

## **Scientific Foundations and Controversies of Cryonic Preservation**

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### **Abstract:**

Cryonic preservation is a scientific concept based on the idea that human bodies can be preserved at extremely low temperatures after death with the hope that future medical technologies may restore life. The concept emerged from early ideas about delaying death and preserving biological organisms through freezing. Historical discussions, scientific experiments with embryos, and real-life cases of extreme hypothermia have contributed to the theoretical foundations of cryonics. Modern cryonic procedures involve the use of cryoprotectant chemicals and storage in liquid nitrogen at temperatures near  $-196^{\circ}\text{C}$  to prevent cellular damage. Despite technological advancements, the revival of cryonically preserved individuals remains impossible with current medical knowledge. This paper examines the scientific basis of cryonic preservation, its historical development, and the ongoing controversies surrounding its feasibility and ethical implications.

**Keywords:** Cryonics, Cryonic preservation, Hypothermia, Cryoprotectants, Liquid nitrogen, Future medicine, Immortality research

Cryonic preservation is based on the hypothesis that death, as defined by modern medicine, may not necessarily represent an irreversible state. Some researchers believe that future medical technologies could repair cellular damage and restore life to

individuals who have been preserved at extremely low temperatures. This idea has stimulated both scientific curiosity and ethical debate.

Historical interest in the possibility of reviving the dead can be traced back to the late eighteenth century. In December 1799, George Washington became ill after being exposed to cold weather while inspecting his land on horseback. After returning home in wet clothes, he developed a fever that rapidly progressed into pneumonia. Physicians attempted to treat him using medical practices common at the time, including bloodletting and the administration of mercurous chloride, but these efforts failed and he died shortly afterward. Because Washington feared being buried alive, he requested that his burial be delayed for three days. Before his burial, his physician William Thornton proposed an unusual idea: Washington's body could be covered with ice, frozen, and later warmed while transfusing lamb's blood in an attempt to revive him. Although the idea was never implemented, it represents one of the earliest conceptual discussions related to preserving the human body through extreme cold.

Scientific research has also explored the preservation of simpler biological organisms. During the earliest stage of human development, the organism exists as an embryo. Scientists have discovered that embryos can be frozen and stored for many years while remaining capable of developing normally after thawing. Some studies have shown that embryos preserved for up to ten years can still develop into healthy organisms. This observation suggests that simpler biological systems are easier to preserve for long periods.

A real-life medical case that influenced discussions about cryonics occurred in 1999 with Anna Bågenholm. While skiing, she fell into a frozen lake and became trapped under the ice. She survived for approximately eighty minutes in freezing water before her circulation stopped and her body temperature dropped to about  $-13.7^{\circ}\text{C}$ . Remarkably, doctors were eventually able to revive her. Although she initially

experienced paralysis in the neck region, her condition improved significantly over time with medical treatment. This case demonstrated that survival from extreme hypothermia is possible because low temperatures can slow metabolic processes in the human body. The modern concept of cryonics was strongly promoted by Robert Ettinger, an American soldier and scientist. After being wounded during World War II, he began to think deeply about the possibility of avoiding death.

In his book *The Prospect of Immortality*, he proposed that human bodies could be preserved through deep freezing until future technologies become capable of reviving them. After his death in 2011, Ettinger himself was cryonically preserved as patient number 106. Another supporter of cryonics, Neil Watson, carries a bracelet with instructions requesting that his body be placed on ice and transported to a laboratory immediately after death.

The cryonic preservation process follows several scientific steps. First, cryoprotectant substances are introduced into the body to protect cells from damage caused by freezing. These chemicals prevent the formation of ice crystals that could destroy delicate tissues. The body is then gradually cooled, often using dry ice. Finally, it is placed in a container filled with liquid nitrogen, where the temperature slowly decreases to approximately  $-196^{\circ}\text{C}$  over several days. At this temperature, biological activity essentially stops, allowing long-term preservation.

Currently, only a few organizations provide cryonic preservation services, including Alcor Life Extension Foundation and the Cryonics Institute in the United States, as well as KrioRus in Russia. Individuals interested in cryonics must sign a contract before death and pay substantial fees, typically ranging from 40,000 to 250,000 US dollars for full-body preservation. A less expensive option involves preserving only the brain or head, which costs significantly less.

Despite the technical development of cryonic preservation methods, the greatest challenge remains the possibility of revival. At present, no scientific technology exists that can successfully restore life to a cryonically preserved human being. Critics argue that freezing causes irreversible cellular damage, while supporters believe that future technologies such as advanced nanomedicine may one day repair such damage.

Nevertheless, cryonics has developed into an organized industry. Several thousand individuals around the world have already arranged for cryonic preservation, and dozens of animals have been preserved as well. For example, the Russian facility KrioRus currently stores multiple animals, including dogs, cats, and birds, alongside human patients from different countries. These individuals voluntarily chose cryonic preservation in the hope that future scientific progress may make revival possible.

In conclusion, cryonic preservation remains a controversial intersection of science, medicine, and philosophy. While current technology cannot revive preserved individuals, scientific developments in fields such as biotechnology and regenerative medicine continue to inspire debate about the limits of life and death. For many supporters, cryonics does not provide certainty but rather the possibility that future generations may possess the knowledge and tools necessary to restore life once again.

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