



GROWTH FACTOR

Mu-ming Poo is nurturing a Shanghai neuroscience institute that offers a glimpse of his country's future as a bioscience superpower.

BY DAVID CYRANOSKI

Mu-ming Poo leads a double life. For three weeks every month, he works in a cramped, cluttered office at the University of California, Berkeley. Looking drab in his dark-green pullover, olive trousers and black Adidas sports shoes, the 62-year-old neuroscientist slumps slightly in his chair. In the adjoining laboratory, half a dozen postdoctoral researchers, expected to work independently, go quietly about their business.

Cut to Shanghai, China, where Poo spends the remaining quarter of his time. In the director's office at the Institute of Neurosciences (ION), he sports a pressed, light-blue shirt neatly tucked into belted trousers (same trainers). With few books and papers about, the room seems more spacious than its Californian counterpart; mangoes and other fruit in a bowl provide a tasteful flourish. Here, Poo supervises only one postdoctoral researcher, but a dozen chattering graduate students are stuffed into an office, waiting for the hour that he sets aside for each one during his whirlwind visits. Poo sits straighter, talks faster and seems more alert, alive — younger, even. As stimulating as he finds his research in the United States, where he is a member of the National

Academy of Sciences, Poo finds a sense of mission in China. "It's more exciting, exhilarating here," he says. "They need me. I feel it's the best use of my life."

China is alive with possibilities in science, but realizing them is a complicated affair. The country's fondness for speed — for short-term achievements and, increasingly, short-term profits — has worked relatively well in the chemical and physical sciences and in large-scale genomics, where researchers can systematically tick off the chemical compounds or genetic sequences that they have produced (see 'Eastern promise'). But neuroscience and other fields of biology, which involve so many more unknowns, require more patience and a free-thinking academic culture that doesn't mesh well with some entrenched features of Chinese academia. Graduate students in China typically become cogs in their supervisor's machine, emulating his or her work. With quantity used as the yardstick for achievement, students churn out articles in minor journals. And principal-investigator positions are assigned by a bureaucratic tallying of young researchers' publications. The best scientists, therefore, are almost guaranteed to go to the United States or elsewhere to progress.

But that is changing, thanks in no small part to Poo and the ION, a decade-old institute with 26 research groups, 350 members of staff and an outsize reputation. Poo is sometimes criticized as a micromanager and dictator ("Maybe a benevolent dictator," he smiles), but ION students and group leaders revere him for his tireless mentoring, and for creating a US-style research culture geared towards top-level science. From his students, he demands critical thought and one first-author publication in a high-quality journal, rather than several in lesser ones. He evaluates faculty members and recruits on the basis of peer-reviewed publications and other achievements.

The results are clear. ION researchers authored China's first neuroscience papers in *Cell*, *Science*, *Neuron*, *Nature Neuroscience* and *Nature Cell Biology* and, until 2005, the ION accounted for more than half of all top-level neuroscience publications from Chinese institutions, by Poo's count. The ION's "primary accomplishment has been to put neuroscience on the map in China in a way that no other basic neuroscience-research institute in the country has done", says Richard Morris, a neuroscientist at the University of Edinburgh, UK, and a member of the institute's international advisory board.

Over the past two years, the government and the Chinese Academy of Sciences (CAS) in Beijing awarded the institute three major

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funding programmes that will allow it to double in size by 2020. And the institute is pumping out some of the world's sharpest, and most

aggressive, young neuroscientists, who are seeding its culture elsewhere. "It is exciting to see that high-quality neuroscience research has spread beyond the ION to other institutions throughout China," says Bai Lu, who helped Poo to draft the proposal for the ION and is now vice-president of biology at the pharmaceutical company GlaxoSmithKline (GSK) China in Shanghai.

Even Westerners can see the tide turning. "It is only a matter of time before students will remain in China for their postdoctoral training," says Thomas Insel, director of the US National Institute of Mental Health in Bethesda, Maryland. "And perhaps in a few years, we will be seeing US students and postdocs applying for positions in China."

THE DILETTANTE

Born on the mainland and raised in Taiwan, Poo earned a degree in physics at Taiwan's elite Tsinghua University before moving to the United States, and into biophysics. His early studies of the movement of cell-membrane proteins led to an interest in events at the synapse, the junction between two neurons — and then onto synapse formation and plasticity, the process by which the junctions change with neuronal activity. His conversion from physicist to biologist defined

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a dilettante approach that he has maintained to this day. "I have a rather unconventional style," says Poo. "I don't work on one problem until it's fully solved. I tend to skip around."

Poo says what he thinks, an approach that he acknowledges has made him some enemies. And he is as direct when poking holes in the Chinese research system as when pinning down the next key experiment. He took that attitude to the ION, which opened in 1999. Although the institute was part of the crusty CAS, Poo's mandate was to transform how science is practised in China by operating with autonomy and a Western style.

