of GDP in 2015[33] to 0.92% in 2019.[34] From our fact finding, it is common that clinical researchers and clinician scientists in Hong Kong medical schools have limited protected time for research. They have to undertake multiple tasks including teaching, clinical services and research at the same time. On financial aspect, it is noted that the average pay for research positions is generally 10–15% less than that for doctors working in public hospitals. This contributes to a supply shortage of clinical research talent. There is, therefore, room to further improve local initiatives to attract talent to pursue biomedical subjects and careers. Even though these new schemes the Hong Kong government and others have implemented will need time to mature and to result in grooming future scientists and engineers. A snapshot of government funding schemes for STEM (Science, Technology, Engineering, and Mathematics) or biomedical-related education and training is presented below.

1.7.1 Sub-degree Studies

- **EDB LIFE-WIDE LEARNING GRANT**

  At the primary and secondary school levels, the Education Bureau provides a new Life-wide Learning Grant starting from the school year 2019/20, with an annual provision of HK$900 million for public sector and direct subsidy scheme schools, to support them in taking forward life-wide learning including STEM-related learning.[35] This is through organizing more out-of-classroom experiential learning activities.

- **PUBLIC EDUCATION BY NGOS**

  Non-government organizations (NGOs) play an active role in arousing awareness and interest in STEM and providing education among young people, including primary and secondary school students. For example, **Our Hong Kong Foundation** organizes the **InnoTech Expo**, an annual event to showcase China's history and progress in science and technology development.[36]

The **Hong Kong Young Academy of Sciences**,[37] a Chapter of the Hong Kong Academy of Sciences, is running a series of education programs for high-school students, including **ST Yau Prize High School Science Award** — a research-based competition that encourages students and teachers to formulate questions with quantitative precision and scientific rationales, with a view to nurturing students' passion for scientific discovery, patience in investigation, and rigor in deliberation. Another initiative is **Distinguished Master Accomplished Students Mentorship Program** with successful scientists and engineers in Hong Kong volunteering to serve as mentors to provide advice and other support to help local senior secondary students interested in science and technology to realize their potential.

The **STEM Alliance** works to strengthen STEM teaching and learning at primary and post-primary levels, including enriching students' knowledge and experience through Mainland exchange tours.[38] The Alliance also emphasizes on continuing professional development for science teachers. Given the booming biomedical technology industry in GBA, Hong Kong students will benefit if they are given more opportunities to explore and understand the development in Mainland China either through exchanges during school term, or internship or short-term visit/study tours especially around GBA.

1.7.2 Undergraduate Studies

- **STEM INTERNSHIP SCHEME**

  Launched in 2020, the ITF STEM Internship Scheme aims to encourage STEM students (undergraduates and post-graduates) to gain related work experience during their studies and to continue to pursue a career in their field after graduation.[18] HK$40 million was set aside to subsidize these short-term internships for students.

- **GREATER BAY AREA YOUTH EMPLOYMENT SCHEME**

  As a new measure announced in 2020 Policy Address, the Greater Bay Area Youth Employment Scheme encourages and supports enterprises with operations in Hong Kong and Mainland cities in the bay area to employ university graduates from Hong Kong, and station them in bay area cities to work and receive on-the-job training.[39] The scheme provides 2,000 places, around 700 of which are designated for innovation and technology posts. A total of HK$430 million will be funded for the entire scheme.

- **HKX FOUNDATION FINAL YEAR PROJECT ACCELERATING PROGRAM**

  HKX Foundation is an NGO that supports the building of I&T start-up ecosystem in Hong Kong, including supporting local young entrepreneurs. Their Final Year Project Accelerating Program provides funding and coaching for selected undergraduate Final Year Projects to support the execution and enhancement of the research projects.[40]

1.7.3 Post-graduate Studies

- **UGC TARGETED TAUGHT POSTGRADUATE PROGRAMMES FELLOWSHIPS SCHEME**

  This is a pilot program under the University Grants Committee (UGC), with the primary goal to attract more meritorious local students to pursue postgraduate studies in priority areas conducive to the development of Hong Kong including STEM and promoting good health.[41] As subsidy of tuition fees for fellowship students, a funding of HK$60 million is allocated for 2020/21.

