ALCOR LIFE EXTENSION FOUNDATION
A Non-Profit Organization

CRYONICS

MAY–JUNE 2016 · VOLUME 37:3

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CRYONICS

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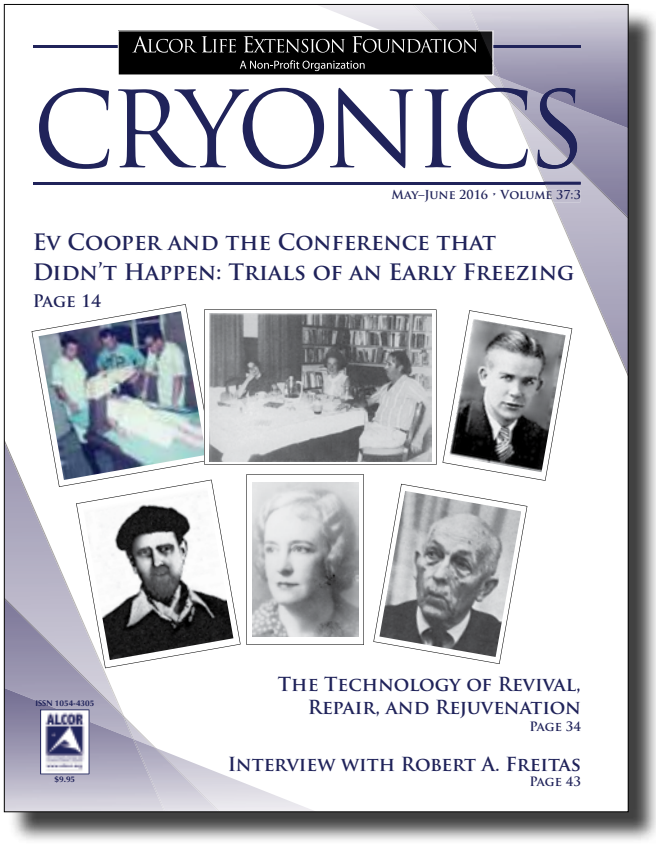

Ev Cooper and the Conference that Didn't Happen: Trials of an Early Freezing

The earliest days of the cryonics movement, before anyone was frozen, were a time of hope and optimism untroubled by the problems of the technical requirements of cryopreservation, including the cost and details of long-term storage. This "honeymoon" period came to an end as cryopreservations occurred that were not well-funded and had to depend on outside help from the cryonics community. The problems were particularly acute and soul-searching when someone well-known and well-respected experienced sudden arrest and very little funding was in place to carry out their strongly expressed wish to be cryopreserved for later revival. Such was the case of Marie Phelps-Sweet, who was frozen in the summer of 1967; its effects on the fledgling cryonics community are reported here.

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QUOD INCEPIMUS CONFICIEMUS

Photo: Cryo-Care Equipment Corporation at 2340 E. Washington St., Phoenix, AZ. Dr. Bedford's "home" in 1970 or 1971.

HOW "REPAIR DENIALISM" PREVENTS A RATIONAL DISCUSSION ABOUT CRYONICS By Aschwin de Wolf

Scientific critics of cryonics often do not seem to understand the basics of cryobiology (freezing does not "burst" cells), or remain ignorant that cryopreservation without freezing ("vitrification") has been a routine procedure in cryonics since 2000. It is not surprising, then, that some advocates of cryonics question the integrity of such critics. Are they deliberately ignoring or distorting the evidence that supports the technical feasibility of cryonics? One Alcor official has informally called such critics "cryonics deniers." One might object to using such a strong characterization because the feasibility of cryonics is a conjecture not a fact. I would like to suggest a more specific kind of denial. Many critics of cryonics seem unwilling to recognize the possibility of repair, or at least not factor it in when evaluating the coherence of arguments in favor of cryonics.

The ultimate goal of cryonics organizations is to offer reversible human cryopreservation (suspended animation) but is proof of suspended animation necessary for cryonics to be plausible?

The answer to this question is a resounding "NO." To reiterate the premise of cryonics; long term care at cryogenic temperatures allows the person to take advantage of medical advances of the future, including cell repair. Cryonics permits the use of an imperfect preservation technique, provided that the damage produced by sub-optimal technologies does not exclude inferring the original state of the brain (or body) from the damaged state. This is a subtle, but important, implication of the idea of medical time travel. Pointing out that existing cryopreservation techniques are imperfect does not refute the cryonics premise, unless it can be shown that such techniques produce information-theoretic death.

Not all injuries to the brain can be repaired. For example, when the period of cerebral ischemia is so extensive that bacteria-driven autolysis has erased most of the brain structure, meaningful restoration is not likely to be possible. Do all sub-optimal cryopreservation technologies that fall short of true suspended animation produce this kind of damage? Not likely! For example, let's assume that modern vitrification solutions produce some degree of protein denaturation and membrane damage that compromise viability. Is it plausible to argue that this completely renders the idea of repair impossible? Does ice formation produce alterations in the brain that do not allow future "reconstructive connectomics" techniques to infer the non-frozen state from the frozen state? Sweeping claims about "freezing damage" are not acceptable substitutes for detailed structural arguments, especially given the fact that damage incurred during the cryopreservation process is also locked into place by those same low temperatures.

One might object that the idea of cell repair is itself implausible, i.e. that the laws of physics do not permit the idea of healing at the molecular level. The problem with this argument is that human biology already features molecular assembly and DNA repair. Whether one subscribes to the idea of mechanical molecular nanotechnology, modification of viruses or white blood cells, or further miniaturization of 3D printing, it is reasonable to assume that some kind of nanomedicine will be developed in the future.

I once called the idea that human suspended animation is a necessary condition for cryonics to be taken seriously the "Prehoda fallacy." (Robert Prehoda in the 1960s was an early champion of this position.) It does not serve advocates of cryonics well to discuss the feasibility of cryonics without discussing the plausibility of molecular medicine. If a critic of cryonics claims that cryonics is not technically feasible, insist upon a detailed exposition why the forms of damage associated with today's technologies cannot be repaired by future medical technologies. ■

CEO Update

By Max More

NEW PATIENT

On Tuesday March 15, we concluded a case (our 145th patient). This was a 97-year old member. She was pronounced late in the afternoon. Despite some concerns about the facility in which she was located, we received cooperation and things seem to have gone well. Total time from pronouncement to beginning of cryogenic cool down: six hours. Steve Graber ran the perfusion with Hugh being required to merely observe. Steve passed the test with flying colors. Shortly after that, on March 25, we received our 146th patient (and third for the year) from New Mexico.

KIT PROGRESS

Six kits are being assembled, with one being used as the template and backup to keep in-house. These kits are essentially finished, including a new, more efficient organization and list of contents for each Pelican case. We are sending one of these kits, as I write this, to England for a possible last-minute case, and to replenish our supplies with Cryonics-UK.