To replace the bureaucratic review of scientific work in China, for example, Poo brought in an independent review system that applied even to esteemed CAS members. "That was totally unheard of," says Poo. One refused to be assessed, and left. In a review last year, two out of eight research groups at the ION got a 'conditional' pass, meaning that they need to publish within two years or risk dismissal.

The institute spans the range of basic neuroscience, from sensory mechanisms to neurodegeneration, stem cells and genetics. Following the US system, ION students — 20 or so graduate with PhDs each year — rotate through three different laboratories, evaluate their experiences and then choose a principal investigator as a thesis supervisor. Poo encourages students to critique articles in

Nature, *Science* and *Cell*, which are often considered unassailable in China. He arranges for renowned scientists to give lectures, and asks his students to grill them with challenging questions. The ION was also the first CAS institute to allow a departing investigator to take, with some compensation, equipment and reagents to their next employer. "That offered the mobility that this country needs," says Poo.

Meanwhile, Poo's research continues full steam at Berkeley, where he has worked since 2000. He studies how neural activity shapes neural circuits, and increasingly how these mechanisms correlate with wider behavioural patterns such as learning and addiction.

In one project, Andrei Popescu, a postdoc in Poo's Berkeley lab, is using mice to improve understanding of a phenomenon seen in children in the 1990s. Researchers at Rutgers University in Newark, New Jersey, found that when children were trained to overcome a hearing problem using rewards for success such as entertaining computer animations, they improved not just in the specific hearing skills, but also in broader language abilities^{1,2}. Popescu and Poo hope to understand that process of 'generalized' learning by mimicking it in mice. Poo's hypothesis is that learning a reward-associated task modifies the brain's dopamine-based reward circuit, which is also thought to have a role in drug addiction³, in a way that makes an individual a better learner for other tasks. As Poo suggests, the subjects become "addicted to learning".

Poo's teaching philosophy mirrors his research hypothesis. He wants students to get hooked on research with the high of an early influential publication. "Those who get frustrated and give up — it's because they didn't have enough self-discipline to make the first success," says Poo, who became hooked with his own paper in *Nature* in 1974 (ref. 4).

Poo works hard to shore up that discipline. Besides the monthly supervisory sessions with each of his ION graduate students, he holds weekly lab meetings over Skype. He reads all manuscripts from the ION to ensure that they are up to scratch. With two labs on different continents, not to mention an entire institute to run, how does he fit it all in? "I put in more time, more effort," he says. "I take no weekends. I work like a dog. I'm here every night."

THE TAO OF POO

Poo's reputation took a public beating in 2002, when one of his Berkeley lab members posted online an e-mail in which Poo lamented the group's poor progress. "If there is no drastic change in the lab, Poo lab will soon cease to be a productive, first-rate lab that you chose to join in the first place," he wrote, before imposing strict rules, including a minimum 50-hour, 6-day working week spent mostly at the bench (reading papers was for after-hours). Anyone who chose not to follow the rules should "start making plans immediately and leave the lab".

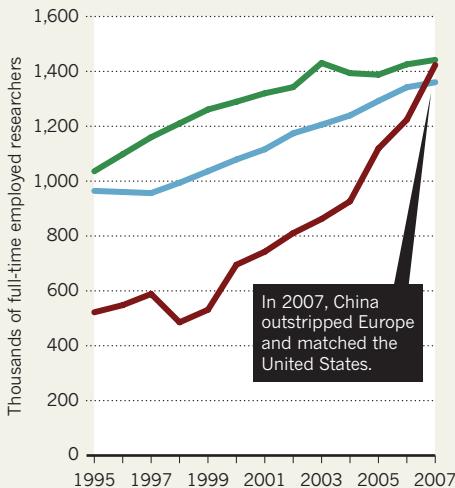
EASTERN PROMISE

Chinese science is flourishing,
but still has a way to go.

United States European Union China

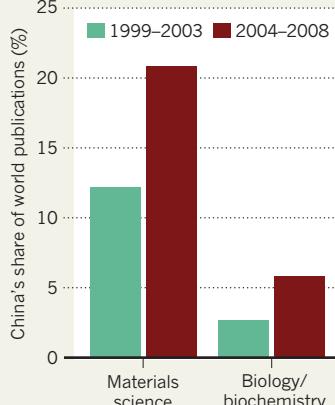
POPULATION BOOM

The number of scientists has grown faster in China than elsewhere.