- **HK PHD FELLOWSHIP SCHEME**

  Established by the RGC, the Hong Kong PhD Fellowship Scheme aims at attracting top-notch students in the world to pursue their PhD studies in Hong Kong's universities.[42] The Fellowship provides an annual stipend and a conference and research-related travel allowance. A total of 300 PhD Fellowships will be awarded in the 2021/22 academic year, involving a funding of HK$99.8 million.

1.7.4 Faculty Career Development

- **EARLY CAREER SCHEME**

  The RGC scheme intends to nurture the development of junior academics by supporting the research projects at the beginning of their academic career.[8] A total of HK$107.8 million was awarded in 2019/20.

- **FACULTY DEVELOPMENT SCHEME**

  The Faculty Development Scheme, also provided by RGC, aims to develop research capability of individual academic staff in the institutions so that they can transfer their research experiences and new knowledge into teaching and learning.[8] HK$44.5 million was awarded in 2019/20.

- **POSTDOCTORAL FELLOWSHIP SCHEME, RESEARCH FELLOW SCHEME AND SENIOR RESEARCH FELLOW SCHEME**

  The RGC launched three new regular fellowship schemes in 2019, with a funding of HK$190 million allocated annually.[43] The Postdoctoral Fellowship Scheme intends to encourage and supports doctoral graduates early in their careers to pursue research, whereas the two RGC research fellow schemes provide sustained support and relief from teaching and administrative duties for exceptionally outstanding academics at their early/mid-career stages. Each year, 50 post-doctoral fellows, 10 senior research fellows (full Professor rank) and 10 research fellows (Associate Professor rank) will be awarded.

1.7.5 On-the-job Training

- **ITB RESEARCH TALENT HUB**

  This scheme aims to provide funding support for organizations/companies undertaking R&D projects funded by the ITF to engage research talent to conduct R&D work.[18] Each ITF project can engage up to 4 research talent at any one time. Totally HK$331.8 million was awarded in 2019.

1.8 Reform Institutional Reward System to Encourage Entrepreneurship

Universities across the world promote knowledge transfer to commercialize viable discoveries and inventions to bring real tangible benefits to society. However, a part of the innovation and entrepreneurial journey is to embrace and learn from unexpected outcome (i.e., failure). Reforming the institutional reward system to encourage and support faculty to pursue entrepreneurial activities is key to driving knowledge transfer and realizing the potential benefits to society. Our Hong Kong Foundation has carried out a comprehensive review on this topic, with the current best practices and key recommendations summarized below:[44]

1.8.1 Recognizing Knowledge Transfer Activities as Part of Universities' Achievements

Incorporating knowledge transfer into the metrics of university assessment commensurate with increased funding is recommended to tap the universities' full entrepreneurial potential. Remarkably, universities in the UK outperform their international counterparts in commercializing their research for each dollar invested in research. Under the assessment framework in the UK, knowledge transfer efforts (the Knowledge Exchange Framework) are regarded as part of university's research impacts, covering activities ranging from research partnerships to IP and commercialization, and public and community engagement. Specifically for the Hong Kong system, it was recommended to revise the key performance indicators (KPI) of the universities in consultation with stakeholders to measure knowledge transfer activities, e.g., including the number of start-ups and social enterprises established by each university annually.

1.8.2 Favorable Patent Ownership and Licensing Policies, and Outside Practice Regulations

Many overseas institutions offer generous IP and licensing terms that drive innovation and knowledge transfer. For example, at the University of Cambridge and the University of Toronto, patents that are owned/co-owned by the university in the creation stage can be transferred back to inventors to assume full ownership in the filing stage if independently commercialized. Regarding the licensing revenue sharing, the University of Waterloo and University of Cambridge allow inventors to receive major share of their revenue of up to 75–100%. Beyond financial incentives, professors in most US research-intensive universities including MIT are also entitled to full autonomy over the hours they spend on outside professional activities, and staff members are only obligated to report the nature of their professional activities to avoid conflicts of interest.

