A key player in biomedical sciences and clinical service in China, Chinese Academy of Medical Sciences (CAMS) and Peking Union Medical College (PUMC)

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Abstract The Chinese Academy of Medical Sciences (CAMS) and Peking Union Medical College (PUMC) is the largest medical institution in China and has a leading high-level multidisciplinary medical research and medial service. Under the CAMS and PUMC infrastructure, there are 17 biomedical institutes and 6 large hospitals, which cover most fields of the human disease-related research. CAMS and PUMC has always attached great emphasis on the control and cure of severe diseases, as well as a series of innovative drug researches, and has made significant progress in those fields. The long-term goals for CAMS and PUMC in the future development are: reaching the international advanced level in the areas of severe disease prediction, prevention, control, diagnosis, and research on drug innovation; establishing theoretical and technological system for explanation of the mechanism of severe diseases, which possesses Chinese style and represents the frontier level in the world, and at the same time, providing scientific support for the prevention and treatment of severe disease and making contribution to the establishment and development of a harmonious society in China.

History of PUMC and CAMS

Founded by the Rockefeller Foundation in 1917 (Fig. 1), Peking Union Medical College (PUMC) has grown to its

present full-fledged scale after nine decades. In 1915, the Rockefeller Foundation decided, based on its studies of Asian countries, to establish a first-rate medical college in Beijing. The Foundation acquired all the assets of the Union Medical College from the London Missionary Society and then purchased all the real estates of a royal palace in Dong Dan San Tiao hutong in downtown Beijing. It took USD 7.5 million to build this complex of 22.6-ha coverage, comprising 14 buildings of the college, hospital, offices, an auditorium, power room, etc. The complex was designed and built as a classic Chinese architecture featuring glazed tiles, upturned eaves, carved beams, and painted rafters to add to the bright coloring (Fig. 2). All these were in harmony with the constructing style of Beijing as an ancient capital city of China. The interior was designed and decorated at the highest standards of the time to meet medical education, medical services, and medical research needs. PUMC was unparalleled in Asia for its library collection at the time. Most noteworthy of all was its elites of entrepreneurship recruited as executives, managers, and discipline leaders, from not only the USA but also UK, Canada, and within China. They were mostly young and vigorous people; for example, the first dean Franklin McLeam was only 28 years old when he took office. For these young people born in industrialized countries, it challenged their courage and dedication to come to China, a nation in the east so mysterious and remote at that time. September 15–22, 1921 witnessed a solemn opening ceremony of Peking Union Medical College (PUMC), attended by principals and professors from China, other Asian countries, Europe, and America, as well as 50 delegates from academic associations and international health organizations.

PUMC was founded in early twentieth century, modeling on the pacemaker of reforms in medical education and

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Fig. 1 Founding ceremony of PUMC in 1917

hospital management in North American, the John Hopkins Medical School. The guidelines for PUMC were established in view of the conditions and requirements specific of China: build a first-rate medical college to educate first-class medical professionals of clinicians, medical educationists, medical scientists, and public health administrators, contributing to medical science in China and medicine of the world. In this regard, the capacity of PUMC was designed as 30 students per class (50 at maximum), a scale matched by its classrooms and laboratories. Peking Union Medical College's hospital (PUMCH), a hospital designed as 250 beds, was open to admit in-patients since June 1921. Founded by the Rockefeller Foundation, the nursing school of PUMC was also the best in China, which is known for its advanced teaching methodology, education quality, especially its courses on public healthcare, which are followed by counterparts in the country. To ensure the command of natural sciences and English proficiency of the students, PUMC established pre-medical programs in a number of universities in China. Other characteristics of PUMC include the "knock-out" mechanism in the entrance exam, teaching in English, emphasis of hands-on practice, and public health courses, with which PUMC became the

pioneer of an 8-year curriculum on medical education and undergraduate nursing programs in China.

In the three decades before the founding of the People's Republic of China and the takeover of PUMC, its medical educationists made numerous contributions to medical research. As early as PUMC was founded, scientific research had been earmarked as one of its key commitments. A recruitment policy was clearly laid down that senior teachers must be capable of both education and scientific research, a policy adhered to as of now. Another policy for research subjects insisted on the emphasis of significant and pressing issues in medicine and healthcare specific of China. PUMC was a major contributor of first-class academic publications carried on prestigious medical magazines such as Chinese Medical Journal (Chinese/English edition) and Chinese Journal of Physiology at that time. Papers and reports were also frequently published on overseas medical journals. For example, the world-known discovery and studies of "Peking Man" skulls made by Professor Black Davidson of anthropology of the Department of Anatomy based on the fossil teeth excavated from Zhoukoudian in Beijing. Invention and studies of ephedrine, translation and study of the Compendium of Materia Medica (the most famous work on Traditional Chinese Medicine in Ming Dynasty), biochemical inspection, and study of blood, all of which effectively propelled the development of medical research in China.

