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Chinese Academy of Medical Sciences and Peking Union Medical College: Leading innovation in the health sciences

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A historic opportunity for innovative health sciences

CAMS and PUMC have made many significant contributions to the advancement of medicine both at home and abroad.
Peking Union Medical College (PUMC) and the Chinese Academy of Medical Sciences (CAMS) share a history of firsts. PUMC was the first medical university in China authorized to grant M.D. degrees to students who have finished an eight-year curriculum that starts in undergraduate school (see Chapter 5). It also opened the first national nursing school in the country. CAMS, its sister institution, is a leading multidisciplinary medical research institution that, among its many accomplishments, developed the new antitumor drug icotinib, which targets advanced lung cancer in the Chinese population more effectively than the preferred drug, gefitinib. CAMS also created the first artificial musk, an ingredient used in many sought-after Chinese medications that previously could be extracted only from the endangered male musk deer; in addition, it established China’s largest stem cell bank—the Tianjin Cord Blood Bank.

These firsts stem from a synergy that exists between the two institutions: CAMS provides PUMC with qualified faculty, and PUMC trains promising scientists and physicians for CAMS. CAMS and PUMC run 19 institutes, 7 satellite centers, 6 hospitals, and 7 schools (see Chapters 1 and 4). The pair are now seeking another series of firsts—to make PUMC an international research-based medical university and to transform CAMS into the “Chinese National Institutes of Health,” giving it international standing (see Chapter 1).

To accomplish these goals, CAMS and PUMC will contribute to two recently launched national megaprojects. The Major New Drug Innovation Program was funded with the ambitious goal of discovering 100 new drugs by 2020. China’s Control and Prevention of Major Infectious Diseases Program was launched to establish a support system for dealing with emerging diseases and to control the incidence of major infectious diseases such as hepatitis B, tuberculosis, and human immunodeficiency virus (HIV).

A mixture of Eastern and Western medicine persists at PUMC and CAMS. For example, foreign and domestic scientists at the Cancer Hospital combine modern clinical immunology with traditional Chinese medicine and its use of Fu Zheng Pei Ben therapy (strengthening the body’s resistance). As a result, several traditional Chinese medicines have been found to protect the adrenal gland and bone marrow and are used as supplementary treatments to chemo- and radiotherapies. Similarly, the Institute of Hematology and Blood Diseases Hospital developed the traditional Chinese medicine indirubin for the treatment of chronic myeloid leukemia, becoming a pioneer in using bisindole drugs in the treatment of cancer.

In addition to looking inward by developing China’s top medical and research programs, CAMS and PUMC have maintained close ties with prominent medical colleges and research institutions around the world. For example, from 1917 to the present, PUMC has invited more than 246 world-class scholars and experts—including presidents, princesses, and Nobel Prize winners—to be honorary or visiting professors and to share their insights and vision with its faculty and researchers (see Chapter 6). Student exchange programs have been underway for more than 30 years with leading medical universities and institutions worldwide.

Despite the many dramatic changes in China since their founding, PUMC and CAMS have remained true to their mission and heritage as elite medical and research institutions. No doubt many more firsts remain in their collective future.

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Spearheading modern medicine in China: The Chinese Academy of Medical Sciences and Peking Union Medical College

Headquartered in an ancient-style courtyard building just a few blocks east of the Forbidden City—the last Chinese imperial palace from 1420 to 1912—the Chinese Academy of Medical Sciences (CAMS) and the affiliated Peking Union Medical College (PUMC) have been leaders in modern medicine in China for over a century. Today, CAMS produces world-class biomedical research and shoulders the responsibility of advising the Chinese government on pivotal health care and medical education reforms.

A reporter for the Science Custom Publishing Office visited CAMS in March 2016 to observe firsthand the progress and achievement in biomedical research there. A series of 46 interviews with more than 60 physicians, surgeons, and researchers, as well as tours of hospitals and laboratories, brought to light the daunting tasks that China faces to care for the health of its 1.3 billion citizens—and the role CAMS plays in helping the government tackle these challenges through scientific innovation. This series of Editorial Reports offers an in-depth look at these challenges, innovations, and achievements.

The dawn of modern medical education in China

For centuries, traditional Chinese medicine (TCM) was the mainstay of health care in China. Those who had mastered the art of healing were called daifu, and were trained by the apprentice model, with a vast amount of medical knowledge passed down verbally from generation to generation. In fact, very little TCM knowledge was systematically recorded until the completion of Shizhen Li’s Compendium of Materia Medica in 1578. And, as was the case for other technical innovations from China such as gunpowder and pyrotechnics, the Chinese rarely investigated the science behind TCM.

Missionaries brought Western medicine to China in the 19th century, and many recognized its superior effectiveness in treating acute illness compared to TCM. With the growing acceptance of modern medicine came an increasing need to build hospitals and to train medical doctors in China to serve more people.

In 1906, a coalition of foreign missions, endorsed by Empress Dowager Cixi, the de facto ruler of China at the time, founded a clinic that later became PUMC Hospital. The precursor of PUMC, a Western-style medical school modeled after Johns Hopkins University School of Medicine in the United States, broke ground at its current site in the Dongdan neighborhood. “In the 1900s, Dongdan was the center of Western medicine in Beijing,” explained Xuetao Cao, president of both CAMS and PUMC. “The layout and construction were unprecedented at the time, with independent supplies of water, heat, and electricity. All the interconnected basements and underground corridors still in use today were built at that time.”

PUMC was officially founded in 1917 with exclusive financial support from the newly established Rockefeller Foundation. The first director of PUMC was Franklin C. McLean, a medical resident in the hospital of The Rockefeller Institute for Medical Research in New York, who later returned to the United States to help found the University of Chicago medical clinics in 1927.

From the beginning, PUMC has been one of China’s top-tier medical schools; it is the first in the country to offer an eight-year curriculum of comprehensive medical education. To this day, PUMC remains one of the few elite medical
schools in China that takes time to rigorously train its small student body to the highest standards. “The best doctors in China and most health policy-makers in the government today are graduates of PUMC,” says Denian Ba, who was president of PUMC from 1992 to 2001. Echoes President Cao, “The undergraduate courses like math, chemistry, and biology build a strong foundation and enable our students to embark on independent medical research and discovery later on.”

**Founded through reorganization of the Central Hygiene Research Laboratory in 1956, CAMS assumed the responsibility of leading medical research and advising on national health policy.**

Center of the political ground zero, PUMC Hospital had seen its share of “luminary patients” such as Sun Yat-sen, the revolutionary founding father of the Republic of China, who died in PUMC Hospital on March 12, 1925. Founded through reorganization of the Central Hygiene Research Laboratory in 1956, CAMS assumed the responsibility of leading medical research and advising on national health policy. The following year, PUMC merged with CAMS. Since then, the medical college and the academy have operated closely together, fulfilling their common mission as “two entities under one roof.”

CAMS and PUMC researchers continued to make important contributions during difficult times in the second half of the 20th century. One example was the development of an oral poliovirus vaccine (OPV) in the 1950s, the research for which was carried out by former CAMS president Fangzhou Gu. In the early 1950s, after decades of war, several epidemics of poliomyelitis broke out that affected many young children and impeded the reconstruction of the young nation. Enlai Zhou, then premier of China, ordered CAMS to come up with a strategy to control this devastating disease. Gu was sent to the Soviet Union to study poliovirus prophylaxis. He quickly realized that the injectable, inactivated poliovirus vaccine (IPV) commonly administered in the West, while safe, was not feasible for use in China due to its cost and the lack of cold-chain transportation.

Gu’s challenge was to develop China’s own poliovirus vaccine based on the live, attenuated virus. To do this safely, in 1958 he went to the mountains in the remote Yunnan Province in southwest China and built a virology lab in Kunming, far from population centers. He cultured poliovirus in primary monkey kidney cells (there is a surplus of monkeys in the hills of Yunnan) and successfully developed the first attenuated OPV in China. To solve the transportation problem, he formulated the vaccine with syrup and made candies that did not need refrigeration. According to legend, Gu gave his son a high-dose vaccine to test its safety before reporting his success to Beijing.

China began a mass OPV campaign in 1962 and was certified polio-free by the World Health Organization in 2000. This OPV is still in use today—it was successfully deployed to control an outbreak in the Xinjiang Uyghur Autonomous Region in 2011. The virology laboratory that Gu set up grew into the CAMS Institute of Medical Biology (IMB), with more than 100 staff working on R&D for a list of critical vaccine development projects, vaccine production, and public health preparedness.

Other examples of important medical research that CAMS has been involved with include the development of penicillin manufacturing capability during the Korean War, and a large-scale collaborative drug discovery program for antimalarial agents derived from TCM regimens, to treat North Vietnamese and Chinese soldiers stricken with the disease during the Vietnam War.

Mao Zedong assigned special status to antimalarial drug discovery research. Code-named “Project 523,” the malaria program involved around 200 to 300 scientists from major academic institutions, including CAMS, who were given special permission to continue research at the peak of the Cultural Revolution, according to academician Dequan Yu of the CAMS Institute of Materia Medica (IMM), who was a member of this special project. One antimalarial agent that the group discovered was artemisinin, Youyou Tu, another Project 523 scientist from the China Academy of Chinese Medical Sciences, shared the 2015 Nobel Prize in Physiology or Medicine for her role in the isolation of the active ingredient from sweet wormwood (Artemisia annua). The determination of artemisinin’s chemical composition and molecular structure was conducted by IMM researcher Xiaotian Liang, a coauthor of the key publication on the discovery.

**CAMS today**

This year, CAMS celebrates its 60-year anniversary, and PUMC marks its

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<tr>
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Table 1: State Key Laboratories in CAMS
EDITORIAL REPORT

Dongfeng Gu

Building that will add another 500 beds for its cardiology and cardiac surgery. Fuwai Hospital—which is well known for its own specialty—opened in late 2015. The outpatient operation in these hospitals can be eye-popping. "Our goal is to become a first-class, international cardiovascular disease center. Fuwai’s doctors perform 13,000 procedures," says Ma. "The system was designed to train doctors who are ready to lead medical research and to teach." Since its founding in 1917, PUMC has never lost its focus on comprehensive medical education, and it strives to maintain its elite model even while hundreds of other medical schools have cropped up across the country graduating a hodgepodge of "doctors" with various qualifications. PUMC maintains a small incoming class every year—less than 100 medical students and 150 nursing students. Thus, a high school graduate must do very well on the National College Entrance Exams to be admitted to PUMC.

Currently, there are about 1,100 medical and nursing students enrolled in PUMC. The medical students spend the first two-and-a-half years taking undergraduate premed courses in order to build a strong knowledge base in math, physics, chemistry, and biology. Then they study basic medicine such as anatomy, histology, and physiology for one-and-a-half years before entering three years of clinical training. At the end of the program, PUMC medical students are required to conduct an eight-month biomedical research project to “sow the seed of translational research” in their minds, says Ma.

The merger of PUMC and CAMS in 1956 further increased the synergy between research and education. Many medical students chose to continue research projects after graduation regardless of whether they stayed in clinical practice. There are paths for these students to continue research study toward an M.D./Ph.D. degree and opportunities to conduct postdoctoral training abroad through international collaborations. Many current directors and department chairs in CAMS/PUMC, including President Cao, are graduates of this comprehensive education system, as are many other health policy-makers and top physicians and surgeons in China. According to Ma, the guiding principle of medical education in PUMC is “to educate and inspire future leaders in the biomedical sciences.”

Biomedical research

Biomedical research is the bread and butter of CAMS. “The prestige of a scientific academy like CAMS is determined by the quality of scientific research conducted there. This is why research administration is one of the most important function of CAMS,” says Qimin Zhan, who is in charge of the Research Administration Department, which oversees all research-related affairs, from funding allocation to project prioritization.

A wide range of projects are undertaken in the 19 CAMS research institutes, seven schools, and six affiliated hospitals throughout China, including major research centers in five cities: Beijing, Tianjin, Nanjing, Kunming, and Hangzhou. Together, these units form the three pillars of CAMS: clinical medicine, medical education, and biomedical research. As evidence of its leadership role in the medical sciences, CAMS boasts five state key laboratories (SKLs) that receive direct funding from the central government (Table 1). The SKLs and associated hospitals or research institutes have been producing some of the best biomedical research in the world and frequently publish important results in high-profile, international peer-reviewed journals.

Clinical medicine

Among the six affiliated hospitals, PUMC Hospital is the oldest, tracing its history back to 1906. It is a full-service general hospital, serving residents of Beijing and the surrounding areas. Each of the other five affiliated hospitals, including the Plastic Surgery Hospital, CAMS Cancer Hospital (CCH), and the Fuwai Hospital in Beijing; the Skin Diseases Hospital in Nanjing; and the Blood Diseases Hospital in Tianjin, has its own specialty.

The scale and efficiency of clinical operation in these hospitals can be eye-opening. In late 2015, the outpatient department and a cardiology ward in Fuwai Hospital—which is well known for its cardiology and cardiac surgery departments—moved into a brand new building with 1,000 beds; then renovation began on the adjacent older building that will add another 500 beds by the end of 2016. Dongfeng Gu, Vice President of Fuwai Hospital, says, “Our goal is to become a first-class, international cardiovascular disease center. Fuwai’s doctors perform 13,000 heart surgeries each year and 15,000 percutaneous coronary intervention procedures.” These numbers far exceed those in major cardiovascular centers in the West, yet “the surgical mortality rate in Fuwai is as low as, or even lower than, [the rates in] world-renowned cardiac surgery centers such as the Mayo Clinic,” says Gu.

Located in the southeastern part of Beijing, CCH is the top cancer treatment and research center in China. Also the site of the National Cancer Center, CCH is where new cancer therapies are first tested. Oncologists around the country come to CCH to learn new treatment strategies. The efficiency of patient care at CCH is impressive. Yexiong Li, head of the Department of Radiation Oncology, told Science that his department treats about 5,500 patients a year with eight linear accelerators. That’s about the same number of patients treated annually at the University of Texas MD Anderson Cancer Center, where more than 20 linear accelerators are in service, he says. “Our machines run from 7:30 in the morning to 12:00 midnight,” explains Li. “Therefore, a lot of the quality control, maintenance, and calibration work needs to be done at night; it’s hard work.”

Medical education

PUMC is the education arm of the CAMS/PUMC system and works hand in hand with the research institutes in CAMS. Clinical medicine is taught in five PUMC schools (Clinical Medicine, Basic Medicine, Nursing, Public Health, and Continuing Education); a separate graduate school trains nonclinical scientists obtaining a Ph.D. degree. “The gene of medical education is in the blood of PUMC,” says Chao Ma, dean of medical education for the School of Clinical Medicine and School of Nursing at PUMC. “Our unique focus on education played a big role in transforming PUMC, from a school [in which courses were] taught only by foreigners in 1917, to a modern medical school with an all-Chinese faculty in just 40 years,” says Ma. “The system was designed to train doctors who are ready to lead medical research and to teach.”

In the first two-and-a-half years taking undergraduate premed courses in order to build a strong knowledge base in math, physics, chemistry, and biology. Then they study basic medicine such as anatomy, histology, and physiology for one-and-a-half years before entering three years of clinical training. At the end of the program, PUMC medical students are required to conduct an eight-month biomedical research project to “sow the seed of translational research” in their minds, says Ma.

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The last two categories set CAMS apart from the country’s other academic universities. Being the top and only national biomedical research organization in China, CAMS is responsible for collecting and maintaining databases that help guide the nation’s health policy, and also for keeping up with the latest technology for disease control and prevention. Since its founding, CAMS has successfully fulfilled these mandates, even in difficult times of war or social unrest.

For its cutting-edge work in the biomedical sciences, “CAMS focuses on application-oriented research. In today’s parlance, that’s called ‘translational medicine,’” says President Cao. The projects CAMS scientists choose to work on typically have some near-term medical applications. This tradition can be traced back to the 1930s, when PUMC doctor Sizhi Liu first developed a biochemical assay for antibody quantification, which became the key technique used in the first rheumatology clinic in Asia—decades before the development of modern antibody titration assays. Since then, CAMS researchers have closely followed this model of choosing research projects with potential impact on patient care.

The merger of CAMS and PUMC in 1956 further helped medical scientists bounce ideas between bedside and bench. “To encourage interdisciplinary research projects, CAMS also established a number of research centers in the last few years, such as the Diabetes Research Center and the Center for Stem Cell Medicine,” says CAMS vice president Zhan. These research centers, funded by the Research Administration Department, allow investigators from different institutes and hospital departments to work together to tackle key biomedical questions.

In recent years, direct funding to CAMS from the central government has significantly increased, allowing the academy to initiate a number of large-scale public health studies and to fund some breakthrough projects that traditionally would be too risky to receive funding through competitive grant applications. Another source of funding is commercialization and support from the private sector. Many clinical trials are funded by global biotech or pharmaceutical companies, which have started to invest heavily in the Chinese market in recent years. Many CAMS research institutes also produce transferable R&D results and are actively engaged in commercializing their technologies.

The future

Following six decades of success, CAMS is entering a new era of intense competition for research funding. Now there are also major challenges in the Chinese health care system, such as an imbalance in resource utilization and inconsistent quality of care. The dream of President Cao, who assumed the post in 2011, is to model CAMS on the U.S. National Institutes of Health (NIH). His dream is not that far-fetched. In fact, CAMS may have a few advantages over the NIH, such as quick access to a large patient pool in affiliated hospitals, in-house drug discovery programs and the know-how for technology transfer, and medical education resources that provide a large talent pool.

President Cao also knows very well the setup of similar national health research organizations. He served as the board chair of the Global Alliance for Chronic Diseases until December 2015 and brought CAMS in as a key member alongside NIH, the Medical Research Council of the United Kingdom, the Canadian Institutes of Health Research, and the European Commission’s Directorate-General for Research and Innovation, among others.

Based on the advocacy of Cao and CAMS, two national megaprojects have already been launched by the Chinese central government. The Major New Drug Innovation Program aims to discover 100 new drugs by 2020, whereas the Control and Prevention of Major Infectious Disease Program sets the goal of establishing a support system for potential emerging diseases such as severe acute respiratory syndrome (SARS), and controlling the incidence of major infectious diseases such as hepatitis B, tuberculosis, and AIDS. These megaprojects bring together multidisciplinary talents from different research departments to find innovative solutions through open collaboration.

Later in 2016, CAMS will launch the CAMS Innovation Fund for Medical Sciences (CIFMS) as part of China’s 13th Five-Year Plan for 2016–2020. CIFMS will build on the existing infrastructure and strength in CAMS and PUMC to accelerate the progress of scientific innovation in a number of strategic R&D areas (see page 9). Under CIFMS, CAMS will improve and modernize five aspects of its operation: clinical medicine, medical education, biomedical research, product commercialization, and disease prevention. The first three aspects are the existing pillars of CAMS/PUMC, and the last two additions reflect the current strategic direction of CAMS as well as the needs of the nation.

Modern medicine has come a long way in China since 1906, when PUMC began training homegrown medical doctors. Today, Western medicine is the default health care choice for most Chinese people. While the spirit of comprehensive medical education has not changed in the past century, the landscape of biomedical research cannot be more different than it was only 60 years ago, when CAMS and PUMC merged. China’s rapid economic growth has lifted all areas of science and engineering in terms of funding and infrastructure, but very few research institutes in China have the mission-driven tradition of CAMS and PUMC. With the launch of CIFMS this year, CAMS and PUMC will aim to leverage the latest innovations in science to bring the best doctors and health care system to the Chinese people, as they have been doing for the past 110 years.
CAMS and PUMC are launching the CAMS Innovation Fund for Medical Sciences (CIFMS) in 2016. The program coincides with the 13th Five-Year Plan (2016–2020), the periodic review and planning exercise that occurs at every level of the Chinese government. The overall objective of the CIFMS is to rejuvenate the century-old medical college and to make CAMS a world-class national medical research institute, according to Hui Chi, director of the Center for Planning and Development at CAMS.

Horizontal and vertical integrations

At the core of the CIFMS is the integration of five aspects of modern health care: clinical medicine, medical education, biomedical research, product commercialization, and disease prevention. “Our goal is to reinforce the advantages of CAMS and PUMC to achieve excellence in all these aspects through collaboration among different teams within or across institutes and hospitals,” says Chi. For example, the vaccine development work at the Institute of Medical Biology is intimately integrated with clinical trials, safety testing, large-scale production, and supply-chain management that all take place within CAMS, he explains. “In academic universities, such whole-spectrum medical product development would require several external collaborations on clinical trials and commercialization,” says Chi.

In fact, integration is the key difference in the CIFMS from previous Five-Year Plans, which typically set specific goals in discrete areas such as new drug development or prevention of a particular chronic disease. “There are both horizontal and vertical integrations,” says Chi. The former brings together different disciplines to tackle difficult problems in medicine from multiple angles; the latter couples early-stage R&D with clinical trials, production, and commercialization in order to maximize the impact of scientific research results.

A top-down approach will be used to drive cross-functional integration within CAMS. Specifically, new integrative research centers are being established to bring experts in different fields together to achieve the goal of integration. These centers provide a flexible platform that can quickly adjust to new needs or research directions. This approach ensures efficient resource allocation and research consolidation in the areas most critical to CAMS.

Critical missions

As the only national organization of its kind in China dedicated to biomedical research, the goals of CAMS are more complex than those of most academic universities. CAMS will leverage CIFMS to strengthen its support for investigators conducting research projects in certain fields, such as genomic science and precision medicine, “which are at the frontier of today’s biomedical research,” explains CAMS President Xuetao Cao.

CAMS is also responsible for advising the government on major public health issues and national security matters. For example, CAMS provides critical consultation on the monitoring, prevention, and mitigation of highly contagious diseases such as severe acute respiratory syndrome (SARS), which struck southern China in 2002-2003. CIFMS is designed to ensure that critical missions with national importance to public health are achieved using the latest scientific innovations. “For instance, a specific project proposed to receive support from CIFMS is the development of a rapid detection system for disease monitoring and control,” says President Cao.

Many such missions require sustaining long-term effort and maintaining continuity. “Improving the stability of support for these projects is a key objective of CIFMS,” says Director Chi. CAMS has been conducting many large-scale public health projects, such as cross-sectional mapping studies for chronic diseases and cancers in China, and longitudinal studies on measures of cardiovascular disease prevention. CIFMS will ensure continuous support for these studies, which provide critical baseline data for setting Chinese health care policy.

Another critical need in China right now is the setting of guidelines and standards to serve as the foundation for ongoing health care reform. Basic disease treatment guidelines and health care evaluation standards simply did not exist until recently. The result is an enormously variable quality of care supplied by a range of providers with different levels of training and competence. “In rural areas, many citizens simply do not trust their local doctors, and therefore travel to major hospitals in big cities to get treatment for very minor conditions, resulting in overcrowding [at urban hospitals] and an imbalance of resource utilization,” says Limin Li, deputy director of the Graduate School. Together with the comprehensive medical education reform now underway in China, CIFMS’s new guidelines and standards will bring Chinese health care to a uniformly high level.

Under the framework of CIFMS, research projects will be evaluated using a set of objectives different from the traditional goals used to measure academic research output, according to Director Chi. For example, researchers will not be evaluated solely on the number of papers published in peer-reviewed journals; other factors, such as the success of commercialization and the impact of their research on public health, will also be considered.

Project funding directly linked to CIFMS will be controlled by the CAMS central office, particularly through the Research Administration Department. Internal funding support will be guided by three key focus areas set forth in the CIFMS plan: (1) cutting-edge biomedical research, (2) long-term public health projects, and (3) the strategic needs of the nation, such as the setting of health care standards and emergency preparedness. CIFMS funding and evaluation mechanisms will facilitate CAMS/PUMC in achieving these critical missions.
The elite circle of pioneers in biomedical research

Since the founding of CAMS in 1956, much outstanding biomedical research has been produced by scientists in affiliated hospitals and research laboratories. Many of these findings were firsts, either in China or in the world, highlighting the strong leadership position of CAMS and PUMC. Below we highlight some of the distinguished scholars at CAMS/PUMC who have made important discoveries in biomedical science.

Distinguished scholars at CAMS/PUMC often carry the title of “Academician,” granted by the Chinese Academy of Engineering (CAE) or the Chinese Academy of Sciences (CAS), a distinction which acknowledges the highest level of engineering or scientific achievement in China; although CAMS per se does not confer this title. Many of these outstanding scholars also received international honors or awards recognizing their contribution to the advancement of biomedical science.

What sets CAMS apart from other Chinese scholarly academies such as CAE and CAS is their emphasis on education, which serves to perpetuate the culture of elite biomedical research. There is a strong sense of “passing the torch” and maintaining the CAMS/PUMC traditions of education and application-driven research. At the end of this report, we highlight the perspective of two young physician scientists on the role that CAMS/PUMC plays in determining the biomedical research culture in China for future generations.

Treasures in natural products

Treatment using traditional Chinese medicine (TCM) is based on natural products such as herbs and animal-derived ingredients. In the early days of CAMS, a major research focus was identifying active substances found in thousands of ancient TCM regimens. These projects were mostly carried out in the CAMS Institute of Materia Medica (IMM). The methods used for these discoveries were shockingly simple by today’s standards, and were mostly based on chemical fractionation combined with a series of biological activity assays. The success of this kind of drug discovery approach was made possible by a thorough understanding of chemistry and an education in the basic sciences and mathematics, which illustrates the importance of these subjects.

Perhaps the most well-known example to date of a drug discovery using TCM was the isolation and identification of artemisinin by Youyou Tu at the China Academy of Chinese Medical Sciences, the TCM counterpart to CAMS. In fact, the determination of the chemical structure of artemisinin was done in collaboration with IMM scientist Xiaotian Liang. As told by Dequan Yu, a CAE Academician affiliated with IMM, “back in the 1960s and 1970s, drug discovery was a group endeavor to aid the state’s strategic needs; individualism was actually discouraged when publishing reports of the findings.”

Yu has dedicated his career to the analysis and identification of active substances from natural products. “New drugs are discovered through three pathways: chemical synthesis, biological production, and isolation from natural products. It was difficult for Chinese researchers to compete with laboratories and pharmaceutical companies in the West in the first two categories. But the wealth of knowledge in TCM gave us a leg up in the race for drug discovery from natural products,” Yu explains of his choice of research focus.

