

Beijing

Beijing, the political centre of China for nearly a millennia, has seen unprecedented growth in its research output, scientific impact and technological innovation in the last 15 years. And the momentum shows no signs of abating.

ARTICLE COUNT (AC): **3,985**
 FRACTIONAL COUNT (FC): **1,453**
 WEIGHTED FRACTIONAL COUNT (WFC): **1,329**

Beijing is among the most dynamic capital cities when it comes to advancing scientific research and supporting technological innovation. Last year, the metropolis spent US\$19.3 billion (6.1% of its gross domestic product, GDP) on research and development — US\$7 million more than nearest rival Shanghai. There has been controversy over the way this money is used, however, and in October 2013 the Ministry of Education released new guidelines on the management of research funds. The unprecedented move was seen as a response by the government to reports of embezzlement and fraud.

Beijing is home to the Chinese Academy of Sciences (CAS), the world's largest research body, and to the universities of Peking (PKU) and Tsinghua — the country's two leading universities, making the city by far the most productive in the index. Beijing is the national leader across all subject categories except astrophysics — an accolade taken by Nanjing (page S66). Beijing generates 2.4 times as many research articles as Shanghai, and five times as many as Nanjing. The city has a higher weighted fractional count (WFC) — a measure of the relative contribution of a city to the papers it has published — than the entire country of Canada.

Despite its glittering scientific achievements,

Beijing has been plagued by a problem usually associated with more primitive economic activity: chronic air pollution. This year, in the National People's Congress and Chinese People's Political Consultative Conference, the Chinese president Xi Jinping vowed to improve the city's air quality through a "hefty investment" of US\$124 billion to reduce coal burning, car emissions and fine particulates. Some of this money will also go towards developing technologies for monitoring air quality and preventing smog formation.

BEIJING HAS A HIGHER WFC THAN THE ENTIRE COUNTRY OF CANADA

Founded in 1898, PKU was the first comprehensive national university in China. In 2013 it published 743 articles (WFC = 275.5) in the index, accounting for 21% of the city's WFC (see 'City WFC breakdown').

PKU's output is fairly evenly distributed across three of the four subject areas, the exception being earth and environmental

sciences (see 'Institutional subject spread').

The university is also the largest contributor to *Nature* and *Science* by article count, having published 14 articles (WFC = 4.1) in these two journals. It does not, however, have the highest ratio of output in these two journals (see '*Nature* and *Science* ratio').

Ning Jiao from the State Key Laboratory of Natural and Biomimetic Drugs is PKU's leading chemistry contributor, having published ten articles (WFC = 8.8) on organic synthesis. "One of the traditional methods for preparing aromatic nitriles uses cyanide, a toxic reagent that is bad for human health and the environment," says Jiao. "We developed efficient nitrogenation reactions for converting methyl, alkenyl or alkynyl groups to nitrile groups by incorporating a nitrogen atom into carbon-hydrogen or carbon-carbon bonds".

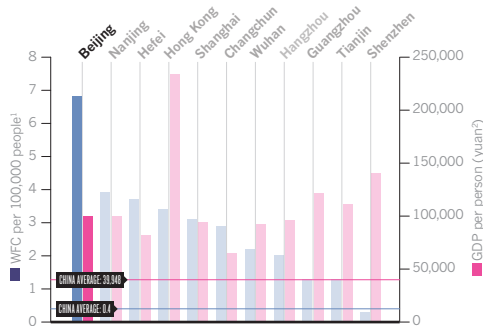
Other major chemistry contributors include Yong Huang from the Peking University Shenzhen Graduate School and Jian Pei from the college of chemistry and molecular engineering, with eight (WFC = 7.6) and ten articles (WFC = 7.5), respectively.

Huang studies asymmetric synthesis, essential for the development of novel drug molecules. Pei, meanwhile, develops conjugated polymers for use in organic field-effect transistors, solar cells and light-emitting diodes.

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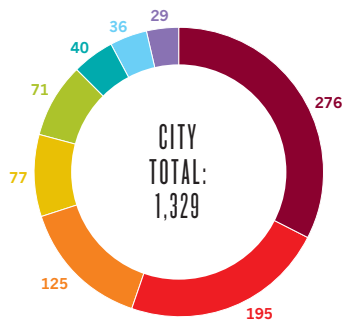
Beijing data

Beijing has the second highest GDP of any Chinese city, but far and away the highest WFC per person.



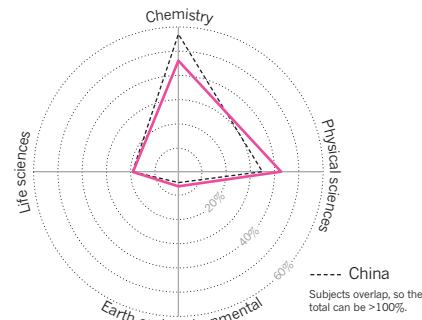
City WFC breakdown

Peking University is top of Beijing's 150 research institutions in the index.



City subject spread

Compared to China as a whole, Beijing has a stronger slant towards physical sciences.



