plotting how the rover might travel from its landing site – recently named after the late science-fiction writer Octavia Butler – to the 40-metre-high cliffs of the ancient river delta that was the reason for Jezero's choice as landing site in the first place. The delta, deposited billions of years ago by a river flowing on Mars, would have been an ideal landscape for ancient microbial life, had such life existed. But a treacherous dune field, which the rover cannot cross, lies between Perseverance and the delta. Researchers are discussing whether to drive the rover clockwise or anticlockwise around the dune field; the latter would make for a shorter trip, but the former would take Perseverance past a greater variety of interesting rocks.

Flight of Ingenuity

None of this is likely to happen, however, until June at the earliest. First, Perseverance must drive to a suitable spot for it to test Ingenuity, its helicopter. This place will probably be a rock-strewn area not too far from the rover's current location. There, the rover will lower Ingenuity from its belly, drive off a safe distance and shoot a video as the helicopter takes to the Martian skies. "We're looking forward to those historic, aviation-first movies," said Jim Bell, a planetary scientist at Arizona State University in Tempe who leads one of the rover's camera teams. The helicopter test comes first because Ingenuity will fly with the rover as it drives, helping Perseverance to navigate its way across the landscape.

Until that first flight test, which is expected no earlier than the first week in April, team scientists will continue to explore the rocks around the landing site. Immediately surrounding the rover are lighter-coloured rocks peeking out from dark soil. Perseverance has used a laser-based instrument to determine that several of these rocks, including two that team scientists named Máaz and Yeehgo, are chemically similar to basaltic rocks on Earth, which form from molten rock. The instrument zaps rocks with a laser to vaporize small portions and study their chemical make-up. Through this analysis, the scientists have seen that Yeehgo shows signs of having water locked up in its minerals, said Roger Wiens, a geochemist at Los Alamos National Laboratory in New Mexico who is head of the laser-instrument team. These discoveries fit with what scientists had expected from Jezero – that it might have volcanic rocks on the crater floor, which could have interacted with water over time.

Rock sculptures

Many of the rocks around the landing site seem to have been sculpted by strong winds; one of these rocks is a dark, odd-shaped object that scientists have dubbed the harbour seal, for its similarity to a seal perching on a rock. The winds seem to have scoured the rocks mainly from the northwest, a direction that matches the major wind patterns calculated by global circulation models for Mars, said Bell.

Another dark-coloured rock looks as if it has been weathered not by wind but by water, said Farley. That suggests it could have been tumbled around in running water – perhaps in the ancient river flowing into Jezero, or in its lake. "This is quite promising for our study," he said.

"We're looking forward to those historic, aviation-first movies."

Perseverance scientists have been giving informal names to rocks, craters and other objects around the landing site using the Navajo, or Diné, language, which is spoken by many Native Americans in the southwestern United States. Following a tradition from earlier Mars landings, the scientists are choosing themes for names based on geological maps of Jezero, which are divided into sections named after national parks on Earth. Perseverance happened to land in the section named after Canyon de Chelly National Monument, which is in Arizona on Navajo tribal lands. Aaron Yazzie, an engineer on the rover team, is a member of the Navajo Nation and has led the effort to coordinate the names. Máaz, for instance, means Mars, while Yeehgo is an alternative spelling of the word for 'diligent'.

After the helicopter test, and before Perseverance sets off for the delta, the rover will probably drill for its first rock sample into the dark, fractured rock that makes up much of the Jezero Crater floor. Scientists have not yet determined whether this rock is volcanic – but if it is, it could help to determine the age of the crater floor. That's because molten rock traps radioactive elements that decay at a predictable rate and can be used as a clock to date when the material was originally molten.

During its mission, Perseverance will collect about 30 tubes full of Martian rock and soil, laying them down on the Martian surface for a future mission to retrieve and fly back to Earth for scientists to analyse. When this happens, no earlier than 2031, it will be the first time that a sample has ever been returned from Mars.

