ALCOR LIFE EXTENSION FOUNDATION
A Non-Profit Organization

CRYONICS

MAY - JUNE 2018 · VOLUME 39:3

Member Profile: The Gillmann Family

PAGE 22

Alcor Position Statement on Brain Preservation Foundation Prize

PAGE 8

Revival of Alcor Patients

PAGE 10

ISSN 1054-4305

$9.95

Improve Your Odds of a Good Cryopreservation

You have your cryonics funding and contracts in place but have you considered other steps you can take to prevent problems down the road?

- ✓ Keep Alcor up-to-date about personal and medical changes.
- ✓ Update your Alcor paperwork to reflect your current wishes.
- ✓ Execute a cryonics-friendly Living Will and Durable Power of Attorney for Health Care.
- ✓ Wear your bracelet and talk to your friends and family about your desire to be cryopreserved.
- ✓ Ask your relatives to sign Affidavits stating that they will not interfere with your cryopreservation.
- ✓ Attend local cryonics meetings or start a local group yourself.
- ✓ Contribute to Alcor's operations and research.

Contact Alcor (1-877-462-5267) and let us know how we can assist you.

Visit the ALCOR FORUMS www.alcor.org/forums/

Discuss Alcor and cryonics topics with other members and Alcor officials.

- The Alcor Foundation
- Cell Repair Technologies
- Cryobiology
- Events and Meetings
- Financial
- Rejuvenation
- Stabilization

Other features include pseudonyms (pending verification of membership status) and a private forum.

Visit the ALCOR BLOG www.alcor.org/blog/

Your source for news about:

- Cryonics technology
- Cryopreservation cases
- Television programs about cryonics
- Speaking events and meetings
- Employment opportunities

Alcor is on Facebook

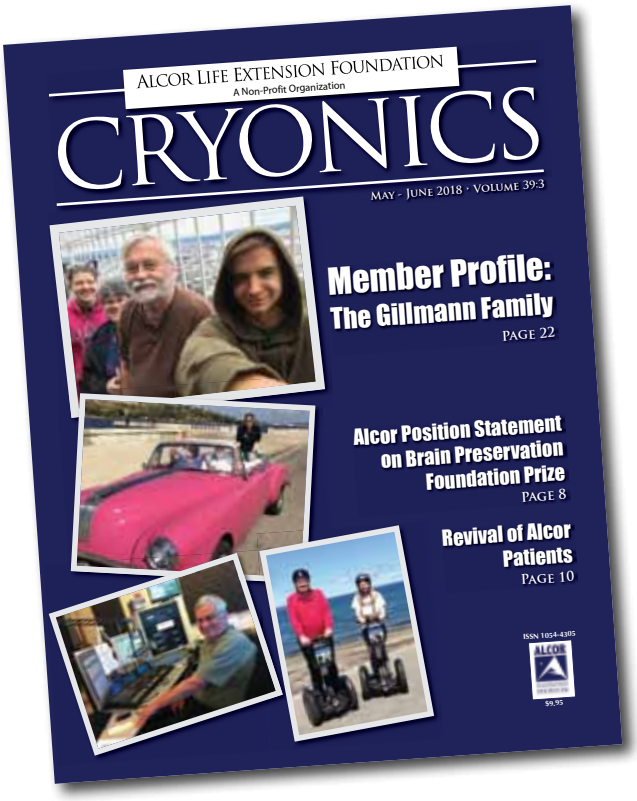
Connect with Alcor members and supporters on our official Facebook page:

www.facebook.com/alcor.life.extension.foundation

Become a fan and encourage interested friends, family members, and colleagues to support us too.

ALCOR LIFE EXTENSION FOUNDATION
A Non-Profit Organization

CRYONICS



COVER STORY: PAGE 22

Member Profile: The Gillmann Family

Meet the Gillmanns, a Renaissance family of four bringing cryonics to Cascadia….

On the cover: The Gillmann Family Photos

ALCOR LIFE EXTENSION FOUNDATION
A Non-Profit Organization
CRYONICS

Cryonics magazine is published bi-monthly.

Please note: If you change your address less than a month before the magazine is mailed, it may be sent to your old address.

Address correspondence to:
Cryonics Magazine
7895 East Acoma Drive, Suite 110
Scottsdale, Arizona 85260
Phone: 480.905.1906
Toll free: 877.462.5267
Fax: 480.922.9027

Letters to the Editor welcome:
aschwin@alcor.org

Advertising inquiries:
480.905.1906 x113
advertise@alcor.org
ISSN: 1054-4305

Visit us on the web at www.alcor.org

Alcor News Blog
http://www.alcor.org/blog/

CONTENTS

EDITORIAL

Photo: Cryo-Care Equipment Corporation at 2340 E. Washington St., Phoenix, AZ. Dr. Bedford's "home" about 1970.

REVIVAL SCENARIOS By Aschwin de Wolf

Ralph Merkle's new article "Revival of Alcor Patients" constitutes an important contribution to the growing cryonics survival literature. What sets Merkle's latest piece apart from (his) prior efforts is its extensive treatment of the validation of revival attempts ("did we do it right?") and the ethical principles of revival.

The most important distinction between revival methodologies concerns those that involve in-situ repair and revival and those that aim for repair and revival on a different substrate (i.e. "mind uploading") after conducting a (molecular) scan. Merkle also presents a revival scenario that involves a destructive scan of the cryopreserved individual, followed by in-silico repair, and biological revival. Some cryonicists (including the "godfather" of cryonics, Robert Ettinger) have expressed concerns that some of these proposals will not produce meaningful individual survival. In particular, it is argued that "running" a complete simulation of the brain on a computer won't give rise to consciousness, let alone produce individual survival.

Since it may be quite some time before technology is at a state to favor one position over the other, we need sound principles to make prudent decisions now. In his article "Brain Preservation and Personal Survival: The Importance of Promoting Cryonics-Specific Research" (*Cryonics* magazine, November-December, 2017), Alexandre Erler introduces a new kind of "wager" to make such decisions when faced with philosophical uncertainty concerning the nature of identity and consciousness.

The use of Pascal-style "wagers" is nothing new in cryonics. The most famous wager was proposed by Ralph Merkle himself to compare the potential outcomes for an individual who faces a choice between signing up for cryonics or not. "Merkle's Wager" consists of a matrix of four choices: Sign up and it works; sign up and it doesn't work; don't sign up and it works; don't sign up and it doesn't work. Merkle concludes that signing up for cryonics is the favored rational option. Michael O'Neil and Aschwin de Wolf extended this wager to making a choice between neuropreservation and whole body cryopreservation in their "The Case for Whole Body Cryopreservation" article (*Cryonics* magazine, expanded version, June 2014). Most readers may not be too concerned about the loss of identity-critical information in either cryopreservation option but being wrong on the nature of consciousness could be fatal. If consciousness is substrate-dependent and/or destroying the original brain (during a scan) excludes personal survival, choosing a wrong revival method can produce certain death, despite having received an excellent cryopreservation.

Erler simply asks the question what would be the prudent choice to make given that we cannot know with certainty (right now) which philosophical position is right. The short answer is that in-situ repair and revival of the preserved brain (or whole organism) will give rise to individual survival *regardless* of which philosophical view is correct.

One thing that is important to emphasize here, which is also discussed in Ralph's repair article, is that non-destructive (molecular) scans of some kind and in-silico repair may still be a necessary step for in-situ biological repair and revival. The conservative position on revival only claims that it would not be prudent to instruct the cryonics organization to discard the original brain and seek revival by "running" that model on a computer.

Alcor allows for members to express their revival preferences. One complex question is whether it is currently possible to give informed consent for a revival scenario other than in-situ biological repair. A related question is to what degree cryonics organizations should honor requests for enhancements during the revival process, especially if these requests are (then) known to produce substantial identity-altering effects. There has been little serious discussion of these topics to date. ■

CEO Update

By Max More

MEMBERSHIP TRENDS

Last time I reported that we ended up with only 2.4% membership growth despite a record number of membership approvals. That was due to a large number of terminations. I speculated that if we can keep terminations down – which should be easier this year – for 2018, 6 to 8% growth seems feasible. The first two months of 2018 are on-track, with an annualized net growth rate of 7.9%.

Some attrition is inevitable. But we are working hard to reduce the drop-out rate by (a) taking an active approach to reviewing life insurance to ensure that it is sustainable; (b) raising awareness of the Hardship Fund; (c) raising awareness of Alternative Funding options; and (d) keeping both operating and patient care costs under control.

A few updates relating to my core goals for 2018:

"Continue to build response capability and options." First of all, I am pleased to announce that Alcor has hired Sandra Russell as our Medical Outreach Director. Details on her role will appear soon in *Cryonics* magazine. For now, I can say that she will be boosting our outreach to check on members' wellbeing and to gather medical information. Sandra has also shown interest in doing something that no one else much wants to do: organize supplies and maintain a current inventory. In addition, Sandra has participated in numerous Alcor standbys, has considerable research experience, and will be a valuable addition to our Alcor-based response team.

Some of you may be thinking: Can Alcor really afford a new, full-time staff member? Yes! For the first year, renewable for a second year, we have a generous (anonymous) benefactor to thank. This benefactor has done rather well by getting into cryptocurrencies early on. Supporting a valuable new position is certainly an effective and admirable way of using those gains.

I am pleased to announce that Alcor has hired Sandra Russell as our Medical Outreach Director.

Also on the capability building front: One sub-goal was to "Implement at least one additional cool down system". Thanks to Steve Graber, this has already been completed. Another of Steve's innovations is the SuperDewar, as previously reported. We recently finished testing the boil-off. It took 10 months from topping off until liquid nitrogen ran out. That's about a 25% improvement over the best previously tested Bigfoot dewar. In the event of some truly drastic emergency in which none of the local LN2 suppliers could service us, that means we will have more time to purchase our own LN2 production plant.

My second major goal for 2018 is "Organizational Capacity Building: Build resilience and prepare for a heavier case load and membership size." A major part of this involved implementing a new IT system to replace the current membership system. This is now 99% complete. (We have just to verify the carry-over of data of some remaining data from the old system to the new.) Everyone who has used the new Salesforce system speaks of it enthusiastically. We still want to streamline and enhance other processes that take staff time and make our ability to scale more difficult. These include digitizing our purchase order system, and automating more of the sign-up process. On the old-fashioned paper-based records front, we recently acquired four Fireking File Cabinets to securely store member and patient records. (These are also backed up in both local and cloud-based digital form.)

Crucial to building up our local response capabilities is finding and training suitable persons who we can call on to participate in standbys and stabilizations. Although several young and smart volunteers have been brought in over the last year or two, their availability is spotty.

We are therefore very encouraged by a recent development: Just in the last week,

we have given tours to about a dozen ICU nurses (with more likely to follow) from a major hospital in the area. These highly trained medical professionals typically work three days per week at the hospital, followed by four days off. We already have the blessing of their supervisor, so long as we release them at least 11 hours before their shift is due.

Crucial to building up our local response capabilities is finding and training suitable persons who we can call on to participate in standbys and stabilizations.

We aim to create a pool of these nurses to draw on when a standby is needed. Given their existing skills, little additional training will be required, and their primary job ensures that they keep their skills current and fresh. With a large enough pool to draw on, we should be able to maintain an extended standby without exhausting anyone. Many of the ICU nurses who came on the tour seem very interested and willing to participate. Building on this, we will also look into hospice nurses to draw on to help with end-of-life prognostication – a critical aspect in decisions concerning whether and when to deploy a team.

Another major goal for the year is: "Speed up production and publication of case reports." I have to acknowledge that we have made poor progress in the first two months of the year. On the upside, we have now set in motion weekly case report progress meetings to identify bottlenecks, improve communication of case data to the case report writer, and clarify who is to take the next step.

PUBLIC EDUCATION

Helen Whitney, writer and director of the acclaimed 2011 documentary, *Forgiveness: A Time to Love and a Time to Hate*, has just released her latest two-hour documentary: *Into the Night: Portraits of Life and Death*. I have not yet watched the entire documentary, but found the segment (one of nine) devoted to cryonics – based on filming at Alcor – to be pleasantly objective. I was allowed to explain the idea without editorial distortion. Into the Night will premiere on PBS on March 26, 2018 at 9/8c. According to Broadwayworld, "The film was shown at the Austin Film Festival in October 2017 and has received rave reviews."

http://www.pbs.org/program/into-night-portraits-life-death/

Among the very few media requests to which we agreed recently was to filmmaker Alexander Ganz, filming for Superflux. Alexander Ganz is based in Arizona. He is currently working on a Ph.D. degree in Transcultural German Studies at the University of Arizona/University of Leipzig. Filming took place on February 28.

We aim to create a pool of... nurses to draw on when a standby is needed. Given their existing skills, little additional training will be required, and their primary job ensures that they keep their skills current and fresh.

Coming up:

Perhaps some of you remember the original *In Search Of* show on the history channel, hosted by Leonard Nimoy (best known as Spock). That show ran for 127 episodes from 1977-1982. The History Channel has restarted the show, this time hosted by Zachary Quinto – also known as the new Spock from the rebooted *Star Trek* movies (and as Sylar for those who watched the series, Heroes, a while back.) We have booked March 22 for filming. Quinto is quoted as saying: "I am so excited to be reimagining *In Search Of* and exploring new questions and phenomena with all of the advancements in science and technology from which we have benefitted in the past forty years since the original series first aired." "In the spirit of my late dear friend Leonard Nimoy, we intend to honor and perpetuate his endless curiosity about the world – and universe – in which we live." ■

Alcor Position Statement on

Brain Preservation Foundation Prize

In December 2015, 21st Century Medicine, Inc. published peer-reviewed results of a new cryobiological and neurobiological technique, aldehyde-stabilized cryopreservation (ASC) that provides strong proof that brains can be preserved well enough at cryogenic temperatures for neural connectivity (the connectome) to be completely visualized. This week the Brain Preservation Foundation (BPF), after independent evaluation by neuroscientists and Dr. Ken Hayworth, President of the BPF, awarded The Large Mammal Brain Preservation Prize to 21st Century Medicine based on these results. In 2016 the company had been previously awarded the Small Mammal Brain Preservation Prize for work using the same technology.

Many people are wondering whether Alcor plans to adopt the "Aldehyde-Stabilized Cryopreservation" (ASC) protocol used to win the prize and what the win means for cryonics in practice. Alcor's position is as follows:

We are pleased that vitrification, the same basic approach that Alcor Life Extension Foundation has utilized since 2001, is finally being recognized by the scientific mainstream as able to eliminate ice damage in the brain during cryopreservation. Alcor first published results showing this in 2004. The technology and solutions that Alcor currently uses for vitrification (a technology from mainstream organ banking research) were actually developed by the same company that developed ASC and has now won both the Small Mammal and Large Mammal Brain Preservation Prize.

ASC under the name "fixation and vitrification" was first proposed for cryonics use in 1986. ASC enables excellent visualization of cellular structure – which was the objective that had to be met to win the prizes – and shows that brains can be preserved well enough at low temperature for neural connectivity to be shown to be preserved. Current brain vitrification methods without fixation lead to dehydration. Dehydration has effects on tissue contrast that make it difficult to see whether the connectome is preserved or not with electron microscopy. That does not mean that dehydration is especially damaging, nor that fixation with toxic aldehyde does less damage. In fact, the M22 vitrification solution used in current brain vitrification technology is believed to be relatively gentle to molecules because it preserves cell viability in other contexts, while still giving structural preservation that is impressive when it is possible to see it. For example, note the synapses visible in the images at the bottom of the following page (http://www.brainpreservation.org/competitors/).

While ASC produces clearer images than current methods of vitrification without fixation, it does so at the expense of being toxic to the biological machinery of life by wreaking havoc on a molecular scale. Chemical fixation results in chemical changes (the same as embalming) that are extreme and difficult to evaluate in the absence of at least residual viability. Certainly, fixation is likely to be much harder to reverse so as to restore biological viability as compared to vitrification without fixation. Fixation is also known to increase freezing damage if cryoprotectant penetration is inadequate, further adding to the risk of using fixation under non-ideal conditions that are common in cryonics. Another reason for lack of interest in pursuing this approach is that it is a research dead end on the road to developing reversible tissue preservation in the nearer future.

Alcor looks forward to continued research in ASC and continued improvement in conventional vitrification technology to reduce cryoprotectant toxicity and tissue dehydration. We are especially interested in utilizing blood-brain barrier opening technology such as was used to win the prize.

It may remain unclear to some whether this research and associated prizes show whether ASC or current vitrification without pre-fixation is more likely to preserve cell structures and molecular structures necessary for memory and personal identity. What we can note is that Robert McIntyre, the lead researcher on ASC at 21st Century Medicine, made a point during his presentation at the Alcor 2015 Conference of recommending against adoption of ASC in cryonics at this time.

For cryonics under ideal conditions, the damage that still requires future repair is now more subtle than freezing damage. That damage is believed to be chiefly cryoprotectant toxicity and associated tissue dehydration. It's time for cryonics debate to move past ill-informed beliefs of "cells bursting."

This is a groundbreaking result that further strengthens the already strong case that medical biostasis now clearly warrants mainstream scientific discussion, evaluation, and focus. ■

TURN BACK THE CLOCK

*High-potency **carnosine** with R-lipoic acid, benfotiamine, taurine, luteolin, and PQQ*

For full product description and to order **Mitochondrial Energy Optimizer with PQQ**, call **1-800-544-4440** or visit **LifeExtension.com**

Item #01868 • 120 capsules • Retail price is $68.00 • **Your price is $51.00** • 4 bottles are only $45.00 each

Please mention Discount Code **PIM801X** · Offer expires April 30, 2018

MKAQAV180301

Revival of Alcor Patients

Part 1 of 2

By Ralph C. Merkle

Abstract

Reviving Alcor's patients from cryopreservation is fundamental to its mission. As the revival technology begins to come into focus, the process of planning patient revival can begin. At an abstract level, the revival process might use any of three primary means: *in situ* repair, scan-and-restore, or scan-to-WBE (Whole Brain Emulation). *In situ* repair will require the development of medical nanorobots capable of operating in cryopreserved tissues ("cryobots"), while scan-and-restore and scan-to-WBE could benefit from this technology. The cryonics community will likely have to play a major role in the development of cryobots. In addition, while it might not seem immediately obvious, the need to test any cryopreservation revival protocol on human subjects before it is used to revive cryopreserved patients, combined with the need to comply with basic ethical principles, will force the extensive use of computer simulations, WBEs, neurobots to monitor nerve impulses, and technologies to scan cryopreserved brains. WBEs, neurobots and scanning technologies are, therefore, of broad interest to all members of the cryonics community who seek to ethically evaluate cryopreservation revival protocols before they are used to revive cryopreserved patients.

INTRODUCTION

Alcor's mission has three major elements:

1. Maintain the current patients in biostasis.
2. Place current and future members into biostasis (when and if needed).
3. Eventually restore to health and reintegrate into society all patients in Alcor's care.

While acknowledging its importance, we have historically ignored the third major element of our mission: reviving our patients.

The technologies that will allow us to carry out this component of our mission are finally becoming clear, and we can now begin the process of planning for the revival of Alcor's patients. In the following discussion, we will distinguish between those technologies that are likely to have such broad societal value that they will probably be developed without substantial input from the cryonics community, such as molecular nanotechnology and nanomedicine, and those technologies that might require support from the cryonics community, such as medical nanorobots capable of operating at cryogenic temperatures in cryopreserved tissues (i.e., "cryobots").

Identifying the critical tasks that will not happen unless we make them happen is crucial if the cryonics community is to revive our cryopreserved friends and loved ones as rapidly and reliably as possible.

