THIS WEEK

EDITORIALS

VOTING Maths researchers help overturn partisan electoral fiddling **p.250**

WORLD VIEW Reach out for voices from developing nations **p.251**

SANCTUARY Peru sets up nature reserve in Amazon rainforest **p.255**

Chinese science is ready to step up

The country seems to be on course to sail into scientific dominance, but it must listen to what researchers at home and abroad really need.

In the past 12 months or so, China has opened its first facility for research into the world's most dangerous pathogens, unveiled another world-leading telescope and turned on its first world-class neutron source. Researchers in the country have also established a neuroimaging factory to automate the highly detailed imaging of human brains.

Money has poured in, too. Chinese artificial-intelligence (AI) companies, in a crowded field, impressed international investors. Companies specializing in computer-vision technology pulled in more than US$1 billion in investment last year. Legend Biotech in Nanjing reported positive results from a clinical trial of a CAR-T therapy — showing its clout in a highly competitive field in which researchers engineer a patient's own cells and reintroduce them to treat cancer. In response, Janssen Biotech of Horsham, Philadelphia, put $350 million into further development of the therapy.

Look at most scientific indicators — publications, patents, number of researchers — and China seems to be on course to sail into scientific dominance. And, as many observers point out, that could happen much sooner than anyone previously expected if the US government continues to hold policies as destructive to science as those pushed by the administration of President Donald Trump. The upshot of this is a lot of opportunities for researchers in China. A Career Guide starting on page S1 this week offers details on how to embrace them.

But pitfalls lie in wait if officials and researchers in China are not careful. The country's AI research, for example, is booming right now, with publications outpacing those produced in the United States. But researchers acknowledge that many of these papers are not of particularly high quality. They also wonder whether Chinese academia or industry will invest in the ways necessary to create fundamental breakthroughs in the field.

As we discuss in a News story on page 260, billions of dollars announced for a provincial AI park in China came as a surprise to many AI researchers in the capital, Beijing. This doesn't bode well, because it suggests a top-down effort made without consulting the research or academic community. Existing pricey science parks dedicated to trendy fields such as biotechnology and software development have produced mixed results and raised the question of whether resources are being wasted on fancy infrastructure.

Meanwhile, China might ratchet up its firm grip on the Internet. If it does so, many scientists there could lose access to the virtual private networks that they use to bypass restrictions and reach crucial websites such as Google Scholar. That would cut off access to literature, results and discussion, and isolate them from the international community.

Despite China's claim to the throne of scientific superpower, the government retains a soft spot for unproven claims of traditional Chinese medicine. (This is one area in which the United States, in its attempts to rein in naturopathy and homeopathy in the past two years, seems to be cleaning up its own scientific house.)

The lack of transparent or predictable funding decisions could also derail China's ambitions. Although the National Natural Science Foundation of China is generally well regarded for the grants it distributes, however small, larger projects continue to be marked by disarray. Neuroscientists have been sounded out to join a multimillion-dollar national programme meant to rival (and hopefully complement) brain-science projects in the United States, Europe and Japan. But so far, all the Chinese project has produced is false starts and confusion as scientists attempt to ready their research programmes to align with a national project that is always just around the corner.

"Lack of transparent funding decisions could derail China's ambitions."

China is right to praise itself for its accomplishments in building a successful scientific community. And its stated goals of becoming an attractive place for foreign or returning scientists and a more desirable partner for international collaborations are the right ones for a country ready to take up a much needed leadership role and act as a model for other nations. But China will need to make more effort to listen to its scientists and survey the needs of researchers elsewhere to find out what problems — including those mentioned above — might hamper attainment of those goals. ■

Vaccine boosters

A new French law that makes immunizations mandatory is not the only way to improve.

It is one thing to be certain (as *Nature* is) that widespread immunization is a vital tool for public health. But it is much more contentious, given the diversity of humanity's ethical and cultural norms, to impose vaccinations on a population. That diversity is reflected, for example, by differing choices among countries in Europe: some (mostly the post-Soviet Union states) make vaccinations for many diseases mandatory, whereas the majority do not.

France is now providing a case study of exactly these debates.

A new French law requires that babies born after 1 January be vaccinated in their early years against 11 diseases. Previously, vaccines against only three of these — diptheria, tetanus and polio — were mandatory. The others were recommended, but the decision was left to parents. Now, children must also be vaccinated against *Haemophilus influenzae* B, hepatitis B, pertussis, pneumococcal disease, meningitis C, measles, mumps and rubella. Those who haven't had all their immunizations, including booster shots, the government says, will be refused admission to nurseries, schools and camps in France.

This policy is dividing public-health scientists in the country. Many French general practitioners are among those who argue that the measure is authoritarian and could backfire, not least by alienating parents and increasing wariness of vaccines in a country where various health scandals (most infamously, HIV-infected blood transfusions given in the early 1980s to people with haemophilia) have spread mistrust of health authorities.

Misguidedly, authorities seem to think that the new law is a pertinent response to scare stories about the safety of childhood vaccines, in particular, those told by anti-vaccine groups. Countering such misinformation is important, but does not alone constitute the basis for a coherent vaccine policy. Data on vaccine coverage of most diseases in France show that the situation is now better than it has been in years. Coverage rates for some newer vaccines are too low, but have nonetheless been increasing; the rates of meningitis-C vaccination, for example, have steadily increased since it was introduced a decade ago, from just 48% among 2 year olds at the end of 2011 to 71% in 2016. But vaccine coverage in France for most diseases is high overall. The challenge is rather to develop policies that will get the stragglers vaccinated to ensure that enough of the population is immunized to surpass the thresholds needed for herd immunity.