LAB-GROWN STRUCTURES MIMIC HUMAN EMBRYO'S EARLIEST STAGE YET

Human stem cells imitate the blastocyst phase – offering a crucial window into human development.

By Nidhi Subbaraman

Scientists have used human stem cells to mimic the earliest stage yet of embryo growth.

Multiple research groups independently report that they have grown balls of cells that look like human blastocysts, which form about 4 days after an egg is fertilized by sperm. Two teams published their results in *Nature* on 17 March[1,2]; last week, two other groups reported similar results on the bioRxiv preprint server[3,4] that have not been peer reviewed. These experiments offer a window into a crucial time in human development, and an opportunity to better understand pregnancy loss and infertility without experimenting on human embryos.

"This is an important milestone," says Jianping Fu, a bioengineer at the University of Michigan in Ann Arbor.

Some of what scientists currently understand about this early stage of development has come from studies on human embryos. But access to these embryos is limited and tightly regulated in light of ethical considerations. Because blastocysts grown in the laboratory from human stem cells differ from human embryos, they might avoid some of the ethical limits on human embryo research and could increase access to this type of work, scientists say. They do not expect the new blastocyst-like structures to have the ability to develop into a complete embryo.

Researchers have previously grown blastocysts in the lab from mouse stem cells[5], but mice have different developmental pathways from humans, so the resulting structures weren't a perfect model of human development.

The latest studies are "really putting all the pieces together in a way that you can potentially model how the embryo actually develops in its earliest stages", says Janet Rossant, a developmental biologist at the Hospital for Sick Children in Toronto, Canada. "This is a period we don't understand very much about."

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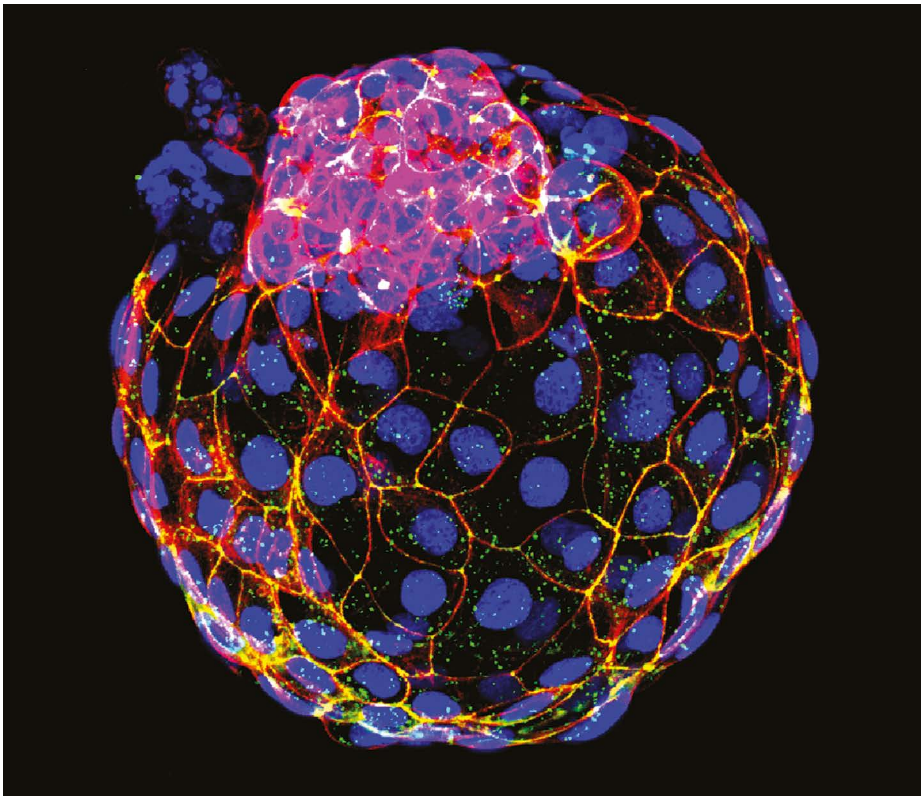

Researchers have created artificial blastocysts like this one from human stem cells.