What are these critical tasks? Horizon Mission Methodology[1] is a method for making long term plans to accomplish major objectives that appear, upon initial examination, to be either very difficult or even impossible. We can apply Horizon Mission Methodology to the problem of reviving Alcor's patients.

The core concept is to look back at the present from the perspective of a future in which the objective has already been successfully achieved. Reorienting one's thinking to this new conceptual framework greatly facilitates the search for a solution and allows a clearer reexamination of previous assumptions that might otherwise have inhibited a clear understanding of possible answers.

The assumption that the objective has been accomplished also significantly reduces the size of the search space, simplifying the search for a solution. Paradoxically, the more difficult the objective appears, the greater the reduction in the size of the search space and the more effective Horizon Mission Methodology becomes.

Our conceptual framework is that we are looking back from the year 20xx[2] (with the particular value of "xx" left unspecified), the year in which Alcor's patients were revived. In looking back from the perspective of those who successfully revived Alcor's patients, the first thing we realize is that we almost certainly had to carry out repairs at cryogenic temperatures, at least in the early stages of the repair process, even if some less major components of the process were deferred until after the patient was warmed. We now can examine what these early stages of the repair process must have looked like.

THREE METHODS FOR REVIVAL

The three primary methods by which revival from a state of cryopreservation might take place include *in situ* repair, molecular scan-and-restore, and scan-to-WBE.

IN SITU REPAIR

In situ repair uses the minimum repair methodology necessary for any given region of tissue. In this approach, any functional tissue, or tissue that can be restored to a state from which it can restore itself to a functional state, will be retained and repaired.

In situ repair scenarios typically involve medical nanorobots called "cryobots" that enter the cryopreserved tissue at liquid nitrogen temperature by "tunneling" through the circulatory system,[3] bringing them to within ~20 microns of every point in the patient's brain and ~40 microns of every point in other tissue.[4]

CRYOBOTS

Cryobots might be about 2 microns in diameter and have robotic arms designed using rotary joints. Molecular rotary joints can have very low energy dissipation.[5] Small onboard computers guide their actions, while more substantial computational power is provided externally.[6] Onboard power dissipation must be limited to prevent undesired elevation of tissue temperature. External computation does not suffer from this constraint and guides overall repair activity.

Alcor need not develop the required molecular computers, nor the medical nanorobots that operate in liquid water. However, it is less clear that operation of cryobots at cryogenic temperatures for repair of cryopreserved tissue will be developed by mainstream organizations. It seems more likely that the organization that develops cryobots will be founded by cryonicists, possibly with Alcor's help. In any event, we assume that cryobots are developed by an organization called Cryobotics, whose precise nature (for profit, non-profit, jurisdiction, source of funding, etc.) is left open.

In situ repair will use cryobots. Cryobots operate in cryopreserved patients at cryogenic temperatures. Their first mission is to tunnel out the patients' circulatory system. Their second mission is to assess the state of each region of tissue. The primary purpose of this assessment is to determine if the local tissue can be warmed to enable further repairs to take place in the liquid state. The expectation is that well cryoprotected regions that are minimally damaged ("good regions") could be re-warmed until they are liquid, and repairs would continue in the liquid state.[7] Regions where cryoprotectant did not penetrate, or which were otherwise subjected to significant damage ("bad regions"), would be processed at low temperature using *in situ* molecular scan-and-restore. Repair of fractures proceeds by taking a local molecular scan of the region near the fracture, and enough of the surrounding region to enable entry of cryobots into the extended fracture region, followed by rebuilding of the extended fracture region. On-site cryobots will report out to off-site computers, which will analyze the results of any regional molecular scans and develop a regional rebuilding plan for the bad regions compatible with the boundary conditions defined by the adjacent good regions.

Cryobots will need to be able to communicate with external computational resources, as well as take local molecular scans.

The primary requirement for correct functioning of cryobots is the ability to identify and tunnel through the circulatory system. For this to be possible, the circulatory system in the cryopreserved patient must be relatively intact and identifiable, especially the capillaries. If the circulatory system cannot be identified, or if it is not possible to create an appropriate network of tunnels without damaging the tissue, then it might be necessary to take a molecular scan of the cryopreserved patient as a whole. If, upon assessment, most of the tissue cannot be warmed to a liquid state but must be scanned in place, then a molecular scan of the cryopreserved patient as a whole would seem more appropriate. The level of damage that would prevent correct identification of the circulatory system, followed by tunneling into it by cryobots, would likely be severe.

CRYOBOTICS DEVELOPMENT

We assume that the organization that develops cryobots is called Cryobotics. The primary charge of Cryobotics will be to develop those components of the technology that mainstream companies have not developed. We can safely assume that mainstream companies will have developed medical nanorobots able to operate in patients at liquid-water temperatures as well as the nanofactories necessary to build these nanorobots. Cryobotics will have to develop the cryobots that carry out the cryogenic component of *in situ* repair. Once the tissue has been restored to a liquid state it is reasonable to expect that more conventional medical nanorobots will be able to deal with the patient. The specific questions raised by cryonics will be operation of cryobots at cryogenic temperatures: tunneling through the circulatory system, setting up the communications and power infrastructure, taking local molecular scans, restoring tissue at cryogenic temperature, and rapidly warming cryopreserved tissue to a liquid state. Cryobotics might also play a major role in the development of molecular scan technology, as local molecular scans are an integral component of *in situ* repair. Local molecular scans might be necessary in patients with imperfect cryopreservation in narrowly confined areas, even when the overall cryopreservation is excellent.

WHO FUNDS CRYOBOTICS?

A few questions of great practical importance will include:

1. Who will fund Cryobotics and why?
2. Does funding have to come entirely from the cryonics community?
3. Must funding be in the form of donations, or are there commercial applications of cryobots?
4. Might Cryobotics be funded because cryobots could perform useful surgical procedures on patients who are beyond the ability of conventional surgical techniques? Might a conventional medical patient ever decide to be cryopreserved because certain treatment options are only available to cryopreserved patients?
5. Are there medical conditions that can be treated by cryobots, but whose treatment would be difficult or impossible by other means?

If cryobots have applications in conventional medicine, then Alcor and the cryonics community would not have to fund some or all of their development. A high-leverage activity would be to envision such applications, find those who would

benefit from them, and explain to them the benefits thereof. Such beneficiaries might then be induced to provide significant funding for Cryobotics. However, it seems almost certain that the task of envisioning and identifying high-value applications of cryobots – and very likely the early developmental work as well – will fall to the cryonics community.

If funding comes from donations, Cryobotics should be structured as a non-profit. If funding comes from investors, Cryobotics should be structured as a for-profit. If funding comes from both, great care should be exercised with respect to intellectual property (IP) issues, as mixing non-profit and for-profit organizational structures can create legal issues. For-profit entities can legally donate IP to non-profit entities, although normally they would not wish to do so because this would mean lost profit opportunities. There are legal restrictions on the sale of IP developed and owned by non-profit entities to for-profit entities. Developing IP under the guise of being a non-profit and then using the fruits of that development work in a for-profit activity would violate the public purpose for which the non-profit status was granted. There is likely to be a very restricted market for IP in the early stages of development, and therefore difficulty in establishing that the sale was in fact an arm's length transaction. The terms of any sale are likely to be subjected to intense legal scrutiny in hindsight, once the great monetary value of the IP is obvious and any early uncertainty has been forgotten.

As a consequence, if a close working relationship involving both non-profit and for-profit components is anticipated for the structure of Cryobotics, then a careful legal review of that structure should be conducted to ensure that IP issues are handled in a way that will produce satisfactory results for all parties concerned throughout the life of the project.

Identifying sources of funding for Cryobotics is critical for rapid development of the required technology. These sources might include: (1) wealthy members of the cryonics community who expect to be cryopreserved and who set up trusts or foundations able to fund Cryobotics; (2) living wealthy members of the cryonics community with cryopreserved loved ones who wish to fund Cryobotics; or (3) members of the cryonics community who can identify major value creation opportunities for Cryobotics, and then help to develop those opportunities.

GETTING FUNDING FROM OUTSIDE THE CRYONICS COMMUNITY

It would be highly desirable to obtain funding from outside the cryonics community. How to obtain this funding before successful revival of cryopreserved patients has been demonstrated is not entirely clear. Hopefully, there are reasons for pursuing research in this area that are unrelated to reviving cryopreserved patients.[8]

MOLECULAR SCAN-AND-RESTORE

The *in situ* scan technology used for a particular region of cryopreserved tissue might depend on the quality of its cryopreservation. The lower the quality of the cryopreservation, the more difficult it will be to accurately restore the tissue and the more important it will be to use a scan technology that provides as much information about the tissue as possible. The greatest amount of information would be provided by a molecular scan, which, by definition, produces exact information about the position and type of every atom and molecule in the scanned tissue. A molecular scan is therefore the most conservative type of scan technology, and would be preferred if there was any question about the type of scan technology that was needed.

Should the quality of an entire cryopreservation be sufficiently poor that it becomes prudent to perform local molecular scans in essentially all regions of the brain, then the use of molecular scan-and-restore throughout the entire brain would be preferred. It would also be logistically simpler and more reliable. The precise level of damage at which it becomes reasonable to do this is unclear, but given that the quality of cryopreservation can vary widely, it seems likely that this will be the appropriate course of action for at least some patients.

Molecular scan-and-restore should be effective even in cases of severe damage. It consists of three steps: (1) a molecular scan, (2) processing of the scan, and (3) physically restoring the patient from the processed scan. In this approach, the molecular scan gathers complete information about the molecular structure of the patient's tissues, particularly including the brain. A molecular scan gives the position and type of every atom. It provides the raw information that could, after processing, serve as the basis for restoring the scanned patient. This approach should be applicable in cases that would, by any present-day criteria, be considered beyond hope.

WHAT IS A MOLECULAR SCAN?

A *molecular scan* is any method of scanning which provides the location, orientation and type of every atom and molecule in the cryopreserved tissue. If we assume that every molecule has one, or at most a few, stereotypical three dimensional shapes,[9] then we can readily approximate the total number of bits required to store an exact description of the molecular structure of the scanned tissue. A molecular scan will literally give us the location and type of every atom in the cryopreserved tissue.

To give a specific example, a single hydrogen atom might be encoded by four numbers: an X coordinate, a Y coordinate, a Z coordinate, and an atom type. Each coordinate might require 40 bits to specify, so that the three coordinates together might take 120 bits to specify. The atom type might take 6 bits to specify. A single atom would then take 126 bits to specify. A water molecule, consisting of three atoms, would require 372 bits. A more compact representation for a water molecule would specify its location (120 bits), the type of the molecule (perhaps 20 bits),[10] and its orientation (roll, pitch, and yaw, perhaps 20 bits each), for a total of 200 bits. This is a more compact representation (200 is less than 372), especially useful in cases such as water where large numbers of them are present.[11] This method of compressing the representation becomes more effective for bigger molecules and larger structures. A single molecule, no matter how big, can be specified with only 200 bits (provided it adopts only one functionally significant conformation during normal biological operations).[12] For example, specifying the

position and orientation of a ribosome specifies the positions and types of all the atoms that compose it.[13] Those familiar with data compression methods will realize that a variety of methods for reducing the size of the data encoding the information about the molecular structure of the tissue are available.

Molecular scans are generally divided into two types: destructive and non-destructive. Destructive scans, as their name implies, disassemble the cryopreserved tissue in the process of scanning it. Non-destructive scans preserve the tissue intact.

Reliable methods for conducting *destructive* molecular scans that entirely disassemble the tissue are relatively easy to envision (e.g., "Backups Using Molecular Scans"). Such methods might be based on high resolution Scanning Probe Microscopy (SPM) methods. SPMs rely on the physical interactions between a molecular-sized tip and the surface being scanned. The mechanism positioning the tip can be large (as in today's SPMs) or could be very small, even molecular, in scale, in future SPMs built using molecular nanotechnology (MNT). A parallel array of SPM tips spaced approximately 100 nm (10^{-7} m) apart seems feasible, and would allow the surface of the brain (or other tissue) to be rapidly scanned. Assuming a moderately fast scan rate of 10 MHz (10 million pixels per second per tip) and an atomic resolution of 0.1 nm (10^{-10} m, one angstrom), means each tip would be able to scan its 100 nm x 100 nm square region in 0.1 second. Assuming a rate of penetration into the tissue of 1 nm per 0.1 second yields a molecular scan rate of ~10^6 nm/day, or 1 mm/day. A 100 mm thick brain could be completed in ~100 days.[14] Thus we can readily envision at least one future molecular scan technology able to scan an entire cryopreserved human brain in a few months or less. Partial molecular scans would require less time.

There has not yet been published any detailed proposal for a *non-destructive* molecular scan technology able to scan a structure as large as a cryopreserved human brain. How this might be done is, at present, an open research question, although some intriguing research has been done in the area of high resolution MRI.

PROCESSING MOLECULAR SCAN DATA

Once we have the raw scan data from the molecular scan, that data must be processed. In the most favorable case, the cryoprotection went well and the data is beautiful, crisp, and complete. As the data becomes increasingly distorted and as increasing amounts of noise are introduced from various sources, the inherent redundancy in the original structure will be increasingly called upon to allow an accurate reconstruction.[15] Accurate reconstruction in the face of noise is initially computationally inexpensive when the amount of noise is limited, but becomes computationally increasingly expensive until, at some point, it becomes prohibitively difficult shortly before the ability to provide an accurate reconstruction becomes infeasible and the data becomes inherently ambiguous.[16]

Deep learning[17] algorithms can be adapted to apply to the kind of data we'll be able to generate from molecular scans: three dimensional high resolution atomically precise data. We'll also have quite a bit of computer power available: at least 10^{12} GFLOPS/Watt.[18] The cost of electrical power should then be at least 100-1000 times cheaper than today.[19] That combination will give us quite a bit more computational power to apply to our image analysis. An object the size of the human brain has ~10^{27} voxels, assuming one angstrom voxels. We may be able to buy 10^{15} joules for as little as $10,000, giving us 10^{27} GFLOPS, or 10^9 FLOPS per voxel. That should be more than sufficient for most image analysis and deep learning purposes.

The deep learning and image analysis algorithms will have been developed for other purposes, and their application to whole brain emulation and reconstruction might have been pursued by others. However, it seems likely that at least some of this development will need to be pursued by members of the cryonics community, and possibly by Alcor.

It will be useful to plan how the image analysis will integrate with the data produced by the molecular scan. We'll likely have to start with "model systems"[20] and incrementally work our way up to bigger and bigger systems.

The "image analysis" or "deep learning" or "AI software" is assumed to produce, as output, an atomically precise description (possibly in some compressed format) of a biological system, such as a human brain, along with the surrounding support structures and interface systems.

This description could then be entered into a suitable atomically precise 3D manufacturing system (or "3D printer for atoms") to fabricate the described structure. It seems reasonable to assume that manufacturing takes place at cryogenic temperatures and is followed by rapid warming.[21]

The algorithms for processing molecular scan data will need to be developed, and it would be helpful to have as clear an idea of what these algorithms will look like as possible. One strategy for doing this would be to generate synthetic molecular scan data. If we assume that molecular scans will provide us with atomically precise information about the cryopreserved structure, then it should be possible to generate synthetic molecular scan data by creating atomically precise descriptions of cellular structures based on our current understanding of such structures, then applying damaging transformations based on our current understanding of the transformations involved in present-day cryopreservation methods. The resulting synthetic molecular scan data could then be used as input to aid in developing and debugging the algorithms used in processing molecular scan data.

Arguing against this approach is the likelihood that synthetic molecular scan data will deviate from actual molecular scan data in significant ways. While it would still be possible to test and debug the algorithms to be used in processing real molecular scan data on synthetic scan data, there would be a risk that the resulting algorithms, even if they performed well on the synthetic scan data, might still not perform well on real scan data. But developing and testing algorithms on synthetic scan data should speed development even if such testing was incomplete, and even if further testing and debugging on real scan data was still required.

Of course, it is also possible that molecular scans might prove to be significantly more

detailed than is required, and that some lesser scanning method will prove to be sufficient (see "Lower Resolution Scans"), rendering the need to analyze molecular scan data moot.

Should it be possible to develop algorithms that are easily generalizable, then algorithm development could start today, with the understanding that any specific algorithm might not be used but that the general concepts developed could still form the framework within which the actual scan technology would be developed and the scan processing would take place.

A MOLECULAR SCAN IS THE BEST WE CAN DO

A molecular scan provides us with all the information about the cryopreserved tissue that it is possible to obtain. No further information can be obtained. A molecular scan puts us in the best possible position to restore the scanned tissue to a healthy state. If we can't restore a person with their memories and personality intact after a molecular scan, then there's too little information in their cryopreserved brain to do this.

To put it another way, if someone has been cryopreserved and we pursue any other method for reviving them based on their cryopreserved tissues, we cannot, in principle, do any better than by starting with a molecular scan. In particular, if a cryopreservation went badly and we attempt to revive the person by warming them up and using some form of biological repair, such a biological repair process cannot, in principle, do a better job than a restoration process that started with a molecular scan. The reason for this is simple. After rewarming, the biologically oriented repair process must contend with the continuing deterioration of the damaged molecular and cellular structures. Ruptured membranes will continue to allow mixing of the contents of cellular compartments. Damaged molecular structures will continue to deteriorate and entropy will continue to increase. The biological repair processes, whatever they might be, will be fighting against extensive levels of damage and would have to move with implausibly great speed simply to limit the further spread of that damage, let alone to perform repairs.

By contrast, a molecular scan provides a snapshot of the system at the moment it was cryopreserved. There will be no further deterioration. Entropy is held in check. The computational processes that examine the digitized tissue can do so at leisure, mathematically restoring the digital representations of the structures to their appropriate state as though they were frozen in time.

Only after the full digital restoration has been completed and every detail has been attended to would the whole digitally restored structure then be actually converted back into a physical structure. This conversion process could take place either by carrying out a series of low-temperature repairs on the existing physical structure, using the digital restoration held in computer memory as a guide; or by using what would amount to a 3D printer for atoms that allows the exact three dimensional structure to be printed in atomically precise detail.

If a non-destructive molecular scan technology can be developed, then it could be applied to every cryopreserved patient. It would provide valuable information that could be used to assist the repair process, whatever that repair process might be, and would cause no damage that might impair subsequent efforts to revive the patient. Further, it would provide an invaluable fail-safe in case the repair process went awry.

However, if only destructive molecular scan technologies are available, then their application to a specific patient would require weighing the benefits of the information they provide against the possibility that damage to the original structure might impair subsequent steps in the revival process. Some cryopreservation patients would prefer recovery of complete information about themselves through a molecular scan, regardless of whether or not it was destructive. Other cryopreservation patients might elect to have a destructive molecular scan only if it were necessary for their successful revival and only if there were no other options [Alexandre Erler, Brain Preservation and Personal Survival: The Importance of Promoting Cryonics-Specific Research, Cryonics magazine, November-December, 2017]. There may even be some cryopreservation patients who would forego a destructive molecular scan altogether, even if this meant failure of their revival.

A destructive molecular scan is compatible with, and could be used as the starting point for, the biological restoration of a patient. A destructive molecular scan, followed by the use of a digital restoration algorithm, followed by the use of an atomically precise 3D printer to instantiate the resulting atomically precise digital restoration, might be effective at producing a high fidelity and biologically accurate reproduction of the original person, in cases where methods that did not involve digital restoration would produce unsatisfactory results.

For these reasons, further research on a purely non-destructive molecular scan should be pursued. This technology could be used in all cases, by all people, regardless of their philosophical views.

