

**CONDITIONS AND PROSPECTS FOR  
VIROLOGY RESEARCH AT CHINA'S  
ACADEMY OF MILITARY MEDICAL  
SCIENCES AND OTHER  
DOMESTIC INSTITUTES**

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## **Executive Summary**

1. The Academy of Military Medical Sciences (AMMS) has emerged as one of China's most capable virology research institutes. AMMS has extensive "in-house" capabilities, domestic scientific partnerships and strategic international partnerships.
2. The AMMS, which is organised under the People's Liberation Army (PLA), conducts research on multiple virus types including SARS-CoV-2 and the recently detected Langya Henipavirus (LayV). The lead institute for the scientific analysis of LayV is the Beijing Institute of Microbiology and Epidemiology, which is officially part of AMMS.
3. The PLA Centre for Disease Prevention and Control (PLA CDC) was established within AMMS in 2003 and AMMS was formally incorporated into the Academy of Military Sciences in 2017. During the COVID-19 pandemic, AMMS also developed Convidecia, a vaccine used by the PLA.
4. AMMS researchers have collaborated in high-risk virology research with researchers from the University of Texas Medical Branch (UTMB) in Galveston. It is noteworthy that UTMB, a top US virology outfit, would cooperate with the PLA-related AMMS.
5. AMMS researchers also collaborated with researchers at the Canadian National Microbiology Lab in Winnipeg in virology research, specifically in relation to Ebola and Henipavirus.
6. The AMMS has developed and maintained transnational links to be at the cutting edge of global virology research. Such transnational collaboration may become increasingly tenuous as the relations between the West (especially the United States) and China deteriorate amid a more competitive geopolitical relationship.

7. Another significant Chinese lab is the Guangzhou Institute of Respiratory Health (GIRH). Professor Zhong Nanshan, China's most famous virologist, leads the GIRH and spearheaded the country's campaigns to eradicate the 2003 SARS and COVID-19 pandemics.
8. The Institute of Pathogen Biology (IPB), under the flagship of the Chinese Academy of Medical Sciences and Peking Union Medical College (CAMS/PUMC), is also making rapid scientific progress.
9. The Christophe Merieux Laboratory (CML) is IPB's key platform for transnational collaboration. CML was co-founded by the French Merieux Family Foundation and CAMS/PUMC in 2005. In October 2021, CML researchers developed their own synthetic SARS-CoV-2 virus in the lab to inform treatment options.
10. Indeed, China has made considerable progress in virological research. It is emerging as a "virology leader" with world-class scientific capabilities to prepare for the next global pandemic.

# CONDITIONS AND PROSPECTS FOR VIROLOGY RESEARCH AT CHINA'S ACADEMY OF MILITARY MEDICAL SCIENCES AND OTHER DOMESTIC INSTITUTES

Ryan CLARKE, LAM Peng Er, LIN Xiaoxu, Richard YARROW & L J EADS\*

## Introduction

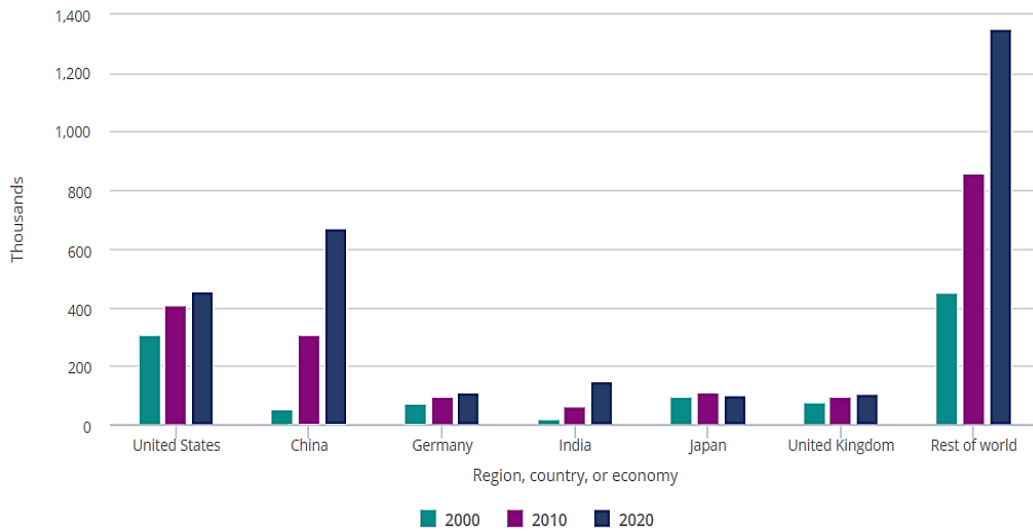
1.1 China has made considerable progress in virological research. It is emerging as a significant global player in virology, including with better scientific capabilities to prepare for the next global pandemic. China's percentage of global scientific publications has experienced continuous strong growth from 2000 to the present with a substantial portion of this research being conducted in partnership with American researchers (Figures 1 and 2). In the field of virology, China aspires to be the clear peer competitor of the United States. Chinese virology publications appear to account for an increasing percentage of the 1% most highly cited publications globally, though they still comprise a far smaller share than publications from the United States. At the same time, the validity of most citation or publication count-based indicators for measuring scientific quality and capacity remains intensely debated in China and internationally.<sup>1</sup>

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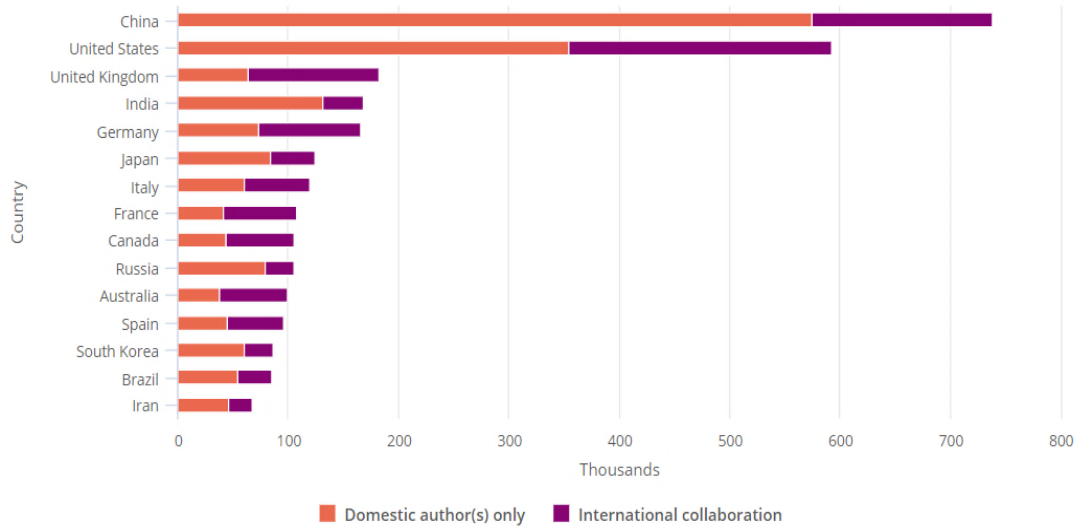
<sup>1</sup> Caroline Wagner, Lin Zhang and Loet Leydesdorff, 'A discussion of measuring the top-1% most-highly cited publications: Quality and impact of Chinese papers', *Scientometrics*, Vol. 127, 2 March 2022. For varied views related to challenges of measuring science in China, see for instance, Richard Yarrow, 'Measuring and Mis-Measuring China's Scientific Rise', *The Wire China*, 24 April 2022; Michael Fire and Carlos Guestrin, 'Over-optimization of academic publishing metrics: observing Goodhart's Law in action', *GigaScience* 8 (2019); Yutao Sun and Cong Cao, 'Planning for science: China's 'grand experiment' and global implications', *Humanities and Social Sciences Communications*, 8 (2021).

**FIGURE 1 SCIENTIFIC ARTICLES BY SELECTED REGION, COUNTRY, OR ECONOMY: 2000, 2010 AND 2020**



Source: "The State of U.S. Science and Engineering 2022", National Science Board, January 2022.

**FIGURE 2 INTERNATIONAL COLLABORATION ON SCIENTIFIC ARTICLES FOR THE 15 LARGEST PRODUCERS OF SCIENTIFIC ARTICLES, BY COUNTRY: 2020**



Source: "The State of U.S. Science and Engineering 2022", National Science Board, January 2022.

1.2 At the top of China’s hierarchy of virology laboratories (based on capabilities, resources, reputation and achievements) are the three Biosafety Level 4 (BSL-4)

labs<sup>2</sup> at the Wuhan Institute of Virology (WIV), Harbin Veterinary Research Institute (HVRI)<sup>3</sup> and Institute of Medical Biology (IMB)<sup>4</sup> in Kunming.

- 1.3 AMMS has emerged as one of China's most capable virology research institutes. This is possibly due to the critical role that infectious disease control plays in force protection programmes for any military, let alone the PLA.
- 1.4 AMMS has extensive "in-house" capabilities, domestic scientific partnerships (including with WIV), as well as strategic international partnerships. The AMMS has joint collaboration with the University of Texas Medical Branch (UTMB) in Galveston, Texas.
- 1.5 Though transnational virology cooperation has been manifestly useful to the AMMS and Chinese civilian labs, the latter are steadily developing their domestic research capability. Both top military and civilian labs in China have reached a "critical mass" whereby Chinese virology research can "stand on its own feet" for many kinds of existing methods and experiments, without relying on the mentorship of Western laboratories.
- 1.6 Equally significant, though without BSL-4 capabilities, is the GIRH/Huyan Institute. It is led by Professor Zhong Nanshan, China's most famous virologist and respiratory disease specialist. GIRH has played a leading role in addressing the 2003 SARS and COVID-19 pandemics.

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<sup>2</sup> BSL-4 designates a laboratory with the highest level of biosafety precautions. Its facilities are specifically designed for work with pathogens that could easily be transmitted within the laboratory and result in severe to fatal disease in humans with no available vaccines or treatments. BSL-3 designates a lower tier of biosafety precautions for a laboratory involving microbes which can cause serious and potentially lethal disease via inhalation. Many protocols and control measures in BSL-4 and BSL-3 labs are similar.

<sup>3</sup> For more in-depth analysis on WIV and HVRI, see Ryan Clarke and Lam Peng Er, 'Coronavirus Research Networks in China: Origins, International Linkages and Consequences', Centre for Non-Traditional Security Studies, May 2021, Singapore. <https://rsis-ntsasia.org/wp-content/uploads/2021/06/NTS-Asia-Monograph-Coronavirus-Research-in-China-by-Ryan-Clarke-and-Lam-Peng-Er-May2021-1.pdf>, accessed 9 February 2022.

<sup>4</sup> For more in-depth analysis on IMB, see Ryan Clarke, Lam Peng Er and Lin Xiaoxu, 'High-Risk Virology Research at the Chinese Academy of Medical Sciences and Peking Union Medical College', *EAI Background Brief*, No. 1642, 24 March 2022.

- 1.7 Besides GIRH, the Institute of Pathogen Biology (IPB) is quickly emerging as an important virology laboratory, especially via its constituent Christophe Merieux Laboratory (CML).
- 1.8 While these leading Chinese virology labs have benefitted from extensive international links in the past, they appear to have reached “criticality” in that they are self-sustaining domestically in their research capabilities. Even if Western virology labs and universities were to decouple from collaborations with these Chinese counterparts, Chinese institutes such as AMMS, GIRH and IPB in recent years appear to be on a pathway to domestic self-sufficiency in some areas of their virology research.

