BIOMEDICINE

India pushes for animal alternatives in research

Technologies that model human disease are fast improving.

GAYATHRI VAIDYANATHAN

India has become the latest nation to explore using emerging technologies such as organs-on-a-chip to replace animals in research. Last month, the national regulator for biomedical research recommended fast-tracking investments in technologies that can replace animals. Some Indian scientists have welcomed the plan, but they say that alternatives for drug toxicity and efficacy tests are not yet sufficient to replace animals.

They also note that a move towards alternative technologies will require a costly overhaul of the drug-approval process in India, which requires medicines to be tested in animals.

Emerging technologies that model complex human physiology — such as organoids and organs-on-a-chip, which are laboratory-grown versions of human tissues — are starting to rival, and in some cases outperform, animals in their ability to model human disease, according to the Indian Council of Medical Research (ICMR).

In a discussion paper (S. Swaminathan, V. Kumar & R. Kaul *Indian J. Med. Res.* **149**, 584–592; 2019), a team representing the ICMR that includes Soumya Swaminathan, the council's former director-general and now deputy director-general at the World Health Organization, argue that such technologies, and others including computer models that simulate drug toxicity, are more cost-effective and humane than animal testing. They are calling for the government to establish centres of excellence for developing such approaches, and to increase funding and collaborations for alternative technologies.

The United Kingdom and the United States have road maps for developing non-animal technologies, and in September the US Environmental Protection Agency stated plans to limit the use of animals in toxicity tests.

The paper notes that after two decades of drug-discovery research using animals, India has not developed a single new drug that has made it to market. This is because molecules that were safe and efficacious in animals were later found to be toxic or ineffective in humans, says Swaminathan.

Some researchers,including Thomas Hartung, director of the Center for Alternatives to Animal Testing at Johns Hopkins University in Baltimore, Maryland, say there are technologies that provide reliable ways of testing for toxicity. He has developed an algorithm that has successfully predicted the toxicity of tens of thousands of chemicals in human tissue — and in some cases has outperformed animal tests in terms of reliability.

But Addicam Jagannadha Rao, an emeritus biochemist at the Indian Institute of Science in Bengaluru, says that studying disease or toxicity in a dish does not show how drugs are metabolized in the whole body. "I am for the judicious use of animals," says Rao.

Amit Misra, a pharmacokinetics researcher at the Central Drug Research Institute in Lucknow, India, acknowledges that animal toxicity studies do not always translate well in humans. But he doesn't think organs-on-a-chip or disease-in-a-dish models will be any better. Instead, he thinks toxicity studies in a small number of consenting patients should replace animal studies. ■

ASTRONOMY

China's gigantic telescope opens to the world

Astronomers around the globe can use data from the super-sensitive radio telescope.

BY ELIZABETH GIBNEY

The world's largest single-dish radio observatory is preparing to open to astronomers around the world, ushering in an era of exquisitely sensitive observations that could help to hunt for gravitational waves and probe the mysterious fleeting blasts of radiation known as fast radio bursts (FRBs).

The Five-hundred-meter Aperture Spherical Radio Telescope (FAST) in southern China has just passed a series of technical and performance assessments, and the Chinese government is expected to give the observatory the final green light to begin full operations at a review meeting scheduled for this month. "We do not see any roadblocks for the remaining transition," says Di Li, the chief scientist of FAST. "I feel both excited and relieved."

The complex project has not been without challenges — it has a radical design and initially struggled to attract staff, in part because of its remote location. But the pay off for science will be immense. FAST will collect radio waves from an area twice the size of the next-largest single-dish telescope, the Arecibo Observatory in Puerto Rico.

The Chinese observatory's massive size means that it can detect extremely faint radio waves from sources across the Universe, such as the spinning cores of dead stars, known as pulsars, and hydrogen in distant galaxies. It will also explore a frontier in radioastronomy — the use of radio waves to locate exoplanets, which might harbour extraterrestrial life.

Since testing began in 2016, only Chinese scientists have been able to lead projects studying the telescope's preliminary data. But now, observation time will be accessible to researchers from around the world, says Zhiqiang Shen, director of the Shanghai Astronomical Observatory and co-chair of the Chinese Academy of Sciences' FAST supervisory committee.

"I'm super excited to be able to use the telescope," says Maura McLaughlin, a radio-astronomer at West Virginia University in Morgantown, who wants to use FAST to study pulsars that are too faint to see with current telescopes, including those in galaxies outside the Milky Way.

During the testing phase, the telescope discovered more than 100 pulsars.

EYE IN THE SKY

The 1.2-billion-yuan (US$171-million) telescope, also known as Tianyan or 'Eye of Heaven', took half a decade to build in

FAST could help to hunt gravitational waves.