MATERIAL WORLD

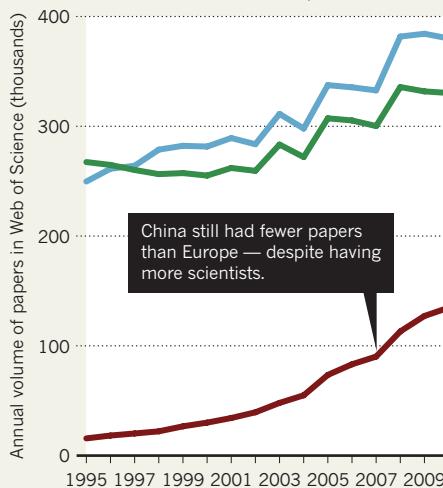
Progress in biology lags behind that in materials science.



Annual volume of papers in Web of Science (thousands)

Scientific publications have increased around the world in the past decade.

China still had fewer papers than Europe — despite having more scientists.



One student did.

Poo stands by his words. "Young people, if they want to make it in sciences, must work hard," he says. Did the letter have an effect on his ability to get graduate students? Poo pauses. "It had a screening effect." His last Berkeley PhD student graduated last year, and he hasn't actively recruited since. "I don't have the time to mentor them," he says. The lab has shrunk from some 20 people in 2007 to just 6.

Popescu says that images of Poo as a dictator are off-base. Two conversations with former lab members quickly reassured him before he joined. "I thought it better to trust people who had been there than something posted on the Internet," he says. Poo's dozen Shanghai students, who come from nearly as many provinces around China, describe an intense but supportive and tolerant atmosphere. One boasts about starting work days at noon (although admits working six or seven days per week). Hailan Hu, a principal investigator at the ION, says that Poo's meticulous attention — he "doesn't just fix the paper but also teaches grammar and presentation skills" — is "difficult for him but great for the students. You need to book him in advance".

Insel recalls a visit to the ION a couple of years ago that "left quite a lasting impression". Challenging questions from graduate students and the intense focus of the faculty members, he says, "all left me with a very profound sense of respect for what Mu-ming Poo and his colleagues were building in Shanghai".

FERTILE GROUND

In 2009, the CAS approved a ten-year plan to expand the ION to 50 laboratories. In the same year, it selected the centre as a 'trial institute' for stable funding and doubled the support per investigator from 600,000 renminbi

(US\$93,000) to 1.2 million renminbi. Stable funding now covers 40–50% of the ION budget, in comparison with 30% before. Research grants make up most of the rest. Poo scored an even bigger coup this year, when his 'neural basis of intelligence' project was selected to receive one of China's largest and most sought-after basic-science grants, as part of the science ministry's National Basic Research Program. Only 11 projects were selected this year, and just 3 in biological sciences. With 80 million renminbi for the next five years and a promise that the project will continue for another ten, Poo is now building a national programme and recruit-

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ing a dozen research groups from ten institutions, in addition to the existing ION groups.

Signs of China's impending boom in neuroscience are evident elsewhere. In

2008, East China Normal University in Shanghai launched an Institute of Cognitive Neuroscience, full of returnees from the United States, and started planning a large primate centre. This April, Patrick McGovern, a technology and media tycoon who bankrolled the McGovern Institute for Brain Research at the Massachusetts Institute of Technology in Cambridge, agreed to donate \$10 million to form a sibling institute at Tsinghua University in Beijing. He is negotiating similar agreements with Beijing Normal University and Peking University.

But the rapid progress in Chinese neuroscience is creating problems for the institute that is driving it. GSK's international neurodegenerative-disease research base — attracted to Shanghai partly because of the ION — has recruited at least seven graduate students from

the institute, many of whom, Poo laments, left without finishing a doctorate. The ION has also lost senior staff to the National Institute of Biological Sciences in Beijing, and other universities. Poo blames the departures on better salaries elsewhere, although a critic — who does not want to be named — points to his 'overly controlling' managerial style. Either way, more than half of the researchers at the ION have been there for fewer than five years; and publications in leading journals have dropped. Poo created a fluid system, and the people flowed. "But I don't worry," he says. "It's a place to start your career. It's a nursery."

Poo is still sceptical about the future of Chinese science. He worries that misconduct is still tolerated and that the country's work ethic is being eroded, with students demanding comfortable living arrangements, better food and vacations. And Poo pooh-poohs the government's readiness to give huge packages to scientists solely because they have worked overseas. "That's no way to cultivate native talent," he says.

Listen to Poo talk about China, and it sounds as if the country might not soon become a global force in biological sciences. But watch what he does, and the signs of the country's emergence in this field are clear. "I have 40 years of experience in first-rate institutions," he says. "If you want this to be a first-rate institution, follow me."

And China is following. ■ SEE EDITORIAL P.5

David Cyranoski is Nature's Asia-Pacific correspondent.

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