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Sex in space: Our final reproductive frontier

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Over recent decades, our ability to regulate and manipulate our own reproduction has expanded significantly. We have developed the ability to collect and manipulate gametes, fertilise the oocyte outside of the body, culture the embryo in a dish and transfer it back to the uterus to continue its development. To date, over eight million babies have been born from assisted reproductive technologies (ART) such as *in vitro* fertilisation (IVF)[1]. Using ART, we are able to delay having children until a time that suits us best, putting our fertility on ice, literally.

While ART such as IVF have enabled millions of people to have a family of their own, our ability to collect and store sperm, oocytes and embryos may have one unexpected benefit, potentially helping the human race to colonise other planets. This is because sex in space is surprisingly difficult. Firstly, just staying in close contact with each other under zero gravity is hard. Secondly, as astronauts experience lower blood pressure while in space, maintaining erections and arousal are more problematic than here on Earth. If that's not enough, then the sheer lack of privacy on shuttles and space craft mean there are no rooms into which two astronauts can retreat for some time together. Therefore, it's probably not surprising that to date there have been no confirmed accounts of astronauts having had sex in space.

However, astronauts have been experimenting with reproduction for many years[2]. A range of animals have been blasted into space to see how microgravity might affect their reproduction. Initially, rats and mice were sent to see if they would mate and if their pregnancies would develop normally. Unsurprising to anyone who uses rodents to study reproduction, the significant disruption of travelling into space and back meant none of the females actually developed to term with their pregnancies. Similarly, astronauts explored whether IVF could be done using isolated mouse sperm and oocytes, or whether mouse embryos which had been generated on Earth would develop in space. However, in both cases, the experiments did not yield positive results. Separate studies conducted on the Russian space station Mir also showed that microgravity seemed to have negative effects on the eggs and embryos of a range of species including salamanders, sea urchins and quails.

Together, these studies seem to suggest reproduction in space might not be as straightforward as it is here on Earth. However, more recent experiments have approached the question of sex in space from a different position. The current thinking is to send freeze-dried sperm, oocytes or embryos across space, like an interplanetary reproductive delivery service. The simple reason for this is that frozen gametes and embryos take up far less space and resources on a spaceship than living humans do, and can potentially be stored for decades. Once at their destination, they can be revived and implanted. The downside to this is that in space, the levels of cosmic radiation are significantly higher than here on Earth. Thankfully for us, our atmosphere shields out significant amounts of solar radiation, but in space, astronauts, and their gametes, are exposed to doses hundreds of times higher than on Earth. This high-energy radiation can damage DNA, causing mutations and impairing the development of an embryo[3]. Therefore, researchers and space agencies want to know whether sending gametes and embryos on long journeys into space is safe. In 2017, researchers sent packages of freeze-dried mouse sperm to the International Space Station (ISS) for nearly 10 months[4]. When it returned to earth, they compared it to control fresh samples taken from the same mice. The first observation was that the sperm which had been on the ISS had more fragmented DNA than the control sperm. As high levels of sperm DNA fragmentation are associated with male infertility and increased miscarriage risk, these observations were a worry[5]. However, when used in IVF, the space sperm were able to generate the same number of embryos as the sperm which stayed on Earth. Furthermore, following transfer, embryos derived from the space sperm were just as able to develop into healthy adult mice as the control sperm.

The next step for some is to test the effects of microgravity and space travel on human gametes and embryos. While some may view such experiments as unethical, many believe that in order to understand the impact of space travel of human reproduction, the use of human sperm, oocytes and embryos is a necessity. In a study presented to the European Society for Human Reproduction and Embryology (ESHRE) in 2019, researchers explored the effects of microgravity on human sperm[6]. Using a specially modified plane, normally used for training astronauts, the researchers exposed 10 human sperm samples to reduced gravity. Using the same array of tests normally undertaken within a fertility clinic, the research saw there was no detrimental effect of the microgravity on sperm quality.

While such studies show that aspects of human reproduction are possible in space, there is still a long way to go before we see the whole reproductive process undertaken outside the confines of our home planet.

"The research saw there was no detrimental effect of the microgravity on sperm quality"

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