While still a student in the pharmaceuticals department of Peking University, Yu worked on the isolation of podophyllotoxin from Podophyllum species. After graduation in 1956, he joined the newly reorganized CAMS IMM, and continued his herbal plant chemistry work there. During the Vietnam War and the Cultural Revolution, he was able to continue research work as part of the 523 Project (see page 6). The goal of the 523 Project was to identify antimalarial agents from TCM regimens to aid the war effort in the jungles of Vietnam. Yu’s team isolated an active compound, yingzhuajiasu, from Artabotrys uncinatus, a shrub grown in the southern provinces of China. This compound exhibited very strong antimalarial activity in animal models, but eventually lost favor to artemisinin due to its toxicity in humans and the difficulty of cultivating it on a large scale.

Yu then turned his focus to another key ingredient in TCM: musk, a class of aromatic substances found in the musk pods of the endangered musk deer. Used as a base note in Western perfumes, musk is also an indispensable component of TCM found in numerous regimens. When the musk deer was listed as endangered, the natural source of musk pods was eliminated, causing a critical shortage of musk extract. Yu began working on synthetic musk starting in 1976, and soon produced an active equivalent that was a mix of synthetic and natural compounds. The activity of Yu’s synthetic musk was validated by more than 20 in vitro and
in vivo assays, and the commercialized product has successfully replaced natural musk in TCM products on the Chinese market since 1994.

Also working in Beijing, Shujun Cheng, another CAE Academician, has been studying tumor biology and antitumor agents at the CAMS Cancer Hospital (CCH) for many years. One of his key achievements at CCH was the successful treatment of genital and perianal warts using kunecatechins from the green tea leaves of *Camellia sinensis*.

Originally known for its antitumor activity, kunecatechins is a mixture of catechins and other green tea components. After demonstrating its immune-enhancing activity, particularly against infections, Cheng transferred the development rights to the German pharmaceutical company Medigene, which brought the botanical product to the U.S. Food and Drug Administration (FDA) for the treatment of genital and perianal warts. In 2006, kunecatechins was approved by the FDA and branded as Veregen.

Cheng has maintained a strong interest in the development and treatment of cancer. “We must take a holistic view of cancer biology,” he says, explaining that his latest work seeks a common biology shared by cancer and normal embryonic development. “There are many parallels; tumor cells may have hijacked the mechanisms used for embryogenesis during a normal pregnancy,” says Cheng. He plans to compare the potential similarities in immune evasion by tumors with that of the developing embryo. “There may be clues in the placenta that can point us to how a tumor escapes the immune response,” says Cheng, “and understanding this mechanism could lead to new treatment strategies for cancer.”

**From surgery to genomics**

The current Director of CCH, Jie He, is a thoracic oncology surgeon and a CAS Academician. Since completing medical training at the Norman Bethune University of Medical Sciences in Jilin Province, China, and doctoral training at PUMC, he has dedicated his career to becoming a top specialist in complex surgeries for patients with lung, esophageal, and other thoracic cancers.

“Lung cancer and esophageal cancer are common in China,” says He, “and we have many experts here [at CCH] to combat these cancers.” Those experts include surgeons as well as medical and radiation oncologists. He is not only fighting cancers with a comprehensive treatment team, but also using the latest genomic technologies to understand and manage cancer, particularly esophageal cancer, which is highly prevalent in China. “More than 50 percent of the esophageal cancer cases worldwide occur in China,” says He. Years of work from He’s team at the Cancer Institute and Hospital has helped to develop tools for early diagnosis, molecular subtyping, and molecular prognosis of esophageal cancer.

Partnering with other teams at CAMS and CCH, He recently published a series of analyses of the genomic mutational landscape of esophageal squamous cell carcinoma in Chinese populations. This kind of collaboration shows the advantage of integrating clinical practice and research at CAMS, where the distance between operating rooms and state-of-the-art genomic labs can be just a few steps across the hallway.

Research experience is always a critical part of a PUMC education—it helps PUMC-trained clinicians to better navigate the process of clinical or basic research. “Good clinical doctors need to work on research and actively collaborate with basic scientists to learn the latest advances,” says Guixing Qiu, an orthopedic surgeon at the PUMC Hospital and a CAE Academician.

Since graduating from PUMC in 1968 (in the second class following the merger with CAMS), Qiu has dedicated his career to studying the surgical treatment and classification of scoliosis, the sideways curvature of the spine. “In China, scoliosis tends to be more severe at diagnosis due to lack of systematic early-childhood screening,” says Qiu. Classification of scoliosis is important in guiding surgical planning. Until 2005, the classification system for scoliosis was based on small-scale studies with poor reproducibility and reliability. Through a prospective study of 427 surgically treated idiopathic scoliosis patients, Qiu and colleagues developed a PUMC classification system that improved both the reproducibility and reliability of the old King classification system. “We had more patients with scoliosis at PUMC than all other hospitals in the world did; therefore, it was faster for us to develop an improved classification system,” says Qiu. In fact, the development of the PUMC classification system, along with the superb skill of surgeons in its orthopedic department, have made PUMC Hospital one of the world’s leaders in scoliosis treatment and research, according to Qiu.

Like He at CCH, Qiu has also taken his research on scoliosis to the genomic level. Last year, in collaboration with Feng Zhang of Fudan University in Shanghai and James Lupski of Baylor College of Medicine in Houston, Texas, Qiu’s team analyzed two cohorts with a total of 237 cases of sporadic congenital scoliosis, 166 healthy controls, and two pedigrees with a known chromosomal deletion. The results, published in *The New England Journal of Medicine*, led to the discovery of a genetic mechanism involving two alleles of the **TBX6** gene in the development of congenital scoliosis, and enabled future development of prenatal diagnostic tests for the congenital form of the disease.

**Elite management**

Since its founding in 1956, CAMS has been led by successive presidents with distinguished research records, maintaining a tradition of meritocracy-based leadership. As demonstrated in interviews with three current and former presidents, their management achievements, long-term vision, and
outstanding research contributions have left a long-lasting impact. Denian Ba served as CAMS President from 1992 to 2001. In the early 1980s, he conducted pioneering research in antitumor immunity and early prototypes of cell therapy. He has been a CAE Academician since 1994 and a foreign member of the U.S. Institute of Medicine (IOM) since 1990.

Since assuming the presidency in 2011, Cao has encouraged young physicians, surgeons, and scientists to honor the elite traditions of CAMS and PUMC. He has been a CAE Academician since 1992, CAMS/PUMC faced two major challenges: limited space at the downtown Beijing campus and a talent gap left in the wake of the Cultural Revolution, which ended about two decades earlier. Although there was no quick fix for the space restriction, Ba carried out some groundbreaking measures to address the lack of ready talent.

Under Ba’s management, CAMS/PUMC revamped the staff promotion system to accelerate the development of the younger generation into leaders. By the end of Ba’s tenure, there were 120 full professors under the age of 45 compared with just one at the start. These included the current CAMS/PUMC president Xuetao Cao, and the president of PUMC Hospital, Yipei Zhao. “The majority of current leaders of health administration and medical associations in China came from this batch of accelerated promotions in the 1990s,” says Ba. “They stepped up to the plate and all did a superb job in research, clinical practice, and education.”

Ba’s successor, Depei Liu (2001–2011), is a distinguished molecular biologist. His research focused on gene expression regulation in blood cells and the molecular mechanisms underlying cardiovascular disease. Liu was elected a CAE Academician in 1996 for his research achievements and was made a member of IOM and the Third World Academy of Sciences in 2008.

When Liu assumed the CAMS presidency in 2001, still facing the pressure of limited space on campus, he began to relocate some research laboratories to the suburbs, such as the new Xishan campus in the western part of Beijing. He also promoted the idea of translational medicine and integrated research before these terms became hot topics in biomedical research. “The idea of an innovation chain starts from a scientific problem in clinical practice. Through systematic analysis and basic research, a solution is found and then used to solve the problem in clinical medicine,” says Liu, summarizing the early concept of translational medical research.

The current president, Xuetao Cao, took the helm in 2011. Like his predecessors, Cao is also a CAE Academician; he is also an internationally renowned scientist in immunology. His research focus is immune homeostasis, and he has published several groundbreaking findings on the function of human dendritic cells, novel gene regulation mechanisms, and signal transduction pathways.

Cao sees an opportunity to help reform the health care system and medical education in China based on what has worked for CAMS/PUMC in the past 60 years. The elite education system at CAMS can serve as a model to raise the level of medical training in China, which will then help solve the biggest problem in the country’s health care system: the imbalance in resource utilization due to lack of confidence in the capabilities of rural doctors by citizens living outside big cities.

Cao also maintains the CAMS/PUMC tradition of translational research, set forth in the CIFMS plan (see page 9), to bring together clinical medicine, biomedical research, medical education, product commercialization, and disease prevention. “Our mission is to take the lead in biomedical research in China, and my dream is to build CAMS into a Chinese National Institutes of Health,” says Cao.

The next generation

Since assuming the presidency in 2011, Cao has encouraged young physicians, surgeons, and scientists to honor the elite traditions of CAMS and PUMC. To this end, two forums have been established to foster comradery among young research scientists and clinicians. “The scientist forum started four years ago in 2012, and the clinician forum had its first meeting last December. The cutoff age is 45 for research scientists and 50 for physicians or surgeons,” says Bin Lu, current chair of both forums. “We meet about four times per year and there is no fixed agenda or objectives to achieve,” says Zhicheng Jing, cochair of the scientist forum. The goal is to provide an informal and relaxed environment for basic as well as clinical scientists from different disciplines to interact with each other, “like an academic salon,” explains Jing. “The exchange of information brings up new ideas and can lead to new translational research projects.” For example, while chatting with a basic molecular biology researcher at a recent meeting, it dawned on Jing, a clinical cardiologist who has been studying the effect of nitric oxide on the vascular system, that free radical byproducts could explain some of his paradoxical findings. They are now planning a joint project to test new hypotheses that may lead to further understandings of the vascular biology in cardiovascular disease settings.

These forums serve as more than just a breeding ground for new research ideas. “They also help us keep the ‘PUMC spirit’ by building a sense of family and collaboration,” says Jing, “and they inject vitality into the old PUMC system.” Lu and Jing both echo the notion of President Cao and other distinguished scholars of previous generations that it is not only the CAMS/PUMC emphasis on elite education that sets them apart from other academic institutions, but also their hope for successful health care reform in China.

With unrelenting determination to maintain their tradition of elite medical education, generations of CAMS/PUMC doctors and scientists have come a long way in leading medical research in China, and they will certainly continue to bring the best health care possible to the Chinese people.
Research highlights at CAMS and PUMC

As two of the leading biomedical research organizations in China, CAMS and PUMC undertake some of the most important research in the nation, and their findings often have international impact. Although it is not easy to pick from the large number of quality research projects they have undertaken, this report attempts to highlight some of the most successful from representative project teams.

Medical molecular biology and translational research

Clinical medicine is based largely on our understanding of biological processes; this understanding has been significantly accelerated in recent decades by the application of molecular methods. As the flag bearers for translational medical research in China, CAMS and PUMC are major players in molecular biology research. The Institute of Basic Medical Sciences (IBMS) is at the heart of a wide range of exciting research projects—it also hosts the State Key Laboratory of Medical Molecular Biology, directly funded by the Chinese central government.

Currently staffed by only 51 principle investigators, IBMS is a “small but complete research institute with the advantage of cross-disciplinary collaborations,” says IBMS Director Chengyu Jiang. Jiang returned to CAMS in 2003 after Ph.D. and postdoctoral studies in the United States, and now leads a team that studies many aspects of respiratory diseases as well as normal respiratory function. Her team’s diverse research interests range from the pharmacology of respiratory medicine to signaling pathways regulating epithelial and alveolar cell development.

According to Jiang, basic medical sciences at her institute cover almost every facet of biology, including molecular biology, immunology, neurobiology, genetics, biochemistry, and pathology. Diseases of particular interest at IBMS are often part of translational research projects carried out in collaboration with clinical departments in CAMS-affiliated hospitals—examples include autoimmune diseases, cardiovascular diseases, developmental disorders and infertility, neuropsychiatric diseases, and respiratory diseases.

Meanwhile, according to Jiang, IBMS is actively recruiting talent in promising areas such as bioinformatics, biophysics, and biomedical engineering. Her goal is to add about 20 to 30 principal investigators to the IBMS faculty through the nation’s Thousand Young Talents incentive program, thereby fulfilling their motto, which is “to recruit the best people and keep them happy,” according to Jiang.

One way to keep everyone happy will be to move in the next few years to a larger space in the Beijing suburbs, away from the cramped downtown campus space. However, “some of us will certainly miss the convenience of the location in downtown Beijing,” says Jiang.

The diversity of basic science disciplines studied at IBMS are showcased by two outstanding young researchers. Bo Huang, who spent years studying tumor immunology and cancer immunotherapy in Sweden, Canada, and the United States, joined IBMS in 2006 and decided to change the focus of his research to understanding how biophysical forces lead to biochemical signal transduction inside cells. “Our new findings shed light on the immune surveillance of the tumor environment,” says Huang, who is developing new cancer therapies using tumor-derived vesicles to bring cytotoxic agents back to the tumor cells.

Another interesting research project at IBMS is led by Chunhua Zhao, who studied mesenchymal stem cells at the University of Minnesota before joining IBMS in 2000. In 2004, Zhao was the first to receive approval for stem cell therapy from the China Food and Drug Administration. Zhao recently completed preclinical evaluation of mesenchymal stem cells for more than six disease types and is now moving his research forward to full clinical trials.

Cardiovascular disease

The pinnacle of cardiovascular disease research in China is found at Fuwai Hospital and headed by the influential cardiovascular surgeon Shengshou Hu. “Cardiovascular diseases are the leading cause of mortality in China, leading to more than 3.5 million deaths each year,” according to Dongfeng Gu, the hospital’s vice president. The hospital is also the home of the National Center for Cardiovascular Diseases, where assistant director Lixin Jiang has been conducting several outcome research projects that have health policy impacts far beyond China.

Jiang describes her medical career as three phases of an evolving journey. She was a practicing cardiologist until 1998, when she got the opportunity to join forces with the Clinical Trial Service Unit of Oxford University to run the large-scale COMMIT (ClOpidogrel and Metoprolol in Myocardial Infarction Trial) study. Over 45,000 patients with acute myocardial infarction were enrolled from more than 1,200 hospitals in China, including many...
small, secondary hospitals in remote rural areas. The study results were published in back-to-back reports in The Lancet, and in 2006 became the basis for the U.S. Food and Drug Administration (FDA) to grant a label expansion beyond the drug’s original, approved indications—the FDA’s first such expansion based solely on data from China. The results of COMMIT have been incorporated into more than 18 international treatment guidelines for myocardial infarction.

The COMMIT experience changed Jiang at a personal level, and she has since become China’s top expert in clinical trial management. “Before COMMIT, I lived in a very limited, narrow world,” says Jiang. “But when I visited these hospitals, I was so touched by the difficult situation faced by doctors and patients in the rural areas. Through these visits, I learned about running multicenter clinical trials and, more importantly, I learned about China, particularly the difference between urban and rural settings,” she explains.

In the decade since starting COMMIT, Jiang’s team has mastered the art of meticulous planning, tireless follow-up, and prospective capacity building. Relying on more than a decade of hands-on experience, she has built a team of interdisciplinary experts to run large-scale trials and cohort studies at all levels of the Chinese health care system. Today, Jiang is a codirector of the China Oxford Centre for International Health Research, and since 2009, when she witnessed the huge health care disparity between rural and urban China, her focus has expanded from interventional trials focused on single drugs to health outcomes research with the potential to impact national health policy.

One such outcome study run by Jiang’s team is the China PEACE (Patient-Centered Evaluative Assessment of Cardiac Events) study series that involves more than 200 primary-care hospitals across China. “The lowest tier primary-care centers account for 98.9 percent of health care institutions in China. Yet, national health guidelines and policies are often based on studies conducted in the top 1.1 percent of tier-1 or tier-2 hospitals,” explains Jiang. “The national health policy needs evidence from the primary care level!”

Now, with support from the Chinese government, Jiang’s team has embarked on the China PEACE Million Persons Project, aimed at identifying risk factors for cardiovascular disease in the Chinese population by systematically screening 1 million people across 16 provinces. The trial sites will include hundreds of town and village clinics. Jiang’s team has successfully run a pilot in four provinces, meticulously collecting data from 400,000 patients, including blood pressure, blood lipid levels, height, and weight, also using a questionnaire on cardiovascular-related health status. This large-scale approach to influencing public health policy has been extended to other chronic diseases such as diabetes and kidney disease, opening up a new era of evidence-based medicine in China.

Besides Jiang, there are many talented researchers at Fuwai Hospital and the affiliated State Key Laboratory of Cardiovascular Diseases. Zhou Zhou is working on genetics-based precision medicine and early diagnosis tools for cardiovascular diseases, while Miao Wang is applying genetic principles in pharmacology to identify new drug targets and new indications for previously approved drugs. Both Zhou and Wang represent the young talent recently recruited from the United States to expand the scope of biomedical research at CAMS.

Cancer research
CAMS also leads cancer research in China, with much of the latest groundbreaking work taking place at the CAMS Cancer Hospital (CCH) in Beijing. Similar to Fuwai Hospital, CCH also houses the National Cancer Center, directly supported by the Chinese central government.

The research projects at CCH are three-pronged, including basic research, clinical trials, and cohort studies. These distinct approaches often cross-pollinate through collaborations to produce translational projects or policy-guiding epidemiology megaprojects. Currently, the focus of research at the hospital is in six main categories:

1. Basic molecular biology of oncogenesis, tumor recurrence, and metastasis;
2. Building the Chinese cancer map based on bioinformatics to guide public health policy;
3. Cancer screening, prevention, and intervention in high-risk populations;
4. Molecular subtyping of tumors, and the use of precision medicine in cancer treatment;
5. Novel therapeutics, diagnostics, and prevention strategies; and

One leading edge of cancer research at the hospital is the study of the genomic profile of common cancers in China, particularly lung cancer and esophageal cancer. Under the leadership of Director Jie He, CCH researchers including Dongxin Lin and Qimin Zhan have made major contributions in mapping genetic risk factors for lung cancer and other thoracic cancers.

In addition to identifying genetic risk factors, CCH researchers like molecular biologist Min Dai are also working on basic tumor biology clinical drug trials and other frontier discovery projects. For instance, Yuankai Shi, a deputy director at CCH, is conducting anticancer drug clinical trials on the safety, efficacy, pharmacokinetics, and affected biomarkers of a number of therapeutics developed at CCH or other domestic clinical trial centers, including chidamide, a novel benzamide class of histone deacetylase inhibitor, and targeted drugs such as icotinib, an epidermal growth factor receptor (EGFR) tyrosine kinase inhibitor that was developed in China and approved for lung cancer treatment there.

Another example of cutting-edge research at CIH is the biomarker study led by Jie Wang, who was among the first to develop a circulating tumor DNA-based plasma test for EGFR gene mutations to better predict the efficacy of EGFR inhibitor therapy for small cell lung cancers. Her findings were published in the Journal of Clinical Oncology in 2009, years before the potential of using liquid biopsies first gained broad attention in 2015. “The gap between cancer research in China and the West is rapidly narrowing,” says Wang.

As China’s leading cancer research institution, CCH is responsible for maintaining national cancer epidemiology data. To this end, a network of 308 tumor registration sites, where community-based doctors report cancer cases and archive biopsies, has been set up across the country, covering 31 provinces and approximately 22% of the Chinese population. This network provides an accurate and updated cancer map of China, essential for guiding public health policies on cancer prevention and high-risk population screening.

This epidemiology work is further assisted by the development of special...
screening tools designed for the unique circumstances on the ground in China. A perfect example is the self-sampling human papillomavirus (HPV) DNA test for cervical cancer primary screening, developed by Youlin Qiao at CCH. The tool solves the logistical challenge of testing a large cohort of women in a vast rural area by traditional pap smear. Applying the tool in a high-risk area surrounding Xiangyang County, Shanxi Province, Qiao’s team established the basic epidemiology data of HPV infection and the cervical cancer disease burden in China. Not only do the data confirm the association between HPV and cervical cancer in the Chinese population, they also make a strong case for HPV vaccination. Equipped with the new data, Shao-Ming Wang, an epidemiologist on Qiao’s team, is actively advocating for the vaccine’s approval in China, where it could save thousands of women from cervical cancer and related mortality.

Innovative drug development

One of the CAMS research institutes present since its founding in 1956 is the Institute of Materia Medica (IMM). As indicated by its Latin name, one of IMM’s missions is to identify medically active ingredients from natural products and use a scientific approach to understanding traditional Chinese medicine (TCM) regimens. One of the best examples of a research product from IMM is the synthetic musk developed by Dequan Yu (see page 10).

Today, IMM also houses the State Key Laboratory of Bioactive Substance and Functions of Natural Medicines (see page 21), and its ground floor is a long corridor of chemical analysis laboratories equipped with state-of-the-art spectrometers and other tools. With the latest technologies in analytical and synthetic chemistry at their disposal, many IMM researchers carry on the tradition of innovative drug discovery using natural products.

Many well-known TCM regimens are being analyzed at IMM. For example, Ping Zhu researches the active ingredient of the Cordyceps species of fungi, a natural product with many uses that also has lipid-lowering properties. IMM is also using new techniques to study other TCM regimens known for helping to manage chronic diseases like diabetes. Zhuowei Hu, for instance, has been developing new therapeutic agents for various chronic diseases—agents based on computer-assisted small-molecule design as well as natural product screening.

One common theme running through the natural product-driven drug discovery at IMM is the complexity of therapeutic activity. “When we break down an active natural product, there are many active ingredients, each with very weak activity by itself,” explains Guanhua Du, who has been screening new drugs from TCM regimens at IMM since 1998. “What we have learned through the years is to focus on isolating active fractions as well as pure compounds with special activities and indications,” says Du. The active fractions are tested in many animal models before moving onto clinical study. Du’s group has successfully isolated and commercialized a complex drug with efficacy in treating stroke.

Some active ingredients can be traced down to a pure compound. A good example is the work of IMM Director Jiandong Jiang, who studied the antibacterial activity of berberine, which is also effective in the treatment of hyperlipidemia and type 2 diabetes. Furthermore, compounds isolated from natural products can be improved by molecular redesign. IMM’s Shishan Yu is an expert in this approach. “Many TCM materials classified as ‘low grade’ in the Compendium of Materia Medica are actually very powerful medicines with high toxicity,” explains Yu. “Today, we can use chemical analysis and molecular design to modify the active ingredient and widen the tolerability window for safe use.”

Besides IMM, the Institute of Medicinal Plant Development (IMPLAD) at CAMS is also actively involved in developing drugs from natural products. According to IMPLAD Director Xiaobo Sun, the institute has three missions: understanding the medicinal uses of existing species, protecting endangered medicinal plants, and exploring potential uses for previously unknown species. There are seven satellite locations under IMPLAD’s jurisdiction, covering more than 70% of the medicinal plant cultivation areas in China and highlighting IMPLAD’s critical role in preserving valuable natural resources. Another notable resource maintained by IMPLAD is its vast germplasm library. According to Sun, this is the largest collection of medicinal plant resources in the world, which can serve as the foundation for innovative drug discovery at IMPLAD and CAMS.

Blood diseases

Less than 100 miles southeast of Beijing, the CAMS-affiliated Institute of Hematology and Blood Diseases Hospital (IH) in Tianjin houses the State Key Laboratory of Experimental Hematology (SKLEH). Researchers there are making important discoveries in hematology, hematological cancers, and stem cell biology.

IH traces its history back to 1957, when the concept of hematology in China was still in its infancy. SKLEH and IH are headed by Tao Cheng, who decided to move his laboratory from the University of Pittsburgh back to Tianjin in 2007. Cheng’s main reason for the move was so that he “could study what he really wanted to using the relatively abundant funding and resources [available at CAMS].” His research interest is in the biology of hematopoietic stem cells, which play a major role in the study and treatment of hematological cancers. Housed on several floors in IH, SKLEH features an open-floor plan to encourage spontaneous interchanges among different research teams—a concept that Cheng brought back from Pittsburgh. Cheng also established the Center for Stem Cell Medicine at CAMS and the Department of Stem Cell and Regenerative Medicine at PUMC, which are focused on leading translational stem cell research and education in China.

Cheng’s vision for SKLEH and IH is to integrate clinical work, biomedical research, and commercialization. He is especially keen to highlight the success of commercialization efforts, including the first cord blood bank in China, whose derivative stem cell company recently had a stock market value of over RMB30 billion (US$4.6 billion). Additionally,
IH has developed many monoclonal antibodies for research or diagnostic use, three novel chimeric antigen receptor T-cell lines as potential cancer therapies, and several leukemia mouse models for research or drug screening.

**Disease prevention is one of the five aspects to be targeted in the Medical Science Innovation Program that will be kicking off at CAMS in 2016.**

The key clinical services provided at IH, according to medical director Jianxiang Wang, include treatment of anemia, thrombosis, and pediatric and adult blood cancers, as well as stem cell transplantation. A clear advantage in biomedical research at IH is the large pool of patients. One of Wang’s research interests is acute myeloid leukemia, with more than 400 newly diagnosed cases treated at IH each year. The large numbers allow clinical researchers like Wang to conduct many investigator-initiated research projects sponsored by either pharmaceutical companies or government funding. These projects not only bring in new research funding from the pharma industry; they also provide patients critical access to experimental drugs.

Wang’s goal is to continue building the clinical research capacity at IH. “The concern right now is that without an adequate clinical research capacity, there will be a growing gap between basic research findings and clinical validation or application,” says Wang.

**Clinical sciences**

The elite education system of PUMC stresses the value of research alongside clinical practice. Thus, many alumni of the PUMC medical program continue working on research projects long after they begin practicing medicine. A good example of such life-long interest in clinical research is Fengchun Zhang, chief of the Department of Internal Medicine and former director of the Division of Rheumatology at PUMC Hospital. Zhang believes that “it is critical for physicians to continue with clinical or basic research, because that is the best way for them to discover new problems in day-to-day practice and make new advances in biomedical science.”