We already have a kit in Canada in the Toronto area. Currently, we are discussing providing another kit, along with organizing a training session, for Canadians in the Vancouver area. If you are in the area, interested, but not yet in the loop, please contact me so I can put you in touch with the organizers located north of the border. In contacting me, it would be helpful if you could answer these questions:

Q: Are you seriously interested in attending a training session to familiarize yourself and your cryo-comrades with the current composition and use of Alcor's international kit (including field cryoprotection kit)?

Q: How much is your answer dependent on the location of the training? (Portland; Seattle; Vancouver; Toronto; Scottsdale.)

Q: What are your constraints in relation to scheduling a training session. (Which should not need to take more than one day.)

Q: What previous training have you received?

Q: Do you have any relevant medical/emergency care qualifications independent of Alcor (or other cryonics) training?

CASE REPORTS

New finalized case reports were published over the last month. Many more are in various stages of completion. Apart from assisting with this process, I created and updated a Case Report Checklist. Christine Gaspar turned this into a tabular format and we are now using it for each new case report to ensure consistency and quality.

Added April 8, 2016:

Alcor Case Report: Ronald Selkovitch, A-1497

Added March 2, 2016:

Alcor Case Report A-2813

Alcor Case Report A-2758

AARON DRAKE: NOW "SENIOR MEDICAL RESPONSE CONSULTANT"

After being on staff full-time with Alcor for over seven years (starting in late January 2009), Aaron Drake is undergoing a change of status. Imagine being on-call 24 hours per day, 365 days per year, for seven years and two months. That's 62,736 hours of responsibility (not counting leap years). Aaron's change of employment status will allow him to recharge while still remaining available to consult on urgent situations.

~/~ CORRECTION TO SUOZZI REPORT ~/~
CT SCAN REVEALS PERFUSION MUCH BETTER THAN INITIALLY THOUGHT

Alcor has been doing CT scans of some patients for the last few years. When we started the project, we did not know how to properly calibrate the output of the scans. This, along with a mistaken assumption, led to a most unfortunately pessimistic assessment of the degree of cryoprotection of Kim Suozzi, the 23-year victim of brain cancer. Now that Alcor has more experience with CT scan data and has created correct calibration standards, we have re-analyzed that report. It turns out that cryoprotection was ***vastly better*** than originally reported.

Details here: http://www.alcor.org/Library/html/CorrigendumA2643.html

Corrigendum (correction) for Case A-2643

The case report published in the March 2014 issue of Cryonics magazine for case A-2643 contains the following two paragraphs. The underlined text is now known to be incorrect and is explained below.

> While surgery and perfusion were accomplished without incident, the actual success of perfusion in this case appears negligible. A lack of brain dehydration, as seen in all patients under non-ideal circumstances of death and/or stabilization and transport, suggests that perfusion was significantly impaired. Further evidence from CT scans corroborates this assumption, revealing what is assumed to be significant perfusion impairment, minimal dehydration, and areas of significant pathology.

and

> Further evidence of poor perfusion can be observed when viewing images of Kim's brain serially using various CLUTs (color scales) to differentiate areas of presumed impairment vs. cryoprotected areas. When viewed serially there appear to be some areas of cortical cryoprotection, though minimal. The entire subcortex appears impaired.

The incorrect conclusion of "negligible" or "minimal" cryoprotection was based upon uncalibrated post-cryopreservation CT scan data, and belief that lack of brain dehydration during cryoprotectant perfusion necessarily implied poor perfusion. Calibration of the CT scan data to a quantitative scale in October, 2015, revealed that although cryoprotection was non-uniform as originally observed, the non-uniformity mostly spanned a range between 50% and 100% of target cryoprotectant concentration. Areas of cortical cryoprotection that had been characterized as "minimal" actually contained near or above 100% target concentration necessary for vitrification.

The concentration-calibrated CT scan of the entire brain of A-2643 is shown below in movie form. Approximately half the brain volume outside the tumor and fluid-filled ventricles appears to have achieved a cryoprotectant concentration near or above that required for vitrification (light purple or orange). The remainder of the brain experienced various degrees of cryoprotected freezing. Only very small volumes appear to have received negligible cryoprotection (pale blue), such as necrotic portions of tumor and vitreous humor of the eyes.

For comparison, the CT scan A-1088 shows the CT density of a brain frozen without cryoprotectant due to circumstances of the case. The grey appearance of the brain is completely different from A-2643. Much of the brain of A-2643 more closely resembles the CT density visible in the scan of A-1002, a case in which the dehydrated brain is believed to have vitrified completely.

It's also notable that there are no inflections in the cryogenic cooling curve (shown below the CT scan on this page) of A-2643. This implies that tissue in contact with the two temperature probes vitrified. (Significant freezing would cause delay and inflection in the cooling curve due to release of latent heat as water froze.)

A high level of cryoprotection without accompanying cerebral dehydration is a surprising finding of this case. This had never been seen before, which led to the initial incorrect interpretation of poor cryoprotection. The absence of dehydration in this case is now presumed due to opening of the blood brain barrier caused by the one hour of warm ischemia that preceded cryoprotectant perfusion. While tumors can also compromise the blood brain barrier, absence of dehydration was not seen in case A-1097, in which a brain tumor was also present, but no significant interval of warm ischemia occurred.

His many years of experience will be invaluable in maintaining Alcor's high standards of patient care.

As Alcor members should know, cases outside of Arizona but within the USA have primarily been handled by Suspended Animation (SA). During the transitional period, we are pleased to be able to tell you that SA has agreed to cover any Arizona-based cases (augmented by Alcor staff or potential team members). At the same time, we have been working toward bringing in a highly-skilled individual in the Scottsdale/Phoenix area to take over Aaron's core duties. In addition, we are building up our local capabilities by bringing in additional trained individuals (with credentials as paramedics or nurses) so that we have more personnel than ever available for Arizona-based (and international) standbys, stabilization, and transport.

We thank Aaron for his years of service. As of now, Aaron's title is "Senior Medical Response Consultant."

We are currently interviewing candidates to take over or to supplement Aaron's core duties. If you are interested in applying – or know someone who might be – see the job description on the website under the Contact Us drop down, or go directly to: http://alcor.org/jobs.html

DVD AND DOWNLOADABLE VIDEOS OF THE 2015 ALCOR CONFERENCE

Weren't able to attend the Alcor Cryonics Conference in October of last year? Wish you could watch some of the presentations again? We have great news! We are happy to announce that the 2015 Alcor Cryonics Conference is now available for purchase (and viewing) on our new Alcor pay per view purchase portal! We have put together the best and brightest presenters and talks from the 2015 Alcor Conference and now offer you 13 HD (High Definition) videos for your viewing pleasure!