BACKUPS USING MOLECULAR SCANS

At a deeper level, tissue is information: the two are interchangeable.[22] Anyone who seeks a very long lifespan, and who acknowledges that accidents can happen, must at some point come to terms with the need for backups: sufficiently accurate descriptions of themselves from which they can be restored, should they suffer from a misfortune so catastrophically damaging that no recovery from that misfortune is otherwise possible.[23] This is both feasible and obviously desirable.[24]

If a destructive molecular scan is taken of your cryopreserved self and the processed scan is used as the blueprint from which you are restored, this is philosophically similar to awakening from a backup after a catastrophic mishap.[25] Can existing proposals for destructive molecular scans, based on SPM technology, be carried out reliably? In other words, if we disassemble tissue in the process of scanning it, as is called for by existing proposals for molecular scans, then the scan needs to be quite reliable, as the tissue will be gone when the scan is finished. If the scan is lost, and the tissue that was scanned is no longer available, then the person being scanned will be dead – clearly an undesirable outcome.

An SPM can scan the exposed surface of a block of tissue, characterizing it completely. After the surface has been completely characterized, but not modified, the information about the surface could be digitized and stored. All information from this surface scan can be continuously and redundantly transferred to stable storage media as the exploration of the tissue block proceeds. Only after information from the ongoing scan had been duplicated and stored redundantly, or even triplicated or quadruplicated, thus providing whatever level of reliability might be desired, need the scanning process proceed to the next step: removing the scanned surface layer to expose the layer beneath it. Very high reliability should be feasible.

This method of analyzing tissue is both conceptually simple, and can be made highly reliable:

1. Analyze the tissue surface using SPM technology.
2. Redundantly and reliably store the results of the surface analysis.
3. Only then, after confirming storage of the analyzed surface, remove the analyzed surface and expose the next layer.
4. Repeat.

While simple and reliable, and capable of providing molecular scans, this method does have the obvious disadvantage that is disassembles the tissue in the process of analyzing it.

Is there a method of carrying out a molecular scan that does not require disassembly? The answer to this question is more difficult. There could well be a way of gaining molecularly and atomically precise knowledge of tissue without disassembly, but it is not immediately obvious how this might be done. Magnetic Resonance Imaging (MRI) using nanoscale devices operating from adjacent capillaries and performing indirect scans of the intervening tissue offer intriguing possibilities, but a molecular scan of something as large as the human brain still presents significant technical challenges. The options made available by MNT and complete access to the circulatory system have not been fully explored. Further studies are needed to understand the possibilities and to provide a reliable answer to this question.

LOWER RESOLUTION SCANS

A question of some interest is whether molecular scans are actually necessary, and if lower resolution scans might be sufficient. While we can be confident that a full molecular scan will be sufficient if anything is sufficient, lower resolution scans that provide less information about the tissue being scanned might also be sufficient, depending on the type of scan and the use to which the data is being put.

The question of what sort of information we need is one where neuroscience must inform our discussion. How much information is required to construct a satisfactory model of the human brain? While it's rather obvious that we don't need to know the location and orientation of every molecule in the brain (esp. the orientation of all the water molecules), how much information do we need to know? And what sort of scanning technologies might provide us with enough information at a sufficiently low cost? There are many existing research projects aimed at developing high resolution three dimensional images of biological tissues, including the human brain. At some point in the future, it should be possible to obtain funding to apply MNT to this problem. Again, further research is required.

SCAN-TO-WBE

A third alternative that some patients might explicitly request is to process the information from a molecular scan and use it to directly construct a whole brain emulation (WBE).[26] This "scan-to-WBE" option might be simpler than the molecular scan-and-restore process, as it would eliminate the need for physically restoring a biological body. Scan-to-WBE would rely entirely on the information recovered from the cryopreserved tissue.

It is possible that the technology for molecular scans and Whole Brain Emulations might become available before the technology for *in situ* repair.[27] Alcor members wishing to return to an active life as quickly as possible might want to take advantage of whatever technology arrives first. Of course, those members who wish to be revived as a WBE would have to communicate this wish to Alcor before they are cryopreserved as, once cryopreserved, further communication will not be possible. This process could be facilitated if Alcor provided forms enabling members to explicitly express their wishes in this regard.[28]

As will be discussed later, scan-to-WBE will be an essential component of the process that we will use to ethically evaluate any proposed method of reviving a cryopreserved patient. As a consequence, methods for scanning-to-WBE are of interest to everyone in the cryonics community, not just those who are specifically interested in themselves becoming WBEs.

TECHNICAL CONSIDERATIONS

What criteria should be applied in deciding whether to use *in situ* repair or molecular scan-and-restore? Some might argue that we should always employ *in situ* repair, relying on the fact that *in situ* repair will include local assessments of tissue damage and utilize local molecular scans on an as-needed basis. These local molecular scans might be performed on a larger and larger percentage of the tissue as the quality of the cryopreservation became poorer and poorer.

Many patients in Alcor's care have inevitably suffered extensive damage. Some have suffered such extensive damage that there are serious questions about the ability of any technology, no matter how advanced, to revive them with their memories and personality completely intact. In such cases, the use of a molecular scan followed by digital restoration prior to any attempt to carry out a biological restoration (guided by the digital restoration) would seem appropriate.

While Alcor seeks to comply with patient wishes, there might be two opposing wishes at work here. On the one hand, some patients may prefer to use *in situ* repair for philosophical reasons. On the other hand, some patients may want to get out of the dewar as quickly as possible. It is possible that fully developing the technology for *in situ* repair might take longer because it appears to be a more complex technology. There are plausible scenarios in which molecular scan-and-restore might turn out to be a simpler technology to develop and deploy. It is even possible that in some circumstances, scan-to-WBE might

be available before molecular scan-and-restore, which in turn might be available before *in situ* repair. Molecular scan-and-restore might also be less prone to residual damage than *in situ* repair, and more likely to correct all the damage incurred by both the cryopreservation and any preexisting medical conditions. For example, if an existing region of tissue is evaluated as "good" during the *in situ* repair process and is warmed without being scanned, then there is no backup for that region. Any failure during the revival process, or any undetected damage in that region, could result in a less-than-optimal revival.

As an additional confounding variable, some Alcor members might prefer being revived as a WBE living in a virtual world (if the technology is reliable). This arguably offers certain benefits, most notably the ability to make regular or even continuous backups and the opportunity to quite literally expand your mind. Patient preferences should be taken into account. The best course of action is probably to explicitly ask members what they prefer – before they are cryopreserved.

DID WE DO IT RIGHT?

An obvious and rather awkward question is this: once we revive someone, how do we know we did it right? We could, of course, ask them: "How do you feel?" If they say "Terrible! I don't feel like myself!" we might naturally be concerned. But how do we know that's not the right answer? There are people who say that kind of thing quite a bit.

One solution is to conduct some sort of test before a person is cryopreserved, then test them again after we revive them, and compare the results. What sort of test might we conduct? How can we determine if we've done a high-fidelity cryopreservation and revival?

EVALUATING AN ANIMAL REVIVAL PROTOCOL

Perhaps the most detailed functional information we could acquire about an experimental animal's brain would be a record of every nerve impulse for some period of time. Is this feasible? Certainly with MNT, the answer appears to be "yes".

We consider one possible approach: building "neurobots", a class of medical nanorobots, and locating them on, in, or near nerve cells. Neurobots detect and record passing nerve impulses and have an accurate time base (either built in, or based on a centrally transmitted clock). When a nerve impulse passes by, the neurobots note the time and record the associated small fluctuations in voltage or electric field on a polymer "tape". The tape is extruded into the extracellular space and finds its way out of the body, where it and many others like it are later recovered and analyzed. Other methods of communicating the data recorded by the neurobots are also possible.[29]

We could record every nerve impulse in the brain by embedding a sufficient number of neurobots. A few back-of-the-envelope calculations show that the storage density of polymer tape is more than sufficient to hold all the data. Some specific proposals along these lines have already been advanced in the literature,[30] though their effectiveness without MNT may be marginal.

The objective is to record all neuronal activity within the test subject's brain (or other volume of interest). This has been a long-standing goal of neuroscientists. The major limitation facing neuroscientists today is the relatively large size of the devices needed to record the voltages and electric fields. MNT will enable the manufacture of devices of sufficiently small size and precision to enable this long-sought goal.

We could then record data from neurobots in the brain of an experimental animal before they were cryopreserved, cryopreserve them, revive them, and then record data from neurobots in the brain of the revived experimental animal, giving us two sets of neuronal data: "before" and "after". Comparing the "before" and "after" data would let us tell if we had done a good job in cryopreserving and reviving the experimental animal. At a purely structural level, the connectome[31] from "before" should be the same as the connectome "after", except for those changes that took place because of learning, where we interpret "learning" broadly as "plastic changes in the brain caused by its normal functioning as a consequence of its interactions with a normal environment".

To spell this out in more detail, if we wish to evaluate a protocol for cryopreserving a biological experimental animal and reviving them as a biological experimental animal, we would: (1) use neurobots to monitor all nerve impulses in a test subject, (2) construct a "before" WBE from the monitored nerve impulses, (3) cryopreserve the test subject while continuing to monitor their nerve impulses, (4) revive the test subject biologically, (5) use the neurobots to monitor all nerve impulses in the revived test subject, (6) construct an "after" WBE from the second set of data produced by the neurobots, and then (7) compare the "before" and "after" WBEs and see if there are any significant differences. If there are significant differences, then the cryopreservation and revival technologies are regarded as "not good enough". If there are no significant differences, then the cryopreservation and revival technologies are regarded as "good enough".

We construct "before" and "after" WBEs and compare them because it's difficult to compare the raw data generated by the neurobots from "before" and "after". Merely knowing that a nerve impulse passed neurobot A at time t_1 "before" and that a nerve impulse passed neurobot B at time t_2 "after" is not going to tell us much without a great deal of analysis.

Conceptually, the required analysis must convert the raw nerve impulse data into a picture of the neural connections of the test subject's brain. This may be roughly likened to deriving the connectome, that is, the network of neural connections between the nerve cells in the brain, from the pattern of nerve impulses.[32] The progression of a nerve impulse as it passes individual neurobots could be monitored, allowing the existence of a neuronal path winding along between those neurobots to be inferred. The generation of a new nerve impulse by the summation of several input nerve impulses could likewise be inferred from a sufficiently dense network of neurobots monitoring the nerve impulses in the brain. With a sufficient number of neurobots monitored for a long enough period of time, the entire connectome of the brain could be inferred. We can then use the connectome as a significant subset of the information required for a WBE.[33]

INJECTION OF NERVE IMPULSES

A question that needs to be addressed is whether or not passive data collection by neurobots will be sufficient to allow reconstruction of the connectome. That is, is it sufficient if neurobots simply monitor the existing neuronal traffic for some reasonable period of time? One can readily imagine that a particular synaptic connection between two neurons only occasionally plays a role in the pattern of nerve impulses actually generated. Monitoring nerve impulses between those occasions when that synapse plays a role would reveal nothing about that synapse.

A simple (but not necessarily realistic) example from computer science will serve to illustrate the point. A three-input MAJORITY gate has three inputs, input 1, input 2, and input 3. It will only fire if two of the three inputs take on the logical values of "1" at the same time. If we only knew the data values on the wires connecting the various logic gates, we might never realize that input 3 was connected if the actual pattern of data never had a logic "1" on input 3 at the same time there was a logic "1" on either input 1 or input 2. Thus, if there was a logic "1" on input 1 and input 2 at the same time, but never a pattern showing the gate firing when input 3 was at a logic "1" (because neither input 1 nor input 2 was at a logic "1" at that point in time), then we would conclude that the gate was a two-input AND gate, not a three-input MAJORITY gate.

While we don't yet know whether passive collection of nerve impulse data is sufficient to allow correct inference of an individual's WBE, we'll need to determine the full set of synaptic connections even if passive collection is insufficient. To this end, we might need to inject signals into the nervous system, allowing us to interrogate the cellular circuits with a sufficient number of possible inputs to ensure that we have accurately determined all of the synaptic connections.

In our example of a MAJORITY gate that was incorrectly labeled as an AND gate, we would need to inject a "1" on input 3 at the same time that there was an input of "1" on input 1 or input 2. In this way, we could guarantee that we had enough data to deduce the nature of the MAJORITY gate, and correctly distinguish it from an AND gate.

Whether this will be necessary or not is unclear at the present time. If it is not necessary, then the neurobots will not need to inject signals into the nervous system, which could potentially simplify their design. If it is necessary, then the neurobots will need to be able to inject signals (nerve impulses, selective depolarization of the cell membrane) into the nervous system. A variety of methods for carrying out this task are possible.

Such an ability would, in any event, be desirable for other reasons, both in terms of treating a variety of medical conditions and in terms of diagnoses.

COMPARISON OF WBES

Once we have constructed a WBE from the raw data gathered by the neurobots, then it would become possible to compare two such WBEs to each other in a meaningful way, as we expect that information like the connectome of a primate before and after they have been cryopreserved should remain the same. Changes in the WBEs would either be the result of damage caused by the cryopreservation-and-revival process, or would be the result of learning that took place between the "before" and "after" WBEs. Assuming the neurobots remained in place during the cryopreservation, recording nerve impulses before and during the cryopreservation, and then later recording nerve impulses immediately following revival, there would be no loss of neuronal information. It should be possible to more directly compare the "before" and "after" WBEs with less concern about unaccounted-for changes that took place because of learning between the time the "before" WBE was taken and the "after" WBE was taken. The only unaccounted changes would then be those caused by damage due to the cryopreservation and revival process.

While this protocol works for experimental animals, we shall see later that it is ethically inappropriate to apply it to human test subjects. After some analysis of the ethical principles that must be followed, we derive a different protocol for evaluating a revival protocol that should be ethically acceptable for human use.

WHEN IS A SCAN TECHNOLOGY GOOD ENOUGH?

In the previous Section, we discussed how to evaluate a method for biologically reviving a cryopreserved experimental animal: gather data from the brain of the experimental animal before it is cryopreserved, and gather data from the brain of the experimental animal after it has been revived.

In this Section, we discuss how to evaluate a method for scanning a cryopreserved test subject and constructing a WBE.

That is, if our objective is not to biologically revive the test subject, but to construct a WBE directly from a scan, how might we evaluate the result? The scan might be a molecular scan, or it might be a lower resolution scan. We will also need to evaluate the algorithm used to construct the WBE from the scan data.

We will be using the same basic principle as before: constructing a "before" and "after" WBE and comparing them. However, while the "before" WBE will be constructed from neurobot data, the "after" WBE will be constructed directly from the scan data.

Again, we use neurobots to monitor all nerve impulses in a test subject, either a non-human test subject or, eventually, a human test subject. We construct a WBE from the recorded nerve impulses. We then cryopreserve the test subject. We then scan the test subject's brain using the scan technology under investigation. We then do the scan-to-WBE using the algorithm under investigation. We then compare the two WBEs and see if there are any significant differences. If there are, then the scan technology in combination with the scan-to-WBE algorithm is judged "not good enough". If there aren't, the scan technology in combination with the scan-to-WBE algorithm is judged "good enough".

It is worth emphasizing that in this case, the "after" WBE is constructed from scan data, not from neurobot data. That is, the existence of a neuron that carries nerve impulses is deduced from scan data, not from the pattern of nerve impulses. The manner in which a dendritic network processes incoming nerve signals and produces an outgoing nerve signal

along the outgoing axon is deduced by examination of the scan data rather than from the incoming and outgoing nerve impulses recorded by neurobots. That is, we are deducing the existence of a neuron by examination of the scan data. The better the quality of the cryopreservation and the better and more accurate the quality of the scan, the easier it will be to determine the connectome of the test subject, and the easier it will be to build an accurate WBE of the test subject's brain from the scan data. As the quality of the cryopreservation gets worse, and as the quality of the scan gets worse, the ability of the scan-to-WBE algorithm to recover the connectome information with high fidelity will become increasingly difficult, and will require increasingly sophisticated algorithms that are increasingly computationally intensive.

This comparison of before and after WBEs appears to be the best we can do in terms of evaluating the quality of the combined cryopreservation and revival technology, whether we are considering biological revival, or revival as a WBE. It certainly appears to be the kind of testing that Alcor and future physicians will have to carry out before reviving any patients.

Regardless of the specifics of how the before-and-after comparison is performed, the critical insight is that detailed information gathered from the entire brain, both before cryopreservation begins and after revival is complete, will be required to assess the quality of the overall process. Neurobots can gather this detailed information that is required for the "before" WBE, and neurobots can gather the same information for the "after" WBE when biological revival of animals is being evaluated, as they'll be able to quite literally record every nerve impulse in the animal brain. If the objective is to construct a WBE without biological revival, then the "after" WBE can be constructed directly from the scan data of the experimental subject's brain, whether that experimental subject is animal or human. ■

To Be Continued

REFERENCES

1. "On Creating New Horizons: Integrating Non-Linear Considerations To Better Manage the Present From the Future" by John L. Anderson, National Aeronautics and Space Administration (NASA); Michael Radnor, Professor of Management, J.L. Kellogg Graduate School of Management, Northwestern University; and John W. Peterson, Manager, Technology Strategy, Switching and Access Solutions R&D, Lucent Technologies Inc. (1998).
2. 78% of respondents in a survey of the cryonics community thought the first cryopreserved patients would be revived by the year 2100. *Swan, Melanie. (in review). "Global Cryonics Attitudes about the Body, Cryopreservation, and Revival." In: special journal issue "Posthuman and Transhuman Bodies in Religion and Spirituality," Ed. F. Ferrando. /Springer. Sophia International Journal of Philosophy and Traditions/.*
3. Robert A. Freitas Jr., Nanomedicine Vol. I, Landes Bioscience, 1999, "10.5.2 Viscosity and Locomotion in Ice," http://www.nanomedicine.com/NMI/10.5.2.htm.
4. "The surface area of the brain microvasculature is ~ 100 $cm^2 \cdot g^{-1}$ tissue, with the capillary volume and endothelial cell volume constituting approximately 1% and 0.1% of the tissue volume, respectively (Pardridge et al., 1990). The mean intercapillary distance in the human brain is ~ 40 μm (Duvernoy et al., 1983). This short distance allows for near instantaneous solute equilibration throughout the brain interstitial space for small molecules, once the BBB has been overcome." http://davislab.med.arizona.edu/content/anatomy-and-physiology-cerebral-capillary-endothelia. See also http://www.nanomedicine.com/NMI/8.2.1.2.htm#p11.
5. Tad Hogg, Matthew S. Moses, Damian G. Allis, "Evaluating the Friction of Rotary Joints in Molecular Machines," Molecular Systems Design & Engineering, 2:235-252 (2017) DOI: 10.1039/C7ME00021A, https://arxiv.org/abs/1701.08202.
6. Ralph C. Merkle, Robert A. Freitas Jr., Tad Hogg, Thomas E. Moore, Matthew S. Moses, James Ryley, "Molecular Mechanical Computing Systems," IMM Report No. 46, April 2016; http://www.imm.org/Reports/rep046.pdf.
7. Ralph C. Merkle, Robert A. Freitas Jr., "A Cryopreservation Revival Scenario using MNT," *Cryonics* 29(Fourth Quarter, 2008):6-8; http://www.alcor.org/Library/html/MNTscenario.html.
8. For example, IARPA funding might be available for an objective that is simpler than reviving cryopreserved patients: recovery of any information at all from a cryopreserved human brain. "The Intelligence Advanced Research Projects Activity (IARPA) invests in high-risk, high-payoff research programs to tackle some of the most difficult challenges of the agencies and disciplines in the Intelligence Community (IC)." https://www.iarpa.gov/index.php/about-iarpa.
9. This is a good approximation for most molecules, including most proteins, which fold into one of only a few characteristic three dimensional structures in a healthy person, though not for some very large molecules, such as DNA, which would require additional information to describe their three dimensional shape. Molecules like DNA would require a description of their linear information content (the information contained in their base sequence) coupled with some additional information describing their geometry – although here, too, DNA structure is often quite stereotypical (e.g., being wrapped around histones).
10. 20 bits would allow selection of molecular type from a library of 2^{20} ~ 1 million types. Informal estimates (e.g., Ellert van Koperen, 2 Oct 2014; https://chemistry.stackexchange.com/a/16952) put the number of known biologically naturally-occurring molecules at ~500,000 types.
11. An estimated 98.7% of all molecules present in a typical human cell are water molecules. Robert A. Freitas Jr., Nanomedicine Vol. I, Landes Bioscience, 1999, "Table 3.2 Estimated Gross Molecular Contents of a Typical 20-um Human Cell," http://www.nanomedicine.com/NMI/Tables/3.2.jpg.
12. Other factors such as isotopic composition, electronic state and electronic charge of constituent atoms may require special consideration in certain instances but should not materially alter this conclusion.
13. Molecules that adopt multiple functionally significant conformations could either be restored to one "standard" conformation, or additional bits could be added to specify which functionally significant conformation they had adopted. Similar considerations apply to biomolecules containing minor random atomic-level structural errors that do not affect functionality.