### **Historical Overview and Current Organisational Structure of AMMS**

- 2.1 AMMS is the highest medical research institution of the PLA. Founded in Shanghai in August 1951, the AMMS relocated to Beijing in 1958. In November 1961, the executive meeting of the Central Military Commission (CMC) decided that the AMMS should exercise operational authority (as opposed to solely research) and in 1970 this authority was made permanent by the CMC. In August 2003, the PLA Centre for Disease Control and Prevention (PLA CDC) was formally established within AMMS.
- 2.2 The PLA CDC has capabilities separate from the civilian Chinese Centre for Disease Control and Prevention (Chinese CDC). It is unclear whether the PLA CDC and Chinese CDC have intentionally redundant capabilities in the event of a public health emergency or whether there are specific complementarities. Chinese CDC reports to the National Health Commission (State Council) while PLA CDC ultimately reports to the CMC.
- 2.3 During the 2003 SARS outbreak in China, AMMS formed an industry partnership with BGI Genomics<sup>5</sup> to fully sequence the entire genome of the SARS virus. The

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<sup>5</sup> BGI Genomics is a Chinese government-linked but publicly traded company (Shenzhen Stock Exchange) that is headquartered in Shenzhen. BGI Genomics has its origins as a research institute that was involved in the Human Genome Project that ran from 1990 to 2003 and officially led by the United States, United Kingdom, Canada and New Zealand. For additional information, see ‘Fact Sheet – Human Genome

Chinese Academy of Sciences (CAS) was also a key research partner in this exercise as was Peking Union Medical College (PUMC). This full genome sequencing of the then-novel SARS virus was instrumental in China's response efforts.<sup>6</sup>

2.4 In August 2005, AMMS established and operationalised the “three major forces” structure. This comprises the (i) strategic planning force for military combat medical preparations to address strategic scientific and technological problems; (ii) specialised tactical force for counter-terrorism operations and public health emergency crisis response; and (iii) specialist technical unit for the PLA's disease prevention and control activities. See Figure 3 for the organisational graph of the AMMS.

2.5 AMMS consists of 11 research institutions and affiliated institutions, including 307 hospitals, the PLA Medical Library, experimental instrument factory, experimental animal centre and various graduate student teams. Jilin and Heilongjiang provinces are two key locations for research on military medicine, basic medicine, biotechnology, health equipment design and drug development. These provincial bases are responsible for biodefence-related military missions and counter-terrorism operations, and strategic preparations for China's broader infectious disease prevention and control efforts.<sup>7</sup>

2.6 AMMS hosts four researchers from CAS and seven from the Chinese Academy of Engineering (CAE). AMMS houses three National Key Laboratories, one National Engineering Laboratory and four National Engineering Research Centres. AMMS has 10 additional laboratories, one Tianjin Engineering Centre and one Tianjin Key Laboratory. AMMS awards doctoral degrees in six disciplines and master's degrees in 36 fields.<sup>8</sup>

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Project', National Human Genome Research Institute, National Institute of Health, 24 August 2022. [https://www.genome.gov/about-genomics/educational-resources/fact-sheets/human-genome-project#:~:text=The%20Human%20Genome%20Project%20was,90%25%20of%20the%20human%20genome,accessed 19 September 2022.](https://www.genome.gov/about-genomics/educational-resources/fact-sheets/human-genome-project#:~:text=The%20Human%20Genome%20Project%20was,90%25%20of%20the%20human%20genome,accessed%2019%20September%202022.)

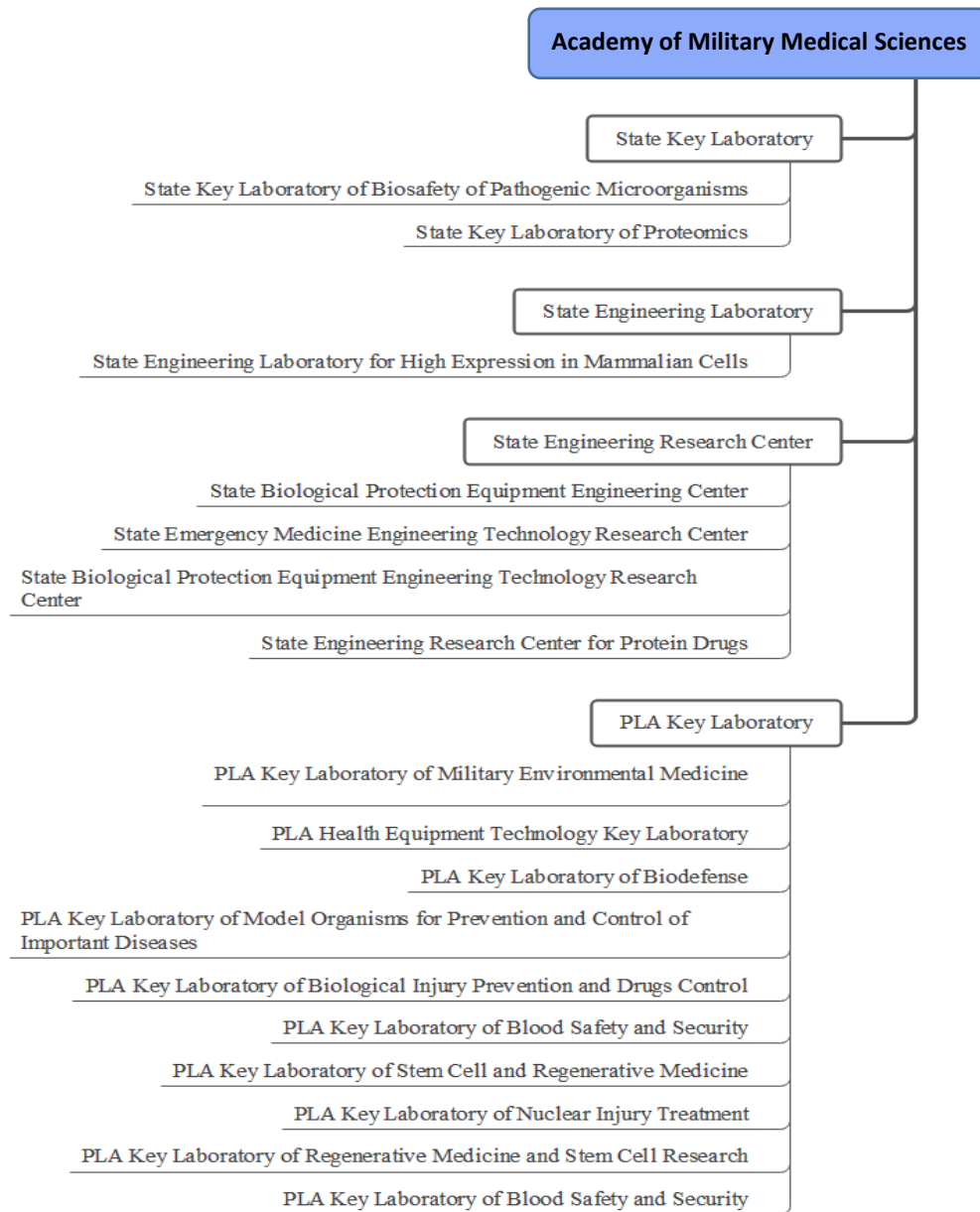
<sup>6</sup> Chinese Academy of Sciences, 2 May 2003. [https://www.cas.cn/zt/kjzt/fdgy/ggqy/200305/t20030502\\_1709485.shtml](https://www.cas.cn/zt/kjzt/fdgy/ggqy/200305/t20030502_1709485.shtml), accessed 26 May 2022.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.



**FIGURE 3 ORGANISATIONAL GRAPH OF THE ACADEMY OF MILITARY MEDICAL SCIENCES**



Source: Chart based on organisation descriptions in 'Zhongguo renmin jiefangjun junshi yixue kexueyuan' (People's Liberation Army Academy of Military Medical Sciences) page, Baidu.com.

2.7 In 2021 AMMS partnered with Yunnan Walvax Biotechnology and Suzhou Abogen Biosciences<sup>9</sup> to develop an mRNA vaccine, commonly known as the ARCoV vaccine. Clinical trials have involved participants from Yunnan and Guangxi

<sup>9</sup> Both companies are publicly traded on the Shenzhen Stock Exchange.

provinces as well as Mexico, Indonesia and Nepal. The ARCoV vaccine is currently in Phase 3 clinical trials.<sup>10</sup>

- 2.8 In response to the recent outbreak of Langya Henipavirus (LayV) in Henan and Shandong provinces, the Beijing Institute of Microbiology and Epidemiology (BIME) has led the scientific response. BIME is part of AMMS.<sup>11</sup>

### **Major General Dr Chen Wei: Most Prominent AMMS Virologist**

- 3.1 Major General Dr Chen Wei (陈薇) is a virologist, epidemiologist and renowned biodefence and biological anti-terrorism specialist. She was born in the small city of Lanxi in inland Zhejiang. Chen studied at Zhejiang and Tsinghua University before completing a microbiology PhD at AMMS in 1998. She was subsequently designated as part of the “Class A talent pool” and continued to work at her alma mater.<sup>12</sup>
- 3.2 Chen joined AMMS in 1991 and was rapidly promoted after graduating from her studies. She became a doctoral supervisor in microbiology in 2003, the deputy director of the Institute of Microbial Epidemiology in 2006 and the director of the Institute of Bioengineering in 2012.
- 3.3 By 2002, she was said to have a team of 50 people working with or under her on a PLA “special drugs” project (“中国人民解放军军队特需药品中试基地”). By

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<sup>10</sup> Minnie Chan, ‘How China’s military took a frontline role in the coronavirus crisis’, *South China Morning Post*, 17 March 2020. <https://www.scmp.com/news/china/military/article/3075396/how-chinas-military-took-frontline-role-coronavirus-crisis>, accessed 26 May 2022.

Roxanne Liu and Se Young Lee, ‘Chinese military researchers move a new COVID vaccine candidate into human trial’, Reuters, 25 June 2020. <https://www.reuters.com/article/health-coronavirus-china-vaccine-idUSL1N2E11I2>, accessed 26 May 2022.

<sup>11</sup> ‘A new virus that can infect people has been discovered’, Health Commission of Hebei Province, 9 August 2022. <http://wsjkw.hebei.gov.cn/wbcz/390125.jhtml>, accessed 26 May 2022.

Liu Wei, Wang Linfa, et. al, ‘A Zoonotic Henipavirus in Febrile Patients in China’, *New England Journal of Medicine*, Vol. 387, 4 August 2022.

<sup>12</sup> ‘Zhandou zai kang yy yixian nu yuanshi Chen Wei’ (Chen Wei, female academician at the pandemic’s front lines), Women.org.cn, 3 February 2020. [https://www.women.org.cn/art/2020/2/3/art\\_24\\_163679.html](https://www.women.org.cn/art/2020/2/3/art_24_163679.html), accessed 30 May 2022.

Minnie Chan and William Zheng, ‘Meet the major general on China’s coronavirus scientific front line’, *South China Morning Post*, 3 March 2020. <https://www.scmp.com/news/china/military/article/3064677/meet-major-general-chinas-coronavirus-scientific-front-line>, accessed 30 May 2022.

2003, she was personally greeted by then-CCP General Secretary Hu Jintao (Image 1).<sup>13</sup>

**IMAGE 1 HU JINTAO MET CHEN WEI IN 2003**



Source: 'Qianxin ku zuanyan shi nian mo yi jian ——ji wo de tongchuang haoyou Chen Wei boshi' (Concentrate on ten years of hard work and sharpen your sword——Remember my classmate and friend Dr. Chen Wei - Master of 1988), *China Youth Science and Technology*, Vol. 12, 2003, p. 13.

3.4 Chen has led teams in developing vaccines for Anthrax and Ebola, including the first recombinant vaccine in China's national strategic reserves.<sup>14</sup> She was also a leader in Biohazard Control (生物危害防控). In 2003, Chen and her laboratory researched on interferons that could inhibit the virulent SARS virus. She was credited for developing an anti-viral nasal spray that won her recognition as a "Top Ten Outstanding Youth".<sup>15</sup>

<sup>13</sup> 'Ten years of hard study - remember my classmate Dr. Chen Wei' (Qianxin ku zuanyan shi nian mo yi jian ——ji wo de tongchuang haoyou Chen Wei boshi), *China Youth Science and Technology*, Vol. 12, 2003, p. 13.

<sup>14</sup> Wan Lin, 'Anthrax human immunoglobulin enters trials, important to China's defense against biological and chemical attacks', *Global Times*, 6 June 2020. <https://www.globaltimes.cn/page/202006/1190749.shtml>, accessed 30 May 2022.

<sup>15</sup> 'Xi Focus: Xi signs order to award 4 persons for outstanding contribution in COVID-19 fight', *Xinhua*, 11 August 2020. [http://www.xinhuanet.com/english/2020-08/11/c\\_139282926.htm](http://www.xinhuanet.com/english/2020-08/11/c_139282926.htm), accessed 30 May 2022.