You will enjoy almost 5.5 hours of the best talks from the 2015 Alcor Cryonics Conference that can now be purchased for a reduced price and watched on the portal for the next several months. Additionally, we have also created a great new DVD of the 2015 Alcor conference and you have the option to order that as well and own and enjoy the 13 HD videos forever!

Pricing, speaker lists, and ordering can all be found at www.alcorconference.com/videos. If you didn't get a chance to join us in Scottsdale in October for the 2015 Alcor Conference—***now is your chance to see what all the buzz was about!***

WHY CRYONICS MAKES SENSE

Happily, over the last few years, we have seen a growing number of respectful, informative, and even supportive news stories and documentaries on Alcor and cryonics. One piece that came out in March stands out. This was a 14,600+ word blog entry by Tim Urban. His Wait But Why blog has over 358,000 subscribers. (You may have previously come across his famous pieces on Elon Musk or Procrastination.) That alone would not have necessarily made much of an impact. But Tim wrote with such eloquence, wit, depth of research, and lucidity that many of his readers could not escape the iron logic. Tim says that "A year ago, I knew almost nothing about cryonics, and my impressions of it were something like this sentence" then proceeds to summarize the way too many people view cryonics. He then goes on to deconstruct that sentence, drawing the reader along to the inevitable conclusion:

"I hope you'll do it the same way I'd hope you'd take a shot with an experimental drug if you were sick and it were the one chance you had. Because it's worth a try. Because it just might work. Because why the fuck not."

Many of us who have read "Why Cryonics Make Sense" have felt compelled to describe it as "possibly the single best piece ever written on cryonics". Warning: It is long and, once you start reading it, you will find it hard to stop. Please use it to persuade your non-cryonicist friends and relatives! The blog post has already generated a surge in visits to Alcor.org and in people engaging Marji in online chat, and in serious requests for membership information packets. You can find it here:

http://waitbutwhy.com/2016/03/cryonics.html

DEWAR DELIVERY

Last time we ordered new Bigfoot dewars, they arrived with no warning. This was quite inconvenient since we have to go out and rent forklift trucks and plan the unloading of these large, heavy, valuable items. Last time, we had to send the truck away, to come back a few days later. Despite our repeated insistence on being given tracking information, our two newest Bigfoot dewars arrived unexpectedly on the evening of Easter Sunday (March 27).

Fortunately, the truck driver (an independent with no tracking capabilities who apparently stepped in for a mess-up by the major trucking company originally to be used) was content to sleep in his truck overnight. On Monday morning, Steve Graber and Hugh Hixon rented two forklifts, and I joined them in unloading and securing them inside the building.

Although the lack of notice (the fabricator later said the truck was supposed

to show up on Tuesday) was inconvenient, I'm not complaining. Anything that gets me away from my desk and atop a tall ladder or driving a forklift is a welcome change.

PUBLIC EDUCATION

As I write this update, we are sending out the third of the renewed *Alcor News*. This will allow us to send out news items on a more timely basis, now that *Cryonics* magazine is bi-monthly. This will not be on a set schedule, but I expect to send out an issue at least once per month.

The emailed newsletter will carry more details on public education and media coverage (with links), while here I will note just a short selection.

On March 29, I conducted a tour for ASU's Death and Dying class. The students were attentive throughout the 2.5 hours and asked many questions. The post-tour response was very positive, with several people taking the trouble to write in their thanks, including an RN and future paramedic interested in working with us.

We were filmed by CNBC on April 15, 2016. A film crew from *National Geographic* led to a March 30 web clip ("Cryopreservation Explained") that you might still find here: http://channel.nationalgeographic.com/explorer/videos/cryopreservation-explained/ The full show (with the unfortunate title, "Explorer: Faces of Death") was broadcast on Sunday, April 3rd. Perhaps it will be shown again in future. The Alcor/cryonics segment was the last part and presented us quite objectively.

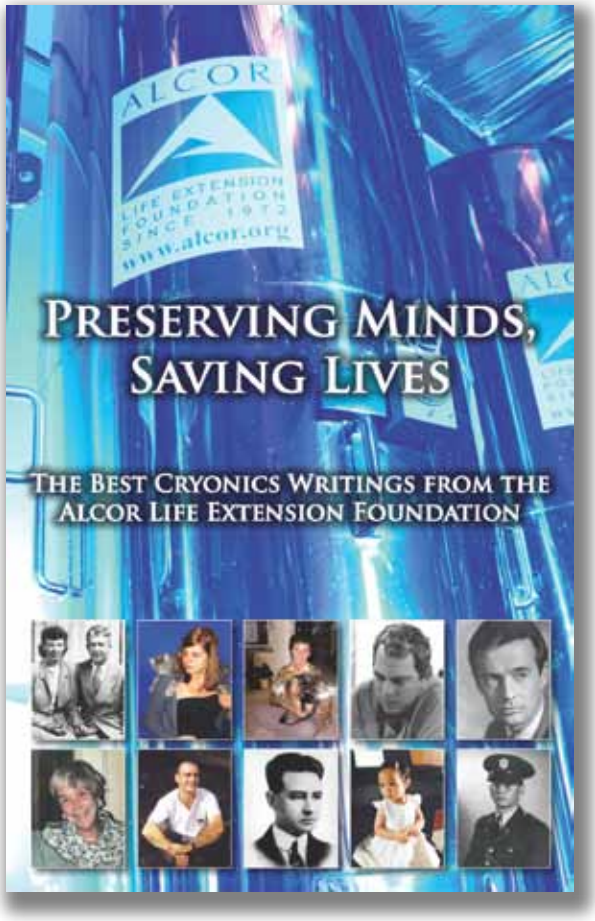
Other news and documentary filming included: Australia's Channel 7; an interview with *Vanity Fair* with some video for web clips; filming for a documentary by Ikuko Takano; and Channel 3, Phoenix (resulting in several print stories). I saw our section in the forthcoming documentary, *Mortal*, by Bobby Sheehan. I also did phone interviews for Talk Radio Europe

There was also a huge amount of press coverage resulting from the awarding of the Brain Preservation Foundation's prize for aldehyde-stabilized cryopreservation. Various versions of the story appeared in *The Huffington Post*, *Newsweek*, *New Scientist*, *Slashgear*, *Tech Times*, *Science Recorder*, *Digital Trends*, *The Daily Mail*, *Gizmodo*, and several Reddit forums, among others.