14. Alternatively, in situ molecular scans could take advantage of the ~10 m^2 surface area of the capillaries in the brain, which would increase the surface area over which scanning could take place by 1,000-fold, decreasing scan time to a few hours assuming local nanodevice power consumption does not become excessive. It should be feasible to design molecular machines able to carry out molecular scans able to fit into the space available in the circulatory system, although more detailed size estimates will be needed before such a conclusion can be drawn with confidence. The 1,000-fold increase in surface area should more than offset any decrease in scanning efficiency resulting from the tighter size constraints on the scanning equipment.

15. Ralph C. Merkle, "Cryonics, Cryptography, and Maximum Likelihood Estimation," Proceedings of the First Extropy Institute Conference, Sunnyvale, California, 1994; http://www.merkle.com/cryo/cryptoCryo.html.

16. See Tad Hogg et al., "Phase transitions in constraint satisfaction search," http://www.hpl.hp.com/shl/projects/constraints/; Tad Hogg, "Information Storage and Computational Aspects of Repair," *Cryonics*, 1996, Vol. 17 No. 3, pages 18-25, http://www.alcor.org/cryonics/cryonics1996-3.pdf#page=20.

17. https://en.wikipedia.org/wiki/Deep_learning.

18. Ralph C. Merkle, Robert A. Freitas Jr., Tad Hogg, Thomas E. Moore, Matthew S. Moses, James Ryley, Molecular Mechanical Computing Systems, IMM Report No. 46, April 2016; http://www.imm.org/Reports/rep046.pdf.

19. Ralph C. Merkle, "The Molecular Repair of the Brain," *Cryonics*, Vol. 15, Jan/Apr 1994, http://www.merkle.com/cryo/techFeas.html#REPAIR; Robert A. Freitas Jr., "Economic Impact of the Personal Nanofactory," Nanotechnology Perceptions: A Review of Ultraprecision Engineering and Nanotechnology 2(May 2006):111-126, http://www.rfreitas.com/Nano/NoninflationaryPN.pdf.

20. http://www.openworm.org/.

21. MNT should enable precise, uniform warming of brain-sized objects in microseconds by the use of embedded heating elements in the cryogenically manufactured tissue. See, for example, "Cold Starting" by Ralph C. Merkle, *Cryonics*, November 1990, http://www.alcor.org/cryonics/cryonics9011.txt

22. All physical objects can be described in perfect detail by a sufficient number of bits, as a consequence of the Bekenstein bound. "In physics, the Bekenstein bound is an upper limit on the entropy S, or information I, that can be contained within a given finite region of space which has a finite amount of energy—or conversely, the maximum amount of information required to perfectly describe a given physical system down to the quantum level. It implies that the information of a physical system, or the information necessary to perfectly describe that system, must be finite if the region of space and the energy is finite." https://en.wikipedia.org/wiki/Bekenstein_bound.

23. As a practical matter, vastly less information than is required by the Bekenstein bound is sufficient to capture all the personality-relevant information in the human brain. See, for example: Ralph C. Merkle, "How many bytes in human memory?" Foresight Update No. 4, October 1988, http://www.merkle.com/humanMemory.html; Forrest Wickman, "Your Brain's Technical Specs: How many megabytes of data can the human mind hold?" Slate, http://www.slate.com/articles/health_and_science/explainer/2012/04/north_korea_s_2_mb_of_knowledge_taunt_how_many_megabytes_does_the_human_brain_hold_.html; and Robbie Gonzalez, "If your brain were a computer, how much storage space would it have?" io9, May 24 2013, http://io9.gizmodo.com/if-your-brain-were-a-computer-how-much-storage-space-w-509687776.

24. After Alcor has discharged its current mission, that of reviving its patients, it might find that it is well positioned to carry out a new mission: that of providing backup services to its members. Indeed, after reviving current members Alcor will already have the necessary backup data for many of its newly awakened members under the scenarios envisioned here. Offering backup services as a component of the revival and reintegration package for awakened patients seems both obvious and useful to the patient. It represents a new opportunity for Alcor that could be offered to future members. Of course, backup services can only be provided if, at a minimum, a scan of the entire patient's brain has been conducted at a sufficient resolution to support restoration. *In situ* repair might not include such a scan.

25. Purists might note that, in the case of the backup, you will lose all the experiences and memories gained between the time the backup was made and the time the catastrophic mishap occurred. In the case of reviving a cryopreserved patient using a destructive molecular scan, there would be little or no such loss of experiences.

26. See A. Sandberg, N. Bostrom, *Whole Brain Emulation: A Roadmap*, Technical Report #2008-3, Future of Humanity Institute, Oxford University, 2008, http://www.fhi.ox.ac.uk/brain-emulation-roadmap-report.pdf. There is growing interest in this area. One of the 14 Grand Challenges for Engineering in the 21st Century is to Reverse-Engineer the Brain (National Academy of Engineering (nae.edu), Grand Challenges for Engineering, www.engineeringchallenges.org, 2010). "The goal of the Blue Brain Project is to build biologically detailed digital reconstructions and simulations of the rodent, and ultimately the human brain." (http://bluebrain.epfl.ch/cms/lang/en/pid/56882). The Human Brain Project will "establish a generic strategy to reconstruct and simulate the multi-level organisation of the brain for different brain areas, whole brains and species; [and] use this strategy to build high-fidelity reconstructions, first of the mouse brain and ultimately, of the human brain". (https://www.humanbrainproject.eu/en/brain-simulation/, see https://www.youtube.com/watch?v=ldXEuUVkDuw for a discussion of their work on mouse brain simulation).

27. As discussed in "Backups Using Molecular Scans", a conceptually simple method for carrying out a destructive molecular scan can be described. This might avoid the technical complexities of designing cryobots, entering the circulatory system at cryogenic temperatures, etc.

28. Proposals along these lines have been made before, including a draft Advanced Draft Reanimation Directive and accompanying Reanimation Preferences Addendum that were prepared as part of the efforts by the LifePact organization.

29. Robert A. Freitas Jr., Nanomedicine Vol. I, Landes Bioscience, 1999, "7.3 Communication Networks," http://www.nanomedicine.com/NMI/7.3.htm.

30. See Adam Marblestone et al., "Physical Principles for Scalable Neural Recording," Frontiers in Computational Neuroscience, 7:137 (2013), doi: 10.3389/fncom.2013.00137, https://www.frontiersin.org/articles/10.3389/fncom.2013.00137/full, among other articles.

31. https://en.wikipedia.org/wiki/Connectome.

32. A connectome is a comprehensive map of neural connections in the brain, and may be thought of as its "wiring diagram"; https://en.wikipedia.org/wiki/Connectome. Whether or not the "connectome" provides all the data necessary for a WBE might be viewed as a definitional matter, but it seems clear that there is information necessary for a WBE, that can be derived from the raw data provided by the neurobots, which would not fit into the usual definition of the "connectome". This being the case, the information required for a WBE would be a superset of the connectome, and the connectome would be a proper subset of the information required for a WBE.

33. The connectome, viewed as a static entity, is not sufficient to construct a WBE, as a WBE must also provide sufficient information to enable learning, including changes to the connectome. This requires additional information in the WBE, information which is not included in the connectome but should be extractable from a sufficiently long time series of neural data provided by longer-residence neurobots.

Fight Back Against Aging with LONGEVITY A.I.™

Geroprotect™ Longevity A.I.™ has been formulated using cutting-edge, artificial intelligence (AI) technology to *modulate* over **90 *anti-aging pathways*** favorably affected by a **calorie-restriction mimetic**.

Longevity A.I.™ concentrates three unique **geroprotective** ingredients in one daily softgel.

Modulate Over 90 Aging and Longevity Pathways

MKAQAV180301

For full product description and to order **Geroprotect™ Longevity A.I.™**, call **1-800-544-4440** or visit **www.LifeExtension.com**
Please mention Discount Code **PIM801X**
Offer expires April 30, 2018

	Retail Price	Your Price
1 bottle	$56	**$42.00**
4 bottles		**$38.00 each**

Item #02133 • 30 softgels

NON GMO LE CERTIFIED

Patent Pending. Developed in collaboration with Insilico Medicine, Inc.

Bring in a NEW member and save a year of dues!

Membership growth has been slowly accelerating since bottoming out in 2013. But we would benefit from faster growth. Alcor is now at a point where we could enjoy considerable economies of scale: We could manage many more members with minimal or no increase in staffing costs. That would enable us to *reduce membership dues* while building up our resources. A modest acceleration in membership growth would move us into a virtuous circle where growth enables reductions in dues which further spurs membership growth. Growth will also make it easier to hire highly skilled people in medical and technical areas.

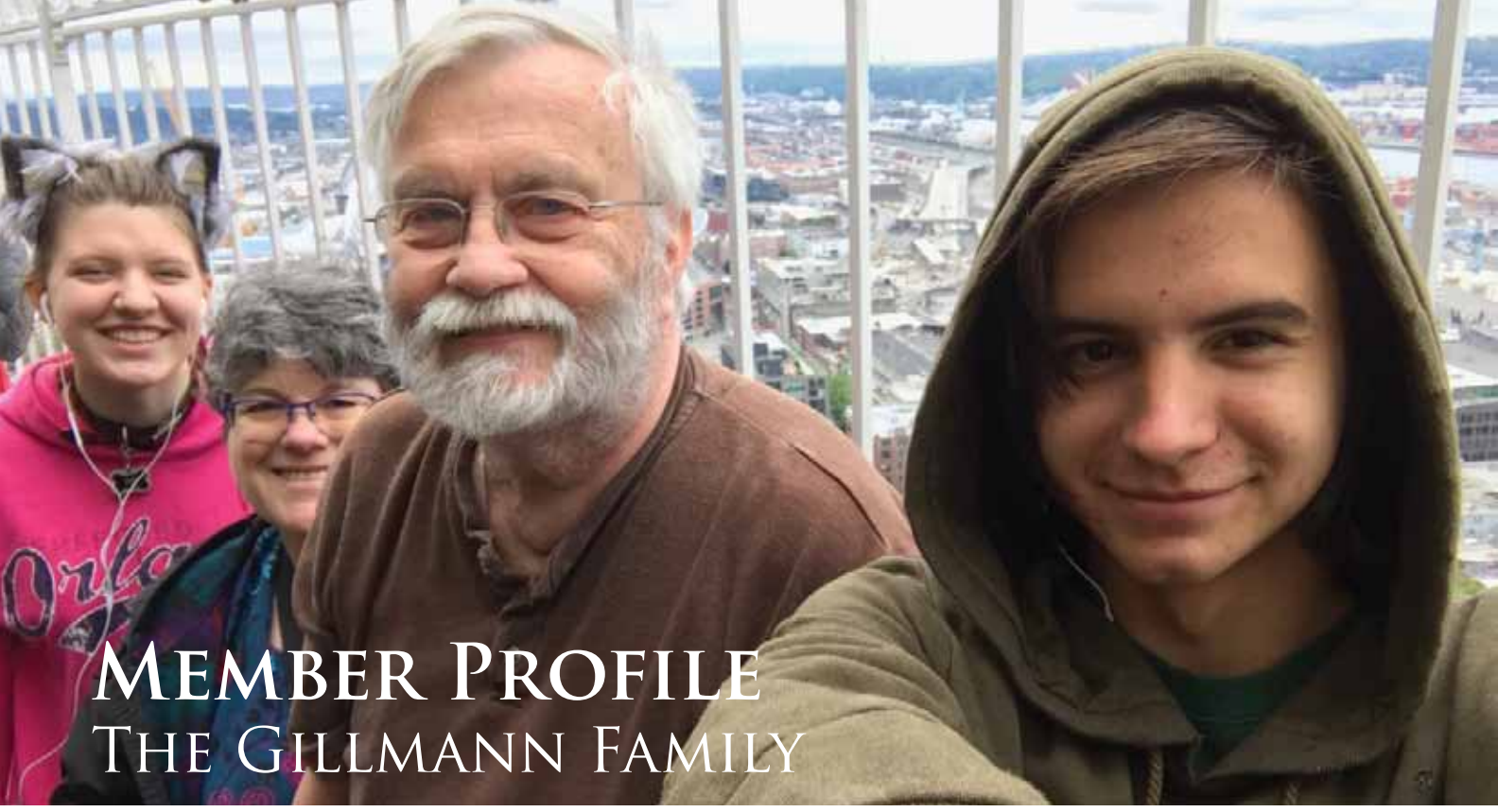
The most effective way to bring in new members has been through direct encouragement by existing members. Many of us realize this, but may not make it a priority to nudge our friends a little more to sign up and potentially save their lives. How can we spur more members to gently persuade those they care about to move ahead with making cryonics arrangements? Perhaps some financial incentive will help.

Anyone who is primarily responsible for getting a new member to sign up will, at their request, be given a one-year waiver of membership dues.

For an existing member to receive the dues waiver, they must (a) be credited by the person who has signed up; (b) ask for the waiver; (c) not be otherwise profiting from the signup; (d) wait until the new member has completed all essential cryopreservation paperwork and has paid at least six months of dues; and (e) the new member must not be a member of their family. If the member signs up two new members, they are eligible for a two-year waiver of dues. If the new member is a student, the existing member is eligible for a waiver of six months of dues.

Who do you know who could do with some encouragement to sign up? Please, give it some thought, then help yourself and help the organization by helping to stimulate membership growth. Bring in one new member per year, and you will never pay dues again!

ALCOR
ALCOR LIFE EXTENSION FOUNDATION
The World's Leader in Cryonics



Member Profile
The Gillmann Family

By Nicole Weinstock

The Gillmanns celebrate Father's Day of 2017 at the top of Seattle's Smith Tower.

"They always say that you're not gonna know anyone [when you wake up]," says Stacia, describing the reaction of her teenage friends to her cryopreservation arrangements and life post-resuscitation. "I'm like, 'Number one, my entire family is signed up, and number two, they have meetups. And when you come back to life, not only will you be the best history teacher in the world, you'll be able to explain all the weird things going on nowadays that they won't know about.'"

It's not uncommon to see optimism and adventure in a cryonicist. But it is quite rare to meet one in her teens, and moreover, someone who is part of a family of cryonicists. The potential absence of family and, as a result, the essentiality of key traits, like independence and emotional resilience, typically exist as a packaged deal in the world of cryonics; we have many partners, siblings, parents and children, who, for one reason or another, may not have the same plans as their loved one.

Richard and Shelly at Red Square in Moscow in 2002, on their first of two trips to Russia to adopt Bobby and Stacia.

This is precisely what makes the Gillmann family of four—Shelly and Richard, and their teenage children, Stacia and Bobby*—one of the most unusual member profiles to date. They are all signed-up cryonicists with Alcor. Parents Shelly and Richard joined around 2000, and their kids became members in 2012.

THE SUNSHINE YEARS

Richard is originally from Homewood, Illinois (where it's *not* particularly sunny). His father sold lumber and millwork and his mother was a part-time medical secretary. Richard had strong interests in science, music, and technology. "I traveled off to college at Caltech in Pasadena for my first flight in an airliner," he says.

Unsurprisingly, Caltech boasted some amazing academic resources. "We got direct access to professors with Nobel Prizes." But it didn't quite have everything at that point. "It was a really nice place, but it wasn't co-ed. There weren't any girls," laughs Richard. "The year after we left they ended that."

Fortunately for him, a computer bulletin board system (BBS) would later link him to his future wife, but until then, Richard worked in a series of programming jobs after deciding that four years of undergrad was enough school for him. At one point, he even formed his own company to do software for the IBM PC that had just come out.

Shelly, on the other hand, was a valley girl. She spent most of her formative years in Studio City, North Hollywood, and the Pacific Palisades of Southern California. Unlike Richard, she attended college close to home, at Cal State Northridge. After earning her degree in Radio & TV Broadcasting, she worked at writing and producing videos and slideshows for businesses.

In the early 80s, Shelly and Richard met at a park in North Hollywood, at a picnic electronically organized on a computer bulletin board. Her primitive Commodore-64 computer only allowed 64 characters a line. They were friends for years before they dated and eventually wed in 1988.

THE GREAT NORTHWEST

Three hundred plus days of sun isn't for everyone, so the now-Gillmann family started looking northward for a fresh start. "We took a surreptitious trip up to Seattle in the middle of January," says Richard. "We assumed the weather would be the worst then, and we wanted to see if we could stand it."

Sound advice for any hopeful northwesterners-to-be—and certainly those that hail from the tireless sunshine of the land down south—it served the Gillmanns well. Undeterred by the famous clouds and rain of the Emerald City environs, they made their move, settling down in Issaquah, a small city in King County, just twenty minutes' drive outside of Seattle.

There, Richard worked in a managerial role at Microsoft for seven years—one that was a bit more of hiring and firing than suited his coder preferences. As with many challenges, though, it seems that humor prevailed with Richard. He describes the cafeteria with a chuckle: "There were 1,000 people eating lunch, and I'm the only one with grey hair."

Nevertheless, these tradeoffs were well-rewarded when he managed to retire at the arguably enviable age of forty-nine. But unlike most nearly-fifties, he (and Shelly) decided to ring in the semicentennial with a trip to Siberia where they would adopt their now-teenage children, Bobby and Stacia.

FROM RUSSIA WITH LOVE

Apart from the obvious reason, the two trips leading up to the parental finale were quite memorable. Says Richard, "We get to Novosibirsk, and it's a city of two million people and it had two hotels. And Issaquah is a town of 30,000 people and has three hotels. We got out to our hotel and they said we didn't have a reservation. Not very service oriented, they said, 'Well, you can take a suite.' And it was like, $140. We were the rich Americans."

Apart from the hospitality, Russia also presented a new perspective on a beloved American pastime. "It was twenty-five below zero," Richard notes, "and they were selling ice cream from an outside stand, and people were lined up to buy it. They had a cooler to keep it warm!"

Shelly and Richard traveled to the village of Cherepanono, where the baby home staff introduced them to two biological siblings, a girl who was nineteen months old and a boy of four years. Enter Stacia and Bobby…

The Gillmanns en route to the bus stop in 2010 with their beloved pets, Ricco and Ruby.

ALL ABOARD

For many, it might seem a bit coercive to sign up one's children for cryonics. And Richard and Shelly would agree with you 100%. As a matter of fact, Bobby and Stacia didn't become Alcor members until several years into their lives, and as a result of some very persuasive arguments on their end as well.