1.8.3 Co-Investment with Industry Partners/Investors in University Spin-off Companies

Technology Start-up Support Scheme for Universities (TSSSU) provides funding critical for early-stage spin-offs. As a best practice, integration of TSSSU with private incubator programs allows start-ups to leverage the mentorship resources and comprehensive support provided by these incubators to maximize their chance to succeed. There were suggestions to scale-up the TSSSU by matching with private funding. A two-phase funding mechanism was proposed — with the first phase to provide a condition-free grant for verifying technical feasibility and developing prototypes, and the second phase to require start-ups to seek funding from private investors or collaborate with industry partners to further develop the commercial viability of the start-up.

1.9 Conclusion

Talent development is at the heart of an innovation-driven economy. Enhancing the academic curriculum is necessary to develop quality biomedical technology talents that are in high demand. Removing barriers is vital to create a healthy, self-sustaining entrepreneurial ecosystem. It is also important to create a culture of collaborations, and drive synergies and opportunities across the GBA to enable researchers to continue to thrive and evolve. It is worthwhile noting that most of the current Hong Kong programs are PI-focused unlike CTSA and Broad Institute that are multi-institutional in nature. A strong public-private-partnership model with a clear mandate in technology translation and talent cultivation through

curriculum development is needed. In preparing talent to be market-ready, technical skills, translational skills and business skills are all key pillars of training programs. Longer duration and larger amount for translational projects research funding would be more effective. Cohesive coaching-based training, and aligned reward system for individual researchers to embark on entrepreneurial activities will sustain the whole ecosystem for years to come. Additional protected time for clinical and basic researchers to work on translational research with enhanced financial incentives would enable a sustained supply of translational and clinical researchers.

Key Recommendations: Cultivate Biomedical Technology Talent in GBA

- **Address current knowledge and skills gaps in biomedical research workforce, especially in technology translation to bridge bench science and clinical care, by rethinking graduate education and post-doctoral training programs**
- **Establish a cross-institutional entity with a clear mandate in biomedical technology translation and talent cultivation in translational sciences**
- **Establish public-private partnership to ensure long-term sustainability while leveraging the knowledge domain of the commercial sector**
- **Mitigate the manpower shortage in medical service providers and position Hong Kong as a training hub. Training of medical service providers requires cooperation from the medical sector and also internship requirement for foreign trainees**
- **Scale up initiatives to encourage primary and secondary students to pursue biomedical subjects and careers with an emphasis on entrepreneurship and understanding risks**
- **Encourage a cultural change and facilitate the structured progression of researchers in the area of entrepreneurship, e.g., by providing more flexible policies on patent ownership, outside practice regulations and performance evaluations, etc.**

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SECTION 2

Attract International Talent to GBA

SECTION 2 ATTRACT INTERNATIONAL TALENT TO GBA

2.1 Introduction

In IMD 2020 World Talent Ranking,[1] Hong Kong ranks 18th in the "Appeal Factor" which assesses the extent to which an economy retains homegrown talent along with drawing talent from the international pool. In the global race for talent, the Hong Kong Government has increased investment and introduced new talent admission schemes to attract more talent and professionals to work and settle in Hong Kong. Similarly, neighboring GBA cities have been offering favorable incentive schemes and living benefits packages. This section reviews the key initiatives of Hong Kong and of GBA cities in attracting local and foreign talent. It is worth noting that most of these schemes are new and would need time to mature and to result in attracting needed talents.

2.2 Hong Kong's Initiatives

2.2.1 InnoHK

The InnoHK is a major initiative of the Hong Kong Government intended to attract world-leading research institutions to conduct collaborative research in Hong Kong. The Government has provided funding of $10 billion to establish two innovative clusters in the Hong Kong Science Park, namely "Health@InnoHK" focusing on healthcare technologies and "AIR@InnoHK" focusing on artificial intelligence and robotics technologies.[2,3] The two clusters will pool together top-notch researchers locally and from overseas to carry out collaborative research, in areas that Hong Kong has strength and potential in its pursuit of innovation and technology. Collaboration is one key feature, as renowned research institutes overseas team up with local academic partners to form international joint research centers in Hong Kong, focusing on cutting-edge research and application development of technologies along the themes of the two clusters. Early planning in adoption and commercialization of these promising technologies mostly through the formation of spin-off companies is key to realizing the benefits and contributions to the society and economy. Urgent outstanding issues to address include the sustainability of the Centers beyond the 5-year funding period, the resolution of cost and profit sharing model amongst PI, local and foreign institutions, PI management strategy, and the sustained active engagement and institutional commitment of the overseas institutions.