The rapid emergence of rheumatology research at PUMC and more broadly in China is a perfect example of the importance of clinical research. The first rheumatology clinic in China wasn’t established until 1979 at PUMC; now there are more than 6,000 rheumatologists serving in hospitals throughout China. The number of publications from the PUMC Rheumatology Department has grown from one paper every three to four years to about 40 papers per year (in English-language journals). The growth and spread of rheumatology practice and studies can be attributed to research driven by clinical need. Recent publication highlights from Zhang and colleagues include genome-wide associate studies and functional validations for rheumatoid arthritis, as well as the role of the gut microbiome in rheumatic diseases.

**Taisheng Li**, chief of the Department of Infectious Diseases at PUMC, graduated from PUMC in 1984, then worked in France on some of the early HIV research. He brought his expertise in HIV and AIDS back to China in 1999, and successfully convinced the central government to support AIDS research and to give out free anti-HIV medicine. Li’s own research has had significant impact on the management of AIDS patients in China. For example, he discovered early on that the recommended dosage of nevirapine used in the West (400 mg daily) was too toxic for Chinese patients. Through careful clinical pharmacology study, Li’s team established the effective dose for Chinese patients (200 mg daily) and greatly reduced toxicity in Chinese AIDS patients.

At the Plastic Surgery Hospital next door to the PUMC Hospital, Baoxi Wang carries out genetic analysis on acne inversa, also known as hidradenitis suppurativa (HS), a skin disorder that can significantly impact a patient’s quality of life. Using samples collected from several families, Wang has mapped the HS susceptibility gene to chromosome 19. Having recently moved to the dermatology department at PUMC Hospital, Wang has begun the process of establishing a Chinese HS registry to further advance the study of HS etiology as well as its treatment.

**Public health and disease prevention**

Disease prevention is one of the five aspects to be targeted in the Medical Science Innovation Program that will be kicking off at CAMS in 2016. Research projects to enhance public health and prevent communicable diseases are being conducted across PUMC and CAMS, in the School of Public Health at PUMC, the CAMS Institute of Pathogen Biology (IPB), and the Institute of Medical Biology (IMB).

The public health program at PUMC can be traced back to the 1920s, when John B. Grant established the Department of Public Health in the college’s early days. Grant is often credited with setting up the tiered primary care program in China. “Grant paid a lot of attention to disease prevention,” says Yuanli Liu, dean of the School of Public Health. After almost a century, the public health education and research programs at PUMC have helped to grow the department into a full-size school with five branches of research and education focus: biostatistics and epidemiology, health policy and management, food and drug safety, behavioral science and health communications, and environmental/occupational health.

“Compared to the work of our clinical colleagues, public health research has three main differences,” says Liu of his focus. These include attention to the population rather than individual patients, consideration of the whole disease spectrum rather than single diseases, and prevention instead of treatment. A recent development of this research is a mobile app called “Yikangtong,” which is designed to provide essential public health information and services to the population. Liu’s team has recently completed a pilot run of 100,000 users in Jiangsu Province; it plans to open the app to the general public shortly. Acknowledging the leadership role China plays in global public health, the World Health Organization (WHO) will hold the annual Global Conference on Health Promotion in Shanghai in November 2016, with Liu chairing the expert committee.
In contrast to the long history of Liu’s department, the new IPB at CAMS was established only 10 years ago, “partly as a reactive to the SARS [severe acute respiratory syndrome] pandemic in 2003,” says Qi Jin, director of IPB. “The goal of establishing IPB was to boost the power of research in infectious diseases, with missions to enhance the nation’s overall preparedness for emergent infectious disease response through research.”

Besides providing technical supports for the Chinese Center for Disease Control and Prevention, “IPB is also an experiment in new ways to manage a research institute,” says Jin, who is also leading the management reform in talent recruitment and faculty evaluation at IPB.

Currently, IPB researchers focus on major infectious diseases found in China, such as Middle East Respiratory Syndrome (MERS), tuberculosis, hepatitis B, and foot-and-mouth disease, among others. Several research products from IPB have been successfully deployed in real-world situations to help combat outbreaks, and many technologies have been commercialized.

Also in the frontline of disease prevention is IMB, originally established in the 1950s as a virology lab for polio vaccine development by former CAMS president Fangzhou Gu (see page 6). Today, vaccine development still constitutes the majority of research work at IMB. “There is active research right now, sponsored by WHO, to replace the attenuated polio virus vaccine—which has been used essentially unchanged since 1962—with a new version by 2018,” says Qihan Li, director of IMB in Kunming, Yunnan Province. IMB is also an active player in technology transfer, commercialization, and international collaboration.

Medical informatics

All biomedical research projects at CAMS and PUMC are supported by a central CAMS library, which has been expanded into the Institute of Medical Informatics (IMI). IMI also serves as the Chinese equivalent of the U.S. National Library of Medicine, responsible for archiving historical medical books and media. According to Tao Dai, director of IMI, it “has also established a series of professional knowledge and policy support platforms that can quickly make policy recommendations in response to requests from the government or other agencies.” Furthermore, Dai has also set up the Center for Health Policy and Management within IMI to serve as a think tank and to support ongoing health care reform in China.

Medical education is what makes PUMC and CAMS different from other scientific and engineering academies in China. Since its founding in 1917, PUMC has never lost its tradition of elite medical education, which insists on two principles: a carefully selected student body and a comprehensive eight-year curriculum. While the “elite” label can sound a little bourgeois in a socialist state, the highly selective model of medical training may actually be the best solution to many problems faced by the Chinese health care system today.

The eight-year journey

Today—as was true for the past 100 years—it is not an easy task to gain admission to PUMC; in fact, it is downright difficult. The incoming class is limited to about 100 medical students and 150 nursing students each year. This is in sharp contrast to many other medical schools in China, which have explosively expanded their student bodies in recent years. A high school graduate must score extremely well on the National College Entrance Exam to be considered for PUMC admission.

Once a student is admitted to the medical program at PUMC, the journey has just begun. PUMC was the first school in China to offer an eight-year medical education curriculum. This has not changed since the school’s founding—generations of PUMC educators have taken the time to train the best physicians and surgeons in the country.

A student’s medical education starts with two-and-a-half years of basic premed study, currently administered at Tsinghua University. Prior to 2006, the premed course was offered in collaboration with Peking University, which has expanded its own eight-year medical program since then. Students learn basic sciences during these years. “The training in basic sciences establishes a solid foundation for our students to embark on the best biomedical research in the future,” says PUMC President Xuetao Cao.

After completing the premed courses, PUMC medical students...
continue with another one-and-a-half years of basic medicine, including courses in physiology, anatomy, and histology. “At the transition between premed and medical courses, students can decide whether a medical career is right for them,” says Chao Ma, dean of education for both the medical and nursing schools at PUMC, adding that many high school graduates don’t know exactly what career they want to pursue until a few years into college, despite a high test score allowing them to enter the elite medical program at PUMC. On the flip side, PUMC is experimenting with accepting transfer students from other undergraduate programs who have excelled in basic science courses and wish to enter the rigorous medical track, says Ma. After five years, with both premed and medical courses under their belts, PUMC medical students start three years of practical training in various clinical departments. A unique aspect of the clinical education at PUMC is putting patients at the center of practice as opposed to focusing on the techniques of mundane diagnosis and treatment. “The medical education at PUMC is very rigorous. In the old days, students learned how patients feel by practicing techniques—such as inserting a gastric tube—on each other,” says Guixing Qiu, professor of orthopedics at PUMC, “and the physicians did all the laboratory tests themselves; hence the premed basic training in chemistry and biology became very important.” Former CAMS President Denian Ba explains the patient-centric education in another way. “There are two basic principles we teach our students: Respect life and love the patient. The first prescription given by a PUMC-trained medical doctor is always love for the patient,” he says.

The medical education at PUMC is closely tied to the CAMS mandate of leading biomedical research in the country. Near the end of the three-year clinical training, all students must conduct a complete research project within the last eight months. “This period of lab research training seeds the central idea of translational medicine in all PUMC graduates, regardless of which career path they choose,” explains Ma. Many PUMC students decide to carry on their research project after graduation, and some choose to continue a few years of research study for a combined M.D./Ph.D. degree.

Medical education reform

The highly selective admission process combined with the long, rigorous training makes PUMC unique among the many medical schools in China. There are a few other eight-year programs, but none is as selective as PUMC in terms of admission. Meanwhile, many other medical schools throughout the country offer shockingly heterogeneous training—even as little as two years of apprenticeship in the operating room directly out of high school. While physicians and surgeons from elite programs like the one at PUMC are knowledgeable and capable of state-of-the-art practice in modern medicine, other doctors are much less qualified and can often be unprepared for basic medical problems.

The uneven training and education among practicing medical doctors in China is at the core of the challenge faced by the country’s health care system today. Confidence in doctors is very low in the rural areas, where practitioners are often trained at one of the less rigorous medical programs. Many people in rural villages simply do not trust the doctor in their local clinic, so they flock to big cities to seek medical treatment at major academic hospitals (such as PUMC Hospital and other CAMS-affiliated hospitals) for minor symptoms. Unlike the tiered health care system that is standard in developed nations, in China, essentially everyone goes to the top-tier hospital for any medical condition. This unbalanced resource utilization is placing a huge strain on the operation of major hospitals. On a typical day, the waiting rooms of CAMS-affiliated hospitals are overcrowded and waiting times can be extended, with some turned away without ever seeing a doctor. For instance, in the cardiology outpatient department of Fuwai Hospital, security staff are needed at the entrance to prevent a crush of patients seeking treatment. It’s hard to imagine how patients with heart problems or high blood pressure survive the added stress of trying to get an appointment for three minutes of attention from the doctor in a 10-foot-by-10-foot office jammed with more than a dozen people. Yet, this is likely the best outpatient cardiology care one can find in China.

The issue of elite medical education (small classes, long training periods) versus big-batch, accelerated training reflects a basic philosophical divide in how to fulfill the monstrous health care demand in the most populous country on the planet. One camp proposes that a drastic expansion of basic medical training could quickly produce a large number of health care providers to serve in every town and village throughout the country. On the other side, there are those who believe that quality is as important as—if not more important than—quantity. In an attempt to solve the urgent demand problem quickly, the former camp had taken an upper hand in past decades. But it’s rather obvious that the results of that approach are unsatisfactory.

The pendulum is gradually swinging toward the elite camp. At the very least, there is now a consensus that comprehensive medical education reform is necessary to bring the quality of health care to a minimum level across the nation. According to President Cao, the current thinking of the central government, advised by PUMC and CAMS, is to make a five-year curriculum standard in all medical schools in China and to combine the change with a reform of the clinical residence program. In the meantime, a small number of elite medical schools will keep the eight-year curriculum in
order to develop leaders in biomedical research and national health policy. “PUMC was the first medical school in China running an eight-year curriculum; so it is reasonable to hope that PUMC will remain one of the elite schools in the wake of the medical education reform,” explains President Cao.

**The future elite**

Until a final decision is made on nationwide medical education reform, PUMC and CAMS will continue improving its own medical education, incorporating the latest pedagogical theories and technologies. This is a perfect example of how PUMC and CAMS serve in a leadership role in biomedical research and education in the nation.

For example, new teaching methods are being utilized throughout the classrooms at PUMC. “We encourage question-based courses,” says Ma. As opposed to the traditional method of didactic, one-way knowledge transfer, many PUMC courses now use seed questions to encourage interactive discussion and spontaneous problem solving by the students. The knowledge acquired through active discovery has a much better retention rate than that gained from lecture and tests.

As an example of what interactive learning can accomplish, Ma shared some booklets compiled by a current medical student at PUMC, and he marveled at the creativity and tech-savvy of the younger generation. One booklet is a collection of Q&As on interesting and important questions in basic biology, physiology, and clinical medicine. But this is not like the medical Q&As typical of the last century—these students set up an open forum using Chinese social media and collated discussions from students and expert respondents from around the country. The final product was a series of often humorous conversations on some very complex biological and medical problems faced by students throughout the course of their medical training. Undoubtedly, the students will be less likely to forget these complex facts after reading or participating in such unorthodox discussions and lessons.

The torch of elite medical education has been passed from generation to generation at PUMC for over 100 years. In the future, this model will very possibly be the leading light in medical education and health care reform in China.

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**Innovations in sync with the world**

As the first Chinese institution established by foreigners for medical education, PUMC has always maintained a close connection to the rest of the world with respect to the latest clinical practice and health management. And because CAMS and PUMC also have the mandate as the leading biomedical research organizations in China, their research and innovation are naturally compared with the progress of biomedical science around the world.

As many of their researchers are doing world-class science, they have begun reaching out and building long-term collaborations to foster intellectual exchange between China and the West. Here we highlight some of the international collaboration projects at CAMS and PUMC.

**Infectious disease**

The Christophe Mérieux Laboratory (CML) is part of a global infectious disease research network across developing countries called the “GABRIEL Network” (Global Approach to Biological Research, Infectious diseases and Epidemics in Low-income countries). A joint committee from CAMS and the France-based Fondation Mérieux advises CML.

“The CML is a prime example of how CAMS and PUMC approach the CAMS Innovation Fund for Medical Sciences (CIFMS) (see page 9) from four directions: encouraging cutting-edge biomedical research, fostering international collaboration, recruiting new and talented staff, and building state-of-the-art research facilities,” says Jianwei Wang, director of CML and of the Research Administration Department at CAMS.

Current projects at CML include identification and detection of new emerging pathogens, and a broad spectrum of basic, clinical epidemiological studies of major pathogens in China. Working closely with the newly established Institute of Pathogen Biology (IPB) and under the guidance of the National Health and Family Planning Commission,
To aid the nation’s health policy decisions by providing critical epidemiology data, Jiang’s research interests have expanded from interventional studies to large-scale outcomes studies, such as the China PEACE Million Persons Project.

Chronic diseases

CAMS and PUMC are also an important part of the global chronic disease research network. CAMS was a founding member of the Global Alliance for Chronic Diseases (GACD) in 2007. CAMS/PUMC President Xuetao Cao served as the GACD board chair from 2013 to 2015. Cao is a renowned immunologist himself, but his contribution to the global alliance, along with that of CAMS and PUMC, extends far beyond the scope of basic immunology research.

One of the major initiatives that Cao started and oversaw at GACD was a global diabetes program, aimed at combating the rising pandemic of type 2 diabetes around the world. Many CAMS and PUMC hospitals and institutes joined the program, providing ideas and resources to improve diabetes diagnosis, treatment, and prevention.

For example, at the Institute of Materia Medica, Zhouwei Hu is working to discover new antidiabetic medications by using computer-assisted small molecule design and by isolating natural products. Several antidiabetic agents are being developed by Hu’s group and may one day become new treatment options for this devastating metabolic disease.

The medical significance of type 2 diabetes is rising rapidly in China. When Hu was a cardiologist in training in the 1980s, the majority of heart failure cases were related to infection or rheumatic heart disease. “Today, the most common cause of heart failure in China is diabetes,” says Hu. When he returned in 2004 from years of research at Stanford University, the estimate of diabetes prevalence in China was about 30 million cases. In just over 10 years, that number has risen to more than 100 million cases, accounting for almost 9%-11% of the Chinese population. Not only is there an urgent need for more antidiabetic treatment, a public health system must be put in place to slow down the rise of diabetes and prediabetes in China before the situation reaches a crisis point.

Researchers at CAMS and PUMC are also experienced at running large-scale epidemiology studies for chronic disease in collaboration with international partners. For more than a decade, Lixin Jiang of Fuwai Hospital has been doing just that, for a long list of cardiovascular diseases and interventions (see page 13). The collaboration began in 1999 when Jiang joined Richard Peto and Rory Collins from Oxford University’s Clinical Trial Service Unit (CTSU) to run the COMMIT (ClOpidogrel and Metoprolol in Myocardial Infarction Trial) study in a large group of Chinese patients with acute myocardial infarction (MI).

COMMIT was a “watershed moment” for Jiang and “for clinical research as a whole in China,” as The Lancet reported in a 2012 profile piece on her achievement. Since then, Jiang has built up a team of about 100 experts to run large-scale clinical trials in China, often involving primary-care level clinics in remote, rural villages. Because of meticulous planning and execution by Jiang and her team, along with input from the Oxford CTSU, the data from these large-scale cardiovascular trials meet international standards for quality. “In 2005 and 2006, the U.S. Food and Drug Administration [FDA] sent a delegate to China to examine our raw data ahead of a label expansion for clopidogrel. We collaborated with them and accompanied them to many trial sites in rural health clinics. The data were all good and became the sole basis for the new indication to use clopidogrel in patients with acute MI,” says Jiang. This research not only resulted in changes made through the FDA, but also influenced cardiology treatment guidelines worldwide.

Since the COMMIT trial, Jiang’s team has been running other large-scale clinical trials in close collaboration with the Oxford CTSU in China. The China Oxford Centre for International Health Research was established to solidify the trend of evidenced-based medicine in China. In addition to regular meetings and visits, the center also holds joint Oxford–Fuwai Hospital symposia on topics at the frontiers of biomedical research, such as dyslipidemia management and cardiovascular disease risk.

To aid the nation’s health policy decisions by providing critical epidemiology data, Jiang’s research interests have expanded from interventional studies to large-scale outcomes studies, such as the China PEACE Million Persons Project (see page 14). Her team now also collaborates closely with Harlan Krumholz, a renowned leader in cardiovascular outcomes research based at Yale University School of Medicine. Jiang’s large research network in China will continue collecting important cross-sectional and longitudinal data on cardiovascular diseases, to feed into global outcomes research megaprojects coordinated by Krumholz, while several trainees from Fuwai Hospital, CAMS, and PUMC are spending time at Yale to learn the latest techniques in outcomes research.

Microcirculation research

Microcirculation is a branch of biophysics and bioengineering that uses intravital imaging to study small vessels in the body. One of the world’s leading experts in microcirculation research, Ruijuan Xiu, is based at CAMS and PUMC and is director of the Institute of Microcirculation. In 2010, the Microcirculatory Society presented Xiu with the Benjamin W. Zweifach Award, an honor named for a leader in the field. While working as assistant to the chair of the Pathophysiology Department at CAMS and PUMC in the early 1960s, Xiu pioneered the study of microcirculation during an outbreak of meningitis in the Beijing area, and found a correlation...
between microvascular constriction and the prognosis of pediatric meningitis patients. Her imaging method became a rapid diagnosis tool that eventually led to a steep decline in the meningitis death rate, which dropped from 67% to 12% between 1963 and 1969.

In 1972, Yuan-Cheng Fung, a bioengineering professor at the University of California, San Diego (UCSD), happened upon Xiu’s research during a visit to CAMS and PUMC with the American delegation led by then-President Richard Nixon. Fung invited her to carry out research in the United States. Xiu arrived at the University of Missouri and soon began to master the art of building animal models for microcirculation disease studies. Later, Xiu was invited to UCSD to work with Zweifach and Marcos Intaglietta.

To this day, Xiu still spends several months each year in San Diego, bringing along a few students from CAMS and PUMC to train the next generation of microcirculation researchers who will apply their knowledge in clinical practice back in Beijing. “We have an advantage in China in terms of building animal disease models and collecting data from patients, but the imaging equipment in UCSD is still superior. Thus, my team from the Institute of Microcirculation spends time here each year to make discovery more efficient,” says Xiu.

Xiu and the Institute of Micro-circulation are committed to a translational medicine approach to studying microcirculation. She believes that changes in microcirculation play an important role in almost all diseases. Her plan is to use the latest imaging technology, combined with appropriate animal models, to gain insights about microcirculation in the tumor microenvironment and about other disease conditions as well, such as hypertension, diabetes, or atherosclerosis.

Future collaboration

It is noteworthy that in line with the tradition of application-driven research, the international collaboration projects highlighted here are all translational projects with immediate potential to impact clinical practice or public health policy. There are many more such international collaboration projects undertaken at CAMS and PUMC—often at the individual research-team level. As research from CAMS and PUMC gains international visibility, one can certainly expect continued growth in exchanges between CAMS/PUMC and the global research community.

Commercializing success

Traditionally, the mission of CAMS and PUMC has fallen into three categories: clinical medicine, medical education, and biomedical research. Advocated by current CAMS President Xuetao Cao, two new areas have been added to strategic planning for the organization: technology transfer and disease prevention. These new strategic goals illustrate the desire to apply success in biomedical research to areas beyond clinical practice. Whereas disease prevention has long- and short-term implications for public health and national security, technology transfer has a simple objective, which is to commercialize results from the biomedical research at CAMS and PUMC.

The rationale behind technology transfer and commercialization is not just to make money. By encouraging the commercialization of research results, CAMS and PUMC are able to steer new research projects in the direction of translational medical research, encouraging creative thinking about how to use discoveries in the lab to improve health.

New drug development

One area of technology transfer from the research portfolio of CAMS and PUMC is obviously new drug development. In fact, developing new drugs, vaccines, or other types of medical intervention is the primary mandate for several research institutes at CAMS.

For instance, the Institute of Materia Medica (IMM) was started in 1958 with the goal of not only leading pharmacology research in China, but also of bringing new drugs into clinical use. In the early years of IMM's history, during the Soviet era, this mission meant simply stepping up manufacturing capacity once a new drug was ready for clinical use. Today, however, the process of commercialization has become more complex, involving considerations of government regulations, market conditions, competition, and strategic prioritization.

IMM has established a system to streamline its commercialization and research cycle. This includes sending a drug that is commercialization-ready to a dedicated engineering center affiliated with IMM, where a process for large-scale production is developed. Once this process is validated and tested, the new drug enters the regulatory approval pipeline and is moved into market-level production and initiated at one of the IMM-affiliated pharmaceutical companies, such as Beijing Union Pharmaceuticals. Marketed drugs not only bring in additional funding to IMM through patent fees and royalties, but the integrated commercialization system also feeds market information back to IMM researchers to help shape future drug development strategies.

IMM’s achievements are impressive. Currently, 53 domestic and international patent applications from IMM are pending, and 33 drug patents have been authorized. The total number of new drug patents obtained by IMM is now over 700. The range of commercialized products from IMM is broad, including compound drugs based on natural products or traditional Chinese medicine regimens, synthetic small-molecule drugs, and active pharmaceutical ingredients.

IMM has established a tried and tested network of affiliated or associated pharmaceutical entities that support the commercialization process in China. IMM primarily utilizes two directly affiliated Beijing Union Pharmaceuticals companies, and has major stakes in three domestic manufacturers, one of which specializes in the production of synthetic musk developed at IMM. In addition, IMM has also collaborated with a constellation...
of multinational pharmaceutical companies, including Bayer, Roche, Sanofi, Pfizer, and Lilly, to make novel drugs developed in China available on the international market.

Apart from IMM, other CAMS and PUMC research institutes also participate in more specialized areas of new drug development and commercialization. The Institute of Medicinal Biology (IMB) in Kunming, Yunnan Province, was originally a virology laboratory for polio vaccine development. Today, IMB has become the center of vaccine research, development, and commercialization in China. “We uniquely integrate industry, academics, and research, and currently have more than 100 staff members working on new vaccines in several disease areas,” says Qihan Li, director of IMB. A unique strength of IMB is the primate animal facility, which allows complex pharmacology testing not feasible in small laboratory animals such as mice and rats.

With many ongoing drug development programs, the need for animal model testing in the preclinical stage is great. CAMS and PUMC have set up a dedicated institute to develop animal models for clinically relevant problems and rapid testing of new treatments. “Laboratory animals are the ‘live test tubes’ of biomedical research and an important last frontier before a new agent is tested in humans,” says Chuan Qin, director of the Institute of Laboratory Animal Sciences and Comparative Medicine Center. This institution develops animal models to support preclinical research and drug development in CAMS and PUMC. It also advises and supports the government during pandemic emergencies, such as the 2003 SARS (severe acute respiratory syndrome) outbreak, and assists with accelerated drug or vaccine validation.

Medical devices

Commercialization success at CAMS and PUMC extends beyond drug development. In Tianjin, the Institute of Biomedical Engineering (IBE) has been developing medical devices since the 1960s, according to Yingxin Li, director of IBE. The institute started small; its predecessor was the machine repair shop of PUMC, set up to fix medical devices when financial resources were limited. Today, there are more than 10 research labs within IBE, working on the development of a broad range of medical devices. Apart from medical devices, IBE researchers also develop new biomaterials, according to Li.

Li’s background is in bioengineering using lasers. In 2010, he moved from the Tianjin Medical Institute to IBE and began building an R&D platform that encourages technology transfer and commercialization. “In the past two years, our research projects have resulted in seven successful tech transfers,” says Li. A new platform he has built enables IBE engineers to work together with clinical doctors from PUMC and CAMS to identify relevant problems in clinical medicine and then set about finding engineering solutions. This way, research resources are geared toward the most meaningful clinical applications.

Examples of innovative medical devices developed and commercialized at IBE include several types of specialized ultrasound devices for ophthalmology and dermatology uses, a pulse-based diagnostic device for traditional Chinese medicine, and photoactivated cancer drugs. Li plans to guide IBE into the era of big data and cloud-based medical informatics. IBE researchers are already on the front lines of device development, working on wearable devices connected to the cloud and participating in the data collection for the PEACE Million Persons Project, which aims to collect baseline epidemiology data on the health of a large part of the Chinese population (see page 14).

Also based in Tianjin is the CAMS Institute of Radiation Medicine (IRM). IRM was originally set up in 1959 to support the national security needs in nuclear warfare readiness. “The [IRM’s] mission was two-pronged: [developing] radiation protection technology and understanding the effects of radiation exposure,” says Saijun Fan, IRM vice-director.

These days, Fan’s institute is more involved in developing protective gear for civil applications than preparing for a nuclear war. The IRM’s most significant commercialization success is a form of lightweight radiation-protective clothing. It weighs less than 3 pounds compared with the traditional, heavy lead-based garments, yet offers very efficient protection against external exposure to gamma and X-rays. The new gear makes for better working conditions in many professions, including nuclear power plant workers and miners. The same materials have been used to create protective underwear for commercial pilots at risk of cosmic radiation exposure at high altitudes.

