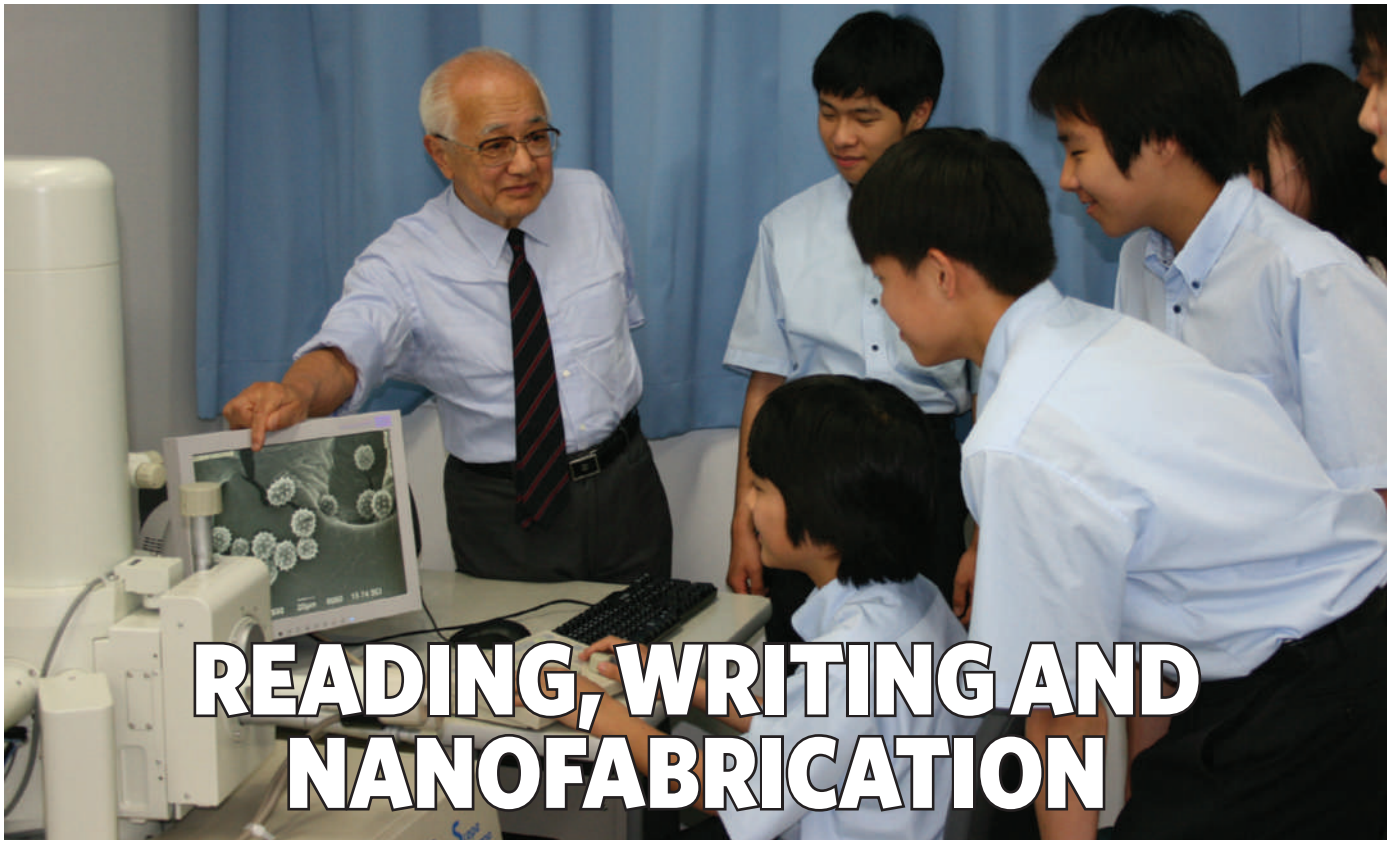
YSFH

READING, WRITING AND NANOFABRICATION

With its electron microscope, genetic sequencing machines and observatory, the Yokohama Science Frontier High School is equipped like no other. Will future scientists be inspired there, asks **David Cyranoski.**

The timetable for 15-year-old students at Yokohama Science Frontier High School (YSFH) can be busy. Before break, they might grow single-layer carbon nanotubes in argon gas and evaluate them with micro-Raman spectroscopy. After break, there are polymerase chain reactions (PCR) to be done. Things don't slow down after class, when students stick around in the observatory to glimpse star clusters or Saturn's rings from the school observatory. The equipment list at Japan's first dedicated science high school, which began classes in April, could rival a small research institute.