The elder Gillmanns had always been open about their cryonics arrangements, as well as other choices that people make for (after) their death. This was forefronted when Shelly's father's health began to decline. "We told [our kids] from the beginning, that when my dad passed, we knew he was going to be dying. He had a prognosis, and I also knew that he had elected to be cremated. We talked to them about the various arrangements people can make for the dead."

It wasn't long before Bobby and Stacia pointed out that "kids die, too!" and they all made the collective decision to sign them up as well.

Shelly shows students in Stacia's fourth grade class the finished class art piece before it was sold at their Sunset Elementary School auction. Each rectangle of fiber in this piece was woven by one of the students during a class lesson which she led.

Richard and Stacia celebrate her twelfth birthday in 2013 with a Segway tour of Edmonds in the Seattle area.

SOME WORDS TO THE WISE

Richard and Shelly financed their cryopreservation with single-payment universal life insurance policies. The decision to pursue a prepaid policy was influenced, in part, by their experiences watching elders grapple with aging, and its many challenges. Richard notes "I've seen this with some people who get old. They can no longer take care of their financial affairs."

He and Shelly also went to great pains to word their Medical Power of Attorney document so their wishes would be respected: "We took the standard form and inserted a paragraph in bold letters saying that we want 'extraordinary measures taken' until our cryonics standby team is there and ready, and then pull the plug...I know from experience that these hospitals and doctors kind of ignore these things anyway. But at least you got some paperwork there, in case you're unconscious."

In addition to the improved execution of wills, Richard is also hopeful that one day the local mortician and coroner will better acknowledge cryonics, and the special needs and essence of timing involved. He's a great advocate for the strategic separation of research and storage facilities, and ideally, the subterranean establishment of the latter in an entirely unremarkable rural area. "There could be wars, bombings, terrorist attacks, epidemics. If you're way out in the middle of nowhere, that's not going to affect you. … Even if there's a nuclear war, they're not gonna target a field in the middle of nowhere." Another one of his ideas to optimize this hypothetical storage facility for unexpected conditions—political or otherwise—is to equip it with an on-site generator of liquid nitrogen. Though this is less cost-effective than a third party supply, it could help create a truly off-grid storage facility.

Shelly's greatest concerns regarding their cryonics arrangements revolve around the logistics of moving from living to suspension. "Not everybody who dies is on some kind of life support machine that can be unplugged," she notes. Shelly cites car crashes or other circumstances that do not permit a cryonicist to transfer to a hospice near Alcor as just a couple of challenges that influence this process.

Richard on the air at KBCS-FM-1

ART SMART

As much as cryonics requires their basic—if not advanced—understanding of the sciences, the Gillmanns are quite the creative bunch. With a lifelong interest in music, Richard plays guitar, ukulele, keyboard, and more, and also teaches here and there for fun. He helped to start a ten watt radio station in high school, and volunteered as a radio DJ at KBCS for sixteen years and at Sirius/XM for two years, creating a top 70s music chart for the Folk Alliance every year for over a decade. He might warm his home studio with the sounds of classics like Joni Mitchell or Bob Dylan, John McCutcheon or Utah Phillips.

Shelly, on the other hand, is drawn towards more tactile arts in her free time. When she and Richard first moved to to the Seattle area, she got involved in the Northwest Bead Society, first as an attendee, and later as a leader and an occasional teacher, leading the group in a bead craft once a year or so. She also explores other jewelry-making techniques, glass fusing, and scrapbooking, to name a few.

With respect to the scrapbooking subset of her crafting, Shelly has been particularly keen to work on Pocket Letter Pals as of the last few years. She discovered it while juggling her own home remodel and the aftermath of her mom's passing—organizing her belongings, selling her house, donating various items, etc. "Our house is very open, and so when when we had noisy remodelers, the downstairs was basically a woodshop, I got into paper crafting more."

A very niche subset of this craft area, Pocket Letter Pals is a web-organized combination of scrapbook-meets-pen pal. "Someone comes up with some idea, let's say it's Groundhog's Day. 'Sign up for a partner by such and such a date, we'll assign partners by this date, and your swap is due by this later date.'" Shelly adds, "I have made some nice acquaintances, and it

A necklace Shelly beaded for her mother-in-law as part of the NWBS (Northwest Bead Society) 2012 Bead Retreat challenge. Photo courtesy of Karen Williams.

stretches the creativity." Not to mention it helped her create a solid reward system for doing the often less-than-exciting tasks of rifling through boxes.

Shelly's passion for art is also intertwined with her giving nature. She's volunteered to teach creative projects through her kids' extracurricular activities and schools throughout the years, in addition to a leadership role at the Northwest Bead Society. When Stacia was charged with leading her Girl Scout troop in earning a badge, Shelly helped her and her partner craft and led their troop in creating a "wearable art badge" using simplified macrame knotting. One of the troopers even took their lesson to the next level, designing more complicated iterations of this piece thereafter. "I loved seeing Stacia and her partner grow as leaders. I loved seeing that one of our crafts further inspired one of the other girls so much, and I loved that I had forged the kind of relationships with these girls where one would be so excited to share that with me."

Richard playing music on his ukulele.

Shelly, Richard and Stacia in Havana, Cuba during the spring of 2017.

Jewelry can be for gents too, as Shelly's volunteerism with Bobby's former school, LEADPrep, illustrated. She taught students how to do Viking knit necklaces or bracelets, an activity that helped bring some classroom history lessons to life.

VISIONS OF THE FUTURE

When it comes to the future, no one has better ideas than Stacia. "You know the *Back to the Future* movie? It's kind of a mixture of that and that *Spongebob* episode where everything is frozen and Squidward's in a ball on the floor and he's like, 'fuuuuuuutuuuuuuuuure.'"

I'm admittedly rough on my *Spongebob* trivia, but this sounds intriguing to me. In Stacia's imagination, the future will boast one world government, possibly centered in London, with regional leaders that will meet regularly. Cars will accommodate more people, like a train, in different rooms. Food will grow in vertical gardens and genetic engineering will prevail, but without its current stigma. And the outdoors will be lit by floating lights.

"I imagine it in sections. I don't imagine everything at once. Things as simple as a chair. I just think about all the possibilities of what chairs could look like. If you look at history, chairs have come a long way, and just how much longer could they go?"

Bobby takes a "puppy break" from his work with Americorps NCCC, where he is helping to rebuild storm-damaged homes near Houston.

Observing beauty in the past, and shaping it as inspiration for the future. Stacia may be the youngest of the Gillmanns, and one of the youngest cryonicists in the world to boot, but I do believe there's a beautiful chunk of wisdom, and a solid piece of encouragement, in her question. Family Gillmann is well-positioned to enjoy the unknown that lies ahead. ■

**Bobby Gillmann is up to his ears in AmeriCorps NCCC duties at this time, and unable to interview. Nevertheless, he sends his best from Hurricane Harvey relief in Texas!*

CRYONICS NEWSLETTERS:
SOME HISTORICAL HIGHLIGHTS, PART 2A: NEW YORK

By R. Michael Perry

This is a multipart series. Part 1 covered the newsletters of Ev Cooper's Life Extension Society, which started in 1964 and extended to 1969. Here in Part 2 we look at the next important group, those of the Cryonics Society of New York, which cover the period 1966-1971. There is a lot of material here, so I've split it into subparts 2a and 2b; 2a, reported here, will cover from the beginning, 1966, into 1969.

Newsletters are an important historical source for their times and circumstances, and accordingly there is some overlap in this series with earlier articles about historical events. In the case of the CSNY newsletters this is especially so, in view of an earlier series of articles on cryonics in the important, early staging area of New York. The intention here, in any case, is to adopt a different focus from the earlier chronicling of history and look more into the details of the publications which are interesting in their own right. I've subtitled this whole series "some historical highlights" to suggest something short of a full, comprehensive coverage or even an "evenly balanced" abridgment. Instead I try to select according to what seemed most interesting; someday a book or books should be written with more complete coverage.

CSNY AND ITS NEWSLETTER[1]

With the publishing of Ettinger's book, *The Prospect of Immortality*, in 1964, the cryonics idea achieved wide publicity, and interest groups started to form in different parts of the U. S. and abroad. One important place for interest was New York City and its environs. Saul Kent was a youthful, recent, phys-ed graduate at a local college in the area, looking for things of interest, when he came across a copy of *Prospect*, and began to read. As he tells it, "I was exhilarated to a degree I had never before experienced. Instantly, I knew—beyond a shadow of a doubt—that the most profound and powerful idea in history had been unleashed and that I would devote my life to it." After a few months he did become active, contacted Ettinger, and was contacted in turn by Curtis Henderson who lived nearby and was also interested in the idea. Evan Cooper in Washington, D.C. then was contacted, and briefly the nascent group in New York was a part of Cooper's Life Extension Society which had been started at the end of 1963. But frustrations developed quickly when Cooper was reluctant to share mailing lists and in other ways proved a hindrance, so a decision was made to cut ties with LES and form a separate organization.

What should it be called? A new name was needed, not related to "Life Extension Society." One of the group, Karl Werner, coined the term "cryonics" as a makeover of "bionics" with the prefix "cryo-," already in use for cold-related fields such as cryogenics and cryobiology. (Its origin traces to the Greek word *kryos* for extreme cold.) The Cryonics Society of New York (CSNY) was incorporated July 13, 1965, and the company name soon became lower-cased and used more generally for the practice of human cryopreservation with the hope of eventual revival. In June 1966 CSNY published the first issue of their monthly newsletter, *Cryonics Reports*, which over the next 18 months would eclipse Cooper's *Freeze-Wait-Reanimate* as the leading publication in the field. To achieve a more professional look the editor, Saul Kent, typed each article twice over to create a master with even right margins.[2] (The newsletter was in letter-size format, stapled at upper left corner, through 1967; half-letter size, saddle stitched afterward.) The opening paragraph of the first issue tells why the publication was being started and asks for reader contributions:

> "The Cryonics Society of New York desires to inform its members as thoroughly and accurately as possible, as to the progress of the freezing movement. Since the ordinary modes of communication have proven to be inadequate, we have chosen to start the publication of a monthly newsletter, of which this is the first edition. We also hope to arouse a greater element of self-initiative in our members, so that they will participate more fully in the activities of the Society. If any of you do, hear, or read anything, which you believe to be of interest, we would greatly appreciate it, if you would inform

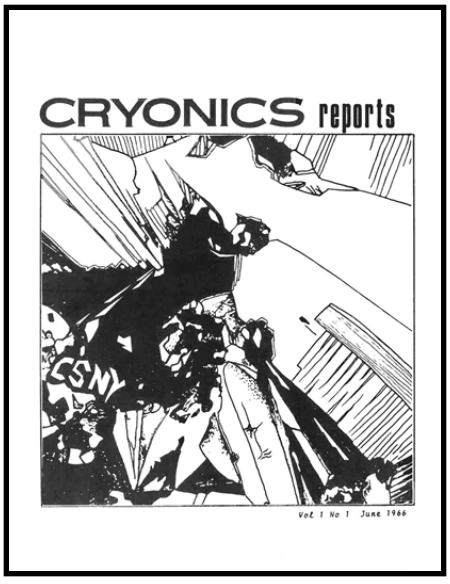
us as quickly as possible. We also welcome any comment, critical or otherwise, which you may have, concerning this newsletter."[3]

Further objectives are outlined, including the intention to offer interviews of prominent people in the movement. An effort would also be made to contact doctors, funeral directors, and manufacturers of human-sized cryogenic capsules. With diligent effort a "complete system" would be created for realizing the goal of cryopreservation and long-term storage for those desiring it. In particular, it was "generally felt that the funeral profession can play a major role with regard to the realization of this concept. Perfusing the body with a protective chemical solution, which is a necessary part of the procedure, is similar to the embalming process. The embalmer has the basic training to administer this treatment properly. Immediately after death, he could work with or without the doctor, if necessary, to help bring the patient to the frozen state."

An editorial cautions against too much complacency, and urges those desiring cryopreservation to prepare carefully: "The facts are inescapable—money will be needed, the right people *must have* access to this money, it is *your* problem and your problem alone, and if this problem is not solved, nothing else matters." Additional preparations are also urged, such as insisting that relatives not merely affirm verbally that they accept the choice of cryopreservation and will cooperate and not interfere, but also sign affidavits to that effect.

Also included in this first issue is a log of major events covering the previous two months, including efforts to acquire land for a projected cryonics facility, and Saul's appearance on a radio program discussing the cryonics idea.

Another section offers "suggestions for organizing local chapters": "It is advisable to become incorporated under the name of The Cryonics Society of *your state*, elect officers, and structure your organization in a legally acceptable manner. We found it advantageous, when we formed The Cryonics Society of New York, to use, the *Blumberg Kit*, which includes a set of complete bylaws, space for minutes and membership listing, a booklet of fifty membership certificates, and a corporate seal. This set may be obtained through any attorney at a cost of approximately $25." There are further detailed recommendations for setting up cryonics chapters, with encouragement to reprint and distribute literature, contact local officials including doctors and hospitals, investigate laws that might apply, and the like. Money from dues would be used, among other things, for membership in LES for the useful services it could provide even though it was now a separate organization. Interested persons were also advised to contact radio and TV stations in their area, "and try to interest them in having discussions on cryogenic interment."



The first issue of Cryonics Reports

In all it was a good start. The events log would continue, and soon be reporting on a trip Curtis Henderson and Saul Kent made across the U. S., where they helped organize other groups somewhat along the lines sketched above, notably the Cryonics Society of Michigan (CSM) and the Cryonics Society of California (CSC), both of which would be publishing newsletters of their own.

1966 CRYOBIOLOGICAL CONFERENCE; FREEZING OF BEDFORD; FUTURE SPECULATION

A conflict was recognized early between cryonicists who advocated freeze-now and non-cryonicist scientists who felt that human cryopreservation should be postponed. This was underscored by events at the Third Annual Conference of the Society for Cryobiology, held August 8-10, 1966 at the Statler Hilton Hotel in Boston, reported in the August newsletter. Curtis Henderson, Saul Kent, and Karl Werner of CSNY attended, with Kent as usual reporting.

"On the first day of the conference we obtained permission from the chairmen of the exhibits to set up a table alongside the commercial exhibits [by prominent manufacturers of cryogenic equipment]. After 15 minutes of distributing our literature, Dr. Arthur Pappas, the co-chairman of the entire conference, decided not to let us continue our display. When Mr. Kent asked him why, he explained that they did not feel that the purpose of our Society was in keeping with the scientific nature of the conference."[4]

An editorial cites two reasons for opposition from scientists. First, human cryopreservation is seen as "premature in its development" and something that should not be done until the process is perfected—starting with individual organs and graduating up to small mammals then large mammals. (A point apparently overlooked is that the brain is an "individual organ" that might be preserved to save the patient's life before a process had been perfected for an entire body.) The objection, it is noted, ignores the basic cryonics premise that technology will improve in the future so that revival of persons cryopreserved today might become feasible. A second objection is that the public may be defrauded by an unscrupulous practitioner who offers them "immortality" then fails to deliver. "Their alternative," Saul writes, "is to freeze no one, and thus guarantee certain death. Apparently the promise of something definite, even death, is more appealing to these scientists than any uncertainty." "The time has come," the article concludes, "for scientists to openly support cryogenic interment. This will greatly stimulate public demand, and influence businessmen favorably. As more people are cryogenically interred, the pace of scientific research necessary for resuscitation will be accelerated. What is there to lose? – certainly nothing more valuable than life."[5]

Not all reputable scientists were hostile, however. It helped if cryonicists could offer at least some token financial support, which CSNY was prepared to do. "The possibility of reanimation is based on our hopes for scientific progress," writes Kent in the September, 1966 newsletter's log entry dated August 24. "We must, therefore,

encourage it in every way possible. We intend to allot a certain percentage of our budget for contributions to scientific research." In fact this had already occurred, as recorded in the same log entry: $100 had been sent to Interscience Research, a non-profit, independent group of scientists working in Jackson Mississippi. Their research director, cryobiologist Armand Karow, Jr., agreed to write an article for *Cryonics Reports*, which would be "a comprehensive coverage of the work on organ and whole animal preservation."[6]

"The Freeze Preservation of Organs and Animals" by Karow appeared in the November, 1966 *Cryonics Reports*, some six pages of closely printed text including nearly a page of references. It sketches the history of cryobiology, discusses difficulties and recent research, and recounts successes such as the resuscitation of dog kidneys after brief storage at -20°C. Finally, it offers an optimistic forecast. "The results achieved to date will encourage new research. The field of cryobiology is in need of vigorous, imaginative, and creative thinking from individuals in many disciplines including biology, chemistry, physics, engineering, and medicine. This interdisciplinary approach offers the greatest hope for future success."[7]

One of the group, Karl Werner, coined the term "cryonics" as a makeover of "bionics" with the prefix "cryo-," already in use for cold-related fields such as cryogenics and cryobiology.

Over the next year and a half Karow would contribute many other columns, all under the heading "Scientifically Speaking," detailing other matters in cryobiology and biology more generally. In one he comments on the freezing of Dr. James Bedford that happened in January 1967 (in California). "Dying of cancer, he desired and provided for his cryonic suspension. Showing even greater foresight, he went one step further, and endowed a foundation to support research in cryobiology." (This was the Bedford Foundation, unfortunately to be bankrupted in a legal battle over the Bedford will, so that it actually would have little effect, though Bedford remained frozen.[8]) "Whether it will be possible to restore Dr. Bedford to life cannot be predicted. However, by his act, he has definitely improved the chances of those who will be frozen in the future."[9]

With cautious scientific endorsement such as this, cryonics gained a foothold of respectability—or so it seemed. Proponents might place it among other phenomena of the times that pointed to an unprecedented, technology-enhanced future. Indeed, exciting things were happening: space exploration, computers, and human organ transplants, to name a few of the most prominent. The mysteries of DNA were being unraveled,[10] pointing toward a more general control and enhancement of human biology. The American economy was strong and benefitting from developing technology,[11] which, among other things, would feedback into scientific research on many fronts.

The heady optimism inspired a 1967 book, *The Year 2000: a Framework for Speculation on the Next Thirty-Three Years*, by Herman Kahn and Anthony J. Wiener.12 Excerpts of a preliminary draft are quoted in *Cryonics Reports*. The book included a listing of 100 "very probable" technical innovations which were expected to occur by the year 2000. (Heading the list were: (1) multiple applications of lasers; (2) extreme high-strength structural materials; and (3) new or improved superperformance fabrics.[13] Arguably all had been well-realized by the stated date.) These and others of the "100" are not listed in the *Cryonics Reports* summary, however, but instead 25 others that were "of greater interest," though judged in the book as only "less likely, but important possibilities." Among these were: suspended animation (for years or centuries); "true" artificial intelligence; and verification of some extrasensory phenomena. In addition ten other "far out" possibilities are included, such as life expectancy extended to more than 150 years and creation of artificial live plants or animals.[14] None of these more speculative possibilities have been more than marginally realized (cryonics might in fact prove to be "suspended animation" but this is unverified). It has to be concluded that the optimism of the cryonicists was overblown and unwarranted, though it is to their credit, as we in cryonics would say, that their dream of life extension by cryonics was doggedly pursued.