Innovation at IRM goes beyond protective clothing. Besides researching the medical effects of radiation on the human body, IRM scientists are also working on medically relevant solutions using their accumulated expertise about radiation medicine and radiobiology. “IRM presented a new antioxidant drink at a trade show in the spring of 2016 that will change the practice of radiation therapy,” says Fan. This is an innovative product and proven very effective in speeding recovery after radiation-induced injury. The specially formulated drink is given to patients before and after radiation therapy and loads the body with scavenger molecules that neutralize free radicals generated during the therapy. As a result, collateral damage to cells is limited and the patient recovers more quickly.

Problems leading to solutions

Biomedical research at CAMS and PUMC has always had an eye toward applications. For decades before CAMS and PUMC got involved in commercialization, the driving force behind new technology was clinicians seeking solutions for problems they saw in clinical practice. But now, as health care has become more interdisciplinary, more problems are being found and solved outside the operating or examination room. New drugs, new vaccines, and new devices will continue to come out of CAMS and PUMC research projects, benefiting patient health and well-being.
Founded by the Rockefeller Foundation in 1917, Peking Union Medical College (PUMC) was the first medical university in China offering an eight-year curriculum leading to an M.D. degree. PUMC was also the first national key university to establish undergraduate courses for nursing students. Its sister institution, the Chinese Academy of Medical Sciences (CAMS), founded in 1956, is a leading multidisciplinary medical research institution.

PUMC and CAMS are jointly administered by the National Health and Family Planning Commission and the Ministry of Education. A synergy exists between the two institutions: CAMS provides PUMC with qualified faculty, and PUMC trains promising scientists and physicians for CAMS. CAMS and PUMC run 19 institutes, 7 satellite centers, 6 hospitals, and 7 schools. The guiding principles for PUMC are small class sizes, high academic standards, and high-quality education. The unique eight-year undergraduate curriculum and superior Master’s and doctoral training are central to its mission. PUMC was one of the first universities in China qualified to grant Master’s and doctoral degrees in medicine.

After having been approved by the State Council Academic Degrees Committee, PUMC began to autonomously appraise and approve Master’s degree-granting programs in 1993. In 1994, PUMC was authorized to independently appraise and approve the supervisors of doctoral candidates. Now PUMC maintains three Master’s programs and eight doctoral programs, and is eligible to grant academic degrees including M.D., Ph.D., Doctor of Engineering, Master of Medicine, Master of Science, Master of Engineering, and Master of Management.

The number of candidates who receive medical doctoral degrees from PUMC each year is unparalleled among medical schools in China. In 2015, of the 4,966 students at the school, 80% were graduate students, 15% were undergraduates, and 5% were enrolled in three-year college courses. PUMC has nurtured a large number of distinguished clinicians, medical scientists, and medical educators and is seen as a highly prestigious institution both at home and abroad.
The CAMS/PUMC library

The CAMS and PUMC library—with its long history and large collection—is known as one of PUMC’s three treasures, alongside its medical records and staff. The library was designated a medical branch of the National Science and Technology Library and a World Health Organization (WHO) collaborating center for health care and biomedical information. The majority of the more than 2.75 million books are publications in the biomedical field. Especially noteworthy is the large collection of complete runs of original medical periodicals and the more than 1,000 ancient Chinese medical books dating back to 1335. The library’s analysis and retrieval system for medical literature is openly accessible nationwide, and its rich holdings constitute a valuable resource for medical education, research, and medical practice.

Research facilities

CAMS and PUMC have a strong scientific research program that covers all medical fields including basic medical sciences, clinical medicine, materia medica, and medical engineering. These two institutions have 5 national key laboratories, 31 ministerial key laboratories, 18 national research bases and centers, 6 postdoctoral training centers, and 5 WHO collaborating centers. During the 12th Five-Year Plan period (2011–2015), CAMS and PUMC undertook 6,691 projects and received RMB4.1 billion (US$627 million) in grants for research projects. More than 7,000 articles were published from 2011 to 2015 in Science Citation Index-listed journals. Since the establishment of CAMS, 198 national or provincial scientific awards have been received, and research projects have won 11 national scientific and technological prizes, 135 ministerial or provincial prizes, and 107 CAMS prizes. To date, 788 patent applications have been submitted, and 9 certificates for drug and medical apparatuses (including 4 Class I new drug certificates) have been obtained.

CAMS and PUMC have 6 directly affiliated hospitals that cover both general medicine and numerous specialties: Peking Union Medical College Hospital, Fuwai Hospital, the Cancer Hospital, the Plastic Surgery Hospital, the Institute of Hematology and Blood Diseases Hospital, and the Hospital for Skin Diseases, with a total of 5,652 beds. The hospitals are leaders in health care both domestically and abroad, particularly in the diagnosis and treatment of cardiovascular diseases, malignant tumors, blood diseases, dermatological diseases, hereditary diseases, organ reconstruction, and autoimmune diseases. This health care system features a closely integrated combination of clinical practice, education, and research. The strength of CAMS and PUMC in medical practice and research is exemplified by its preeminent medical experts, who hold key positions on the National Health Care Committee, the National
are 704 supervisors for doctoral candidates at CAMS and PUMC, and 903 for Master’s candidates.

**International cooperation**

CAMS and PUMC actively participate in international academic exchanges and technological cooperation, and have established cooperative relationships in scientific research, education, and medical practice with medical colleges and research institutions in dozens of countries and regions. Over 240 foreign experts and scholars have been awarded the title of honorary professor or guest professor at PUMC. Since 1985, PUMC has signed exchange agreements with Harvard Medical School, the University of Western Australia School of Medicine and Pharmacology, the University of California, San Francisco School of Medicine, the Chinese University of Hong Kong Faculty of Medicine, and the Kiang Wu Nursing College of Macau. Under these agreements, senior students are selected to undertake short-term clinical studies at partner universities. After approval by the National Education Committee (now the Ministry of Education) in 1993, PUMC began to enroll foreign students. Since 1997, it has been qualified to enroll students from Taiwan, Hong Kong, and Macau. In September 2006, PUMC entered a new phase in its development: a close cooperation with Tsinghua University pursuant to an agreement between the Ministry of Education and the National Health and Family Planning Commission. Its English name, PUMC, remains unchanged, and its new name, Peking Union Medical College–Tsinghua University Medical School, is also officially in use. This powerful alliance between Tsinghua University and PUMC serves as a creative engine for the reform of higher medical education in China.

The 21st century is the golden moment for China to realize its dream of comprehensive development. As CAMS and PUMC face the new century’s challenges and opportunities, two of their strategic goals are to make PUMC an international, research-based medical university, and to help CAMS become the “Chinese National Institutes of Health,” an institution with international status and recognition. With the hard work of their entire staff, CAMS and PUMC are well placed to realize these ambitious goals and make significant contributions to the medical sciences and to medical education in China.
A historic milestone was witnessed in 2016 in the development of the Chinese Academy of Medical Sciences (CAMS): the official launch of the CAMS Innovation Fund for Medical Sciences (CIFMS), supported by the Finance Ministry and the National Health and Family Planning Commission. Prepared and refined over four years, this program aims to further enhance CAMS’s capacity for innovation development and enable it to engage in sustainable research.

The objectives of CIFMS include serving the strategic population and health needs of China, piloting cutting-edge development of China’s medical sciences and technology, developing innovative mechanisms for the organization of medical research, coordinating the deployment of science and technology resources, and building a tiered medical research network with an international outlook based on current research needs. The program’s goal is to boost medical research at CAMS to a world-class level. CIFMS will focus on research areas that have long-term, strategic, and global interests, while also responding to strategic needs of the country and carrying out projects in medical sciences and technology that are of national interest. Its resources will be put toward those technologies important to the health and common benefit of the Chinese people that may be inaccessible through other means.

Utilizing CAMS’s current resources in basic and clinical research, drug R&D, and experience in multiple disciplines, CIFMS aims to develop a medical research system with parallel tracks supporting research and academic development. Approximately 100 academic areas and 200 major research interests will be supported under the major disciplines of biology, basic medicine, clinical medicine, preventative medicine and hygiene, and pharmacology, among others. Funding of RMB2 billion (US$300 million) in the first three years will be invested in innovative disease prevention and treatment strategies for cancer, cardiovascular diseases, diabetes, neurodegenerative diseases, infectious diseases, and rare diseases. The program will also cover drug development and treatment, as well as research into new vaccines and medical devices for disease diagnosis and treatment. Other areas of major interest include the multidisciplinary fields of inflammation and immunization, neuroscience, ‘omics and systems biomedicine, stem cells and regenerative medicine, biotherapies, the microbiome, synthetic biology, and big data. CIFMS funding will also cover research in areas of major national concern including childhood health and disease, geriatrics, biosafety, blood safety, and radiological safety. Support will also be provided for essential supporting platforms such as drug resource libraries, biobanks, biomedical databases, and experimental animal models.
Since the founding of CAMS in 1956, scientists there have played leading roles in determining the focus of China’s biomedical research and national strategies for disease control and prevention. The following achievements are some of their milestones.

Implementation of vaccines to control poliomyelitis
CAMS former president Fangzhou Gu developed China’s first polio vaccines, in particular the “Sugar Ball” attenuated oral vaccine, first created in 1959. Implementation of a countrywide immunization strategy eradicated the indigenous polio strain by 1994. Poliomyelitis has since been effectively controlled, with China being declared polio-free by the World Health Organization (WHO) in October 2000. This was a significant achievement in global public health, possibly second only to the global eradication of smallpox. Recently, scientists at the Institute of Medical Biology have developed a series of polio vaccines for national immunization, including oral and injectable live poliomyelitis vaccines produced in both monkey and human cells. A significant milestone occurred when the China Food and Drug Administration (CFDA) approved the Sabin strains of inactivated polio vaccine for human immunization in 2015, providing further safeguards to keep China polio-free.

Leprosy control and elimination
Since the founding of CAMS, scientists at the Institute of Dermatology have spearheaded a national strategy for leprosy control and research, with the goal of controlling infection through active prevention and treatment. They successfully achieved the goal of largely eliminating leprosy in China by the end of the 20th century, while establishing nationwide networks for the detection and control of infectious sources and the early diagnosis of cases, and also studying the efficacy of multidrug therapies. Creating a sustainable development model for leprosy control is one of the institute’s primary aims, in concert with preventing disability caused by the disease and reducing its social stigma. The establishment of a national leprosy epidemic surveillance system has provided timely alerts of endemic trends and allowed effective evaluation of control efforts—efforts that will hopefully lead to the complete elimination of leprosy in China.

Gynecologic malignancies and fertility-sparing treatments
The department of Obstetrics and Gynecology at PUMC Hospital has a long history of excellence and innovation. In the 1950s, a team led by Hongzhao Song was among the first in the world to develop a breakthrough chemotherapy for metastatic choriocarcinoma, which achieved a 100% remission rate for malignant hydatidiform moles and a drop in the choriocarcinoma mortality rate from 90% to 20%. In the last 20 years, teams led by Jinghe Lang and Keng Shen developed a series of innovations in fertility-sparing treatments for gynecologic malignancies. Their work resulted in the release of the first protocols for this field in China, “Diagnosis and Treatment Guidelines for Fertility-Sparing Treatments for Patients with Gynecologic Malignancies in China.”

Prevention and treatment of esophageal cancer
Scientists at CAMS uncovered the principle carcinogens (nitrosamine compounds) and lifestyle factors associated with esophageal cancer in the Linxian region of Henan Province, an area where this often-fatal cancer is endemic. Investigators have developed innovative early diagnoses for the disease based on esophageal exfoliative cytology. Over the past 30 years, scientists at the Cancer Hospital have systematically investigated the epidemiology, diagnosis, and therapeutic technologies for treating esophageal cancer, generating standardized treatment guidelines. The Cancer Hospital is designated as the National Cancer Center and provides comprehensive nationwide cancer surveillance and prevention, in addition to publishing an annual report on cancer statistics in China.
Prevention and management of hypertension and cardiovascular diseases

In 1969, a team led by Yingkai Wu and Lisheng Liu at Fuwai Hospital established China’s first chronic disease prevention network at the Capital Iron and Steel Company in Shougang, focusing on chronic disease monitoring, investigation of environmental risk factors, and the prevention of hypertension. Since then, three generations of scientific researchers at Fuwai Hospital have carried out screening of high-risk individuals, performed research, and provided education in hypertension and cardiovascular disease prevention and management. In recognition of the outstanding contribution of the Shougang model to the field of chronic disease prevention and control in China, specifically in the areas of hypertension and cardiovascular disease, in 1994, WHO promoted the use of this model worldwide. It is characterized by a focus on primary care and individual self-management, including health education, systematic monitoring, hierarchical management, and behavior interventions. These interventions are believed to be responsible for the drop in the incidence of hypertension among Shougang workers from 1.2% to 0.65%, and a reduction in morbidity and mortality rates following a stroke of 54.7% and 74.3%, respectively.

Development of natural medicine

NBP (dl-3-n-butylphthalide), China’s first antiepileptic drug, was discovered and developed by the Institute of Materia Medica (IMM). NBP is used clinically for the treatment of mild to moderate acute ischemic stroke, and has also been widely used in patients with acute cerebral ischemia. It has annual sales in China of over RMB1 billion (US$150 million), holding a significant share of the domestic market for new drugs.

IMM has also successfully developed bifendate and bicyclof for the treatment of liver diseases and successfully established several international new drug development programs through collaborations with industry, universities, and research institutes.

Development of artificial musk

Musk is a precious Chinese medicinal material and is credited with effects such as inducing resuscitation, promoting blood circulation, detumescence, and pain relief. It is an essential component of more than 11% of traditional Chinese medicine formulae and is considered to be a national treasure. Male musk deer that are native to China are the only source for natural musk, but they are a protected species. In 1975, the Ministry of Health initiated a project to find a synthetic replacement for natural musk. Scientists at IMM successfully isolated the principle constituents of natural musk and demonstrated their pharmacological effects, elucidating the key molecules. They then successfully developed an artificial musk, which was approved by CFDA as a Category I new drug. Artificial musk has filled a large gap in the production of traditional Chinese medicine, protecting more than 26 million musk deer from being hunted and benefiting more than 100 million patients annually.

Control, prevention, and treatment of infectious diseases

The Department of Infectious Disease at PUMC Hospital reported the first case of HIV/AIDS in China in 1985. A team led by Taisheng Li has developed and optimized antiretroviral therapy regimens with high efficacy, low cost, and minimal side effects, which have markedly decreased the mortality of the disease in China. They have further initiated a comprehensive model for HIV/AIDS management that has contributed to a decrease in key organ-specific complications. Li and his group also contributed in 2005 to the first version of the “Guidelines for Diagnosis and Treatment of HIV/AIDS in China,” leading to the standardization of HIV/AIDS care nationally and the effective control of new epidemics.

Following the SARS (severe acute respiratory syndrome) outbreak in 2002–2004, in 2006 the Chinese government founded the Institute of Pathogen Biology (IPB) to respond to the global challenge of major infectious diseases. Over the last 10 years, IPB has sequenced more than 1,000 human and animal pathogens, constructing one of the most comprehensive genomic databases of virulence factors. IPB scientists have set up a system for high-throughput metagenomic sequencing and bioinformatics analysis of clinical samples that enables rapid screening for thousands of pathogen species/types within 96 hours. By analyzing a large number of samples using this workflow, they elucidated the spectrum of viral pathogens in human respiratory infections and in wild animals such as bats. The use of multiplex detection and metagenomic analysis has provided the basis for infectious disease surveillance and alerts, allowing the origins of emerging infectious diseases to be traced. Since its establishment, IPB has been at the forefront of infectious disease emergency support and has played an indispensable role in the control of recent outbreaks of major contagious diseases, including H1N1 influenza, H7N9 influenza, hand, foot, and mouth disease, and Ebola in West Africa.

The first global, inactivated vaccine against enterovirus 71 (the causative agent of hand, foot, and mouth disease) was developed solely by the Institute of Medical Biology over a period of seven years, began production in 2015, and has been available in China since March 2016. The release of this vaccine was a critical milestone in the control and prevention of hand, foot, and, mouth disease in China, and will play a significant role in improving the health of its people.

Animal models are essential for research into the prevention and control of infectious diseases. The Institute of Laboratory Animal Sciences (ILAS) at CAMS has developed the first animal model platform for the study of SARS, and the lab’s current R&D capacity is now world class. The laboratory established the first animal-model resources center for infectious disease...
testing, which includes 105 pathogen-sensitive species/strains and 95 disease models and preclinical antiviral drug development platforms for infectious diseases. The excellent work done at ILAS has overcome the deficit in the availability of animal models and supported infectious disease prevention and control in China. These animal models have contributed significantly to the development of the first vaccines against SARS, H1N1, and H7N9. They have also been critical for testing nearly half of the HIV/AIDS vaccines and drugs currently being studied in China, as well as for risk assessment of the transmission, infectivity, and pathogenesis of emerging viruses.

Medical genetics in China

Min Wu, working at the Cancer Hospital, established the first research group in China examining cell genetics, initiating research into human cell genetics and cancer genetics. Under his leadership, the research team developed a series of cell culture methods and staining techniques for human peripheral blood lymphocytes, human embryonic cells and tissues, and malignant effusion cells. These techniques have become standard protocols for biomedical research and clinical diagnosis for conditions including prenatal and genetic disorders, cancers, and radiation sickness. Wu’s team also obtained the first comprehensive chromosome idiograms for the Chinese population. Their work has contributed significantly to the establishment and development of human and mammalian cell genetics in China.

Fangzhou Gu made significant contributions to the control and eradication of poliomyelitis in China.

Guanyun Wu’s group provided the first DNA diagnosis and prenatal testing for Chinese patients with Mendelian disorders. Wu and Wilson H. Y. Lo, a pioneer medical geneticist in China, were both awarded the National Science and Technology Progress Awards for their contribution in this area. The research groups led by Yan Shen and Xue Zhang have focused on understanding the molecular basis of rare Mendelian disorders, and have discovered the causative genes for a dozen monogenic disorders. Shen’s group identified the first pathogenic mutation of the dentin sialophosphoprotein gene (DSPP) in dentinogenesis imperfecta Shields type II, a genetic disorder involving the teeth. Zhang’s group found that mutations in an upstream open reading frame (uORF) of the hairless gene (HR) could cause Marie Unna hereditary hypotrichosis. The two groups jointly showed that loss-of-function mutations in the gamma-secretase component genes were associated with familial acne inversa, also known as hidradenitis suppurativa. Zhang’s group has also established congenital generalized hypertrichosis syndromes as genomic disorders.

Dongxin Lin and colleagues at the Cancer Hospital have been researching the molecular genetics and molecular epidemiology of cancer, and have identified multiple genetic susceptibility loci associated with the development and progression of cancers in Chinese populations using candidate gene approaches and genome-wide association studies. Based on their data, Lin highlighted the involvement of multiple genetic loci and gene-environment interaction in the development
of esophageal squamous cell carcinoma (ESCC), and employed these genetic variants together with environmental factors such as drinking and smoking to establish a model that would be useful in identifying individuals at high risk for ESCC, thus helping to prevent the disease.

Dongfeng Gu, vice president of Fuwai Hospital and of the affiliated National Center for Cardiovascular Diseases, has led large-scale observational and interventional studies in both population epidemiology and population genetics. Using standardized protocols for collection, preservation, and database categorization, he has established the largest clinical genotype and phenotype databases for coronary artery disease, hypertension, and dyslipidemia in China. Through genome- or exome-wide association studies of Chinese populations, Gu and his colleagues have established that genetic information can be used to assess future risk for cardiovascular diseases in population-based prospective cohorts, and have demonstrated the value of this information in a clinical setting.

**Adult stem cells: Theoretical and technological innovation and clinical translation**

Stem cell research carried out at the Institute of Hematology and Blood Diseases Hospital (IH) using hematopoietic stem cells (HSCs) in a clinical application represents some of the most important work now being done in this field in China. In 1986, the first autologous hematopoietic stem cell transplantation (HSCT) in China was performed on a leukemia patient at IH by Wenwei Yan and his team. Since then, autologous HSCT technology has been further improved and extended to allogeneic HSCT, utilizing human leukocyte antigen (HLA)-matched or unrelated sibling donors, as well as to haploidentical HSCT. Both are routinely undertaken at IH for patients with leukemia, aplastic anemia, lymphoma, multiple myeloma, myelodysplastic syndrome, and other hematological diseases. The long-term, disease-free survival rate for these patients is similar to that seen in other clinics around the world.

Based on a series of preclinical studies, Zhongchao Han and his team have been exploring the potential value of autologous HSCs in the treatment of nonhematological diseases. Autologous mesenchymal stem cells (MSCs) isolated from umbilical cord or bone marrow by Han and by Chunhua Zhao were used for clinical trials to treat multiple diseases such as graft-versus-host disease, liver disease, and heart disease. The potential value of autologous stem cells for the treatment of disease inspired investigators at IH to launch the first—and now largest—cord blood bank in China.

To overcome the current bottleneck in the development of stem cell therapies and further expand the clinical applications of HSCs, a series of innovative and collaborative research projects using HSCs have been initiated by Tao Cheng, together with colleagues at IH and partners at other institutions. These studies will not only provide critical biological parameters for the culture of therapeutic stem cells, but also offer new strategies and methods to further enhance current therapies.

Apart from the milestones discussed above, over the past 60 years many CAMS and PUMC scientists have made significant contributions to the field of medicine both in China and worldwide. These achievements include the prevention and control of hypertension and cardiovascular disease at Fuwai Hospital; epidemiological research on liver disease at the Cancer Hospital; novel diagnostic methods developed for investigating pituitary tumors, creation of a clinical diagnostic system for scoliosis, and advances in the clinical management of pancreatic cancer at PUMC Hospital; breakthroughs in leukemia immunophenotyping and clinical diagnosis at IH; development of antibiotics and anti-infective drugs including pingyangmycin and norvancomycin at the Institute of Medicinal Biotechnology; the protection and sustainable use of medicinal plant resources including *Amomum* and *Rhizoma Gastrodiae* at the Institute of Medicinal Plant Development; establishment and application of detection methods for doping in sports at IMM; and creation of a national clearinghouse for medical literature and information at the Institute of Medical Information and Library.
The Chinese Academy of Medical Sciences (CAMS) boasts competitive facilities for scientific research, including 5 state key laboratories, 10 key department laboratories, and 23 key provincial and municipal level laboratories. CAMS is affiliated with major national research facilities for medical science—including the Peking Union Medical College Hospital (PUMCH)—and multiple national R&D and clinical centers. Through its affiliations, it provides strong support for research at the frontiers of medical science that addresses the nation’s most crucial needs. To further advance medical innovation, CAMS has built 25 internal research centers and plans to build further key laboratories to facilitate cooperation among these research institutions and encourage interdisciplinary engagement. With the goal of being at the forefront of international development in the medical sciences, all key laboratories and research centers uphold the ideal of being “open, flexible, cooperative, and competitive.” This goal includes sponsoring academic exchanges and cooperation at home and abroad. Below, the five state key laboratories at CAMS are described in more detail.

The Five State Key Laboratories

State Key Laboratory of Medical Molecular Biology
The State Key Laboratory of Medical Molecular Biology (SKLMMB) was established in 1992 in accordance with China’s mid- and long-range plans to develop science and technology. It is based in the Department of Biochemistry at PUMC and is the only comprehensive SKL of its kind in China.

At present, research teams are made up of young scientists who have made outstanding contributions in molecular biology. Research is facilitated by advanced equipment and the use of progressive biological techniques. SKLMMB has 63 faculty and staff members, including 38 researchers or associate researchers, 5 members of the Chinese Academy of Sciences, 3 members of the Chinese Academy of Engineering (CAE), 25 Ph.D. candidate advisors, 4 Cheung Kong Scholars from the Chinese Ministry of Education, and 8 awardees of the National Science Fund for Distinguished Young Scholars.

Medical molecular biology is a rapidly progressing field dealing with the structure and function of
It provides a general basis for an important link between multiple disciplines including biochemistry, genetics, biophysics, cell biology, immunology, and neurology. Intensive studies in medical molecular biology may not only help shed light on the nature of eukaryotic cell growth, differentiation, development, and death, but more importantly, may provide detailed insight into the molecular mechanisms underlying cardiovascular and cerebrovascular, metabolic, age-related, and autoimmune diseases, as well as their progression and prognosis. Studies on the nervous, hematopoietic, muscular, and male genital systems will illuminate the genes involved in various physiological functions. With an eye on basic medical research trends in China, SKLMMB’s focus is on topics such as the structure, function, and expression of human genes and their protein products, and the development of genetically engineered and antiviral drugs.

State Key Laboratory of Molecular Oncology (SKLMO) is a center for cancer research located at the National Cancer Center/Cancer Hospital at CAMS. It includes 17 research groups with 29 professors, 14 associate professors, and 14 staff members. The main research directions are:

- To explore the fundamental molecular mechanisms of tumorigenesis and cancer progression, and ultimately develop novel perspectives on cancer prevention, early diagnosis, and treatment
- To use molecular biology and cell biology to investigate the biological mechanisms involved in malignant tumors, including proliferation, differentiation, migration, and apoptosis in tumorigenesis and cancer development
- To identify specific biomarkers and clarify gene/protein profiles that can be used for early diagnosis, therapy, and prognosis
- To carry out studies combining basic and clinical research in collaboration with molecular epidemiology, cytogenesis, and molecular genetics, in areas with a high incidence of specific cancer types, and to conduct systematic, original exploratory research into the molecular biology of cancer.

State Key Laboratory of Experimental Hematology (SKLEH) was established in 1988 by the Ministry of Science and Technology and is housed in the Institute of Hematology and Blood Diseases Hospital (IH). SKLEH opened for domestic and international collaboration in 1991 and has broad research strengths, with a particular emphasis on hematopoietic stem cell biology and its applications, the molecular biology of pathological blood cells, the molecular basis of the pathological microenvironment in the bone marrow niche, and biotherapy for blood-related diseases. The laboratory has established five major technological platforms, including a pathological cell bank, a stem-cell isolation facility, a live-cell and small-animal imaging facility, a functional genomic core, and a specific pathogen-free–grade animal facility.

