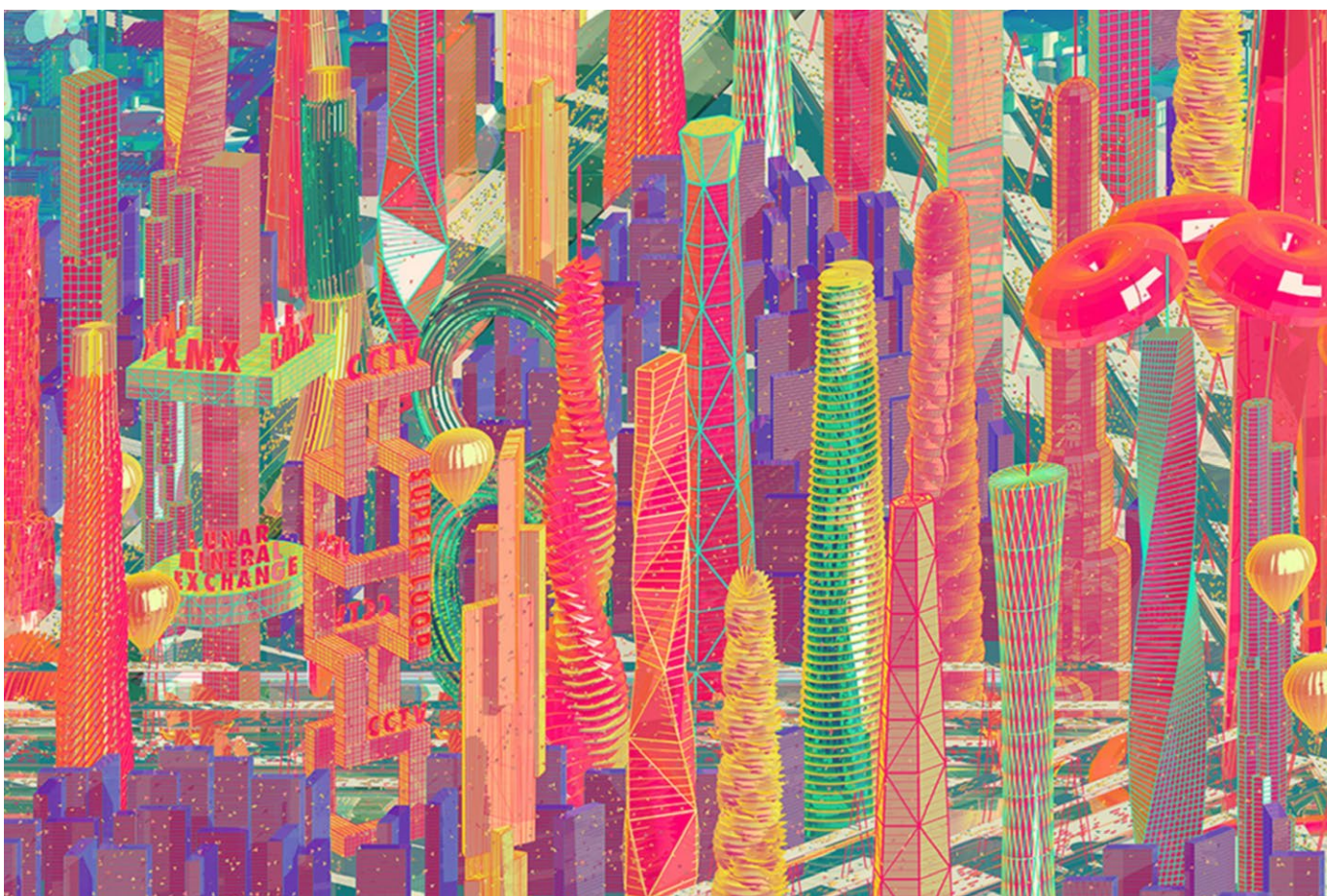
HEALTHCARE & LIFE SCIENCES REVIEW

PHARMA BOARDROOM

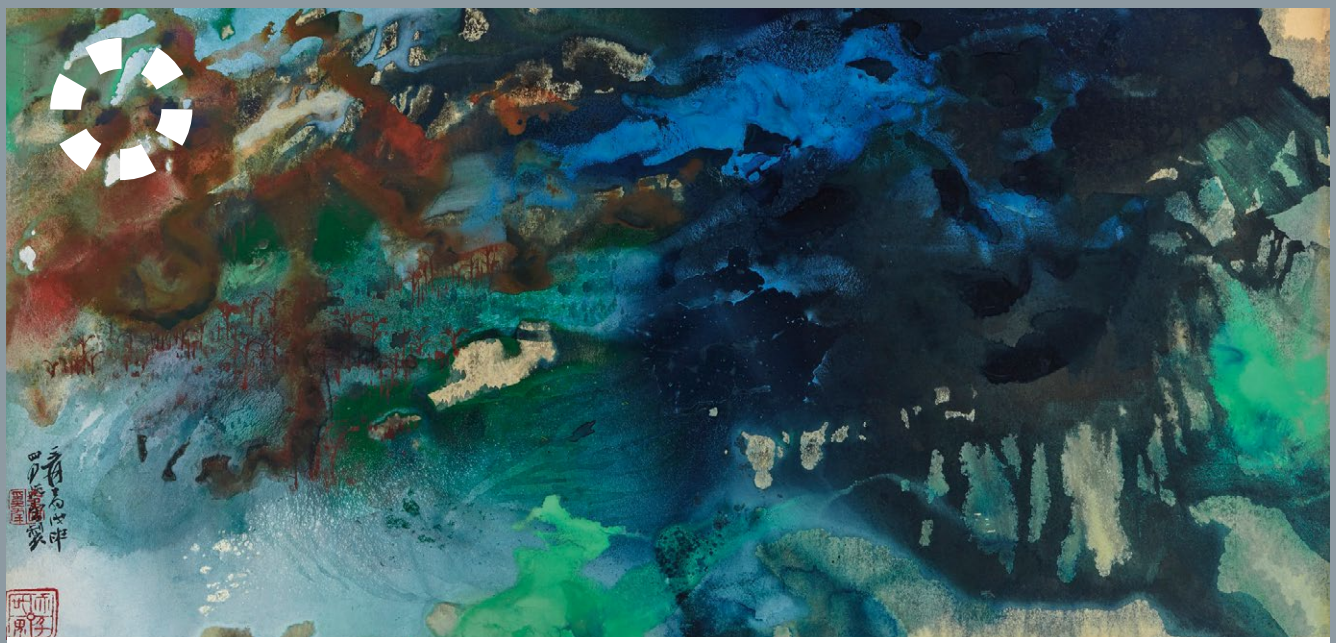


FROM FACTORY FLOOR TO SILICON DELTA

GREATER BAY AREA

GUANGDONG - HONG KONG - MACAO

OCTOBER 2018



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Dr. Harley Seyedin, President, American Chamber of Commerce South China

for their continuous support, enthusiasm and encouragement in the compilation of this report.

PHARMA BOARDROOM

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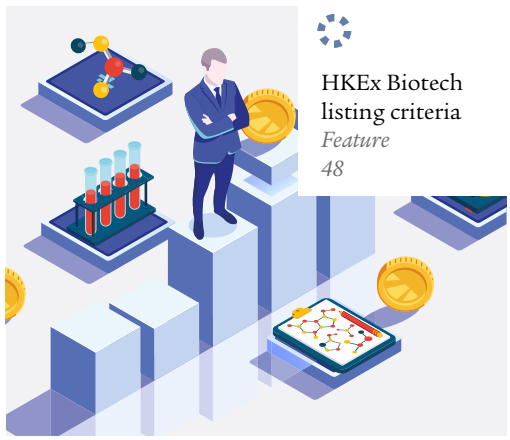
— October 2018



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As the President of the Shenzhen Life Science and Biotechnology Association, I am proud to introduce the 2018 edition of the Guangdong-Hong Kong-Macao Greater Bay Area Healthcare and Life Sciences Review, which I consider an excellent opportunity to showcase the excellent opportunities and growth potential of the healthcare and life sciences sectors in this region.

The healthcare and life sciences sector has been designated as a key strategic industry not only by the central government but also by the Shenzhen government, who sees it as a critical driver of the city's growth and prosperity. This is very understandable, given that the industry represents CNY 200 billion (USD 31.45 billion) and has been experiencing annual growth of 20 percent in recent years. With the launch of the Guangdong-Hong Kong-Macao Greater Bay Area strategy by the Chinese government, Shenzhen will undoubtedly be the innovation heart of the region in the healthcare and life sciences sectors.

The Shenzhen Life Science and Biotechnology Association is committed to the development and progress of the Shenzhen ecosystem, having offered a wide variety of services to government, healthcare providers and institutions, academic institutions and industry since our establishment in 2012. Our ultimate goal is to act as a partner for the long-term growth and development of the industry in Shenzhen. With over 160 members and growing steadily, including leading industry players, hospitals, and academic and research institutions, we will continue to collaborate with public and other private stakeholders to position ourselves as one of the most innovative regions in the world.

The healthcare and life sciences sectors are highly complex and technical industries. Shenzhen is still a relatively young city with huge potential, huge talent and huge dreams. I am fully confident that the industry in Shenzhen - as well as the Greater Bay Area - will continue to advance to play a critical role in addressing healthcare needs, innovating new technologies, and promoting better quality of life for people in the region and beyond.

I therefore invite you to find out more about Shenzhen and the Greater Bay Area through this publication, and also to visit Shenzhen personally to discover the abundant opportunities within this vibrant and dynamic city.

Yuan Qing
President
Shenzhen Life Science and Biotechnology Association

As Chairman of Hong Kong Biotechnology Organization (HKBIO), it is my pleasure to introduce the 2018 Greater Bay Area Healthcare and Life Sciences Review.

The biotech industry in Hong Kong and China are booming, with priorities to foster leadership and partnering networks as well as knowledge, and be seen as a worldwide platform for the development of leading-edge products and services in all fields related to biotechnology. In proximity to China, Hong Kong is suitably located as a regional headquarters for overseas companies looking to capitalize on the growth of the region. Meanwhile, companies from China use it as a bridge to connect with the West.

Recognized for its scientific excellence, Hong Kong universities produce more than 200 biomedical publications every year and are actively involved in large-scale genomics research and studies of emerging infectious diseases. Hong Kong stands as an international player bringing together domestic and foreign life science innovators to improve the quality of healthcare for the people in Asia and the rest of the world. Effectively, Hong Kong creates an ecosystem that builds upon its strengths to foster yet more innovation.

The report's launch coincides with the Hong Kong Biotech Horizons 2018: Annual Global Biotech Summit, which hopes to promote the overall biotech scene in the region, and connect professionals from across industries, in order to create a diverse network that can further development and innovation in the biotech industry.

The following report, with its comprehensive study, invites industry stakeholders to understand the challenges and opportunities within the extraordinary Greater Bay Area. With this Healthcare & Life Science Review, I invite all members to learn more about the evolvement of the biotech sector in the region and especially to learn about the entire region's immense contribution to the global advancement of life sciences sector.

Albert Cheung – Hoi YU, PhD, J.P.
Chairman
HKBIO

JOIN THE CONVERSATION

Greater Bay Area

Additional full-feature interviews from our GBA 2018 Report can be accessed on PharmaBoardroom, the premier website for C-Level executives, consultants and state actors in the pharmaceuticals and life sciences sector, alongside hundreds of exclusive interviews featuring the main movers and shakers of the industry, free country reports and sector insights supplemented by the latest news from global markets.

AMPLIFIED CONTENT

XIE YUEHUI
Chairman, LifeTech Scientific, China

SIMON YAM
MD, Geodis Greater China

ALEX WANG YIMIN
CEO, SONTU Medical Imaging, China

DAVID PENG
CEO, Medical Excellence International, China

IN BRIEF

@pharmaboardroom

Ostrich antibodies: A health and beauty elixir - we spoke to Japanese #biotech Maz World about their ground-breaking use of ostrich antibodies for the treatment of rare diseases, weight loss and skin care. #Japan #HongKong #weightloss #skincare #hcsm

Read the article

@pharmaboardroom

Prof Justin Wu, chief operating officer @CUHKofficial, talks about the challenges of merging traditional Chinese medicine with Western medicine and Hong Kong as a new hub of #Biotechnology

Read the interview

@pharmaboardroom

One ring to track your sleep... We spoke to Lady of the Rings, Lydia Leung - CEO of the startup, Belun Technology about their magical sleep tracking ring and her hopes for #AI in #healthcare @hktdc #HongKong #medtwitter #MEDTECH #pharma18 #HealthTech

Read the article

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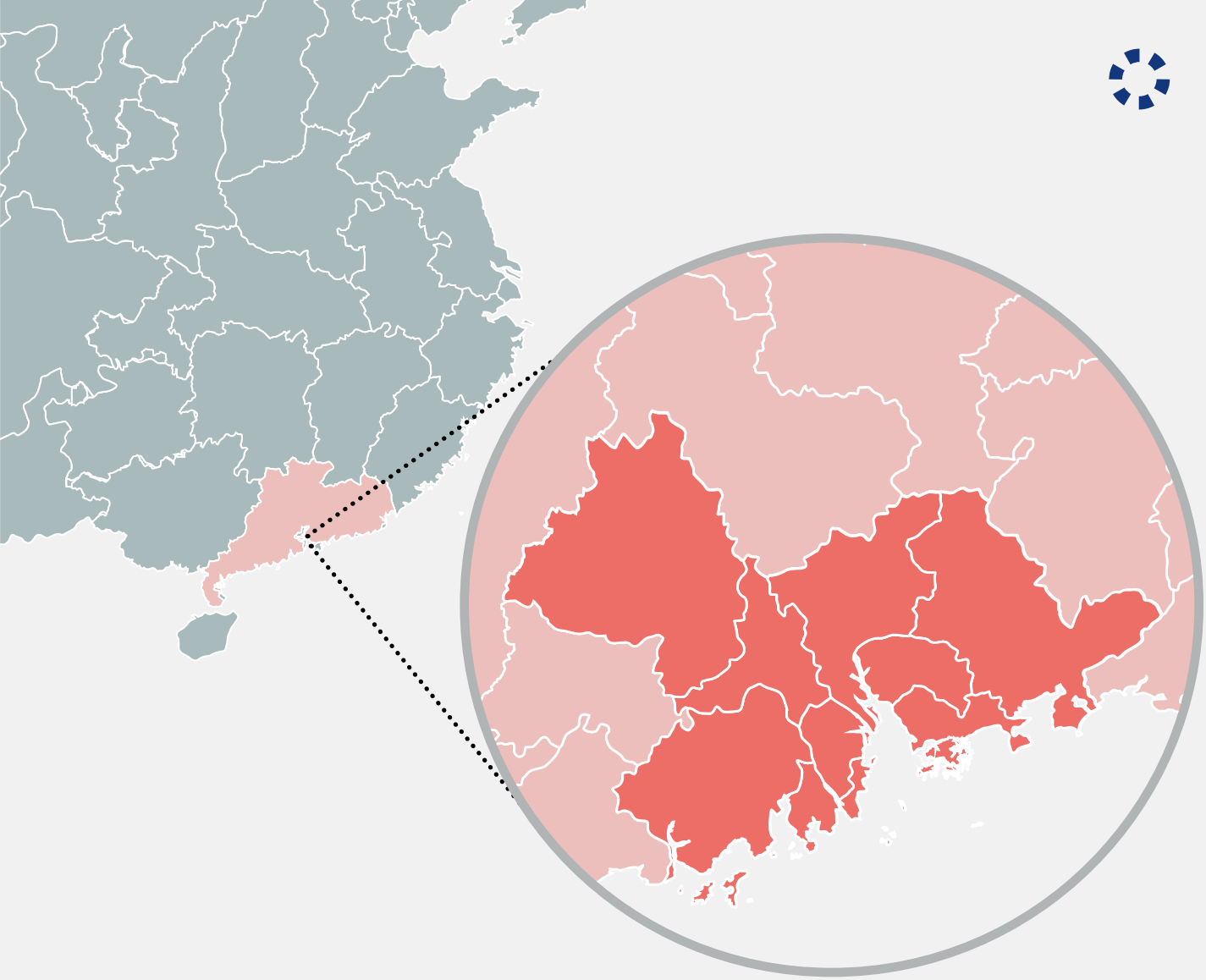
China's Vaccine Crisis

Read the article



Preface

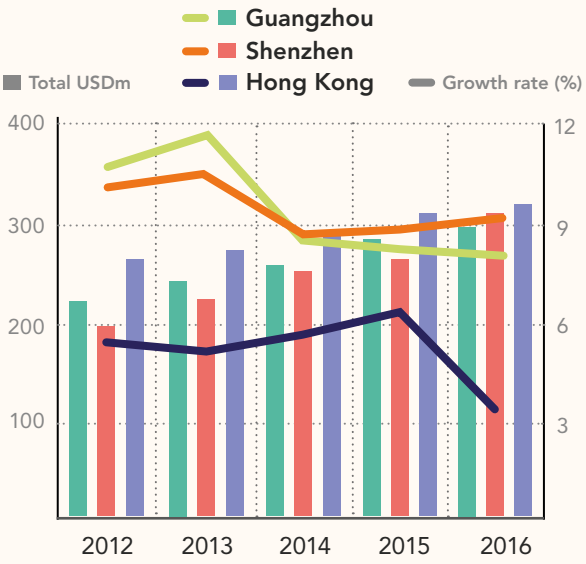
In 2013, Chinese President Xi Jinping launched the Guangdong-Hong Kong-Macao Greater Bay Area initiative, corralling the two Special Administrative Regions (SARs) of Hong Kong and Macao with Guangdong, one of the richest province of China's 34 provinces. While the official government blueprint was due to be unveiled in mid-2018, escalating tensions from the US-China trade war has delayed it indefinitely for fear of courting additional tariffs, leaving all stakeholders in the dark about the Chinese government's concrete plans for the region.

For the sheer potential of the region, recognized by the World Bank as the largest mega-city in the world with 67 million residents, is matched only by the Sisyphean task of integrating the different cities and systems, which must happen if ideology is to be translated into impact.

Already the moniker 'Greater Bay Area' begs comparisons to the original San Francisco Bay Area, today the mecca of tech innovation, and behind the Great Chinese Firewall lies Chinese facsimiles of virtually all the digital accessories of modern life: Tencent as Chinese Facebook, Huawei as Chinese Apple, WeChat as Chinese WhatsApp, Didi as Chinese Uber, and so on. When it comes to healthcare innovation, the Greater Bay Area seems to possess the same core components as "the original" Bay Area: high-tech IT sectors, electronics hardware capabilities, riotous VC activity, vibrant academic and basic science research, favorable government policy, and a huge market.

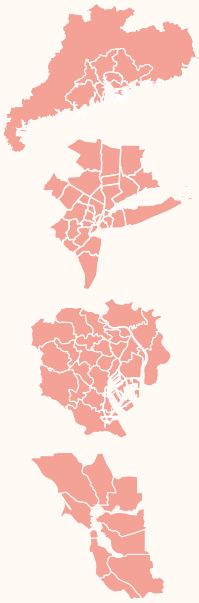
Just as in 1978, Chinese leader Deng Xiaoping launched China's modern-day opening up with the unveiling of 'Socialism with Chinese characteristics', among other things establishing the first Special Economic Zones to spur trade - starting, in fact, with Shenzhen and Zhuhai. Four decades later, is Chinese President Xi's Greater Bay Area initiative the genesis of a new flagship model, 'Innovation with Chinese characteristics', or simply a Chinese knock-off of yet another American model?