2.2.2 Global STEM Professorship Scheme

The 2020 Policy Address proposed the launching of a Global STEM Professorship Scheme at an estimated cost of HK$2 billion.[4,5] The scheme primarily aims to support local universities in recruiting internationally renowned I&T scholars and their teams to work in Hong Kong by providing more competitive remuneration package. Up to 100 professorships can be awarded in 5 years. In addition to internationally renowned scholars, the scheme also covers outstanding and promising junior scholars. Research teams who work for the scholars can receive subsidy for at most 3 years.

2.2.3 Technology Talent Admission Scheme and Other Immigration Schemes

The Hong Kong Government has put in place immigration schemes to meet the needs of different professionals, as presented in **Table 2**.[6] In 2018, the ITC launched the Technology Talent Admission Scheme (TecTAS), which provides a fast-track route for admitting overseas and Mainland technology talent to undertake R&D work in Hong Kong. TecTAS is a 3-year pilot scheme. Talent enrolling in this scheme came from the Mainland, Taiwan, the United States, South Korea, Malaysia, etc.[7] The scheme was further enhanced in 2020, with the applicable technology areas expanded from 7 to 13 and the coverage to all companies undertaking R&D activities in Hong Kong.

TABLE 2. KEY FEATURES OF TALENT ADMISSION SCHEMES IN HONG KONG

Talent admission scheme (Standard processing time)	Eligibility criteria
Technology Talent Admission Scheme, TecTAS (2 weeks)	• Target: Overseas and Mainland technology talent • Employing company/institute must apply for quota from the ITC to admit the talent
Quality Migrant Admission Scheme, QMAS (≥6 months)	• Target: Highly skilled or talented persons from overseas and the Mainland; annual quota: 1,000 • Attainment of minimum passing mark scored according to academic/ professional qualifications, work experience, age and family background, attainment of renowned achievements etc; job offer not required
General Employment Policy, GEP (4 weeks)	• Target: Overseas talent and professionals from places other than mainland • Possession of special skills, knowledge or experience not readily available locally; job offer required before entry to Hong Kong
Admission Scheme for Mainland Talent and Professionals, ASMTP (4 weeks)	• Mainland talent and professionals • Eligibility criteria are same as those for General Employment Policy

These programs are relatively nascent where short to long-term impacts are yet to be demonstrated. However, it is worthwhile to note that similar schemes in the Mainland had met with mixed long-term outcome.

2.3 Greater Bay Area's Initiatives

In Greater Bay Area, there are multiple schemes available nation-wide, province-wide and city-wide to attract talent at home and abroad, with varied amounts of funding provided.

2.3.1 National Level

CHEUNG KONG SCHOLAR PROGRAM 长江学者奖励计划

The Cheung Kong Scholar (also known as Changjiang Scholar or Yangtze River Scholar) is a national program jointly sponsored by the Ministry of Education and Li Ka Shing Foundation in 1998. It is considered one of the highest academic honors for individuals in China. The aim is "further improve China's standard of education and intellectual competitiveness through the training of the country's best and brightest young minds." The program entails:[8]

- *Cheung Kong Scholar Special-term Professorship Scheme and Chair Professorship Scheme*, funding the appointment of 150 Special-term Professors each year with an annual stipend of RMB200,000 for 5 years each; and appointment of 50 Chair Professors each with a monthly stipend of RMB30,000 for 3 years.
- *Cheung Kong Achievement Award*, which gives recognition to academics who have made an outstanding achievement in their field of research. Winners of First Prizes are awarded RMB1 million each. A Young Scholar Section was also added in 2015.

