



The cryonics dilemma: will deep-frozen bodies be fit for new life?

350 corpses stored in liquid nitrogen await immortality. But detractors say the brain's complexity is a major stumbling block

Hannah Devlin Science correspondent

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“My primary strategy for living through the 21st century and beyond is not to die,” Ray Kurzweil, the futurologist and Google engineer has said. But in the event that plan A doesn’t work out, he has opted to have his body cryogenically preserved at the world’s largest facility, the Alcor Life Extension Foundation in Scottsdale, Arizona.

Cryonics was first proposed in the 1960s by a Michigan professor, Robert Ettinger, in a book called *The Prospect of Immortality*, which argued that death could, in fact, be a reversible process. Ettinger, who died in 2011, went on to found the Cryonics Institute in Michigan where he, his mother and his first and second wives all now reside in metal flasks kept at -196°C .

While the concept has never become mainstream, the number of people choosing to sign up is steadily increasing year on year. There are now nearly 300 cryogenically frozen individuals in the

US, another 50 in Russia, and a few thousand prospective candidates signed up.

The central idea is simple: preserve the body in a pristine condition until such times as medicine has developed a cure for whatever brought about death in the first place - at which point the corpse is thawed and reanimated.

“Calling someone ‘dead’ is merely medicine’s way of excusing itself from resuscitation problems it cannot fix today,” Alcor’s website states.

The real question, though, is not whether medicine will advance - clearly it will - but whether the frozen bodies will be in a fit state to bring back to life.

The world’s three major facilities - two in the US and KrioRus, a Russian centre on the outskirts of Moscow, differ slightly in price and ethos. Alcor has a reputation for celebrity clients, while KrioRus offers budget service, probably due to its communal approach to storage, with bodies sharing tanks with a menagerie of 20 or so pets (cats, dogs, birds) that owners have paid to preserve.

“We have big cryostats, each about 3 cubic metres. About seven bodies fit in,” says Danilo Medvedev, the company’s CEO. “They’re placed in sleeping bags. There’s no point in having separate metal containers. It would only make it more complicated.”

About half of KrioRus’s 50 clients opted for entire body freezing, with the rest choosing to just preserve their heads. The bodies are placed vertically, with their heads at the bottom of the tank, where it is coldest, so the feet would thaw first in the case of a technical glitch.

The companies all use the same basic technology. First, the body is obtained as soon as possible after death, packed in ice and transported to the facility. Here the blood is drained and replaced with a mixture of anti-freeze and organ-preserving chemicals. This transforms the corpse into a glassy vitrified state, ready to be lowered into liquid nitrogen, at a temperature of -196C.

Alcor acknowledges that the process is tricky and that sometimes the brittle corpses, or patients as it refers to them, can fracture on immersion. Medvedev says “issues with hospitals and relatives” means that the freezing process is not begun in an optimal timeframe.

“The overall theory is extremely sound,” Medvedev says. “It’s not correct to say there haven’t been experiments.” His own team, he says, have shown that rats can be cooled to zero degrees and kept in suspended animation for several hours before being re-awoken. He cites another case, in which a rabbit brain was vitrified and then thawed, appearing structurally intact - although the brain was first set in a formaldehyde-like substance, that would rule out it ever functioning as a living organ in the future.

These examples, and clinical advances in storing sperm and egg cells, bear little relation to the technical challenge of trying to perfuse the entire human circulatory system, and, crucially, the brain, with anti-freeze without causing any damage.

This is where the science of cryonics really falls apart, according to Clive Coen, a professor of neuroscience at King’s College London. “The main problem is that [the brain] is a massively dense piece of tissue. The idea that you can infiltrate it with some kind of anti-freeze and it will protect the tissue is ridiculous.”

Since the brain is so densely organised and so well shielded by the blood-brain barrier and the fatty myelin coating around neurons, the cocktail of cryonic chemicals would need to be vigorously pumped in to ensure every nook and cranny was infiltrated. “You’re dealing with an organ that is deliberately protecting itself from things coming in,” says Coen.

This means that achieving full vitrification is likely to lead to the exact kind of damage - membranes being ruptured, neuronal connections being lost - that the technique is designed to avoid.

Coen argues that by the time the cryogenic support team arrives at the side of the patient’s hospital bed it may already be too late. “Within a few minutes of anoxia, your hippocampal neurons are dead. Gone,” he says, adding that global brain damage would be inevitable.

“Would you really want to wake up in 100 years’ time and be basically a cognitive vegetable and have your cancer fixed?” he asks. “These vulnerable people don’t realise they’re paying for something to be stored that is massively damaged.”

KrioRus charges \$36,000 (£29,000) for whole body storage or \$18,000 (£15,000) for just the head, and Medvedev says that after the running of the facility and its expansion is paid for, he’s not making much profit. By contrast, Alcor charges \$200,000 (£162,000) for the full body and \$80,000 (£65,000) for head-only preservation, and also offers the option of clients taking out a life insurance that will pay out to the company.

Anders Sandberg, of Oxford University’s Future of Humanity Institute, has such a life insurance policy that, for £15 each month, will pay for his head to be frozen in the hope that the brain’s contents might be “downloaded” into a robotic agent in the future. He gives the freezing, thawing and reanimation process “maybe a 5% chance” of working. “That’s actually worth quite a lot, though,” he says.

“The funny thing about cryonics is that they’re selling immortality, but very few people buy it,” he adds. Is this because people don’t actually want to live for ever, or because people think it’s nonsense? “I think it’s partially the nonsense part,” he says.

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- Cryonics
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- Health
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- news