THE BIG 3 IN GDP



Source: SCMP (South China Morning Post)

WORLD'S MAJOR BAY AREAS



GUANGDONG - HONG KONG - MACAO GREATER BAY AREA
POPULATION (million) 66
GDP (USD trillion) 2.0

NEW YORK METROPOLITAN AREA
POPULATION (million) 24
GDP (USD trillion) 1.3

GREATER TOKYO AREA
POPULATION (million) 38
GDP (USD trillion) 1.8

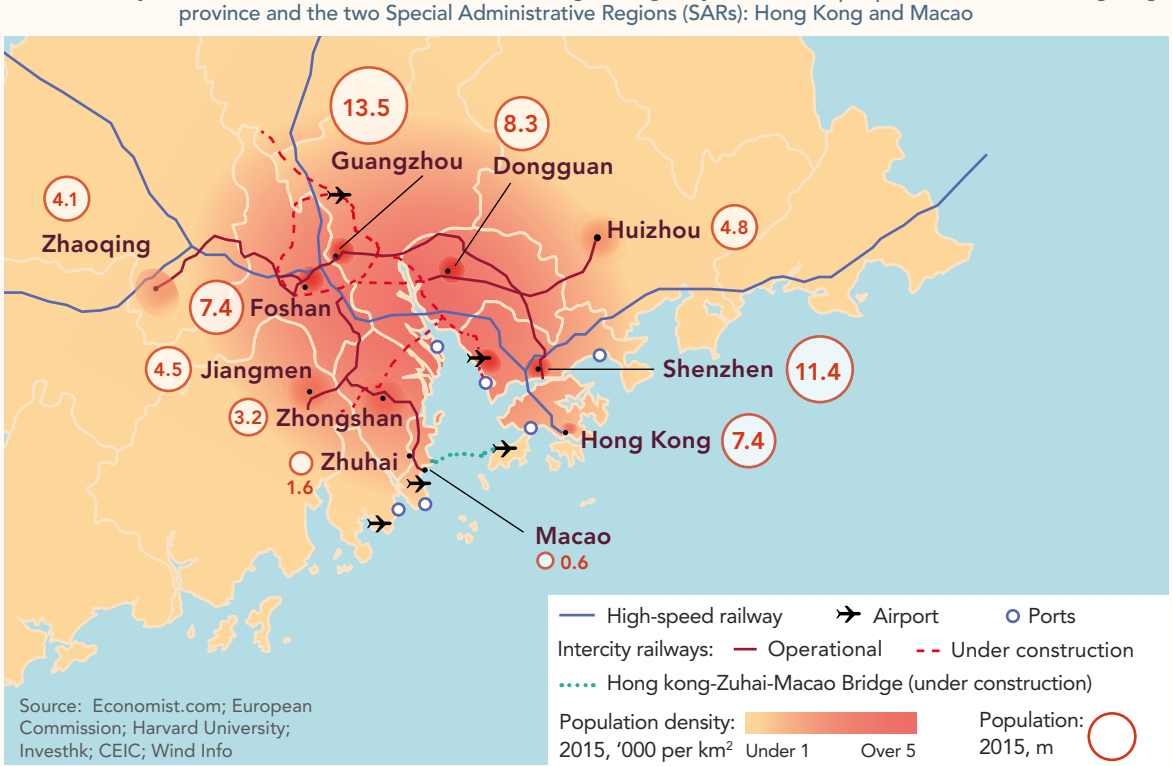
SAN FRANCISCO BAY AREA
POPULATION (million) 7.7
GDP (USD trillion) 0.8

Source: CGTN

GBA INFRASTRUCTURE (2017)

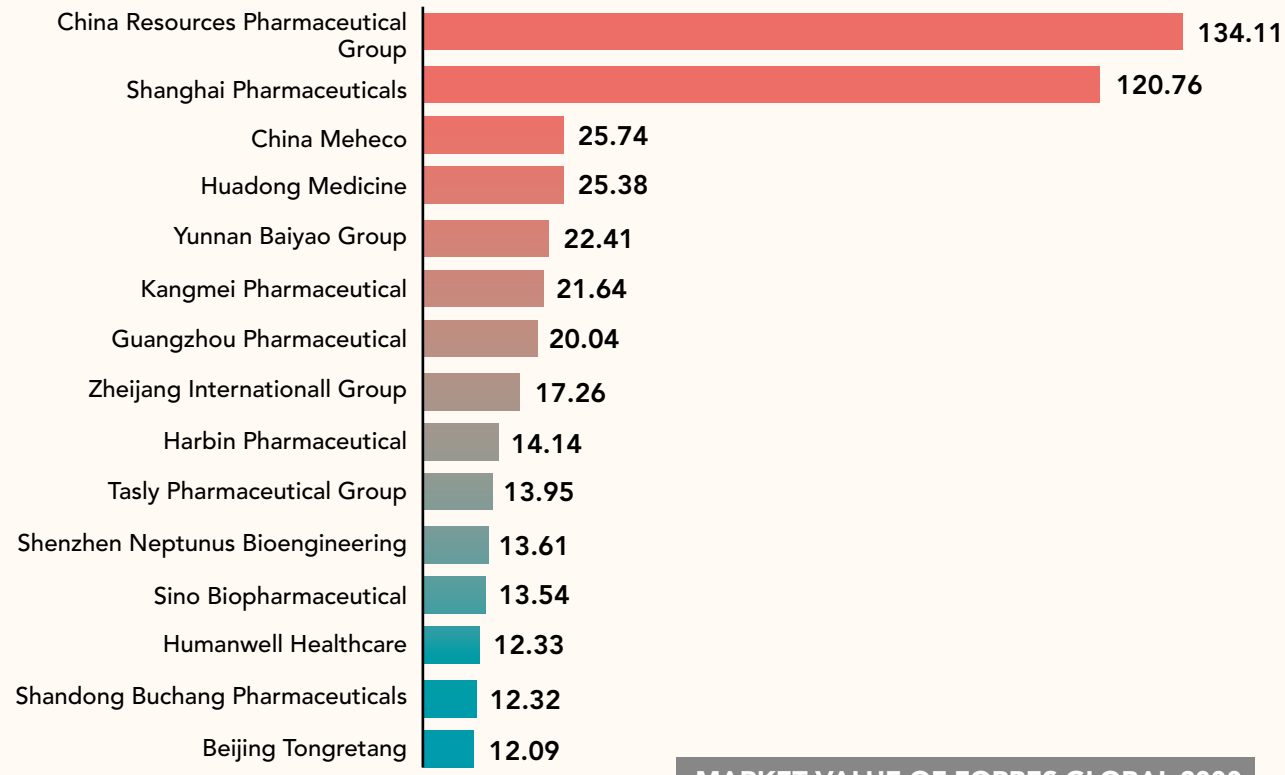
The "Greater Bay Area" (GDHKMC Bay Area) refers to the Chinese government's scheme to link the cities of Hong Kong, Macao, Guangzhou, Shenzhen, Zhuhai, Foshan, Zhongshan, Dongguan, Huizhou, Jiangmen and Zhaoqing into an integrated economic and business hub.

The Greater Bay Area, taken as a whole, forms the world's largest mega-city at 66 million people - nine cities in Guangdong province and the two Special Administrative Regions (SARs): Hong Kong and Macao



Source: Economist.com; European Commission; Harvard University; Investhk; CEIC; Wind Info

LEADING CHINESE BIOTECH AND PHARMACEUTICAL COMPANIES ON THE FORTUNE CHINA 500 RANKING IN 2017, BY REVENUE (IN BILLION YUAN)



REVENUE OF FORTUNE 500 COMPANIES IN GREATER BAY AREA (2016)

BY LOCATION OF THE HEADQUARTERS

SHENZHEN
REVENUE (RMB 100 million)
19,267
NUMBER OF COMPANIES
5

HONG KONG
REVENUE (RMB 100 million)
17,327
NUMBER OF COMPANIES
7

GUANGZHOU
REVENUE (RMB 100 million)
7,038
NUMBER OF COMPANIES
2

FOSHAN
REVENUE (RMB 100 million)
1,430
NUMBER OF COMPANIES
1

Source: Fortune; Factiva (exchange rate: closing price of USD against RMB on 31 March 2016); PwC Analysis

MARKET VALUE OF FORBES GLOBAL 2000 COMPANIES IN GREATER BAY AREA (2016)

BY LOCATION OF THE HEADQUARTERS

HONG KONG
MARKET VALUE (RMB 100 million)
39,713
NUMBER OF COMPANIES
39

SHENZHEN
MARKET VALUE (RMB 100 million)
34,750
NUMBER OF COMPANIES
17

GUANGZHOU
MARKET VALUE (RMB 100 million)
6,884
NUMBER OF COMPANIES
10

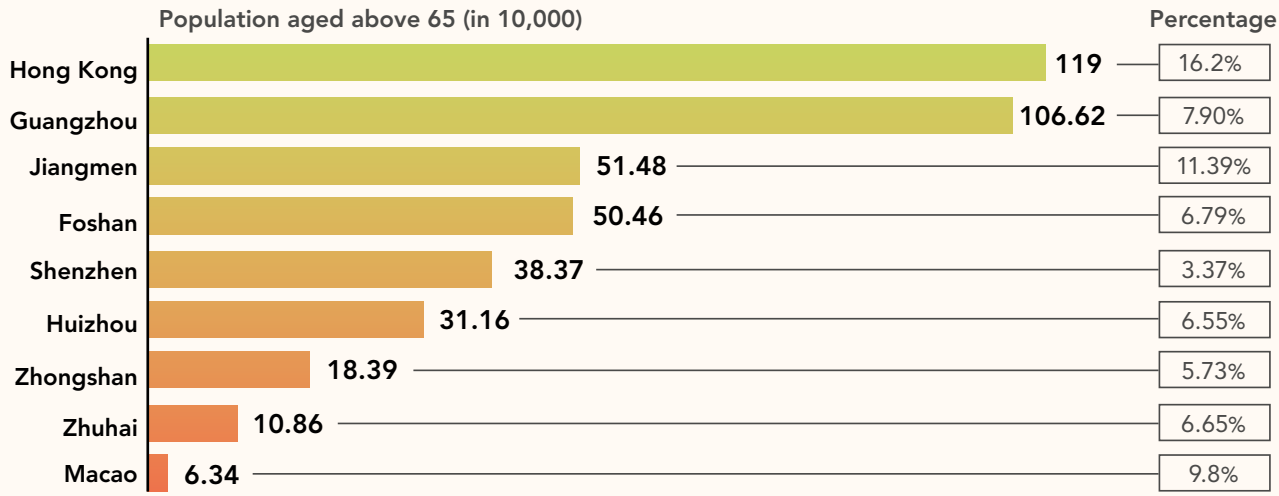
FOSHAN
MARKET VALUE (RMB 100 million)
2,694
NUMBER OF COMPANIES
3

ZHUHAI
MARKET VALUE (RMB 100 million)
1,156
NUMBER OF COMPANIES
1

HUIZHOU
MARKET VALUE (RMB 100 million)
442
NUMBER OF COMPANIES
1

Source: Forbes Wind Info, PwC Analysis; Factiva (exchange rate: closing price of USD against RMB on 22 April 2016)

POPULATION AGED ABOVE 65 AND ITS PERCENTAGE OF THE WHOLE POPULATION OF GBA



Source: Official statistics, goverment portal website, PwC Analysis

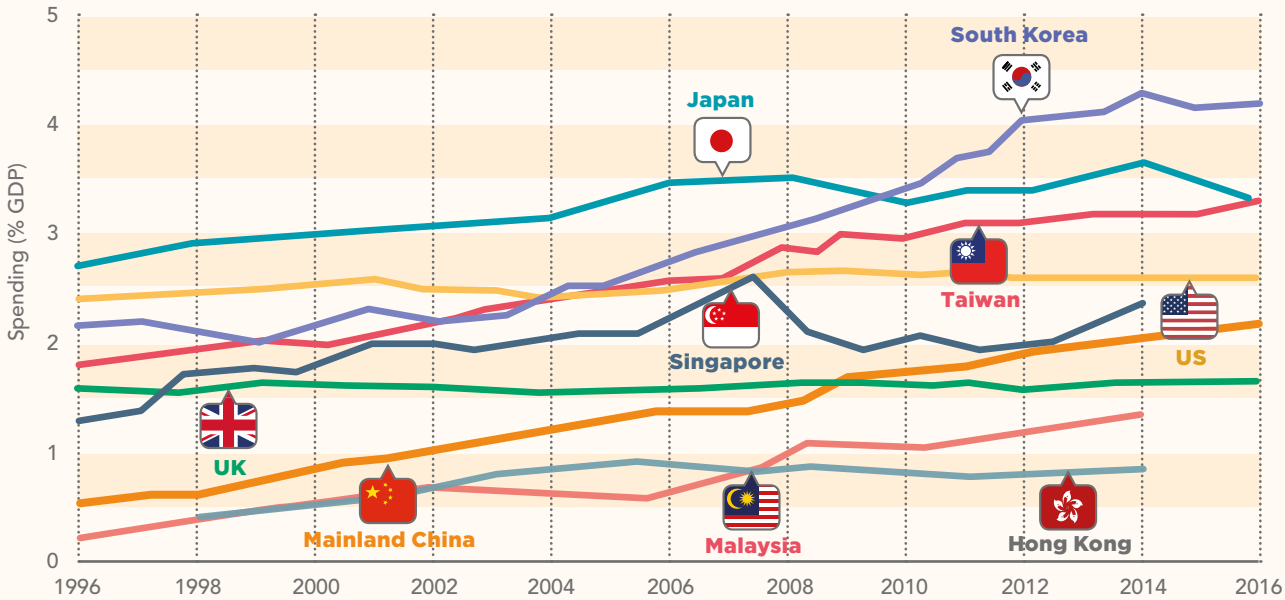
OVERVIEW OF THE THREE MAIN HEALTH INSURANCE PROGRAMS IN CHINA

Characteristic	New rural Cooperative Medical Scheme (NCMS)	Urban Employee-Basic Medical Insurance (UE-BMI)	Urban Residents-Basic Medical Insurance (UR-BMI)
Administration	County level (2176 countries)	Municipal Level	Municipal Level
Local Goverment Authority	Countries determines the dedustible, ceiling, reimbursement ratio, medical savings account	Wide variations across municipalities in eligibility, financing, benefits packages	Wide variations across municipalities in eligibility, financing, benefits packages
Date started	2003 (Old rural cooperative medical scheme at village in plac since 1950s)	1998	32007 (79 pilot cities) 2010 target-all cities
Participation	Voluntary at household	Mandatory for individuals	Voluntary at housegold
Populations	Rural residents	Urban employed	Children, studemts, elderly, disabled, other non-working urban residents
Target	Est. 840 million	Est 300 million	Est. 200 million
Current coverage	94.2% (2009)	67% (200 million, end 2008)	60.4& (118 million, end 2008)
Revenues (billion RMB)	94.435 billion RMB (13.9 billion USD) (2009)	270.9 billion RMB (39.8 billion USD)	15.4 billion RMB (2.3 billion USD)
Expenditures (billion RMB)	92.292 billion RMB (13.6 billion USD) (2009)	201.6 billion RMB (29.6 billion USD)	6.7 billion RMB (985 million USD)
Source of revenues	100 RMB/year (2009) For western areas, the contribution is 40 RMB each from local and central government, and 20 from individuals. The central contribution to eastern provinces tends to be lower, compensated by higher provincial or municipal contributions.	8% of employee wages: "6+2": 6% payroll taz on employers (ranging from 4 to 1% by municipality) and 2% employee contribution Medical savings accounts generally cover OP expenses, medicines (employer contribution +30% of employee contribution)	Average 245 RMB for adults, 113 RMB for minors (pilots 2008) In 2008, the government contribution was at least 80 RMB/ person, with a central level contribution to west and central areas of 40 RMB/ person. Provincial contributions vary. The poor and disabled receive and additional 60 RMB per year (50% from central)

WHO Report: Health insurance systems in China: A briefing note

R+D SPENDING IN ASIA AND BEYOND

Research and development (R&D) investment is rising rapidly in South Korea, Taiwan and Malaysia - albeit from different bases. In two decades, South Korea has close to doubled the share of its economy spent on research. Taiwan´s proportion is not far behind, an it overtook Japan in 2016. Singapore´s spending was keeping pace with Taiwan´s, but has dropped off because of a decline in business R&D spending. Only Hong Kong´s investment has plateaued in the past decade or so.



Source: Nature, UNESCO/OECD

HONG KONG FUNDING SUPPORT - 2018/19

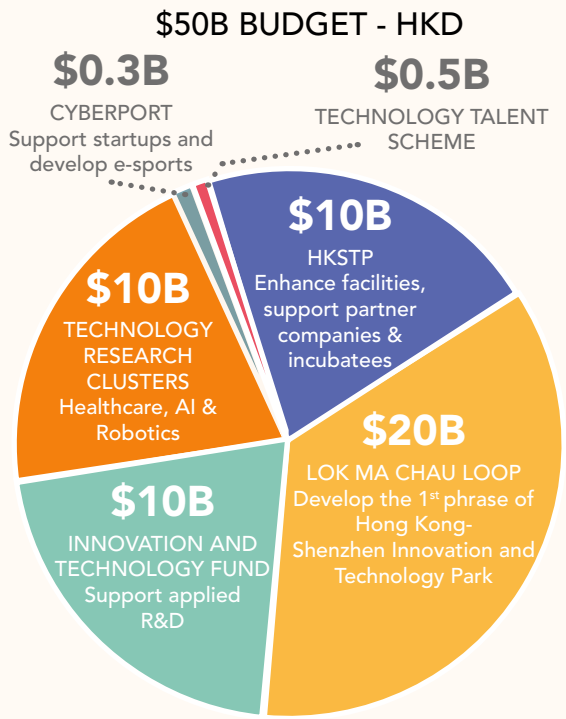
Biotechnology | A.I. | Smart City | Fintech

R&D / GDP — **Double** spending on R&D as percentage of GDP **by 2022**

ADDITIONAL TAX DEDUCTION for R&D expenses by firms
300% for first $2M
200% for remainder

$2B INNOVATION & TECHNOLOGY VENTURE FUND

Co-invest in start-ups with selected VC partners targeted matching ratio of 1.2 (Government/VC)



THE AWAKENING DRAGON: CHINA'S BELT AND ROAD INITIATIVE

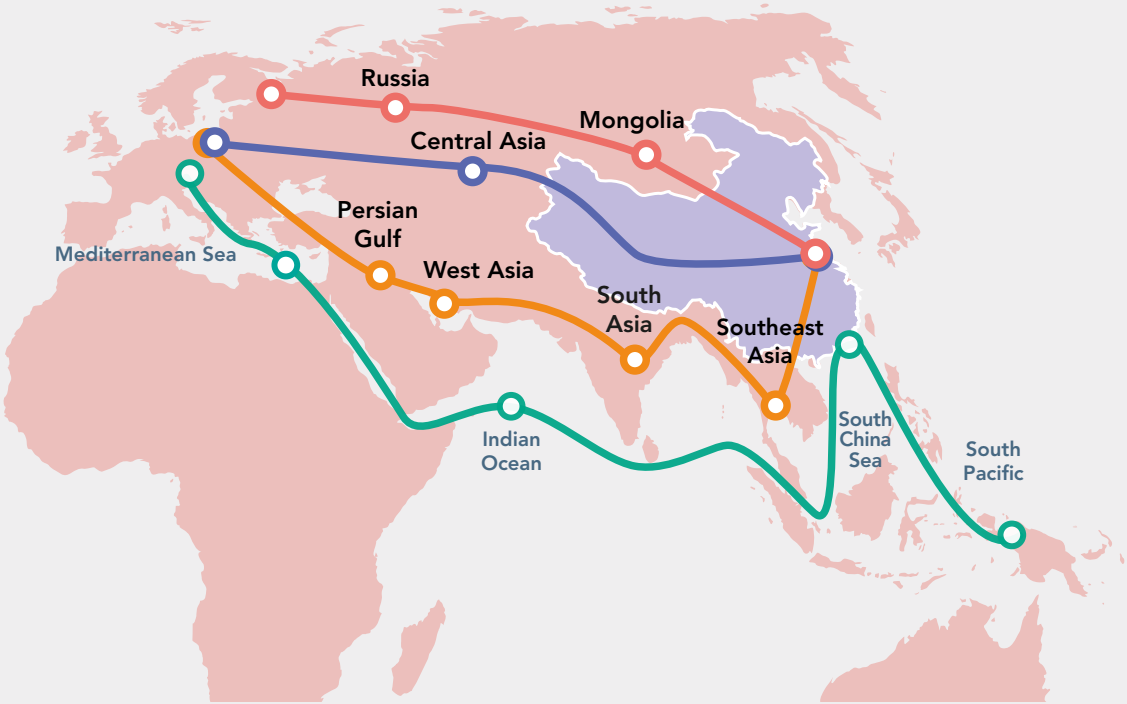
China's stupendous economic resurgence over the past four decades never ceases to awe, but what has captured attention in recent years has been the country's international awakening. Against a backdrop of intensifying populist nationalism, right-wing radicalism and trade protectionism in many advanced economies, Chinese President Xi Jinping's surprising 2017 Davos speech shook the world with its staunch message in support of economic globalization. He proclaimed, "To grow its economy, China must have the courage to swim in the vast ocean of the global market ... China took a brave step to embrace the global market." Quoting the likes of IMF Chief Christine Lagarde and Red Cross founder Henry Dunant, one of his key messages was the need to develop simultaneously "a dynamic, innovation-driven growth model" and "a balanced, equitable and inclusive development model".

2018 marks the fifth anniversary of his Belt and Road Initiative (BRI), the modern-day evocation of the ancient maritime Silk Road that connected Asia, Africa and Europe. The 'belt' refers to overland corridors through the Silk Road Economic Belt and the 'road' consists of the maritime shipping lanes forming the 21st Century Maritime Silk Road. From Southeast Asia to Europe and Africa, and extending even to South America, BRI now includes 71 (and counting) countries accounting for 50 percent of the world's population and a quarter of global GDP, and concerns not just trade but four other broad areas of policy coordination, facilities connectivity, financial integration, and people-people bonds. Already, Chinese companies have poured over USD 50 billion of investments and launched a spate of major infrastructure and development projects along these lines, though not without facing criticism and backlash from opponents accusing China of propagating a Chinese 'Marshall Plan'.

While the calculus of the BRI's domestic and international effects is complex and as yet inconclusive, what is certain is that this initiative will continue to be a core part of China's foreign policy, with the March 2018 removal of the constitutional two-term presidential limit at the First Session of the 13th National People's Congress (which sits from 2018-2023). President Xi and his ideology - of which a prime tenet is to support China's ambition to be a 'nation with pioneering global influence between 2035 to 2050' and the delivery of a new world order with Chinese characteristics - have also been enshrined in the country's Constitution, a feat elevating him to the status of Chinese Community Party (CCP) founder Mao Zedong. The longevity of Chinese government policy can no longer be questioned - if, indeed, it ever was.