To portray societal hesitation about vaccination as a simple battle between anti-vaccine groups and ignorant populations on the one side, and scientific reason and public health on the other — as the French government has done — promotes an unproductive and sterile controversy, and a simplified view that obscures complex issues, such as the multiple causes of 'vaccine hesitancy' in populations, and the fundamental role of building trust in health-care institutions and information from government and scientists.

One of the biggest practical problems that France faces is the often poor follow-through of booster shots. Health data show that only eight in ten babies get the MMR booster (for mumps, measles and rubella) due at 18 months of age — a lower rate than in many other countries, and a problem because it weakens herd immunity in the population.

This has no-doubt contributed to a slight recrudescence of measles in the country, with a few dozen to a few hundred cases annually — and in particular, to an epidemic of several thousand cases in 2010 and 2011. But the French government's reaction of making childhood vaccines mandatory is simplistic, and reneges on the administration's greater responsibility to work patiently hand in hand with health-care workers and the public to improve what is already high take-up of vaccines. Multiple studies show that simple reminders — text messages among them — of when vaccines and booster shots are due can have a big impact on compliance and coverage. The same is true of national electronic vaccine-information systems to track people's vaccinations, an area in which much progress remains to be made.

"The challenge is to develop policies that will get the stragglers vaccinated."

To its credit, the French government has pledged to review annually the compliance and impact of the new law. But in a country where '*liberté*' is one of the three pillars of the national motto, the heavy-handed law could do something that nobody involved wants: fuel further unfounded resistance to life-saving vaccines. Making vaccines mandatory should be at most a stopgap. The only sustainable policy is for the government to put its efforts into making a strong case to the public about the benefits of vaccinations, and to better use the available evidence to implement more proactive strategies that can extend already respectable coverage rates for most diseases to those vaccines that are lagging. ■

Electoral plot

Maths helps to catch Republican politicians who unfairly fiddled with voting districts.

Mathematicians are no longer devices for turning coffee into theorems, as the Hungarian mathematics researcher (and caffeine addict) Alfréd Rényi is said to have claimed. They seem pretty useful for preserving democracy, too. In striking down the way that officials in North Carolina unfairly partitioned the state into electoral districts, a US federal court last week conspicuously cited the work of mathematicians including Jonathan Mattingly, an expert in mathematical modelling.

In a 200-page decision released on 9 January, the three-judge court in Richmond, Virginia, said that the districting had unfairly favoured the Republican Party. Maths played a key part in helping the court to reach that decision, by demonstrating the unlawful use of partisan gerrymandering — fiddling with district boundaries to include or exclude certain voters and steer the results of an election. Those apportioning districts might draw borders that pack large numbers of voters for an opposition party into a small number of districts, for example, limiting the number of seats that the opposition can win. The process has been likened to allowing lawmakers to choose their voters, rather than the other way around.

Mattingly, a researcher at Duke University in Durham, North Carolina, used his expertise to argue that the state districts were drawn up to give Republicans an unfair advantage. To do so, he used an algorithm that produced around 24,000 maps of marginally different district configurations that were randomly drawn on the basis of geographic criteria. The Republican-drawn boundaries, which had delivered 9 Republicans to the state's 13 seats in the House of Representatives in Washington DC in 2012, were more gerrymandered than practically every single one of Mattingly's algorithm-derived maps. Using the same voting data, his maps nearly all gave a larger number of wins to the Democratic Party and, in many cases, gave it the majority.

Mattingly had taken an interest in the process after the 2012 elections and was called to testify after two advocacy organizations sued the state in federal court following the 2016 elections. In October, they asked Mattingly to take the stand and explain his work and its implications. He was ready: by then, he and his collaborators had done more-recent studies of the state's current redistricting, engineered in 2016 by the Republican majority in the North Carolina General Assembly.

Some of the modelling is preliminary, but it has had a historic impact: last week's ruling was the first time that a US federal court has struck down electoral districting for favouring one political party over another. (Previous rulings have done so for other reasons, such as racial disparities.) Gerrymandering is not exclusive to North Carolina, or to the US Republican Party. Courts have struck down pro-Democratic redistricting in Maryland, for example, and similar cases are being debated in the United Kingdom and elsewhere.

Last week's ruling is not the final word on North Carolina's system. The General Assembly has filed an appeal, and the case is likely to end up in the US Supreme Court. The court has ruled in the past that politically motivated gerrymandering was illegal, but also that there were no objective metrics to establish it.

But that is what Mattingly and others have been working to change — and the computer simulations could be needed more than ever. The upcoming 2020 US census will trigger widespread redrawing of electoral districts, and there are already concerns that gerrymandering will be rife.

Mattingly and other academics who study electoral systems are organizing to train their colleagues on the science of gerrymandering, and how to communicate it to a non-mathematical audience. One summer camp held last year had planned for 50 attendees; more than 1,000 applied. That's a lot of coffee — and all of it consumed in a good cause. ■