equator and listens for 'marsquakes', the Mars equivalent of earthquakes. So far, InSight has detected around 500 of these, meaning the planet is less seismically active than Earth but more so than the Moon. Most marsquakes are small, Lognonné said, but nearly 50 have been between magnitude 2 and 4 – strong enough to provide information on the planet's interior.

Just as seismometers do on Earth, InSight measures the Martian core size by studying seismic waves that have bounced off the deep boundary between the mantle and the core. With information from enough of these waves, InSight scientists were able to calculate the depth of the core–mantle boundary and hence the size of the core. The seismic data also suggest that the upper mantle, which extends to around 700 to 800 kilometres below the surface, contains a zone of thickened material in which seismic energy travels more slowly.

In an effort to replicate conditions inside planetary cores, other researchers have squeezed combinations of chemical elements at high pressures and temperatures in the laboratory. InSight's estimate of Mars's core density agrees with many of their results, says Edgar Steenstra, a geochemist at the Carnegie Institution for Science in Washington DC.

InSight might be running out of time to make discoveries. Dust has been piling up on its 2-metre-wide solar panels, cutting down the amount of power the spacecraft can generate. Mars is also moving towards the farthest point from the Sun in its orbit, which will further limit the craft's opportunity to recharge.

"This is going to cause us to reduce our instrument usage," says Mark Panning, InSight's project scientist at the Jet Propulsion Laboratory in Pasadena, California.

In January, the team already had to give up on its German-built 'mole', a thermal probe that was supposed to bury itself in the soil and measure heat flow, but which encountered problems with friction and couldn't dig deep enough.

Drastic temperature changes on Mars that occur when day turns to night, and vice versa, create noise in the signals that InSight's seismometer collects. That's because the tether connecting it to the lander lies exposed on the planet's surface. So InSight is now trying to bury the tether by scooping dirt on to it, with the aim of insulating it.

SCIENTISTS GROW TEAR GLANDS IN A DISH — THEN MAKE THEM CRY

Organoids made of tear-producing cells offer chances to study, and possibly treat, eye disorders.

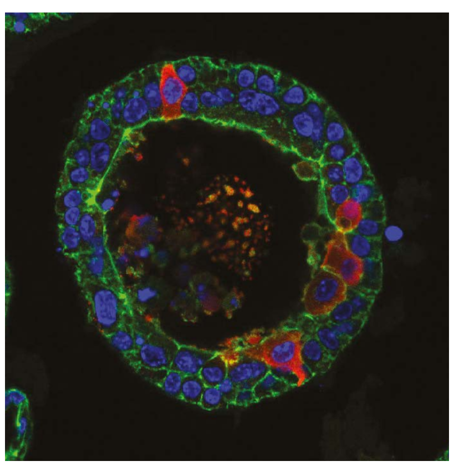
By Heidi Ledford

At first, it took a long time – up to a day – to make the cells cry. But, with experience and a little prodding, the researchers eventually made them weep in only half an hour.

The tearful cultures, reported in *Cell Stem Cell* on 16 March (M. Bannier-Hélaouët *et al. Cell Stem Cell* https://doi.org/10.1016/j.stem.2021.02.024; 2021), are the first tear-gland 'organoids' – 3D assemblages of cells that are designed to resemble miniature versions of organs. Organoids of the glands that produce tears could be used to study and eventually treat disorders that cause dry eyes, including an autoimmune condition called Sjögren's syndrome.

"It's very promising," says ocular pathologist Geeta Vemuganti at the University of Hyderabad in India.

In addition to their role in displaying emotion, tears help to lubricate and protect the eye. Dry eyes can be painful, inflamed and prone to infection. To study tear production, developmental biologist Hans Clevers' laboratory at the University Medical Center Utrecht in the Netherlands developed a way to grow tear-gland cells as organoids. The group has found ways to grow a menagerie of organoids, including miniature livers, cervical cancers and snake venom glands.



The organoids produce a tear-like fluid (red).

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Welling up

Tear glands, which are also called lacrimal glands, are a particular challenge to study, says Darlene Dartt, who studies tear production at Massachusetts Eye and Ear in Boston. The glands are located above each eyeball, behind the bony orbit of the eye, making them difficult to biopsy. Clevers' lab used their expertise to work out culturing conditions for cells from mouse and human lacrimal glands. To stimulate tear production, they then exposed their organoids to several chemicals, including the neurotransmitter noradrenaline, that relay messages between nerve cells and glands.

Because the organoids lack ducts, 'tear' production causes them to swell. "If there had been a little duct, there would have been droplets," says Clevers. And when the team transplanted the organoids into mice, the assemblages matured and developed duct-like structures containing proteins found in tears.

The team hopes that the cells can be used to study tear glands, and to screen for drugs that affect tear development. Clevers and his colleagues have already used CRISPR genome editing to study tear-gland development, and have found that a gene called *Pax6* is important in guiding cells to take on a tear-gland identity. *Pax6* is a known regulator of eye development: expressing the fly version of *Pax6* on the leg of a fruit fly will cause an eye to develop there.

Clevers' lab is now teaming up with Dutch naturalist and television-show host Freek Vonk to study structures resembling tear glands in crocodiles. The team hopes to use the organoids to study actual 'crocodile tears', which the reptiles use as a way to excrete salt.

Transplant potential

Organoids derived from human cells could also eventually provide material for transplants, to replace diseased or damaged tear glands. Clevers' group and its collaborators have developed salivary-gland organoids that will be tested in clinical trials starting this summer for people who suffer from dry mouth, a condition that can cause tooth decay and difficulty in chewing and tasting.

Those salivary-gland trials could serve as a testing ground to work out methods that could then be adapted for future tear-gland transplants, says Dartt. In the meantime, she says, the work that Clevers' team has done in characterizing tear glands – including creating a detailed cell-by-cell map of the structures and their organoids – has demonstrated that the glands are more heterogeneous than was previously appreciated and could send researchers back to reinterpret old data. "That has implications for a lot of studies."