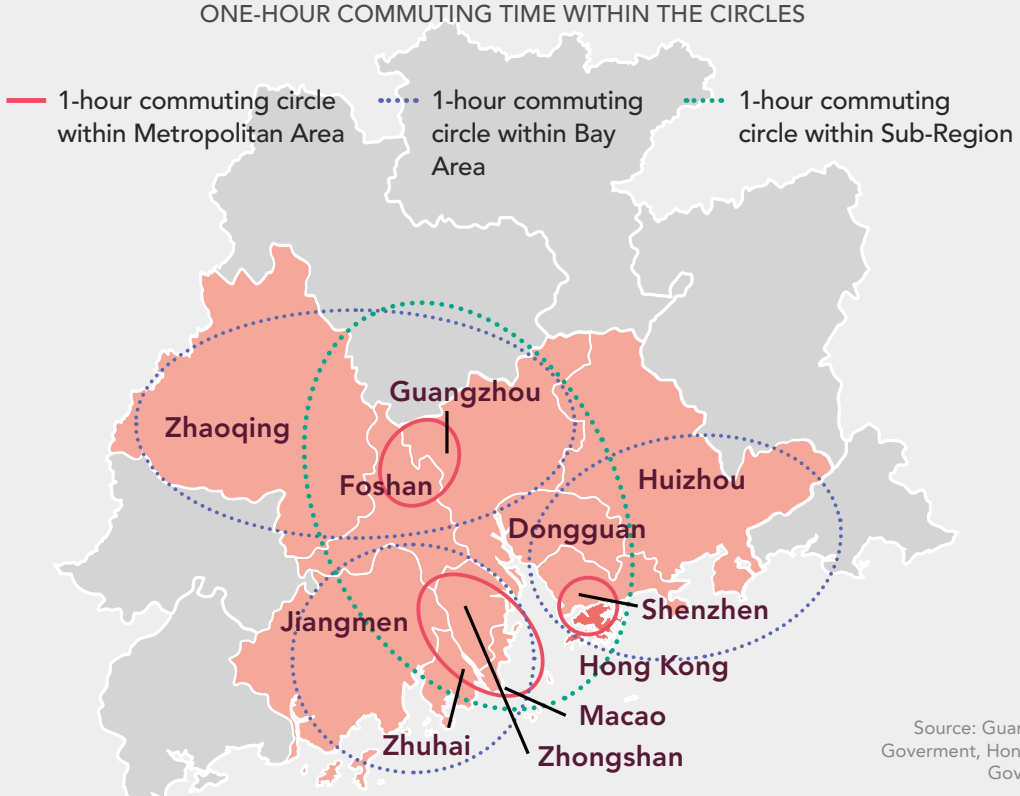
> ***Let China sleep, for when she wakes, she will shake the world.***
>
> **Napoleon Bonaparte**

CHINA'S "BELT AND ROAD INITIATIVE"



LINKING THE 9+2 CITIES OF THE GREATER BAY AREA

ONE-HOUR COMMUTING TIME WITHIN THE CIRCLES



Source: Guangdong Goverment, Hong Kong Goverment

"ONE COUNTRY, THREE SYSTEMS"

Guangzhou city was the beginning of China's ancient Maritime Silk Road so it is fitting that the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) is a lodestone of China's Belt and Road Initiative (BRI). The GBA consists of nine cities in the Pearl River Delta (PRD) region of Guangdong Province, starting with Guangzhou and including Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing, along with the two Special Administrative Regions (SARs), Hong Kong and Macao.

The 'Pearl River Delta' region is one of the oldest gates into China with Guangzhou having welcomed Indian and Roman traders as early as the year 200 AD, with the distinction of being the only Chinese city to have never been closed to foreign trade. Comparatively, Shenzhen is a 'new' city, having been opened up only in 1978 by then-Chinese premier Deng Xiaoping when he designated Shenzhen one of China's first Special Economic Zones (SEZs).

From such illustrious roots the region has since experienced transformative growth and development, growing at an annual average of 12 percent in the past decade - arguably even outstripping the rest of the country - to become one of the richest regions of China. In 2017, the Guangdong province alone registered a GDP of RMB 2 trillion (USD 310 billion). Despite representing less than 1 percent of China's territory and only 5 percent of its population, the Pearl River Delta accounts for 10 percent of China's GDP, 20 percent of FDI and 25 percent of its exports, selling USD 233 billion worth of goods in 2016. Little wonder that the GBA boasts three of the ten busiest cargo ports and two of the twenty air cargo hubs in the word.

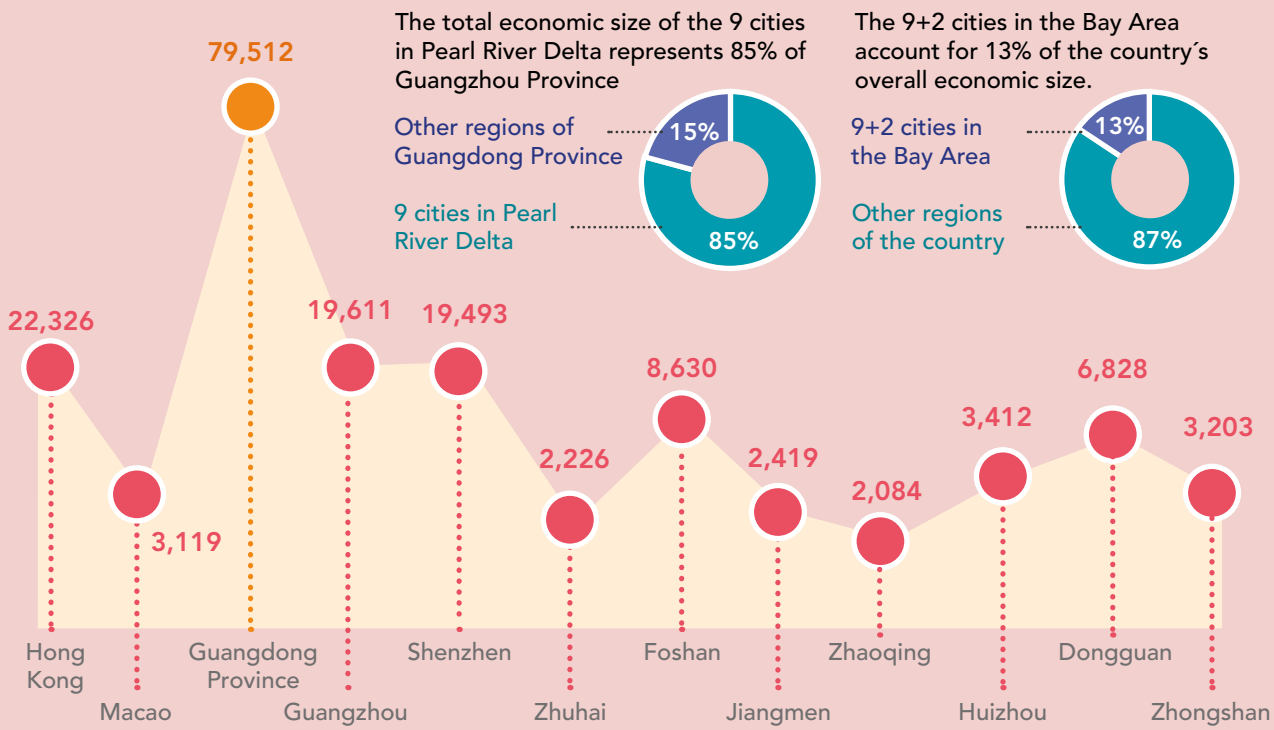
Unfortunately, these numbers themselves can only attest to the region's sheer potential. While the World Bank considers the area the largest mega-city in the world, the devil is inevitably in the details: the three different areas - Guangdong province, Hong Kong SAR and Macao SAR - exist as separate jurisdictions with their own, distinct sets of administrative, legal, financial and regulatory processes and systems.

HARLEY SEYEDIN
president, American Chamber of Commerce in South China

Leviathan efforts have been made to connect the 11 cities in terms of transport infrastructure. As President of the American Chamber of Commerce in South China, Dr. Harley Seyedin, reminisces, "connectivity in the region, particularly between the leading cities, Guangzhou and Shenzhen, has evolved a lot. Two decades ago, it was a real struggle. While you could use the highway that connected Guangzhou to Shenzhen since the 1950s, the highway only have two lanes where two cars could barely go through at the same time, and most of it would be washed out during the rainy season, which lasts from April until October. The longest travel distance from Guangzhou to Zhuhai is now 45 minutes, while all distances between the fourteen cities are within half an hour's reach." In addition, "anyone can travel anywhere within the Greater Bay Area without ever hitting an 'Out-of-Service' spot. Looking forward at the Greater Bay Area initiative, it is essential to remember the historical transformations that have built the foundation of the largest metropolis in the world."

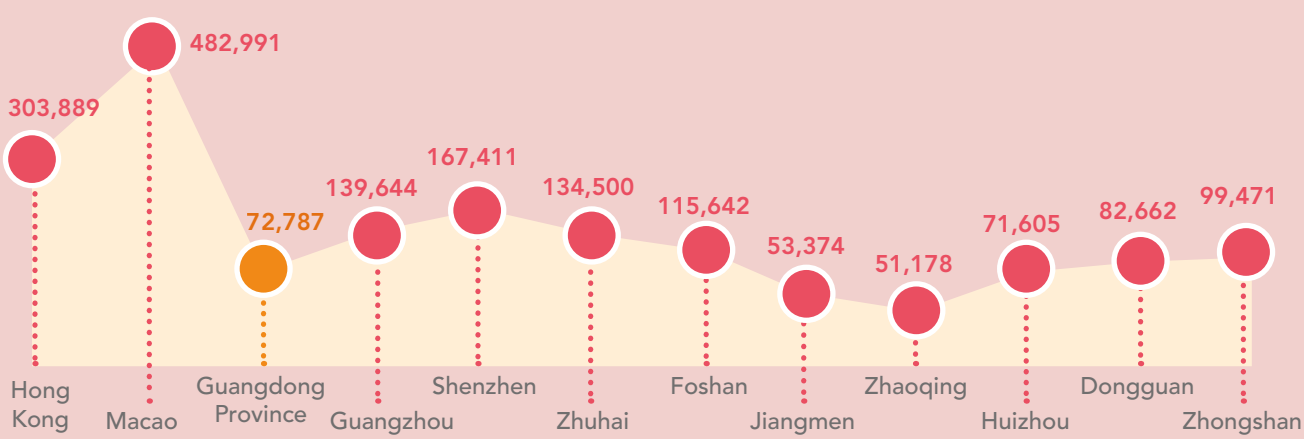
As always, the devil is inevitably in the details: the three different areas - Guangdong province, Hong Kong SAR and Macao SAR - exist as separate jurisdictions with their own, distinct sets of administrative, legal, financial and regulatory processes and systems. Dr. Seyedin agrees: "there is still a critical element currently holding the region back." The 'One Country, Three Systems' conundrum is by far the largest roadblock to circumvent for companies and indeed, government entities, seeking to unlock the region's true potential - and a particularly sensitive pain point for the highly regulated healthcare and life sciences sector.

GDP OF GREATER BAY AREA, 2016 (RMB 100 MILLION)



Source: Municipal Bureau of statistics, Wind info; Factiva (exchange rate: closing price of HKD and MOP against RMB on 31 December 2016) PxC Analysis

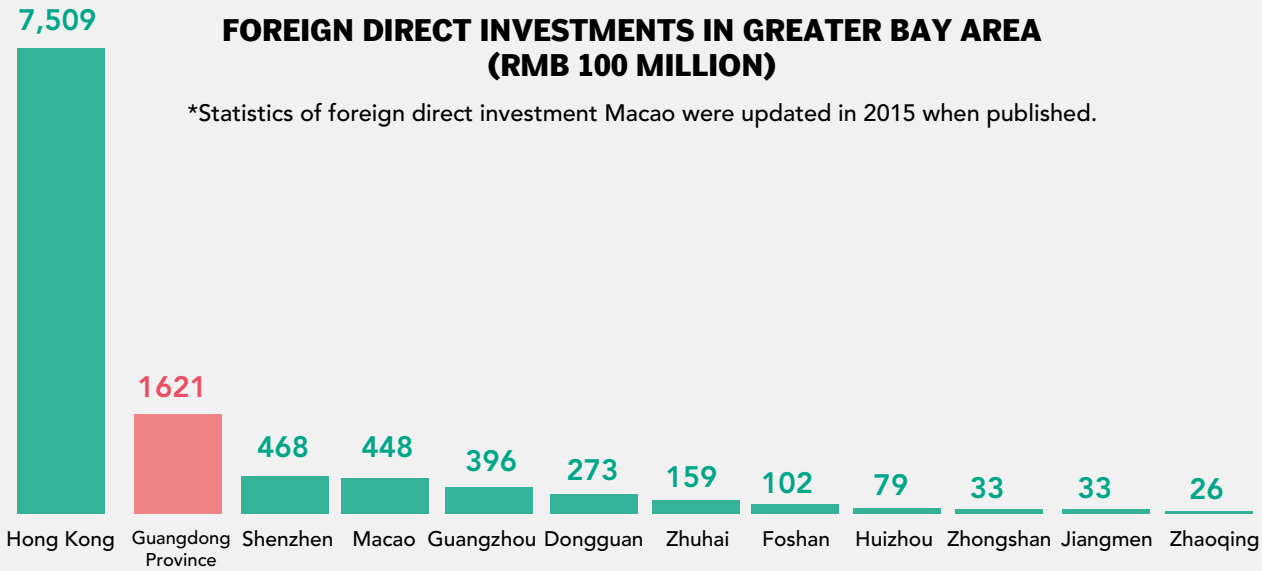
GDP PER CAPITA IN GREATER BAY AREA, 2016 (RMB / PERSON)



Source: Municipal bureaus statistics, Wind Info; (exchange rate: closing price of HKD and MOP against RMB on 30 December 2016). PwC analysis.

FOREIGN DIRECT INVESTMENTS IN GREATER BAY AREA (RMB 100 MILLION)

*Statistics of foreign direct investment Macao were updated in 2015 when published.



Source: Municipal bureaus statistics, Wind Info; (exchange rate: closing price of HKD and MOP against RMB on 30 December 2016). PwC analysis.

WORLD'S TOP TEN BUSIEST CARGO PORTS

1	SHANGHAI
2	SINGAPORE
3	SHENZHEN
4	NINGBO-ZHOUSHAN
5	BUSAN
6	HONG KONG
7	GUANGZHOU
8	QINGDAO
9	DUBAI
10	TIANJIN

WORLD'S TOP TEN BUSIEST AIR CARGO HUBS

1	HONG KONG
2	MEMPHIS TN
3	SHANGHAI
4	INCHEON
5	ANCHORAGE AK
6	DUBAI
7	LOUISVILLE KY
8	TOKYO
9	TAIPEI
10	PARIS

KEY GOVERNMENT INITIATIVES

THE 13TH FIVE-YEAR PLAN 2016-2020 (13TH FYP)

- The first Five-Year Plan to be developed under President Xi Jinping's leadership
  - 6.5 percent GDP annual growth target over the next five years
  - Part of the Party's long-term goal to double GDP and household income from 2010 to 2020
  - Particular focus on innovation and AI

- 'Healthy China'
  - Extensive healthcare reform
  - Domestic industrial development
  - Growth of traditional Chinese medicine (TCM)
  - Implementation of a 'fitness for all' strategy
  - Encouraging non-governmental stakeholder participation within the healthcare services industry

- Examples of specific targets:
  - Increase the number of qualified doctors and medical assistants to 2.5 per 1,000 persons
  - Increase the number of general practice doctors to 2 per 10,000 persons
  - Establish 1-2 public hospitals in each county
  - Maintain the proportion of urban and rural citizens with health insurance above 95%
  - Reduce premature mortality from critical chronic diseases by 10%

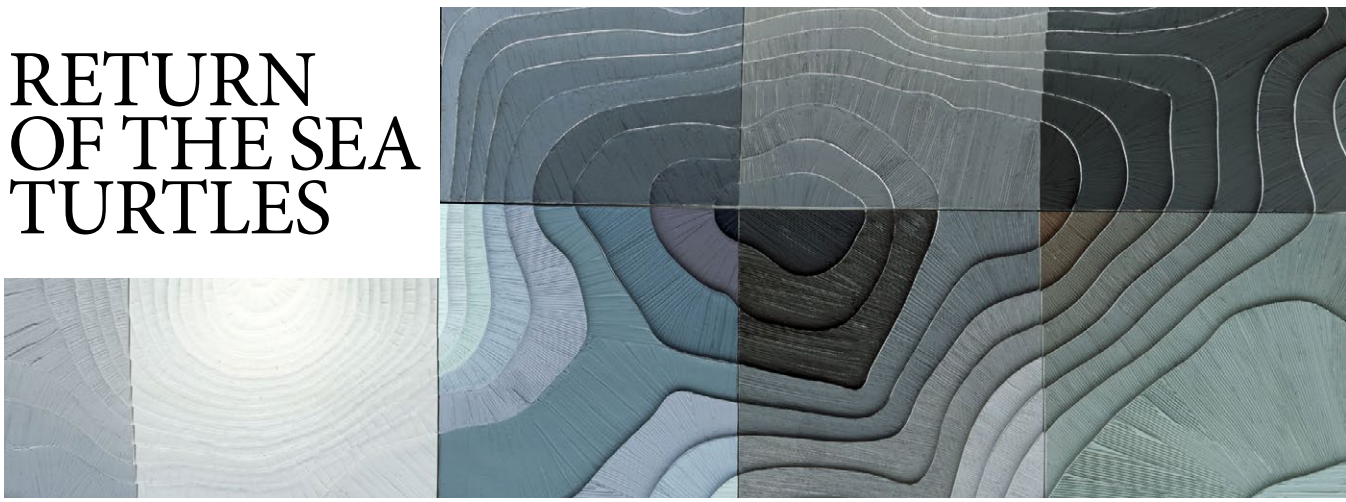
THE THOUSAND TALENTS PLAN

- Announced in 2008, the Thousand Talents Plan started as a scheme to bring leading Chinese scientists, researchers and entrepreneurs living abroad back to the motherland
- In 2011, this was expanded to include younger talents and more remarkably, foreign scientists
- In a decade, the Thousand Talents Plan has attracted over 7,000 people

- Requirements
  - You must already have a firm job offer from a Chinese institution
  - Chinese scientists under 55 years of age
  - Foreigners younger than 65 years of age
  - Strong publication record and academic credentials

- Benefits
  - Starting bonus of CNY 1 million (USD 151,000)
  - Additional incentives like accommodation subsidies, meal allowances, relocation compensation, subsidised education costs, etc.
  - Employers are obliged to find jobs for foreign spouses or provide an equivalent local salary

RETURN OF THE SEA TURTLES



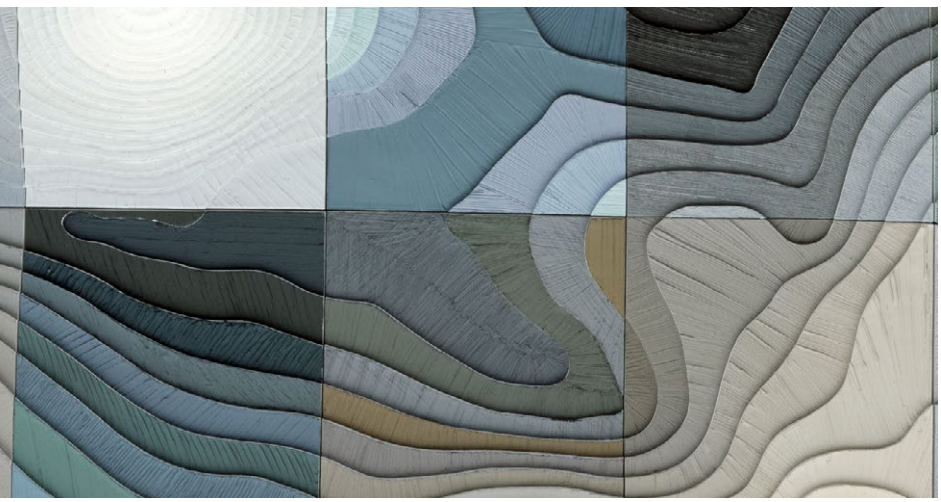
In Chinese, to say 'return from overseas' or 'overseas returnees' sounds like the characters for 'sea turtle'. Ever since the mass exodus of educated Chinese in the 1970s and 1980s following the Cultural Revolution, Chinese people that went abroad to study and work, who subsequently chose to return to their motherland, have been fondly referred to as 'sea turtles'. Like their spirit animals, such individuals were part of an endangered species, with the National Science Foundation reporting in 2013 that 92 percent of Chinese graduates with American PhDs still lived in the US five years after graduation. However, through tireless government efforts and changing tides, the population of such Chinese 'sea turtles' is making an impressive recovery. The Chinese Ministry of Education estimated in 2017 that nearly 80 percent of students now return to China after completing their studies overseas. This trend is seen not only in fresh graduates but even in accomplished professors, academics and researchers, many whom are leaving behind decorated careers, companies and laboratories in the US (typically) to join the Chinese cavalry.

Much of the credit must go to the Chinese government. Even as beleaguered US and European economies cut back on academic, research and healthcare funding, the Chinese government has announced a slew of investments into healthcare in their 13th Five Year Plan, in addition to attractive incentives and subsidies specifically targeted at luring back overseas Chinese. Shenzhen has attracted more than its fair share of 'sea turtles' due to a combination of extremely supportive municipal government policies, the creative space that a 'new' city offers enterprising immigrants, and the intense streak of private enterprise that runs through the city's economy.

Dr. Grace Zhou, Dean of the Shenzhen International Institute for Biomedical Research (SIIBR), a research institute cum start-up incubator she established with a team of US university professors, sheds some light on the government's motivations. "The current weakness is in education and healthcare facilities. When you consider the top universities in China - and indeed, the world - their reputation and quality have been built over centuries. Shenzhen cannot catch up organically within just a few decades, so the government's strategy has been to bring talents from all over the world to Shenzhen." While many Chinese cities have rushed to follow suit, Shenzhen still manages to stand out. "Shenzhen uses a system of 'recognition', unlike many other cities that follows a review process by an expert panel. As long as an individual or team meets certain requirements or criteria, they will automatically receive the grant or award."

> **"THE CHINESE MINISTRY OF EDUCATION ESTIMATED IN 2017 THAT NEARLY 80 PERCENT OF STUDENTS NOW RETURN TO CHINA AFTER COMPLETING THEIR STUDIES OVERSEAS.**

Dr. Zhou reveals, "two of my post-doctoral students met the criteria of a particular award and received a personal grant of CNY 1.6 million (USD 230,000) over five years, which can be matched 1-1 by the Dapeng



PROF. XUE-JUN SONG
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

district government" - the city district where SIIBR is based.