■ Peking University ■ Tsinghua University ■ Institute of Chemistry* ■ Institute of Physics* ■ University of Chinese Academy of Sciences ■ Beijing Normal University ■ Institute of Semiconductors*



Beauty meets brains in the grounds of China's leading university, Peking

In physical sciences, Qihuang Gong from the State Key Laboratory for Mesoscopic Physics is the most prolific contributor, with 15 articles (WFC = 13.8) on optics and meta-materials. Other major contributors to this field include Bin Chen from the State Key Laboratory of Nuclear Physics and Technology and Bo Shen from the State Key Laboratory of Artificial Microstructure and Mesoscopic Physics. Chen published eight articles (WFC = 8) on the expansion, phase structure and thermodynamics of black holes, while Shen published seven (WFC = 4.3) on electric double-layer transistors, which can be used in next-generation computer chips.

For astrophysics, Yuefang Wu from the department of astronomy, and Xiaowei Liu from the Kavli Institute for Astronomy and Astrophysics are PKU's most active researchers in the index. Wu (who is officially retired, yet still active) published seven articles (WFC = 0.9) on molecular clouds and stellar formation, while Liu published five (WFC = 0.8) on planetary nebulae. Because of the down-weighting of astrophysics journals in the index, the WFC contribution of these researchers is relatively small (see 'A guide to the Nature Index', page S76).

For 2013, Tsinghua has 474 articles (WFC = 194.9) in the index, representing 15% of

Beijing's WFC. Compared to PKU, Tsinghua has a greater percentage of its output in the physical sciences.

Although Tsinghua's 12 articles in *Nature* and *Science* fall short of the number of PKU's publications in these most-selective of journals, its WFC of 5.4 is higher. Indeed, Tsinghua has the highest ratio of all the Beijing universities.

TSINGHUA IS NOTABLE FOR ITS STRENGTH IN STRUCTURAL BIOLOGY — 7 OF ITS 12 NATURE AND SCIENCE PAPERS ARE IN THIS FIELD

Yadong Li from the department of chemistry is Tsinghua's leading contributor, having co-authored seven articles (WFC = 6.4) on bimetallic nanocatalysts. Next is Xi Zhang, from the Key Laboratory of Organic Optoelectronics and Molecular Engineering, who has published six articles (WFC = 5.2) on supra-molecules, followed by Jinghong Li, from the department of chemistry, with seven (WFC =

4.9) — including one in *Nature Communications* — on graphene synthesis and biosensors. Li's technique to synthesize high-conductivity graphene uses a sodium-ammonia solution. "The method is simple, inexpensive and can be used in large-scale production," he says.

In the physical sciences, Shoushan Fan and Qunqing Li from the department of physics are the most prolific researchers. Together they co-authored five articles (WFC = 4.9) on strings of carbon nanotubes. "We made ultra-thin membranes using these special yarns," says Li. "They may serve as lacy support films in transmission electron microscopes."

Also notable at Tsinghua are Fei Zeng and Feng Pan from the school of materials science and engineering. Together they published four articles (WFC = 4) on organic resistive memory devices that operate on electrical pulses. "The technology can dramatically reduce the power consumption for large-scale applications," explains Pan.

Tsinghua is also notable for its strength in structural biology, where life sciences research meets biophysics and biochemistry. Indeed, 7 of its 12 *Nature* and *Science* papers are in this field.

The leading researcher is Yigong Shi from the school of life sciences. In 2013, Shi produced eight articles (WFC = 2.1) — including three in *Nature* and one in *Science* — on the structures of various enzymes, signalling proteins and transporters including aspartate proteases and histidine kinases.

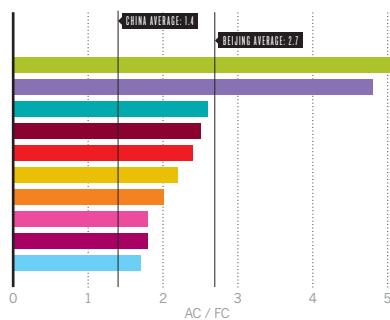
Other major contributors to the index from the same school include Yeguang Chen and Jiawei Wang, who between them produced six articles (WFC = 4.2) on the structures of several proteins that have important roles in cell signalling.

In particular, says Chen, their work shows that the tumour growth factor TGF- β plays a major role in malignancy. "This protein may serve as a drug target for inhibiting leukaemia," he adds. ■

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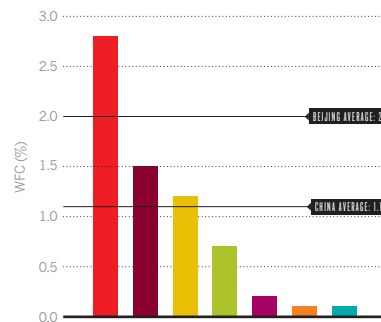
Collaboration rate

Institutes in Beijing are highly collaborative, led by UCAS.



Nature and Science ratio

Tsinghua University has the highest proportion of papers in these two journals.



Institutional subject spread

Beijing Normal University has the most balanced spread of subject areas.