The good news is that all this generally-favorable coverage seems to be boosting the number of serious inquiries we get for more information or application forms. ■

Why You Want to Read Alcor's New Book

By Stephen Bridge, co-editor



So perhaps you're fairly new to Alcor and cryonics. You're pretty sure this technology might be worth investigating; maybe you've even gotten signed up. But there's a lot you don't know. When your friends and relatives ask you those awkward questions about WHY you're doing this and what makes you think it will work, you haven't figured out solid answers yet. Especially if you live in an area without many other people involved in cryonics, you may really need solid ideas. You may even wish you have a book you could hand some of them, something that might make all of these ideas clear.

We have that book – *Preserving Minds, Saving Lives: The Best Cryonics Writings from the Alcor Life Extension Foundation*. We have been working on those answers for more than 35 years, often in the pages of our magazine, *Cryonics*. This book takes many of those great answers and puts them together in one volume for you.

Why do we preserve patients in liquid nitrogen? How might that change in the future?

What is the difference between freezing and vitrification? Why is vitrification better?

How does cryonics connect with religious beliefs?

What kind of research has been done in the past and what is needed for the future?

Why do some people choose whole body preservation and some choose to only preserve their brains?

When will the cryopreserved patients be brought back to life? Wait – should we even call them "dead" or are they already "alive" in some way? And who will pay for it?

How did this odd idea get started in the first place? What has Alcor gone through to get to this point? What mistakes were made along the way and how do we know cryonicists have learned from those mistakes? Why the heck isn't cryonics wildly popular?

It's all here, along with many other discussions, by the best writers Alcor has had to offer for more than three decades. There are a handful of technical articles, because we want to make sure that the bases for this technology are readily available for future researchers. But most of the articles are accessible to anyone.

This is the book you need. We have both hardcover and paperback copies, and we're working on an e-book version. The book is printed on very high-quality paper and will last a long time. It ought to say something worth lasting as long as the paper.

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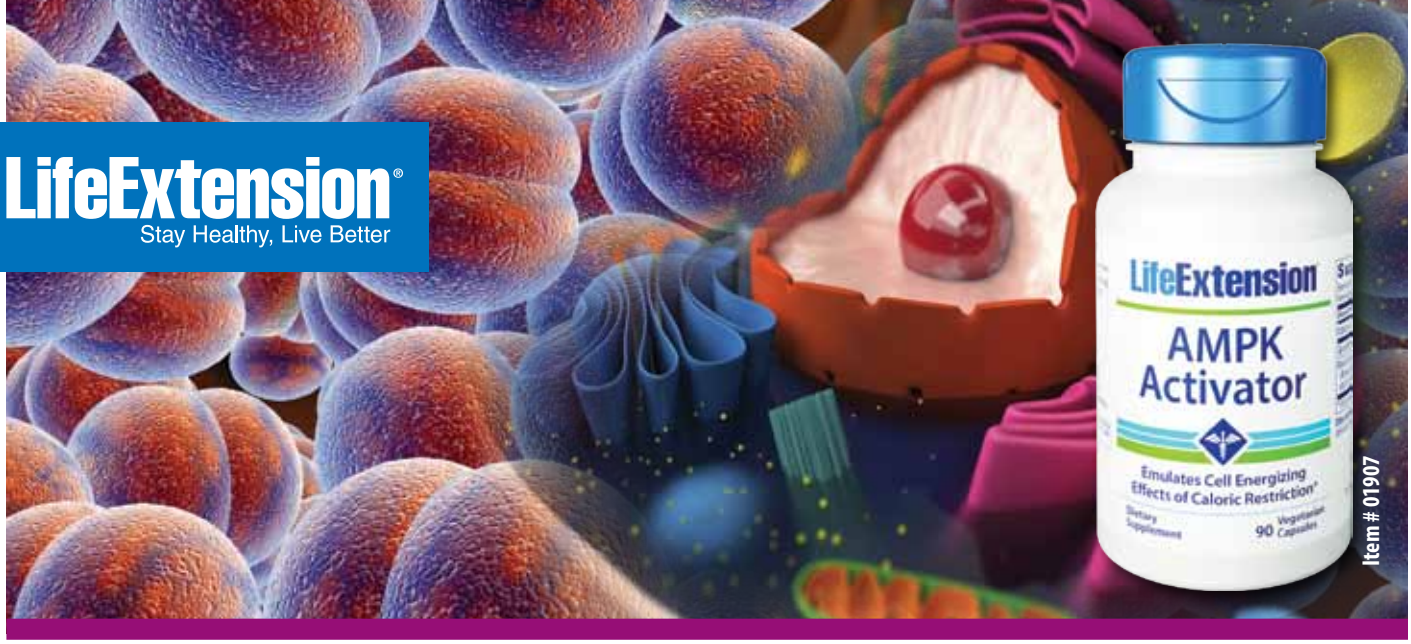

AMPK Activator

A New Paradigm in Controlling Aging

AMPK is an *enzyme* that serves as the body's "**master regulating switch**." It inhibits multiple degenerative factors by *revitalizing* aging cells.[1]

Found in every cell,[2,3] **AMPK** promotes ***longevity factors*** that have been shown to extend life span in numerous organisms.[1,4] Increasing AMPK signaling "turns off" many damaging effects of aging, thus enabling cells to return to their youthful vitality.[5]

Life Extension® scientists have compiled years of research to create **AMPK Activator**, a specialized *dual-extract formulation* that supports **AMPK** activation for health optimization. This natural formula supports AMPK enzymatic activities required to safely support a more youthful cellular environment.

Importance of AMPK

Greater **AMPK** (*adenosine monophosphate-activated protein kinase*) activation has been shown to help target damaging factors of aging.[5] Studies show **increased** AMPK activity supports reduced fat storage,[6] new mitochondria production,[7] and the promotion of healthy blood glucose and lipids already within normal range.[4]

Gynostemma Pentaphyllum

An extract of the plant *Gynostemma pentaphyllum* was traditionally used in Asian medicine to promote longevity and scientists now know why — *G. pentaphyllum* promotes **AMPK** activation![8-10] In one of many studies showing a wide variety of benefits, researchers documented a one-inch reduction in **abdominal circumference** in overweight individuals who took **450 mg** daily of *G. pentaphyllum* extract for 12 weeks.[11]

Trans-Tiliroside

Trans-tiliroside, extracted from plants such as **rose hips**, also boosts **AMPK** activation, but triggers different downstream metabolic benefits than *G. pentaphyllum*.[12-14] Among its many benefits, a low human equivalent dose of **56 mg** daily *trans*-tiliroside has been shown by researchers in preclinical studies to promote healthy blood glucose levels and body weight already within normal range.[15]

The suggested daily dosage of **AMPK Activator** is to take two capsules with the first meal of the day and one capsule with the second meal. Three vegetarian capsules provide:

ActivAMP™ *Gynostemma pentaphyllum* extract (leaf)	**450 mg**
Rose hip extract	**1,120 mg**
Standardized to ***trans*-tiliroside**	**56 mg**

Anti-Aging Discovery That Cannot Be Overlooked

Scientists uncovered the cell-energizing effect of **AMPK** in the 1970s. Since then, an exponential volume of data (over 7,500 published studies) has documented the critical role that activated **AMPK** plays in maintaining life-sustaining cellular functions.