There is a common four-character phrase that portmanteaus the top four cities of China: Beijing, Shanghai, Guangzhou and Shenzhen. With Beijing being the country's political capital and the base of most state-owned enterprises, and Shanghai being the country's financial capital and typically the country headquarters of multinationals, these are the two most obvious location choices. However, as Professor Xue-jun Song at the Southern University of Science and Technology and a global expert in pain, discovered, the obvious may not necessarily be the best. He shares, "after spending more than twenty years as a biomedical scientist and professor at various universities in the United States, I decided to come back to China. I have always felt in my heart that I need to work for my motherland. Additionally, I wanted to have the opportunity to apply my research to clinical trials and do more clinical research in pain medical field, particularly cancer pain research and treatment." Professor Song spent his first five years in China at the Peking University Health Science Center and established the Center for Pain Medicine."

> **"I HAVE ALWAYS FELT IN MY HEART THAT I NEED TO WORK FOR MY MOTHERLAND**
>
> — Prof. Xue-Jun Song

He admits, "After a couple years however, I experienced and realized many difficulties like the lack of laboratory space, research staff, and financial support, etc. In early 2016, encouraged and invited by the President of SUSTech Dr. Shiyi Chen, who was also the Vice President of the Peking University, I decided to take the opportunity to join SUSTech in Shenzhen. Forty years ago, Shenzhen represented almost nothing in any field. Today, it is a well-recognized metropolis. I am confident that Shenzhen will become an important biomedical innovative center. I wanted to be part of it."

PROF. MICHAEL YANG
CITY UNIVERSITY OF HONG KONG

Talent inflows are particularly important to the region because innovation is fundamentally a creative act. Professor Michael Yang, Chair of the Biomedical Faculty at Hong Kong CityU, laments, "Human resources could be the region's weakest link as the Chinese educational system is heavily dependent on rote memorization and lack many of the creative problem-solving skills associated with more Western educational models. For now, the region - and Shenzhen in particular - is heavily dependent on talent inflows, both nationally and internationally, as part of the central government's charm offensive to lure both foreign and Chinese talent to the country."

Professor Lam Hon-ming from the Chinese University of Hong Kong (CUHK) returned from post-doctoral training in the US to Hong Kong in order to solve genuine unmet meeds in China. He reminisces, "At that time, many researchers were entering the medical field, in part because it was easier to attract funding. China was then still a very rural, developing country. With limited land and water resources coupled with the huge agricultural needs of 1.3 billion people, intensive use of fertilizer in Chinese agriculture has started to result in long-term negative environment impact. Therefore, I decided to research ways to increase

PROF. LAM HON-MING
CHINESE UNIVERSITY OF HONG KONG (CUHK)

soil productivity and therefore farmers' incomes without affecting environmental sustainability." He decided to study soybeans for both biological - soybeans' nitrogen fixation capability - and sentimental - soybeans originated from China - reasons.

When the genomic revolution occured in the 2000s, he boldly seized the opportunity to apply genome sequencing technology to his soybean research. He recalls, "Back then, it was still a risky endeavor because it was early, still expensive, and no one knew what the potential results might be." He sought help from BGI, the Shenzhen-based research institute that still has, today, the largest gene sequencing capabilities in the world, and whose founder, Dr. Henry Yang, was one of the pioneers involved in the Human Genome Project. "At that time, they were still focused on the human genome though they had sequenced a couple of plants, starting with the cucumber. Lam convinced them about the importance of the research.

Lam laughs, "I heard that there were two other groups, one in the US and one in South Korea, also working on sequencing soybeans." Therefore, he decided to analyse over a dozen domesticated and wild soybean cultivars. In December 2010, his team managed to publish their first milestone paper in Nature Genetics comparing the genomics of cultivated and wild soybean varieties from China and elsewhere, taking the cross-border research team to the cover of that month's issue.

Traditionally, the top centers of learning and research in China have been concentrated in Beijing and Shanghai, with a dearth of globally recognised educational and research institutions in south China. In fact, in the whole of southern China, the top ranked universities are all located in Hong Kong - which actually has five universities ranked in the QS Universities top 100, the most of any city in the world. While leading Chinese universities like Peking University, Tsinghua University as well as Hong Kong universities like CUHK and the University of Hong Kong (HKU) have established satellite campuses in Shenzhen, it is not enough to just have campuses. These returning academics bring not only academic expertise but also valuable translational and business experience.

Professor Yang shares, ""I would characterize my profile as a "start-up specialist". I co-founded in 2004 my first biotech company, Genetel, in Shenzhen, focusing on developing a biochip product enabling early screening of cervical cancer. Our product received CFDA approval after three years of development and clinical trial, and Genetel was acquired by a large listed company in 2009. In 2010, I then co-founded another start-up with a PhD graduate from my lab in 2010, Prenetics, in Hong Kong, which is the first biotech company admitted into

WORLD CLASS UNIVERSITIES AND RESEARCHES

LOCAL UNIVERSITIES

Source: HKSTP

QS RANKING (16-17)	OVERALL	ENGINEERING AND TECHNOLOGY SUBJETCS
The University of Hong Kong	26th	27th
HKUST	30th	15th
香港中文大學 The Chinese University of Hong Kong	46th	50th
CityU 香港城市大學 City University of Hong Kong	49th	76th
The Hong Kong Polytechnic University	95th	51th

26 CAS Hong Kong Fellows

6 CAS Foreign Fellows

7 CAS Foreign Fellows

4 CAE Foreign Fellows

25 IEEE Fellows in HKUST alone

16 state key laboratory partner laboratories

3 national industrialization partner base

6 national engineering technology research centres

1 national incubator (HKSTP)

the Hong Kong Science Park´s biotech incubation program." Prenetics is now the largest consumer genetic testing company in Hong Kong and Southeast Asia.

> **WE ARE BUILDING UP CRITICAL MASSES IN THE AREAS OF CANCER RESEARCH, SYSTEMS NEUROSCIENCE, REGENERATIVE MEDICINE, MICROBIOLOGY AND BIOTECHNOLOGY**
>
> — **Prof. Michael Yang** CityU Hong Kong

Most recently, however, Professor Yang has been responsible for yet another start-up project: "establishing the new academic department of biomedical sciences in City University. Together with seven founding faculty members, the department has rapidly grown to include thirty-two faculty members, 150 Ph.D. students, and more than 60 research staff. We are building up critical masses in the areas of cancer research, systems neuroscience, regenerative medicine, and microbiology and biotechnology" – further developing the biotech ecosystem in the region.

The region also depends on such returnees for valuable commercial projects and ideas - and enterprising academics often find a nurturing and eager environment awaiting their start-up projects in Shenzhen. Dr. Zhou testifies, "In 2005, I started my work on oncolytic viruses, which hinted at potential breakthroughs in the treatment of solid tumors in the future. The biggest achievement for me here was the development of the first targeted virus that only targets tumor cells, not normal cells. In 2009 [we] established a company to take it to pre-clinical studies [but] at that time, it was incredibly difficult to raise funds in the US."

She shares, "I decided to return to China in 2013: to see if it is possible to set up our company here instead. I toured many of China's largest cities, including Beijing, Shanghai and Suzhou, and ultimately chose Shenzhen as the ideal location for a very simple reason. The Shenzhen government not only supports the industry in words but also in policy and concrete action. The first time Mayor Xu met us, he actually said, you have brought the projects that I have earnestly been waiting for!" Her company, ImmVira, was spun off from SIIBR in 2015 and she is now hoping to IPO on NASDAQ very soon.

CEO PROFILE

SETTING UP IN SHENZHEN

From one of China's youngest academic star to accomplished researcher at the University of Chicago to successful biotech entrepreneur and Dean of recently established Shenzhen International Institute for Biomedical Research (SIIBR), Dr. Grace Zhou, dean of SIIBR, shares her career trajectory as well as the most exciting developments of her own start-up company, ImmVira, which focuses on developing oncolytic viruses.

HCLS: To move from academic research to the commercial biotech space is a big step for many professors and researchers. Why were you interested in making this transition?

GRACE ZHOU (GZ): I have always been – and still am – incredibly passionate about fundamental science and basic research. I started my career at the Shanghai Institute of Biochemistry, Chinese Academy of Sciences, spending almost 11 years there, receiving first my PhD and then a promotion to Associate Professor. At that time, I received the national award and a Special Government Allowance – being the youngest person to do so! At that time, I felt like I knew everything.

One day, my father came down with the flu. I told him, there is no cure for the flu virus. There is nothing you can do. After a few days, you will feel better naturally. He looked at me and sighed, I cannot believe that after spending so much money on your education, you tell me you cannot even do anything for a simple flu! While a joke, this little conversation stuck with me.

I started to ask myself: what is the purpose of publishing so many research papers? I wanted to be able to help the people around me.

I went to the University of Chicago to switch to studying human viruses. Virology can sometimes seem rather hopeless, because it is incredibly difficult to develop a cure or vaccine. At the University of Chicago, we tried to develop a cure or vaccine for the herpes virus, but ultimately failed. In 2005, my work on oncolytic viruses hinted at potential breakthroughs in the treatment of solid tumors in the future. The biggest achievement for me here was the development of the first targeted virus that only targets tumor cells, not normal cells.

HCLS: Having built extremely successful careers in both Shanghai and Chicago, what motivated you to relocate once again to Shenzhen to help establish the Shenzhen International Institute for Biomedical Research (SIIBR)?

GZ: In 2009, our University of Chicago research team established a company with the vision of developing this oncolytic virus and take it to pre-clinical studies. However, at that time, it was incredibly difficult to raise funds in

the US because the oncolytic virus field was still unrecognized. I decided to return to China in 2013 to see if it is possible to set up our company here instead. I toured many of China's largest cities, including Beijing, Shanghai and Suzhou, and ultimately chose Shenzhen as the ideal location for a very simple reason. The Shenzhen government not only supports the industry in words but also in policy and concrete action.

I am originally from Shanghai, so I did not have any connections in Shenzhen when I first arrived. Professor Albert Yu, Chairman of the Hong Kong Biotechnology Organization (HKBIO), connected me to the Shenzhen International Bio Valley initiative the Dapeng New District government in Shenzhen was organizing, and invited me to an official meeting. I told them, if you really want to establish a biotech science and industrial park like this Bio Valley, you need to ensure that you have strong companies with commercializable products. I just happen to have the kind of product you are looking for!

The Dapeng government saw the caliber of our team and said it would be a waste to simply establish a company. We have three members of the Chinese Academy of Sciences along with other extremely well-known scientists and professors globally. Shenzhen was extremely eager to bring in high-level educational facilities and institutions. What was possible was the establishment of an independent institution – the Shenzhen International Institute for Biomedical Research (SIIBR).


Courtesy of SIIBR

HCLS: Shenzhen is definitely becoming a very 'hot' city in this area. What advice do you have for professors or researchers looking to come here?

GZ: Interested individuals or teams looking to bring their projects here need to first ensure they are strong enough to compete. Shenzhen offers incredibly attractive incentives and therefore the competition for them is intense. Early successes like the Institute are very difficult to duplicate.

The city really considers the caliber of your team. It is not enough to have one 'bigshot' – the entire team needs to be very strong and work well together. In addition, they need to be committed to working in Shenzhen. It is not possible to simply come in, win the grant, and leave. There must be a good fit between the team and the city as well.

Teams also need to show that their ideas have market potential, and ideally, market support –with their own money invested in it, which shows their commitment to the project, and also VC backing, which shows validation of their project. The Shenzhen government wants to see that their money is just 'icing on the cake' and not the main source of funding.

HCLS: Can you share with us the projects that the Institute and its spin-off companies are involved in?

GZ: The main research foci of our team members are infectious diseases and oncology. We also specifically wanted to bring in products with market potential, because this is an area that China is especially focusing on. We also wanted to focus on research areas most relevant to the Guangdong province.

The original team had two projects: mine, on the oncolytic virus, and one from Professor Ralph Weichselbaum, who is the Chair of the Radiation Department at the University of Chicago, the first one to combine the use of oncolytic virus with radiation in clinical studies. A number of other professors also decided to join us, bringing a project on antibiotic-resistant

bacteria in hospitals (e.g. MRSA) by Professor Olaf Schneewind, who was awarded a Chinese Academy of Sciences this year; a project on anti-viral infection; and also small-molecule development from innate immunity to anti-virus.

We now have six projects in total, all in the areas of oncology or infectious diseases. Out of the six, two have been spun-off: mine, ImmVira, in May 2015, and Professor Schneewind's, in June 2015. We are now looking to spin off a third company very soon!

> **WE ARE NOW LOOKING TO SPIN OFF A THIRD COMPANY VERY SOON!**

HCLS: As for your company, ImmVira, what have been the main developments over the past few years?

GZ: This is a company I co-founded with my mentor Professor Bernard Roizman, who is really the original inventor of the oncolytic virus. He was the first to discover that the herpes simplex virus 1 (HSV-1) could become an oncolytic agent; if you delete the viral γ34.5 gene, the virus will no longer replicate in normal cells, only tumor cells. As the virus replicates and starts to kill the tumor cell, the tumor cell degrades and releases oncogen, which stimulates local immunity. When he started his research on HSV in 1965, he was the first in the world.

My discovery was the creation of the targeted virus. For oncolytic viruses, the challenge with using systemic delivery instead of intratumoral injection is that you will need to inject a huge amount to ensure that some reach the tumor. Typically, over 90 percent of patients will become infected. The best option is to create a targeted virus that can be used for systemic delivery. I managed to modify the virus so that it no longer goes to normal cells at all.

In addition, the virus is also able to express anti-PD-1 (programmed cell death protein 1) monoclonal antibodies. The overall efficacy of PD-1 antibodies is around 26 percent but there are significant side effects. Using the virus to bring the antibodies directly into the tumor reduces the impact of the side effects.

Also, as the virus replicates within the tumor, it is using the tumor as a production factory for more PD-1 antibodies! We are also able to express the immune mediator Interleukin IL-12. Finally, this virus is not associated with any checkpoints, so we can combine it with any other existing cancer immunotherapy.


Courtesy of SIIBR

HCLS: What exciting developments do you have in store for ImmVira in the future?

GZ: This summer, we are beginning clinical trials for our virus + IO-12 combination therapy in Australia. We also hope to combine the oncolytic virus therapy with radiation. Another co-founder, Professor Ralph R. Weichselbaum, is a radiation expert. We are also doing research into oncolytic virus-resistant tumors. At the moment, combination therapy with oncolytic virus and PD-1 inhibitor has a great efficacy of 62 percent, but we want to see if we are able to reach the other 40 percent of tumors as well.

As a company, ImmVira is also preparing for an IPO on the NASDAQ Stock Market.

Our team is already ambitiously considering the establishment of another company.

I am also very interested in providing consultancy services to both biotech companies with interesting projects that are now approaching the Institute for help, as well as investment companies and VCs targeting the life sciences skills, who may lack the necessary technical knowledge or background.

BUILD IT AND THEY WILL COME?

With nearly 1.4 billion people, China is the most populous country in the world - nearly 20 percent of the global population. As China's economy grows by leaps and bounds, more people have thronged into cities in search of a better life. Over the past three decades, China's urban population has increased by 500 million people, leading The Economist to describe this as "the biggest movement of humanity the planet has seen in such a short time." Though the largest, the Greater Bay Area is not the only mega-city in China - staggeringly, most of the top-tier cities in China like Shanghai, Beijing, Wuhan and Chengdu already qualify as mega-cities with far more than ten million people each. While urbanization is an undeniable trend, efforts of the central Chinese government to build up urban centers in a bid to develop overlooked regions have led to the proliferation of ghost cities, where buildings and infrastructure have been built in the hopes of attracting occupants.

This 'build it and they will come' impulse is palpable even in the heavily populated Greater Bay Area, particularly when it comes to research, science and industrial parks, as governments in the region have seized upon such 'clusters' as a one-stop solution to producing home-grown innovation. Billions of renminbi have been injected into large-scale projects. However, as Dr. Grace Zhou, Dean of the Shenzhen International Institute for Biomedical Research (SIIBR), itself one of the first occupants of the Shenzhen International Bio Valley, cautions, "It is not enough to construct some buildings, it is essential to have the necessary infrastructure, as well as the surrounding industrial ecosystem for biotech companies to be able to successfully commercialize their products." Shenzhen Bio Valley is a planned science and technology park located in Dapeng New District, around 1.5 hours' drive from Shenzhen city center.

> **"IT IS NOT ENOUGH TO CONSTRUCT SOME BUILDINGS, IT IS ESSENTIAL TO HAVE THE NECESSARY INFRASTRUCTURE, AS WELL AS THE SURROUNDING INDUSTRIAL ECOSYSTEM**
>
> — Dr. Grace Zhou SIIBR

Dapeng New District is a relatively new administrative area in Shenzhen city and forms an idyllic backdrop for any future R&D activities. Flaunting a coastline exceeding half the total length of Shenzhen's, as well as a staggering, 54 out of the 56 sandy beaches in the entire city - of which one, the Xichong Beach, ranking as one of the 'Eight Most Beautiful Beaches in China' - it has been designated a National Ecological Conservation Pilot Zone and a National Ecological Conservation Demonstration Area. While the greenfield site is still under development, the management team has already set lofty goals, including the aim to have the bio-industry's total added value reach RMB 80 billion (USD 11.7 billion) by 2020 and the ambition of becoming China's pilot zone for advanced biotechnology industries. Even though the park has not bee completed yet, it already contains the Chinese National Gene Bank (CNGB), established by BGI, which aspires to become China's first national gene bank and the world's largest. As of 2017, the District has already attracted 75 enterprises and 14 institutions into its two industrial parks, with a stated annual output of RMB 80 million (USD 11.7 million), with the most notable projects featuring Nobel Prize Laureates like James Watson, leading the Cheerland-Watson Center for Life Sciences

and Technology, and Barry Marshall, heading a R&D center for gastrointestinal diseases.

Nevertheless, there are always two sides to each coin. Dapeng's breathtaking beauty is a result of its location, but its distance from existing hubs makes international collaboration a challenge. Dr. Zhou elaborates, "SIIBR's location in Dapeng New District is extremely conducive to basic research because the environment is very peaceful. However, when it comes to development and commercialization, its distance from the city center is a bit disadvantageous, so we are also now looking to establish a virtual incubator closer to the city, for instance, in Futian, Nanshan or Guangming districts."

Such science, technology and industrial parks abound across the region, with examples like Shenzhen Biomedical Innovation Industrial Park (SBIIP), Guangzhou Bio Island, the Sino-Singapore Guangzhou Knowledge City and so on. While many of these projects have been conscious to confirm at least some tenants and companies to act as anchoring presence in the parks even before construction is fully complete, to avoid risks of white elephants, it is not an easy feat to attract new companies or convince existing companies to relocate. The very synergistic 'cluster' effects that these new parks hope to leverage are exactly the forces they need to contend with. The high-tech locus of Shenzhen city is Nanshan district, the bustling innovation heart of Shenzhen, that alone acts a headquarters to 125 publicly listed companies representing a combined market value of USD 400 billion. It is their over 6 percent annual R&D investment - higher than the national average of 4 percent - that oils the engines of Shenzhen's high-octane economy.

As always, however, the government has a development plan. To consciously ease the congestion within Shenzhen's main districts, Nanshan district and Futian district (the financial district), the Shenzhen government is orchestrating a new 'Eastward Strategy' to massage Shenzhen's industries across the vast undeveloped lands east of the city. Many large enterprises in Shenzhen, particularly those with advanced technology manufacturing, have started the process of relocating their headquarters and/or manufacturing out of Nanshan district into newer districts like Guangming district or Pingshan district. To accommodate, residential blocks, workers' dormitories and related amenities have also been erected, as well as reasonable transport links. For instance, high-speed rail links Pingshan district with downtown Shenzhen. Already, there are over 120 healthcare and life sciences companies established in the National Biological Industrial Base in Pingshan district, including Shenzhen Mainluck, one of the top ten pharma companies in Shenzhen, as well as French vaccines giant Sanofi Pasteur's manufacturing facility.

> **HKSTP HAS ALWAYS OCCUPIED A PIVOTAL ROLE IN HELPING HONG KONG TECHNOLOGY COMPANIES AND START-UPS GROW AND THRIVE**
>
> — **Dr. Sunny Chai** HKSTP

Should mainland authorities wish to consult a successful model, all they need to do is cross the border south and look at the Hong Kong Science and Technology Parks (HKSTP). Established since 2001, it can point to a longstanding track record of successfully fostering innovation and igniting industrial development. As new Chairman Dr. Sunny Chai proclaims, "HKSTP has always occupied a pivotal role in helping Hong Kong technology companies and start-ups grow and thrive. With increased focus to position Hong Kong as an international innovation and technology hub, supported by both the mainland Chinese and Hong Kong governments, we will continue to facilitate collaboration between government, industry, academia and research institutions to nurture and sustain the development of talent and resources not only in Hong Kong but within the Greater Bay Area." Concretely, he highlights, "this means offering incentives and support measures for technopreneurs across different stages of the talent lifecycle. We believe that Hong Kong is the best city location for overseas companies hoping to expand their business presence in Asia

and China, as well as Chinese companies going overseas." With his personal background as a successful industrialist with public service experience and a pioneer in the use of artificial intelligence, Dr. Chai hopes to preside over the next era of HKSTP's flourishing.

> **WE BELIEVE THAT HONG KONG IS THE BEST CITY LOCATION FOR OVERSEAS COMPANIES HOPING TO EXPAND THEIR BUSINESS PRESENCE IN ASIA AND CHINA, AS WELL AS CHINESE COMPANIES GOING OVERSEAS**
>
> — **Dr. Sunny Chai** HKSTP

Perhaps most importantly, HKSTP is able to point to concrete achievements in its nearly two decades of operations, from hosting over 680 technology companies, raising HKD 1.2 billion in direct investment in FY 2017/2018, and incubating three unicorn start-ups. In this way, Hong Kong's Achilles' heel of space constraints and sky-high real estate costs, may actually have been instrumental in ensuring that HKSTP focuses its investments and resources wisely. Without the luxury of space and cheap real estate, there is no chance of falling prey to the 'build it and they will come' mentality, resulting instead in purposeful, results-driven progress.