1968 CRYONICS CONFERENCE

In what was possibly the high-water mark of New York cryonics of this early period, before anyone had been frozen by CSNY, a conference was held in March 1968 at the New York Academy of Sciences, 2 E. 63rd Street, New York City. Announced as the First Annual Cryonics Conference, it covered four broad categories: (1) cryonic suspension techniques, (2) cryonics and society, (3) research and future technology, and (4) legal and financial problems.[15] Afterward the conference proceedings were printed in a volume of nearly 100 pages.[16]

The March 1968 *Cryonics Reports* has a main article on the conference and a lengthy editorial, both by Saul Kent, who was also the conference chairman, and the source of the quotes, abridged from the original, that follow:[17]

> "Saturday, March 2, 1968 was the beginning. The First Annual Cryonics Conference was an unqualified success. Approximately one hundred and ten people from all over the country attended; only one scheduled participant, Dr. Richard C. Lillehei, failed to attend; coverage by the communications media was excellent.
>
> "The New York Academy of Sciences' building provided a beautiful, intimate setting for the Conference. All the leaders of the movement were there except for Dr. Dante Brunol, who said that he could not afford to come and Evan Cooper, who said nothing. The participants showed an extraordinary degree of interest in the proceedings. Every speaker, even to the end, had a substantial audience, and the auditorium of the Academy was filled for several of the presentations.
>
> "The opening session was concerned with the impact of cryonics on society. Robert C.W. Ettinger reviewed the history of the movement and then, with an eye to the future, examined the moral questions raised by cryonics. The Rev. Kay M. Glaesner Jr. advanced

a progressive religious approach to the possible extension of human life, while Frederick Pohl warned of impending catastrophic developments resulting from the prohibitive costs of future medical technology. Robert F. Nelson closed the session by relating some of his experiences in coordinating a cryonic suspension team and expressed his views on the prospects of the program.

"The second session was devoted to cryonic suspension techniques. E. Francis Hope outlined the scope of his company's activities and described the method of inserting a frozen body into one of his permanent cryonic storage units. John Flynn discussed the problem of rewarming and presented a proposal for a large-scale business operation. The cryonic suspension procedure, from emergency phone call to final storage, was then dramatically illustrated by a color, sound film, produced and directed by Karl Werner under the auspices of the Cryonics Society of New York. Both the film and the subsequent talk by Frederick Horn portrayed the Method For Freezing Humans created by Dr. Dante Brunol.

"After lunch, three scientists reviewed the history of cryobiology and delved into some of the problems involved in the viable preservation of mammalian tissues and organs. Drawing upon their experimentation in the laboratory, Dr.'s Armand M. Karow Jr., Peter Gouras, and Ralph Hamilton elaborated on such topics as heat transfer, cryoprotective agents, perfusion techniques, assay of freezing damage, and methods of rewarming.

"Dr. Robert Duncan Enzmann then expressed his faith in man's ability to achieve his goals, giving pertinent examples of modern technologic advances. He expressed the feeling that we are on the threshold of fantastic adventures.

"What is the shape of the future? was the theme of the ensuing panel discussion, which included Dr.'s Gerald Feinberg and Robert D. Enzmann, R.C.W. Ettinger, Frederick Pohl, and Lester Del Rey. The interchange of ideas was both entertaining and educational.

"Legal and financial problems was the subject of the final session. Prof. David Haber dissected the law against perpetuities and enumerated ways of circumventing it when seeking to perpetuate funds for cryonic storage and revival. With a sense of urgency in his voice, Curtis Henderson closed out the Conference by advancing a step-by-step program to maximize the individual's chances of being frozen upon death.

"Exhibits displayed at the Conference were: an equipment-filled van from the Cryonics Society of Michigan, which was parked directly outside the Academy; new and old model cryocapsules; a temporary, insulated storage unit; and apparatus for perfusion assembled with a dummy. Bound volumes of CRYONICS REPORTS, copies of The Prospect of Immortality by R.C.W. Ettinger, and advance copies of Robert F. Nelson's book, We Froze the First Man, (April 1968, Dell) were on sale at the registration desk.

"Those who listened to the speakers, watched the film, and examined the exhibits are now very much aware of our stage of development.

"The accomplishments of the program, however, are infinitesimal when compared with the problems to be overcome. It is unfortunate that only a handful of members qualify as hard core activists. It is to their additional efforts, rather than to any significant increase in their number that the accelerated progress of the past year was due.

"Meeting on Sunday afternoon at the home of Michael Hart, Officers of the Cryonics societies of New York, Michigan, and California decided to incorporate as the Cryonics Societies of America (CSA). An Accrediting Committee composed of the President or appointed representative of recognized groups has the authority to admit new groups and administer policy.

"Our specific, major objectives for the following year include: first, the building of organizational strength. The CSA Accrediting Committee has agreed upon certain prerequisites for membership and for standards to be maintained by existing groups. The standards are basic and serve to differentiate between talkers and doers. For example, any group that is serious in its efforts, must answer the mail efficiently and in depth, and keep proper, detailed records of all financial matters, as well as basic information regarding all individuals and groups in the program.

"Our second objective is to freeze more people at death, on a sound financial basis. The Cryonics societies are non-profit. They have frozen and will continue to freeze people until reputable commercial firms can take over.

"Efforts to freeze more people must focus upon the two most vital aspects of the program—financial and legal preparation for cryonic suspension and improvement of existing facilities.

"Life insurance is a relatively easy way of providing funds, and is the key to financial preparation for the young and healthy. The cost of a policy increases with age, however, and is impossible to obtain when the individual is threatened by death. The majority of people who die are old and not wealthy enough to afford the treatment. Their prospects of being frozen today are slim.

"Freezing a person and storing him indefinitely is an expensive proposition. The

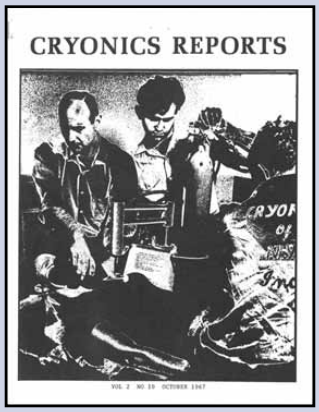
facilities in existence have been established by the investments of a few individuals. Most of these individuals have also been subsidizing the Cryonics societies. All hold other jobs or have sources of income apart from cryonics. None are wealthy. Those who speak of freezing people for free are misleading the public. Someone has to pay for cryonic suspension. Someone has to accept the responsibility. Who is that to be?

"The brutal truth is that the rich, as in most other matters, have an enormous advantage over the poor. At this stage, financial sacrifices must be made by relatives and close friends of the individual. A systematic approach to freezing the aged and poor will only be possible when the program is large and institutionalized.

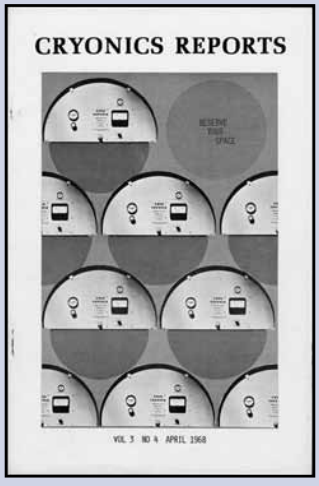
"It is important to have irrefutable evidence of the individual's desire to be frozen. Several legal documents should be executed immediately because papers signed while the individual is in good health are less open to question than those signed in the throes of terminal illness.

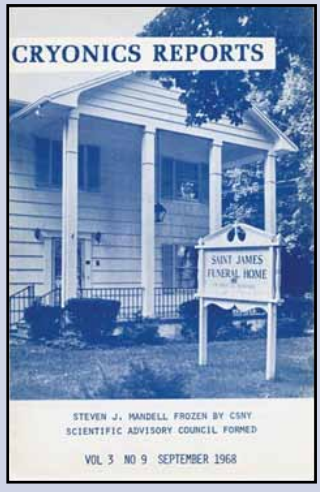
"Existing facilities are primitive, scattered, and understaffed. Efforts must be made to obtain use of equipment, such as heart-lung machines with heat exchangers, as well as the cooperation and participation of hospitals, physicians, and morticians. The construction of special facilities for storage is imperative. The success of these efforts will depend upon the extent to which proponents of cryonics invest their money and time to further them.

"Our third major objective is to establish a closer relationship with scientists, particularly cryobiologists. In approaching these scientists in the past, we cited the fact that the need to support scientific research was an integral part of our program. Nevertheless, little or nothing was done. The time has come to follow through with something more than mere declarations of intention.



Cryonics Reports *covers from October (left) and December 1967. Left shows (from left) Fred Horn, Saul Kent, and (maybe) Curtis Henderson, surrounded by apparatus pertinent to cryopreservation. These and earlier issues were letter size (8 ½" x 11").*





Cryonics Reports *covers from April and September 1968. Right shows St. James Funeral Home where cryopreservations were carried by mortician Fred Horn and CSNY personnel. Starting January 1968 issues were half-letter size (5 ½" x 8 ½").*

"A proposal discussed at the CSA meeting was the establishment of a special foundation for scientific research aimed at perfecting methods of suspended animation and aging control. Such a foundation could be administered by a board of directors consisting of members of the CSA Accrediting Committee, along with prominent scientists. All money for research could be channeled through the foundation, which would be a direct and significant expression of the growth of the program.

"Prof. James H. Bedford left $100,000 for cryobiologic research to a foundation bearing his name. This bequest has already been contested legally. The money is tied up in probate and may never be available for research. Such hassles must be avoided in the future. They have a discouraging effect on people of means who are contemplating similar bequests. The establishment of a foundation of known dependability is the obvious solution. Contributions to the foundation could be solicited from individuals, corporations, other foundations, and the government.

"These are our major objectives. Next year the Cryonics Conference will be held in Michigan. It will reflect the

extent of our progress over the coming year. Let's make it a year to remember."

REALLY DOING IT: CSNY STARTS FREEZING PEOPLE

Up to this point, CSNY itself had not frozen anyone, though duly reporting freezings elsewhere. Prominent among these was that of James Bedford in January 1967, handled by the Cryonics Society of California (CSC), and also that of Marie Phelps-Sweet in August that year, by the same group. Putting out a newsletter is a chore, and after some initial efforts on its own CSC decided to partner with CSNY in getting the word out about what they were doing. The April 1968 *Cryonics Reports* has this brief notice: "Starting with the May issue, there will be a special California section in CRYONICS REPORTS. Paul Porcasi will be Editor of this section. It will include first-hand reports of cryonics news out west, as well as scientific information, opinion, and speculation."[18] The May issue has the first installment of the California section, one topic being the imminent cryopreservation of Helen Kline. In the June issue there is a report of this cryopreservation, while the July issue has a notice that CSC has decided to publish its own newsletter henceforth.[19]

Almost as if on cue, in the same month a CSNY member, Steven Mandell, arrested and the organization suddenly found itself in the business of actually freezing people. Mandell had joined CSNY the previous November, after a year of subscribing to *Cryonics Reports*. He was then a student at New York University in the Bronx, majoring in aeronautical engineering; a science fiction story had sparked his interest. Reporting his health as "fair," in fact he would soon succumb to Crohn's disease or regional enteritis, an inflammatory bowel disorder. Financially, matters seemed to be in order. A $10,000 insurance policy (about $71,000 in late-2017 dollars) plus donations from friends and relatives, "placed in a special trust," would "insure indefinite care of the body."[20]

Steven Mandell, CSNY's first cryonics case. Photo credit: Robert West, Suffolk Sun.

Long before this a need for preparedness had been recognized,[21] and CSNY had been fortunate in enlisting a nearby mortician, Fred Horn of the St. James Funeral Home, who would provide unflagging assistance in their cases. Otherwise, at a basic level CSNY was prepared. They had a cryogenic capsule, which was featured in multiple exposures on the April, 1968 issue of their newsletter. This is an "old style," horizontal capsule manufactured by Cryo-Care Equipment Corporation of Phoenix, Arizona.[22] Only one such capsule was actually used by CSNY.[23] Horn now took charge of legal formalities and also assisted in preparing the body for cryogenic cooling at his facility. This involved replacing the blood with a solution of glycerol (20%) in Ringer's solution, using an embalming pump. The body then was cooled to dry ice temperature. Encapsulation and storage in liquid nitrogen would follow on September 5, at Washington Memorial Park, a cemetery-based facility in Coram, L. I. (Encapsulation was actually a difficult operation. Initially the inner chamber of the capsule where the patient would rest was welded shut and had to be cut open and resealed with a leak-proof seal after the occupant was inside. A master welder – Tom Gartland – and an assistant were required.)[24]

Among the CSNY personnel were Paul Segall and Harold Waitz,[25] who also were prominent in the Laboratory for Life Extension Research (Segall as Director of Biological Research and Waitz as Director of Engineering Research). Based in Segall's garage in Lindenhurst, L. I., this laboratory had been founded the previous June by Segall himself under sponsorship of CSNY. Segall's main purpose was "to create an atmosphere geared solely to research designed to extend the human lifespan," which, as far as he knew, did not exist anywhere in the world. Among the "many avenues of approach to control and reversal of the aging process" Segall proposed "cryonic suspension, clonal reproduction, and manipulation of hormonal balance." Granted "we have been forced to start on an extremely modest scale with minimal equipment, we do have the freedom to pursue our goals without interference or coercion." The rather ambitious immediate objectives were: (1) to prove that aging can be halted in mice, with corresponding insight into aging more generally; (2) to achieve reversible suspended animation of mammals through cryopreservation; and (3) to perfect cryonics storage technology, starting from the Cryo-Care capsules.

In retrospect let it be said that while goals (1) and (2) were not achieved and are still being pursued today, considerable progress was at least made swiftly with (3), though not through Segall's laboratory – more later. The laboratory itself did some experiments with deprivation of the amino acid tryptophan in mice which stunted their growth though failed as far as I can tell to produce a demonstrated increase in their life span.

Yet cryonics seemed to be guardedly entering a new era of respectability, with New York playing a leading part. We have seen how, at a meeting hosted by CSNY just after the March Cryonics Conference, the Cryonics Societies of America had been tentatively formed (not actually incorporated), with the cryonics societies of New York, Michigan, and California as founding members. An important feature of the CSA, announced in the September 1968 *Cryonics Reports* along with Steven Mandell's freezing, was a Scientific Advisory Committee with an impressive list of a dozen or so PhDs and MDs, including cryobiologist Armand Karow Jr. and physicist Gerald Feinberg.[26]

As might be expected, not all developments were favorable. The same issue of the newsletter that reports the freezing of Mandell announces the resignation, effective Aug. 21, of a married couple who were important to CSNY: Karl and Glenda (Allen) Werner. Karl was vice president, newsletter art director, a CSNY cofounder, and the man who coined the term *cryonics*, while Glenda was the CSNY

treasurer. Their reasons were religious. They had been married May 18 in the Church of Scientology. Now they were severing all affiliation with cryonics because it had "opposing goals."[27]

In November 1968 another cryonics case occurred, this time under less favorable circumstances than Mandell's, and it quickly showed the frustration and heartache that can follow. Andrew Mihok was a 48-year-old drill press operator who lived in the upstate New York town of Vestal, some hours' drive from CSNY's facilities in the environs of New York City. Mihok had suffered an injury in an auto accident that had damaged his heart and forced him to retire a few months before. Before that his wife, Mildred, had read about the freezing idea and was interested but the couple had made no arrangements. When Andrew suffered a fatal heart attack Nov. 19 his wife decided to act, first requesting the hospital staff to carry out the freezing. When they refused, she contacted the Allen Memorial Home funeral parlor in nearby Endicott. At first they didn't know what to do. All they had to go on was the June 1968 issue of *Casket & Sunnyside*, which had some articles on cryonics. There they found Pierce Brothers mortuary in Los Angeles mentioned in a review of Robert Nelson's recently published book, *We Froze the First Man*. A call to Pierce Brothers was referred to Cryo-Care Equipment Corporation in Phoenix, Arizona, who referred them to CSNY.

Saul Kent received the call from the Allen mortuary at 10:30 p.m. and contacted Fred Horn. After a few hours' sleep, at 6 the next morning, Nov. 20, Horn and Paul Segall loaded Horn's station wagon with perfusion chemicals and paraphernalia and started on the 200-mile journey to Endicott. They arrived at the mortuary at 11 p.m., and a consultation was held. Relatives, funeral home officials, doctors, and the widow's attorney all advised Mrs. Mihok to back off, but she was determined to go ahead. The body was retrieved from the hospital's refrigerated morgue where it still rested, and transferred to the mortuary. The perfusion carried out there by Horn and Segall went well by account; a glycerol solution was circulated through the body for 1½ hours, while the entire Allen staff watched with great interest. The body was packed in ice and rock salt, placed in a rubber "disaster bag," and loaded in the back of the station wagon. Horn and Segall started back about 8:30 p.m., driving slowly through rain, sleet and fog, and arrived at the St. James Funeral Home at 3:30 a.m., Nov. 21.

Mihok was then placed in dry ice, and it appeared might soon be in liquid nitrogen like Mandell. But it was not to be. Two weeks later, Dec. 5, the thawed body was buried. By this time family members had all lined up against the continued freezing, saying that the cost of $10,000 was more than they wanted to help the needy widow pay. "I feel just dreadful about it," the saddened Mrs. Mihok responded. "I didn't want it this way." (Another discouragement from CSNY's standpoint was that Mrs. Mihok had the unrealistic expectation that cryonics could bring her husband back soon, so he could support her again.)[28]

In what was possibly the high-water mark of New York cryonics of this early period, before anyone had been frozen by CSNY, a conference was held in March 1968 at the New York Academy of Sciences...

The next case started a few weeks later, under somewhat better, if still unusual, circumstances. Ann DeBlasio, a 43-year-old cancer patient, died in New York University Hospital, Manhattan, Jan. 3, 1969 and was frozen by CSNY the next day. (Again it does not appear that prior arrangements were in place.) Technically freezing was now being done by a newly-formed New York corporation, Cryo-Span. It would offer "all services attendant to the cryonic suspension treatment including negotiation with administrative authorities and professionals, preparation of the body, and the provision of indefinite permanent storage." Incorporators are listed as Curtis Henderson, Saul Kent, and Paul Segal. Nicholas, Ann's husband, was a gun-toting policeman whose appearance and demeanor apparently had some influence with reluctant hospital personnel in the early stages of the freezing. Yet a report notes that "it was impossible to obtain authorization for emergency use of a heart-lung machine in order to perfuse the patient under optimum conditions," despite efforts of the husband, Cryo-Span personnel, and sympathetic physicians. Though the freezing was not as good as it might have been, the body was cooled immediately postmortem with water ice and then perfused and frozen at the Cryo-Span perfusion facility.[29] (Apparently this latter was the same St. James mortuary that had been used before.)

The body was stored on dry ice for a few months, until a cryogenic capsule could be obtained. When the specially designed unit finally arrived from Minnesota Valley Engineering it was a great improvement over its predecessor made by Cryo-Care. It stood upright and had a lid on top that could be easily removed, rather than the patient being welded inside, as before. Though the boiloff was slightly higher with the more open construction it was far more convenient to work with and took up much less floor space. It also performed more reliably than the earlier, horizontal capsules which required continuous pumping to evacuate or "harden" the vacuum jacket (space between inner and outer walls of the vessel) to insulate against heat leak and reduce boiloff. The family was Catholic and, when Mrs. DeBlasio was placed in the capsule Aug. 15, a priest was on hand to consecrate the "forever flask" as it was now named.[30] ■

To Be Continued

SOURCES

CR. *Cryonics Reports*, Saul Kent ed. Newsletter of Cryonics Society of New York, 1966-69.

DNA. (Brief historical survey of DNA research, including work in the 1960s) https://web.archive.org/web/20150611151627/http://www.accessexcellence.org/RC/AB/BC/Search_for_DNA.php, accessed 13 Feb. 2018.

IC. Inflation calculator, https://www.bls.gov/data/inflation_calculator.htm, accessed 11 Jan. 2018.

JB. James Bedford (now Alcor cryonics patient), archival materials at Alcor Foundation, Scottsdale, AZ.