The school is also a sophisticated experiment. Its main champion, biophysicist and genomics pioneer Akiyoshi Wada, hopes a "flood" of such institutes will open up throughout the country, inspiring students and Japan's future leaders. Wada thinks that the school is key to reversing children's waning interest in mathematics and science, a phenomenon that has attracted political hand-wringing and has even been given a name — *rika banare*.

As one of five 'super advisers' to the school, and the only one with a permanent position there, Wada has been instrumental in its creation. He spent most of his four-decade career initiating, managing and administrating ambitious science projects aimed at keeping Japan at the forefront of international scientific trends. A decade ago, when the city of Yokohama asked Wada to be on the planning committee for a new high school, he brought the same bold, uncompromising vision. "It was precisely because of Dr Wada that the school was able to establish its educational principles and goals," says the school's principal, Haruo Sato.

There are wrinkles to be ironed out. The school will be open to accusations of elitism and, with a price tag of ¥9.5 billion (US$100 million) — not including the land, which was donated by the city — some people ask whether the model really has a chance of spreading.

Wada answers yes to the question before it is even finished. But he acknowledges that the Yokohama experiment has much to prove. "The future of science education in Japan will depend greatly on the success of the YSFH," he says, "and I am aware of that massive responsibility."

Ancient roots

Wada is softly-spoken. On a tour of the five-floor, 25,000-square-metre buildings that overlook the Tsurumi River, he trails behind letting an English teacher, Yukimasa Uekusa, lead. Wada seems proudest of the finer details, such as the two famous trees outside — a descendant of the apple tree in Isaac Newton's garden and an offshoot of the grape vine used in some of Gregor Mendel's experiments — and the larger-than-life images of famous scientists that cover many of the walls. "The captions are all in English," he says. "They need to learn English." Besides spending 2–3 days a week at the school, Wada also runs the 'Wada Salon' where he discusses, over tea and scones, recent scientific articles and ethical issues.

Visiting scientists might be more interested in the instruments, such as the 30-centimetre automated telescope with a retractable dome. For this and other expensive equipment, the school is devising a system by which students who have shown themselves to be capable of handling a machine will receive a licence to do so without supervision.

Few schools in the world can match this level of instrumentation. Jim Jarvis, division manager for science and technology at the Thomas Jefferson High School for Science and Technology in Alexandria, Virginia, says that his school, like the YSFH, has a telescope, a scanning electron microscope and PCR machines. But his wish list would include some things that Yokohama has but he does not, such as multiple fume cupboards and gene sequencers.

Judy Scheppler, who directs the Grainger Center for Imagination and Inquiry at the Illinois Mathematics and Science Academy (IMSA) in Aurora, says the nanofabrication and nano-observation facilities at Yokohama are what sets it apart. "Different schools around the country and the world may have some of

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Akiyohshi Wada and Yokahama students (inset). The school (above) is next door to the RIKEN Genomic Sciences Center.

this. But one school having everything is extraordinary," she says.

Sophisticated instruments don't mean much without sophisticated instructors, and the YSFH is providing those too. Before taking up his teaching post, for example, Yutaka Mizogami spent a year training in a Tokyo University laboratory. There he got his name — and his affiliation with the YSFH — in the scientific literature as a co-author[1]. He says he decided to come to the YSFH because he was tired of only being able to give 10% of his time to experiments at his previous school. He is happier now with 30%.