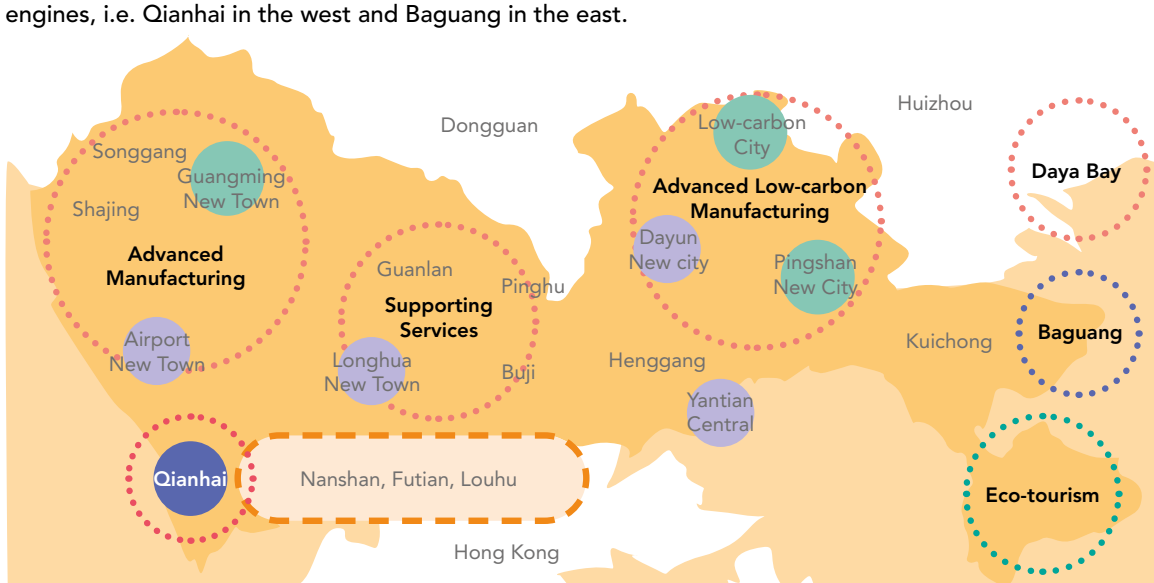
For this reason, the Hong Kong 2018-19 Budget has not only earmarked HKD 10 billion (USD 1.3 billion) for enhancing research and incubation at HKSTP, it has also promised HKD 20 billion (USD 2.6 billion) for the Hong Kong-Shenzhen Innovation and Technology Park in the Lok Ma Chau loop, which comes under HKSTP management. Situated on a 87-hectare piece of land between Hong Kong and Shenzhen, Dr. Chai outlines, "this will be the largest innovation and technology platform in Hong Kong, with the mission being to generate and exploit R&D synergies between Hong Kong and Shenzhen." This will ultimately further complement Guangdong province's recent innovation-driven development strategy with the Guangzhou-Shenzhen Science and Technology Innovation Corridor.

Across the region, entrepreneurs and other stakeholders are surely faced with almost a surfeit of options for launching their biotech start-up dream, though the choice must be a carefully considered one.

DEVELOPMENT PATTERN OF SHENZHEN

Qianhai in the west: finance - - effective, intensive and modern
Baguang in the east: biology - - scientific, new and ecological
Expedite the development of Shenzhen International Bio-Valley and drive its development through two engines, i.e. Qianhai in the west and Baguang in the east.

Source: Shenzhen Medtech Association



A BIOMEDICAL HUB FOR ASIA

Hong Kong, as a leading city in Asia, offers unprecedented opportunities for biomedical technology (BMT) companies from around the world – fuelled by increased funding and support from the Hong Kong Government and industries. Clinical trials in the city's two fully fledged clinical trial centres at the University of Hong Kong and the Chinese University of Hong Kong are recognised by regulatory authorities globally as well as the China Food and Drug Administration (CFDA).

HONG KONG SCIENCE AND TECHNOLOGY PARKS CORPORATION (HKSTP) - AN ADVOCATE FOR BIOMEDICAL TECHNOLOGY

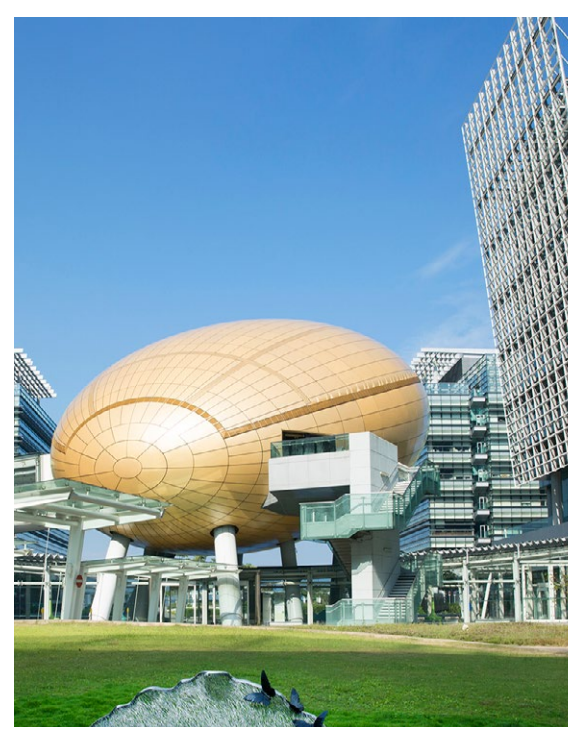
HKSTP puts its strategic focus on areas where Hong Kong boasts a distinct edge, especially in BMT. The HK$10 billion from the latest government funding earmarked for HKSTP will be invested in building research and advanced production facilities as well as boosting support measures for BMT. The increased funding is a testament to HKSTP's hard work.

HKSTP's BMT-related park companies are supported by HKSTP's state-of-the-art facilities at Hong Kong Science Park – including the Biomedical Technology Support Centre (BSC) and Healthcare Devices Innovation Hub (HDIH). BSC provides shared equipment, a cell culture room, genomics laboratory and other R&D tools, affordable technical support for local research and enables knowledge sharing and networking among partner companies. HDIH launched in March 2018, offers shared facilities and business development support for accelerating product development of healthcare devices, from prototype testing to clinical evaluation, and it provides a platform for bringing together biomedical device researchers and companies. Also, a four-year Incu-Bio programme – supporting programme members with office space facilities, technical and management assistance, promotion and development assistance, business support and financial aid packages – is custom-made to groom biomedical start-ups.

The efforts are delivering results as the biomedicine cluster has been growing rapidly. Around 100 of the over 680 companies at Hong Kong Science Park are doing work that promises to expand biomedical frontiers. Some of them are already seeing encouraging outcomes.

HONG KONG EMBRACES INNOVATORS FROM AROUND THE WORLD

As the Hong Kong Government is making a stronger commitment to build innovation and technology as a key pillar of the city's diversified economy, favourable policies are being implemented to attract local and overseas start-ups and technology talent. As a key connector in the city's innovation and technology ecosystem, HKSTP welcomes all innovators to establish a foothold in the city, which is an integral part of the Greater Bay Area comprising 11 major cities in southern China and is sure to present a multitude of opportunities to access the vast mainland China market.



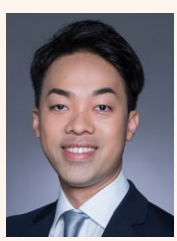
BIOTECH COMPANIES AT HONG KONG SCIENCE PARK

STANLEY SY
—
CEO, Sanomics

Sanomics Limited (Sanomics), a park company since 2005, has developed an innovative genetic testing service which is able to quickly and safely diagnose cancer. The liquid biopsy solution separates the blood plasma and blood cells in blood samples to test for abnormal genetic materials released by cancer cells into the blood plasma. The quick diagnoses help doctors determine effective treatment regimes and save valuable time and money.

Stanley Sy, CEO and Executive Director of Sanomics, said, "we have gained HKSTP's help in connecting with targeted investors, establishing partnerships with hospitals and R&D partners and winning government policy support." Its solution has been adopted by more than 80% of the private hospitals in Hong Kong and is being extended to specialist hospitals in other parts of Asia. Sanomics is developing Asia's first liquid biopsy centre in Hong Kong and looking to expand the liquid biopsy service beyond lung cancer to breast cancer and other forms of cancer.

"Hong Kong is the ideal base for the company because it offers an open market with unique strengths in precision medicine. It is also a good location for pharmaceutical and technology suppliers to test the market response to new products and develop their business. The approval process for new cancer drugs is faster in Hong Kong than in Mainland China, and patients are willing to travel from overseas to Hong Kong for diagnosis or treatment," added Stanley.



LANGSTON SUEN
—
founder and CEO, Opharmic

Opharmic Technology (HK) Limited (Opharmic), a member of HKSTP's Incu-Bio Programme since 2015, has been working on an ocular drug delivery device using non-intrusive ultrasound technology to replace needle-injected eye drugs, so patients no longer need to endure intravitreal injections and risk injury. It also makes eye drug delivery much easier, through a 5- to 15-minute procedure that can be administered by nurses.

"We received financing and market development assistance from HKSTP. Leveraging HKSTP's extensive network, we were able to participate in international exhibitions to explore cooperation opportunities. Our innovation garnered multiple awards at the 45th Geneva International Exhibition of Inventions in 2017," stated Langston Suen, Founder and CEO of Opharmic. The company will conduct clinical trials and obtain regulatory approvals on the use of the technology for the treatment of retinal and corneal diseases, on the road to becoming a holistic eye care platform covering both human and animal eye care.

LOUIS SZE
—
chief executive officer, Persona Surgical Modelling Co.

Persona Surgical Modelling Co., Ltd. (Persona), which has made Hong Kong Science Park its base, is delivering personalised healthcare through 3D printing, 3D modelling, 3D scanning, tissue engineering and material science. The company produces customised anatomical models, surgical tools and wearable devices after conducting individual medical image and body scans. Such personalised tools and materials are the most effective for applications in orthopaedics, neurology, cardiology and plastic surgery.

"Our research is supplemented by the state-of-the-art facilities at HKSTP, especially facilities for complex 3D modelling, material testing and small batch production. HKSTP's Healthcare Devices Innovation Hub (HDIH), which is fully equipped with 3D drawing and simulation software, 3D printers and testing facilities, are all available for our use. We also gained support from HKSTP in connecting with partners in the medical field and academia. We are ready to diversify our products and services to other vertical markets such as dentistry, rehabilitation science and bioprinting," commented Louis Sze, Chief Executive Officer of Persona.

HKSTP

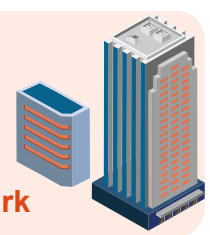
A VIBRANT INNOVATION AND TECHNOLOGY ECOSYSTEM IN HONG KONG

Comprising Science Park, InnoCentre and Industrial Estates, Hong Kong Science & Technology Parks Corporation (HKSTP) is a statutory body dedicated to building a vibrant innovation and technology ecosystem to connect stakeholders, nurture technology talents, facilitate collaboration, and catalyse innovations to deliver social and economic benefits to Hong Kong and the region.

Established in May 2001, HKSTP has been driving the development of Hong Kong into a regional hub for innovation and technology. We enable science and technology companies to nurture ideas, innovate and grow, supported by our R&D facilities, infrastructure, and market-led laboratories and technical centres with professional support services. We also offer value added services and comprehensive incubation programmes for technology start-ups to accelerate their growth.

Technology businesses benefit from our specialised services and infrastructure at Science Park for applied research and product development; enterprises can find creative design support at InnoCentre; while skill-intensive businesses are served by our three industrial estates at Tai Po, Tseung Kwan O and Yuen Long.

700+
Technology Companies **at Science Park**



550+
Graduated Incubatees **since Inception**

13,000 Working Population

21 Countries/Regions of Origin for Park Companies

9,000 R&D Practitioners

3.5+ Millions sq ft
Lab & Office space

FIRST Unicorn- SenseTime

HK$1,2 Billion Investment
Raised by Park Companies
(2017-18)

190,000
Lab Utilised Hours
(2017-18)

Achievements as of 31 July 2018 unless otherwise stated.

HKSTP 香港科技園

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CROUCHING TIGERS, HIDDEN DRAGONS

YUAN QING
president, Shenzhen Life Sciences and Biotechnology Association

CAI XIAOWU
Shenzhen Medical Devices Association

Perhaps only a few years ago, China had some of the largest companies that the rest of the world would never have heard of - before Alibaba Group's 2014 IPO USD 25 billion on the New York Stock Exchange, the biggest in history, propelled it and its extraordinary founder and Chairman Jack Ma Yun to global attention. In September 2018, the same week that Ma announced his retirement from the Chinese behemoth, its competitor and another Chinese giant, Meituan Dianping, is busily preparing for its IPO on the Hong Kong Stock Exchange. Meituan Dianping, described as the world's largest food delivery app but in reality is able to deliver almost anything and everything under the sun via its app platform.

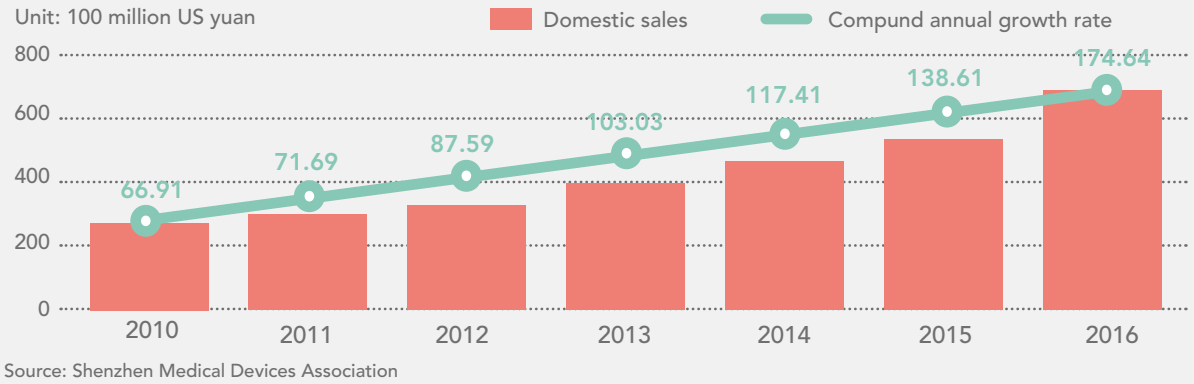
Shenzhen is today headquarters of some of the largest Chinese tech companies like Huawei and Tencent, who are going head to head with their US counterparts Apple and Facebook, if not in global prevalence than at least market capitalisation and technology development. In many respects, even as Silicon Valley pushes for the uptake of new digital technology like e-wallets and cardless payments, China has already far outpaced the rest of the world when it comes to mobile payments, with USD 15.4 trillion worth of mobile payments handled in 2017, more than 40 times that in the US.

The dizzying rise of such electronic and IT giants has fostered a robust ecosystem of both hardware and software capabilities and resources that acts as fertile soil for the growth of the medical devices, diagnostics and regenerative medicine sectors in Shenzhen. These areas, where much of the complexity lies more in the manufacturing and development processes rather than early-stage basic science research, unlike traditional drug development, have therefore boomed much more in Shenzhen than the conventional biopharma industry. As Shenzhen Life Sciences and Biotechnology Association President Yuan Qing shares, "Healthcare and life sciences is one of the five strategic industries that the Shenzhen government has identified. The Shenzhen life sciences industry is a huge market reaching CNY 200 billion, with 20 percent growth over the past few years. The medtech sector is comparatively more advanced and mature in Shenzhen versus the pharma sector."

Most notably, Shenzhen is the birthplace of the domestic Chinese medical devices industry with the first ever medical devices company, Anke, a joint venture between a US company and a Chinese state-owned enterprise. Still today, Shenzhen

DOMESTIC MARKET SCALE OF SHENZHEN´S MEDICAL DEVICES

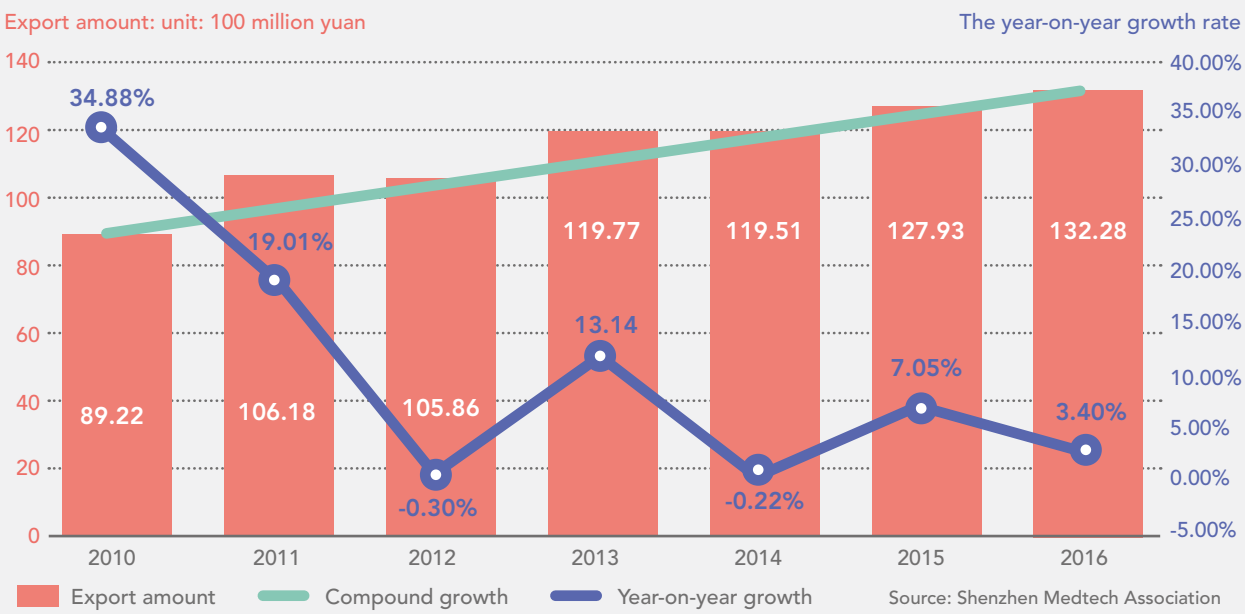
The compound annual growth rate of the domestic sales was 17.34%



Source: Shenzhen Medical Devices Association

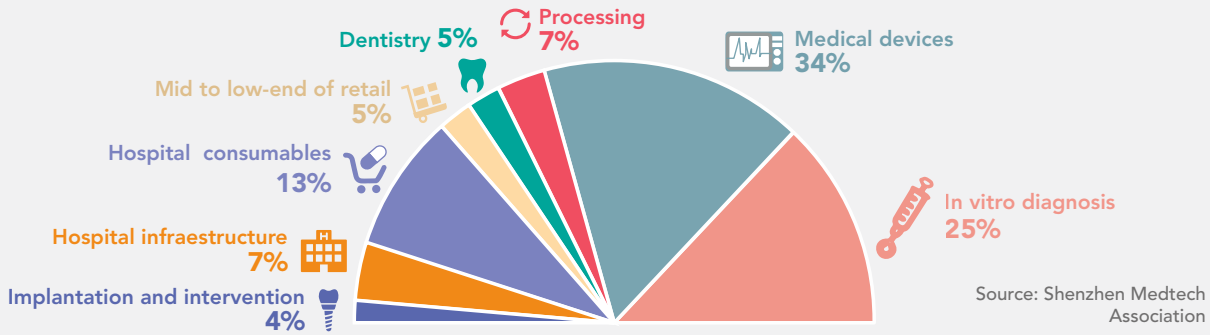
EXPORT GROWTH OF SHENZHEN´S MEDICAL DEVICE INDUSTRY FROM 2010 TO 2016

The compound growth rate from 2010 to 2016: 6.78%



Source: Shenzhen Medtech Association

PRODUCT FIELD DISTRIBUTION OF SHENZHEN´S TOP 50 MEDICAL DEVICE INDUSTRY MANUFACTURING ENTERPRISES IN 2016



Source: Shenzhen Medtech Association

SEAN HU XIANG
founder and chairman, Beike Biotechnology

GEORGE ZHANG
founder and chairman, PRO HIFU

produces nearly half of China's medical devices and equipment exports.

Today, the largest Chinese medtech company, Mindray, is headquartered in Shenzhen with CNY 11.2 billion (USD 1.6 billion) in revenues in 2017. Aspiring local IVD company KingFocus Biomedical Chairman and CEO Zhang Guojian quips, "in the Chinese medtech industry, there used to be a saying: on the international market, people differentiate between two types of products - Mindray products, and non-Mindray products." Nevertheless, the global recognition and reputation of Chinese and Shenzhen medtech companies are still lower than they should be, and not many seem to be aware of the Shenzhen companies quietly toiling away at the vanguard of biomedical research, sometimes for decades.

A prime example is Beike Biotechnology. Founder and Chairman Dr. Sean Hu Xiang established the company in 2005 as one of the world's first stem cell therapy company way before regenerative medicine became the buzz word it is today. Dr. Hu waxes nostalgic, "When we were established, we were the earliest company doing stem cell clinical translation. We realized that stem cell therapy had potential for more indications than just bone marrow transplants for leukemia, as they can release multiple cytokines that promote angiogenesis and reduce inflammation. We therefore started to treat different kinds of diseases, from neurological disorders to autoimmune diseases, using mesenchymal stem cells (MSC). Patients from countries like Canada, Australia, the US and the UK that had exhausted all conventional treatment options would come to us for stem cell therapy. No one understood the science behind this when Beike was established and we actually received some criticism from Western media." Today, of course, MSCs are widely accepted and there are a multitude of clinical trials involving their use.