The Program has attracted a large group of overseas Chinese to return to the Mainland to work in academic and research positions. As of 2017, a total of 2,051 Special-term Professors, 897 Chair Professors and 440 Young Scholars were awarded.[8] Beginning in 2005, the Programme has been expanded beyond the Mainland to cover tertiary institutions in Hong Kong and Macau. There were discussions of cancelling the program due to concerns of creating vicious competitions between institutions in mainland China.[9]

NATIONAL SCIENCE FUND FOR DISTINGUISHED YOUNG SCHOLARS 国家自然科学基金优秀青年科学基金项目

Launched in 2012[10], the National Natural Science Foundation of China (NSFS) Excellent Young Scientist Scheme supports young academics who have obtained promising achievements in basic research, to focus on areas of their choice and carry on innovative research. It aims to accelerate development of young talent in science and technology and eventually to nurture a group of outstanding academics of international standards.[11,12] Starting from 2019, the scheme is open for application from academics in Hong Kong and Macau institutions. Applicants need to be full-time academic staff aged below 38 for men and that below 40 for women. Funding limit is RMB1.6 million (direct cost) for 3 years. As of 2018, totally 2,795 applications were granted.[13]

2.3.2 Provincial Level

GUANGDONG NATURAL SCIENCE FOUNDATION 广东省自然科学基金

The Guangdong Natural Science Foundation was first founded by the Guangdong Province in 1987, and became a joint fund with National Natural Science Foundation of China since 2006.[14] There are two funding schemes under Guangdong Natural Science Foundation, namely the General Program and Distinguished Young Scholars Fund. The schemes aim to support academics and direct national research efforts to address key research questions of particular social and economic impacts to Guangdong. Funding limit for General Program is RMB0.1 million for 3 years and that for Outstanding Youth Fund, RMB1 million for 4 years.[15] The schemes are open for direct application from academics in Hong Kong and Macau. In 2019, for the General Program a total of 1,651 applications involving funding of RMB165 million were approved; for the Distinguished Young Scholars Fund, a total of 65 applications and funding of RMB65 million, approved.[16,17]

GUANGDONG SUPERIOR TALENT CARD 广东省人才优粤卡

Since 2018, the Guangdong Province has piloted "Guangdong Superior Talent Card" program to attract high-caliber academics and professionals to settle in the province, allowing card holders, their spouses and children to register as permanent residents of the city, and enjoy the same living benefits as local residents, including access to public services in housing, education, social insurance, car-purchasing and professional qualification assessment, etc.[18,19] There are two types of Superior Talent Cards, A card and B card. Holders of A card are top-notch talent and are not required to hold Chinese nationality. They are entitled to extra privileges in medical care and transportation services. The program is open for application from Hong Kong, Macau and Taiwan talent.

2.3.3 City Level

The cities in GBA have been offering generous cash incentive to attract talent.[6,20] **Table 3** below summarizes related schemes in the GBA cities that intend to develop biomedical technology among other high-tech industries. In addition to cash incentives, other funding supports including rental subsidy or home purchase allowance at a total value of RMB0.1–1 million are provided for each eligible talent.

To highlight, the 'Peacock Talent Project' in Shenzhen was launched in 2011 to bring in international high-tech experts and research teams, including those working in biomedicine. The amount of subsidy is tiered, with RMB3 million awarded for each Class A talent, RMB2 million for Class B talent and RMB1.6 million for Class C talent. There are additional subsidies covering the spouse's employment expenses, education expenses for children, residence permits of both the beneficiary and dependents, medical care, social insurance, and tax. For each research team, the government provides funding up to RMB100 million.

TABLE 3. TALENT ATTRACTION SCHEMES IN SELECTED GBA CITIES

City	Launch year	Cash incentive	Target no. of awards
Guangzhou (Kapok Plan 红棉计划)[21,22]	2012	Overseas talent: 1) Individual incentive: start-up funding of up to RMB2 million for innovative entrepreneurship projects	No more than 30 overseas talents per year
Shenzhen (Peacock Plan 孔雀计划)[23]	2010	Top-notch foreign talent: 1) Individual incentive: cash subsidy of up to RMB3 million 2) Research funding for the team: RMB100 million for the team	More than 1,000 top-notch foreign talents and 50 research teams led by the talent in 5 years
Huizhou (Swan Talent Program 天鹅计划)[24]	2013	Leading talent: 1) Individual incentive: working expense subsidy of up to RMB1 million 2) Research funding for the team: up to RMB10 million for the team by phases	Approximately 100 leading talents and 30 teams in 5 years
Zhaoqing[25]	2016	Innovation team: 1) Research funding for the team: start-up fund of RMB10 million.	Approximately 100 innovation leaders and 20 teams in 5 years