Lin Lin, 'The Eighth Chinese Young Women in Science Awards', All-China Women's Federation, 12 January 2012. <https://web.archive.org/web/20200416155646/http://www.womenofchina.cn/html/people/Crowd/137083-7.htm>, accessed 30 May 2022.

- 3.5 Chen was promoted to PLA major general in 2015. She also served as one of 268 PLA delegates to the 12th National People’s Congress (NPC). Chen was a medical sector delegate to the 13th national-level Chinese People’s Political Consultative Conference (CPPCC). Thus, Chen is well connected to the party, state and domestic virology community.<sup>16</sup>
- 3.6 MG Chen Wei is further known for leading the team that developed Convidecia, a vaccine against SARS-CoV-2. In 2020, Xi Jinping honoured her as a “People’s Hero” for leading the fight against the COVID pandemic.<sup>17</sup>

### **Chen Wei and Qiu Xiangguo: Transnational Linkages Between AMMS and Canada’s National Microbiology Laboratory BSL-4 Lab**

- 4.1 MG Chen Wei collaborated on virus research with Qiu Xiangguo, a scientist who led the vaccine and antiviral sections of Canada’s National Microbiology Laboratory (NML) in Winnipeg, the only BSL-4 lab in the country. Qiu was born in Tianjin, studied in Tianjin and Hebei, joined NML in 2003 and did cutting edge research on the Ebola virus.
- 4.2 In July 2019, Qiu had her security clearance revoked and was removed from the lab by the Royal Canadian Mounted Police.<sup>18</sup> Qiu and her husband Chang Keding were subsequently fired from NML in January 2021. In 2019, Qiu sent Ebola and Henipah virus samples to the Wuhan Institute of Virology, with the apparent knowledge of some NML’s leaders.<sup>19</sup> However, NML has yet to provide an official explanation for their dismissal.

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‘Zhandou zai kang yu yixian nu yuanshi Chen Wei’ (Chen Wei, female academician at the pandemic’s front lines).

<sup>16</sup> Ibid.

<sup>17</sup> Ibid.

<sup>18</sup> Robert Fife and Steven Chase, ‘Chinese PLA general collaborated with fired scientist at Canada’s top infectious disease lab’, *The Globe and Mail*, 16 September 2021. <https://www.theglobeandmail.com/politics/article-chinese-pla-general-collaborated-with-fired-scientist-at-canadas-top/>, accessed 30 May 2022.

Karen Pauls, ‘Wake-up call for Canada: Security experts say case of 2 fired scientists could point to espionage’, *CBC News*, 10 June 2021. <https://www.cbc.ca/news/canada/manitoba/winnipeg-lab-security-experts-1.6059097>, accessed 30 May 2022.

<sup>19</sup> Ibid.

- 4.3 In their first joint paper, MG Chen Wei and Qiu Xiangguo reported on an experiment in which they modified an adenovirus base to trigger immune responses to the Ebola virus. The paper notes sponsorship from many Chinese and Canadian institutes, as well as the Chinese company CanSino Biologics.<sup>20</sup>
- 4.4 Notably, the vaccine that Chen worked on, Convidecia with CanSino Biologics, was the only domestically developed Chinese vaccine to rely on an adenovirus. This is similar to the AstraZeneca and Sputnik vaccines, but unlike the Sinovac vaccine that is based on a deactivated coronavirus.

### **Higher-Risk Virology Studies Identified on SARS-CoV-2 and African Swine Flu Virus**

- 5.1 In 2021, researchers from WIV and the Communist Party Central Military Commission Joint Logistic Support Force (CPC CMC JLSF, which AMMS is subordinated to) published a study describing a high-risk serial passaging experiment with a SARS-CoV-2 virus.<sup>21</sup> One of the key scientists involved in this study was WIV's Shi Zheng-Li.<sup>22</sup>
- 5.2 Dr Qi Chen is the director of Virology at the Institute of Virology and Microbiology (IVM) under AMMS. Qi has a well-established track record of conducting higher-

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<sup>20</sup> Xiangguo Qiu, Wei Chen, et. al., 'An Adenovirus Vaccine Expressing Ebola Virus Variant Makona Glycoprotein Is Efficacious in Guinea Pigs and Nonhuman Primates', *The Journal of Infectious Diseases*, Vol. 214 (Suppl 3), 2016.

See also Xiangguo Qiu and Wei Chen, 'Potent neutralizing monoclonal antibodies against Ebola virus isolated from vaccinated donors', *MABS*, Vol. 12, No. 1, 2020.

CanSino Biologics is publicly traded on the Hong Kong Stock Exchange.

<sup>21</sup> Serial passaging involves continuously selecting for the most infectious viral strains, isolating them, and then combing and reinserting them back into mice to produce new viral strains that are more infectious, lethal and/or drug/vaccine-resistant than the SARS-CoV-2 viruses found in nature.

<sup>22</sup> Zheng-Li Shi, Ben Hu, et. al., 'Genetic Mutation of SARS-CoV-2 during Consecutive Passages in Permissive Cells', *Virologica Sinica*, Vol. 26, 2021.

The following studies conducted at WIV demonstrate, in aggregate, how to engineer a bat coronavirus to directly infect humans without the need for an intermediate mammalian host for the first time in history:

Shi, Zheng-Li, Baric, Ralph et. al., 'A SARS-like cluster of circulating bat coronaviruses shows potential for human emergence', *Nature Medicine*, Vol. 21, No. 12, December 2015.

Mazet, Jonna, Daszak, Peter, Zheng-Li, Shi et. al., 'Isolation and characterization of a bat SARS-like coronavirus that uses the ACE2 receptor', *Nature*, Vol. 503, No. 28, November 2013.

Li, Fang, Wang, Linfa, Shi, Zheng-Li, et. al., 'Angiotensin-converting enzyme 2 (ACE2) proteins of different bat species confer variable susceptibility to SARS-CoV entry', *Archive of Virology*, Vol. 155, 22 June 2010.

risk pathogen research with Chinese counterparts from WIV and CAMS/PUMC as well as with international collaborators at UTMB in Galveston. In July 2021, Qi and colleagues published a study on an experiment that involved deliberately infecting the olfactory system of humanised mice<sup>23</sup> to stimulate rapid viral replication and massive cell death, and cause neurological damage.<sup>24</sup>

5.3 A key finding of the July 2021 study is that the SARS-CoV-2-infected humanised mice experienced a damaged olfactory system, degradation of immune cell function and impaired olfactory function. The researchers note that these findings have direct implications for human health. Robust viral replication and direct antiviral responses were only detected in the olfactory systems of the infected humanised mice and not in other parts of the brain, thus identifying a new “efficient” route for SARS-CoV-2 infection in human beings by using an ACE2 humanised mouse model.<sup>25</sup>

5.4 In 2020, Qi and colleagues published a study on an artificially created “pseudorabies virus” (PRV) that expressed the CD2v protein of African Swine Flu (ASFV) and evaluated its effectiveness and safety as a vaccine candidate in mice.<sup>26</sup> No similar experiment has been conducted outside of China (likely due to biosafety concerns) and it was well established for over a decade that the CD2v protein plays a key role in enhancing the replicability and transmissibility of ASFV in pigs.<sup>27</sup>

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<sup>23</sup> Humanised mice are mice that are genetically modified to have lungs that are genetically identical to humans. Humanised mice are used in multiple biomedical domains to most closely simulate how disease pathogenesis occurs in humans.

<sup>24</sup> Qi Chen, et. al., ‘SARS-CoV-2 infection in the mouse olfactory system’, *Cell Discovery*, Vol. 7, No. 9, 2021.

See also Qi Chen, Chao Shan, Shi Peiyong, et. al., ‘Treatment of Human Glioblastoma with a Live Attenuated Zika Virus Vaccine Candidate’, *mBio*, Vol. 9, Iss. 5, September/October 2018.

<sup>25</sup> Qi Chen, et. al., ‘SARS-CoV-2 infection in the mouse olfactory system’, *Cell Discovery*, Vol. 7, No. 9, 2021.

<sup>26</sup> Qi Chen, et. al., ‘The recombinant pseudorabies virus expressing African swine fever virus CD2v protein is safe and effective in mice’, *Virology Journal*, Vol. 17, No. 180, 16 November 2020.

<sup>27</sup> For example, see Daniel Pérez-Núñez, et. al., ‘CD2v Interacts with Adaptor Protein AP-1 during African Swine Fever Infection’, *PLOS ONE*, 27 April 2015.

Rebecca Rowlands, et. al., ‘The CD2v protein enhances African swine fever virus replication in the tick vector, *Ornithodoros erraticus*’, *Virology*, Vol. 393, Iss. 2, October 2009.

- 5.5 The November 2020 study stated that specific PRV strains have the now-demonstrated ability to reduce the immune system function in the early stages of infection, specifically the initial generation and proliferation of adequate T-cells. One key conclusion of this study is that CD2 is actually safe for use in mice and is therefore a viable component of a vaccine candidate.<sup>28</sup>
- 5.6 The decision to experiment with the CD2v protein may be noteworthy. CD2v has the proven primary function of increasing viral load and transmissibility of the AFSV virus. Therefore, any experimentation of the type that Qi and colleagues conducted would primarily “discover” methods to enhance those functions. The “discovery” of vaccine-related utility (if any) of CD2v would be a secondary discovery at best.

#### **Additional Transnational Linkages Between AMMS and UTMB in Galveston, Texas**

- 6.1 In a 2018 study, UTMB’s Dr Chao Shan and Dr Shi Peiyong worked with Dr Qi Chen (IVM - AMMS) to use a live attenuated Zika virus vaccine candidate (ZIKV-LAV) to treat Glioblastoma (GBM), a brain tumour.<sup>29</sup> The wild-type Zika virus strain (ZIKV) used in this study was originally isolated from a Chinese patient returning from Venezuela in 2016 and then transferred into mice. The live attenuated vaccine strain of ZIKV (ZIKV-LAV) was generated by reverse genetic engineering technology.<sup>30</sup> Notably, the current reverse genetic engineering technology, in which China has a demonstrated record, can render it very difficult to determine whether a virus in question is natural or synthetic in origin.<sup>31</sup>
- 6.2 Qi, Chao and Shi conducted injections of ZIKV-LAV into mice brains and claim that ZIKV-LAV demonstrated efficacy against GBM by selectively killing glioma

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<sup>28</sup> Ibid.

<sup>29</sup> Qi Chen, Chao Shan, Shi Peiyong, et. al., ‘Treatment of Human Glioblastoma with a Live Attenuated Zika Virus Vaccine Candidate’, *mBio*, Vol. 9. Iss. 5, September/October 2018.

<sup>30</sup> Ibid.

<sup>31</sup> Ryan Clarke, ‘Emerging Global Pandemic Risks Come from Engineered Viruses in Chinese Labs, Not the Jungle or Bat Caves’, *Epoch Times*, 4 September 2021. [https://www.theepochtimes.com/emerging-pandemic-risks-come-from-engineered-viruses-in-chinese-labs-not-the-jungle-or-bat-caves\\_3980204.html](https://www.theepochtimes.com/emerging-pandemic-risks-come-from-engineered-viruses-in-chinese-labs-not-the-jungle-or-bat-caves_3980204.html), accessed 27 May 2022.

stem cells within the tumour. They also claim that ZIKV-LAV exhibited an “excellent safety profile” upon intracerebral injection into the treated animals thereby making ZIKV-LAV a potential candidate for combination with the current treatment regimen for GBM therapy.<sup>32</sup>

- 6.3 In the same study Qi, Chao and Shi state that recent epidemics of ZIKV in the Americas have generated a global public health emergency due to ZIKV’s causal link to microcephaly and other congenital diseases in fetuses from infected pregnant women. They note that ZIKV preferentially infects neural progenitor cells, causing cell death and reduced proliferation, which results in impaired brain development in the fetus.<sup>33</sup>
- 6.4 Implicitly acknowledging the risks of this research, they stated that applying this oncolytic virotherapy to clinical treatment requires wild-type ZIKV to be modified to reduce neurovirulence to ensure that GBM patients do not have their brains directly infected by ZIKV. They also note that ZIKV-LAV should only retain its infectivity and oncolytic activity against glioma cells. The study claims to have demonstrated how to achieve these two endpoints in mice.<sup>34</sup>
- 6.5 On the opposite end of the biomedical spectrum, in one 2020 PNAS study, Chao, Shi and colleagues took a pre-epidemic Asian Zika virus strain (FSS13025 isolated in Cambodia in 2010) and inserted the “E-V473M” substitution that significantly increased neurovirulence in neonatal mice and produced higher viral loads in the placenta and foetal heads in pregnant mice.<sup>35</sup>
- 6.6 This E-V473M mutant strain was further studied in competition experiments in cynomolgus macaques. The results showed that this mutation increased Zika’s

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<sup>32</sup> Qi Chen, Chao Shan, Shi Peiyong, et. al., ‘Treatment of Human Glioblastoma with a Live Attenuated Zika Virus Vaccine Candidate’, *mBio*, Vol. 9. Iss. 5, September/October 2018.