Dr. Hu laughs, "we were right all along! In the innovative and technological sectors, sometimes if you are too early, the market is not ready for your innovations", Secure in their position as the industry pioneer, Beike is now forging ahead with yet another groundbreaking project to establish localised stem cell production facilities through China. Dr. Hu compares it to "the cell towers build throughout the country to enable full network coverage for mobile phones in China. We have thus far signed agreements with over 17 provincial and municipal governments to establish cell manufacturing centers there. Our mission is to build a comprehensive, highly regulated infrastructure and network for the use of precision medicine in China. We also have plans to extend this network internationally, once we establish a successful track record in China."

> **"OUR MISSION IS TO BUILD A COMPREHENSIVE, HIGHLY REGULATED INFRASTRUCTURE AND NETWORK FOR THE USE OF PRECISION MEDICINE IN CHINA. WE ALSO HAVE PLANS TO EXTEND THIS NETWORK INTERNATIONALLY, ONCE WE ESTABLISH A SUCCESSFUL TRACK RECORD IN CHINA.**
>
> — Sean Hu Xiang
> BEIKE BIOTECHNOLOGY

Looking globally, he suggests, "We are developing from a traditional stem cell therapy biotechnology company into a platform company ready to enter what I believe will be the huge field of personalized healthcare. I think the industry is at a tipping point. We are the pioneers in this area and we have accumulated many years of experience and expertise that we can share with latecomers."

With China simultaneously being one of the oldest civilizations and larges countries in the world, Shenzhen start-up PRO HIFU is proving that size and youth are no obstacle to market leadership. Founder and Chairman George Zhang introduces, "PRO is the pioneer of high intensity focused ultrasound (HIFU) Noninvasive Therapy, established in 2003. In the past few years, we have developed a series of ultrasonic treatment equipment, with the first, PRO 2008, launched on the market in 2012, specializing in gynecological non-invasive therapy. It is also one of the world's most advanced focused-ultrasound device." He continues, "We now have three products on the market and we expect to

obtain CFDA approval for two more this year. With five products on the market by the end of this year, that would make our product portfolio the largest in this area in the entire world - and what is even more impressive is that all of these products are highly innovative and developed in-house by us!

With the global medtech market dominated by American and European brands, who have 70 percent of the global market, a shrewd strategy is required for a plucky GBA company to carve out a niche. Zhang elaborates on PRO's competitive edge, "First and foremost, there are no big companies operating in this space. International giants like Siemens, GE Healthcare and Phillips have either have not invested or have divested their HIFU operations. Where there are competitors, they are very small, and often a few years behind us. [US companies'] R&D costs, particularly when it comes to clinical trials for US FDA approval, are probably around six times ours, and the timelines are around twice as long - and that only considers the domestic US market! European companies lack the necessary market size needed to grow. In Asia, there are a few smaller companies from South Korea and Taiwan, but these are not only small countries, they are also very tough to navigate from a regulatory perspective."

Therefore, he concludes, "our closest competitors are perhaps three to five years behind us! We are in an enviable position to become global leaders within this space, which is very exciting for a new Shenzhen company. We have already obtained CFDA approval and the European Union CE mark."

THE GENENTECH OF CHINA?

DR. LU XIANPING
president and CSO, Chipscreen

While the biotech scene in Shenzhen is eclipsed by the medtech industry, the same ingredients driving medtech start-up success can also work their magic in the biopharma space. Shenzhen is the adopted home of the first truly innovative Chinese biotech pharma company, Chipscreen, which has been called the Genentech of China. Cofounder and President Dr. Lu Xianping recounts: "I am originally from Chengdu city in Sichuan province, did my PhD in Peking University Medical College, went to the US for my postgraduate fellowship in the University of California San Diego (UCSD) and subsequently worked there for many years. When I returned 18 years ago, my team and I decided to establish our company in Shenzhen because we found it to be a very beautiful city with a vibrant immigrant culture, reminiscent of California in the US. We decided to bring our technology, our funds and our team here. This initial environment really supported our money-losing but innovative R&D effort."

After 12 painstaking years of R&D in Shenzhen's nurturing environment, Chipscreen launched their flagship compound, Chidamide, in 2015. Dr. Lu explains, chidamide is "a novel subtype selective HDAC inhibitor acting as an epigenetic modulator – it is the third in this area in the whole world, and the only subtype selective inhibitor in the world". He reflects, "When our results were published 10 years ago, it was not initially recognized because people doubted that such innovation could come from a Chinese company. Today, we have been widely cited in reviews and articles and companies in the world have developed other compounds in this class. We are now acknowledged globally as the pioneer of this class of compounds." Testament to this is the fact that Chidamide was selected to feature on the front and back cover as a case history study in the American Chemical Society (ACS) 2017's annual medicinal chemistry review. Dr. Lu exults, "Chidamide is the first non-FDA approved drug to be selected for this purpose, because it is not just a first-in-class but also best-in-class compound."

Not satisfied with this precedent, Dr. Lu is gunning for another first. "Chidamide is scheduled to submit NDA in Japan next year and phase III in US too by our partner. If work goes well, that would make us the first Chinese-discovered and developed innovative drug to receive approval in a highly regulated country like Japan or the US – ever!"

SHENZHEN´S TOP 30 MEDICAL DEVICE MANUFACTURERS IN 2016

#	Enterprise name
1	Shenzhen Mindray Bio-medical Electronics Co., Ltd.
2	Siemens Shenzhen Magnetic Resonance Ltd.
3	Flextronics Industrial (Shenzhen) Co., Ltd.
4	Winner Medical Co., Ltd.
5	Shenzhen New Industries Biomedical Engineering Co., Ltd.
6	Sonoscape Medical Corp.
7	Edan Instruments, Inc.
8	Respironics Medical Products (Shenzhen) Co., Ltd.
9	Hongbang Electronics (Shenzhen) Co., Ltd.
10	Flextronics Technology (Shenzhen) Co., Ltd.
11	Sanmina Electronics (Shenzhen) Co., Ltd.
12	Lifetech Scientific (Shenzhen) Co., Ltd.
13	Philips Goldway (Shenzhen) Industrial Co., Ltd.
14	Shenzhen BASDA Medical Apparatus Co., Ltd.
15	Shenzhen Anke High-tech Co., Ltd.
16	Modern Dental Laboratory (Shenzhen) Co., Ltd.
17	A&D Electronics (Shenzhen) Co., Ltd.
18	Shenzhen Glory Medical Engineering Co., Ltd.
19	Yaneng Biotechnology (Shenzhen) Co., Ltd.
20	Shenzhen Ant Hi-Tech Industrial Co., Ltd.
21	Rayto Life and Analytical Sciences Co., Ltd.
22	Shenzhen Comen Medical Instruments Co., Ltd.
23	SCW Medicath Ltd.
24	OrbusNeich (Shenzhen) Co., Ltd.
25	Masep Medical Science & Technology Development (Shenzhen) Co., Ltd.
26	Shenzhen Landwind Industry Co., Ltd.
27	Shenzhen Dongdixin Technology Co., Ltd.
28	Glory Medical Co., Ltd.
29	Shenzhen Juding Medical Equipment Co., Ltd.
30	ReLIA Bioengineering (Shenzhen) Co., Ltd.

FROM IMITATION TO INNOVATION

The Greater Bay Area's - and in particular, Shenzhen's - prowess in life sciences manufacturing and development must also be attributed to the decades of experience and expertise gained from acting as OEM/ODM to global companies, in line with China's overall positioning as the world's factory floor. One of the clearest indications of this can be seen in the fact that, Phillips and Siemens all have significant manufacturing operations in Shenzhen - and in fact, these global giants entered Shenzhen through the acquisition of local companies.

However, emerging from the proliferation of run-of-the-mill color Doppler ultrasound machines and various diagnostic platforms companies content to simply capture the low-hanging fruits of the booming domestic Chinese market are a few frontrunners determined to develop truly innovative products.

Xue Yuehui, Chairman and CEO of Lifetech Scientific, an interventional cardiovascular medtech company established in 1999, proclaims, "Ever since our establishment, we have decided to make innovation a strategic priority. This is reflected in our annual R&D investment, which has exceeded 20 percent for the past ten years or so. Today, Lifetech may not be one of the largest companies in Shenzhen but we are certainly one of the most innovative. Many of our products are often first or best in class in China and even globally." A great example is their most recent product, the LAmbreTM left atrial appendage (LAA) closure system, the first and only LAA closure system from China to receive the CE mark.

Xue is eager to dispel lingering myths about the lack of IP protection in China. He stresses, "China as a country is increasingly realizing that to become the innovative, high-tech, advanced country we aspire to be, we need to strengthen our IP regime. The Chinese government has made tightening IP regulations a priority. For instance, the CFDA plans to look at IP protection in its market registration and approval process, such as designating a window where a product under approval cannot be sued for IP infringement, or it will be rejected." Coming to Lifetech specifically, he affirms, "Lifetech has already advanced so far in front of our peers, we have strong innovation capacity and high R&D expenditure, so we are of course not interested in copying other people's products. We have the ability to create our own novel products. Now that China is talking about 'Made in China', we need to remember that manufacturing is not just copying or processing, it is about creating and producing."

XUE YUEHUI
chairman and CEO, Lifetech Scientific

SHINE LIU XIANCHENG
founder and CEO, Lifotronic

Industry veteran, Shine Liu Xiancheng, founder and CEO of Lifotronic, who started his career at Mindray in 1993 when it was still a start-up of 27 people, concurs wholeheartedly with this approach to innovation and IP. He remarks, "When I was at Mindray, the strategy was to follow what was called the international "GPS" - where GPS here stands for General Electric, Philips, and Siemens - follow their products and imitate their strategy. On the contrary, when I established Lifotronic, while I wanted to learn from the best practices of international companies like Medtronic and J&J, I was also committed to innovating and creating new products as a company."

He encapsulates his philosophy thusly: "It boils down to the concept of 'creating real value'. Of course, 'creating real value' is a very difficult concept. It is also a huge risk, because when you are investing in these new technologies and products, you have no idea whether they will succeed or fail until a few years later." Nevertheless, he is quick to reassure, "I am not a gambler. I have spent a significant amount of time analyzing and investigating the market to understand this concept of 'real value'. My job as CEO is to know the market extremely well - and I want to do this

because I do not see any future in simply copying other companies' products! That would be a very boring job."

He illustrates the practice of this concept with the example of Lifotronic's C-reactive Protein C (CRP) system, used in the diagnostic process to evaluate whether antibiotics are an appropriate treatment, explaining, "China restricts the use of antibiotics, so healthcare practitioners need to test before they can prescribe antibiotics. What we have done is produce a fully automated CRP system. This has won international recognition, because in January 2016, we signed a strategic supplying cooperation agreement with leading Japanese diagnostic company, Sysmex, who will act as our exclusive distributor in China. What is even more impressive is that Sysmex is selling this CRP product under the Lifotronic brand itself, not under their own brand! This is a huge achievement. almost all the top-tier hospitals in CHina are now using this product."

US President Donald Trump's 2018 lambasting of China's alleged IP violations and theft amidst the furore surrounding an escalating trade war between the US and China reignites the tired argument about China's weak IP protection regime and army of copycat companies.

CLUSTER RANKINGS BY PATENT AND PUBLISHING PERFORMANCE

TOP 10 CLUSTERS RANKED BY PATENTS

	CLUSTER NAME	NUMBER OF PATENTS
1	TOKYO-YOKOHAMA	104,746
2	SHENZHEN-HONG KONG	48,084
3	SEOUL	37,118
4	SAN JOSE-SAN FRANCISCO	36,715
5	OSAKA - KOBE - KYOTO	27,046
6	NAGOYA	18,837
7	SAN DIEGO	18,217
8	BEIJING	18,041
9	BOSTON - CAMBRIDGE	13,659
10	PARIS	13,318

TOP 10 CLUSTERS RANKED BY SCIENTIFIC PUBLICATIONS

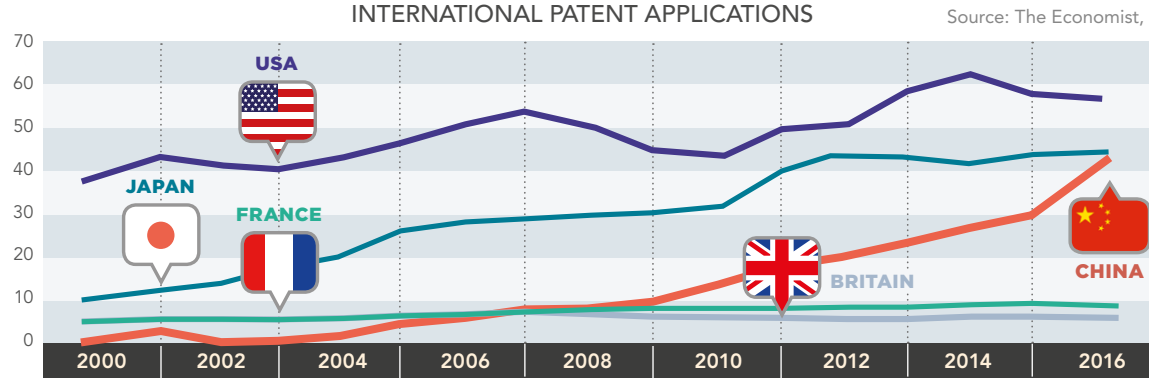
	CLUSTER NAME	NUMBER OF PUBLICATIONS
1	BEIJING	197,175
2	TOKYO - YOKOHAMA	141,584
3	SEOUL	130,290
4	NEW YORK	129,214
5	WASHINGTON - BALTIMORE	124,968
6	BOSTON - CAMBRIDGE	119,240
7	LONDON	104,238
8	SHANGHAI	102,132
9	PARIS	94,073
10	SAN JOSE - SAN FRANCISCO	90,238

Source: WIPO's Global Innovation Index 2018

SHENZHEN LEADS CHINA IN PATENT GENERATION

INTERNATIONAL PATENT APPLICATIONS

Source: The Economist, 2017



CHINA'S INTERNATIONAL PATENT APPLICATIONS BY CITY (%, 2016)

RISING TO THE APEX OF INNOVATION

SCOTT LIANG
president, Apex (Guangzhou) Tools and Orthopaedics

We have developed our portfolio of products under the brand 'iTool'. This is a very exciting development for Apex and we have most recently signed a distribution agreement with a well-established UK company for our latest product, the Apex Advanced Wound Irrigation System product, for global distribution.

I am personally very excited about this product because it was specifically designed for very difficult-to-heal wounds like pressure ulcer, diabetic foot ulcer, leg ulcer, and it is also very cost-effective solution. For instance, elderly or bedridden people often develop pressure ulcers, which this product can relieve. Diabetic foot amputation is also a major issue. It is reported globally that every 40 seconds, a diabetic foot ulcer patient has a certain grade of foot amputation and over 50 percent of these patients with foot amputation will die in fewer than five years! This product can save many people's lives.

This is a product that we have designed completely in-house, so it is another milestone for us. R&D is a very important aspect of our company as well and to date, we have over 20 patents. This year alone, we have applied for six! This is a testament to how far we have come, from starting as a medtech manufacturer to now having our own in-house R&D team and portfolio of products!

Currently, our company is split 50:50 between CMO and own product lines. In a few years, we expect our Apex brand products to grow to 70 percent of our business. This will be another transformation for us! We hope to become global leaders in the small niche area of disposable hospital products, where we are present.

Scott Liang, President of Apex (Guangzhou) Tools and Orthopaedics, which is also a member of US-based Colson Associates, is well-positioned to offer an incisive and balanced perspective. He muses, "IP is a global issue. Even within Silicon Valley, we can see that many of the tech companies like Apple often have conflict over IP rights with their peers, and the same is true with American pharma and medical devices companies." He adds, "What I have noticed is that US companies use the word 'reverse-engineering' for product improvement and development. Indeed, there is a difference between simply 'copying' and 'reverse-engineering'. No one can invent something from nothing. The medtech industry is built on a technological base and innovation is often incremental based on the current state-of-the-art technology. 99.99 percent of new products are developed by

FOCUSING ON INNOVATION

Purpose-driven, focused innovation is what has driven the success behind fledging Shenzhen IVD Point-Of-Care-Testing (POCT) start-up KingFocus Biomedical. Zhang Guojian, Chairman and CEO; and Zhang Erying, deputy CEO and Head of Research reveal how they managed to commercialize their groundbreaking quantum dots IVD POCT technology when US and European researchers failed.

Quantum dots are tiny particles or nanocrystals of a semiconducting material with diameters in the range of 2 to 10 nanometers – they are so small that they are deemed to be 'zero-dimensional', and behave like individual atoms. Zhang explains, "A very useful property is that they can be precisely controlled to perform certain functions. But The fundamental challenge was the inherent instability of the material. Precision, stability, consistency are all critical. You cannot ask a patient to provide multiple blood samples just because your technology is not so 'reliable'!

These nanocrystals were first discovered in 1983 at Bell Laboratory by Professor Louis E. Brus. "Yet within the life sciences sector, academic and research institutions across the US and Europe have been working with this material for decades now, with over tens of thousands of academic papers published on this subject, but no one has yet managed to successfully commercialise it," Zhang states.

This, more than anything, he adds, is what makes it remarkable that "we are the first team globally to have successfully industrialized this concept into a commercial product. We are now even able to manufacture our own quantum dots, where previously we had imported it from an American company. Our own quantum dots have a proprietary technology that makes them even more tailored for IVD use.

reverse-engineering, a real disruptive invention can only be found every 20 years. The reality is that the US is the most innovative and technologically advanced country in the world. Many countries in the world, not just China, are learning from American technology and innovation."

Nevertheless, Liang is sympathetic towards such concerns. "Apex has had our own products copied by other Chinese companies so I understand the frustration. At Apex, we do everything legally. We have in fact invested a lot of money and time in learning and acquiring new technologies. This is how we have been able to enter the US market ourselves and manufacture for US companies, who would not work with us if they would be worried about their IP being taken. Apex has had our own products copied by other Chinese companies so I understand the frustration."

Chairman and CEO of Considerin Group, Sheng Sitong, philosophizes, "I think it is useful to differentiate between incremental and breakthrough innovation. What you need for economic growth and industrialization, and what you need for true breakthrough innovation, are very different. While China can now move very quickly to build and scale up a productive industry, for highly innovative, breakthrough inventions, I do think the US still has a much stronger advantage in this respect, because it is also a matter of culture. In China, the system emphasizes more purpose-driven, focused innovation."

THE FUTURE INDUSTRY GOLD STANDARD

Zhang Guojian, Chairman and CEO; and Zhang Erying, deputy CEO and Head of Research, at KingFocus Biomedical, reveal the inner workings of a groundbreaking quantum dots in-vitro diagnostics (IVD) Point-Of-Care-Testing (POCT) start-up, determined to lead the next transformation of the sector.

Zhang Guojian
KINGFOCUS BIOMEDICAL

Zhang Erying
KINGFOCUS BIOMEDICAL

HCLS: What exactly is quantum dots technology?

ZHANG GUOJIAN (ZG): Quantum dots are tiny particles or nanocrystals of a semiconducting material with diameters in the range of 2 to 10 nanometers – they are so small that they are deemed to be 'zero-dimensional', and behave like individual atoms. A very useful property is that they can be precisely controlled to perform certain functions. It was first discovered in 1983 in the world renowned Bell Laboratory in Columbia University by Professor Louis E. Brus. Its most prevalent use thus far has been in display monitors for electronics in what is called QLED. Within the life sciences sector, academic and research institutions across the US and Europe have been working with this material for decades now, but no one has yet managed to successfully commercialise it, due to the inherent instability of the material.

We are the first team globally to have successfully industrialized this concept into a commercial product. Our own quantum dots have a proprietary technology that makes them even more tailored for IVD use. We are now even able to manufacture our own quantum dots, where previously we had imported it from an American company.

HCLS: How has KingFocus develop as a company since its establishment in March 2014?

ZG: We are a vertically integrated company with R&D, manufacturing and commercial sales, and have since grown extremely quickly over the past four years. We now have over 150 employees and a number of products with market authorization from the Chinese FDA. Our first product was launched on the Chinese market just over a year ago.

I am happy that we have managed to use one of the most advanced technologies and materials in this area, and over four years, convert a great technology into a great product! We have proven this through a global survey by RIQAS, which compiled results across 34,000 international laboratories, and certified that our technology is comparable to global giants like Roche and BioMerieux.

In total, we have three products on the market at the moment, starting with a PCT diagnostic product since 2015. We currently have 12 market authorization for different cardiovascular diagnostic kits, control reagents and medical devices. This quantum dots technology effectively acts as a platform: it can be used within a number of diagnostic fields, including but not limited to Immune Repertoire sequencing (IR-SEQ), Procalcitonin (PCT) and C-reactive Protein (CRP).

HCLS: As a new technology, how has the market responded to KingFocus' 'quantum dots IVD'?

ZG: The reputation of the Chinese medtech industry as a whole on the global stage is still very low.

For this reason, KingFocus has always placed product quality as its top priority and focus. For a medical technology or product, quality must always be the top priority for two reasons.

Firstly – and most importantly, it is our responsibility to the patient and end-user. Secondly, it is the only means of survival for the company. A company's development relies on its products.

Despite being a small and young company, KingFocus' products already have an excellent reputation in mainland China, because we have a strong network of good hospitals using our products and also through the State Ministry of Health's recognition.

We have a slightly different sales strategy from most Chinese medtech companies. Like many of the international medtech companies, instead of focusing on a purely commercial sales and marketing strategy, we emphasis medical education of healthcare professionals as a way of raising awareness not just of our products but the medical technology behind our products. After all, as the first company in the world to use this quantum dot technology in medical diagnostics, most, if not all healthcare practitioners have never heard of our technology! If they do not know about our technology, how can they trust and buy it? This is why we have invested significant efforts and energies over the past two years in providing medical education and awareness to healthcare practitioners, patients and distributors.

We have already successfully penetrated over 300 hospitals, of which over 100 are top-tier hospitals, which is a great achievement. Hospitals, especially the top-tier public ones, tend to favor the large established brands like Roche and BioMerieux. For new independent brands to break into this market is extremely difficult! Our strategy was therefore to conduct blind tests in front of hospital administrators, directors and physicians directly, placing our products in head-to-head competition with those of the big brands. This is the best way of proving to potential clients that our products are as good as, if not better, than those from the big names.