2.4 Conclusion

As the global competition for talent intensifies, it is important to adopt appropriate measures to attract the needed talent, taking into account the key factors that impact the talent's motivation to work and stay in one place. There are multiple schemes with different selection criteria and packages, pointing to the need for a coordinated approach and standardized package to ensure optimal distribution of talent. It is worth noting that apparent overlapping scope administered by different local and national bureaus have created mixed reactions and in some cases, unnecessary competition among GBA cities. Better alignment and complementarity are needed to drive for a holistic and even development of talent across the GBA region.

Key Recommendation: Attract International Talent to GBA

- **Improve alignment and complementarity of existing schemes to drive a holistic and even development of talent across the GBA region**

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SECTION 3

Recommendations

SECTION 3 RECOMMENDATIONS

Cultivate Biomedical Technology Talent in GBA

Train Cohorts of Translational Scientists with Curriculum Reform

- Address current knowledge and skills gaps in biomedical research workforce, especially in technology translation to bridge bench science and clinical care
- Offer dedicated professional development programs to support the individual development and teaming up of research scientists and clinician scientists
- Adopt coaching-based training which is widely considered to be beneficial for researchers throughout their careers
- Establish a public-private partnership institute with a clear mandate in technology translation and talent cultivation
- Consider more joint degrees or dual-degree programs combining basic life sciences with business and regulatory sciences to develop well-rounded talent for future industry growth
- Provide more opportunities for biomedical students to explore and understand the development in Mainland China, either through exchanges during school terms, or internship or short-term visit/study tours especially around GBA

Explore Support Model to Foster Cross-disciplinary Collaboration and Technology Translation

- Shift from a PI-focused to multi-institutional approach
- Establish a cross-institutional entity with a clear mandate in biomedical technology translation and talent cultivation in translational sciences
- Consider longer duration for translational projects research funding and provide a special category with higher upper limit for attracting top international talent
- Foster collaborations by creating an incentive framework for universities and businesses to promote mobility of ideas and people across the sectors

Establish Public-private Partnership to Ensure Long-term Sustainability While Leveraging the Knowledge Domain of the Commercial Sector

Mitigate the Manpower Shortage of Medical Service Providers

- Review procedures in place for overseas-trained professionals and introduce greater flexibility to attract foreign-trained talent
- Strengthen resources for healthcare manpower training, including increasing the number of healthcare training places in Hong Kong

Position Hong Kong as a Training Hub for Medical Service Providers

Augment the Funding for Talent Development in Biomedical Technology at Primary, Secondary, Tertiary and Post-grad Levels

- Scale up initiatives to encourage primary and secondary students to pursue biomedical subjects and careers with an emphasis on entrepreneurship and understanding risks
- Launch new internships and training programs, in partnership with industry

Reform Institutional Reward System to Encourage Entrepreneurship

- Encourage commercialization of publicly-funded research
- Develop new impact metrics for commercialization of publicly funded research as universities' reward system, including applied research, industrial collaboration and activities
- Encourage a cultural change and facilitate the structured progression of researchers in the area of entrepreneurship, e.g., by providing more flexible policies on patent ownership, outside practice regulations and performance evaluations, etc.
- Additional protected time for clinical and basic researchers to work on translational research with enhanced financial incentives would enable a sustained supply of translational and clinical researchers.

Attract International Talent to GBA

Improve Alignment and Complementarity of Existing Schemes to Drive for a Holistic and Even Development of Talent Across the GBA Region

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About the HKBDAP

The Hong Kong BioMedical Technology Development Advisory Panel (HKBDAP) comprises a multidisciplinary group of professionals dedicated to establishing Hong Kong as an international innovation hub by establishing and strengthening a vibrant biomedical technology ecosystem. The Panel held its inaugural meeting in September 2020 and includes leading academics, venture capitalists, legal experts and industry leaders. The Panel's mission is to provide thought leadership and advocacy for technology development, adoption, and integration to improve health outcomes.

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