<sup>33</sup> Ibid.

<sup>34</sup> Ibid.

<sup>35</sup> Chao Shan, et. al., ‘A Zika virus envelope mutation preceding the 2015 epidemic enhances virulence and fitness for transmission’, *PNAS*, Vol. 117, No. 33., 18 August 2020.



fitness for viral generation in macaques, a clear demonstration of high-risk research that was based on reverse genetics techniques.<sup>36</sup>

### **Institute of Pathogen Biology: History and Organisation**

- 7.1 IPB in Beijing was founded in May 2006. It is organised under CAMS/PUMC.<sup>37</sup> CAMS/PUMC is under the National Health Commission (NHC), a cabinet-level department of the State Council tasked with formulating national health policies.
- 7.2 In October 2009, IPB received a boost when it signed a Research Cooperation Agreement with the Institut Pasteur of Shanghai (IPS). The agreement set a joint mission “to promote science and technology innovation in the field of infectious diseases” and to train future generations of Chinese biomedical scientists. Qun Meng, deputy director general of the Science and Education Department in China’s Ministry of Health, was present to inaugurate the collaboration agreement.<sup>38</sup> IPB’s connection with IPS suggests that it indirectly benefits from IPS’ transnational links with the central Institut Pasteur in Paris.
- 7.3 Dr Jin Qi is the director of IPB. He completed a postdoctoral fellowship at the United States Centres for Disease Control and Prevention.<sup>39</sup> IPB has 22 additional senior scientists listed as full-time faculty on its official website. See Table 1 for the transnational linkages of senior scientists in the IPB.

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<sup>36</sup> Ibid.

For additional GoF work conducted by Galveston/UTMB’s Pei-Yong Shi and colleagues at AMMS involving Zika viruses in mice, see Ling Yuan, et. al., ‘A single mutation in the prM protein of Zika virus contributes to fetal microcephaly’, *Science*, Vol. 17, No. 358, 17 November 2017.

<sup>37</sup> See the website of the Institute of Pathogen Biology. [http://www.mgc.ac.cn/IPB\\_en/index.html](http://www.mgc.ac.cn/IPB_en/index.html), accessed 27 June 2022.

<sup>38</sup> See Institute Pasteur of Shanghai, ‘Institute Pasteur of Shanghai and Institute of Pathogen Biology, Chinese Academy of Medical Sciences initiated research cooperation’, 27 October 2009. [http://english.shanghaipasteur.cas.cn/NEWS2016/nae2016/201805/t20180530\\_193378.html](http://english.shanghaipasteur.cas.cn/NEWS2016/nae2016/201805/t20180530_193378.html), accessed 23 June 2022.

<sup>39</sup> ‘Faculty’, Institute of Pathogen Biology, Chinese Academy of Medical Sciences. [http://www.mgc.ac.cn/IPB\\_en/faculty.html](http://www.mgc.ac.cn/IPB_en/faculty.html), accessed 9 June 2022.

**TABLE 1 TRANSNATIONAL LINKAGES OF SENIOR SCIENTISTS IN IPB<sup>40</sup>**

Researchers	Transnational Linkages
Cui Sheng <sup>41</sup>	PhD from Italian International School for Advanced Study in 2004
Deng Tao <sup>42</sup>	DPhil degree in Molecular Virology, conferred in 2006 by Sir William Dunn School of Pathology, Oxford University
He Yuxian <sup>43</sup>	Studied in the University of Ulm, Germany. Previously worked as a visiting scholar at the Allen Diamond AIDS Research Centre of Rockefeller University, a postdoctoral researcher at the New York University Institute of Public Health, and an assistant researcher at the LFK Institute of the New York Blood Centre
Jin Qi <sup>44</sup>	Graduated from Beijing Medical College and a former postdoctoral researcher at the US Centre for Disease Control and Prevention
Zhang Leiliang <sup>45</sup>	Held a postdoc at Harvard Medical School and the University of Florida

7.4 The mission of IPB is to (i) conduct fundamental research to provide a domestic platform for the improvement of infectious disease research; (ii) conduct directed applied research to augment nationwide efforts regarding the prevention and treatment of infectious diseases; (iii) conduct research and development to build up domestic infectious disease-related and biotechnology industries; (iv) and provide policy-relevant inputs to inform decision-making on the prevention and control of infectious diseases at the national level.<sup>46</sup>

7.5 IPB has 10,000 square metres of space for lab experiments and offices with over 3,000 pieces of equipment. The institute's hardware and software are focused

<sup>40</sup> Only a few of the 20 listed scientists' open-source profiles are available online.

<sup>41</sup> Cui Sheng's profile on ORCID. <https://orcid.org/0000-0001-6329-3582>, accessed 22 July 2022.

<sup>42</sup> 'Deng Tao', Institute of Microbiology, Chinese Academy of Sciences. [http://english.im.cas.cn/people/\\_facultyandstaff/KLPMI/202012/t20201204\\_256026.html](http://english.im.cas.cn/people/_facultyandstaff/KLPMI/202012/t20201204_256026.html), accessed 29 June 2022.

<sup>43</sup> He Yuxian's publication profile on the website of X-Mol Academic Platform. <https://www.x-mol.com/university/faculty/188213>, accessed 29 June 2022.

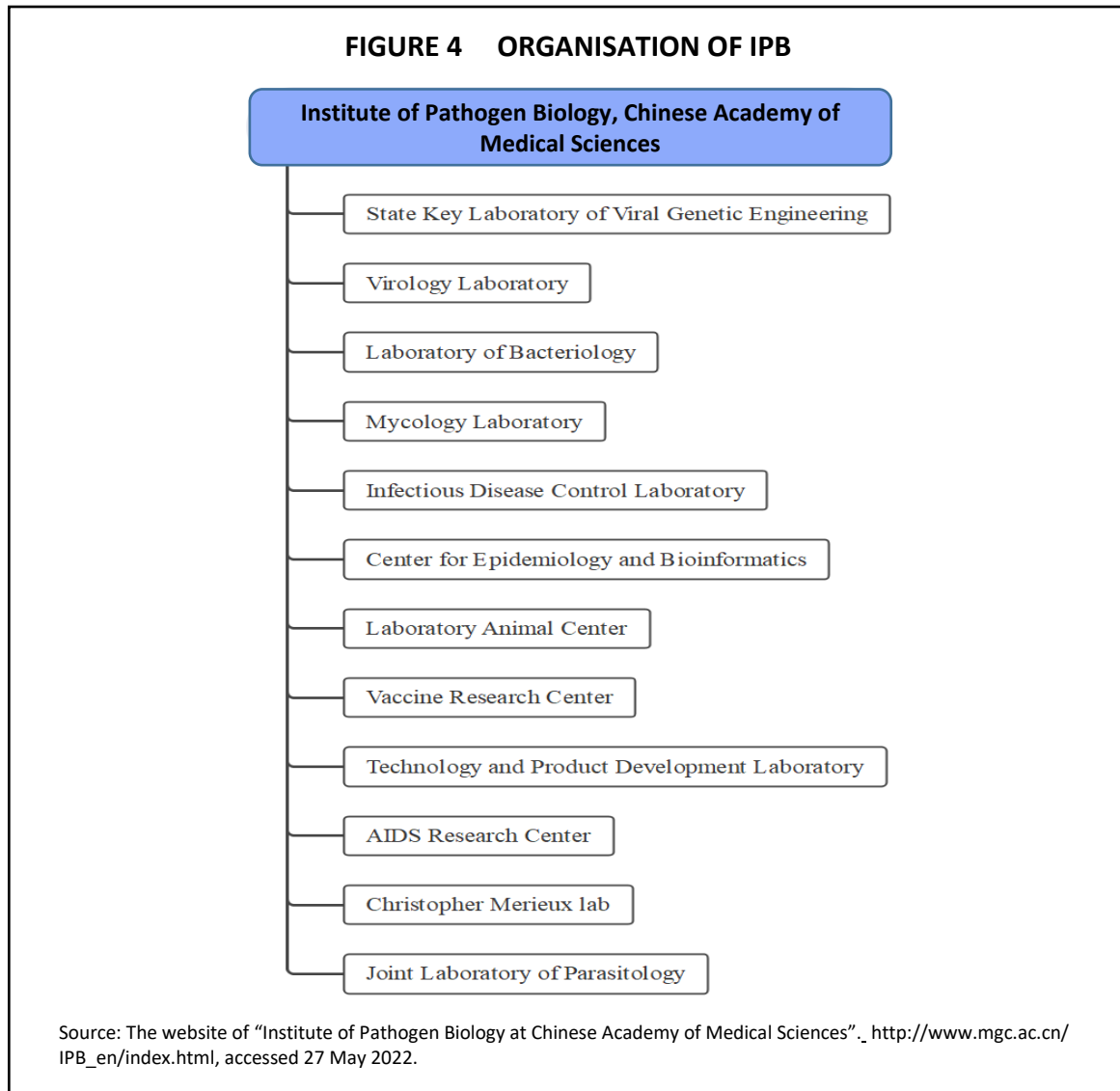
<sup>44</sup> Jin Qi's profile on X-MOL. <https://www.x-mol.com/university/faculty/210903>, accessed 22 July 2022.

<sup>45</sup> Zhang Leiliang's profile on the website of Shandong First Medical University. <https://stic.sdfmu.edu.cn/info/1012/1196.htm#>, accessed 29 June 2022.

<sup>46</sup> 'Director of IPB', IPB, CAMS and PUMC. [http://www.mgc.ac.cn/IPB\\_en/index.html](http://www.mgc.ac.cn/IPB_en/index.html), accessed 23 July 2022.

'Institute of Pathogenic Biology, Chinese Academy of Medical Sciences 2022 Recruitment Notice', Institute of Pathogen Biology, Chinese Academy of Medical Sciences, 20 May 2022. <http://www.gaoxiaojob.com/zhaopin/zhuanti/zgykxxybyswxyjs2019/index.html>, accessed 23 July 2022.

primarily on immunology, cell biology, morphology, structural biology and bioinformatics.<sup>47</sup> See Figure 4 for IPB’s organisation.



7.6 IPB is a member of both the National Major Basic Research Programme (973 Programme) and the now-defunct National High-Tech Development Programme (863 Programme).<sup>48</sup> The 863 Programme was a major initiative that was modelled on the American Strategic Defence Initiative. It was officially active from 1983 to 2016.<sup>49</sup>

<sup>47</sup> Ibid.

<sup>48</sup> Ibid.

<sup>49</sup> Qiang Zhi and Margaret Pearson, ‘China’s Hybrid Adaptive Bureaucracy: The Case of the 863 Program for Science and Technology’, *Governance: An International Journal of Policy, Administration, and Institutions* 30, no. 3, July 2017; Julian Gewirtz, ‘The Futurists of Beijing: Alvin Toffler, Zhao Ziyang, and China’s “New Technological Revolution,” 1979–1991’, *Journal of Asian Studies* 78, no. 1, February 2019.

7.7 The 863 Programme had seven strategic priority areas: laser technology, space platforms, biotechnology, information technology (including artificial intelligence), automation and manufacturing technology, energy and advanced materials.<sup>50</sup> Presumably, IPB’s role in this programme was in biotechnology.