Current CAMS and PUMC

Being the only university directly under the Ministry of Health (MOH), PUMC is under the management of the same executives as the Chinese Academy of Medical Sciences (CAMS). CAMS was founded in 1956 to function as the only state-level academic center in medical sciences and a high-level multidisciplinary medical research institution in China. PUMC played a major role in founding the two key medical institutions of the new republic. In 1983, a number of research institutes were separated from CAMS to establish the Chinese Academy of Preventive Medicine (the Chinese Center for

Fig. 2 *Left* Auditorium and, *right*, back yard of PUMC/ CAMS buildings in classical Chinese architecture, organization and different units of the CAMS and PUMC

Fig. 3 Units under CAMS and PUMC

Disease Control and Prevention—China CDC) along with other institutions. China CDC is the state center for science research center and technology guidance on preventive medicine. In 1950, many senior medical professionals were transferred from PUMC to establish the Academy of Military Medical Sciences. Researches conducted by these institutions stand for the highest academic level in the medical and public health sector in China. In 1998, when the Chinese Academy of Sciences and the Chinese Academy of Engineering released respectively their first senior academicians, scientists from PUMC amounted to half of those from medical science sector. There are more academicians in CAMS and PUMC than any other medical institutions in the country. CAMS provides

PUMC with rich resources of qualified faculty and expertise, while PUMC trains high-quality graduates for CAMS. PUMC and CAMS are mutual supportive and interdependent, share each other's strengths, and develop from teaching and research.

Establishments under PUMC/CAMS

CAMS and PUMC has under it 17 research institutes, 6 hospitals, 5 schools, 1 graduate school, 2 presses, 1 medical industry groups, and 2 pharmaceutical enterprises, totaling a workforce of 11,075 people. Thanks to the ceaseless efforts in the past decades, a number of R&D bases have taken shape under CAMS and PUMC, namely 4 state key laboratories, 9 ministry-level key laboratories, 16 state-level industrial experiment bases and centers, 18 state-level key disciplines of medical sciences, 10 WHO cooperation centers, and 40 national-level academic institutions and associations. In addition, it is the sponsor of 15 and undertaker of 17 national-level academic periodicals. See Fig. 3 for names of these units.

These hospitals and institutes are located in Beijing, Tianjin, Nanjing, Chengdu, Kunming, and Hainan. Under the unified management system of the hospitals and institutes, the mechanism of shared head office and leaders is followed in the Basic Medicine College and Basic Medicine Institute, Fuwai Cardiovascular Hospital and Cardiovascular Institute (Fig. 4), Plastic Surgery Hospital, and Plastic Surgery Institute, Blood Diseases Hospital and Hematology Institute, as well as the Skin Diseases Hospital and Dermatology Institute. PUMC Hospital is characteristic of the unified management system comprising the clinical medical school, clinical teaching hospital, and research institute.

Fig. 4 Cardiovascular Institute and FUWAI Hospital

Scientific research

In the time before 1954, science subjects were mostly established to resolve clinical diagnosis or teaching demands and confined to medical science in general, for such factors as the changing management structure and teaching assignments, heavy workload of clinical medicine, and slow pace in science research. Years after 1954 witnessed gradual adjustment of science research planning made by the departments and their inclusion into the state science and technology plan. As China is rapidly becoming an economic power in the world, thanks to its successful reforms and open policy, state grants on science research are escalating year by year as guided by the state administration policy “Science and technology are the top productivity.” Against this background, scientific research of CAMS and PUMC is much more powerful than before.

PUMC maintains six disciplines with doctorate programs, basic medicine, clinical medicine, biology, pharmacy, combination of traditional Chinese medicine and western medicine, and biomedical engineering. Under its divisions/class-2 disciplines are 49 doctorate programs and 51 master programs. There are six post-doctorate workstations of basic medicine, clinical medicine, biology, biomedical engineering, public health, and preventive medicine.

PUMC is renowned for its 18 key national disciplines: Genetics, Cell Biology, Biochemistry and Molecular Biology, Immunology, Pathology and Pathophysiology, Internal Medicine (cardiovascular diseases), Internal Medicine (blood diseases), Internal Medicine (digestive diseases), Internal Medicine (endocrinology and metabolism diseases), Dermatology and Venereology, Image Medicine and Nuclear Medicine, Surgery (thoracic), Obstetrics and Gynecology, Oncology, Anesthesiology, Pharmacochemistry, Microbiological and Biochemical Pharmacy, and Pharmacology. These national ones are supplemented by three key disciplines of Beijing municipal level: Surgery (General), Epidemiology and Health Statistics, and Pharmacognosy. The leading position of PUMC in China is augmented by its three national key labs, namely the State Key Laboratory of Molecular Oncology, the State Key Laboratory of Medical Molecular Biology, and the State Key Laboratory of Experimental Hematology, and nine ministerial key laboratories, and 17 national-level research bases and centers.

