

# Shanghai

Shanghai has long been the commercial and financial centre of China. Because of its leading life–science research institutions, the city has become the hub for multinational pharmaceutical companies establishing a presence in China.

ARTICLE COUNT (AC): **1,646**  
 FRACTIONAL COUNT (FC): **734**  
 WEIGHTED FRACTIONAL COUNT (WFC): **712**

Shanghai, the most populous city in China, has undergone rapid expansion and economic transformation over the past few decades. Electronics, car manufacturing and steelmaking have long been integral industries, and now fine chemicals and biopharmaceuticals are becoming significant. In 2013, the metropolis spent US\$12 billion (3.4% of its gross domestic product, GDP) on research, and signed 9,274 technology transfer agreements — 86% of which were for electronic data services, biopharmaceuticals and advanced materials. Innovation-based industries are now responsible for 40% of the city’s GDP. Only one Chinese city — Beijing — has a higher output in the Nature Index.

Shanghai is home to 68 universities, 58 research institutes, 328 hospitals, and 400 joint venture or foreign-owned research centres. Of these, 63 institutions (including 13 institutes of the Chinese Academy of Sciences, CAS) are represented in the Nature Index. The Zhangjiang Hi-Tech Park, located in the central district of Pudong, is home to dozens of multinational pharmaceutical companies, including GSK, Roche, Novartis and Pfizer. This concentration of expertise cements Shanghai’s position as the world’s fastest-growing city in terms of economic contribution to the life-sciences industry, according to a 2012 survey conducted by the

Swiss consultancy BAK Basel Economics.

Nearly one-third of Shanghai’s research output is in the life sciences — a greater proportion than the national average (see ‘City subject spread’). Overall, the major contributing institutions are Fudan University, Shanghai Jiao Tong University (SJTU), East China Normal University (ECNU), East China University of Science and Technology (ECUST), Tongji University, and the Shanghai Institutes for Biological Sciences (part of CAS, see page S56), each of which contributes between 6% and 18% of the city’s weighted fractional count (WFC) — a measure of the relative contribution of an institution to the papers it has published (see ‘City WFC breakdown’).

Fudan is strongest in chemistry (see ‘Institutional subject spread’), particularly in materials chemistry. Huisheng Peng from the department of chemistry is the largest contributor, with nine articles (WFC = 8.6) representing more than 10% of Fudan’s output in this field. Peng has developed composite nanofibres that can be woven into paper-thin capacitors or used in flexible lithium batteries. “These materials perform like conventional planar batteries but are flexible and wearable,” says Peng. Such batteries might one day be used to power electronics in jackets and clothes, he adds.

Other major contributors from the same department include Dongyuan Zhao, Zhongsheng Wang and Yuping Wu. Each of these researchers published between three and five articles in a range of chemistry journals. Notably, one of Wu’s papers in the journal *Nano Letters*, titled ‘LiMn<sub>2</sub>O<sub>4</sub> nanotube as cathode material of second-level charge capability for aqueous rechargeable batteries’, was listed as one of China’s 100 most influential academic papers in 2013 by the Institute of Scientific and Technical Information of China. The highest individual WFCs in life sciences at Fudan are from Yanhui Xu and Qunying Lei, both from the department of biochemistry and molecular biology. Xu contributed to three articles (WFC = 2.5) — including one in *Cell* — on crystal structures of important proteins. Lei’s

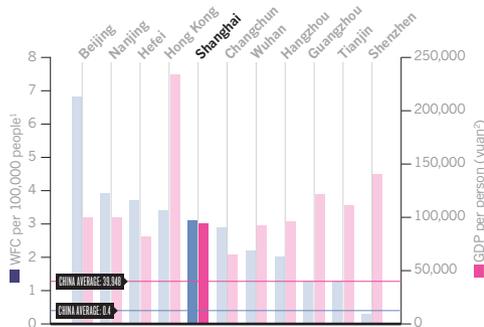
## NEARLY ONE THIRD OF SHANGHAI’S RESEARCH OUTPUT IS IN THE LIFE SCIENCES

Fudan is Shanghai’s premier institution for higher education and has the highest WFC of any institution in the city. In 2013, the 109-year-old establishment published 255 articles (WFC = 129.2), including three (WFC = 0.8) in *Nature* and *Science* (see ‘Nature and Science ratio’).