### **IPB’s Christophe Merieux Laboratory: Pathogen Research and Transnational Links**

8.1 The CML is IPB’s key platform for international cooperation. CML was co-founded by the Merieux Family Foundation and CAMS/PUMC in 2005.<sup>51</sup> The lab is formally an integral part of IPB at CAMS/PUMC. It seeks to identify “emerging and infectious pathogens and conducts research on the etiology and epidemiology of acute viral respiratory infections”.<sup>52</sup>

8.2 CML participates in the Merieux-founded GABRIEL network of 20 research institutes and over 70 international scientists conducting joint research, education and training programmes, primarily in developing countries such as Lebanon and Bangladesh. The GABRIEL network has three official strategic objectives:

- “to publish and share the expertise, tools and knowledge required for advanced applied research in emerging countries, particularly in the field of pathogenic agent identification and monitoring”;
- “to conduct international, collaborative epidemiological studies in conjunction with people working in local healthcare and biomedical research and/or private partners”; and
- “to help improve public health policies by introducing surveillance studies, and generating reliable and accurate epidemiological data”.<sup>53</sup>

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<sup>50</sup> Tai Ming Cheung, *Fortifying China: The Struggle to Build a Dual-Use Economy* (Ithaca: Cornell University Press, 2019).

<sup>51</sup> On high-risk pathogen research across the entire CAMS network, see Ryan Clarke, Lam Peng Er and Lin Xiaoxu, ‘High-Risk Virology Research at the Chinese Academy of Medical Sciences and Peking Union Medical College’, *EAI Background Brief*, No. 1642, 24 March 2022.

<sup>52</sup> ‘Christophe Merieux Laboratory’, Merieux Foundation. <https://www.fondation-merieux.org/en/what-we-do/enhancing-research-capabilities/research-laboratories/christophe-merieux-laboratories/>, accessed 27 May 2022.

<sup>53</sup> Ibid.; “GABRIEL Network”, Merieux Foundation. <https://www.fondation-merieux.org/en/what-we-do/enhancing-research-capabilities/gabriel-network/>, accessed 28 June 2022.

8.3 CML also articulates more specific scientific and technological objectives related to the entire spectrum of virology and respiratory disease epidemiology:

- “Development of technology platform of unknown virus identification and discovery of unknown respiratory viruses in respiratory samples”;
- “Development of multiplex assays for respiratory pathogens”;
- “Molecular evolution of new emerging respiratory viruses”;
- “Identification of biomarkers for diagnosis, treatment assessment and prediction of respiratory infections”.<sup>54</sup>

8.4 In October 2021, CML researchers developed their own synthetic SARS-CoV-2 virus in the lab, which they refer to as the “SARS-CoV-2-GFP replicon”, with the logic that experimentation on this synthetic virus would more fully inform treatment options.<sup>55</sup> Despite titling their paper, “Construction of Non-infectious SARS-CoV-2 Replicons and Their Application in Drug Evaluation”, they note that their synthetic virus did in fact replicate over the course of their experiment.

8.5 CML shares BSL-3 laboratories with the Institute of Laboratory Animal Sciences (ILAS) and CAMS. CML officially acknowledges collaborations with the following premier Chinese institutions, some of which also have an established track record of high-risk pathogen research, namely ILAS:

- Centre for Disease Control and Prevention (CDC) of Beijing
- Peking Union Medical College Hospital (PUMCH)
- Beijing Children’s Hospital (BCH)
- Beijing Chaoyang Hospital (CYH)
- Shanghai CDC
- Jiangsu Provincial CDC
- Shandong Provincial Academy of Medical Sciences and
- Institute of Laboratory Animal Sciences (ILAS), CAMS<sup>56</sup>

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<sup>54</sup> ‘Christophe Merieux Laboratory – Beijing, China’, Gabriel Network. <https://www.gabriel-network.org/laboratoires/christophe-merieux-laboratory/research-activities/?lang=en#menu>, accessed 27 May 2022.

<sup>55</sup> Bei Wang, et. al., ‘Construction of Non-infectious SARS-CoV-2 Replicons and Their Application in Drug Evaluation’, *Virologica Sinica*, Vol. 36, No. 5, October 2021.

<sup>56</sup> See, for example, Bao Linlin, et. al., ‘Novel Avian-Origin Human Influenza A(H7N9) Can Be Transmitted Between Ferrets via Respiratory Droplets’, *Journal of Infectious Diseases* 209, no. 4, 15 February 2014.

8.6 Though IPB was established only in 2006, its domestic and transnational networks are extensive and impressive. Indeed, IPB is rapidly emerging as a top virology laboratory in China. Undoubtedly, IPB is an important and integral part of China's expanding network of virology laboratories with emerging expertise and capabilities.

### **Guangzhou Institute of Respiratory Health/Huyan Institute: History, Organisation and Leadership**

9.1 In 1971, the First Affiliated Hospital of Guangzhou Medical College established a "chronic bronchitis prevention team" at the calling of then-Premier Zhou Enlai. In 1979, Guangzhou Medical College (now named Guangzhou Medical University) founded the Guangzhou Institute of Respiratory Diseases (GIRD) as one of the first respiratory disease research institutes in China.<sup>57</sup>

9.2 In August 2017, GIRD was renamed the Guangzhou Institute of Respiratory Health (GIRH, also known as the Huyan Institute). The Huyan Institute has played an active role in combatting SARS in 2003 as well as multiple H5N1, H1N1, H7N9, H5N6 and MERS outbreaks in China, including the clinical treatment of patients. GIRH has received many national honours for having an "advanced grassroots party organisation" (in 2003) and aiding "civilisation construction" (in 2005).<sup>58</sup>

9.3 Apparently, GIRH continues to retain its local Guangzhou-based governance and does not formally fall under the control of CAS, CAMS, or departments of the State Council. This governance structure is exceptional in China for an institute of this domestic significance and rare among virology research institutes in the country.

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Bao Linlin, et. al., 'Transmission of H7N9 influenza virus in mice by different infective routes', *Virology Journal* 11, Article No. 185, 2014; 'Christophe Merieux Laboratory – Beijing, China', Gabriel Network. <https://www.gabriel-network.org/laboratoires/christophe-merieux-laboratory/research-activities/?lang=en#menu>, accessed 27 May 2022.

<sup>57</sup> Guangzhou Institute of Respiratory Health. [http://www.gird.cn/show\\_list.php?id=11](http://www.gird.cn/show_list.php?id=11), accessed 26 May 2022.

<sup>58</sup> 'The history of the Huyan Institute', Guangzhou Institute of Respiratory Disease Institute Overview, 24 August 2011, archived at <https://web.archive.org/web/20120825030305/http://www.gird.cn/girdweb/Article-565.aspx>, accessed 27 June 2022.

- 9.4 The institute’s director is Professor Zhong Nanshan, China’s most well-known and respected virologist. Zhong graduated from Beijing Medical College in 1960 and received further training from 1979 to 1981 in the Department of Respiratory Medicine of the University of Edinburgh, where he received a MD.<sup>59</sup> He was president of the Chinese Medical Association from 2005 to 2009.
- 9.5 Zhong is a recipient of the Medal of the Republic, the highest honour of the PRC, for his “outstanding contribution to fighting the COVID-19 epidemic”.<sup>60</sup> In 2020, he was the winner of his Scottish alma mater’s first Being Edinburgh Award with over 90% of the student, staff and alumni vote. Simply put, Zhong is highly decorated at home and abroad for his medical expertise and leadership.<sup>61</sup>
- 9.6 Zhong, of Fujianese ancestry, was born in Nanjing in 1936. Both his parents received medical training, with Zhong’s father returning from the State University of New York to China in 1946. During the Maoist era, Zhong’s father established a virology laboratory at Sun Yat-sen University in Guangzhou where viral specimens were isolated and reproduced.<sup>62</sup> Zhong Nanshan’s current laboratory is a short distance from the Guangzhou hospital where his father worked.
- 9.7 Zhong Nanshan’s family suffered during the Cultural Revolution when his father was labelled a “reactionary academic”. The laboratory of Zhong’s father was

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<sup>59</sup> ‘Journal Editor-in-Chief’, website of the *Journal of Thoracic Disease*, <https://jtd.amegroups.com/about/editorInChief>, last accessed 27 June 2022; “Brief introduction of Academician Zhong Nanshan,” Guangzhou Institute of Respiratory Disease Academician Column, 2 August 2011, archived at <https://web.archive.org/web/20120825010142/http://www.gird.cn/girdweb/Article-460.aspx>, accessed 27 June 2022.

<sup>60</sup> ‘Zhong Nanshan: outspoken doctor awarded China’s top honour’, *Xinhua*, 8 September 2020. [http://www.xinhuanet.com/english/2020-09/08/c\\_139352929.htm](http://www.xinhuanet.com/english/2020-09/08/c_139352929.htm), accessed 27 June 2022; ‘Respiratory disease expert wins alumni award’, University of Edinburgh, 16 April 2020, <https://www.ed.ac.uk/news/2020/respiratory-disease-expert-wins-alumni-award>, accessed 24 May 2022.

<sup>61</sup> ‘Epidemiologist Zhong Nanshan wins Edinburgh honor’, *China Daily*, 7 April 2020. <https://global.chinadaily.com.cn/a/202004/07/WS5e8be5b1a310128217284bbb.html>, accessed 24 July 2022.

<sup>62</sup> ‘Zhong Nanshan’, Chinese Academy of Engineering, 7 March 2017. <https://web.archive.org/web/20170306224833/http://www.cae.cn/cae/jsp/introduction.jsp?oid=20111231115352671145511>, accessed 26 May 2022.

‘Three Generations of Medical Professionals: Listening to the story of their family’s heritage told by Zhong Nanshan’s son’, *Xinhua*, 19 August 2020. [http://www.xinhuanet.com/2020-08/19/c\\_1126386735.htm](http://www.xinhuanet.com/2020-08/19/c_1126386735.htm), accessed 26 May 2022.

‘Doctor Zhong Nanshan’, Peking University, 12 September 2019. <https://news.pku.edu.cn/bdrw/f09c73a1063a43b0a02132aff3d51f6a.htm>, accessed 26 May 2022.

apparently dismantled in the 1960s and his research assistants were sent to the countryside for ideological reeducation. Red Guards attacked Zhong Nanshan's mother, who reportedly committed suicide in 1968. Zhong married Li Shaofen, a basketball player whose team had been supported by Premier Zhou Enlai. With his wife's help, Zhong Nanshan was able to return to Guangzhou in 1971 with a medical position.<sup>63</sup>

9.8 Zhong has largely remained in Guangdong since. From 1992 to 2002, he served as party secretary and/or rector of Guangzhou Medical College (the institution which GIRD/GIRH belongs to and later renamed as GMU); from July 1992 to July 1994, Zhong served as both party secretary and rector, a relatively unusual distinction for GMC/GMU. In 1992, Zhong was named a “model worker” and in 1996, Zhong became an academician of the Chinese Academy of Engineering. In 2008, he also joined the 11th National People's Congress in Beijing.<sup>64</sup>

9.9 Guangzhou Medical University and the State Key Laboratory of Respiratory Diseases in 2011 supported the creation of the “Zhong Nanshan Medical Foundation of Guangdong Province”, with Zhong Nanshan as the foundation's “honorary chairman” and with the participation of industry, venture capital and party groups. The foundation lists goals and activities including poverty alleviation, COVID-19 pandemic resource distribution, science popularisation, scientific research funding and funding for graduate students.<sup>65</sup> A researcher at GIRH serves as the foundation's chairman and a former asset management financier serves as the foundation's party secretary.<sup>66</sup>

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<sup>63</sup> ‘Doctor Zhong Nanshan’, Peking University, 12 September 2019.  
‘Zhong Nanshan's wife wears the number Five in China's Female National Basketball Team’, *Sina*, 16 June 2003. <http://news.sina.com.cn/c/2003-06-16/02521173575.shtml>, accessed 26 May 2022.