Once they are convinced of our product quality and strength, then our cost advantage over imported products from international players comes into play.

HCLS: Where do you hope to take KingFocus in the next five years?

ZG: The Chinese name of KingFocus Biomedical is actually "金准生物" - the first two characters are the characters for 'gold' and 'standard', which evokes our ambition to become the gold standard for POCT IVD globally!

We expect to break even in two years or so by diversifying our product portfolio and increasing our market penetration of Chinese hospitals.

In the longer term, we are very interested in expanding into international markets through potential partnership opportunities, whether through out-licensing, co-development, setting up affiliates or even M&A. We have already had some interest from established diagnostics companies.

At the end of the day, we just hope to better serve society and patients by developing our products. If a partner can help us in this mission, we welcome them.

GLOBAL LEADER IN HIFU THERAPY

George Zhang, founder and Chairman of Shenzhen PRO HIFU Medical (PRO), discusses the medical complexity and significance of the high-intensity focused ultrasound (HIFU) technology behind the products in his company's portfolio.

George Zhang
PRO HIFU MEDICAL

HCLS: George, could you introduce PRO to our global audience?

GEORGE ZHANG (GZ): PRO, is the pioneer of high intensity focused ultrasound (HIFU) Noninvasive Therapy, established in 2003. We operate in an extremely unique and niche market providing what we call non-invasive ultrasound treatment. Our team actually started the R&D in Shanghai. After a very long R&D period of around nine years, five of which were spent in clinical trials, we moved to Shenzhen for the commercialization stage.

We had two rounds of private capital investment for a total of around CNY 160 million. We also participated and won various governmental grants and competitions, such as the 2015 Innovation and Entrepreneurship Competition Enterprise. As a young and innovative company, we invest everything into our R&D.

In the past few years, we have developed a series of ultrasonic treatment equipment, with the first, PRO 2008, launched on the market in 2012, specializing in gynecological non-invasive therapy. It is also one of the world's most advanced focused-ultrasound device. We now have three products on the market and we expect to obtain CFDA approval for two more this year.

With five products on the market by the end of this year, that would make our product portfolio the largest in this area in the entire world - and what is even more impressive is that all of these products are highly innovative and developed in-house by us! With this product range, we also have high-end and low-end product options to cater to different market needs.

HCLS: Why has HIFU technology been relatively overlooked within the global medtech industry?

GZ: Firstly, there used to be some safety misconceptions surrounding high-intensity focused ultrasound, mainly because of the extreme precision required. Since then, a lot of research has been conducted proving that there are no safety implications, especially for HIFU.

In addition, there have been some market failures in the past with companies in the US working in the area of MRI-guided radiation therapy, which did not see success in the field of gynecology and subsequently moved to neurology.

However, we strongly believe that there remains a huge market in ultrasound guiding. In particular, Chinese companies have made significant progress in this area over the past 15 years. New technologies are now advanced enough to bypass any potential safety issues.

HCLS: How confident do you feel about the future prospects of this niche - and consequently, PRO?

GZ: With the previous track record of failed investments, this market is also very under-invested, even non-invested, market!

In addition, ultrasound is a very familiar concept to consumers and patients, and it appeals in particular to women. It is very easy and safe to operate.

The Chinese government also strongly supports the development and use of such technologies. As an indication, the government has increased the public reimbursement price of ultrasound therapy in Shanghai from CNY 2,400 to CNY 10,000. This is very important because a low reimbursement cost of ultrasound therapy discourages doctors from using it.

> **WE HAVE DEVELOPED A SMALL, VERY PRECISE ROBOT, THAT CAN BE CONNECTED TO ANY EXISTING ULTRASOUND DIAGNOSTIC SYSTEM TO HELP LOCATE AND POSITION**

The ultrasound and diagnostic device markets are quite big. 20 years ago, when I first entered this market, one hospital will only buy one unit. In China today, a hospital will buy 40 to 50 units! The market is growing so fast – around 15 to 20 percent, though from a small base, as only the top hospitals will buy new, innovative products like this at the moment. We also offer leasing programs to private hospitals. We are waiting for the middle base of hospitals to catch up.

In my view, the ultrasound therapy market shares the same characteristics as the ultrasound diagnostic market. As it is non-invasive, every clinical practice can use it. We plan to launch different product lines catering to the individual needs of different hospital departments, from gynecology to oncology to radiology and so on.

In China, our hospitals have unique ultrasound departments. They currently do diagnostics but they can also offer ultrasound therapy because doctors, not technicians, run those departments, unlike in other countries where ultrasound diagnostics are conducted by technicians. We have developed a brand new product, a small, very precise robot, that can be connected to any existing ultrasound diagnostic system to help locate and position.

HCLS: What are you most excited about for PRO in the next few years?

GZ: A great achievement I would like to highlight is that our company broke even last year! This is a great milestone for a medtech start-up. We now have 126 employees, most of which work in R&D. Rather exceptionally, we also have 11 doctors on our medical team to support our clients in installation, training and delivery. Our training process typically takes one month, which is much shorter than the three to six months it might take for other products. We are developing our AI platform to decrease that time even further to two weeks.

We are also in the middle of conducting clinical trials for pancreatic cancer. This would be the first product in the area of tumor therapy in the whole world, so we are very proud.

We are a market innovation company. What this means is that we do not simply focus on our products alone but we develop products specifically to meet customer needs or even drive market trends.

We also hope to IPO in three years. This will give us the resources needed to drive further growth.

Ultimately, we aspire to be the world's most powerful therapy company.

A PLAYGROUND FOR NEW HEALTHCARE MODELS

With such a vast market, the fragmentation of healthcare provision and services across provincial and municipal health authorities as well as variously tiered public and private hospitals, and great healthcare needs, China offers entrepreneurs a giant playground to develop, test and most importantly, deliver their diverse ideas and solutions to the Chinese population.

TIAN YAOLIN
CEO, Shenzhen Govita

Tian Yaolin, CEO, Shenzhen Govita: "Govita Health is a relatively young company focusing on healthcare management and preventative medicine, established in January 2016. We have a sister company, Govita Laboratory, based in Hong Kong, established in June 2015. As a company, our core business is on healthcare management, preventive medicine and anti-aging. In mainland China, there is a concept called 'sub-health' (亚健康), which refers to the state between health and disease where a person may not be diagnosed with any particular condition but exhibits some mild symptoms of disequilibrium.

As a testing laboratory, we are unique because we not only provide the test results, which are after all just reports, but we can also create a personalised treatment and management program based on the individual's test results. Through this, we can offer one-to-one, personalised services like drug regimen monitoring, food and sleep tracking, and fitness programs. We also provide digital health technology like wearable medical devices. All in all, we are able to provide our clients with an advanced, comprehensive and personalised healthcare management program."

ANDY A. LIU
CEO, CW Data Technologies

Andy A. Liu, CEO, CW Data Technologies: "CW Data is a joint venture between two very large organizations: WuXi AppTec and China Electronics Data Corporation. The healthcare ecosystem is highly fragmented. CW Data is a Big Data Healthcare company focused on taking the vast amounts of data that we have on hand, as well as other existing data to help provide a better and more clear view of healthcare information for all the stakeholders from hospitals to patients. We have experts in healthcare, data analytics and health technologies. Ultimately we want to help better manage healthcare priorities and processes, for all stakeholders by leveraging big data insights.

The model itself is very unique: you have China Electronics, a large electronics data enterprise, and you have WuXi AppTec, one of the largest and most successful healthcare company working together to solve important healthcare challenges."

Simon Liang, Chairman and CEO, Glory Medical Group: "When we started, the Chinese healthcare and medical industry was really behind global standards. There was a huge gap between the needs of the people and the hospital and medical facilities available in China. I wanted to help improve healthcare conditions for ordinary people. Today Glory Medical offers a turnkey hospital project solution, delivering all aspects of hospital construction from design to engineering to construction to procurement, as well as financing. We have participated in the construction of over 1,400 hospitals in China. We also own, manage and operate 12 hospitals ourselves!

"The one-stop turnkey model is particularly suited to the Chinese market because the Chinese mentality is that it is better to hire one company to handle all aspects of the project. It is more efficient and cost-effective. If many companies are involved in a project, there is a tendency for the project to become very messy."

SIMON LIANG
chairman and CEO, Glory Medical Group

"We already have operations in Sri Lanka and Pakistan, and are exploring projects in Indonesia and Bangladesh, as well as in Latin America and the Middle East. Countries with large populations offer the most opportunities for us, such as Asia, and also along The Belt and Road countries."

Dr. Chen Hao, CEO, Imsight: "When I graduated from my PhD in 2017, I had a strong desire to explore how far AI technology could go in the medical field. As more medical diagnostics testing centers were becoming available in China, I quickly realized AI technology could be transferred into clinical practice. I could have joined the San Francisco based company, Enlitic, the first medical imaging analysis company using artificial intelligence that I visited four years ago. However, the fact thatthe US did not collect much data and that its hospitals were very cautious with data collection, made me reluctant to start in this market."

DR. CHEN HAO
CEO, Imsight

Our government and also Chinese hospitals in general are now extremely curious and eager to try AI technology. AI is a key priority for the national strategy, and healthcare is one of its three main applications, alongside surveillance and drive-less cars. With our headquarters in Shenzhen and a branch in the Hong Kong Science and Technology Park, Imsight is today one of the fastest growing companies using AI for medical imaging analysis in Greater China, already raising RMB 100 million (USD 15.7 million) from Shenzhen Capital Group and Lenovo Capital. We aim at being the next unicorn for AI in medical imaging."

Dr. David Peng, CEO, Medical Excellence International: "We act as a family office within the healthcare domain, exclusively serving our club members. In essence, we manage the health of high net worth individuals and their family members, offering two memberships. The first, the Life Membership, is a preventative program that enables our members to enjoy a comprehensive and tailor-made health check-up annually in the hospitals within our network in New York, London or China.

DR. DAVID PENG
CEO, Medical Excellence International

Our second membership is called Global Medpass, a membership-only access that covers the above-mentioned interventional aspect only. It also excludes access to our Chinese medical network. Clients that choose this membership often have very severe or complicated diseases, and the usual treatments they have access to might have failed. This is why they come to us to see if we can offer help within our available medical resources. Those two memberships are very valuable to our members, because they provide them with the fastest access to the best medical institutions and physicians at a competitive price."

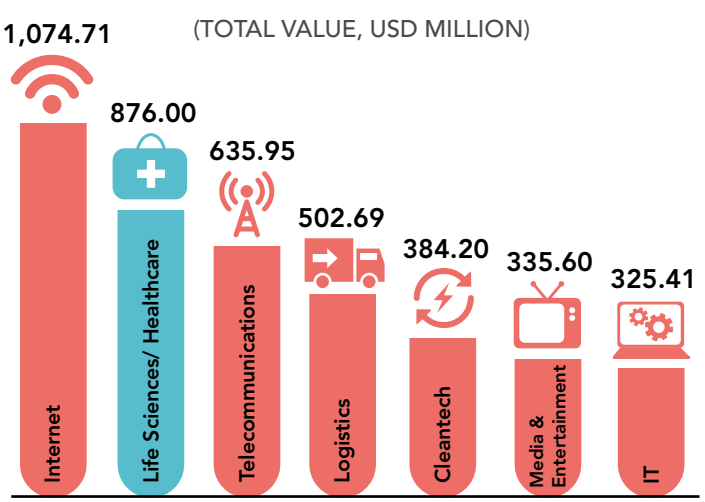
TO VENTURE INTO NEW TERRITORIES

Cash has always ruled the start-up world and when it comes to the healthcare and life sciences sphere, the heavy investment required for R&D and the long timelines make it even more so. Luckily, China is now the second-largest VC market in the world, and a recent Preqin report highlighted that USD 65 billion of venture capital investments were made in Greater China last year, a 35 percent increase year on year and an all-time high, second only to North America with $77 billion.

For investors in the region, the sheer potential of the industry is irresistible. For Tang Dajie of Triwise Capital, an industry veteran that spent a few decades at China's largest VC fund, Shenzhen Capital Group, before deciding to strike out on his own, the choice of biotech was obvious. He shares, "What is interesting about China is that when you look at our largest tech companies - Huawei, Tencent, and so on - their market value is around USD 500 - 600 billion - essentially comparable to top American tech companies like Facebook, and relatively close to Apple and Amazon. Within the digital space, there is no longer a significant gap between leading Chinese companies and leading American companies. However, looking at the life sciences arena, the largest Chinese company here is Jiangsu Hengrui, with a market capitalization of around USD 37 billion. This is only 10 percent of Johnson and Johnson's USD 367 billion! There is therefore an obvious huge gap between the Chinese and the US life sciences industries - which means a huge opportunity for investment and returns on that investment."

He supplements, "I also wanted the opportunity to be able to

CHINA'S VENTURE CAPITAL INVESTMENT BY INDUSTRY SECTOR, 2013



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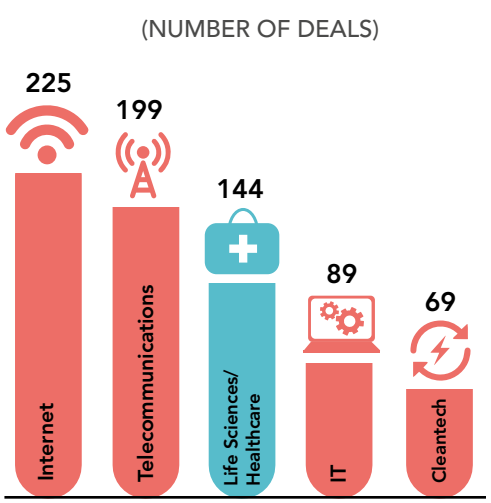

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> **IT IS CLEAR THAT YOU NEED TO HAVE THREE PILLARS: STRONG ACADEMIC RESEARCH, ROBUST FINANCING OPTIONS, AND MATURE PHARMA DEVELOPMENT EXPERTISE**
>
> — **Ian Huen**
> APTORUM GROUP

contribute to society and improve people's quality of life. Given all these external and internal factors - and when you consider the CFDA (Chinese FDA) reforms being conducted – I firmly believe that the Chinese healthcare and life sciences industry is poised on the brink of explosive growth. Shenzhen offers the best development opportunities for both companies and investors in this space."

Hong Kong, one of the top finance hubs in the world, has traditionally focused on the reliable real estate sector. However, for founder and CEO of Aptorum Group, a leading Hong Kong biotech company, Ian Huen, himself an investor, Hong Kong is the ideal location to establish a biotech hub. "Drawing upon the examples of Cambridge Massachusetts and San Francisco in the US, it is clear that you need to have three pillars: strong academic research, robust financing options, and mature pharma development expertise – very different skill sets, but all critical to the process."

He breaks each of them down systematically. "Looking at the top 50 medical schools globally, for instance, only around half are in the US and the rest are in these non-US English-speaking countries. If Hong Kong positions itself correctly, it can leverage not only on its own research excellence but also the work of these other countries." In terms of the financial pillar, and in particular relating to capital mobility, "Hong Kong is part of China and so has access to the Chinese capital markets. At the same time, Hong Kong has a freely floating currency and open capital accounts, which is critical for biotech development because it is such a global industry." Finally, commercial acumen is key, which is why, despite Hong Kong's lack of a strong domestic pharma sector, Aptorum, found Dr. Thomas Lee, who has over ten years of industry experience with giants like Novartis and Celgene, and was also the Professor of Pharmacology at The Chinese University of Hong Kong (CUHK) to head the group's therapeutic arm.

Huen sums up pithily: "I like to draw this analogy. Hong Kong had a great biomedical success story last year with Professor Dennis Lo's Cirina, and he is an amazing scientist – like Superman, he managed to develop his liquid biopsy technology single-handedly. However, pharmaceutical drug development needs the Avengers: a multidisciplinary team of many talents from microbiology, chemistry, pharmacology, clinical trials and so on – and of course, finance and investment! Superman alone cannot do it."

SPECULATING ON BIOTECH STOCKS

According to the Global Financial Centres Index, Hong Kong has the third-most competitive financial centre in the world, after London and New York. Perhaps most uniquely, however, is the fact that Hong Kong's status as an international financial centre is firmly embedded within the country's Constitution. The Hong Kong Stock Exchange (HKEx), one of the world's largest and healthiest, has the sixth-largest market capitalization in the world, just after Shanghai, at USD 3.3 trillion in 2017. However, with various Asian stock exchanges jostling with each other to attract new economy companies and dual-class shareholding structure firms to list, neither HKEx nor Hong Kong itself can remain complacent. A positive step has been HKEx's decision to change its listing rules to allow pre-revenues biotech companies to list subject to specific external development milestones, which has sent excitement reverberating through biotech players across Greater China and even Asia-Pacific. As of September 2018, 13 companies have filed for an IPO and two companies, Ascletis Pharma and BeiGene, have successfully listed.

ON THE STOCK CONNECT

• Shanghai-Hong Kong Stock Connect is a cross-boundary investment channel that connects the Shanghai Stock Exchange and the Hong Kong Stock Exchange. Under the program, investors in each market are able to trade shares on the other market using their local brokers and clearing houses. Chinese Premier Li Keqiang announced the programme on 10 April 2014. The scheme launched on 17 November 2014. On 16 August 2016, a similar scheme was announced for the Shenzhen Stock Exchange and the Hong Kong Stock Exchange and the scheme launched on 5 December 2016.

• Under the program, investors in each market are able to trade shares on the other market using their local brokers and clearing houses. Chinese Premier Li Keqiang announced the programme on 10 April 2014. The scheme launched on 17 November 2014.

• Mainland Chinese investors have traded a total of HKD 3.32 trillion worth of Hong Kong stocks since the launch of the two channels, while international investors have trade a total of HKD 4.1 trillion worth of Chinese stocks.

• Interestingly, the third-favourite pick of international investors is Jiangsu Hengrui Medicine, the largest pharma company in China.

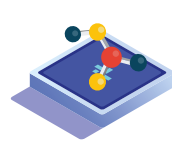
HKEx has been careful to list a number of external milestone requirements should pre-revenues biotech companies wish to list, and they have also convened a Biotech Advisory Panel of leading industry experts to provide guidance. However, some industry insiders have already started to sound a cautionary note amidst fears of the nascent biotech market in Hong Kong overheating. Despite no small amount of hype, both Ascletis' and BeiGene's listings saw lacklustre demand and both are now trading below their respective IPO prices. Dr. Lu Xianping, cofounder and President of China's first truly innovative biotech company, ChipScreen, warns, "The public funding situation has changed a lot in the past five years, so much so that I do see a bit of a bubble forming. Even a newly established company with just an idea but no products can somehow be valued at CNY 500 million (USD 73 million). The challenge is that any Chinese scientists are only focused on making quick money in hot areas, looking at the short term. I hope this mentality changes, because otherwise, the bubble will burst one day and companies will realize that their products are not truly globally competitive."

Veteran investor, Nisa Leung, Managing Partner (Healthcare) of Qiming Venture Partners, observes, "we have been seeing the pouring of money into traditional drug development. It is staggering that we have seen multiple pre-clinical companies raising USD 150-200 million in Series A. We have had to back away from a few companies, who had received multiple termsheets with USD 400 million valuations, without a single IND. These are not the kind of investments Qiming would consider, but there are investors doing this. Part of this stems also from the fact that new investors without a biotech background are now entering the sector."

As one of the first few VCs in China when it was established in 2006, Qiming has since built up an enviable track record. In 2018 alone, Nisa recounts, "we closed three funds – a USD 935 million fund, our fifth RMB fund with RMB 2.1 billion (USD 310 million), and our first US-based healthcare fund with USD 120 million – and now manage a total of USD 4 billion. 40 percent of that goes to healthcare, and oversaw 11 IPOs. Six of these have been healthcare-related." Looking back, she summarizes, "In total, we have invested in around 280 companies and 80 of those have been in healthcare, so you can see that healthcare is a very significant sector for us. Out of the 280, we have had over 60 exits, either in the form of IPOs or M&As."

With this extensive experience, she is able to speak authoritatively on recent developments. "As an investor, the changes at HKEx are definitely very exciting because it means another channel for our companies to exit. Having gone through a few US IPOs, it is much easier for Chinese companies to list in Hong Kong than in the US for a number of reasons. There is less travelling involved in the roadshows. Hong Kong investors are far more knowledgeable about the Chinese tech and biotech scene, and also already travel to the mainland quite often. There are the Shanghai and Shenzhen Stock Connects, which allows Chinese investors to invest in Hong Kong-listed companies. Public institutional investors like Fidelity and Wellington all have emerging market funds based in Hong Kong, whose mandates would be to invest in Asia, whereas US-based investors may not necessarily see investing in US-listed Chinese companies as part of their mandate.

She is circumspect about the challenges and opportunities ahead. "There have been many new investors and actors entering this space. Biotech is a very specialist industry so there is a need for investors, entrepreneurs and other stakeholders to educate themselves. Stakeholders need to understand that there is a cycle as well. We are already starting to see this, perhaps, because VC fundraising in China has dropped by 40 percent in H1 2018. It took the US biotech investment market 30 years to mature. Even though Hong Kong is able to learn from lessons of other stock markets, it will still take around a decade for Hong Kong to mature."



> **BIOTECH IS A VERY SPECIALIST INDUSTRY SO THERE IS A NEED FOR INVESTORS, ENTREPRENEURS AND OTHER STAKEHOLDERS TO EDUCATE THEMSELVES**
>
> — **Nisa Leung** QIMING VENTURE PARTNERS

HKEX BIOTECH LISTING ELIGIBILITY CRITERIA

A core product forms the basis of a biotech company's listing application and such core product must be evaluated and approved by one of the specified competent authorities (see below) before it can be marketed and sold.

At the time of the listing application, a biotech company must have developed at least one core product beyond the concept stage.