Currently, SKLEH has 35 faculty members and 10 adjunct members. Among them are a member of the French National Academy of Sciences, 2 professors in the Cheung Kong Scholars Program, 3 recipients of the Distinguished Young Scientist Award, and 2 recipients of the Outstanding Young Scientists Award from the National Natural Science Foundation of China (NSFC). Ten faculty members have also held overseas faculty appointments. Tao Cheng, an internationally renowned investigator in hematology and stem cell research, is the current director of SKLEH.

SKLEH receives government support of around RMB20 million (US$3 million) annually from sources including the National Science and Technology Major Projects Program, the National High-Tech R&D Program (863 Program), National Health projects, the National Basic Research Program of China (973 Program), the NSFC, and the Tianjin Science and Technology Commission. SKLEH has won 3 national prizes and more than 30 ministerial scientific prizes.

SKLEH also serves as a national and international hub for collaborative research in hematology and stem cell biology, education, training of students and scientific staff, and academic exchanges. In the last few years,
SKLEH held eight international conferences, including the 1st through 4th International Forum on Stem Cells, which have become an important venue for discussing stem cell research, applications, commercialization, and governance.

State Key Laboratory of Bioactive Substance and Function of Natural Medicines

The SKL of Bioactive Substance and Function of Natural Medicines (SKLBSFNM) was established by the Ministry of Science and Technology in 2011. The fundamental task of the laboratory is to develop innovative drugs useful in treating and preventing cancer and diabetes, as well as cardiovascular, neuropsychiatric, infectious, inflammatory, and autoimmune diseases. To that end, this SKL focuses on discovering the bioactive substances in natural medicines, possibilities for translating those substances into drugs, and related technologies and methodologies. Its efforts will provide the scientific basis and technical support for developing and modernizing traditional medicine to treat and prevent major diseases.

The laboratory consists of 89 staff members including 44 full professors, 23 associate professors, one academician of the CAE, 3 Yangtze River Scholar professors, and 4 Outstanding Young Scholars supported by the NSFC. Shi-Shan Yu is the chairman of the laboratory and Dequan Yu is the chairman of the academic committee.

In the past five years, over 80 major national research projects have been undertaken in the laboratory, resulting in 533 publications, 126 domestic and international patents, and 230 pending patents. One Class I new drug certificate was approved by the China Food and Drug Administration (CFDA). Other achievements include 21 drug candidates in various stages of R&D: 11 in preclinical trials, two in phase 1, six in phase 2, and two in phase 3 trials.

State Key Laboratory of Cardiovascular Disease

The SKL of Cardiovascular Disease (SKLCD), supervised by the Ministry of Science and Technology, was founded in 2011 and is currently led by Academician Shengshou Hu, an internationally recognized cardiac surgeon and scientist. Its goal is to be one of the world’s leading institutes in cardiovascular disease research.

The laboratory is the only national institution in China involved in the field of cardiovascular disease research. Through domestic and international collaboration, it shares its passion for and knowledge of clinical cardiology. It also shares the clinical and research infrastructure of the National Center for Cardiovascular Diseases at Fuwai Hospital with global and local partners to shape the future of cardiovascular medicine. Through its translational research, SKLCD delivers innovative clinical practice and groundbreaking research to improve heart health.

Following the philosophy of “integrity, teamwork, innovation, and quality," SKLCD conducts basic, translational, clinical, and epidemiological research to solve today's medical mysteries, generate knowledge, and translate discoveries into prediction, prevention, diagnosis, and personalized therapy for cardiovascular diseases. Its culture aims to encourage researchers to unravel complex research questions in cardiovascular medicine more quickly and easily by integrating basic research with clinical and epidemiological resources, and by cultivating collaboration and teamwork. Physicians examine, diagnose, and treat their patients using knowledge and technology acquired at the bench and, in turn, raise questions for basic scientists to answer. Basic scientists investigate the molecular underpinnings of health and disease, and epidemiologists study the effects of disease on populations. We expect that this closely integrated way of working will benefit tomorrow’s patients, doctors, and scientists with proven diagnostics and therapeutics.

The CAMS and PUMC Research Centers

Immunotherapy Center

The Immunotherapy Center (IC) of CAMS, located in the Institute of Basic Medical Sciences (IBMS), was established in April 2015. It consists of three research units, including the Department of Immunology at IBMS, the Department of Immunology at the Cancer Hospital, and the Institute of Medical Biology (IMB), all within CAMS. IC focuses on vaccine design, adaptive cellular immunotherapy, antibody development, and the preparation of recombinant proteins to combat
cancer, infectious diseases, and autoimmune diseases, among other specialties. IC’s goals are to establish an integrated immunotherapy platform for the prevention and treatment of chronic diseases, conduct innovative research into the pathological mechanisms and immunotherapeutics of immune disorders, and strengthen the translation of basic research to clinical practice.

Current research projects include designing new types of preventive and therapeutic vaccines; identifying new molecular and cellular effectors for cancer immunotherapy; screening biomarkers that will predict the prognoses and responsiveness of interferon and antibody therapy for hepatitis B virus (HBV) infection and HBV-related hepatocellular carcinoma; and studying the characteristics of RNA modification in the pathogenesis of hepatocellular carcinoma. Some examples of recent work includes phase 3 trials of the antigen-pulsed dendritic-cell therapeutic vaccine for metastatic cancer; approval of the first enterovirus 71-inactivated vaccine; and optimization of cytokine-induced killer HBsAg-CAR T, Her2-TCR T, and CDR3-γδT-cell technologies.

Diabetes Research Center
Recent research suggests that China is now the country with the largest burden of diabetes in the world (1). To better understand, prevent, and treat diabetes, the Diabetes Research Center (DRC) was founded on November 14, 2011. It has also taken the lead in carrying out national projects and comprehensive research on diabetes in the areas of basic science, animal models, drug development, epidemiology, and clinical research. DRC provides an open and dynamic environment in which researchers can share and collaborate.

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New Drug Safety Evaluation Center
The New Drug Safety Evaluation Center (NDSEC) was established on July 2001, and is linked to the Institute of Materia Medica. It has already obtained CFDA good laboratory practice (GLP) certification, Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) International certification, ISO 9001:2008 regulatory certification, national measurement certification, and national chemical GLP certification. NDSEC conducts tests on acute toxicity, chronic toxicity, genotoxicity, reproductive toxicity, localized tissue toxicity, immunotoxicity, pharmacological safety, carcinogenicity, and toxicokinetics under GLP conditions. The center also studies the mechanisms underlying toxicological effects and the establishment of techniques and methods that focus on new antigen screening, phototoxicity, and respiratory system toxicity. The center’s main technological platforms include facilities to fully evaluate the safety or toxicity of photosensitizers and the phototoxicity of drugs using cell-to-animal models, and a facility to evaluate inhalation exposure to liquid, gas, or dry-powder test materials. Our developmental and reproductive toxicology research provides clients with access to world-class scientific staff who are knowledgeable in the unique difficulties of reproduction and development in both small and large animals. Tests developed at NDSEC include the embryonic stem cell test and the zebrafish developmental toxicity test model for the detection of embryotoxicity/teratogenicity.

Orthopedics Research Center
The Orthopedics Research Center is a comprehensive research institute that encompasses both basic and clinical orthopedic research. It is supported by the orthopedic surgery department of PUMCH, and cooperates with the genetics department of IBMS and the Tissue Engineering Research Center of CAMS. As a Beijing key laboratory, it has a clinical samples library and research facilities for molecular biology, genomics, proteomics, and animal experiments. The research center includes a member of the CAE and eight senior professors. It conducts research primarily in four areas related to joint deformity and chronic bone disease: etiology and pathogenic factors; standardization of diagnostic processes; comprehensive treatment and long-term prognosis; and new technology, material development, and applications.

Molecular Pathology Research Center
The Molecular Pathology Research Center (MPRC) of CAMS and PUMC is composed of the Department of Pathology at PUMCH, the Pathology Center of the Basic Research Institute of CAMS, the Department of Pathology at the Cancer Hospital, and the Key
Laboratory of Clinical Cardiovascular Genetics at Fuwai Hospital. The center has 139 full-time staff members, including an academician of the CAE, 25 professors, 19 associate professors, 8 assistant professors, 20 attending doctors, 13 medical residents, and 53 technicians. As a pioneer and leading center for molecular pathology in China, MPRC has been devoted to promoting the development of clinical molecular pathology and molecular pathology research for the last two decades. It has also served as an internationally recognized center for many important clinical trials. MPRC’s current research focuses predominantly on cardiovascular diseases, pancreatic cancer, lung cancer, breast cancer, and thyroid cancer. Molecular pathology techniques routinely applied include immunohistochemistry, fluorescence in-situ hybridization, chromogenic in-situ hybridization, polymerase chain reaction (PCR), real-time PCR, next-generation sequencing, flow cytometry, tissue array processing, laser capture microdissection, and liquid biopsy.

Center for AIDS Research

The Center for AIDS Research was established in November 2003. Former U.S. president Bill Clinton and leading AIDS scientist David D. Ho attended the opening ceremony. Since its establishment, the center has committed to basic and clinical research on human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) and plays an important role in the diagnosis, treatment, and prevention of HIV infection in China. Currently, the center has more than 50 research staff and clinicians and eight affiliated laboratories equipped with advanced instruments. Yuxian He serves as center director. Current projects focus on epidemiology, molecular virology and immunology, antiretroviral treatment, animal infection models, and preventive/therapeutic vaccine development. In recent years, the center’s scientists have made outstanding progress in the areas of host restriction factors, drug and vaccine development, clinical patient treatment, and the development of inhibitors to HIV entry into cells, while publishing over 100 papers in international peer-reviewed journals.

Center for Bioethics

The Center for Bioethics, founded in 2001 by CAMS and PUMC, is tasked with addressing fundamental ethical issues in the areas of health and medicine, pursuing interdisciplinary research and education including both theory and practice, collaborating with policy makers to identify and analyze the ethical dimensions of their work while providing policy recommendations and counseling, and strengthening international collaboration. The center is devoted to disseminating knowledge and expertise, and to promoting the development of bioethics in China.

The center has established academic links with several esteemed national and international universities, and has hosted distinguished scholars from the United States, the United Kingdom, Norway, Sweden, Singapore, Germany, France, Australia, New Zealand, Holland, Korea, and Japan.

Biomedical Primate Research Center

The Biomedical Primate Research Center of CAMS was formally approved in July 22, 2015, and set up jointly by IMB and IBMS. The center will integrate the resources and talents of the institutes and hospitals of CAMS and PUMC, including IMB's abundant primate resources and extensive experience with animal experimental techniques. In compliance with the government’s major strategic requirements and the 13th National Five-Year Plan on science and technology development, the center will focus on human disease models using advanced modern technology, while integrating medical research, clinical transformation, and high-tech R&D. It will serve major national science and technology research projects and special projects, including studies on the prevention and treatment of major diseases and the realization of precision medicine, innovative drug discovery, stem cell translational medicine, and brain science research.

Center for Health Policy and Management

The Center for Health Policy and Management was founded in 2006 by CAMS and PUMC. Its mission is to conduct in-depth and meaningful health policy and management-related research while developing novel theories and methods to address current problems and strategic issues in the field. The center has focused on addressing health reform and development in China in key areas such as health policy analysis and evaluation, health care systems, global health, health information management and decision-making support, primary health care, maternal and child health care, and health economics. In recent years, it has conducted projects addressing health reform evaluation, public hospital reform, universal health coverage, health service system planning, and plans for the Healthy China 2020 program. It has also developed decision-making support systems, including a new national rural cooperative medical information platform. The center also founded and hosts the Chinese Journal of Health Policy. It has built up a wealth of health policy analysis and policy-making expertise and plays an important role in China’s health policy research and decision-making.

Center for Tuberculosis Research

The Center for Tuberculosis (TB) Research of CAMS and PUMC is supported by the Institute of Pathogen Biology. The center is also affiliated with four internal institutes of CAMS, one general hospital—PUMCH—and two specialized TB hospitals. The director of the Institute of Pathogen Biology, Qi Jin, is the current head of the Center for TB Research, and CAMS President Xuetao Cao leads the center’s scientific advisory board. The board aims to bring together leading scientists in an effort to shape the future of TB research.
The center’s mission is to use state-of-the-art technology to advance our understanding of TB latency and pathogenesis, host immunity, and mechanisms of drug resistance; and to develop animal models that better emulate the disease pathology. With these basic tools, the center intends to build a translational bridge to more effective vaccines, short-term prophylactic treatments, and quicker diagnosis for TB, and to make transformative scientific advances that lead to better prevention and treatment. The TB center has grown out of the demand for innovative TB research and better management of the disease in China. The center is a nationwide driving force in the field, particularly in the development of new technologies for diagnosis, detection, and treatment of TB.

Center of Excellence in Tissue Engineering

The Center of Excellence in Tissue Engineering has been focused on adult stem cell biology and tissue engineering since its founding in 2003. The center brings together talented researchers from CAMS and PUMC in the fields of cell biology, biotechnology, laboratory animal science, and clinical medicine, forming an interdisciplinary research entity that is capable of research from bench to bedside.

The center combines the best in stem cell science, along with state-of-the-art research in clinical studies, for the purpose of developing clinically realizable techniques for stem cell tissue repair and regeneration. In May 2003, the center began a collaboration with the National Institute for the Control of Pharmaceutical and Biotechnological Products. Based on the principles of safety, reliability, stability, and controllability, they collectively developed a highly standardized and stringent procedure for pluripotent mesenchymal stem cell culture and qualification, and set up the first standard operating procedure for large-scale stem cell production. In December 2004, the first stem cell product developed by the center—a bone marrow mesenchymal stem cell—received official approval from CFDA for clinical trials in China. The center has an international reputation for research in adult stem cell science. Over the past few years, it has published more than 40 research papers on adult stem cells in peer-reviewed journals. In 2006, the center published the book *Stem Cell Theory, Technology and Clinical Application*. The research project titled “Biological Characteristics of Adult Stem Cells and Their Large-Scale Preparation Technology” won second prize at the 2009 State Technological Invention Awards.

Center for Systems Medicine

The Center for Systems Medicine, Suzhou Institute of Systems Medicine (ISM), is a joint initiative among CAMS, the local government of Suzhou Industry Park (SIP), and the Suzhou municipality. ISM will serve as a new model that will exploit systems biology and translational medicine approaches for discovery- and innovation-based R&D on medical and health care problems. ISM is committed to gaining an international reputation for excellence in research and education by combining its academic resources with those of affiliated hospitals and translational research incubators. It aims to become a fully integrated patient-to-bench-to-product powerhouse for fighting human disease. The center’s goal is to understand and develop interventions for complex human diseases that affect populations worldwide, including infectious, metabolic, inflammatory, and degenerative diseases as well as cancer. It aims to transform medical practice by developing novel prediction methods, diagnoses, treatments, and preventative interventions for major human diseases.

McKusick-Zhang Center for Genetic Medicine

Three national centers for genetic medicine were created in August 1987 within CAMS, Shanghai Medical University, and Hunan Medical University, and approved by the then Ministry of Health. One of these, the Beijing National Center for Genetic Medicine, was established at CAMS and included the Department of Medical Genetics at IBMS and the Departments of Pediatrics and Obstetrics and Gynecology at PUMCH. In 2004, this center was renamed the McKusick-Zhang Center for Genetic Medicine.

The goals of the McKusick-Zhang Center are to establish an interdisciplinary environment for research, clinical service, and training in medical genetics; to promote the translation of basic genetic discovery into the clinic and the application of new technologies in medical genetics services; and to encourage collaboration between medical geneticists and clinicians.
Over the past decades, investigators at the center have made breakthroughs in the study of many genetic disorders. The team has discovered the causative genes or pathogenic genomic rearrangements underlying a dozen Mendelian disorders, and published papers in high-profile, international peer-reviewed journals. In 2000, the team received the National Science and Technology Progress Award for their work in identifying genetic defects and for advances in the prenatal diagnosis of phenylketonuria.

**Proteomics Research Center**

The Proteomics Research Center was founded in 2002, under the auspices of CAMS. With major financial support from the Ministry of Science and Technology, the center acquired then state-of-the-art instrumentation, such as an electrospray ion-trap mass spectrometer and a matrix-assisted laser desorption time-of-flight mass spectrometer for protein identification, as well as 2D electrophoresis and 2D liquid chromatography systems for protein isolation. In 2007, to better advance its mission, the center moved to IBMS and began providing integrated proteomics research services as a part of the Core Laboratories Center. To keep pace with the field’s rapid development, the center has made significant investments in equipment upgrades and new technology in the past three years. Currently, mass spectrometers in operation include an LTQ Orbitrap Velos and LTQ Orbitrap Fusion Lumos from Thermo Fisher Scientific, an ultraflexXtreme MALDI-TOF/TOF and 9.4 Tesla APEX FTMS from Bruker, and a TripleTOF 5600 and QTRAP 6500 from AB Sciex; the center also has a free-flow electrophoresis system from BD Biosciences, a liquid isoelectric focusing system from Bio-Rad, and a difference gel electrophoresis system from GE Healthcare Life Sciences. The center has set up a Joint Laboratory of Clinical Proteomics with both Thermo Fisher and AB Sciex, and strives to provide a full range of quality proteomics services to the research community, including peptide and protein qualification and quantification, accurate molecular weight analysis, posttranslational modification characterization, and differential proteome analysis.

**International Center of Microvascular Medicine**

The International Center of Microvascular Medicine was founded at the Institute of Microcirculation in 2011. This center consists of three research divisions with 22 faculty and staff members. Its focus is clinical and experimental investigation of the mechanisms behind microcirculatory disturbances in major diseases and malignant tumors.

The center is equipped with advanced experimental stations including an intravital microscopy system incorporating digital image processing and analysis for microcirculatory observation in vivo and in vitro; a time-lapse video recording system for long-term dynamic analysis of endothelial and myocardial cell behavior; and a system for clinical microcirculatory examinations—as well as abundant equipment for research in cellular and molecular methodologies and techniques.

Successful collaborative research is ongoing between this center and the Clinical Research Center of the Karolinska Institute, and the Department of Bioengineering at the University of California, San Diego.
Peking Union Medical College (PUMC) was established in 1906 by American and British missionaries. It was acquired in 1917 by The Rockefeller Foundation and became affiliated with the Chinese Academy of Medical Sciences (CAMS) in 1956. As the first medical school in China offering an eight-year M.D. degree and bachelor of science (B.S.) in nursing program, PUMC adheres to its mission “to educate and inspire potential leaders and innovators who will promote the future development of medical sciences.” Over the past century, PUMC has educated and inspired generations of leaders in academic and clinical medicine and related disciplines. Despite the many significant changes in China since its founding, the school has remained true to its mission and heritage as a small-scale, elite medical educational institution and a flagship of medical education in China.

Education programs available at PUMC include clinical medicine (M.D. and M.D./Ph.D. programs), nursing (B.S. program), Master's and doctoral programs in basic and clinical medicine, and postgraduate continuing education programs. The unique combination of CAMS and PUMC creates a team of distinguished faculty that shares clinical education and research facilities. As the most selective medical school in China—based on entry score requirements and enrollment ratios—PUMC enrolls fewer than 100 students per year into its M.D. program. The majority of candidates are selected from the graduating classes of renowned Chinese high schools. They are assessed based on their general academic performance and their scores on the annual National College Entrance Examinations. The M.D. program also accepts a limited number of undergraduate applicants annually from a small number of collaborating medical schools and universities across China. Applicants are screened through a series of rigorous tests to confirm their academic credentials and compatibility with PUMC’s mission.

Currently, the eight-year clinical medicine curriculum is composed of three main parts: a two-and-a-half year premedical education at the School of Life Sciences at Tsinghua University, a one-and-a-half year basic medicine course at the School of Basic Medicine at PUMC, and a three-year, four-month clinical medicine program (including practical training and internship) at PUMC Hospital (PUMCH, a primary hospital in China).
and other CAMS/PUMC-affiliated hospitals. The final part of the curriculum is an eight-month research training program. Since 1995, an M.D./Ph.D. program has been available for medical students wishing to voluntarily extend their biomedical research training for an additional three years. Most graduates from PUMC enter clinical residency training programs at top tertiary hospitals in China or overseas.

The School of Nursing has a four-year B.S. program that provides exceptionally qualified graduates who begin their nursing career at CAMS/PUMC hospitals and other medical facilities. The nursing school also offers Master’s and Ph.D. programs.

PUMC, thanks to funding from the Chinese government and nongovernmental organizations like the China Medical Board, has maintained its position over the past decade as a top educational institution by initiating a series of programs for faculty/staff training and curriculum remodeling. The ongoing educational reforms at PUMC focus on elevating the professional competency of both students and teachers, with the overarching goals of integrating science and the humanities, encouraging professional development through a lifetime of learning and research, and inspiring critical thinking and innovation. The updated courses are designed to support the students' career development and prepare graduates for future global health challenges. Starting in 2012, medical students in their sixth year at PUMC could be offered a one- to two-month international observership at a leading foreign medical institution. As part of this program, PUMC actively collaborates with a number of prestigious medical institutions around the world to facilitate faculty and student exchanges.

PUMC Schools

PUMC is made up of seven schools established between 1921 and 2014. These are the School of Clinical Medicine (PUMCH, established in 1921), the School of Basic Medicine (Institute of Basic Medical Sciences, 1978), the School of Continuing Education (1984), the Graduate School (1986), the School of Public Health (1989), the School of Nursing (1996), and the School of Humanities and Social Sciences (2014). Each of these schools has unique characteristics and achievements, as outlined below.

School of Clinical Medicine

The Faculty of Clinical Medicine at PUMCH emphasizes basic principles, sound treatment methodologies, and independent thinking. As it works toward recognition as a world-class institution, the hospital continues to contribute to the rapid growth of China's health care system and to play a unique role in the advancement of medical education there.

The medical residency system, which focuses on learning through clinical practice, is at the core of postgraduate education at PUMC. For several decades, the hospital has trained outstanding medical professionals who have become leaders in the development of medical science in China. Since its founding, PUMCH has adhered to a clear set of educational principles for cultivating talent: Students in the classroom must be attentive to basic theories, basic knowledge, and basic skills (the "three basics"); and when involved in work and research they must maintain a serious attitude, follow strict requirements, and adhere to meticulous methods. Such a teaching model has since been followed by other medical colleges in China and has become part of their basic clinical training requirements.

The Faculty of Clinical Medicine maintains a small-scale enrollment model, valuing a strict teaching philosophy that produces quality graduates. The goal of the undergraduate program is to enrich the students' knowledge base while building their practical skills, utilizing a tutorial system for clinical teaching in which students receive one-on-one guidance to ensure that they learn in accordance with their aptitude. A concerted effort has been made to provide "open-door" teaching and encourage international student and lecturer exchanges.
School of Basic Medicine

Reorganized in 1978, PUMC’s School of Basic Medicine plays an essential part in Chinese medical education. The school was among the first in the country to grant an eight-year M.D. degree as well as Master of Science and Ph.D. degrees. There are 48 Ph.D. advisors and 31 Master's advisors at the school, serving more than 400 graduate students. Postdoctoral training programs approved by the Ministry of Education are available in biochemistry, molecular biology, pharmacology, cell biology, medical genetics, biophysics, immunology, and pathology and pathophysiology.

The School of Basic Medicine consists of 14 academic departments and the National Key Laboratory of Medical Molecular Biology. It is engaged in both biomedical research and advanced medical education, and has a faculty of 117 full professors and associate professors, including 3 members of the Chinese Academy of Sciences, 3 members of the Chinese Academy of Engineering, 4 specially appointed Cheung Kong Scholar professors, and 10 professors who have won the Outstanding Young Scientists Award from the National Natural Science Fund.

School of Continuing Education

The School of Continuing Education plays an important role at PUMC. Founded in 1984, it now offers degree programs for adult students, a self-taught higher education examination program, and continuing medical education programs, among others.

The school has degree and nondegree programs for both full- and part-time students. Part-time students can obtain bachelor’s degrees or enroll in nondegree programs in nursing, medical imaging, and medical laboratory technology. Continuing medical education programs are available for hospital managers and medical residents, as are many other specialized training programs. There are currently 12 national continuing medical education training centers at the school offering programs in cardiovascular diseases, plastic surgery, gynecology, skin diseases, sexually transmitted diseases, and oncology. More than 10,000 professionals are trained at these centers each year.

PUMC’s distinguished faculty, solid scientific research capabilities, and advanced medical technology provide a solid ground for continuing medical education in the 21st century.

Graduate School

Graduate education at PUMC started in 1954, but was suspended in 1965 during the Cultural Revolution. In 1978, PUMC was once again allowed to enroll graduate students, being one of a select group of institutions approved by the State Council to grant Master’s and doctoral degrees. It also organized examinations separate from those of other Chinese universities and was approved to enroll students from Hong Kong, Macau, and Taiwan. In 1982, the first Academic Appraisal Committee was established, and the first Master’s and doctoral degrees were granted in 1982 and 1985, respectively.

Today there are more than 3,900 graduate students at PUMC. More than 16,000 graduate students have completed their studies over the past two decades, among whom 7,200 earned Master’s degrees and 7,000 earned doctoral degrees. These graduate students have made important contributions to the development of health, sciences, technology, and education in China.

PUMC grants doctoral and Master’s degrees in medicine, natural science, engineering, management, and the philosophy of medicine. The Graduate School offers a remarkably broad range of research disciplines including basic medicine, clinical medicine, biology, pharmacology, public health and preventive medicine, integrated traditional and Western medicine, stomatological medicine, public administration,
biomedical engineering, library science, information and archives management, and the philosophy of science and technology, among others.

The Graduate School aims to embody PUMC’s school motto: “Rigorousness, Erudition and Expertise, Creation, and Devotion.” It will continue to take on the task of cultivating medical talent, furnishing comprehensive research facilities, and fulfilling PUMC’s goal of providing high-level, research-oriented, and internationally recognized health care.