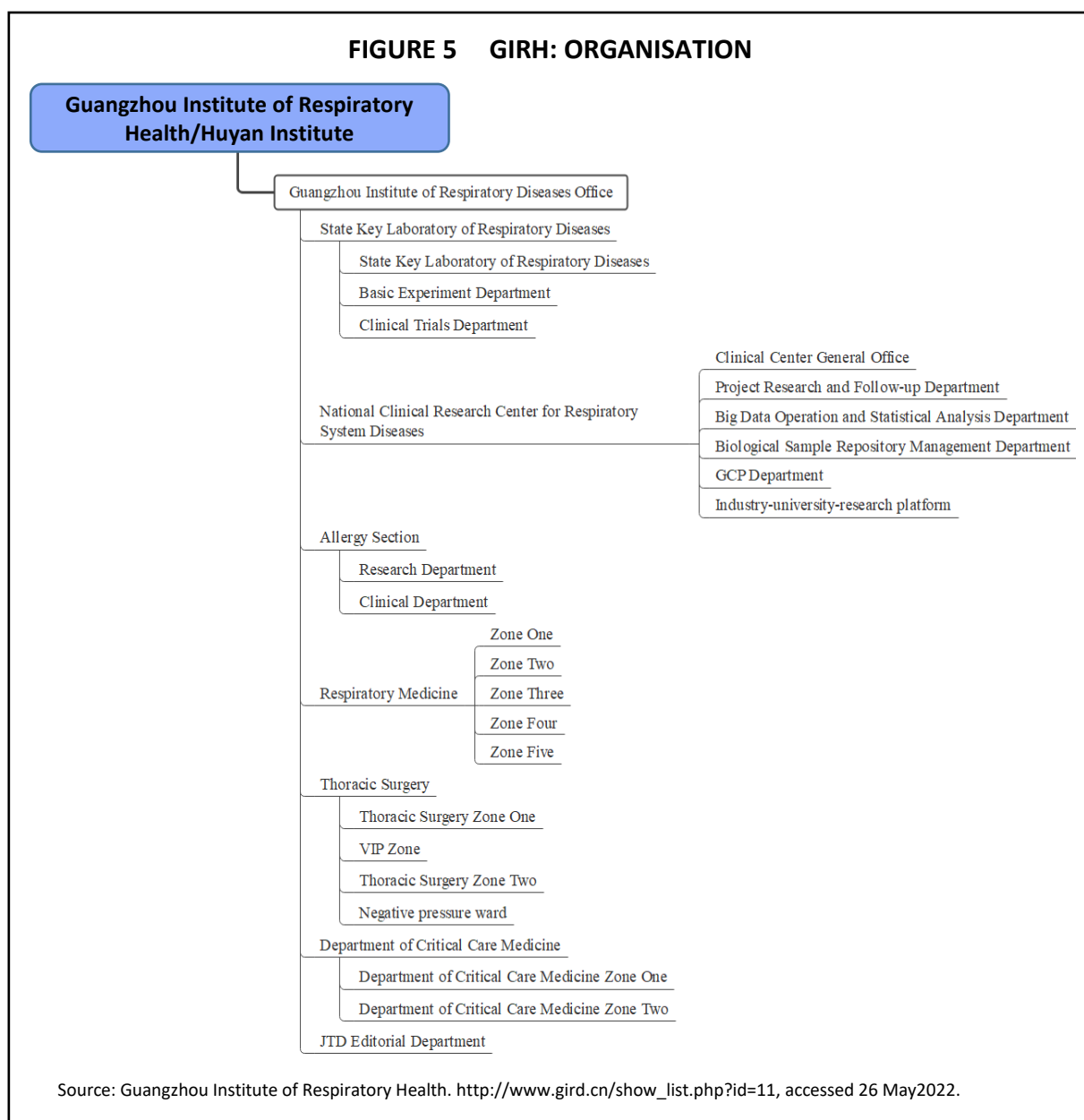
<sup>64</sup> “Brief introduction of Academician Zhong Nanshan,” Guangzhou Institute of Respiratory Disease Academician Column, 2 August 2011, archived at <https://web.archive.org/web/20120825010142/http://www.gird.cn/girdweb/Article-460.aspx>, accessed 27 June 2022; “Past leaders”, Guangzhou Medical University School Profile, archived at <https://web.archive.org/web/20220330042623/https://www.gzhmu.edu.cn/10009021>, accessed 28 June 2022.

<sup>65</sup> ‘About’ and ‘Organisation’ pages, Zhong Nanshan Medical Foundation of Guangdong Province, <http://www.znsfmf.org/jijinhuijianjie/> and <http://www.znsfmf.org/zjjg/>, all accessed 28 June 2022.

<sup>66</sup> ‘Management’ page, Zhong Nanshan Medical Foundation of Guangdong Province, <http://www.znsfmf.org/zjwrh/>, accessed 28 June 2022.



9.10 GIRH also has several centres with “national” titles, including a National Clinical Research Centre for Respiratory Diseases and a National Clinical Drug Trial Institute (with a respiratory specialty), five national key clinical specialties (respiratory medicine, critical care medicine, allergic disease, oncology and thoracic surgery) and one national key (secondary-level) discipline designation (for respiratory medicine).<sup>67</sup> GIRH’s structure is presented in Figure 5.



<sup>67</sup> Guangzhou Institute of Respiratory Health. [http://www.gird.cn/show\\_list.php?id=11](http://www.gird.cn/show_list.php?id=11), accessed 26 May 2022; ‘National Key Disciplines’, China Academic Degrees and Graduate Education Development Centre, PRC Ministry of Education, <http://www.cdgd.edu.cn/xwyyjsjyxx/zlpj/zdxkps/zdxk/>, last accessed 28 June 2022; ‘Introduction’, State Key Laboratory of Respiratory Diseases, [http://www.skIRD.cn/show\\_list.php?id=10](http://www.skIRD.cn/show_list.php?id=10), accessed 28 June 2022.

9.11 GIRH has over 350 hospital beds within the First Affiliated Hospital of Guangzhou Medical University. The institute also houses a State Key Laboratory that has an area of 12,800 square metres. Since the 2003 SARS epidemic, GIRH staff numbers have increased exponentially from 83 to 552.<sup>68</sup>

### **GIRH-CCP Ties**

10.1 As a Chinese government-funded research organisation, GIRH maintains strong ties with the CCP. GIRH's website notes that during the 2003 SARS outbreak, Cheng Donghai served as the CCP branch secretary at GIRD. In August 2013, Cheng was transferred and Huang Qinghui became the new CCP branch secretary, though Huang also appears to have been listed as a party secretary for GIRD in 2012.<sup>69</sup> Huang has been active in public roles on behalf of GIRH, including with businesses and with research institutions in other provinces. Huang's specialty is in insomnia, sleep apnea and other sleep-disorder issues.<sup>70</sup>

10.2 Liu Youning is a respiratory disease doctor who worked on SARS at the PLA General Hospital and PLA Institute of Respiratory Diseases. In the late 2000s, Liu served as deputy director of the academic committee of Zhong Nanshan's laboratory. Other scholars from a variety of institutes belonging to CAS and Guangdong and northeast Chinese universities also served on the academic committee.<sup>71</sup>

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<sup>68</sup> Guangzhou Institute of Respiratory Health. [http://www.gird.cn/show\\_list.php?id=11](http://www.gird.cn/show_list.php?id=11), accessed 26 May 2022.

<sup>69</sup> Guangzhou Institute of Respiratory Health. [http://www.gird.cn/show\\_list.php?id=11](http://www.gird.cn/show_list.php?id=11), accessed 26 May 2022; Huang Xiaoliang, 'Revisit the oath of joining the party', Guangzhou Institute of Respiratory Disease institute news, 20 June 2012, archived at <https://web.archive.org/web/20120827072216/http://www.gird.cn/girdweb/Article-816.aspx>, accessed 27 June 2022

<sup>70</sup> On Huang, see 'Always follow the party for the masses' welfare', Zhong Nanshan Medical Foundation of Guangdong Province, 4 August 2021, <http://www.znsmf.org/news/720.html>, accessed 27 June 2022.

<sup>71</sup> See 'Academic Committee', State Key Laboratory of Respiratory Diseases, posted 23 January 2011, <https://web.archive.org/web/20120311175913/http://www.gird.cn/sklrd/Article-144.aspx>, accessed 27 June 2022. On Liu, see 'Our Family's "White Haired General"', *The Paper*, 3 November 2021, [https://www.thepaper.cn/newsDetail\\_forward\\_15212620](https://www.thepaper.cn/newsDetail_forward_15212620), accessed 27 June 2022; 'Liu Youning personal website', Medcon Conference platform, [https://www.sciconf.cn/cn/person-detail/50?user\\_id=wUtevF5ILL4MV9IBh8geRQ\\_d\\_d](https://www.sciconf.cn/cn/person-detail/50?user_id=wUtevF5ILL4MV9IBh8geRQ_d_d), accessed 27 June 2022.

- 10.3 GIRH reported having 123 CCP members in 2011 and 175 CCP members by 2013. In October 2013, the CCP party committee of Guangzhou Medical University decided to let GIRH have its own “general party branch”, a status accorded to grassroots party groups with 50 to 100 party members. GIRH’s general party branch, like typical CCP party branches, is tasked with propaganda activities, discipline inspection, training cadres and other basic grassroots party functions.<sup>72</sup>
- 10.4 Given its leading role in taming the first SARS pandemic, GIRH has received support from all levels of local and national governments. For example, in May 2003, Zhong Nanshan discussed the institute’s work with then Premier Wen Jiabao, who warmly praised Zhong’s work on SARS.<sup>73</sup>
- 10.5 In 2009, Wang Yang, now an outgoing member of the Politburo Standing Committee of the CCP and chairman of the National Committee of the Chinese People's Political Consultative Conference (CPPCC), made an official visit to mark the 30th anniversary of GIRH. Wang urged GIRH staff to continue “expanding cages, building nests and attracting phoenixes, and never stop the pace of reform and innovation”.<sup>74</sup>
- 10.6 The currently listed leaders of GIRH are Zhong Nanshan, He Jianxing, Li Shiyue, Zheng Jinping and Huang Qinghui.<sup>75</sup> Zheng Jinping, a respiratory and geriatrics doctor and a Jiusan Society member,<sup>76</sup> also serves on the Guangzhou City Committee of the CPPCC. Zheng previously served in the 11th Guangdong People’s

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<sup>72</sup> Guangzhou Institute of Respiratory Health. [http://www.gird.cn/show\\_list.php?id=11](http://www.gird.cn/show_list.php?id=11), accessed 26 May 2022. On number of party members in 2011, see ‘Party branch work’, Guangzhou Institute of Respiratory Disease, archived at <https://web.archive.org/web/20120825030253/http://www.gird.cn/girdweb/List-50.aspx>, accessed 27 June 2022.

<sup>73</sup> ‘Zhong Nanshan: Wisdom, passion, and responsibility’ in *Zhongguo Gaoxin Keji* (Chinese Emerging High Technology), 12 January 2021. <http://www.zggtkjw.com/content-18-9320-1.html>, accessed 26 May 2022.

<sup>74</sup> Guangzhou Institute of Respiratory Health. [http://www.gird.cn/show\\_list.php?id=11](http://www.gird.cn/show_list.php?id=11), accessed 26 May 2022.

<sup>75</sup> Ibid.

<sup>76</sup> The Chinese government recognises eight minor “democratic” parties which accept the leading role of the Communist Party. These parties hold minor, but occasionally influential, representation in China’s national legislative chambers. The Jiusan Society, one of the eight minor parties, is traditionally oriented around intellectuals and people in universities, and has often been led by physicians.

Congress where he represented Guangzhou.<sup>77</sup> Zheng has been noted for helping to develop China's first guidelines for pulmonary function tests.<sup>78</sup>

10.7 Aside from Zhong, all of these leaders received their higher education in Guangzhou. Li was a visiting scholar at Heidelberg University (Germany) and at the US Food and Drug Administration (FDA), while He visited Barnes-Jewish Hospital in St Louis.<sup>79</sup> Perhaps unusually, while He (a lung cancer and surgery specialist) ranks below Zhong at GIRH, he has served as chief physician and president of the First Affiliated Hospital, which contains GIRH.<sup>80</sup>

10.8 Chen Rongchan was formerly a top leader at GIRH, just a level below Zhong Nanshan. Chen had trained under Zhong and briefly at McGill University in Canada. In 2018, he left GIRH to join and direct the Shenzhen Institute of Respiratory Diseases, a newer institution which in 2019 only had a handful of staff.<sup>81</sup>

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<sup>77</sup> 'Zheng Jinping', Guangzhou Medical University. <https://www.gzhmu.edu.cn/10021716>, accessed 26 May 2022.

'Zheng Jinping, the Member of the City's Committee of the Chinese People's Political Consultative Conference (CPPCC): Suggesting building an extra Infectious Disease Unit for Guangzhou National Respiratory Health Medical Center', Guangzhou Institute of Respiratory Health, 5 June 2019. <http://www.gird.cn/show.php?id=458>, accessed 26 May 2022.