Those seeking to meaningfully extend their healthy life span should ensure they optimally activate their cellular **AMPK**. The reason this is so important is that in response to aging, excess calorie consumption, and/or low levels of physical activity, AMPK activity markedly declines.

A targeted way of **reversing** cellular depletion of this critical enzyme is to take the new **AMPK Activator** formula that comprises a dual-extract, plant-based formulation.

A bottle of 90 vegetarian capsules of **AMPK Activator** retails for $48. If you purchase four bottles, the price is reduced to **$33** per bottle.

ActivAMP™ is a trademark of Gencor.

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Dying Does Not Really Affect Overpopulation

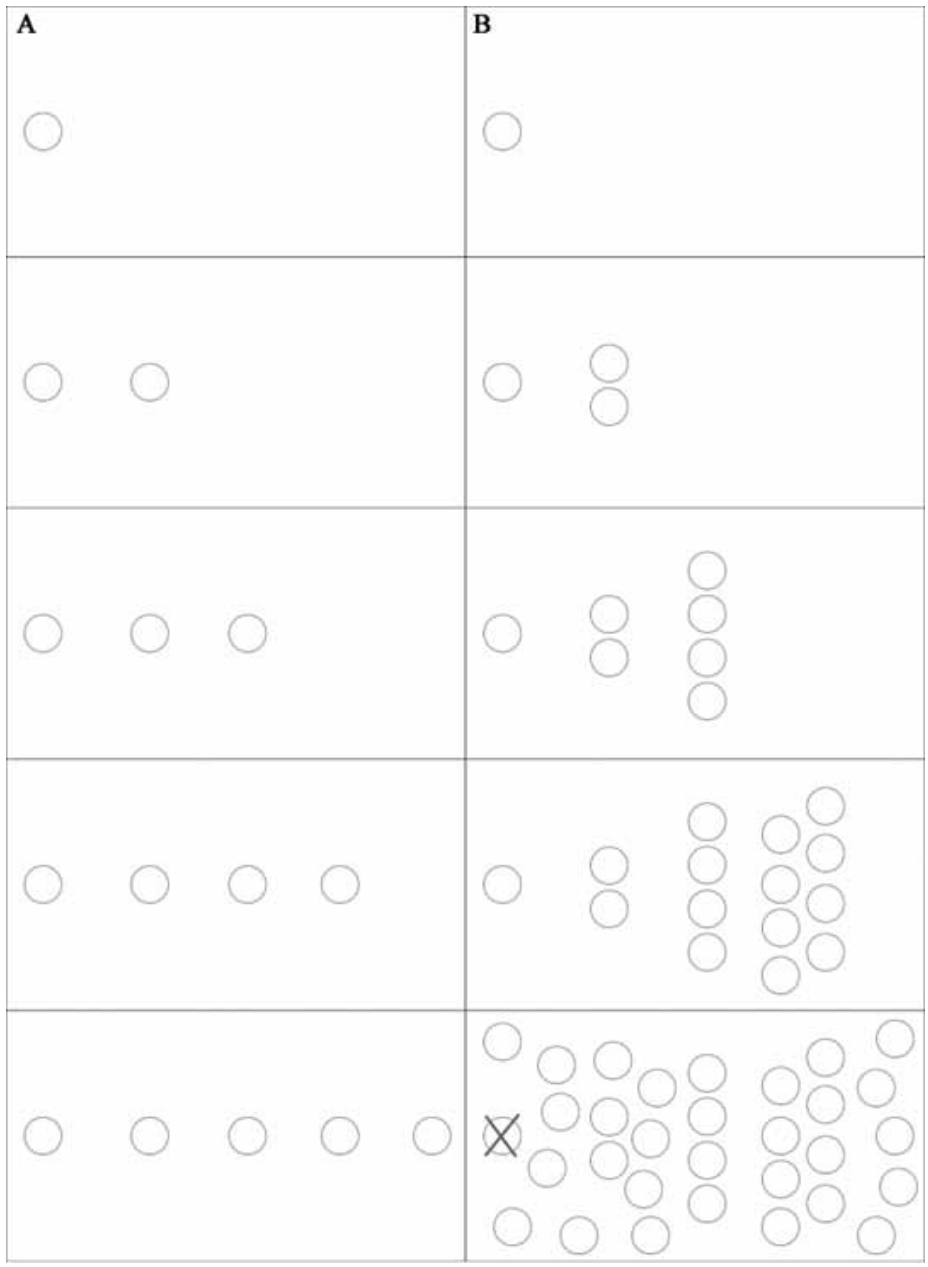
By Martin Borch Jensen

When the subject of curing aging is brought up, someone usually responds along the lines of "what about overpopulation?." It's hard to define what constitutes overpopulation, since it depends not just on the number of people but also on our fluctuating ability to convert the sun's energy into stuff we want, and our consumption of said stuff. But let's assume that with our current consumption, rate of technological progress, population and its growth rate, limits to the Earth's sustainable output either have already been reached or will be in say the next 100 years.

If this assumption is wrong then the original question is irrelevant anyway. But if it's right, then it seems intuitively obvious that eliminating the majority of deaths would greatly exacerbate the problem. Obvious, but only because our intuition is next to useless in dealing with anything exponential (i.e. where some amount is multiplied by a constant value for every unit of time). Let's take a look at two examples of population growth. We'll simplify by rounding some numbers, and looking only at the number of women while assuming an equal number of mates. In A, every woman has one daughter after a certain period of time (say 20 years), and the daughters reproduce after the same period. Nobody dies. B is closer to our current situation: each woman has two daughters after 20 years, and when her great-grandchildren are born (60 years later) she dies.

Quite obviously, B results in a vastly greater population because the birth rate is an exponential increase (in this case doubling), while the deaths are a linear product of the current population. And that's the essence of what I'm trying to describe here: *linear effects are usually negligible in comparison with exponential effects.*

So how important is the mortality rate in comparison with birth rate? In the graph below I plot three curves based on similar simplified math[1]. In each case I start with a population of 1000 women, and project 500 years into the future. The red line is our current situation (it's not quite smooth because we're rounding everything to steps of 20 years, and nobody dies for the

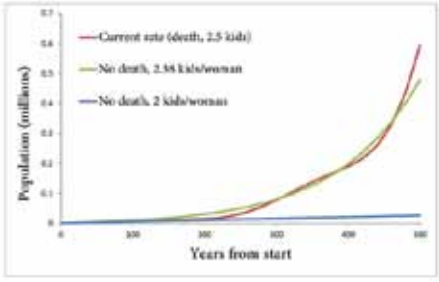


1 Nerd-level population projections are available at http://www.martinborchjensen.com/hypotheses/overpopulation/.

first 80 years): at 20 each woman has the current global average of 2.5 kids, and at 80 she dies. The green line represents the complete absence of death but with the birth rate reduced to 2.38, which results in roughly the same population growth. The blue line is the "extreme" scenario of nobody dying, but each woman having only two kids in her lifetime[2].