School of Public Health

PUMC’s strong emphasis on preventive medicine and public health dates back to the 1920s, when John B. Grant chaired its department of public health. In 2014, the new Peking Union School of Public Health (PUSPH) was established, with the mission of conducting interdisciplinary, innovative, translational research that can inform policy, improve community health, and educate future public health leaders.

The school has five departments: biostatistics and epidemiology; health policy and management; nutrition, food, and drug safety; environmental and occupational health; and behavioral sciences and health communication. Mirroring PUMC’s professional education tradition, PUSPH offers Master’s and doctoral degrees in public health, epidemiology, social medicine, and health management, among others. It has both full-time programs for students and part-time programs for in-service staff. The school is well known for its senior health-executive education programs, which are helping to educate a critical mass of national and provincial policy makers and administrators. The school is also carrying out a series of educational reform programs, including PUMC’s first online course on health systems.

PUSPH has been engaged in a series of important research studies, such as developing healthy countrywide indicators, establishing China’s innovative elderly care models, drafting China’s first Essential Health Law, participating in a big-data intervention study on noncommunicable disease controls, and undertaking China’s first national hospital performance evaluation. All of this work has helped to inform China’s public health policy and practice.

PUSPH pays keen attention to international collaborations. It has signed memoranda of understanding covering faculty and student exchanges and conducted collaborative research with some of the world’s leading universities, including the Harvard T. H. Chan School of Public Health in the United States, the University of Toronto in Canada, and the University of Melbourne and Griffith University in Australia.

By mobilizing faculty resources across relevant research institutes, teaching hospitals, and departments at CAMS/PUMC, and developing a strong network of domestic and global partners, PUSPH is striving to become a new center of excellence in public health education and research in China and worldwide.

School of Nursing

In 1920, PUMC became the first institution to offer higher nursing education in China. In 1993, under the aegis of the Ministry of Health and the Ministry of Education, the School of Nursing began offering Master’s degrees in nursing, launching its doctoral program in 2004. The school is highly regarded in the field and is seen as the model for nursing education in China. Among the graduates are outstanding scholars and specialists in the areas of nursing administration, nursing education, clinical nursing, and public health administration. Six graduates have been awarded the Florence Nightingale Medal, the highest honor that can be bestowed in the nursing profession. Xiuying Wang, the first person to win the medal in China, graduated from the school in 1931.

The reform of nursing education was the impetus
behind both the building and continuing development of the School of Nursing. In 1996, the school was the trial arena for a national education reform project led by the Ministry of Education. The project’s goals were to carry out a systematic, comprehensive reform of China’s graduate-level nursing education, reorganize teaching content to focus on biology, psychology, and sociology, and explore the possibility of establishing a curriculum specific to undergraduate nursing education. In 2001, the project was awarded second prize at the National Teaching Achievement Award and first prize at the Higher Education Teaching Achievement Awards in Beijing.

In 1999, under the leadership of the Ministry of Education, the school undertook a new project entitled “Research and Practice on Reforming Nursing Professional Teaching Models in The 21st Century,” which focused on teaching theory, systems and strategies, faculty, textbooks, and other teaching materials. The project was awarded second prize at the Higher Education Teaching Achievement Awards in Beijing in 2004.

The School of Nursing has an outstanding faculty. Sixteen teachers hold doctoral degrees in nursing and 5 have Master’s degrees in nursing or nursing-related fields. There are also 10 Master’s tutors and 3 doctoral tutors. At present, the school has 40 Master’s degree candidates and over 600 undergraduates. It hosts a dozen workshops each year and has trained close to one thousand nurses.

The school has always maintained strong relationships with prominent universities, including (in the United States) the University of Texas Health Science Center at Houston and John Hopkins University in Baltimore, as well as Hong Kong Polytechnic University and the Chinese University of Hong Kong. These institutions offer significant assistance in the advanced training of nursing specialists. Every year, the school chooses five to eight teachers to study abroad as visiting scholars and invites 20 to 30 distinguished foreign nursing specialists to give lectures in China.

Having built a strong legacy, the School of Nursing retains its character while promoting rigorous scholarship and research and ensuring quality education. It has contributed significantly to the training of nursing staff with skill and integrity. Oriented to small-scale enrollment while maintaining high standards, the School of Nursing is poised to become a world-class institution dedicated to public health and the well-being of Chinese society.

School of Humanities and Social Sciences
The School of Humanities and Social Sciences at PUMC was established in July 2014, with Xiaomei Zhai as its first dean. The school evolved out of the Division of Education Office of Marxism and Leninism at PUMC, founded in 1952, which later became known as the Division of Political Ideology Education and the Division of Education for Social Sciences PUMC (1978). The division had four directors between 1952 and 2014: Renzong Qiu (1959–1968), Yu Lu (1978–1984), Lina Lu (1984–2002), and Xiaomei Zhai (2002–2014). The school comprises four departments: the Department of Two Courses (Political Theory and Ideological Morality); the Department of Philosophy of Medicine, Medical History and Social Medicine; the Department of Bioethics and Health Law; and the Department of Foreign Languages and Literature.

The school serves students at a variety of educational levels, offering Master’s and doctoral degrees, undergraduate programs, and courses for nursing students seeking college and associate degrees. Notably, the school confers Master’s and Ph.D. degrees in bioethics and runs the Center for Bioethics, which is affiliated with CAMS/PUMC and focuses on training in cross-institutional and interdisciplinary research.
research, policy consultancy, and social services. The school and the center have received grants at the international, national, ministerial, and university level, and also boast international collaboration programs.

One of the school’s international partnerships is a joint program with UNESCO (United Nations Educational, Scientific and Cultural Organization) to bring experts in ethics training to educate university faculty across China. As part of this program, a translation of the World Health Organization (WHO) publication *Casebook on Ethical Issues in International Health Research* is being published in China. The school has established international collaboration with institutions and universities in the United States, including the National Institutes of Health, the University of Chicago, the Kennedy Institute of Ethics at Georgetown University, Harvard University, the University of Pennsylvania, and Johns Hopkins University, as well as the University of Bergen in Norway and the National University of Singapore. Faculty members from the school also serve as expert members of international organizations, including the Human Genome Organization, WHO, and the Hinxton Group.

In addition to their teaching commitments, the school’s faculty serve academic and professional associations. These faculty include the vice president of the National Medical Ethics Committee, a member of the expert committee of the National Health and Family Planning Commission, a member of the National Organ Donation and Transplantation Committee, and the director of the bioethics committee of the China Association for Science and Technology. The school strives to foster interdisciplinary research in the social sciences and humanities and to enhance academic collaboration. Its goal is to become an interdisciplinary research and education center that advances the study of humanities in China.
CHAPTER SIX

International cooperation

The Chinese Academy of Medical Sciences (CAMS) and Peking Union Medical College (PUMC) have been part of the world medical arena since their founding in 1956 and 1917, respectively. They have both withstood numerous changes and challenges over the decades. In their medical and pharmaceutical research, education, and medical practice, CAMS and PUMC maintain close ties with prominent medical colleges and research institutions around the world. For example, from 1917 to the present, PUMC has invited more than 246 world-class scholars and experts to be honorary professors or visiting professors and to share their insights and vision with its faculty and researchers. Among these are former China Medical Board President Buchanan Schwartz, Former U.S. President Bill Clinton, former World Health Organization (WHO) Director-General Lee Jong-Wook, Thai Princess Sirindhorn, and many Nobel Prize winners, including Bengt I. Samuelsson, Harold Varmus, Bruce Beutler, and J. Michael Bishop.

Recognized both nationally and internationally, CAMS and PUMC enjoy numerous collaborative learning and research relationships with their counterparts and colleagues throughout the medical world. Over the past decades, they have led or been involved in an increasing number of important cooperative projects. The benefits are evident in the joint research centers and laboratories, academic conferences, and international scientific projects that have resulted, as well as in educational and scientific exchange programs. Some of their accomplishments are listed below:

- CAMS and PUMC are involved in cooperative projects with numerous medical science research institutes in developed countries. Joint projects and high-profile academic conferences focus mainly on a broad range of subjects including cancer, cardiovascular disease, new drug development, and infectious disease control and prevention.
- The U.S. National Institutes of Health (NIH) is a close partner of CAMS and PUMC. Since the 1980s, a number of CAMS institutes have worked with the National Cancer Institute (NCI) and National Heart, Lung, and Blood Institute (NHLBI). Among their numerous significant joint achievements are the Nutrition Intervention Trials run by the Cancer Hospital and
NCI in China’s Linxian County, the Early Detection of Esophageal Cancer program, and the Early Detection and Prevention of Lung Cancer project with tin miners in Yunnan Province, which has been ongoing for over 30 years.

• The China–Harvard Medical School (HMS) Translational Medicine Consortium was established in 2012. It arose from concerted efforts by CAMS and PUMC, Fudan University, Shanghai Jiaotong University Medical College, and HMS. Thanks to the consortium, top-level scientists are applying their efforts to prospective clinical studies of patients suffering from cancer, diabetes, or immunologic diseases.

• CAMS and the University of Oxford have collaborated in the China Kadoorie Biobank. The project started in 2004, and is funded for 15 to 20 years. It aims to investigate the main genetic, environmental, and lifestyle causes of common chronic diseases (such as stroke, ischemic heart disease, cancer, and diabetes) in the Chinese population through the establishment of a blood-based baseline health database. This database will provide a new scientific basis for the formulation of chronic disease control and prevention strategies and the development of new treatment and intervention measures.

• The CAMS-Oxford International Centre for Translational Immunology (CTI) is a joint venture that began in 2013 between CAMS and the Nuffield Department of Medicine in Oxford, United Kingdom. The center carries out hypothesis-driven clinical trials based on a close collaboration between clinicians and basic science researchers with the aim of improving the treatment of cancer and chronic viral infections. Under the cooperation framework, CAMS and Oxford take turns holding an annual CTI Symposium.

• The Chinese Academy of Engineering, CAMS, and PUMC, together with the French National Academy of Medicine, jointly launched the China–France Collaboration on Emerging Infectious Diseases in 2009. The program involves a comparative study on control and prevention of emerging infectious diseases in France and China, in an effort to identify lessons for China. The collaborating institutions take turns holding the China–France medical seminars.

• CAMS and PUMC joined Assistance Publique-Hôpitaux de Paris in 2013 in a collaboration on hospital management training, clinic management training, and faculty and student exchanges, which has led to hundreds of exchange visits between these institutions.

• CAMS and PUMC are collaborating with the Baycrest Center for Geriatric Care in Toronto, Canada. Canada started the CAMS-Baycrest Geriatrics Collaboration program in May 2012. It is a study of policies addressing treatment of the aged and the training of geriatric physicians and caregivers in China. PUMC has sent dozens of graduate students and nursing school students for clerkships at Baycrest.

• CAMS and Danish company Novo-Nordisk signed a cooperation contract in 2010 to collaborate on research into the health and economic impacts of diabetes on the Chinese population, and to set up the CAMS Diabetes Mellitus Research Center and Novo Nordisk Union Diabetes Research Talent Fund. With the help of these organizations, researchers can get invaluable help to develop projects of mutual interest addressing diabetes.

• CAMS and PUMC have hosted a number of successful international events. For example, in August 2015 the
China-Sweden Cardiovascular Disease Summit was cohosted in Beijing by CAMS and the Karolinska Institute. More recent events include forums in China with the publishers of such noted journals as *The Lancet* and *Cell*, among them *The Lancet*-CAMS Health Summit and *Cell* Symposium, “Hallmarks of Cancer: Asia.”

- The Global Alliance for Chronic Diseases (GACD) was set up in 2009. It is the first collaboration of major research funding agencies to specifically address chronic noncommunicable diseases (NCDs). It funds joint programs investigating lifestyle-related chronic diseases such as cardiovascular disease, diabetes, certain cancers, lung disease, and mental illness. As its only representatives for China, CAMS and PUMC have played a key role in GACD and support it financially, together with other funders of public health research such as NIH and the United Kingdom’s Medical Research Council. The alliance coordinates and supports research activities that address the prevention and treatment of chronic NCDs on a global scale. The president of CAMS and PUMC, Xuetao Cao, served as its chair in 2014–2015.

- CAMS and PUMC maintain five WHO collaborating centers, and are an official member of the Heads of International Research Organizations and the M8 Alliance of Academic Health Centers, Universities and National Academies.

- CAMS and PUMC provide medical assistance to developing countries. In June 2015, CAMS and PUMC signed a memorandum of understanding with France’s Foundation Mérieux to collaborate on infectious disease research in Africa. In November 2015 they signed a tripartite agreement with Foundation Mérieux and Le Centre d’Infectiologie Charles Mérieux du Mali (CICM) to work in joint laboratories to study infectious diseases, pneumonia, and febrile diseases in Africa, and to do research on virus diversity. In July 2016, CAMS and PUMC signed a memorandum of understanding with the South African Medical Research Council and the African Cancer Institute at Stellenbosch University.

- In 2016, CAMS and PUMC signed a memorandum of cooperation with the Weizmann Institute of Science in Rehovot, Israel, to collaborate on hematopoietic stem cell research and academic exchanges.

Student exchange programs at CAMS and PUMC were initiated in 1986. The past 30 years have seen dozens of exchange agreements signed, and eligible senior medical students from PUMC have spent one to two months overseas as observers at leading medical universities and institutions, including Harvard University, the University of California, San Francisco, and the University of Chicago in the United States; the University of Melbourne in Australia; Baycrest Global Solutions in Canada; and the Chinese University of Hong Kong, among others. These opportunities broaden the international horizon of both the students and faculty, and build bridges between the medical world in China and its overseas counterparts that will benefit the health of people both at home and abroad.
Peking Union Medical College Hospital

Peking Union Medical College Hospital (PUMCH) is a top comprehensive hospital in China committed to state-of-the-art clinical care, innovative scientific research, and rigorous medical education. PUMCH was designated by the National Health and Family Planning Commission as a national referral center to provide diagnostic and therapeutic care for complex and rare disorders. It was one of the earliest Chinese hospitals to offer medical care to foreign patients. PUMCH is well known for its disciplinary breadth, its cutting-edge technologies, and its outstanding specialists. It was number one in Fudan University Hospital Management Institute’s ranking of the best hospitals in China from 2009 to 2015.

PUMCH was founded by the Rockefeller Foundation in 1921. From the beginning, its founders intended that it become the best medical center in Asia. For more than 90 years, PUMCH has embodied the spirit of “precision, perseverance, diligence, and devotion” encapsulated in its motto, and has also fostered a culture of collaboration between East and West. It has nurtured the careers of many modern Chinese medical pioneers and trained generations of administrative personnel who have gone on to work across China.

Currently, PUMCH has two campuses in Beijing—near the eastern and western “arms” of the Forbidden City—totaling 530,000 square meters. It has more than 4,000 employees, including four academicians from CAMS and the Chinese Academy of Engineering. The hospital comprises 53 clinical and medical departments, 20 national key disciplines, and 29 national key clinical specialties. Its educational offerings include 16 doctoral programs, 29 Master’s programs, 6 national advanced medical education centers, and training courses for residents and specialists in a wide range of disciplines. It also serves as a national clinical research center for gynecology and obstetrics. PUMCH has 2,000 beds, and its staff handles up to 15,000 outpatient visits daily, discharging an average of 80,000 patients per year.

The hospital has received many honors from the national and municipal health authorities; it is responsible for the medical security of some of the country’s underdeveloped and remote areas, and also responds to national emergencies and catastrophic events. It won the “Special Contribution Award” from the Chinese government for its outstanding medical support for the 2008 Beijing Olympics.

PUMCH aims to provide its patients with the finest possible service, undergirded by a commitment to professional ethics and a rigorous academic attitude. Its goal is to be nothing less than the best hospital in China while maintaining its international renown.
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It is the leading domestic center for the diagnosis and treatment of a variety of tumors, such as lung, liver, pancreatic, colorectal, breast, uterine, cervical, esophageal, head and neck, and malignant lymphoma.

The Cancer Hospital

Originally called Ritan Hospital, the Cancer Hospital at the Chinese Academy of Medical Sciences (CAMS) and Peking Union Medical College (PUMC) was established in 1958. It was the first national hospital and remains the leader among all cancer hospitals in China. It is the National Quality Control Center for Cancer Diagnosis and Treatment of the National Health and Family Planning Commission (NHFPC), the National Clinical Research Center for Cancer named by the Ministry of Science and Technology, and has also been certified by the China Food and Drug Administration as a medical institution that can conduct clinical trials for human drug therapies. The CAMS Cancer Hospital (CCH) integrates medical care, education, research, and prevention to address all aspects of cancer prevention, diagnosis, and treatment.

The clinical and technological departments of CCH cover a wide range of subject areas with technical sophistication, advanced equipment, and a superb medical environment. The numbers tell the story:

Currently there are 15 clinical departments and 9 medical technology departments that treat patients through radiation therapy, surgery, chemotherapy, interventional therapy, biological therapy, and other methods.

The National Center for Cardiovascular Diseases

Established in August 2011, China’s National Center for Cardiovascular Diseases (NCCD) has a broad mission to develop national programs, conduct policy studies, and formulate guidelines, technical specifications, and standards for the prevention and treatment of cardiovascular diseases. It is setting up national key systems to monitor and follow up those people exposed to environmental and behavioral risk factors for these diseases. It also provides an annual analysis of the prevention and treatment of cardiovascular diseases as well as a prediction of relevant trends involving disease onset and mortality, burden of disease, prevalence of risk factors, and development trends. Additionally, the center is building a national network to demonstrate and promote effective methods for preventing disease and exploring modes of health management for disease prevention and treatment. It holds training sessions on basic research, clinical practices, and prevention and control measures, as well as facilitating academic exchanges and international cooperation in the cardiovascular sciences.

Fuwai Hospital

Built in 1956, Fuwai Hospital is a specialized facility and one of the world’s largest centers for the diagnosis and treatment of cardiovascular diseases. It has a reputation for dealing with difficult and complicated conditions, and encompasses medical education, research, and disease prevention and treatment. It is the home of the NCCD and the State Key Laboratory of Cardiovascular Disease. Due to its quality of medical care, Fuwai Hospital has been ranked number one in China since the hospital ranking system was initiated, both for its Department of Cardiovascular Medicine and Department of Cardiovascular Surgery.

The National Center for Cardiovascular Diseases

Established in August 2011, China’s National Center for Cardiovascular Diseases (NCCD) has a broad mission to develop national programs, conduct policy studies, and formulate guidelines, technical specifications, and standards for the prevention and treatment of cardiovascular diseases. It is setting up national key systems to monitor and follow up those people exposed to environmental and behavioral risk factors for these diseases. It also provides an annual analysis of the prevention and treatment of cardiovascular diseases as well as a prediction of relevant trends involving disease onset and mortality, burden of disease, prevalence of risk factors, and development trends. Additionally, the center is building a national network to demonstrate and promote effective methods for preventing disease and exploring modes of health management for disease prevention and treatment. It holds training sessions on basic research, clinical practices, and prevention and control measures, as well as facilitating academic exchanges and international cooperation in the cardiovascular sciences.
It has a high-energy, two-photon medical linear accelerator, equipment for intensity-modulated radiation therapy, positron emission tomography–computed tomography, digital subtraction angiography, an automatic biochemical analyzer, nuclear magnetic resonance equipment, a radiofrequency hyperthermia machine for treatment of tumors, an image-guided linear accelerator, flow cytometers, and other advanced equipment.

It serves 57,000 inpatients and 793,000 outpatients annually. Approximately 19,000 surgical operations were performed in 2015.

There are 2,114 employees, including 400 professors and associate professors, three academicians of the Chinese Academy of Sciences, and four academicians of the Chinese Academy of Engineering.

CCH has a strong research force with more than 20 laboratories for basic research and connections to the State Key Laboratory of Molecular Oncology and two Beijing key laboratories. It is one of the first state-level centers for continuing medical education and standardized training for resident doctors approved by NHFPC. It was selected by the U.S. National Institutes of Health (NIH) as the first bilateral joint-development site for the study of cancer epidemiology for international students. It has teaching responsibility for doctoral degree students, Master’s degree students, overseas students, and in-service training—supplying a large proportion of talent to the national cancer prevention and treatment effort. It currently has 4 postdoctoral training programs, 10 doctoral degree programs with 66 advisors, and 12 Master’s degree programs with 112 advisors. Since the hospital was established, 769 Ph.D.s and 1,003 Master’s degree students have graduated, and 52 postdoctoral fellows and 6,220 in-service doctors have been trained there. A joint training program for international students was launched in 2008, which has trained 18 students.

CCH is linked to other institutions including the National Cancer Center (NCC), the Cancer Foundation of China, the Chinese Society of Clinical Oncology, and also to the editorial offices of the Chinese Journal of Oncology, the Chinese Journal of Radiation Oncology, and Cancer Frontier. The hospital is undertaking studies of early diagnosis and treatment of cancers in urban areas—which incorporates the National Central Cancer Registry—and also holds the NCC Conference each year as a national opportunity for academic exchange.

CCH participates actively in international medical exchange activities. It has established cooperative relationships with the United States, the United Kingdom, Japan, France, Italy, Egypt, Iran, Brunei, South Korea, Pakistan, Bangladesh, Mongolia, Vietnam, Thailand, and Singapore, among other countries. The hospital has signed strategic cooperation agreements with the National Cancer Institute of NIH, the Mayo Clinic, the Ronald Reagan UCLA (University of California, Los Angeles) Medical Center, and UCLA’s Jonsson Comprehensive Cancer Center.

Research focus and progress
Cancer is the leading cause of death in China and therefore a major public health problem. Not only have cancer incidence and mortality increased significantly, but more young people are getting cancer. To improve the national cancer control system and mode of diagnosis and treatment, CCH conducts interdisciplinary research on cancer prevention, diagnosis, and treatment, which includes basic medical research such as cancer epidemiology, molecular oncology, cellular genetics, and tumor etiology; clinical research such as pathology, imaging diagnosis, surgery, medical oncology, and radiation research; and innovative anticancer drug research and development. Some specific achievements in these areas are outlined below.

Cancer epidemiology studies
Using high-quality data from a number of population-based registries now available through the National Central Cancer Registry of China, studies indicate that in 2012 there were 3.6 million new cancer cases and 2.2 million cancer deaths in China, with lung cancer being the most common and the primary cause of cancer death. Stomach, esophageal, and liver cancers were also commonly diagnosed and identified as leading causes of cancer death. Residents of rural areas had significantly higher age-standardized incidence and mortality rates for all cancers than urban residents. For all cancers combined, incidence rates for males were stable from 2000 through 2011, whereas these rates increased significantly among females. In contrast, the mortality rates since 2006 have decreased significantly for both males (−1.4% per year; \( P<0.05 \)) and females (−1.1% per year; \( P<0.05 \)). Many potential cancer cases and deaths can be prevented by reducing risk factors while increasing the effectiveness of clinical care delivery, particularly for those living in rural areas and those in disadvantaged populations (1).
Early diagnosis and prevention of cancer

The scientists at CCH are making significant advances in early cancer diagnosis and prevention. A long-term cohort study focused on the effect of endoscopic screening and intervention programs on the incidence and mortality of esophageal squamous-cell carcinoma (ESCC). It showed that endoscopy with iodine-stain screening and index biopsy methods, combined with early treatment of precancerous lesions and early stage tumors, significantly reduced ESCC mortality. Detection and treatment of preneoplastic lesions also led to a reduction in the incidence of this highly fatal cancer in high-risk areas in China (2). A pooled analysis of a self-sampling human papillomavirus (HPV) DNA test showed that the sensitivity of self-HPV testing compared favorably with that of liquid-based cytology and was superior to the sensitivity of visual inspection enhanced with acetic acid application. Self-HPV testing may complement current screening programs by increasing population coverage, especially in locations without easy access to comprehensive cytology-based screening. It will also provide the most viable primary option to improve the effectiveness of screening, particularly in low-resource settings (3). A population-based, cluster, randomized, controlled trial of hepatitis B virus (HBV) vaccination conducted in Qidong demonstrated that neonatal HBV vaccination significantly decreased the hepatitis B surface antigen (HBsAg) seroprevalence in childhood through young adulthood, and subsequently reduced the risk of primary liver cancer and other liver diseases in young adults in rural China. This work also suggests that an adolescence booster should be considered in individuals born to HBsAg-positive mothers and who have completed the HBV neonatal vaccination series (4).

Molecular oncology research

Researchers at CCH have made a number of breakthroughs in the study of cancer genomics, cancer genetics, and cancer etiology. They performed whole-genome sequencing (WGS), whole-exome sequencing, and targeted deep sequencing analyses to detect genetic aberrations in gene-coding regions in paired ESCC samples. WGS, array comparative genomic hybridization, and single nucleotide polymorphism array analyses were also performed to examine somatic copy number alterations in 324 paired ESCC cases. The ESCC samples were from northern and southern areas in China, regions with a high prevalence of ESCC. Scientists at the hospital identified many mutated genes, of which some were well-known tumor-associated genes (TP53, RB1, CDKN2A, PIK3CA, NOTCH1, NFE2L2), while others had not previously been associated with ESCC (ADAM29, FAM135B, ZNF750, and AJUBA). Further analysis of the aberrant genes yielded a number of therapeutic target candidates, including the epidermal growth factor receptor gene (5-7).

ESCC is one of the most common cancers in the world, and about 50% of cases occur in China, where it ranks as the fourth most common cause of cancer-related death. The etiology of ESCC remains unclear. Epidemiological studies suggest that tobacco smoking, heavy alcohol drinking, micronutrient deficiency, and dietary carcinogen exposure may be involved in causing this malignancy. However, only a portion of exposed individuals develop ESCC, indicating that an individual’s genetic makeup may also play an important role. Recently, efforts using genome-wide association studies have identified 14 genetic susceptibility factors for ESCC. These 14 variants have a remarkable cumulative effect on ESCC risk, and some of them have a significant gene-environment interaction with smoking or drinking. These findings highlight the involvement of multiple genetic loci and gene-environment interaction in the development of ESCC (8-9).

