Cryonics: A step towards immortality
Anatomical, Medicolegal and Ethical Implications

*Dr. Sanjeev Kumar Jain, M.S. **Dr. Mukesh Yadav, M.D., LL.B., ***Dr. Shashi Munjal Mongia, M.S.
*Associate Prof., Deptt. of Anatomy SGRRIM&HS, Patel Nagar, Dehradun
**Professor & HOD Forensic Medicine, Muzaffarnagar Medical College, Muzaffarnagar, U.P.
***Assistant Prof, Deptt. of Anatomy SGRRIM&HS, Patel Nagar, Dehradun

Abstract
The inestimable value of human life is a cardinal feature of Jewish Law, which includes an obligation for maintenance of our own health and self preservation. Rabbinical Assembly’s, Committee on Jewish Law and Standards, states that “the preservation of human life is obligatory, not optional”.
Cryonics is an attempt to protect the gift of human life, through low temperature preservation, if necessary for hundreds of years, until they can be revived and cured of whatever illness or injury caused their legal death.
The objectives of this article are:
(a) To strengthen the concept of cryonics, through experiments performed, and cytoarchitectural results obtained thereof, by many research workers in both animals and human beings.
(b) To logically discuss the legal and ethical issues associated with cryonics.
In the end an attempt has been made to introduce the concept of nanotechnology and nanomedicine which will make revival a reality someday.

Key Words: Cryonics, Cryoprotectant, Cryobiologist, Legal Death, Neurosuspension, Vitrification, Nanotechnology, Nanomedicine, Ethical Implication.

Introduction:
The dream of escaping mortality has tantalized humanity for thousands of years. It occurs in all primitive cultures and modern world religions. Even Buddhism, which rejects the concept of an after life, offers the solace of reincarnation.
Benjamin Franklin [1] was probably one of the first to dream of preserving dead bodies for future repair. In 1773, after observing how the heat of Sun reanimated flies preserved in a bottle of wine, he wrote “I wish it were possible from this instance to invent a method of embalming drowned persons, in such a manner that they may be recalled to life, however distant”. When the possibility of cryonics rose many question came to mind of scientists like:
- Why do we want to do such a thing to ourselves?
- What could someone hope to gain by it? Why do we think that we can be stored for so long?
- What is the chance that we really come back?
Answers to all these questions became apparent when an eminent Professor of Physics, C.W. Robert Ettinger (Father of Modern Cryonics) [2] published a book titled “The prospect of immortality” in 1964. He promoted the idea that a person frozen after legal death might rationally hope to be reconstructed at sometime in future when medicine has acquired the ability to cure most of diseases.
A major breakthrough occurred in 1966, when a Japanese Scientist, I. Suda [3] froze isolated Cat brains after perfusing them with glycerol, then rewarmed under carefully controlled conditions. Electromyography studies showed that the brains regained some functions even though they had been frozen for a month or more.
In 1966, Cryonics Society of Michigan and then Cryonics Society of California were formed. The first person to be cryogenically frozen was a 73- years old Psychologist, Dr. James Bedford, who was suspended in 1967. His body is reportedly still in good condition at Alcor Life Extension Foundation. By the late 1970’s there were about six cryonics companies in US, but to preserve and then maintain each body indefinitely was so expensive, many of those companies wound up closing shop by the following decade.
Today only a handful of companies offer full cryopreservation services including Alcor Life Extension Foundation in Arizona and Cryonics Institute in Michigan. In early 2004, Alcor had more than 650 members and 50 patients in cryopreservation. Some cryobiologists are hopeful that, using Nanotechnology, first cryonic revival might occur somewhere around 2040.

Technique of Cryonics:
Once a person has decided to undergo cryonic suspension, he or she has to join a Cryonic Facility by
paying an annual membership fee to be a member of that Cryonic Facility. Then, when a person is pronounced “legally dead” heart has stopped working, but some cellular brain function remains by a Competent Authority, an Emergency Response Team led by Local Funeral Director comes into action. The team stabilizes the body, supplying the brain with enough oxygen and blood to preserve minimal brain function.