QU DONGQU/XINHUA/ZUMA

the remote Dawodang depression in the Guizhou province of southwest China. Its 500-metre-wide dish is made up of around 4,400 individual aluminium panels that more than 2,000 mechanical winches tilt and manoeuvre to focus on different areas of the sky. Although it sees less of the sky than some other cutting-edge radio telescopes, and has lower resolution than multidish arrays, FAST's size makes it uniquely sensitive, says Li.

In August and September, the instrument detected hundreds of bursts from a repeating FRB source known as 121102. Many of these bursts were too faint to be perceived by other telescopes, says Li. "This is very exciting news," says Yunfan Gerry Zhang, who studies FRBs at the University of California, Berkeley. No one knows what causes the mysterious bursts, but "the more pulses we have, the more we can learn about them", he says.

FAST examines only a tiny fraction of the sky at any one time, making it unlikely to discover many new FRBs, which are fleeting and occur in seemingly random locations. But the telescope's "impressive sensitivity" will be useful for following up on sources in detail, says Laura Spitler, an astronomer at the Max Planck Institute for Radio Astronomy in Bonn, Germany. Repeat observations could allow scientists to learn about the environment from which an FRB emerged, and to determine whether the blasts vary in energy or recur with any set pattern.

FAST will also boost the efforts of an international collaboration that is trying to spot ripples in space-time as they sweep through the Galaxy, says McLaughlin. The International Pulsar Timing Array is using radio telescopes around the world to monitor the regular emissions from pulsars, looking for distortions that would reveal the passing of these low-frequency gravitational waves. By the 2030s, FAST should have racked up enough sensitive measurements to study individual sources of such waves, such as collisions of supermassive black holes, says McLaughlin. "That's where FAST is really going to shine," she says.

Li is particularly excited about the study of planets outside the Solar System. No exoplanets have been conclusively detected by their radio emissions, but FAST's ability to spot faint, polarized waves might allow it to find the first examples, says Li. Polarized radio signals might come from planets with magnetic fields that, if similar to the one on Earth, could protect potential sources of life against radiation and keep the planets' atmospheres attached.

Identifying a planet in FAST's wide beam is a challenge because they are so faint and small. But Li's team wants to boost the telescope's performance by adding 36 dishes, each 5 metres wide. Although the dishes are relatively cheap, off-the-shelf products, together they will improve FAST's spatial resolution by 100 times, he says.

Li hopes that FAST's telescope operations will soon move from near the remote site to a $23-million data-processing centre being built in the city of Guiyang. He expects that the move to a major city will help to attract more technical and engineering staff.

Now, the team's biggest hurdle is working out how to store and process the enormous amount of data that the telescope will churn out. The team are negotiating with the Chinese government to get additional funding for more data storage. "A successful review will definitely help," he says. ■

ENVIRONMENT

Oceans under threat from climate change

UN report says storms and floods will intensify.

BY JEFF TOLLEFSON

The world's oceans have long helped to stave off climate change by absorbing heat and carbon dioxide from the atmosphere. But that is changing, with devastating consequences for humanity in the coming decades, leading researchers warn in a high-level report commissioned by the United Nations.

The rate at which oceans are warming has doubled since the early 1990s, and marine heat waves are becoming more frequent and intense — trends that are reshaping ocean ecosystems and fuelling more powerful storms. And as the oceans absorb CO_2, they are becoming more acidic, which threatens the survival of coral reefs and fisheries.

The special report on oceans and ice by the Intergovernmental Panel on Climate Change (IPCC) warns that without steep cuts to greenhouse-gas emissions, fisheries will falter, the average strength of hurricanes will increase and rising seas will increase the risk of flooding in low-lying areas around the globe.

The oceans "can't keep up" with humanity's greenhouse-gas output, says Ko Barrett, vice-chair of the IPCC and a deputy assistant administrator at the US National Oceanic and Atmospheric Administration (NOAA) in Washington DC. "The consequences for nature and humanity are sweeping and severe."

More than 100 scientists from 30 countries contributed to the report. The IPCC released a 42-page summary of the analysis on 25 September at a meeting in Monaco.

The report projects that sea levels could rise by up to 1.1 metres by 2100 if greenhouse gas emissions continue to rise. That is about 10 centimetres more than the IPCC estimated in its last comprehensive report on the global climate, which it released in 2013.

Richard Alley, a geoscientist at Pennsylvania State University in University Park, says that the latest report's sea-level rise projections are conservative. That's because scientists still aren't certain about when rising temperatures might trigger a rapid collapse of ice sheets, particularly in western Antarctica. If that ▶