Clinical therapy and treatment of cancer

Research over the past few decades has significantly advanced clinical therapy and cancer treatment. The scientists at CCH demonstrated that radiotherapy is a curative, primary therapy for early-stage extranodal natural killer/T-cell lymphoma (NKTCL), nasal-type, with a five-year overall survival (OS) of 71% (10). Furthermore, based on a multicenter study, a prognostic model was developed that provides an individualized risk estimate of OS for patients with NKTCL (11). It allows for risk-adapted therapy, such as radiotherapy alone, for low-risk early-stage patients, and radiotherapy plus chemotherapy for high-risk early-stage patients (12). According to a randomized, double-blind, multicenter phase 3 trial, scientists found icotinib—the new oral epidermal growth factor receptor tyrosine kinase inhibitor (EGFR-TKI)—is noninferior to the existing EGFR-TKI, gefitinib, and shows lower incidence of drug-related adverse events than gefitinib in patients with non-small-cell lung cancer (NSCLC). Because of its favorable antitumor activity and relative lack of toxicity, icotinib has become a new treatment option for advanced NSCLC patients with EGFR mutations (13).

References

The Plastic Surgery Hospital

The Plastic Surgery Hospital (PSH) of CAMS and PUMC was founded in 1957 by a group led by Ruyao Song, a noted plastic surgeon. The cradle of Chinese plastic surgery, it was the first center to offer patient care, teaching, and research in the field. Currently the hospital has more than 700 employees, including 174 physicians. It performs more than 40,000 plastic and reconstructive surgeries, handling nearly 140,000 outpatients annually. The hospital has established more than 20 subspecialty centers, including centers for cleft lip and palate repair, auricular reconstruction, craniomaxillofacial surgery, burn surgery, breast surgery, hypospadias repair surgery, rhinoplasty, hair transplantation, and laser surgery.

Clinical work at PSH focuses on developing innovative surgical techniques for repairing organ disorders and for the treatment of disease- or trauma-related tissue damage. Hospital doctors have used pre-expanded skin flaps combined with autologous cartilage to reconstruct auricular defects in nearly 20,000 microtia patients (Figure 1). They have also developed new surgical techniques for treating cleft lip, such as a “group configuration” for muscle tension lines as the key to correcting the nasolabial appearance, optimizing outcomes in nearly 10,000 cases (Figure 2).

Other innovations include using scrotal septal neurovascular pedicle island skin flaps to repair hypospadias in a single step. Ruyao Song popularized the use of the forearm skin flap, later called the “Chinese flap,” for flap and reconstructive microsurgery. Since its clinical application was first reported in 1984 by Yeguang Song at PSH, the anterolateral thigh flap has become one of the most widely used flaps in traumatic and oncological reconstruction.

With the recent growth of China’s economy, cosmetic surgery has become increasingly common. In the field of cosmetic maxillofacial surgery, gonioplasty, L-shaped zygomatic osteotomy, and the implantation of coral as artificial bone into the separated mandibular cortex have been used to reshape facial contours. In mammoplasty, a freestyle endoscopic dissection technique was developed to perform transaxillary augmentation mammoplasty and has been used in over 1,000 cases.

PSH regularly conducts basic and clinical research relating to plastic surgery. Preliminary clinical studies are underway to explore using tissue-engineered bone to treat alveolar cleft, and tissue-engineered cartilage to construct human auricular and nasal cartilage, providing alternative therapeutic strategies for orthopedic diseases in which bone and cartilage tissues are lacking. In the area of stem cells and tissue regeneration, PSH researchers have systematically investigated the biological characteristics of stem cells isolated at different developmental stages and from different tissue sources and cellular microenvironments, and have explored the use of adipose tissue-derived mesenchymal stem cells in plastic surgery. They are currently investigating the coordinated behavior of skin-derived stem cells during skin development and regeneration.
Patients with congenital disorders are commonly seen in PSH. The hospital has established biological specimen banks for these disorders and used big data analysis to make precise genotype-phenotype correlations for these diseases. Recently, clinical investigators at PSH used genome-wide association studies to identify a number of genetic loci related to craniofacial microsomia. Human embryonic stem cell-derived neural crest cells were also employed to study the molecular mechanisms behind congenital disorders induced by teratogenic factors including drugs and chemicals.

As one of the PUMC teaching hospitals, PSH has educated over 600 postgraduate students in plastic surgery, anesthesiology, and cellular and molecular biology, and trained more than 3,000 plastic surgery fellows from around the world. In the last decade, the hospital has conducted 129 research projects, obtained 91 national patents, and published more than 500 peer-reviewed papers. The editorial office of the Chinese Journal of Plastic Surgery, a leading research journal in the field in China, is located in the hospital. With the understanding that plastic surgery is both a science and an art, doctors and researchers at PSH are committed to exploring innovative approaches to improve the quality of the medical services they provide.

The Institute of Basic Medical Sciences

Established in 1978, the Institute of Basic Medical Sciences (IBMS) of CAMS also serves as the School of Basic Medicine for PUMC. IBMS was formed by merging the Institute of Experimental Medicine of CAMS (founded in 1958) and the basic medical science departments of PUMC (founded in 1921). Devoted to excellence in both biomedical research and advanced medical education, IBMS now consists of 13 academic departments, the State Key Laboratory of Medical Molecular Biology, a National Cell Resource Center, and a National Experimental Teaching Demonstration Center of Basic Medicine, with a faculty of 126 full or associate professors including three members of the Chinese Academy of Sciences and three members of the Chinese Academy of Engineering.

The scientific research programs at IBMS are focused on basic and translational medical research in fields including functional genomics, epigenetics, proteomics, molecular immunology, and human molecular genetics. Using the approach of integrated systems biology, research efforts aim to study diseases at the molecular, cellular, tissue, organ, and individual level, and to provide the scientific basis for novel strategies in the early detection, prevention, and treatment of major diseases in China.

Since the start of the 11th Five-Year Plan (2006–2010), more than 100 research projects at IBMS have been sponsored by national scientific research funding programs. Faculty from IBMS have published more than 1,800 papers in leading international scientific journals.

IBMS has recently made remarkable progress in multiple projects involving R&D of diagnostic assays, genetically engineered drugs, traditional Chinese medicine, and biomedical polymers, and has established collaborations with more than 20 pharmaceutical companies in China and abroad. Since 2006, IBMS has been granted 69 patents. Currently there is one clinical trial in progress. IBMS also plays an essential role in medical education at PUMC.

With support from the Ministry of Science and Technology and the National Health and Family Planning Commission, IBMS has established a series of state-of-the-art research centers. The Core Instrument Facility is equipped with the most advanced scientific instruments and staffed with those who have expertise in their applications, to serve the research community inside and outside the institute. The Cell Resource Center, accredited as a national research hub since 2011, offers a broad spectrum of cell line products and cell culture services for biomedical research. The newly renovated Experimental

Researchers from IBMS carrying out a medical study at the Zhongshan Station in Antarctica
Animal Center is a specific pathogen-free-certified animal laboratory equipped with advanced animal research tools and capabilities. The Histopathology Core Facility was recently established to promote translational medical research. IBMS also encompasses the Center for Proteomics, the Tissue Engineering Center, the Nanomedicine Center, the Center for Systems Medicine, the McKusick-Zhang Center for Genetic Medicine, the Center for Neuroscience, the Center for Bioethics, the Center for Medical Primate Animals, and the Immunotherapy Center.

IBMS aims to become a world-class institute and achieve excellence in biomedical research and advanced medical education. To that end, the institute has established long-term development plans and implemented a series of initiatives to facilitate innovation, integration, and efficiency. The faculty and staff members are encouraged to participate in institutional management. The Academic Committee, the Education Committee, and the Developmental Committee all play active roles in decision-making.

Scientific research

Immunity and inflammation

The fundamental function of the immune system is to identify and eliminate nonself-invading pathogens and rogue cancer cells by initiating innate and adaptive immune responses. Xuetao Cao’s laboratory focuses on understanding innate signaling during the inflammatory immune response and on identifying immune cell subsets and new molecules that play a role in the innate immune response and cancer immunotherapy. The laboratory has identified important mediators and regulators of innate signaling (1-3), and characterized immune subsets that have a regulatory function in immunity (4, 5), inflammation, and cancer (6, 7). These findings help illuminate the innate signaling in infection and inflammation, and provide new perspectives for the immunotherapy-based treatment of inflammatory diseases and cancer.

SIRT1 in aging and cardiovascular disease

Heart disease is the leading cause of death and disability in the world (8). Depei Liu’s group at IBMS has proposed that aging, a major risk factor for cardiovascular disease, operates in four layers, from an overall phenotype to a molecular mechanism (9). Studies from this group found that sirtuin 1 (SIRT1), a longevity factor and histone deacetylase, acts against atherosclerosis (10) and prevents hyperglycemia-induced endothelial dysfunction (11) and vascular aging (12). SIRT1 was also found to act as a modulator linking the coordinated responses to injury by vascular smooth muscle cells (13, 14). The results from this group show that SIRT1 can be a novel therapeutic target for the prevention of abdominal aortic aneurysm formation, vascular aging, and age-related vascular diseases.

PCBP2 as a novel potential biomarker of human gliomas

IBMS scientists have uncovered the oncogenic role of an RNA-binding protein in brain tumors known as gliomas (15, 16). They first observed increased expression of poly(C)-binding protein 2 (PCBP2) in human glioma tissues and cell lines. Decreasing its expression halted glioma cell growth both in vitro and in immune-compromised mice. They also showed that two other proteins—four-and-a-half limb domain 3 (FHL3) and Rho GDP dissociation inhibitor alpha (ARHGDIA)—are also found in gliomas. Curiously, the messenger RNAs (mRNAs) of these proteins are binding targets of PCBP2. Furthermore, the work demonstrated that PCBP2 regulates FHL3 expression by stabilizing its mRNA. Removal of PCBP2 inhibits proliferation and induces cell death or apoptosis of glioma cells by increasing FHL3 protein expression. PCBP2 binding of the ARHGDIA-3 untranslated region induces a local change in RNA structure that favors association with microRNA miR-151-5p/miR-16, efficiently suppressing ARHGDIA expression, which may strongly affect tumor migration and invasion.

Molecular basis of Mendelian disorders

The research groups led by Yan Shen and Xue Zhang focus on understanding the molecular basis of rare Mendelian disorders. They have discovered the causative genes for a dozen monogenic disorders. Shen’s group identified the first pathogenic mutation of the dentin sialophosphoprotein gene (DSPP) in dentinogenesis imperfecta Shields type II (17). Zhang’s group found that mutations in an upstream open reading frame of the hairless gene (HR) could cause Marie Unna hereditary hypotrichosis (18). The two groups jointly showed that loss-of-function mutations in the g-secretase component genes were associated with familial acne inversa, also known as hidradenitis suppurativa (19). In addition, genetic findings in Zhang’s group have established congenital generalized hypertrichosis syndromes as genomic disorders (20, 21).

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The Institute of Materia Medica

The Institute of Materia Medica (IMM) at CAMS and PUMC was founded in 1958. Its mandate is to discover and research innovative drugs for treating or preventing human diseases. IMM's scientists use the latest biomedical theories, cutting-edge technologies, and state-of-the-art clinical resources to develop drugs from botanical compounds, synthetic chemicals, and bioproducts.

Principle drug research efforts at IMM focus on cancer, cardiovascular diseases, neurodegenerative and psychiatric diseases, metabolic disorders, infectious diseases, and inflammation. IMM researchers have made significant contributions in phytochemistry, analytic chemistry, computer-aided drug design, molecular pharmacology, high-throughput screening, synthetic biology, and drug-delivery systems, and have had notable successes developing new drugs that serve patients in China and abroad.

The institute hosts the State Key Laboratory of Bioactive Substance and Functions of Natural Medicines and seven ministry-level key laboratories. The departments in IMM include synthetic medicinal chemistry, natural medicinal chemistry, pharmacology, pharmaceutical analysis, biosynthesis, drug screening, polymorphic drugs, drug delivery systems, drug metabolism, and new drug research and development. The Comprehensive Drug Platform funded by the National Science and Technology Major Project for Drug Innovation and Development is one of the very few state drug programs established by China's central government. Establishment of such programs has significantly enhanced IMM's research capabilities.

The institute has 495 faculty and staff members, of whom 123 are full or associate professors and 62 are principal investigators. Five scientists are academicians of the Chinese Academy of Sciences or the Chinese Academy of Engineering. IMM is housed on the main campus of the PUMC School of Pharmacy and provides training for senior pharmaceutical professionals and postdoctoral scientists. The Ministry of Education has classified pharmaceutical sciences at IMM as a national key discipline in medicine. IMM currently has more than 380 graduate students and has graduated 1,488 students to date, granting 782 doctoral and 706 Master's degrees.

Since the institute's establishment, its scientists have discovered or developed hundreds of new drugs and acquired 130 new drug certificates from the China Food and Drug Administration, including numerous innovative drugs such as butylphthalide, bicyclol and imrecoxib. IMM's contributors have won 286 awards from the government and professional societies for drug research and development, including 13 at the national level. Notably, IMM won the first prize in the 2015 National Science and Technology Progress Awards for its research on creating an artificial musk. IMM has published 7,777 academic papers and 349 monographs, and holds 277 approved patents.

IMM stresses translational research and development, and has two wholly owned enterprises: Beijing Union Pharmaceutical Factory and Beijing Union Second Pharmaceutical Factory. It is also the major shareholder of Beijing Lianxin Pharmaceutical Co. Ltd., Beijing Union-Genius Pharmaceutical Technology Co. Ltd., and Beijing Collab Pharma Co. Ltd.

IMM has established extensive partnerships and collaborations with pharmaceutical companies, universities, and research institutes worldwide, including in the United States, France, Japan, Germany, Spain, and Canada. IMM hosts the editorial offices of four scientific journals: Acta Pharmaceutica Sinica, Chinese Chemical Letters, the Journal of Asian Natural Products Research, and Acta Pharmaceutica Sinica B.

In the spirit of its motto, “Devotion, Innovation, Truth-Seeking, and Cooperation,” staff and faculty at IMM look forward to continuing their tradition of excellence in research, creating a sustainable future for Chinese medicine and the Chinese health care industry.
The Institute of Medicinal Biotechnology

The Institute of Medicinal Biotechnology at CAMS and PUMC was founded in 1958 as the Institute of Antibiotics, a national key institute for developing drugs to combat infectious diseases. As the birthplace of penicillin in China, the institute has a history of discovering and developing antimicrobials, nurturing researchers, and industrializing antibiotics. It has contributed significantly to the prevention and treatment of serious infectious diseases. As Chinese society changed and biological sciences advanced, the research fields encompassed by the institute were extended to include cancer, cardiovascular diseases, and immunoregulation. In 1987, the institute’s name was changed to its current moniker.

Today, the institute has 296 staff and faculty members—60 of whom are principal investigators—and 147 graduate students. Members of the faculty include an academician of the Chinese Academy of Engineering, two recipients of awards from the Cheung Kong Scholars Program from the Ministry of Education (MOE), two recipients of the Distinguished Young Scholars award from the National Natural Science Foundation of China (NSFC), and an NSFC Excellent Young Scientists Fund awardee. In addition, teams at the institute have received the Innovative Research Team in a University award from MOE and the Science Fund for Creative Research Groups award from NSFC. Over the past 15 years, the institute has become one of the primary centers of translational research, drug R&D, and biotechnology education in China.

Departments: The institute has 10 research departments: microbial chemistry, bioengineering, microbial pathway engineering, virology, pharmacology, cancer research, immunology, biochemistry, organic chemistry, and pharmaceutics. The ministerial or key laboratories affiliated with the institute include the China Pharmaceutical Culture Collection Center, the National Center for New Microbial Drug Screening of the Ministry of Science and Technology, the Key Laboratory of the Biotechnology of Antibiotics of the Ministry of Health, and the Beijing Key Laboratory of Anti-infective Agents.

Research areas: Research at the institute focuses on the discovery of drugs from microbes and plants and on biotechnology drugs, for the purpose of combatting infectious diseases, cancers, and metabolic disorders. Research areas include biotechnology, medicinal chemistry, microbiology, cell biology, bioengineering, microbial metabolites, synthetic biology, molecular pharmacology and target identification, chemical biology, drug metabolism and toxicology, drug formulation, and resources and informatics.

Scientific achievements: In the past 60 years, the institute has established more than 250 models used for lead compound drug screening, together with procedures for identifying new drugs. More than 90 new or generic drugs have been investigated. Of these, 60 drugs—including generic penicillin, kanamycin, gentamycin, griseofulvin, vancomycin, spiramycin, pingyangmycin, boanmycin, and the quinolones antibiotics—have been developed and are in clinical use in China. More than 50% of all novel antibiotics approved by the China Food and Drug Administration since 1950 originated at the institute. These include norvancomycin, pingyangmycin, and kelimycin. More than 90% of all novel antibiotics in China have been evaluated by the institute.

Since the beginning of the 11th National Five-Year-Plan in 2006, the institute has carried out approximately 300 research projects, including the National High-Tech R&D Program (863 Program), the National Basic Research Program of China (973 Program), the Grand Challenges in Global Health initiative (Gates Foundation/Foundation for the National Institutes of Health), the National Science and Technology Major Project on Infectious Diseases, and the National Science and Technology Major Project for Drug Innovation and Development. In recent years, the institute has been awarded more than 10 patents annually. In 2011, it won the National Science and Technology Progress Award for contributions to antimicrobial research, and in 2012 it was granted a National Natural Science Award for discovering the botanic compound berberine, a novel and safe lipid-lowering agent for patients with hyperlipidemia and type II diabetes. Each year, institute scientists publish approximately 80 papers in Science Citation Index-listed journals. The berberine research article, published in *Nature Medicine* in 2004, was considered one of the top innovative drug discovery studies in Chinese medicine. More recently, institute scientists published 10 academic books that are playing an important role in pharmaceutical research and education.
The Institute of Medicinal Plant Development

The Institute of Medicinal Plant Development (IMPLAD) and the Beijing Medicinal Plant Garden, affiliated with CAMS and PUMC, were established in August 1983. IMPLAD is located in the Zhongguancun Science and Technology Zone, Beijing, with branches in Yunnan, Hainan, Guizhou, and Hubei Provinces, Guangxi Zhuang Autonomous Region, Xinjiang Uygur Autonomous Region, and the city of Chongqing. One of the premier academic institutes in the world dedicated to medicinal plant research, IMPLAD is the only national research institution in China specializing in the protection, development, and utilization of medicinal plant resources. It plays a leading role in research on Chinese medicinal herbs and is a World Health Organization Collaborating Center for Traditional Medicine.

The current generation of IMPLAD researchers maintains the spirit of the institute’s founding motto, “Seeking truth and scientific development,” and is continuing its tradition of innovation. As was affirmed at the institute’s 30th anniversary in 2013, IMPLAD aims to be an innovator in the field of medicinal plant research and also to play a role in its rejuvenation. To that end, IMPLAD plans to unite medicinal plant gardens across China into a nationwide alliance and to create a national system of research on medicinal plants. The institute is promoting the conservation and sustainable use of medicinal plant resources. It plays a leading role in research on Chinese medicinal herbs and is a World Health Organization Collaborating Center for Traditional Medicine.

IMPLAD emphasizes the transformation of scientific achievements into socially useful products. It has successfully introduced and put into large-scale production the plant products Gastrodiae Rhizoma (tian ma), Panacis Quinquefolii Radix (American ginseng), Rhizoma Coptidis (huang lian), and Amomi Fructus (sha ren), which have brought in a total profit of RMB7 billion (US$1.66 billion) to date. The institute has also established cooperative relationships with Guizhou, Yunnan, and Hainan Provinces, and with Ningxia Hui Autonomous Region, which are cooperating in the cultivation of medicinal plants and drug discovery research, with a potential economic value of more than RMB10 billion (US$1.52 billion).
The Institute of Medical Information and Library

The Institute of Medical Information and Library of CAMS and PUMC has a pivotal position as the national medical library. It conducts research on medical information and health policy, providing information services and decision-making support for national health system reform and medical innovation.

Among its many functions, the Institute of Medical Information (IMI) is the designated National Center of Medical Information Research and Biomedical Information Resources, the National Medical Center of Science and Technology Library, the Center for Health Policy and Management of CAMS and PUMC, the Engineering and Technology Center for the National Population and Health Scientific Data Sharing Platform, the home of the International Medical Literature Analysis and Retrieval System (MEDLARS) Center in China, the World Health Organization (WHO) Collaborating Center for Health and Biomedical Information, the lead institution of the Chinese Board for the WHO Global Health Library, and the Office of Medical Information Management, affiliated with the Medical Information Administrative Committee of the Ministry of Health. IMI grew out of the former Medical Information Department of CAMS, which was founded in 1958. It has carried out its institutional mission since the integration of the Medical Information Department and the library of CAMS and PUMC in 1974. In the past decades, IMI has played an important role in supporting national health system reform and medical scientific innovation by conducting research in the fields of medical informatics, medical intelligence analysis, health policy and management, and health information systems. IMI has participated in key health-related national plans, including medical science and technology development programs, national science and technology strategies, and "Healthy China 2020," a national strategy that aims to dramatically improve the health of the Chinese population by 2020. To provide effective and efficient information services, IMI has developed medical information systems serving medical researchers, health professionals, and health policy makers. These include the Chinese Biomedical Literature Database, a Chinese biomedical literature service called "SinoMed," a population and health data sharing system, a consumer health information service, and a system that supports health policy and decision-making. IMI also hosts the editorial offices of medical journals including the Journal of Medical Informatics, the Journal of Medical Research, the China Medical Herald, and China Modern Doctor.

The library grew out of the former PUMC Library founded in 1917. It is acknowledged as one of China's most historic medical libraries and holds the country's largest collection of medical literature. It was designated the First National Medical Library by the State Council in 1957. The library has served as the Ministry of Health's National Center for the Sharing of Medical Literature and Resources since 1990. It has been WHO's depository library in China since 1990. Its holdings comprise more than 2.75 million medical books, journals, and other forms of medical information, including approximately 6,900 foreign journals, 1,400 Chinese journals, 84 databases, 10,000 postgraduate theses, 1,000 ancient books on traditional Chinese medicine dating back to 1335, 1,000 monographs on foreign medical history, and 20,000 WHO publications. The library has taken advantage of digital information technology to improve its service and scope, providing user-centered and subject-oriented information services to support medical innovation and decision-making.

The Center for Health Policy and Management, an independent research institution affiliated with IMI, conducts research related to health policy and management, and has recently become an important part of China's health policy research scene, playing a significant role in supporting governmental decision-making on health care. It has focused on key issues in China's health reform initiative, including health policy analysis and evaluation, health systems, global health, health information management, health decision-making support systems, primary health care, health care for mothers and children, and health economics. It has built a system for supporting health policy analysis and decision-making, providing government and related agencies with evidence and advice necessary for government policy-making. It has also developed decision-making support systems including a new national rural cooperative medical information platform, a national population and health policy and regulation evaluation platform, and a medical science and technology decision-making support system. The center also founded and is home to the widely recognized Chinese Journal of Health Policy.
The Institute of Laboratory Animal Sciences

The Institute of Laboratory Animal Sciences (ILAS) is a comprehensive national research center for laboratory animals and comparative medicine. ILAS is a unique research unit that integrates the conservation, breeding, and supply of laboratory animals and animal disease models, combining the comparative study of medical technology with technical training.

ILAS focuses primarily on laboratory animal resources, comparative medicine, and experiments with pathogens. Laboratory animal resources include genetically engineered animal models, experimental animals, human disease animal models, and Collaborative Cross mice. ILAS also houses a resource center for the genetic engineering of animal models and disease-specific species that is open to researchers. Research in comparative medicine focuses mainly on neurodegenerative diseases, cardiovascular diseases, respiratory system diseases, metabolic diseases, intestinal microecology and diseases, skin diseases, and cancer. ILAS has the largest collection of human disease animal models and facilities for comparative medical analysis in China, which are shared with researchers worldwide. Pathogen experiments based on animal models for serious infectious diseases such as AIDS, influenza, and tuberculosis, and new infectious diseases such as Middle East Respiratory Syndrome (MERS), Ebola, and Zika have led to the establishment of China’s only infectious disease animal model center and preclinical pharmacodynamics facility; ILAS offered significant help in developing vaccines and establishing drug reserves during the major infectious disease outbreaks in China. It also provides technical help with laboratory animals for national efforts in the prevention and treatment of infectious diseases and for drug discovery. Its research facilities include the Key Laboratory of Human Disease Comparative Medicine, overseen by the Ministry of Health, and the Key Laboratory of Animal Models of Human Disease Mechanisms, part of the State Administration of Traditional Chinese Medicine.

To better meet the requirements of the U.S. Animal Welfare Act, ILAS has set up an institutional animal care and use committee that aims to build an advanced management system for the use of laboratory animals throughout the country.

There are two national academic journals affiliated with ILAS: Acta Laboratorium Animalis Scientia Sinica and the Chinese Journal of Comparative Medicine. The Chinese Association for Laboratory Animal Sciences and the National Technical Committee 281 on Laboratory Animal Science of the Standardization Administration of China (SAC/TC281) are also affiliated with ILAS.

The Institute of Microcirculation

The Institute of Microcirculation at CAMS and PUMC was founded and named a national key laboratory in 1984. It has five research divisions with 30 faculty and staff members. Its advisory board is made up of eight invited scientists from China and abroad. The institute’s scientific focus is on the clinical and experimental investigation of the mechanisms behind microcirculatory disturbances in major diseases and malignant tumors. In 2000, the State Planning Commission of China funded the construction of a building (the International Standards Scientific Building) to house the institute on the CAMS and PUMC main campus. In 2011, the International Center for Microvascular Medicine was founded at the institute.

The institute is equipped with advanced experimental facilities, including an intravital microscopy system.
incorporating digital image processing and analysis for in vivo and in vitro microcirculatory observation, a time-lapse video recording system for long-term dynamic analysis of endothelial and myocardial cell behavior, and a clinical microcirculatory examination system. New equipment is constantly being added to support the institute’s research. Institute scientists regularly receive major funding through grants from the National Knowledge Innovation Program, the Chinese Academy of Sciences, the Ministry of Science and Technology, CAMS and PUMC, and other agencies.