CORE PRODUCTS	EXTERNAL DEVELOPMENTAL MILESTONE
Pharmaceutical (small molecule drugs)	· Phase I clinical trials completed; and · Competent Authority has no objection to commence Phase II clinical trials.
Biologics	
Medical Devices (including diagnostics)	· At least one clinical trial on human subjects has been completed; · The product is classified as a Class II · Medical device or above; and · Competent Authority has no objection to the applicant proceeding to further clinical trials or commencing sales.
Other Biotech Products	· HKEx will consider other biotech products on a case-by-case basis to determine if the core product has been developed beyond the concept stage.

COMPETENT AUTHORITIES

HKEx recognizes the following three authorities in the US, China and Europe as competent authorities to evaluate and approve core products:

- US Food and Drug Administration (FDA)
- China Food and Drug Administration (CFDA)
- European Medicines Agency (EMA)

HKEx has the discretion to recognize other national or supranational authorities on a case-by-case basis.

OTHER REQUIREMENTS

- A biotech company must have been engaged with the R&D of its core products for a minimum of 12 months before listing.
- The primary reason for listing must be fundraising for the R&D and commercialization of its core products.
- For pharmaceutical R&D, the company must demonstrate a pipeline of those potential products.
- To demonstrate market acceptance of a core product, a biotech company must have received meaningful investment from at least one investor who is considered as sophisticated with reference to such investor's net assets, experience, knowledge and expertise, at least six months before the date of the proposed listing and remain at IPO.
- A biotech company must have registered patents, patent applications and/or intellectual properties in relation to its core products.

Minimum market capitalization	1.5 billion HKD (approximately 190 million USD) at the time of listing
Track record	Operate in the same business under substantially the same management for at least two financial years
Working capital	125% of the group's costs for a minimum of 12 months
Cornerstone investors	Shares allocated to a cornerstone investor will not be counted towards the minimum public float requirement (25% as a general requirement) at the time of listing and in the first six months after listing

AN ARRANGED MARRIAGE – MADE IN HEAVEN?

It seems like a match made in heaven: Hong Kong brings the academic research, healthcare excellence and financial services, while Shenzhen brings the hardware capabilities, funding, and manufacturing and industrial space – and a rapidly developing transport infrastructure brings them even closer together. But the region still faces the challenge of 'One Country, Three Systems', and when it comes to the healthcare and life sciences sectors, regulatory alignment is still the most critical missing piece.

For clinical research, the potential for collaboration is still high, with the Chinese FDA recognizing clinical trials data from the two clinical trials center in Hong Kong, HKU CTC and the CUHK Clinical Trials Center. As Gene Shigekawa from MAZ World, the first and only Japanese biomedical company to be based in HKSTP, explains, "Our company has been in Hong Kong since 2012, and decided to move to HKSTP in 2017 to focus more on R&D and commercialization activities. Japan is somewhat a closed market and inaccessible for international business development. We believe the innovation in antibody technology we bring can have a significant impact on society, therefore we wanted to jumpstart several projects simultaneously. The financial dynamics in Hong Kong is very attractive, in addition to the opportunity to access the mainland China, one of the biggest emerging markets in the world. The challenge we face is that the regulatory system in China is very different from those in the rest of the world. However, as a tenant of HKSTP, all of the results of any research done here will be recognized by the Ministry of Health in China. Therefore, our operations here in Hong Kong can be considered the MAZ World hub for international development."

Their technology is revolutionary, and have been endorsed by the Japan Science and Technology Agency (JST). The process involves injecting ostriches with specific antigens and harvesting the antibodies from their eggs. One unfertilized ostrich egg can provide the same amount of antibodies equal to 800 rabbits, and the antibodies produced are more resilient: resistant to higher pH levels and can remain active even when exposed to heat of up to 100 degrees Celsius.

He shares, "Our current priority in Hong Kong is to launch a flu mask product into the Chinese market. Influenza is one of the leading causes of death worldwide and there have been several outbreaks of avian influenza reported in China, including Hong Kong, so we believe there is a clear medical need in the region."

For Govita, Hong Kong and Shenzhen offer a win-win proposition. CEO Tian Yaolin elucidates, "while Hong Kong has excellent R&D capabilities and expertise, as well as highly skilled professionals, there are also space and market constraints. For instance, our laboratory space there is only around 300 square meters while our total area in Shenzhen, combining our office space, laboratory and clinic, spans over 4,000 square meters. Furthermore, there are restrictions regarding the transport of mainland Chinese blood samples across the border to Hong Kong. Mainland Chinese blood samples can only be sent to mainland Chinese Labs for testing. Shenzhen's proximity to Hong Kong means that both labs can support each other on various projects and initiatives, and leverage on synergies, versus if we had established our Chinese affiliate further away in Shanghai or Beijing."

> **"REGULATORY ALIGNMENT BETWEEN HONG KONG AND MAINLAND CHINA IS A VERY CRITICAL ASPECT**
>
> — **Rupert Mok** METOS HEALTH

Nevertheless, further down the value chain, the regulatory challenges are more acute given the lack of regulatory alignment between the Hong Kong Department of Health and the Chinese FDA. Veteran of the Hong Kong Medical Devices industry, Rupert Mok, CEO of Metos Health, emphasizes, "regulatory alignment between Hong Kong and mainland China is a very critical aspect. For many start-ups, especially, this is a concern, because if they would like to develop a medical product (as opposed to a healthcare product), they have to go through the regulatory approval process, which is time-consuming and costly. The Chinese FDA has relatively looser regulations for locally manufactured products, but Hong Kong products are treated as foreign products. This is a significant disadvantage for the Hong Kong medtech industry. Resolving this is of utmost importance for the future growth and development of the Hong Kong medtech industry."

DIAL 'D' FOR DIAGNOSTICS

With such low barriers to entry, support from the Chinese government in preventative health and growing consumer demand and affluence, many Chinese start-ups are now entering the diagnostics space. However, beyond carving out a competitive niche amidst the other start-ups jostling for space, not to mention Western diagnostics giants as well as the Chinese behemoth, Mindray, astute entrepreneurs understand the urgency of developing a sustainable commercial model if they are to be viable in the longer term.

Ricky Chiu, CEO of Phase Scientific International, an American company established in 2012 that recently relocated to Hong Kong, indicates, "Currently, the diagnostic landscape has two extremes: rapid point-of-care tests, which are inexpensive, easy to use and fast [but] not accurate or sensitive enough, and their applications limited to pregnancy tests or blood glucose level tests; versus laboratory assays, which although more accurate than the former, are expensive, take a long time to use and require the presence of well-trained technicians."

> **"CURRENT POINT-OF-CARE TESTS ARE SERVING ONLY A SMALL PORTION OF THE MARKET... THE POTENTIAL TO DEVELOP THIS AREA FURTHER IS UNTAPPED**
>
> — **Ricky Chiu** PHASE SCIENTIFIC INTERNATIONAL

Therefore, while the diagnostics field may seem overcrowded at a glance, there are still many unmet medical needs. He opines, "current point-of-care tests are serving only a small portion of the market. Currently, only two such tests are used regularly – pregnancy tests and glucose sugar level tests. So the potential to develop this area further is untapped."

Phase Scientific has developed a simple but effective technology to improve the efficacy of both point-of-care tests and laboratory assays. Ultimately, for him, success lies in developing "highly accessible tests which are affordable for everyone with effectiveness as the main benefit". He adds, "Looking at the point-of-care tests, it is essential that they remain non-invasive whilst concentrating on infectious diseases. We also want to respond to the consumer's desire for home-based tests, which helps them avoid the potential for embarrassment if they have to go to the clinic to be tested, especially for sexually-transmitted diseases."

RICKY CHIU
CEO, Phase Scientific International

QIU JIAZHOU
chairman, H-Guard

For Qiu Jiazhou, Chairman of H-Guard, another IVD company based in Shenzhen, what helps the company stand out from the crowd is their focus on the early diagnosis and screening of cardiovascular diseases. He reveals, "a native Chinese, I did my postdoctoral work at Tufts University in the US [and] spent nearly 30 years in the US and am an American citizen. Prior to returning to China, I was Chief Scientific Officer of IGAN Biosciences, a biotech company developing a drug for a very rare disease, IgA nephropathy. In 2012, IGAN Pharmaceuticals was acquired by Shire. I was inspired by this success

PROFESSOR MICHAEL YANG
head & chair professor of the Biomedical Sciences Department, City University of Hong Kong

to continue to look at areas of unmet medical need. Our technology has been available in the US and Europe for a number of years now but not in China. When I established H-Guard in Shenzhen, we were the very first company to bring this technology into China!"

More relevantly, Qiu had seen the burden of cardiovascular disease on the Chinese population. He cites, "Cardiovascular disease accounts for 44 percent of deaths in China and is one of the leading causes of death nationally, along with cancer. An estimated 290 million Chinese people – nearly the population size of the US – suffer from cardiovascular diseases."

More critically, on the commercial side, he adds, "What fundamentally differentiates us from many of the other IVD companies now cropping up in China is the fact that we have our own independent core technology for not only the hardware and software but also the biomarkers themselves, which are monoclonal antibodies. We have our own patents and IP relating to this technology so we can manufacture them locally. Many other IVD companies in China would have to import foreign-manufactured biomarkers. This not only means that our technology is truly innovative and belongs to us, but also that our cost base is much lower."

> **"AN ESTIMATED 290 MILLION CHINESE PEOPLE – NEARLY THE POPULATION SIZE OF THE US – SUFFER FROM CARDIOVASCULAR DISEASES** — Qiu Jiazhou H-Guard

Arguably most well-known within the region, however, is Prenetics, recognized as the hottest start-up in Hong Kong in 2017 by HK Magazine. Offering a platform of genetic tests from genetic disease risk screening, cancer screening, and family planning screening, in addition to a digital app that allows patients to understand their test results and translate it into actionable items based on nutrigenomics and pharmacogenomics, Prenetics secured USD 40 million in Series B funding in 2018 and looks prime to expand its global presence, with a recent acquisition of U-based DNA-Fit. As cofounder Professor Michael Yang, currently Head & Chair Professor of the Biomedical Sciences Department, City University of Hong Kong, reminisces, "Prenetics was the first biotech company admitted into the Hong Kong Science Park's biotech incubation program. Today, it has grown into the largest consumer genetic testing company in Hong Kong and Southeast Asia!"

NEW FRONTIERS IN CELL REPLACEMENT THERAPY

Cathy N.P. Lui
OPER TECHNOLOGY

HCLS: Cathy, could you please share with us the story of why and how OPER Technology was established in 2014?

CATHY N.P. LUI (CL): After many years of research, in 2013, we officially announced to the public that our invention, 'Autologous Neural Stem Cell Harvest', which we developed at Hong Kong Baptist University (HKBU), could be the first potential treatment providing a cure for neurological disorders rather than simply providing symptom relief. This is the first and the only technology in the world that can safely extract a patient's brain stem cells for cell replacement therapy.

Since then, we received many requests from patients and their families for this treatment, which we were sadly unable to fulfill because we still had – and have – to conduct clinical trials and raise funds. This motivated us a lot to translate our research 'from bench to bed' so this technology did not only stay in academia but can also help patients.

In 2014, we obtained seed funding from the Hong Kong Innovation and Technology Commission (ITC) to start this company.

HCLS: What have been the major milestones or highlights of the past four years?

CL: First and foremost, we have obtained US patents for our technology, which has been highly endorsed by both industry and academia over the four years. We have won over 30 international awards including the first runner up of the fifth China innovation and entrepreneurship competition (HK, Taiwan and Macau), a Gold Medal in Surgery Category and a Diploma of High Scientific and Technological Level of Invention in the 44th International Exhibition of Inventions of Geneva, as well as finalist of the GSK Neuro 2020 Symposium.

Some key achievements

- Finalist ("Autologous Neural Stem Cell Harvest") – GSK Neuro 2020 Symposium (2016)
- Gold Medal in Surgery Category & Diploma of High Scientific and Technological Level of Invention 44th International Exhibition of Inventions of Geneva (2016)
- First Runner-Up – 5th China Innovation and Entrepreneurship Competition (HK, Macau, Taiwan) (2016)
- Top 100 Global Winner – Red Herring (2015)
- Innovative Technological Application Gold Award & Top 10 Investment Value Award – StartHub & Angel Investment Foundation (2017)
- TIC-PDMD International Travel Award – World Parkinson Coalition (2015)
- Top 100 Asia Winner – Red Herring (2015)
- Technological Achievement (Certificate of Merit) – Hong Kong Awards for Industries (2015)
- Top 50 Startups – Global Entrepreneurship Week (2015)
- Semi Finalist – SPIE Startup Challenge Competition (2016)
- Regional Finalist – TiE Silicon Valley International Startup Competition (2016)

We were also named as one of the 30 local biotech companies to watch in Asia. This strongly positioned us as a renowned and highly recognized biotech startup in a short time.

In 2015, we joined the Hong Kong Science and Technology Park's (HKSTP) incubation program. We are very happy to be here because HKSTP provides an intensive platform from R&D to business support and equips young entrepreneurs to start their entrepreneurial journey.

HCLS: OPER Technology is dedicated to developing nanomaterial-based technologies for use within precision medicine, regenerative medicine and personalized therapy for clinical use. What are some of the most exciting projects OPER Technology is currently working on?

CL: OPER Technology is dedicated to developing innovative technologies for neurological disorders and other incurable diseases. Our core technology is 'Autologous Neural Stem Cell Harvest', as mentioned, which is the first and the only technology in the world that can safely extract a patient's brain stem cells for cell replacement therapy.

Through this technology, we inject magnetic nanoparticles into the patient's brain with a small syringe, which attach to the brain stem cell. Using a magnetic field, we can easily manipulate the nanoparticles and detach the stem cells precisely and safely. These stem cells can then be used to repair patients' degenerating or damaged brain area through cell replacement treatment.

We will conduct our first clinical trial in mainland China in Q2 2019. This will be our very first step to commercialize our technology and benefit the patients. We are confident that patients see improvements within the first year of treatment, particularly stroke patients. It may take a few more years for complete regeneration, depending on the condition of the patient and factors like the area of degeneration or damage and disease stage.

What is more exciting is we will plan to IPO once we start our clinical trials.

I believe regenerative medicine and nanomaterial technology are the major trends within advanced therapy. There is no doubt that autologous stem cells are one of the most promising sources of stem cells for regenerative medicine. Autologous means the source of the therapeutic stem cells is the patient himself. This is very important because the cells will be 100 percent compatible with the patient, and the risk of forming cancer cells or other side effects will be greatly reduced. One of the interesting properties of stem cells is they have the ability to renew themselves through cell division, so patients themselves represent a sustainable source of stem cells, through this technology and the use of autologous stem cells.

> **WE WILL CONDUCT OUR FIRST CLINICAL TRIAL IN MAINLAND CHINA IN Q2 2019.**

HCLS: What are the advantages and disadvantages of being based in OPER Technology as a biotech start-up company?

CL: There is a lot of fantastic research in Hong Kong. Sadly, we do not have a lot of chances to commercialize them because of the limitation of resources and support, especially for biotech start-up companies. The system to nourish biotech innovation does not yet exist in Hong Kong and Hong Kong investors still hesitate when it comes to investing in biotech start-up companies.

However, thanks to the geographical advantages of Hong Kong, we have a chance to connect to not only mainland China but also the rest of the world. In addition, with the development of the Greater Bay Area, we are now able to access more resources and support. All this will definitely help to encourage the growth of the biotech industry in Hong Kong and we are looking forward to it.

HCLS: On a more personal note, as an academic researcher by background, how have you found the move now to becoming the CEO of a start-up company?

CL: I received my bachelor and PhD degrees in Hong Kong and then I continued my post-doc training in Oxford University and Northwestern University. I will say I am 100 percent a scientist. I have experienced the same pain that every academic entrepreneur has and will at the very beginning.

It has been incredibly challenging and exciting to finally move forward to bring our technology to patients and people in need of it all over the world. I am glad that I am not only able to translate my research from university research to commercialization but also take myself to the next level and benefit the world.

CROSSING THE RIVER BY FEELING THE STONES?

While not known to be a particularly exuberant people, the Chinese have consistently expressed more optimism about their country's - and their - future compared to most other countries. In 2017, for instance, an online survey by global polling and research agency Ipsos found 88 percent of Chinese respondents expecting optimism about 2018. More saliently, 87 percent of Chinese respondents believe that their country is on the right track, compared to 43 percent in the US, 42 percent in Germany, 35 percent in France and 28 percent in Britain.

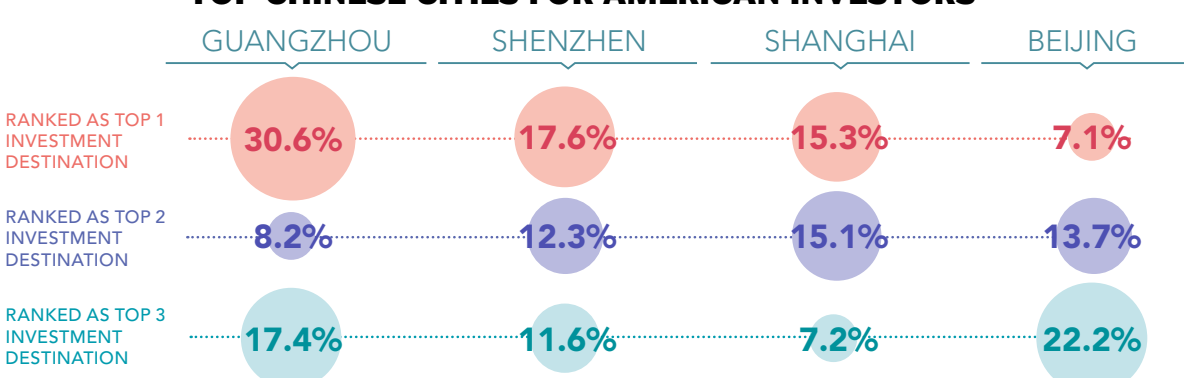
Sheng Sitong, Chairman and CEO of Considerin Group, sheds some light on this optimism. "I feel like there is a lot of momentum in this country. China has an advantage because with our resources, energy, capital and government coordination, we are able to focus all our efforts to develop a specific industry very quickly. We can achieve scale and development very easily."

He exclaims, "Where China has an advantage – and how it is different from the West – is that regardless of the technology, the market is ahead of available technology. It is because we have a staggeringly large population that market needs inevitably drive technology development and innovation. Furthermore, as China is still a developing area, and this is especially true in the Greater Bay Area, people here are much more hungry to grow, learn and innovative."

CW Data Technologies CEO Andy A. Liu, drawing upon his previous experience with one of the world's largest investment funds and President of IQVIA (previously IMS Health) Asia-Pacific and China, concludes, "I think the Greater Bay Area is a critical program and an important driver for healthcare in the region. However, its success boils down to how well it is executed and whether all stakeholders are willing to play together to make it successful. At the end of the day, healthcare and treatment is very local. Each country has their own unique healthcare system and healthcare policies. The question will be how we can balance reaching our local objectives with working as a unified region to solve problems that will allow us to reduce costs and more efficiently in bringing new drugs and technologies to the region."

The global image of China has long been a low-cost, low-tech manufacturing destination competing on scale and cheap labor rather than innovation and cutting-edge

TOP CHINESE CITIES FOR AMERICAN INVESTORS



Source: AmCham: South China's 2018 White Paper on the Business Environment in China and the Special Report on the State of Business in South China

technology, especially within the life sciences industry. Many international companies continue to labor under the misconception that Chinese companies, while adept at copying foreign technologies, still has a giant leap to make before becoming innovative technological leaders themselves - despite some of the largest technology companies in the world now being Chinese. In 2016, China led Asia in the production of unicorns (companies with valuations of USD 1 billion or higher), with 37 - the next was India, trailing behind with 8.

Drawing upon the region's historical role as the country's economic powerhouse, the Greater Bay Area looks poised to revamp China's image on the global stage. Already, according to AmCham South China's 2018 White Paper on the Business Environment in China and the Special Report on the State of Business in South China, Guangzhou and Shenzhen ranked as the two most popular investment city out of 44 cities in China, beating Shanghai and Beijing. While individually these cities are already attractive propositions, taken as a whole, they build the Greater Bay Area into a formidable innovation powerhouse.

As the San Francisco Bay area Council Economic Institute highlights, "China is one of the few places in the world besides the US that has succeeded in developing an integrated innovation system — with university research, engineers, venture capital, accelerators, and a large consumer base — comparable to Silicon Valley's." Combining Hong Kong's legal, financial and services prowess, Shenzhen's entrepreneurial knack and tech domination, Guangzhou's regulatory and pharma presence, the other Pearl River Delta cities' supply chain and manufacturing capacity, and finally, the massive consumer market in the hinterland, the GBA is definitely a force to be reckoned with.

However, that journey is just beginning. Without a clearer blueprint from the central Chinese government and other relevant authorities, the whole project may be far too reminiscent of former Chinese leader Deng Xiaoping's famous saying: 'crossing the river by feeling the stones' for stakeholders at the moment. Given the scale and diversity of the region's activities, with the right policies and branding, the GBA can certainly position itself as the premier destination for innovative life sciences activity and investment within China. The GBA could be a development blueprint for the rest of China to move from imitator to innovator - if all parties come together to work seriously on productive integration and collaboration in order to overcome the serious administrative, logistics and cultural barriers that currently exist. Only then will there be a truly global and powerful model of 'Chinese innovation'.

WORLD'S MOST COMPETITIVE CITIES

1	NEW YORK	11	HOUSTON
2	LOS ANGELES	12	HONG KONG
3	SINGAPORE	13	SEOUL
4	LONDON	14	SHANGHAI
5	SAN FRANCISCO	15	GUANGZHOU
6	SHENZHEN	16	MIAMI
7	TOKYO	17	CHICAGO
8	SAN JOSE US	18	BOSTON
9	MUNICH	19	DUBLIN
10	DALLAS	20	BEIJING

Source: UN, Chinese Academy of Social Sciences

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