Preliminary statistics of the research projects undertaken by CAMS and PUMC in the recent 5 years are as follows: Of the 3,514 projects undertaken at or above CAMS and PUMC level, there are 1,969 national-level projects, accounting for 56% of the total projects. Importance of these projects is evidenced by the year-by-year grants increase for the subjects, rising from RMB 78.1 million in 2001 to 189.9 million in 2005. Research grants to CAMS and PUMC in the 5-year period total RMB 760 million.

The following are facts and figures for the innovation power of CAMS and PUMC: 83 patents and 73 certificates of New Medicine inclusive of six class-one medicines. To name a few, the first class-one new medicine of independent IPR, Biocyclol, and a new medicine for cerebral ischemia, 3-*n*-butyphthalide (NBP). In the past five years, 178 research results of CAMS and PUMC have been certified by competent academic authorities and received 160 awards for science research, including a first-prize winner of the National Scientific and Technological Progress Award—Studies for the Strategy, Prevention and Treatment Technique and Measures for control and elimination nationwide of leprosy. In the past five years, 10,409 papers have been published, of which 1,224 were carried on SCI. The following studies have been published on nature, nature medicine, and Lancet, respectively. The infectious diseases research has discovered that angiotensin-converting enzyme 2 (ACE2) is the *in vivo* receptor of severe acute respiratory syndrome associated coronavirus (SARS-CoV), interpreting the mechanism of lung failure caused by SARS virus at molecular level; major corrections made to the incidence of Parkinson’s disease among the Chinese people in the epidemiological survey of the said disease; finding this incidence as misleading in the past two decades; studies of Goldthread as used in traditional Chinese medicine found the blood-fat reducing mechanism of its ingredient Berberine and important molecular targets; positional cloning has successfully positioned the genes associated with hereditary dentinogenesis imperfecta.

CAMS and PUMC made significant contributions to the nationwide campaign against SARS outbreak in 2003, scoring major research breakthroughs in its research work to be highly commended by the state and the society, namely the “Screening and Establishment of SARS-CoV Sensitive Animal Model”, “Studies of Inactivated Vaccine for SARS”, and “Studies of SARS Pathogenic Mechanism”. Especially noteworthy are the studies on vaccines and animal models, which are acknowledged by the Ministry of Science and Technology as a major breakthrough in China’s science research. The research results of or above ministry-level as contributed by CAMS and PUMC account for 18–30% of the medicine and pharmaceutical system of the country each year. Since its founding, 2,000 research results of CAMS and PUMC have been certified, winning 200 some national-level science/technology prizes and 800 ministry/provincial-level prizes.

Medical care

CAMS and PUMC has under it six hospitals—PUMC Hospital, Fu Wai Cardiovascular Disease Hospital (Fig. 4), Cancer Hospital, Plastic Surgery Hospital, Blood Disease Hospital (Tianjin), and Skin Disease Hospital (Nanjing). These hospitals constitute a comprehensive medical care

system known both at home and abroad, integrating medical care, teaching and research, and offering new therapies and new techniques from time to time. Ceaseless efforts of CAMS and PUMC keep escalating the scale and capabilities of these hospitals to the present level of 4,301 beds, averaging 2.80 million outpatients, 89,013 inpatients, and 43,715 patients for operations on yearly basis. Of these hospitals, PUMC Hospital (PUMCH) is designated as one of the “National Technical Guidance Center for Rare and Severe Diseases” by the Ministry of Health for its advantageous expertise, technology, and resource. In 2004, PUMCH was designated as a health care hospital for senior leaders of the state. Its medical records section is named one of the “Three PUMC Treasures.” Fuwai Hospital is the largest third-level grade-A hospital for cardiovascular diseases in China; the Cancer Hospital is the largest cancer hospital in Asia, and one of the WHO collaboration centers; Plastic Surgery Hospital is the largest academic authority of its kind in the world; and the Blood Disease Hospital in Tianjin is the only national-level hematology clinical and research establishment in China, which integrating clinical study and basic research. This hospital maintains a leading position in the diagnosis and treatment of hematologic malignancies, and the Skin Disease Hospital in Nanjing is the largest and most advanced in dermatology research, which offers academic guidance to its counterparts in China for their diagnosis and treatment of difficult skin disease including STDs and leprosy.

Medical education

PUMC has an 8-year curriculum program in medicine and an undergraduate nursing program, adhering to the education doctrine of “Small in scale, Elite in quality.” PUMC has land coverage of 1.082 million square meters, including a nursing school covering 23,000 square meters. PUMC has 33,000 full-time students.