Then, body is packed in ice and injected with an anticoagulant to prevent blood from clotting. A medical team awaits the arrival of the patient (legally dead individual) at the Cryonics facility. Once the patient has transported to Cryonics facility the actual “freezing” begins. The cryonists first replaces the water from the cells with a glycerol based chemical mixture (cryoprotectant). The goal is to protect the organs and tissues from forming ice crystals. The goal is to protect the organs and tissues from forming ice crystals. This is known as “vitrification”. Once the water from the body is replaced with the cryoprotectant body is cooled on a bed of dry ice until it reaches the temperature of minus 130 degree centigrade. Then the body is inserted into a tank filled with liquid nitrogen at a temperature of about minus 190 degree centigrade. Body is stored with the head down, so that if there were ever a leak in the tank, brain would stay immersed in the freezing liquid.

Due to heavy cost some organizations preserve the brain only (neurosuspension). Hopefully who have been preserved this way, technology will come up with a way to clone or regenerate the rest of the body.

**Ethical Implications:**

Cryonics is based on a view of dying as a process that can be stopped in the minutes, and perhaps hours, following legal death. Scientist (5) has argued that “death” based on cardiac arrest or resuscitation failure is purely a social construction used to justify terminating care of dying patients. In this view, legal death and its aftermath are a form of euthanasia in which sick people are abandoned. Ethical and theological opinions of cryonics tend to pivot on the issue of whether cryonics is regarded as interment or medicine. If cryonics is interment, the religious beliefs about death and after life may come into consideration. Resuscitation may be deemed impossible by those with religious beliefs because the soul is gone, and according to most religions only God can resurrect the dead. Expensive interment is seen as a waste of resources. If cryonics is regarded as a medicine, with ‘legal death’ as a mere enabling mechanism, then cryonics is a long term coma with uncertain prognosis. It is continuing to care for sick people when others have given up, and a legitimate use of resources to sustain human life. Cryonists believe that future technical advances will validate their view that cryonic patients are recoverable, and therefore never really dead. Cryonics is not in conflict with religion any more than medicine is in conflict with religion. Heart bypass surgery extends human life and is fully compatible with religion. Similarly, cryonics may also extend human life by preserving people for future medicine: Extending human Life is not in conflict with religion. To refuse new life extension technologies, could be a sin comparable to suicide.

**Legal Implications:**

Cryonics can only be applied to a person who has been pronounced “legally dead” by a team of authorized health professionals like in case of The Transplantation of Human Organ Act, 1994 in India. When a person is ready to be a cryonic member, he or she has to sign some core documents, which include Cryonic Suspension Agreement, the Uniform Donor Form and the Next-of-Kin Agreement. The contracts must be witnessed or notarized so that there can be no doubt a CI member’s desire for cryonic arrangements. It is important for cryonists that their next of kin are informed and will not interfere in implementing cryonic arrangements when and if the time comes to implement them. Ted Williams a famous baseball legend was embroiled in a bizarre custody battle. Since his death in 2002 he has been stored in Alcor Life Extension Foundation. His daughter, Bobby-Jo Williams fought in Court to get back her father’s body and charged her half brother John-Henry to sell their father’s DNA. But her half brother informed the Court that he signed a pact to preserve all remains of his father. The sibling’s finally reached a settlement: Ted Williams was allowed to stay where he was, and John-Henry (half brother) promised not to sell any of his father’s DNA. [6]

By custom and law dead bodies are objects, not persons with rights or protections. This removal of personhood is a cultural obstacle not faced by living persons even with the poorest prognosis. For this reasons cryonists advocate all cryonic subjects “patients” and agree that morally they should not be considered dead, even though that is their status under present law.