### SHANGHAI ANALYSIS

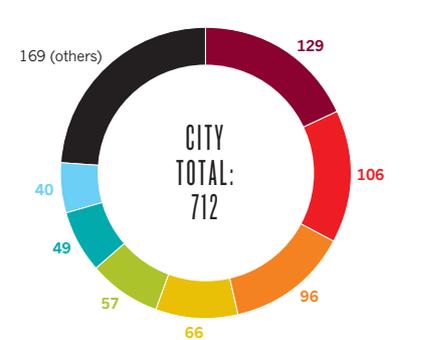
#### Shanghai data

Because of Shanghai’s large population, both WFC and GDP rates are diluted



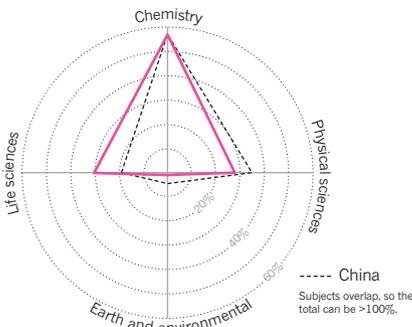
#### City WFC breakdown

Fudan University is top of Shanghai’s 63 research institutions in the index, including many CAS institutes.



#### City subject spread

Shanghai is one of China’s stronger cities in the index for the life sciences.



■ Fudan University ■ Shanghai Institute of Organic Chemistry\* ■ Shanghai Jiao Tong University ■ East China Normal University ■ East China University of Science and Technology



The dizzying heights of the Guanhua Twin Towers at high-flying Fudan University

three articles (WFC = 2.3) were on the molecular mechanisms behind several biological processes, including lipid biosynthesis, tumour growth and cancer development.

SJTU is a comprehensive university with a 117-year history. The index shows that in 2013, the institution had a wide range of research across chemistry, physical sciences and life sciences. There are four articles in *Science*, but because of their collaborative nature, these only earned SJTU a WFC of 0.2. Indeed, the institution also stands out as the Shanghai university most open to collaboration: its AC/FC ratio is the highest among the city's ten top contributors (see 'Collaboration rate').

Wanbin Zhang from the school of chemistry and chemical engineering is SJTU's largest contributor in chemistry. He wrote six articles (WFC = 5.7) on the development of catalysts for use in asymmetric synthesis. "We discovered one of the best catalysts for promoting the hydrogenation of pentacyclic compounds," says Zhang. Pentacyclic compounds are important precursors for the synthesis of natural products and pharmaceuticals, he explains.

Other major contributors from the same school include Yong Cui, who wrote four articles with SJTU colleagues (WFC = 4) on the development of porous materials for separating chiral molecules. Shun'ai Che also co-authored

four articles (WFC = 3.7) on inorganic materials exhibiting optical activity, including one in *Nature Communications*. Che explains that, prior to her research, the only materials known to perform optical rotation for linearly polarized light were organic polymers. "We discovered that titanium dioxide is an inorganic material exhibiting this type of optical activity," she says. The advantage of inorganic material is that it can more easily be incorporated into devices made of metals or into semiconductors, she adds.

In the physical sciences, Zhengming Sheng from the Ministry of Education Key Laboratory for Laser Plasma has four articles in the index (WFC = 1.9) on laser wakefields, a technique for accelerating charged particles to high energies. But Chong Lei from the department of physics and astronomy, had a higher WFC (2), with two articles co-authored with colleagues from the same university on tiny sensors for detecting microbeads and antigens.