What does this mean? That the effect on population of eliminating ALL deaths (not just aging) can be abolished by one woman out of every eight having one or two kids instead of two or three. And if everyone stuck with two kids there would be 20-fold fewer people at the end of the period. So the answer to our question is that *mortality rate is not at all important relative to birth rate.*

Thus far everything is simple math (with a few unassailable assumptions), and the conclusion is not a matter of opinion. It is of course hypothetical that population



could feasibly be controlled by a reduction of births, but it seems quite likely[3]. In fact, I think it's reasonable to assume that any country that had the capacity to eliminate aging and disease would have very low birth rates. As mentioned, the global average birth rate is 2.5. The EU average is 1.6, the US 2. Japan, Hong Kong, Taiwan and South Korea are all below 1.4. The majority of African countries lie between 4 and 7, which brings up the average. Empirically, birth rates have a very strong negative correlation with child longevity and overall level of education. An example of this effect can be seen in South Korea, which in 1970 had a birth rate of 4.53. Concurrent with its explosive economic growth, this rate dropped to its present value of 1.2.

It thus seems reasonable to assume that any society advanced enough to eliminate aging and disease would already have low birth rates, quite possibly well below 2 children per woman (the blue line above)[4]. Other societal changes, both planned and unplanned, are likely to affect the population dynamics of a society where death is voluntary. One possibility is that when we gain the right to live indefinitely, we lose the right to reproduce without limits. A simple version would be a default of one child per family, à la present-day China. Another version might be that you can live as long as you want, but when you have children you start your own aging process and expire in say 100 years. This latter idea sounds kind of crazy, until you consider that it's the situation we have now (plus an option to delay the process). But as we saw earlier, this solution would have greater effect psychologically than on the actual population unless the number of children is also limited. On the other hand, we might see unexpectedly strong effects from simple psychological adaptations to indefinite lifespan. In the absence of an expiration date there would be less reason to have children in your twenties. Everyone, but women especially, would have the choice to postpone parenthood in order to establish a career, travel the world or simply feel fully prepared. A big deal for the individual, certainly, but for the population? Well, if we delay the green line's age of childbirth from 20 to 40 in the graph above, its final value becomes ~8.4% of the red scenario…

I won't pretend that I can predict exactly how societal changes will influence population dynamics. Any number of possible (and seemingly impossible) scenarios might play out, with or without aging and disease. But the one scenario that we *don't* have to worry about is that eliminating aging will lead to "everything the same, but with more people around." Dying, it turns out, is not a viable solution to overpopulation. On the bright side this means that you shouldn't feel compelled to die for the sake of the environment, although it also means that any viable solution will require you to think about how you live. ■

ABOUT THE AUTHOR

Martin Borch Jensen's interest in human aging spans back to his teens, and since then he has tried to place himself at the frontier of research on the topic. He received his bachelor's and master's degrees in nanotechnology from the University of Copenhagen, and then spent three years traveling between the Center for Healthy Aging in Copenhagen and the National Institute on Aging in Baltimore to get his Ph.D. Since September 2013 he has been doing postdoctoral research at the Buck Institute for Research on Aging near San Francisco. His research topics have included accelerated aging disorders, DNA damage/repair, and mitochondrial signals that modulate the aging process.

2 At this point the math is officially oversimplified. The example is true if every woman has 2.38 kids, but it doesn't work if that's the average value of some distribution and kids have the same birth rates as their parents: because the growth is exponential, going above the average has a greater effect than going below. But that just means that the real value is even closer to 2.5, so the point stands.

3 For example, while China's policy of one child per family certainly hasn't worked perfectly it does seem to have had a significant effect. China's birth rate is around 1.6, down from ~6 in 1950. By comparison, India's is 2.5 (also down from ~6). As a result, although China's population was ~50% in 1950, the UN estimates that India will be the most populous country by 2028.

4 In addition to the fact that delaying aging would make for a population that is effectively younger, in terms of dependents vs. contributors.

EV COOPER AND THE CONFERENCE THAT DIDN'T HAPPEN: TRIALS OF AN EARLY FREEZING

By R. Michael Perry

Note concerning quoted material in this article. Lengthier, quoted passages including letters and short essays are in `courier font`. These may be lightly edited for clarity, using ellipses … for omissions and square brackets [ ] for editorial revision. Minor spelling, typographical and punctuation errors are silently corrected. —R.M.P.

INTRODUCTION

Though Robert Ettinger is rightly credited as the principal driving force in starting cryonics, others too were crucial in the early days, and none more than Evan Cooper. Ettinger's much-respected, oft-cited 1964 volume, *The Prospect of Immortality*, offers compelling arguments, both technical and philosophical. For those who follow its logic and its appeal, clearly there *ought* to be a practice of storing people at clinical death at cryogenic temperatures for a hopeful restoration to healthy consciousness someday, when technology is capable. To produce such a study as *Prospect* was an accomplishment hard to overrate. Without this underpinning cryonics might well not have survived the challenges and disappointments it was soon subjected to and which have, to an extent, continued down to the present day. But more than this was needed to get a practice going, and Cooper supplied crucial ingredients, establishing and knitting together, through his organization, newsletter, and conferences, a community of like-minded individuals who could work for the overriding purpose of trying to save lives by this novel method.

In all Cooper's organization, the Life Extension Society (LES), based in Washington, D.C., would host five conferences. The first was in late December 1963 (starting before the organization really existed). The second and third occurred in early January, 1965 and 1966 respectively; a fourth conference was held in October 1966, and a final conference in June 1968. LES, which itself had originated during the first conference, had blossomed at first and served as a rallying point and information exchange for the early "freeze and wait" enthusiasts (soon elaborated to "freeze-wait-reanimate," which was adopted as the title of the newsletter with the January 1965 issue). In addition to the expected news items the newsletter contained extensive comments and other contributions from readers, including artwork, poetry and humor. By its last conference, though, LES was in decline, a major frustration being the inability, despite Cooper's considerable efforts, to complete a laboratory for cryobiological experiments and facilities for patient storage. Within two more years Cooper had effectively dropped his involvement, never to return. (Indulging another passion, sailing, he was lost at sea in 1982.) In fact the fifth conference was originally scheduled for October 1967, a year after the fourth conference, and was well-advertised in the LES newsletter, but then was called off on very short notice, to be rescheduled some months later. Cooper himself, who was both president of LES and editor of the newsletter, gave reasons, but leaving some important details unsaid, particularly in regard to a "very nasty letter" he received. Fortunately enough old correspondence survives that this interesting story can now be told more fully. Along with it is much drama concerning an early freezing.[1]

Cooper household, 1969. From left: Charles Collet, a young visitor from France; Mildred Cooper; her husband, Ev. Source: Alcor Archives, Mike Darwin Correspondence; also appeared in MP1 (see Sources).