'The Representative of the 11th People's Congress of Guangdong Province', The Standing Committee of Guangdong Provincial People's Congress, 11 February 2009. [http://www.gdrd.cn/rdgzxgnr\\_4349/rddbmd/syjrddb/202006/t20200601\\_172252.html](http://www.gdrd.cn/rdgzxgnr_4349/rddbmd/syjrddb/202006/t20200601_172252.html), accessed 26 May 2022.

<sup>78</sup> 'Professor Zheng Jinping of Guangzhou Medical University presided over drafting of the country's first guidelines for pulmonary function testing', Work News, Guangzhou Medical University.

<sup>79</sup> 'The Supervisor for Graduate Studies of Master Program', State Key Laboratory of Respiratory Disease. <http://www.skldr.cn/show.php?id=1027>, accessed 26 May 2022.

'Shiyue LI 李時悅', Chinese University of Hong Kong, 4 July 2019. <https://www.surgery.cuhk.edu.hk/atccs2019/Shiyue%20LI.pdf>, accessed 26 May 2022.

<sup>80</sup> 'President He Jianxing', Current Leadership, First Affiliated Hospital of Guangzhou Medical University, archived at <https://web.archive.org/web/20180209005808/http://www.gyfy.com/cn/list-170-745.html>, last accessed 28 June 2022.

<sup>81</sup> 'A Cohort of Researchers', State Key Laboratory of Respiratory Disease. <http://www.skldr.cn/show.php?id=357>, accessed 26 May 2022.

'Chen Rongchang', Guangzhou Medical University, 5 January 2022. <https://ygc.gzhmu.edu.cn/info/1121/1632.htm>, accessed 26 May 2022.

10.9 Chen’s institute later recruited Zhong to serve as its “honorary” leader with the hope of improving and “internationalising” the Shenzhen institute.<sup>82</sup> Chen is also said to be involved in political activities and once served in the People’s Congress and Consultative Conference in Guangzhou.<sup>83</sup>

10.10 In addition to GIRH’s leaders, Yang Zifeng, Ma Qin Hai, Wang Jian, Luo Yuanming, Ran Pixin, Zhao Jincun and Guan Weijie have all been featured on GIRH’s website, along with Lu Wenjiu and Xie Jiaying for the latter’s earlier accomplishments.<sup>84</sup> The work and activities of these figures are outlined in Table 2.

**TABLE 2 FEATURED RESEARCHERS IN GIRH AND THE STATE KEY LABORATORY OF RESPIRATORY DISEASE<sup>85</sup>**

Researcher Name	Significance	International Experiences
Yang Zifeng	Established a nationally adopted virus detection platform	Unknown
Ma Qin Hai	Participated in clinical researching of anti-viral medicine of COVID-19	Unknown
Wang Jian	Leader of Pulmonary Vascular Disease Group, National Centre for Respiratory Medicine	Senior editor of UK-based journal <i>Experimental Physiology</i> , editorial board member of the US-based journal <i>Pulmonary Circulation</i> , American Thoracic Society Member (ATS), member of the ATS Pulmonary Circulation Academic Committee, member of the American Heart Association and member of the American Physiological Society
Luo Yuanming	NA	Member of the Expert Group on Respiratory Function Testing of the European Respiratory Association, visiting professor at King’s College London, head of Research and Innovation China Base for Clinical Medical Students at Imperial College London, participant of the New

<sup>82</sup> ‘Zhong Nanshan is hired by People’s Hospital of Shenzhen, as a Honorary Director for the Guangzhou Institute of Respiratory Health’, People.Cn. 29 July 2021. <http://sz.people.com.cn/n2/2021/0729/c202846-34842681.html>, accessed 26 May 2022.

<sup>83</sup> ‘Chen Rongchang’, X-MOL. <https://www.x-mol.com/university/faculty/96389>, accessed 26 May 2022.

<sup>84</sup> ‘Vehemently Celebrating Professor LI Shiyue of our Department is Nominated as the Directing Member in the 9th Committee of Chinese Thoracic Society’, Guangzhou Institute of Respiratory Health, 9 July 2020. <http://www.gird.cn/show.php?id=459>, accessed 26 May 2022.

<sup>85</sup> Featured researchers listed on the website of State Key Laboratory of Respiratory Disease, [http://www.skIRD.cn/en/show\\_list.php?id=22](http://www.skIRD.cn/en/show_list.php?id=22), accessed 20 June 2022. See also ‘Professor Luo Yuanming of SKLRD honored as Fellow of the Royal College of Physicians’, State Key Laboratory of Respiratory Disease News Information, 9 February 2021, <http://www.skIRD.cn/en/show.php?id=858>, last accessed 27 June 2022.

		Zealand Health Research Agency's Sino-New Zealand Cooperation Seminar, chief China representative of the European Respiratory Association and fellow of the UK's Royal College of Physicians
Ran Pixin	Secretary of the Party Committee of Guangzhou Medical University and director of the State Key Laboratory of Respiratory Diseases	Unknown
Zhao Jincun	Deputy director of the State Key Laboratory of Respiratory Diseases	Unknown
Guan Weijie	Principal of the Bronchiectasis Research Group of the State Key Laboratory of Respiratory Diseases	
Lu Wenjiu	PI, State Key Laboratory of Respiratory Diseases, Guangzhou Medical University	Principal of research projects supported by the United States National Institutes of Health Fund
Xie Jiaying	NA	Member of European Respiratory Society and awarded the European Respiratory Society Scholarship to study at the National Heart and Lung Research Institute in the United Kingdom

### **GIRH: International Linkages**

- 11.1 Since 2007, GIRH has hosted around 100 foreign scientists from countries including the United States, United Kingdom, Canada, France, Belgium, Japan and the United Arab Emirates. These foreign scientists visit GIRH under the domestic talent development principle of “please come in and then go out” (请进来, 走出去). As of 2018, around 40 GIRH staff had been sent to study outside of China.<sup>86</sup>
- 11.2 GIRH has established partnerships with the Firestone Respiratory Health Research Institute (Canada), McMaster University, University of Toronto, Imperial College London, King's College, Johns Hopkins University, University of Hong Kong, Chinese University of Hong Kong, University of Macau, and Macau University of Science and Technology. In the mid-2010s, GIRH hosted or co-organised at least 22 international academic conferences and 24 national academic conferences.<sup>87</sup>

<sup>86</sup> ‘International Cooperation and Communication’, Guangzhou Institute of Respiratory Health. [http://www.skldr.cn/show\\_list.php?id=47](http://www.skldr.cn/show_list.php?id=47), accessed 6 June 2022.

<sup>87</sup> Ibid.

- 11.3 In February 2020, it was announced that GIRH would evenly share a US\$115 million grant with Harvard University, provided by the large real estate developer China Evergrande Group. The grant aimed to drive new diagnostic technologies, vaccines and other therapeutics in response to COVID-19.<sup>88</sup>
- 11.4 In a reaction to the grant announcement, Zhong Nanshan declared that “[w]e are extremely encouraged by the generous gesture from Evergrande to coordinate and support the collaboration and by the overwhelmingly positive response from our Harvard colleagues”.<sup>89</sup> However, two years thereafter, it emerged that Evergrande had reneged on all but US\$12 million of the grant to its US-based recipients.<sup>90</sup> It is not clear how much of the grant has so far been disbursed to GIRH.
- 11.5 GIRH leaders He Jianxing and Li Shiyue have spent many years working in the United States, helping to raise the institute’s profile in international biomedical research. He and Li are affiliated with the American College of Chest Physicians, World Association of Bronchology and Interventional Pulmonology, Forum of International Respiratory Societies, Global Lung Function Initiative and the journal *Respiration*, among other groups.<sup>91</sup>
- 11.6 GIRH has an international English-language journal, *Journal of Thoracic Diseases* (JTD), which lists receiving support from Italian and Brazilian medical societies.

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<sup>88</sup> Ekaterian Pesheva, ‘Scientists from Harvard, China to unite against coronavirus’, *Harvard Gazette*, 24 February 2020, <https://news.harvard.edu/gazette/story/2020/02/harvard-and-china-collaborate-on-coronavirus-therapies/>, last accessed 27 June 2022; Jennifer Couzin-Frankel, ‘With \$115 million, more than 80 Boston researchers will collaborate to tackle COVID-19’, ScienceInsider, *Science*, 5 March 2020, <https://www.science.org/content/article/115-million-more-80-boston-researchers-will-collaborate-tackle-covid-19>, accessed 27 June 2022.

‘Bill & Melinda Gates Foundation Dedicates Additional Funding to the Novel Coronavirus Response’, Bill & Melinda Gates Foundation, 5 February 2020. <https://www.gatesfoundation.org/ideas/media-center/press-releases/2020/02/bill-and-melinda-gates-foundation-dedicates-additional-funding-to-the-novel-coronavirus-response>, accessed 28 June 2022

<sup>89</sup> Ibid.

<sup>90</sup> Rebecca Ostriker and Deirdre Fernandes, ‘Evergrande reneges on multimillion-dollar pledge to Harvard-led COVID project’, *Boston Globe*, 16 January 2022, <https://www.bostonglobe.com/2022/01/16/metro/evergrande-reneges-multimillion-dollar-pledge-harvard-led-covid-project-another-stumble-its-ties-school/>, accessed 27 June 2022.

<sup>91</sup> ‘Li Shiyue 李時悅’, Chinese University of Hong Kong, 4 July 2019. <https://www.surgery.cuhk.edu.hk/atccs2019/Shiyue%20LI.pdf>, accessed 26 May 2022.

‘Zheng Jinping’, Guangzhou Medical University. <https://www.gzhmu.edu.cn/10021716>, accessed 26 May 2022.

Zhong Nanshan and He Jianxing are the journal's co-editors, while its editorial board has many ethnic Chinese doctors in mainland China, Taiwan, Britain and the United States, as well as non-ethnic Chinese doctors at prominent medical institutions in London, Berlin, Houston, New York and elsewhere.<sup>92</sup>

### **Prospects of China's Key Virology Laboratories**

- 12.1 Chen Wei's established links with Qiu Xiangguo (formerly NML) are significant, especially in the domain of Henipah/Nipah virus research. The Henipah virus has not been clinically detected in China and there are already adequate diagnostics available in the market. This virus has only been clinically detected in Malaysia, Singapore, India and Bangladesh and is characterised by irregular and short-duration outbreaks. It is not clear if there is a viable market for a vaccine and there is likely no viable market for such a vaccine within China.
- 12.2 Another key observation is that AMMS has continued at least some higher-risk research involving the SARS-CoV-2 virus since the start of the global COVID-19 pandemic. Much of the high-risk pathogen research at AMMS appears to be done "in-house" or with a narrowly defined set of transnational partners. As such, AMMS may be close to achieving a self-sufficiency in virology research with less critical dependence on international partners.
- 12.3 China's long term strategic planning and commitment to become "number one" with or without transnational links means that China aspires to become the most prepared country for the next global pandemic.
- 12.4 Based on publicly available information, GIRH does not appear to be engaged in high-risk pathogen research projects. The institute apparently focuses on clinical activity, acute patient care, and public health communication and engagement.
- 12.5 To date, IPB also does not look to be engaged in high-risk pathogen research like the activities at WIV, HVRI, or IMB in Kunming. However, a 2021 study in

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<sup>92</sup> See *Journal of Thoracic Disease*, AME Publishing Company, Hong Kong. <https://jtd.amegroups.com/about/editorialTeam>, accessed 26 May 2022.



*Virologica Sinica*, in which scientists in the CML (a part of IPB) developed a synthetic “SARS-CoV-2-GFP replicon”, appears to be a break from the previous trend. This experiment was conducted within the CML.<sup>93</sup>

- 12.6 That IPB and GIRH have extensive links with virology laboratories and scientists abroad means that they have access to new scientific methods and technologies, and are aware of cutting-edge research in the West. Though transnational links are no doubt beneficial for Chinese laboratories, the latter have also acquired growing capabilities to carry out advanced research on their own if transnational ties are ruptured due to the intensifying geopolitical competition between China and the United States and its allies.

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<sup>93</sup> Bei Wang, et. al., 'Construction of Non-infectious SARS-CoV-2 Replicons and Their Application in Drug Evaluation', *Virologica Sinica*, Vol. 36, No. 5, October 2021.