Life sciences comprise just over a quarter of SJTU's output — one of the highest proportions among Shanghai universities. In this realm, the most prolific researcher is Saijuan Chen from the Shanghai Center for Systems Biomedicine. Chen, who researches leukaemia, published four articles (WFC = 2.6) in 2013 in *PNAS*. Other major contributors in the life sciences include Guang Ning from the laboratory of

endocrine and metabolic diseases, who published two articles (WFC = 1.4): one in *Nature Cell Biology* on white-to-brown fat transition; and one in *Nature Communications* on a special class of pancreatic tumours. Dabing Zhang, from the school of life sciences and biotechnology, also co-authored two papers (WFC = 1.3) — including one in *Nature Communications* — on hybrid rice. "We discovered a novel mechanism for controlling flowering development," says Zhang. This knowledge could be useful for improving rice yield.

ECNU and ECUST are the two Shanghai universities that concentrate most on chemistry. In 2013, ECNU published 123 articles (WFC = 65.6) in the index, and derives 63% of its WFC from chemistry journals. ECUST has fewer articles overall, at 95 (WFC = 56.8), but as it is almost entirely focused on chemistry it has a higher WFC than ECNU in this field.

Wenhao Hu, from ECNU's Institute for Advanced Interdisciplinary Research in Science and Technology, is the university's most prolific contributor; he co-authored eight articles (WFC = 7.4) on organic synthesis. "We discovered several three-component reactions for synthesizing small-molecule drugs," says Hu.

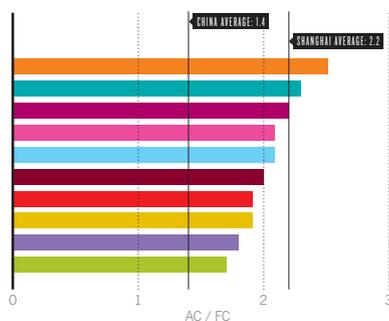
At ECUST, the most prolific contributors were Yitao Long and Huagui Yang from the school of chemistry and biomolecular engineering. Long contributed five articles (WFC = 4.1) on nanoparticles, and Yang wrote five articles (WFC = 3.6) on solar cells.

Although Tongji's output is only the fifth largest by WFC of Shanghai universities (excluding CAS institutes), it is first in terms of the proportion of publications in *Nature* and *Science*. In 2013, the 110-year-old establishment published five articles (WFC = 1.1) in these two journals, representing 2.8% of its WFC. One of these was a paper entitled 'Thin crust as evidence for depleted mantle supporting the Marion Rise' by Huaiyang Zhou — and is notable for being the first *Nature* paper in the field of marine geology with a Chinese lead author. ■

## SHANGHAI ANALYSIS

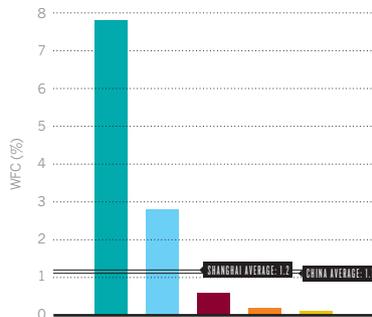
### Collaboration rate

SJTU has the highest collaboration ratio of the top ten Shanghai research establishments.



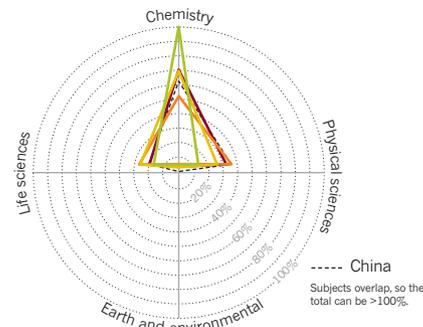
### Nature and Science ratio

SIBS has one of the highest ratios for publications in *Nature* and *Science* of any Chinese institution.



### Institutional subject spread

Excluding specialist CAS institutes, ECUST is the Shanghai institution most dedicated to chemistry.



\*CAS institute. 1. 360doc.com; 2. cnpop.org; yuan = US\$0.16

■ Shanghai Institutes for Biological Sciences\* ■ Tongji University ■ Shanghai Institute of Materia Medica\* ■ Shanghai Institute of Ceramics\* ■ Shanghai Institute of Microsystem and Information Technology\*