HK. (Herman Kahn) https://en.wikipedia.org/wiki/Herman_Kahn, accessed 13 Feb. 2018.

KW. Herman Kahn and Anthony J. Wiener, *The Year 2000: a Framework for Speculation on the Next Thirty-Three Years*, New York: Macmillan, 1967.

MD. Mike Darwin, private communication about 1991, relating to Nicholas Deblasio as an armed policeman pressuring reluctant hospital personnel in freezing his wife.

MNC. "The Man Who Named Cryonics," *CryoCare Report* 8, 22 (Jul. 1996).

MP1. R. Michael Perry, "Suspension Failures: Lessons from the Early Years," http://alcor.org/Library/html/suspensionfailures.html, accessed 15 Feb. 2018.

MP2. R. Michael Perry, "Cryonics in New York: Optimism before the First Freezing, 1966-68," *Cryonics* 34(6) (Jun. 2013) 14-16, https://www.alcor.org/CryonicsMagazine/cryonics2013.html#jun, accessed 13 Feb. 2018.

MP3. R. Michael Perry, "Cryonics in New York: Human Freezings and Other Events, 1968-1969," *Cryonics* 34(7) (Jul. 2013), 29-33, https://www.alcor.org/CryonicsMagazine/cryonics2013.html#jun, accessed 13 Feb. 2018.

SK1. Saul Kent, ed., *First Annual Cryonics Conference*, New York: Cryonics Society of New York, 1968.

SK2. Saul Kent, private communication about 1990.

SK3. Saul Kent, private communication 16 Jun. 2013 (unrealistic expectation of imminent revival).

USX. (Brief historical survey of the U. S. economy, 1950-1975, including events in the 1960s) http://elcoushistory.tripod.com/economics1960.html, accessed 13 Feb. 2018

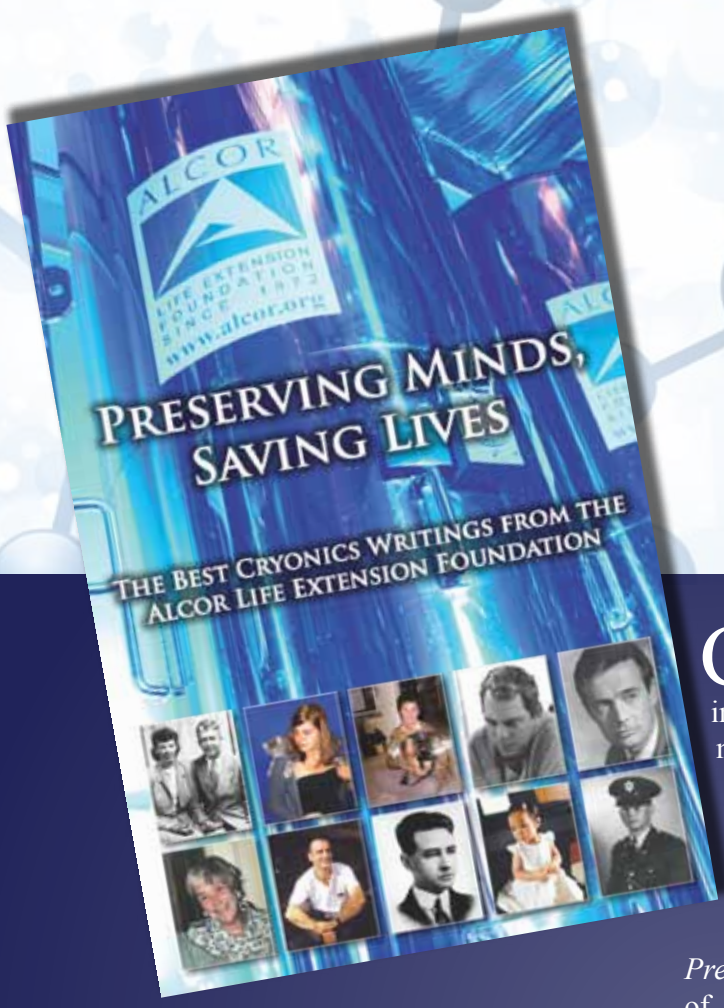
REFERENCES

1. MP2, MP3 (sources for entire article).
2. SK2.
3. CR 1(1) 1, 2 (Jun. 1966).
4. CR 1(3) 1 (Aug. 1966).
5. CR 1(3) 3 (Aug. 1966).
6. CR 1(4) 5 (Sep. 1966).
7. CR 1(6) 8 (Nov. 1966).
8. JB.
9. CR 2(6) 3 (Jun. 1967).
10. DNA.
11. USX.
12. KW.
13. See, for example, HK.
14. *Cryonics Reports* 2(8) 4-5 (Aug. 1967).
15. *Cryonics Reports* 3(2) 21-23 (Feb. 1968).
16. SK1.
17. CR 3(3) 29-30; 39-42 (Mar. 1968).
18. CR 3(4) 45 (Apr. 1968).
19. CR 3(5) 85-90 (May 1968); CR 3(6) 114-122 (Jun. 1968); CR 3(7) 126 (Jul. 1968).
20. "Cryonics News," CR3 (9), 162-66 (Sep. 1968), IC.
21. Preparedness is a major theme of the first issue of *Cryonics Reports*, June 1966.
22. "Cryonics News," CR 3 (4), 45-46 (Apr. 1968).
23. "Cryonics News," CR 3 (10), 182-89 (Oct. 1968).
24. "Cryonics News," CR 3 (9), 164 (Sep. 1968).
25. "Cryonics News," CR 3 (8), 146-47 (Aug. 1968).
26. "Scientific advisory council formed," CR 3 (9), 166-67 (Sep. 1968).
27. CR 3 (9), 161 (Sep. 1968); MNC.
28. "CSNY Calls off Suspension of Heart Attack Victim," CR 4 (1), 4-6 (Jan. 1969); "Family Bars Freezing for Heart Victim," Suffolk, N.Y. Sun (Dec. 5, 1968) – has quote by Mrs. Mihok; SK3.
29. "Cryonics News," CR 4 (2) 3 (Feb. 1969); MD; MP1.
30. "Cryo News Capsules," CR 4 (3) 6 (Mar. 1969).

ORDER NOW!

Preserving Minds, Saving Lives

The Best Cryonics Writings of The Alcor Life Extension Foundation



"Cryonics *magazine introduced me to Alcor and cryonics at its best back in 1983. The visions and technological breakthroughs that you will read about in this book continue to shape Alcor's mission to preserve life through science."*

– Max More, Ph.D.
President and CEO of Alcor

Cryonics is an experimental medical procedure that uses ultra-low temperatures to put critically ill people into a state of metabolic arrest to give them access to medical advances of the future. Since its inception in the early 1960s, the practice of cryonics has moved from a theoretical concept to an evidence-based practice that uses emergency medical procedures and modern vitrification technologies to eliminate ice formation.

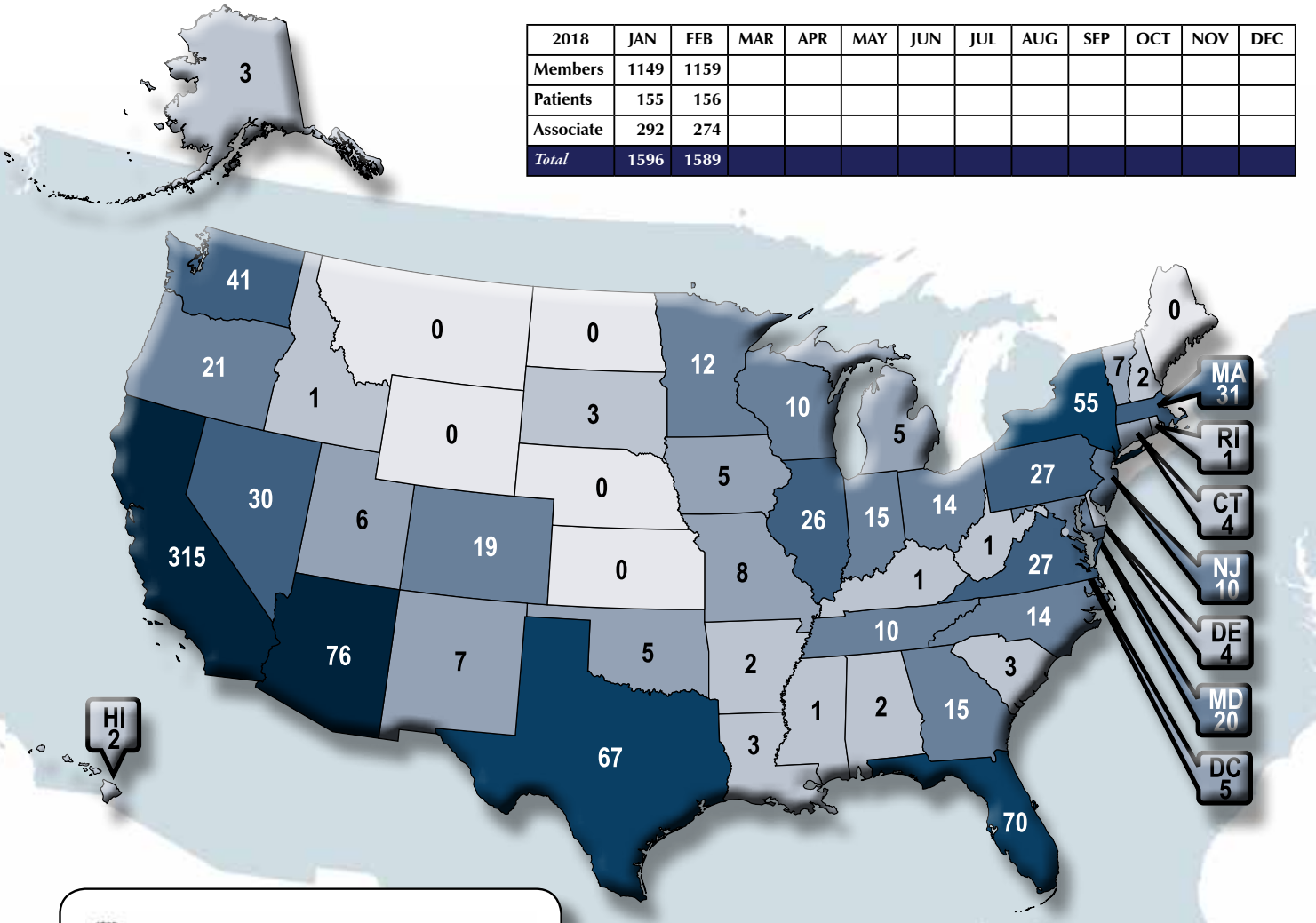
Preserving Minds, Saving Lives offers an ambitious collection of articles about cryonics and the Alcor Life Extension Foundation. From its humble beginnings in 1972, and its first human cryonics patient in 1976, Alcor has grown to a professional organization with more than 1,000 members, more than 140 human patients, and more than 50 pets, all awaiting a chance to be restored to good health and continue their lives.

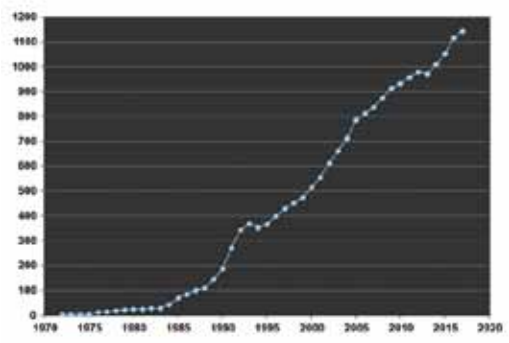
This book presents some of the best cryonics writings from *Cryonics* magazine from 1981 to 2012. There are clear expositions of the rationale behind cryonics, its scientific validation, and the evolution of Alcor procedures. Also covered are repair and resuscitation scenarios, philosophical issues associated with cryonics, and debates within the cryonics community itself.

Soft Cover Edition: $20 – Hard Cover Edition: $35
To order your copy, go to: www.alcor.org/book
or call 1-877-GO ALCOR (462-5267)

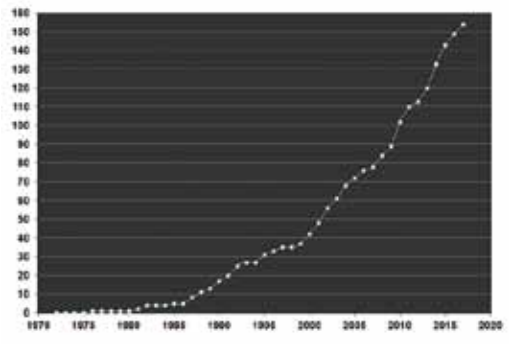
Membership Statistics

2018	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Members	1149	1159										
Patients	155	156										
Associate	292	274										
Total	1596	1589										





Number of Alcor members



Number of Alcor patients

- 0 Members
- 1–4 Members
- 5–9 Members
- 10–24 Members
- 25–49 Members
- 50–74 Members
- 75+ Members

International Members & Patients

Country	Members	Patients
Australia	13	3
Brazil	1	0
Canada	56	3
China	0	1
France	0	1
Germany	14	0
Hong Kong	2	0
Israel	1	1
Italy	3	0
Japan	5	0
Luxembourg	1	0
Mexico	4	0
Monaco	1	0
Netherlands	1	0
Norway	1	0
Portugal	5	0
Singapore	1	0
Spain	5	1
Taiwan	1	0
Thailand	5	1
United Kingdom	33	3
TOTAL	153	14

Engineers Grow Functioning Human Muscle from Skin Cells

Biomedical engineers have grown the first functioning human skeletal muscle from induced pluripotent stem cells. The advance builds on work published in 2015 when researchers at Duke University grew the first functioning human muscle tissue from cells obtained from muscle biopsies. The ability to start from cellular scratch using non-muscle tissue will allow scientists to grow far more muscle cells, provide an easier path to genome editing and cellular therapies, and develop individually tailored models of rare muscle diseases for drug discovery and basic biology studies. The results appear online Tuesday, January 9, in *Nature Communications*. "Starting with pluripotent stem cells that are not muscle cells, but can become all existing cells in our body, allows us to grow an unlimited number of myogenic progenitor cells," said Nenad Bursac, professor of biomedical engineering at Duke University. "These progenitor cells resemble adult muscle stem cells called 'satellite cells' that can theoretically grow an entire muscle starting from a single cell."

Duke University / EurekAlert!
9 Jan. 2018
https://www.eurekalert.org/pub_releases/2018-01/du-egf010518.php

Researchers Develop a Remote-Controlled Cancer Immunotherapy System

A team of researchers has developed an ultrasound-based system that can non-invasively and remotely control genetic processes in live immune T cells so that they recognize and kill cancer cells. The team developed an innovative approach to use mechanogenetics—a field of science that focuses on how physical forces and changes in the mechanical properties of cells and tissues influence gene expression—for the remote control of gene and cell activations. Researchers used ultrasound to mechanically perturb T cells, and then converted the mechanical signals into genetic control of cells. In this study, researchers show how their remote-controlled mechanogenetics system can be used to engineer chimeric antigen receptor (CAR)-expressing T cells that can target and kill cancer cells. The engineered CAR-T cells have mechano-sensors and genetic transducing modules that can be remotely activated by ultrasound via microbubble amplification.

University of California San Diego / EurekAlert!
15 Jan. 2018
https://www.eurekalert.org/pub_releases/2018-01/uoc--rda011118.php

Secrets of Longevity Protein Revealed in New Study

Named after the Greek goddess who spun the thread of life, Klotho proteins play an important role in the regulation of longevity and metabolism. In a recent Yale-led study, researchers revealed the three-dimensional structure of one of these proteins, beta-Klotho, illuminating its intricate mechanism and therapeutic potential. The study findings, published in Nature, could have implications for therapies developed to treat a wide range of medical conditions, including diabetes, obesity, and certain cancers, the researchers said. The Klotho family of two receptor proteins are located on the surface of cells of specific tissues. The proteins bind to a family of hormones, designated endocrine FGFs, that regulate critical metabolic processes in the liver, kidneys, and brain, among other organs. To understand how beta-Klotho works, the research team used X-ray crystallography, a technique that provides high-resolution, three-dimensional views of these proteins. The researchers' analysis yielded several insights. …

Ziba Kashef / YaleNews
17 Jan. 2018
https://news.yale.edu/2018/01/17/secrets-longevity-protein-revealed-new-study

Ultra-Thin Optical Fibers Offer New Way to 3-D Print Microstructures

For the first time, researchers have shown that an optical fiber as thin as a human hair can be used to create microscopic structures with laser-based 3D printing. "With further development our technique could enable endoscopic microfabrication tools that would be valuable during surgery," said research team leader Paul Delrot, from École Polytechnique Fédérale de Lausanne, Switzerland. "These tools could be used to print micro- or nano-scale 3D structures that facilitate the adhesion and growth of cells to create engineered tissue that restores damaged tissues." In The Optical Society (OSA) journal *Optics Express*, the researchers show that their new approach can create microstructures with a 1.0-micron lateral (side-to-side) and 21.5-micron axial (depth) printing resolution. Although these microstructures were created on a microscope slide, the approach could be useful for studying how cells interact with various microstructures in animal models, which would help pave the way for endoscopic printing in people.