The 8-year curriculum of PUMC was founded since 1917, featuring its unique development model of by-section education and mentor mechanism as always. After their enrollment, the students have to take 2.5 years of pre-medical courses and 5.5 years of medical courses, as only the best graduates are granted with M.D. degree. The year 1995 witnessed the commencement of the dual-degree program comprising M.D. and Ph.D. courses. Elite graduates from the 8-year curriculum with M.D. degree will proceed with a 3-year curriculum, during which they will be receiving intensified training on their scientific research capabilities. When they graduate with required credits and qualified exam scores, in addition to success in papers dissertation defense, they will be granted with a Ph.D. degree.

The faculty of PUMC is what makes the difference. There are 643 full-time teachers, of whom 229 with doctoral degree

and 160 with master degree. PUMC has 302 mentors for doctorate candidates and 557 mentors for master candidates. Prestigious professors make one of the “Three PUMC Treasures.” Of the noted experts, professors and discipline leaders of rich experience, outstanding academic achievements, and contributions, there are 11 academicians of the Chinese Academy of Sciences and 15 academicians of the Chinese Academy of Engineering (one of whom is an academician for both academies), one member of the Academic Degree Committee of the State Council. There are also 77 middle-aged and young experts of outstanding contributions as recognized at national or ministry level, nine winners of the Professorship for Cheung Kong Scholar’s Program (sponsored by the Ministry of Education), and four “Excellent Talents in the New Century” as recognized by the Ministry of Education. Recent years also see the return of many excellent young scientists to China, further empowering the research strength of CAMS and PUMC.

PUMC Library has been known as “Top in Asia,” being a library of the longest history and largest collections in China. Regarded as one of the “Three PUMC Treasures,” the library has been cherished in PUMC. At present, the library has been approved by the State Council as a national-level central library and a medical branch of the state center for science/technology books and documentation and a WHO-collaborating center for health and biomedicine information. Its collections amount to 490,000 copies of books and 5,000 kinds of periodicals. The Chinese medical documentation analysis and retrieval system provides medical information to its counterparts in the country and maintains a medical information network nationwide, contributing important information for medical teaching, research, and medical care.

International collaborations

CAMS and PUMC attaches great importance to international academic exchange and collaboration, as it maintains with medical schools and research institutions in 20 countries (regions) ties for academic exchange and science, education, and medical care cooperation. Its nine WHO-collaborating centers work with WHO to introduce intellectuals and funding for furthering research, medical care, and education. PUMC has conferred honorable titles of Honorary Professorship or Guest Professorship to over 200 professors from other countries (regions), namely, Dr. John Walker, the Nobel Prize winner and director of Medical Research Council Dunn Human Nutrition Unit, Samuel Chao Chung Ting, MIT professor of Physics, and Dr. Tim Hunt, a UK MRC scientist and Nobel Prize winner of Physiology or Medicine.

PUMC maintains interschool exchange agreements with such prestigious medical schools as Harvard Medical School, University of California School of Medicine, and Chinese University of Hong Kong Faculty of Medicine,

under which PUMC exchanges senior students with the schools for short-term clinical studies.

In adherence to its doctrine of elite education since its founding, PUMC also endeavors to be an outstanding organizational citizen in the country. For example, it takes initiatives to adapt to the structural and strategy readjustments of the state, to meet the social development and high-tech development needs, and to meet the ever-rising demand of the people for healthcare. On the basis of the small-scale and elite education of its prestigious 8-year curriculum of medicine and nursing courses, PUMC takes appropriate and steady steps to expand its scale of graduate courses with reasonable adjustment of its levels and composition of the professions and with reasonable setup and makeup of professions, relying on its key disciplines and feature disciplines, in compliance with the basic of medical education. These efforts have paid off with the graduate courses shaped into a system centering on medicine, with cross-disciplinary pattern combining science, engineering, management, and philosophy.

To adapt to challenges and opportunities in the new century, medical science has to develop in an integrated

pattern featuring complete systems, reasonable makeup, multi-regional, multi-sectional, multi-industry, multi-discipline, social, networked, internationalized pattern. Centering on the national key labs and state research centers, PUMC will establish a medical science innovation system characteristic of the assurance of resources and technology sharing platform and international exchange platform. In addition, CAMS and PUMC will join its resources to develop a number of advantageous disciplines, research bases and high-caliber teams and engage in systematic researches for major diseases prevention and treatment and leverage the role of national and ministry-level key labs to launch basic and pioneering studies, provide clinical bases for prevention and treatment studies based on national-level research hospitals, and provide demonstration for comprehensive prevention and treatment of diseases based on national-level community medical centers. In the future, CAMS and PUMC will continue to center on research subjects on human health and disease prevention and treatment and work hand in hand with our international counterparts to build the world a better place to live.