## ANNEX 1

### DATA TABLE ANNOTATION – DATA ABYSS

Article processing and aggregation functions were completed by the Data Abyss search engine. The articles, organisations and associated metadata are then aggregated at scale, with an in-memory representational graph approach. This Data Abyss graph derives the relationships across documents and time from Chinese-language open-source data. The massive scale process allows for the generation of a near-complete aggregated picture of every entity-specific relationship across the entire Science and Technology spectrum. This representation of every entity-specific relationship describes the current state organisational network. This computationally intensive process would be nearly impossible for analyst teams to manually derive as the relationships across Chinese strategic Science and Technology organisations contain up to billions of connections.

The net result of this approach is that all entities relationships can be automatically known over a specific time-series. Through the Data Abyss analytical platform, an analyst can quickly query a specific Chinese virology institute, which gives analysts the results of every author, coauthor, organisational affiliation, article title, date, keyword, known high-risk relationships, grant funds and other data that has ever been directly associated with that specific institute. This results in thousands of data points per organisation.

Data Abyss enables stakeholders to recognise entities that are worth their attention. Data Abyss tags entities with risk and impact indicators that are associated with known and potentially unknown risky and impactful entities. Data Abyss identifies risk by leveraging reference data sets of entities from US Department of Commerce tracked Military End Users (MEU) and Entity Lists (EL), Federal Communications Commission’s Covered Lists (CL), and entities tracked by the Australia Strategic Policy Institute (ASPI). Data Abyss leverages AI-assisted processing techniques to track down PLA affiliates and linked transnational entities.

These holistic views of the organisational targeting spectrum allow for in-depth analysis and understandings of:

- Active recruitment of American virologists and other related scientists by Chinese virology institutes
- Chinese research on reverse engineering research for virology-related technologies
- American corporate and university research with sanctioned Chinese state-owned enterprises
- Unidentified Chinese virology organisations and associated research partnerships with sanctioned Chinese state-owned enterprises
- The increasing dual-use virology capabilities in China, including both state and non-state actors, and the demonstrated willingness of these parties to collaborate or transact with each other

## ANNEX 2

### DATA TABLE ON TRANSNATIONAL LINKAGES OF ACADEMY OF MILITARY MEDICAL SCIENCES

The top identified transnational links of AMMS-affiliated organisations by count metrics are as follows:

University of Texas Medical Branch	1st
University at Buffalo – The State University of New York	2nd
Department of Chemistry and Biochemistry – University of Texas at Austin	3rd
National Microbiology Laboratory (Winnipeg, Canada)	4th
Creighton University School of Medicine (Omaha, Nebraska)	5th
CanSino Biologics (Hong Kong)	6th
Biomedical Discovery Institute, Department of Microbiology, Monash University (Melbourne, Australia)	7th
Department of Anatomy and Physiology, College of Veterinary Medicine, Kansas State University	8th
US Army Research Institute of Infectious Diseases	9th
Department of Biomedical Science, Mercer University School of Medicine (Macon, Georgia)	10th

The top identified domestic Institute of Virology and Microbiology-affiliated organisations by count metrics are as follows:

State Key Laboratory of Pathogen and Biosecurity, Beijing Institute of Microbiology and Epidemiology	1st
Science and Technology on Parallel and Distributed Processing Laboratory	2nd
Beijing Genomics Institute-Shenzhen	3rd
Beijing Engineering Research Centre of Protein and Antibody, Sinocelltech Ltd	4th
Beijing Key Laboratory of Monoclonal Antibody Research and Development, Sino Biological Inc	5th
CAS Key Laboratory of Genome Sciences and Information, Beijing Institute of Genomics, Chinese Academy of Sciences	6th
CAS Key Laboratory of Infection and Immunity, Institute of Biophysics, Chinese Academy of Sciences	7th
Laboratory Animal Centre, Academy of Military Medical Science	8th
National Institute for Viral Disease Control and Prevention, Chinese Centre for Disease Control and Prevention	9th
PLA Strategic Support Force Medical Centre	10th
School of Computer Science, National University of Defence Technology	11th
The Central Laboratory of Health Quarantine, Shenzhen Travel Healthcare Centre, Shenzhen Entry-Exit Inspection and Quarantine Bureau	12th

### ANNEX 3

#### DATA TABLE ON TRANSNATIONAL AND DOMESTIC LINKAGES OF INSTITUTE OF VIROLOGY AND MICROBIOLOGY (AMMS)

The top identified transnational links of Institute of Virology and Microbiology (AMMS)-affiliated organisations by count metrics are as follows:

University of Texas Medical Branch	1st
Lindsley F Kimball Research Institute, New York Blood Centre	2nd
Universite de Bordeaux	3rd
Biostatistics Research Branch, National Institute of Allergy and Infectious Diseases, National Institutes of Health	4th
Department of Medicine, UC Irvine School of Medicine	5th
School of Public Health and Family Medicine, University of Cape Town	6th
Division of Basic Biomedical Sciences, Sanford School of Medicine of the University of South Dakota	7th
Department of Clinical Sciences, Institute of Tropical Medicine, Antwerp Belgium	8th

The top identified domestic Institute of Virology and Microbiology-affiliated organisations by count metrics are as follows:

State Key Laboratory of Pathogen and Biosecurity, Beijing Institute of Microbiology and Epidemiology	1st
Science and Technology on Parallel and Distributed Processing Laboratory	2nd
Beijing Genomics Institute-Shenzhen	3rd
Beijing Engineering Research Centre of Protein and Antibody, Sinocelltech Ltd.	4th
Beijing Key Laboratory of Monoclonal Antibody Research and Development, Sino Biological Inc	5th
CAS Key Laboratory of Genome Sciences and Information, Beijing Institute of Genomics, Chinese Academy of Sciences	6th
CAS Key Laboratory of Infection and Immunity, Institute of Biophysics, Chinese Academy of Sciences	7th
Laboratory Animal Centre, Academy of Military Medical Science	8th
National Institute for Viral Disease Control and Prevention, Chinese Centre for Disease Control and Prevention	9th
PLA Strategic Support Force Medical Centre	10th
School of Computer Science, National University of Defence Technology	11th
The Central Laboratory of Health Quarantine, Shenzhen Travel Healthcare Centre, Shenzhen Entry-Exit Inspection and Quarantine Bureau	12th

## ANNEX 4

### DATA TABLES ON TRANSNATIONAL AND DOMESTIC LINKAGES OF THE INSTITUTE OF PATHOGEN BIOLOGY

The top identified transnational Institute of Pathogen Biology-affiliated organisations by count metric are as follows:

Christophe Merieux Laboratory	1st
Institut Pasteur of Shanghai	2nd
University of Southampton	3rd
Lady David Institute, Jewish General Hospital, McGill University	4th
Texas A&M University	5th
Novosibirsk State University	6th
University College Dublin	7th

The top identified domestic Institute of Pathogen Biology-affiliated organisations by count metrics are as follows:

Chinese Academy of Medical Sciences and Peking Union Medical College (CAMS/PUMC)	1st
Beijing Advanced Innovation Centre for Genomics (ICG)	2nd
Beijing Advanced Innovation Centre for Structural Biology (ICSB)	3rd
Beijing Centre for Disease Prevention and Control (CDC)	4th
Beijing Institute of Genomics	5th
Centre for Excellence in Animal Evolution and Genetics	6th
Chinese Institute for Brain Research (CIBR)	7th
Collaborative Innovation Centre for Diagnosis and Treatment of Infectious Diseases	8th
Key Laboratory of Respiratory Disease Pathogenomics	9th
Ministry of Health Key Laboratory of Systems Biology of Pathogens	10th
National Health Commission (NHC) Key Laboratory of Systems Biology of Pathogens and Christophe Mériex Laboratory	11th
Chinese Academy of Sciences (CAS) Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology	12th
Chinese Academy of Sciences (CAS) Centre for Biosafety Mega-Science	13th

## ANNEX 5

### DATA TABLES ON TRANSNATIONAL AND DOMESTIC LINKAGES OF THE CHRISTOPHE MERIEUX LAB, INSTITUTE OF PATHOGEN BIOLOGY

The top identified transnational Christophe Merieux-affiliated organisations by count metrics are as follows:

Rodolphe Merieux Laboratory	1st
Institut Pasteur of Shanghai	2nd
Aix-Marseille University	3rd
University of Southampton	4th
King George's Medical University	5th
Lao Tropical Public Health Institute	6th
Instituto Oswaldo Cruz	7th
Institute of Tropical Medicine of the University of Sao Paulo	8th
Centre d'Infectiologie Clinique Charles Merieux	9th

The top identified domestic Christophe Merieux-affiliated organisations by count metrics are as follows:

Beijing Advanced Innovation Centre for Genomics (ICG)	1st
Beijing Advanced Innovation Centre for Structural Biology (ICSB)	2nd
Beijing Centre for Disease Prevention and Control (CDC)	3rd
Beijing Institute of Genomics	4th
Centre for Excellence in Animal Evolution and Genetics	5th
Chinese Institute for Brain Research (CIBR)	6th
Key Laboratory of Respiratory Disease Pathogenomics	7th
NHC Key Laboratory of Systems Biology of Pathogens	8th
Biomedical Pioneering Innovation Centre (BIOPIC)	9th
China National Centre for Bioinformation	10th
Shenzhen Bay Laboratory	11th
Chinese Academy of Medical Sciences and Peking Union Medical College	12th
University of Southampton	13th

## ANNEX 6

### DATA TABLES ON THE TRANSNATIONAL AND DOMESTIC LINKAGES OF THE GUANGZHOU INSTITUTE OF RESPIRATORY HEALTH

The top identified transnational Guangzhou Institute of Respiratory Health/Huyan Institute-affiliated organisations by count metrics are as follows:

Harvard University	1st
Johns Hopkins University	2nd
University of Embu	3rd
Stony Brook University-State University of New York	4th
King's College	5th
University of Toronto	6th
Firestone Respiratory Health Research Institute	7th
McMaster University	8th

The top identified domestic Guangzhou Institute of Respiratory Health/Huyan Institute-affiliated organisations by count metrics are as follows:

Guangzhou Medical University	1st
Guangzhou Baiyunshan Hutchison Whampoa Chinese Medicine Co. Ltd.	2nd
Kunming Medical University	3rd
Wuhan Institute of Virology (WIV), Chinese Academy of Sciences (CAS)	4th
Key Laboratory of Medical Virology and Viral Diseases, Ministry of Health, Institute of Viral Disease Control, Chinese Centre for Disease Control and Prevention, WHO Western Pacific Region Measles/Rubella Reference Laboratory	5th
Department of Respiratory Medicine, The 458th Hospital of the PLA	6th
General Hospital of Shenyang Military Region of the PLA	7th
PLA Organ Transplantation Institute, Eighth Medical Centre, General Hospital of the PLA	8th
Department of Respiratory Medicine, General Hospital of the Eastern Theatre Command of the PLA	9th
PLA General Hospital	10th
Shanghai Fangyu Health Medicine Technology Co. Ltd.	11th
Shanghai Frontier Health Pharmaceutical Technology Co. Ltd	12th
Guangzhou Joicare Respiratory Medicine Co. Ltd	13th

## ANNEX 7

### DATA TABLE ON LINKAGES BETWEEN UTMB GALVESTON AND CHINESE VIROLOGY RESEARCH INSTITUTES (ex-AMMS)

The top identified Chinese UTMB-affiliated organisations (excluding AMMS) by count metrics are as follows:

Anhui Province Centre for Disease Control and Prevention	1st
Department of Gastroenterology and Hepatology, PLA General Hospital	2nd
Department of Gastroenterology, Chinese Navy General Hospital	3rd
Department of Internal Medicine, Chinese PLA General Hospital	4th
Jinan Junqu Centre for Disease Control and Prevention	5th
School of Public Health, Shandong University	6th
School of Pharmacy, Sun Yat-Sen University	7th
State Key Laboratory of Infectious Disease Control and Prevention China Centre for Disease Control and Prevention Institute for Infectious Disease Control and Prevention	8th
Peking Union Medical College Hospital	9th
Department of Pathology, Zhongnan Hospital, Wuhan University	10th
Department of Pathogen Biology, Wuhan University School of Medicine	11th
Institute of Virology, School of Medicine, Wuhan University	12th

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