ScienceDaily / Optical Society of America
17 Jan. 2018
https://www.sciencedaily.com/releases/2018/01/180117102644.htm

Engineers Design Artificial Synapse for "Brain-On-a-Chip" Hardware

One significant hangup on the way to portable artificial intelligence devices has been the neural synapse, which has

been particularly tricky to reproduce in hardware. Now engineers at MIT have designed an artificial synapse with precise control of the strength of an electric current flowing across it, similar to the way ions flow between neurons. The team has built a small chip with artificial synapses, made from silicon germanium. In simulations, the researchers found that the chip and its synapses could be used to recognize samples of handwriting, with 95 percent accuracy. The design, published Jan. 22 in the journal *Nature Materials*, is a major step toward building portable, low-power neuromorphic chips for use in pattern recognition and other learning tasks. The research was led by Jeehwan Kim, who says that most switching mediums to date are made of amorphous materials with unlimited possible paths through which ions can travel. This can create unwanted nonuniformity in a synapse's performance. Instead Kim and his colleagues looked to single-crystalline silicon, a defect-free conducting material …

Jennifer Chu | MIT News Office
22 Jan. 2018
http://news.mit.edu/2018/engineers-design-artificial-synapse-brain-on-a-chip-hardware-0122

Superconducting Synapse May Be Missing Piece for 'Artificial Brains'

Researchers at the National Institute of Standards and Technology (NIST) have built a superconducting switch that "learns" like a biological system and could connect processors and store memories in future computers operating like the human brain. The NIST switch, described in *Science Advances*, is called a synapse, like its biological counterpart, and it supplies a missing piece for so-called neuromorphic computers. Envisioned as a new type of artificial intelligence, such computers could boost perception and decision-making for applications such as self-driving cars and cancer diagnosis. To build computers that mimic the brain, researchers want to build artificial synapses. NIST has designed an artificial synapse that uses a Josephson junction, a device made of two superconductors separated by an insulating layer. The NIST synapse, however, can fire much faster than the human brain—1 billion times per second, compared to a brain cell's 50 times per second—using just a whiff of energy, about one ten-thousandth as much as a human synapse. …

NIST News
26 Jan. 2018
https://www.nist.gov/news-events/news/2018/01/nists-superconducting-synapse-may-be-missing-piece-artificial-brains

Scientists Unlock the Molecular Secret behind Long-Lived Bat Species

Scientists have identified part of the molecular mechanism that gives long-lived bat species their extraordinary lifespans compared to other animals. The findings published in the journal *Science Advances* point to the protective structures at the end of chromosomes, called telomeres. According to the international team of scientists, in the longest-lived species of bats (Myotis) telomeres don't shorten with age. Whereas in other bats species, humans and other animals they do, causing the age-related breakdown of cells that over the course of a lifetime can drive tissue deterioration and ultimately death. To conduct the study, researchers took 3-mm wing biopsies from some 500 wild bats from across four species that they captured, marked and released. The samples were flash frozen in liquid nitrogen or desiccated using silica beads, high-molecular DNA was extracted, and change in telomere length was assessed. According to Dr. Nicole Foley, lead author of the study, "in the longest-lived species of bats (Myotis), we did not detect any evidence that their telomeres shorten with age …"

University College Dublin
8 Feb. 2018
http://www.ucd.ie/newsandopinion/news/2018/february/08/scientistsunlockthemolecularsecretbehindlong-livedbatspecies/

New Malleable 'Electronic Skin' Self-Healable, Recyclable

CU Boulder researchers have developed a new type of malleable, self-healing and fully recyclable "electronic skin" that has applications ranging from robotics and prosthetic development to better biomedical devices. Electronic skin, known as e-skin, is a thin, translucent material that can mimic the function and mechanical properties of human skin. A number of different types and sizes of wearable e-skins are now being developed in labs around the world. The new CU Boulder e-skin has sensors embedded to measure pressure, temperature, humidity and air flow, said Jianliang Xiao, an assistant professor in CU Boulder's Department of Mechanical Engineering who is leading the research effort with Wei Zhang, an associate professor in CU Boulder's Department of Chemistry and Biochemistry. "What is unique here is that the chemical bonding of polyimine we use allows the e-skin to be both self-healing and fully recyclable at room temperature," said Xiao. A paper on the subject was published Feb. 9 in the journal *Science Advances*. Co-authors include Zhanan Zou, Yan Li …

Jim Scott / CU Boulder Today
9 Feb. 2018
https://www.colorado.edu/today/2018/02/09/new-malleable-electronic-skin-self-healable-recyclable

Nanorobots Shrink Tumors by Cutting Off Their Blood Supply

In a major advance in nanomedicine, Arizona State University scientists, in collaboration with researchers from the National Center for Nanoscience and Technology (NCNST) of the Chinese Academy of Sciences, have successfully programmed nanorobots to shrink tumors by cutting off their blood supply. "We have developed the first fully autonomous, DNA robotic system for a very precise drug design and targeted cancer therapy," said Hao Yan, director of the ASU Biodesign Institute's Center for Molecular Design and Biomimetics and the Milton Glick

Professor in the School of Molecular Sciences. "Moreover, this technology is a strategy that can be used for many types of cancer, since all solid tumor-feeding blood vessels are essentially the same," Yan said. The successful demonstration of the technology, the first-of-its-kind study in mammals utilizing breast-cancer, melanoma, ovarian and lung-cancer mouse models, was published in the journal *Nature Biotechnology*. Yan is an expert in the field of DNA origami, which in the past two decades has developed atomic-scale manufacturing …

ASU Now
12 Feb. 2018
https://asunow.asu.edu/20180212-discoveries-cancer-fighting-nanorobots-seek-and-destroy-tumors

STM Solution May Save Researchers Big Time

Farid Tajaddodianfar, a University of Texas at Dallas graduate student, his advisor, and industry collaborators believe they have addressed a problem troubling scientists and engineers for more than 35 years: How to prevent the tip of a scanning tunneling microscope (STM) from crashing into the surface of a material during imaging or lithography. Details of the group's solution appeared in the January issue of the journal *Review of Scientific Instruments*, which is published by the American Institute of Physics. "What they're trying to do is help bring atomically precise manufacturing into reality," said Dr. John Randall, who co-authored the article with Tajaddodianfar, Dr. Reza Moheimani and Zyvex Labs' James Owen. "This is considered the future of nanotechnology, and it is extremely important work." Randall said Tajaddodianfar's algorithm has been integrated with its system's software but is not yet available to customers. The research was made possible by funding from the Army Research Office and the Defense Advanced Research Projects Agency.

UTD News Center
12 Feb. 2018
http://www.utdallas.edu/news/2018/2/12-32833_UT-Dallas-Teams-Microscopic-Solution-May-Save-Rese_story-wide.html?WT.mc_id=NewsHomePageCenterColumn

A Roadmap to Revival

Successful revival of cryonics patients will require three distinct technologies: (1) A cure for the disease that put the patient in a critical condition prior to cryopreservation; (2) biological or mechanical cell repair technologies that can reverse any injury associated with the cryopreservation process and long-term care at low temperatures; (3) rejuvenation biotechnologies that restore the patient to good health prior to resuscitation. OR it will require some entirely new approach such as (1) mapping the ultrastructure of cryopreserved brain tissue using nanotechnology, and (2) using this information to deduce the original structure and repairing, replicating or simulating tissue or structure in some viable form so the person "comes back."

The following is a list of landmark papers and books that reflect ongoing progress towards the revival of cryonics patients:

Jerome B. White, "**Viral-Induced Repair of Damaged Neurons with Preservation of Long-Term Information Content**," Second Annual Conference of the Cryonics Societies of America, University of Michigan at Ann Arbor, April 11-12, 1969, by J. B. White. Reprinted in *Cryonics* 35(10) (October 2014): 8-17.

Michael G. Darwin, "**The Anabolocyte: A Biological Approach to Repairing Cryoinjury**," *Life Extension Magazine* (July-August 1977):80-83. Reprinted in *Cryonics* 29(4) (4th Quarter 2008):14-17.

Gregory M. Fahy, "**A 'Realistic' Scenario for Nanotechnological Repair of the Frozen Human Brain**," in Brian Wowk, Michael Darwin, eds., *Cryonics: Reaching for Tomorrow*, Alcor Life Extension Foundation, 1991.

Ralph C. Merkle, "**The Molecular Repair of the Brain**," *Cryonics* 15(1) (January 1994):16-31 (Part I) & *Cryonics* 15(2) (April 1994):20-32 (Part II).

Ralph C. Merkle, "**Cryonics, Cryptography, and Maximum Likelihood Estimation**," First Extropy Institute Conference, Sunnyvale CA, 1994, updated version at http://www.merkle.com/cryo/cryptoCryo.html.

Aubrey de Grey & Michael Rae, "**Ending Aging: The Rejuvenation Breakthroughs That Could Reverse Human Aging in Our Lifetime**." St. Martin's Press, 2007.

Robert A. Freitas Jr., "**Comprehensive Nanorobotic Control of Human Morbidity and Aging**," in Gregory M. Fahy, Michael D. West, L. Stephen Coles, and Steven B. Harris, eds, *The Future of Aging: Pathways to Human Life Extension*, Springer, New York, 2010, 685-805.

Chana Phaedra, "**Reconstructive Connectomics**," *Cryonics* 34(7) (July 2013): 26-28.

Robert A. Freitas Jr., "**The Alzheimer Protocols: A Nanorobotic Cure for Alzheimer's Disease and Related Neurodegenerative Conditions**," *IMM Report* No. 48, June 2016.

REDUCE YOUR ALCOR DUES WITH THE CMS WAIVER

Alcor members pay general dues to cover Alcor's operating expenses and also make annual contributions to the Comprehensive Member Standby fund pool to cover the costs of readiness and standby. Benefits of Comprehensive Member Standby include no out-of-pocket expense for standby services at the time of need, and up to $10,000 for relocation assistance to the Scottsdale, Arizona area.

Instead of paying $180 per year in CMS dues, Alcor also provides members the option to cover all CMS-associated costs through life insurance or pre-payment. Members who provide an additional $20,000 in minimum funding will no longer have to pay the $180 CMS (Comprehensive Member Standby fund) fee. This increase in minimums is permanent (for example, if in the future Alcor were to raise the cost of a neurocryopreservation to $90,000, the new minimum for neurocryopreservation members under this election would be $110,000). Once this election is made, the member cannot change back to the original minimums in the future.

To have the CMS fee waived, these are the minimums:

- **$220,000 Whole Body Cryopreservation ($115,000 to the Patient Care Trust, $60,000 for cryopreservation, $45,000 to the CMS Fund).**
- **$100,000 Neurocryopreservation ($25,000 to the Patient Care Trust, $30,000 for cryopreservation, $45,000 to the CMS Fund).**

If you have adequate funding and would like to take advantage of the CMS waiver, contact **Diane Cremeens at diane@alcor.org.**

Become An Alcor Associate Member!

Supporters of Alcor who are not yet ready to make cryopreservation arrangements can become an Associate Member for $5/month (or $15/quarter or $60 annually). Associate Members are members of the Alcor Life Extension Foundation who have not made cryonics arrangements but financially support the organization. Associate Members will receive:

- ***Cryonics* magazine by mail**
- **Discounts on Alcor conferences**
- **Access to post in the Alcor Member Forums**
- **A dollar-for-dollar credit toward full membership sign-up fees for any dues paid for Associate Membership**

To become an Associate Member send a check or money order ($5/month or $15/quarter or $60 annually) to Alcor Life Extension Foundation, 7895 E. Acoma Dr., Suite 110, Scottsdale, Arizona 85260, or call Marji Klima at (480) 905-1906 ext. 101 with your credit card information.

Or you can pay online via PayPal using the following link: http://www.alcor.org/BecomeMember/associate.html (quarterly option is not available this way).

Associate Members can improve their chances of being cryopreserved in an emergency if they complete and provide us with a Declaration of Intent to be Cryopreserved (http://www.alcor.org/Library/html/declarationofintent.html). Financial provisions would still have to be made by you or someone acting for you, but the combination of Associate Membership and Declaration of Intent meets the informed consent requirement and makes it much more likely that we could move ahead in a critical situation.

Start preparing your

MEMORY BOX ...now!

Start your own time-capsule!

Create a Memory Box with items to augment your memories when you are resuscitated.

No one knows better than you what you will want to have with you.

Alcor makes available to every member and patient, without charge, one acid free Memory Box about the size of a standard banker's box (H10" x W12" x L15") for memorabilia to be stored underground at a commercial storage site called Underground Vaults and Storage (UGVS) in Kansas. Additional Boxes are a one-time charge of $250 each for perpetual storage.

Some of the most popular items that have been placed into storage are such things as letters, cards, photographs, diaries, journals, notebooks, books, clippings, army records, directories, recipes, video tapes, cassettes, medical records, flash drives, and external drives.

If you would like to begin working on your own Memory Box, or perhaps contribute items to a Box for an Alcor Member already in stasis, or if you have any questions, please contact **Linda Chamberlain at linda@alcor.org or call toll free at 877-462-5267 ext 115**.

ALCOR
LIFE EXTENSION FOUNDATION
The World's Leader in Cryonics
www.alcor.org

POWER UP!

TURN ON YOUR CELLULAR ENERGY

RESVERATROL activates critical longevity factors in our cells.

For **resveratrol** to deliver functional results, it requires a coenzyme called **NAD+**.

NAD+ levels **plummet** with **age** but increase in response to **nicotinamide riboside.**

Optimized NAD+ Cell Regenerator™ combines **250 mg** of **nicotinamide riboside** with **resveratrol** and other **plant extracts**.

For those already taking resveratrol, we also offer **NAD+ Regenerator™** that provides **250 mg** of **nicotinamide riboside**.

NAD+ Cell Regenerator™
Item #02144 • 30 vegetarian capsules

	Retail Price	Your Price
1 bottle	$42	**$31.50**
4 bottles		**$28 each**

Non-GMO

Optimized NAD+ Cell Regenerator™
Item #02145 • 30 vegetarian capsules

	Retail Price	Your Price
1 bottle	$50	**$37.50**
4 bottles		**$34 each**

Non-GMO

Call **1-866-820-4967** toll-free or visit **LifeExtension.com**.

Please mention Discount Code **PIM701X** • Offer expires December 31, 2017

Consult your healthcare provider before use if you have a bleeding disorder, are taking anticoagulant or antiplatelet medications or beta-blockers such as Nadolol. Keep out of reach of children. Do not exceed recommended dose.

MKAQAV171106

MEETINGS

ABOUT THE ALCOR FOUNDATION

The Alcor Life Extension Foundation is a nonprofit tax-exempt scientific and educational organization dedicated to advancing the science of cryopreservation and promoting cryonics as a rational option. Being an Alcor member means knowing that—should the worst happen—Alcor's Emergency Response Team is ready to respond for you, 24 hours a day, 365 days a year.

Alcor's Emergency Response capability includes specially trained technicians and customized equipment in Arizona, northern California, southern California, and south Florida, as well as many additional certified technicians on-call around the United States. Alcor's Arizona facility includes a full-time staff, and the Patient Care Bay is personally monitored 24 hours a day.

ARIZONA

FLAGSTAFF: Arizona without the inferno. Cryonics group in beautiful, high-altitude Flagstaff. Two-hour drive to Alcor. Contact eric@flagstaffcryo.com for more information.

PHOENIX: This group meets monthly, usually in the third week of the month. Dates are determined by the activity or event planned. For more information or to RSVP, visit http://cryonics.meetup.com/45/ or email Bonnie Magee at bonnie@alcor.org.

AT ALCOR: Alcor Board of Directors Meetings and Facility Tours—Alcor business meetings are generally held on the second Saturday of every month starting at 11:00 AM MST. Guests are welcome to attend the fully-public board meetings. Facility tours are held every Tuesday at 10:00 AM and Friday at 2:00 PM. For more information or to schedule a tour, call Marji Klima at (877) 462-5267 x101 or email marji@alcor.org.

CALIFORNIA

LOS ANGELES: Alcor Southern California Meetings—For information, call Peter Voss at (310) 822-4533 or e-mail him at peter@optimal.org. Although monthly meetings are not held regularly, you can meet Los Angeles Alcor members by contacting Peter.

SAN FRANCISCO BAY: Alcor Northern California Meetings are held quarterly in January, April, July, and October. A CryoFeast is held once a year. For information on Northern California meetings, call Mark Galeck at (650) 772-1251 or email mark_galeck@pacbell.net.

FLORIDA

Central Florida Life Extension group meets once a month in the Tampa Bay area (Tampa and St. Petersburg) for discussion and socializing. The group has been active since 2007. Email arcturus12453@yahoo.com for more information.

NEVADA

LAS VEGAS: A new group for the Las Vegas areas has been started for those interested. Contact Gilda Cabral at gcabral@korns.com or Mike Korns at mkorns@korns.com for details on upcoming meetings.

NEW ENGLAND

CAMBRIDGE: The New England regional group strives to meet monthly in Cambridge, MA—for information or to be added to the Alcor NE mailing list, please contact Bret Kulakovich at 617-824-8982, alcor@bonfireproductions.com, or on FACEBOOK via the Cryonics Special Interest Group.

NEW YORK CITY

Alcor members in the NYC area can contact Javier El-Hage at javier.elhage@gmail.com for information about local meetings which are held once a month at a midtown location.

PACIFIC NORTHWEST

Alcor Pacific Northwest organizes meetings for Alcor members in the Pacific Northwest. Meetings are usually held in the Portland area but other locations are possible, too. The contact person for the meetings is Aschwin de Wolf: aschwin@alcor.org. See also: https://www.facebook.com/alcor.pnw/

OREGON: The contact person for meetings in the Portland area is Aschwin de Wolf: aschwin@alcor.org. See also: https://www.facebook.com/portland.life.extension.

BRITISH COLUMBIA (CANADA): CryoBC, a special interest group within the nonprofit Lifespan Society of BC (http://www.lifespanbc.ca/) holds meetings for cryonicists in the Vancouver area. To be notified of meetings join the CryoBC mailing list: https://groups.yahoo.com/neo/groups/cryobc/info.

TEXAS

DALLAS/NORTH TEXAS: Please join us at www.meetup.com/North-Texas-Cryonauts/ or contact David Wallace Croft at (214) 636-3790.

AUSTIN/CENTRAL TEXAS: A new group for the Austin area has been started for those interested in discussion and understanding of the relevant technologies and issues for cryopreservation, genomics, epigenetics and medical research for increased life/health span. Contact Tom Miller, 760-803-4107 or tom@blackmagicmissileworks.com.

JAPAN

Cryonics meetings are held monthly in Tokyo. Send queries to grand88@yahoo.com.

ALCOR PORTUGAL

Alcor Portugal is working to have good stabilization and transport capabilities. The group meets every Saturday for two hours. For information about meetings, contact Nuno Martins at n-martins@n-martins.com. The Alcor Portugal website is: www.alcorportugal.com.

UNITED KINGDOM

Alcor members in the UK can contact Garret Smyth at Alcor-UK@alcor.org for information about local meetings.

If you are interested in hosting regular meetings in your area, contact Alcor at 877-462-5267, ext. 113. Meetings are a great way to learn about cryonics, meet others with similar interests, and introduce your friends and family to Alcor members!

What is Cryonics?

Cryonics is an attempt to preserve and protect human life, not reverse death. It is the practice of using extreme cold to attempt to preserve the life of a person who can no longer be supported by today's medicine. Will future medicine, including mature nanotechnology, have the ability to heal at the cellular and molecular levels? Can cryonics successfully carry the cryopreserved person forward through time, for however many decades or centuries might be necessary, until the cryopreservation process can be reversed and the person restored to full health? While cryonics may sound like science fiction, there is a basis for it in real science. The complete scientific story of cryonics is seldom told in media reports, leaving cryonics widely misunderstood. We invite you to reach your own conclusions.

How do I find out more?

The Alcor Life Extension Foundation is the world leader in cryonics research and technology. Alcor is a non-profit organization located in Scottsdale, Arizona, founded in 1972. Our website is one of the best sources of detailed introductory information about Alcor and cryopreservation (www.alcor.org). We also invite you to request our FREE information package on the "Free Information" section of our website. It includes:

- A fully illustrated color brochure
- A sample of our magazine
- An application for membership and brochure explaining how to join
- And more!

Your free package should arrive in 1-2 weeks. (The complete package will be sent free in the U.S., Canada, and the United Kingdom.)

How do I enroll?

Signing up for cryopreservation is easy!

Step 1: Fill out an application and submit it with your $90 application fee.
Step 2: You will then be sent a set of contracts to review and sign.
Step 3: Fund your cryopreservation. While most people use life insurance to fund their cryopreservation, other forms of prepayment are also accepted. Alcor's Membership Coordinator can provide you with a list of insurance agents familiar with satisfying Alcor's current funding requirements.
Finally: After enrolling, you will wear emergency alert tags or carry a special card in your wallet. This is your confirmation that Alcor will respond immediately to an emergency call on your behalf.

Not ready to make full arrangements for cryopreservation? Then ***become an Associate Member*** for $5/month (or $15/quarter or $60 annually). Associate Members will receive:

- ***Cryonics*** magazine by mail
- Discounts on Alcor conferences
- Access to post in the Alcor Member Forums
- A dollar-for-dollar credit toward full membership sign-up fees for any dues paid for Associate Membership

To become an Associate Member send a check or money order ($5/month or $15/quarter or $60 annually) to Alcor Life Extension Foundation, 7895 E. Acoma Dr., Suite 110, Scottsdale, Arizona 85260, or call Marji Klima at (480) 905-1906 ext. 101 with your credit card information. You can also pay using PayPal (and get the Declaration of Intent to Be Cryopreserved) here: http://www.alcor.org/BecomeMember/associate.html

ALCOR
LIFE EXTENSION FOUNDATION
The World's Leader in Cryonics
www.alcor.org

Call toll-free TODAY to start your application:

877-462-5267 ext. 132 • info@alcor.org • www.alcor.org