In its first year, the school had more than 5 applicants for every one of its 240 spots for 15–18-year-old students — compared to 3 applicants for a place at the next most popular school in the Kanagawa prefecture. The main reason to come, according to a survey, was the chance to do experiments. In person, some students told *Nature* it was because the teachers are fun. One said he wants to make artificial muscle. Another expressed an interest in methane hydrates.

When talking to students like this, it is hard to believe that there is much to *rika banare*. But politicians have been worrying about science education since 2004, when Japanese 15 year olds dropped from first to sixth in standardized mathematics tests taken the previous year and other science scores started falling. Japan had always prided itself that on such tests it was at or very near the top. By 2006, the last year for which these figures are available, the country ranked tenth in maths and sixth in science.

The counter-attack

Rika banare has inspired the government to designate more than 100 'super science high schools' that receive ¥50 million per year for three years to enhance science education. Wada describes this as a "broad but shallow" first step. Noting the decline in standardized test scores, Wada boasts: "The students at the YSFH will be at the vanguard of a 180° reversal of this trend."

> **"The future of science education in Japan will depend greatly on the success of the school."**
> — Akiyoshi Wada

Wada has long been persuading policy-makers that high-impact science sometimes requires a concentration of resources — although he hasn't always got his way. As a biophysicist in the 1970s, Wada ran into many sceptical biologists when he was one of the first to envision large-scale automated genomic sequencing. But even as these technologies were ramping up elsewhere, Japan's bureaucrats stalled, its genomics fell behind, and when the human genome sequence was finished, Japan accounted for only 6% compared to the 59% and 31% that the United States and United Kingdom produced respectively. The unfolding of Wada's failed efforts are described in a book aptly titled *A Defeat in the Genome Project*[2].

Later, Wada had better luck in turning his vision into reality. He was a key player in creating and maintaining the international Human Frontier Science Program, initiated in Japan in 1989, that has funded 3,000 scientists involved in collaborative projects, including 13 who went on to win Nobel prizes[3]. In 1998, Wada became the founding director of the RIKEN Genomic Sciences Center (GSC) in Yokahama, Japan's first large-scale effort at comprehensive genomics. The generously funded centre led Japan's human- and primate-sequencing efforts and rose to international acclaim with its project to catalogue the active, 'transcribed' parts of the mouse genome[4–5]. "He is a straight-talker, sometimes harsh, but never goes wobbly in his vision and decision," says Yoshihide Hayashizaki, who led the RIKEN mouse project. "I guess that this is why he motivates others to follow him."

Will others follow Wada and his vision for the Yokohama high school? The biggest sticking point in negotiations was the initial cost, which was paid by Yokohama city. Even so, Wada says there have already been half a dozen other regional governments calling to enquire about the school. Scheppler says that select high schools tend to come under pressure because only a few students benefit from their extraordinary facilities. "Shouldn't every student get an excellent science education?" she asks. Wada is sensitive on this point. "Children with outstanding ability, even those from poor households, will be able to take advantage of the low-cost tuition and receive a great education," he says. As it is a public school, students must pay only ¥9,900 a month.

Nobel laureate chemist Ryoji Noyori, president of RIKEN in Wako, says that the school will help to undo the "totally egalitarian public education system in our country". Japan has been chipping away at this way of thinking, and university funding is increasingly focused on competitive funding and centres of excellence. But there is no guarantee that the privileged science track that Yokohama students start on will continue after they graduate. "I fear some students will be disappointed when they later enter the national universities," says Noyori.

Wada is intent on exposing the students to the more luxurious end of Japanese research. The school sits next door to the RIKEN GSC and has collaborative agreements whereby they can use some of the centre's facilities.

Like Wada's other big ventures, this one will eventually be judged on its results: whether the originality being cultured there and at its potential spin-offs translate into improved standardized test scores and a new generation of inspired scientists. Jarvis says that two-thirds of the Jefferson school's 450 annual graduates work in science-related fields. If nanofabrication and PCR can incite a similar passion for science in Yokohama's teenagers, Japan's great experiment in science high schools will have paid off. ■

David Cyranoski is *Nature*'s Asia-Pacific correspondent.

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See Editorial, page 151.