During a pregnancy, a blastocyst would implant in the wall of the uterus at around 7 or 8 days. At this point, it has an outer layer of cells that would give rise to the placenta and a clump of cells within that have the potential to develop into a fetus.

Scientists have previously used human embryonic stem cells to look at later stages of embryo development, around 18–20 days, after the blastocyst has implanted[6]. But the new experiments are the earliest stage of development to be modelled in a lab.

Some knowledge of this phase comes from research groups growing human embryos in the lab for up to 13 days. Laws in about a dozen countries, as well as guidelines issued by the International Society for Stem Cell Research (ISSCR), limit embryo development in the lab to 14 days after fertilization. By this time, implantation is complete, and what's known as a primitive streak appears in the embryo, marking a point at which the cells within are becoming more differentiated and complex.

In one of the two *Nature* studies[1], a team of scientists at the University of Texas Southwestern Medical Center in Dallas and Kunming Medical University in China treated human stem cells with a succession of growth factors to form artificial blastocysts, called 'human blastoids'. The researchers showed they could do this using stem cells derived from human embryos, or using adult skin cells that had been reprogrammed into stem cells.

In the other peer-reviewed study[2], Jose Polo at Monash University in Clayton, Australia, and his colleagues reprogrammed adult skin cells to generate a mixture of cells, some of which grew into human blastoids.

"Is [a human blastoid] exactly equivalent to a human embryo?" asks Aryeh Warmflash, a stem-cell biologist at Rice University in Houston, Texas. "Almost certainly not. Is it a pretty good model for the blastocyst-stage embryo? I think it probably is."

Both teams showed that their artificial structures were built like blastocysts, with a cavity in the centre and a mass of cells — what could continue developing into fetal tissues in real blastocysts — in one corner. They also showed that the structures contained three signature cell types that make up a blastocyst. And they coaxed their human blastoids to 'implant' onto plastic sheets.

"Is it a pretty good model for the blastocyst-stage embryo? I think it probably is."

The two teams that posted preprints showed similar results while working with 'extended' pluripotent stem cells.

"Looking to the future, we want to use this model to gain more insight into early human development, and to understand different gene functions, as well as their mutations," says Jun Wu, a molecular biologist at Southwestern, who led one of the *Nature* studies[1].

Still, the teams acknowledge that their methods can be improved. Both *Nature* studies reported that only about 10% of the reprogrammed or transformed cells developed into human blastoids. Also, both teams acknowledged that there were some cells in the structures that are not typically found in human blastocysts.

"It's a good start," Rossant says of the studies. But, on the basis of these factors, "you would predict that it's not going to be incredibly reproducible".

A workaround

Neither of the teams that published in *Nature* allowed their structures to grow beyond about the equivalent of a 2-week-old embryo, mindful of the 14-day rule's limit on growing human embryos in the laboratory.

Still, some developmental biologists think that these artificial structures differ from human embryos in a key way. Scientists do not expect the structures to be viable beyond this stage of development, on the basis of evidence[7] showing that mouse blastoids do not develop into embryos when implanted in a mouse uterus.

But their similarity to human blastocysts still raises ethical questions. The ISSCR is already aware of this, and is due to release revised guidelines for work with embryo-like structures in May.

The sophistication of these model structures and the uncertainty about their developmental potential and whether they should be treated as embryos have made it hard to get funding for the work. The US National Institutes of Health (NIH) has been reluctant to fund such work, citing a section of federal law known as the Dickey–Wicker Amendment, which bars the government from funding research that creates or destroys human embryos. Researchers argue that the structures are different from natural human embryos, and have called for clarity from the agency on the criteria that guide its funding decisions.

The agency's policy office last year convened a meeting of leading researchers at the US National Academies of Sciences, Engineering, and Medicine in Washington DC to discuss milestones in the field. This month, NIH director of science policy, Carrie Wolinetz, wrote that the agency would consider funding stem-cell-based model structures that mimic embryo development on a case-by-case basis.

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