CRYONICS IN 1967 AND THE FREEZING OF MARIE PHELPS-SWEET

1967 had been a banner year for cryonics. Before that, it had been very difficult to get even one person frozen, despite Ettinger's book and the publicity it generated. There were disappointing near-misses, two cases

in 1965 that might have succeeded but were given up.[2] LES even advertised in its newsletter, after the first of these, to freeze someone for free—but there were no takers. (The offer, in fact, was never accepted and LES would never store any cryonics patients.)[3] Finally in April 1966 the embalmed body of a woman was frozen after several weeks of refrigerated storage by relatives who clearly had some hopes in a future resuscitation. A few months later, though, they gave up and the woman was thawed and buried. It was conceded, almost from the start, that much better than "this imperfect beginning" was needed to carry out the program that Ettinger and others had grandly envisioned.[4] An important further step soon did occur, with the freezing of James Bedford the following January. Though very crude by today's standards, the Bedford cryopreservation happened under controlled conditions. Cryoprotectant was introduced into the circulatory system by repeated injections and circulated, after a fashion, by automated chest compressions. The procedure was started immediately after clinical death without embalming or other protocols not connected with cryonics. The patient then was promptly frozen (and has remained so, now stored at Alcor).[5]

The Bedford freezing generated a wave of publicity and interest, and even before this there were tentative plans for an LES conference the following October. Would it be in Washington, D.C., like all the others up to that point, or Montreal, where the World's Fair would be held?[6] The issue was resolved as reported in the May 1967 newsletter:[7]

ANNUAL FREEZE-WAIT-REANIMATE CONFERENCE TO BE HELD IN WASHINGTON OCT 28TH

In a previous newsletter requests were made for votes and preferences whether to hold our annual meeting in Montreal or in Washington. Mrs Rynex who gathered most of the votes informs us that by far the greater number of LES members intending to come prefer Washington DC. The preference is apparently based on the practical reasons of less distance and less expense for most of the members.

The October date merely imitates last year's date which was found to be relatively convenient. The main conference, similar to the previous year, will be on Saturday (the 28th) with papers, luncheon, talks, and discussion. Maybe another Chinese banquet as instigated by Gerald Feinberg last year? Sunday will be held open for further visits and discussion if desired. If LES does not have a lab and cryogenic facilities available or in operation by then, a firing squad may be observed in operation early at sunbreak that Sunday morning.

All will be welcome. Do come if you possibly can. But as usual, don't come if it would be dangerous to your health or ruinous to your finances. Last year some members attempted to locate rides with other members from their area at the last moment and found it difficult or impossible to make connections. Arrange for rides well ahead of time.

Even more important, get started reading, thinking, and writing now if we can encourage you to present a paper at the conference. There are a few geniuses who are really expert and can come up with something excellent even at the last moment. But for most of us the better plan is to begin our thinking, writing, or experiments now. The advice expressed in one journal was to write up your paper when you thought you had something worth saying. Then let it sit for two weeks and go back and see if it made sense or if it could be improved. Notify us of what you plan to present. And don't be afraid to present something if you think it conceivably could be a contribution. Send us an abstract, or a summary, or a copy of your paper. This will help with the program.

As usual we do not expect a large conference. However, each nation will be notified as well as as many institutions and individuals as possible. Each year we should see increased interest as the freezing movement tends toward greater practical applications.

A few more months and it would be conference time again. Before that, in August, there was another freezing, technically better than Bedford's if still primitive, with active replacement of body fluids with cryoprotectant rather than just injections. The technical improvements were counterbalanced by a lengthy delay before the procedure could be started, however, and did not attract much notice. Yet there were important other ways this case differed from Bedford's that did have public consequences. For one, the 74-year-old patient, Marie Phelps-Sweet of Santa Barbara, California, had been well-known and respected in LES before her sudden arrest. And there was another difference, one that would have deep consequences: unlike Bedford, she had very little funds and had to depend on others, who in turn would also have limited resources.[8]

Marie was married several times in the course of an interesting life but preferred her parents' surnames and liked to be known as Miss Sweet. (Her last marriage, to Russ Le Croix Van Norden in Jul. 1960, was by accounts nonetheless a happy one.) She was involved in numerous causes, mainly dealing with human rights and opposition to war and violence. Another interest was life and health extension, which finally focused her attention on the nascent cryonics movement. Her enthusiasm for this new cause is shown in a letter to Robert Ettinger dated June 26, 1964, three weeks after publication of *The Prospect of Immortality*: "Zestful living has been a long-time hobby of mine, so zestful departure from this vale, via freezeration, is a welcome release from the degrading and wasteful concepts of the past … What bothers me now is how any thoughtful people can fail to realize the scope of the program … more immediate and necessary,

it seems, than the new vistas of interstellar space investigation …" Brave words were soon accompanied by noted deeds. Cooper reported in the December 1964 newsletter: "We are fortunate in having the marvelous support and inestimable services of Marie Phelps-Sweet, our Western Coordinator in Santa Barbara. She is the spark-plug of LES. We are indebted to Marie Sweet and Bill Albaugh for the funds which have been used for such things as stationery and cryogenic equipment for hamster experiments."

Marie Phelps-Sweet, photo courtesy of Robert Nelson.

Russ Van Norden, from GL (see Sources).