**Perspective:**

The dream of escaping mortality is powerfully seductive. It is a worthy dream, but it will only come true if it is pursued on a cautious, skeptical rational basis. Attention to details high ethical standards, state-of-the art techniques, continuing research, and impeccable financial management are indispensable if cryonics is to fulfill the promise which first excited public imagination more than twenty years ago. To fulfill the promise, scientific support for cryonics based on cytoarchitectural studies showing substantial preservation of brain cell structure and other vital organs (see Table No. 1) and projections of this on to...
future technology, especially molecular nanotechnology and nanomedicine has to be taken into account. In future some techniques likely to be available are:

**Nanotechnology and Nanomedicine:**

1. Repair at the level of the cell:
   - A. Ability to design enzymes to produce specific repair function such as:
     - a. Re-naturing denatured proteins
     - b. Joining broken lipoprotein complexes.
     - c. Annealing broken strands of DNA and RNA.
     - d. Giving a cell or organism possessing them the ability to metabolize new substrates, like novel cofactors or construct essential amino acids.
   - B. Specially constructed bacteria or macrophages able to replicate themselves, spread throughout a specific target tissue, and carry out specific repairs according to the programmes designed into their DNA and RNA. These may be so designed to operate at “unnatural" temperatures, and utilize metabolic pathways not presently found in nature.
   - C. Ability to introduce into a cell DNA, or organelles (such as mitochondria), which it may have lost, and ability to introduce entirely new form of organelles.
   - D. Ability at will, to modify the developmental programme of a cell.
   - E. Several different types of repair bacteria able to work together in an integrated fashion for optimal repairs to every cell of the body.

2. Repair at the level of whole organism:
   - A. Understanding the physiology of aging and combined it with the ability to reverse it.
   - B. Control over growth and development.
     - a. Growth of an entire and well formed body from a head alone.
     - b. Re-growth of injured or lost brain tissue.
     - c. Growth of other organs which have been lost or damaged.
   - C. “Substitute organs”, from others which have been lost.

### Table showing experimental results of cryo preservation

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of Tissue</th>
<th>Preservation Temp.</th>
<th>Technique of Preservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Brain</td>
<td>(-98°C)</td>
<td>Brains perfused with glycerol and stored at -98°C, showed no return of electrical activity. (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-20°C)</td>
<td>Cat brains perfused with glycerol and stored for 280 days recover electrical activity. Upon re-warming to -39°C and perfusion with fresh donor blood; appearance of tissue in light microscope “almost normal”. (11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-20°C)</td>
<td>Cat brains stored for 7.25 years, thawed slowly over 12 hours. Brains perfused with glycerol before freezing. Spontaneous electrical activity from thalamus and Cerebrum. (3)</td>
</tr>
<tr>
<td>2.</td>
<td>Kidneys</td>
<td>(-196°C)</td>
<td>Whole rabbit kidney frozen in liquid nitrogen, without cryoprotective agents: kidney epithelium grew in culture. (7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-79°C)</td>
<td>Whole dog kidneys perfused with cryoprotectant (DMSO), stored for one year. Cell culture taken from thawed kidneys immediately after thawing: Growth in culture of all cell types the same as that of controls. (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-50°C)</td>
<td>Kidneys perfused and cooled to minus 50 degree centigrade, DMSO used. Out of 37 kidneys treated, four supported life long term in dog after other kidney was removed. (9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-20°C)</td>
<td>DMSO used two out of 14 kidneys functioned long term. (10)</td>
</tr>
<tr>
<td>3.</td>
<td>Tissue fragments</td>
<td>(-194°C)</td>
<td>One mm thick tissue slice taken from human cadavers, stored in liquid nitrogen for months: all showed growth in culture after thawing. Tissues were: ovary, pituitary, thymus, kidney, etc. (6)</td>
</tr>
</tbody>
</table>

### Summary and Conclusions:

It has often been said that cryonic revival will be a Last-In-First-Out [LIFO] Process. In this view preservation methods will get progressively better until eventually they are demonstrably reversible, after which medicine will begin to reach back and revive people cryo preserved by more primitive methods. Revival of people cryo preserved by the current combination of Neurovitrification and ‘Deep Cooling” may require decades or even more, if it is possible at all.

### References:

9. Robertson, R.S. Jacob, S.N., op. cit, p-145
10. Halasz (1967)