A successful long-term collaborative research effort between the institute and the Clinical Research Center at the Karolinska Institute in Sweden began in 1988, and became an official Sino-Swedish science and technology cooperative project in 2002. Ongoing scientific collaborative agreements between this institute and the University of California, San Diego Department of Bioengineering were initiated in 1997.

The institute has received the National Award for Invention, the National Science and Technology Progress Award, the Ministry of Public Health’s Award for Scientific Achievements, and many international academic awards. Twenty-nine doctoral students and 24 Master’s students have received degrees from the institute. The faculty and graduate students working at the institute look forward to making new strides in translational microvascular medicine and precision medicine. To encourage them, a Nobel Prize corridor was set up in the institute to display posters of Nobel Prize-winning achievements.
will create the optimal environment for scientific research. In its 10-year history, the institute has striven to apply a multidisciplinary approach to studying the biology of infection, incorporating concepts and methodologies from the frontiers of ‘omics, molecular genetics, immunology, morphology, cell biology, epidemiology, structural biology, biochemistry, and bioinformatics. IPB scientists are conducting cutting-edge studies of major pathogens and setting up technology platforms to uncover the pathogenic factors in infectious diseases. Their ultimate goal is to advance both knowledge and technology to bring about more effective diagnosis, treatment, and prevention of infectious diseases.

Novel and resurgent pathogens present a huge threat to public health and are responsible for significant economic loss and social instability. Hence, a primary function of IPB is to conduct basic and translational research into these pathogens. Researchers at IPB have been involved in numerous national research programs in the past 10 years and have published more than 200 peer-reviewed papers on field studies of diseases including tuberculosis (TB), hepatitis C, AIDS, influenza, and hand, foot, and mouth disease (HFMD), as well as interdisciplin ary field studies in bioinformatics, structural biology, and epidemiology. Decade-long systematic studies of major infectious diseases such as TB and HFMD have laid a solid foundation for their diagnosis and treatment. Although China has halved the prevalence of TB in the last 20 years, it is still one of the top lethal infectious diseases in the country. In an effort to confront problems with TB diagnosis and prevention, scientists from IPB are identifying novel biomarkers from the pathogen and the host. Moreover, they have been performing prophylactic treatment studies in large rural populations. Currently, novel antigen biomarker candidates discovered through a genome-wide study are offering the promise of both improving the diagnosis of TB and providing new vaccines against it. An extensive population-based prospective study on latent TB infection (LTBI) in China was completed in 2015. This was the largest LTBI screening study in the world using a TB antigen-specific interferon-gamma assay, which has since been recommended for use by the World Health Organization. In addition, a randomized, controlled trial has been conducted to explore short-term prophylactic treatment for elderly patients with LTBI. Following an outbreak of HFMD caused by an enterovirus in 2008, a systematic study of the disease was conducted by examining 30,000 clinical cases and controls from across the country. It revealed both the viral spectrum of the disease and its evolution. An in-depth study of the mechanisms underlying the host’s immune response contributed to a better understanding of the disease’s development. To promote the proper implementation of projects like those discussed above, IPB has established domestic and international agreements with infectious disease specialist hospitals, research institutions, the Chinese Center for Disease Control and Prevention, and international nonprofit biotechnology organizations. IPB has endowed experts in relevant research fields with honorary or guest professorships to enhance cooperation. In the future, IPB will strive to establish long-term cooperative relationships that will improve responses to emerging diseases, and to attract high-caliber talent who will produce world-class research on the biology of pathogens.

The Institute of Hematology and Blood Diseases Hospital

Established in 1957, the Institute of Hematology and Blood Diseases Hospital (IH) is part of the CAMS/PUMC system. It is the national center for research and education in hematology and is also the largest treatment center for blood diseases in China. The State Key Laboratory of Experimental Hematology (SKLEH) and the National Center of Stem Cell Engineering and Technology are housed there. IH is the top-ranked specialty hospital for both clinical care and scientific impact in the field of hematology in China. Currently, IH has 1,163 employees, 414 research projects, and has received research funding totaling more than RMB300 million (approximately US$50 million) in the last 10 years.

Research

Over the past several decades, IH has made many significant contributions to hematology research in China. Some examples include:

- Isolation of a dextran-producing strain of bacteria—selected from 1,564 isolates between 1957 and 1958—that is still used today as a blood-plasma substitute
- Creation of the first domestic mouse strain in 1961, which set an important precedent for experimental
studies of leukemia in China
• The first large-scale epidemiological investigation of leukemia, aplastic anemia, and other hematopoietic disorders in China
• Discovery of a traditional Chinese herb component, indirubin, for the treatment of chronic myeloid leukemia, and the first use of bisindole drugs for the treatment of cancer
• Development of more than 200 monoclonal antibodies against human proteins that help trigger disease, of which more than 60 were officially listed in the cluster of differentiation monoclonal antibody series by the International Workshop and Conference on Human Leukocyte Differentiation Antigens
• Pioneering use of homoharringtonine as an effective chemotherapeutic agent in the treatment of acute myeloid leukemia (AML)
• Development of an effective immune suppressive therapy for severe aplastic anemia (SAA)
• Development of a stem cell treatment protocol for the management of ischemic ulcers
• Discovery of a new leukemia suppressor gene, SETD2, and its mutation in human acute leukemia.

Patient care
As a top national diagnostic and treatment center in hematology, IH has a great deal of experience with rare illnesses and incurable conditions. It has developed internationally recognized protocols for the management of adult AML, childhood acute lymphoblastic leukemia (ALL), lymphoma, multiple myeloma (MM), myelodysplastic syndrome (MDS), SAA, and idiopathic thrombocytopenic purpura (ITP). IH provides medical services for patients throughout the country. An average of 148,000 patients were treated yearly between 2011 and 2015. IH was ranked as the best hospital for blood diseases for the past six years (2010–2015) by Fudan University’s Hospital Management Institute.

Below are highlights of its clinical achievements:
• Adult AML—nearly 80% of cases achieved complete remission, with a 3-year overall survival rate of over 60%
• Childhood ALL—standardization of diagnosis and treatment of childhood ALL in China, with 98% of patients in complete remission and an 85%, 5-year event-free survival rate
• MM—outlined practical guidelines for diagnosis and treatment of the disease in China and conducted systematic cytogenetic research.
• MDS—developed a new strategy for diagnosis, classification, prognosis, and treatment of MDS based on Chinese patient data
• Hematopoietic stem cell transplantation (HSCT)—carried out the first autologous HSCT in China, achieving a long-term survival rate of 70% in patients with acute leukemia; for allogeneic HSCT, a disease-free survival rate of more than 90% for AA patients was achieved
• ITP—set up the first bleeding score for ITP patients in China and analyzed patient quality of life using the SF-36 health status questionnaire

Education and training
As an institute of PUMC, IH aims to train top-level graduate students. At present, there are six programs available: cell biology, pathology, pharmacology, medicine (hematology), immunology, and stem cell science and regenerative medicine, plus one postdoctoral training program. The Department of Stem Cell and Regenerative Medicine was founded in 2012 by IH at PUMC and offers both Master’s and doctoral degree programs.

IH hosts several international meetings every year, including the Annual International Summit on Hematology and the biannual International Forum on Stem Cells. It provides an arena in which scholars from all over the world can communicate about their work in hematology and stem cell biology.

Outlook
With a brand new campus of 65 acres and 1,200 hospital beds that will be built in the Tianjin International Health Industrial Park by 2018, the capacity of quality patient care is expected to double within five years. Through joint collaborative efforts, IH investigators have discovered a molecular switch for the formation of functional hematopoietic stem cells (HSCs) (1), thus providing new possibilities for generating HSCs for clinical transplantation. IH was awarded a major grant worth US$4.4 million for HSC research, under new initiatives for science
CAMS AND PUMC: LEADING INNOVATION IN THE HEALTH SCIENCES

The Institute of Radiation Medicine

The Institute of Radiation Medicine (IRM) of CAMS and PUMC was founded in Beijing in 1959, moved to Jianyang, Sichuan in 1969, and permanently relocated to Tianjin in 1984. With 57 years of history behind it, IRM has become a comprehensive academic institution and national research center devoted to the study of radiation and nuclear medicine, with a focus on basic, translational, and clinical research, as well as education and clinical practice.

IRM has been one of China's national nuclear emergency clinics since 1997, and has been designated as the Education Center for Radiation Health, approved by the Ministry of Health, since 2009. Since 2015, it has also been one of the country's National Technical Support Centers and a medical rescue team for nuclear emergencies, approved by the National Nuclear Emergency Office. In 2004, IRM was certified as the Tianjin Key Laboratory of Molecular Nuclear Medicine. This laboratory was renamed the Tianjin Key Laboratory of Radiation Medicine and Molecular Nuclear Medicine in 2013.

As of February 2016, the institute has 108 faculty and staff members, of whom 48 are researchers and technical personnel. Among the scientific and technical personnel, four are members of the Medical Emergency Rescue Expert Group for National Nuclear Accidents, one is a Cheung Kong Scholar from the Ministry of Education, one an awardee of the National Natural Science Fund for Distinguished Young Scholars, three are professors recruited through the Tianjin Thousand Talents Program, and four are guest professors of CAMS from the United States and Japan.

IRM has four laboratories and centers: the Laboratory for Radiation Effects, the Laboratory for Radioprotective Drugs, the Laboratory for Treatment of Radiation Injuries, and the Laboratory for the Application of Nuclear Medicine. IRM also has core facilities such as the Laboratory Animal Resource Center and the Large-Scale Structures Center, which support national research goals. The institute offers Ph.D. programs in radiation medicine, pharmacology, and biochemistry and molecular biology, as well as eight Master’s degree programs covering various fields of radiation medicine. The subspecialties of blood, nuclear medicine and medical imaging, and nuclear epidemiology offered in the IRM curriculum have been recognized as key areas of specialization in internal medicine by the Ministry of Education since 2003. IRM's affiliations include the Radiation Hygiene Society of China, the editorial office of The International Journal of Radiation Medicine and Nuclear Medicine, and the Popular Education Center of Nuclear Science for Teenagers in Tianjin.

The institute promotes vigorous research in radiation and nuclear medicine, including screening new radioprotective and radiosensitive agents, investigating physical and biological dosimetry, exploring genes and proteins involved in the response to radiation damage, studying protocols for treating intestinal dysbacteriosis following acute radiation injury, and exploring new nanomaterials for use in nuclear imaging. Over the past five decades, IRM has successfully carried out numerous medical emergency rescue missions following domestic and international radiation accidents. In 1986, our independently developed, proprietary radioprotectors were used for the rescue of irradiated workers involved in the accident at the Chernobyl nuclear power plant in

The Institute of Biomedical Engineering

The Institute of Biomedical Engineering of CAMS and PUMC was founded in 1978, replacing its predecessor, the Institute of Medical Instrument Research, established in 1960. Research at the institute, which is located in Tianjin, is primarily focused on developing new methods, technologies, and materials in the field of biomedical engineering.

The 129-member staff includes 91 research scientists and technical personnel. Areas of study fall into two major categories: biomedical materials and medical electronics engineering. Research on biomedical materials is conducted by the divisions of controlled-release drugs, tissue engineering and artificial organs, gene engineering, cardiovascular biomaterials, and molecular design and nanotechnology. Medical electronics engineering is similarly divided into five divisions: medical ultrasound engineering, medical physics and measurement, neural engineering, bioinformatics, and medical lasers.

The Key Laboratory of Biomedical Materials and the Medical Electronic Diagnostic and Therapeutic Technology Engineering Center are also located within this institute, which also has an in-house editorial and publishing division that publishes the International Journal of Biomedical Engineering.

The institute has garnered over 50 National and Provincial Science and Technology Progress Awards over the years and has been particularly well recognized for its contributions in the field of ultrasonic diagnosis and treatment—using high frequency ultrasound for imaging peripheral organs such as the eyes, skin, and microvascular structures. The institute’s work with optical imaging in conjunction with focused ultrasound markedly improves the diagnosis of several types of glaucoma. Its BME-200 ophthalmic ultrasonic diagnostic instrument was awarded second prize at the National Science and Technology Progress Awards in 2001.

Other medical and clinical equipment designed and developed at the institute include ultrasound instruments for ophthalmic and dermal examination, bedside monitors, an algescic stimulating device, a vision screening device, an antitumor photodynamic therapy...
The Institute of Dermatology and Hospital for Skin Diseases

The Institute of Dermatology was established as the Central Institute of Dermatology and Venereology by the Ministry of Health in 1954, with the aim of having a professional institution for planning, coordinating, and implementing the nationwide campaign to eliminate sexually transmitted diseases (STDs). The institute played a leading role in that campaign with a program of research on detection and treatment, which culminated in 1964, and made a significant contribution to the national elimination of STDs. The institute then shifted its research priorities to other public health issues: leprosy and tinea capitis (a fungal infection affecting the scalp), and has made great strides in bringing these diseases under control. The prevalence of leprosy has been reduced 80-fold between 1966 and 2014, and it has been all but eliminated in over 95% of China’s counties (Figure 1). The institute’s R&D on strategies for combatting STDs, leprosy, and tinea capitis were awarded the top honors in the National Science and Technology Progress Awards and the National Science and Technology Congress Awards in 1978.

Since it joined CAMS in 1957, the institute has been committed to research on the pathogenesis, epidemiology, prevention, diagnosis, and treatment of skin diseases including STDs, and to developing drugs to combat them. During the 1970s and 1980s, the institute set up a study team to conduct research on the chemical, pharmacological, and toxicological characteristics and clinical performance of the traditional Chinese herb *Tripterygium wilfordii* (Figure 2). Studies found that the herb could play an important role in the management of inflammatory and autoimmune diseases. The study team isolated and optimized the active components of the herb, which have subsequently been used to develop a drug that is now widely used for the treatment of various inflammatory and autoimmune diseases in China, including systemic lupus erythematosus. The *Tripterygium* glycoside, an active component of the herb, was developed and then certified as a new traditional Chinese medicine in 1982. In 1984, the institute conducted the first nationwide epidemiological survey of psoriasis, covering a study population of nearly 7 million, which provided data for estimating the prevalence of the disease. In recent years, studies on the clinical diagnosis and management of rare and difficult-to-treat skin diseases have become one of the research priorities of the institute. A number of the skin diseases diagnosed in China, including diffuse hyperpigmentation with guttate depigmented macules, symmetric acrokeratosis paraneoplastica, and idiopathic dermal elastolysis in children, are the first reported cases worldwide. Institute scientists were also the first to identify and report on *Ochroconis tshawytschae*, a fungus that is pathogenic in human beings.

In 1984, the Hospital for Skin Diseases was established within the institute, expanding its mandate to include clinic-based services for patients with skin diseases, including STDs. The hospital is one of the biggest in the country for the treatment of skin diseases, serving over 1 million outpatients annually. It has an...
expert staff and a wealth of clinical departments, diagnostic and treatment equipment, and in-house drugs for topical use. The institute also acts as the National Center for STD Control and the National Center for Leprosy Control, assisting the National Health and Family Planning Commission in developing and coordinating the national program of STD and leprosy control and providing technical support to local health authorities for implementing these programs. In addition, as the Medical Mycology Center of the China Committee for Culture Collection of Microorganisms, the institute is responsible for preserving the standard strains of medical fungi and providing support for the detection and identification of rare strains. The institute has been certified as a World Health Organization Collaborating Center for Prevention and Control of STDs, providing technical consultations and support to other countries. As a teaching institute of PUMC, the institute offers doctoral and Master’s degree programs in dermatovenereology and is designated as a teaching base by the Ministry of Education to provide training for dermatologists.

The institute has nearly 400 faculty and staff members, including experts with national and international standing in areas ranging from the basic sciences and epidemiology to clinical diagnosis and treatment. Its scientists have published more than 5,000 research papers in national and international peer-reviewed journals.
The Institute of Blood Transfusion

The Institute of Blood Transfusion (IBT) is the sole national key research institute devoted to transfusion science and medicine. IBT is committed to improving health and saving lives by conducting basic and applied research in the field of blood services, developing science-based regulations and standards, making policy recommendations, and providing technical and educational support.

Established in 1957 and relocated from Tianjin to Chengdu in 1965, IBT has a long and respected history of achievements. It has played a leading role in the development of transfusion science and technology in China.

IBT is composed of six research centers: Transfusion-Transmitted Diseases (TTD), Immunology and Clinical Transfusion, Plasma Proteins, Stem Cells and their Applications, Biomedical Engineering, and Blood Resource Management.

The TTD center focuses on the early detection of transfusion-transmitted infectious diseases; the establishment of methods for predicting treatment responses in patients infected with hepatitis B and V viruses and human immunodeficiency virus (HIV); and the development of technology for monitoring treatment efficacy during therapy and for evaluation after treatment.

The Immunology and Clinical Transfusion Research center includes four sections: Noninfectious Risks, Infectious Risks, the HLA (human leukocyte antigen) Laboratory, and the Blood Preservation Laboratory. The Noninfectious Risks section studies the genetic basis of human blood groups, with the aim of increasing the safety and efficiency of clinical blood transfusion, identifying complex blood groups, and reducing the rates of immunological transfusion reactions and hemolytic disease in newborns. The Infectious Risks section screens blood donors and develops new blood-screening strategies. The HLA Laboratory studies immunological responses following organ and human stem-cell transplantation, and provides consultation and treatment recommendations for clinicians. The Blood Preservation Laboratory is concerned with proper removal of protective agents following long-term, low-temperature blood storage and with evaluating the functionality of lyophilized red blood cells.

The Plasma Proteins center focuses on elucidating the structure and function of blood plasma proteins and their therapeutic applications in various diseases, as well as developing blood plasma products and diagnostic kits for thrombosis and hemostasis. It also evaluates the safety and efficacy of blood component products and formulates standardized methods for detecting and preparing them.

The Stem Cells center researches the differentiation of human induced pluripotent stem cells (hiPSCs) into functionally mature blood cells and their possible clinical applications. The center is also interested in establishing efficient ways to reprogram small amounts of human peripheral or umbilical cord blood cells into hiPSCs and in developing disease-specific cell models. Scientists are exploring a method for inducing mature blood cells in a xeno-free system and are uncovering mechanisms that control early hematopoiesis by means of regulating genes and adding specific small molecules.

Since its inception, the Biomedical Engineering center’s research has focused on R&D for blood and novel plasma substitutes with oxygen-carrying capacity. Furthermore, the center’s research examines ways to minimize the degradation of stored blood, and includes studying the influence of nitric oxide on red blood cell function and optimizing the storage of blood collected from those living at high altitudes. The center also evaluates biomaterials for their potential use in transfusions, and develops transfusion devices including a leukocyte reduction transfusion set, filters for the depletion of leukocytes from platelet concentrate, and platelet storage bags.

The Blood Resource Management center researches the safety and management of blood resources including blood supply chain management, blood donor recruitment, optimization of the blood resource management system, and emergency management of blood resources.

IBT has several key laboratories, among them the Nucleic Acid Testing Reference Laboratory, the HIV Confirmatory Testing Laboratory, and the HLA Typing Reference Laboratory, all authorized by the National Health and Family Planning Commission (NHFPC); the Tissue Typing Reference Laboratory for the Chinese Bone Marrow Donor Program, accredited by the Red Cross Society of China; and the Sichuan Provincial Key Laboratory of Plasma Protein.

IBT publishes two scientific journals, the Chinese Journal of Blood Transfusion and the International Journal of Blood Transfusion and Hematology.
The Institute of Medical Biology

The Institute of Medical Biology (IMB) of CAMS and PUMC was founded in 1958 to develop and commercially produce viral vaccines for infectious diseases, particularly poliomyelitis, hepatitis A, and hand, foot, and mouth disease. Currently, IMB is both a research institution and a production facility, conducting basic and applied research as well as manufacturing vaccines. It also plays a role in the postgraduate education of PUMC graduate students and is the World Health Organization Collaborative Research Center for Enteroviruses. IMB is the largest research and production center for live attenuated oral poliomyelitis vaccine (OPV) and hepatitis A vaccine (HAV) in China. Since 1960, when OPV was licensed, more than 52 billion doses of the vaccine have been supplied to the national Expanded Program on Immunization, making a tremendous contribution to the control and eradication of poliomyelitis in China. Since HAV was licensed in 1992, IMB has supplied more than 2 billion doses to the Chinese market, playing an essential role in controlling outbreaks of hepatitis A and reducing its incidence in the country.

Throughout its history, the institute has operated on the principle of integrating industry, academia, and innovation. It has a strong program of basic and applied research relevant to vaccine development. Among its goals is the establishment of sustainable, long-term systems for vaccine development and technological innovation. Additionally, it seeks to strengthen the knowledge base of this research field by training high-level creative talent and fostering the development of effective research teams. IMB is the largest center undertaking primate breeding and animal experiments; it has bred more than 2,000 rhesus macaques and other primates, and around 2,000 tree shrews, all with known genetic backgrounds. IMB’s good laboratory practice-certified facility evaluates the preclinical safety and efficacy of new drugs and vaccines in animals.

Currently under construction at the institute, the Kunming National High-Level Biosafety Research Center for Nonhuman Primates will study the etiology, epidemiology, pathogenicity, and diagnosis of existing and emerging infectious diseases and will be the largest such facility in China.

The institute has four good manufacturing practice-certified production lines for the commercial production of its current products; an additional two to four lines are to be constructed for new products within the next five years.

Blood safety is a priority of the Chinese government due to its impact on public health. As the national research institute for transfusion medicine, IBT cooperates closely with NHFPC and the Chinese Society of Blood Transfusion. With a dedicated staff of nearly 210, IBT will continue to make important discoveries in transfusion science and medicine, advancing standards and practices for safe transfusions and helping to ensure blood safety while improving health and saving lives.
The Suzhou Institute of Systems Medicine

The seeds for the Suzhou Institute of Systems Medicine of CAMS, also known as the Center for Systems Medicine, were planted in Shanghai on September 9, 2011, when Zhu Chen, then Minister of Health, hosted Nobel laureate David Baltimore and other dignitaries. Much of the conversation was about the rapid growth of biomedical research in China and how Chinese health sciences could play a leading role in combating major diseases. At the end of the meeting, a consensus emerged: A new systems medicine institute should be established in China. The Suzhou Institute of Systems Medicine (ISM) was created jointly by CAMS and Suzhou Industry Park, which is under the local government of Suzhou municipality in Jiangsu Province. It serves as a model for using systems biology and translational medicine to generate innovative R&D that addresses important health care issues. ISM is committed to gaining an international reputation for excellence in medical research and education by combining its academic resources with those of affiliated hospitals and translational research incubators. Its goal is to become a fully integrated patient-to-bench-to-product powerhouse for fighting disease.

ISM conducts cutting-edge medical research on cancer as well as infectious, inflammatory, autoimmune, metabolic, and degenerative diseases. In one high-priority project, integrated bioinformatics, big data analysis, and computational modeling is being used to better understand the fundamental molecular mechanisms linking environmental and genetic factors to disease susceptibility, and to find effective drug and treatment responses. These efforts will ultimately result in more effective and more personalized programs for disease prediction, diagnosis, treatment, and prevention.

ISM is also a pioneer in scientific research reform in China. It has a board of directors—an innovation for Chinese research institutions—and has benefited greatly from their strong, efficient leadership. ISM has implemented an enterprise-like employment system organized around principal investigators, to encourage innovation and competition and to attract talented researchers. It has also adopted a novel evaluation system to promote basic and translational research that is now being integrated with the more than 25 educational institutes and thousands of biotech and pharmaceutical companies in the Suzhou Industrial Park.

As a newly established institute, ISM has conducted research for just over a year, but has already built two major systems, one for big data analysis and the other for immunology. These systems will support seven research groups comprising around 50 staff members, as well as external institutions. Although the institute is still in its infancy, it has already made important contributions to the war against emerging infectious diseases in China. It is currently responsible for hosting the major national drug discovery program for anti-Ebola drug development as part of the 13th Five-Year Plan. During the next Five-Year Plan, ISM’s focus will be on personalized precision medicine for cancers and new therapeutic and vaccine approaches to combating infectious diseases.

ISM’s new campus is under construction. The complex covers 12 acres and will be able to house up to 1,000 full-time research employees. It will include approximately 50 independent laboratories and centralized facilities for functional genomics, structural biology, animal models of human diseases, and translational research. The campus will also house an incubator unit to aid translation and early product development efforts. ISM is seeking partnership and collaboration opportunities with biopharmaceutical companies, hospitals, and universities worldwide.
Recruitment Plan for CAMS and PUMC

The Chinese Academy of Medical Sciences (CAMS) and Peking Union Medical College (PUMC) are jointly managed. Together, CAMS and PUMC comprise 19 research institutes, 6 clinical hospitals, and 7 academies. They are strongly competitive in scientific research and clinical medicine, integrating the rich resources of a comprehensive hospital and top quality basic and clinical research. Moreover, they boast a large contingent of professors and other experts who have extensive expertise in medicine and health care, significant academic achievements, and outstanding contributions to their fields.

CAMS and PUMC aim to develop PUMC into a leading research-oriented college in the medical sciences, with both domestic and international recognition, building upon PUMC’s elite medical education system. Concurrently, CAMS is being elevated to be a central base for innovation in the medical sciences, acting as a new national academy of sciences. At CAMS and PUMC, we are keen to recruit high-caliber students and staff in the fields of medicine, teaching, research, and management who are recognized by their peers for their academic or professional achievements.

Disciplines needed
- Basic medicine, clinical medicine, biology, biomedical engineering, public health and preventative medicine, nursing, management, and the intersection of traditional Chinese medicine and Western medicine.

Remuneration
- Negotiable, depending on position

Applications
- Applicants should send their résumé as an attachment via e-mail to: camsrsc@163.com

Contact information
- Contact department: Department of Human Resources
- Telephone: +86-10-65105928 | Fax: +86-10-65105931
- Address: No.9, Dongdansantiao, Dongcheng District, Beijing, 100730, China

We eagerly invite all elite scientists and students to join this undertaking to improve the health of the Chinese people. Upholding the maxim of “Rigorosity, Erudition and Expertise, Creation and Devotion,” we will work together as one to blaze a new trail and make valuable contributions to China’s medical sciences and higher education.