Marie started her organizational involvement in cryonics (before the term was in use) with LES but eventually became involved with the Cryonics Society of California (CSC), started in December 1966 and headed by Robert Nelson. It was this organization that had frozen Bedford just a few weeks after its inception. In 1967 Marie continued her heavy schedule of activities, supported by her husband. Russ was an artist in wrought iron, stained glass and other media; Marie had been an interior decorator consultant before moving to California. Though Marie had by far the strongest cryonics interest, Russ agreed to be frozen also, if the time came. And it looked like it might, when he suffered a heart attack in April 1967 and was admitted to St. Francis Hospital in Santa Barbara. Nelson and a mortuary student, Jeff Hicks, contacted the hospital, the City Board of Health, and the nearby Raider Mortuary, receiving assurances of cooperation if Mr. Van Norden didn't recover and a freezing were attempted. Arrangements were made with Forrest Walters of Continuelife Corporation in Latrobe, Pa. to fly out a Westinghouse Iron Heart for chest compressions, as had been used in the Bedford freezing. (Ettinger had sent an Iron Heart for this initial cryonics freezing.) Nelson reported:[9]

Fortunately, Mr. Van Norden recovered. We all learned some valuable lessons from the experience. While I don't know whether our success in gaining the cooperation of the hospital and the mortuary can be attributed to the Bedford freezing or just a growing acceptance of the freezing concept, I am convinced that if such institutions are approached intelligently and positively, there should not be any difficulty in gaining the needed cooperation. Despite past experiences, familiar to everyone involved in the program, there was never a question of either the hospital or mortuary backing out; in fact, the hospital made several broad hints which led us to believe that they would allow the perfusion to take place right there, eliminating the need for other facilities altogether.

Instead, a few months later the end came for Marie, under less favorable circumstances. Marie was found dead in a hotel room August 27. According to an article in the Santa Barbara *News-Press*, September 1, 1967, the undertaking firm of Gates, Langley and Gates was ordered by the Coroner's office to remove the body. They sent out a mortician, who discovered in Marie's personal effects documents naming LES and CSC. But there was bafflement and difficulty over just who should be contacted and how. Three days passed, with Marie stored in a mortuary refrigerator, before a CSC team could be assembled to do the freezing. (The day before that, Cooper of LES had been called by a company official—collect—and, thinking it might be a prank, refused the call when the caller would not pay—see below.) Cooper himself reports in the September *Freeze-Wait-Reanimate*:[10]

MARIE PHELPS-SWEET, PIONEER ACTIVIST FOR JUSTICE AND PROGRESS, DIES AND IS FROZEN IN CALIFORNIA.

Marie once said she always wished to be on the crest of the wave of the future. She was adventurous and progressive to the heart: one in ten million. Direct action for Marie was as inevitable as the rising of the sun.

During the night of August 26-27, Marie Phelps-Sweet (Mrs. Russ Le Croix Van Norden), died in her sleep alone in a Santa Monica hotel room. Reports vary why she stopped in Santa Monica instead of going to their lovely home in Santa Barbara. Perhaps she wished to rest from a long hot drive from where her husband was working in Salina, or perhaps she wished to be convenient to her next project.

A book should be written on all that Marie sparked, engaged in, and carried through. In the 1920's she fought on the side of Margaret Sanger for the

rights of women and birth control. In the 1930's she threw herself into the idealistic but hopeless fight against Bilbo, the racist Senator from Mississippi. In the forties she ran for office in Westchester County, New York on a democratic platform including greater rights for minority groups. In the 1960's she became active for LES (our first LES coordinator in California) and though a Democrat, she fought tooth and nail against U.S. intervention in Viet-Nam…

With all of her marching, organizing, speaking, teaching, learning, protesting, advising, letter-writing, petitioning, telegraphing, visiting, ad infinitum, she apparently had little thought, except in a minor way, of providing funds or insurance for freezing and storage. Being fearless and an eternal optimist she tended to neglect her own future. It may also be that she wished the proper insurance but could not stand the cost of a policy for a septuagenarian. However, she did declare most strongly her wish to be frozen and carried an LES card stating that desire. She was a staunch advocate of an information file for each member desiring to be frozen and supplied LES with exact instructions on how she wished to be restored in the future.

A long time had elapsed, several days we noted, while Marie waited in a refrigerator before she could be perfused with cryoprotectant and frozen. "But," as Cooper says, "at least she was frozen and remains so. This is the best that can be expected considering the delay before anyone was informed who was willing to perfuse and freeze her. Thanks go to Robert Nelson, Dante Brunol, M.D., Jeff Hicks and perhaps others for their usual nerve and willingness to perform the perfusion and freezing. Bob Ettinger spent hours on the phone as well as Russ Stanley and Bob Johnson, all helping to notify and facilitate the operation." (Additional drama not reported was that no mortuary facilities were available and the freezing had to be done in the offices of CSC, thus it appears it was technically illegal.[11]) Cooper notes the varied newspaper and other reports as to where Marie was being stored, one persistent, erroneous rumor attesting to her shipment on dry ice to Cryo-Care Equipment Corporation in Phoenix, Arizona, where Bedford had been sent. (She was actually taken privately to the Renaker-Klockgether mortuary in Buena Park, operated by Joseph Klockgether, and stored there on dry ice.) Moreover, "we have to assume there is no insurance fund available for Marie's care in spite of newspaper reports to the contrary." LES under Cooper's authority sent $100 to Russ Stanley, who himself "had advanced about $75 of his money for dry ice and sundry expenses"; others had also contributed small amounts, including an adopted son who gave $200. It was clear that much more would be needed, several thousand dollars for a cryogenic capsule, as a start, and more for indefinite cryogenic maintenance.

Russ Van Norden in an unaddressed, unpublished note, issued the most touching tribute and appeal:[12]

As I sorrowfully sort thru packet after packet of the miscellaneous papers of Marie Phelps Sweet, organizational identification cards in amazing number come to light, an indication of her membership in almost any humanitarian group that may come to mind. I am humbled that I have done so little.

Tears dim my eyes and anguish wrenches my heart as I recall with crystal clarity the many ([if] still comparative[ly] few) crusades for the peaceful [interactions of] mankind, in which so kind a fate permitted me participation with so wonderful a person…

If she has touched the fabric of your cause then it may be you have felt her contribution to its eventual realization. Now her helpless necessity asks your kind aid in her temporarily arrested life.

Perhaps [an] appeal to help her now when she is powerless to help herself is an unkind necessity[. Yet] it is so vividly remembered that hers was not just the extension of a heartfelt sympathy but action individually or thru some group for [a] practical procedure…

I touched her hair and kissed her now cold lips in a farewell for what may well be only a few short years… If you would dare believe that it could be, the need is now for funds for cryogenic care… for the long wait of months or years ahead. Hers was an ideal passing and traditional fears only hover at the outer edge of my consciousness. For I believe and some of you in steadfast eagerness believe that she will come back to us.

Perhaps there is a special significance in the "INFINITES" membership card [of one of her many affiliations]. It reads: Marie Phelps Sweet is and ALWAYS has been a charter member of the infinites.

Both popular and needy, Marie posed a problem that already had a major consequence for LES, reported in the same issue. William A. Albaugh was another longtime cryonics enthusiast and LES contributor who lived much closer to headquarters, in Mt. Rainier, Maryland, about five miles from Washington, D.C. Aside from his involvement with Cooper's organization, he had a quixotic political career, pressing unsuccessfully for reannexation of the capital city's territory by the state of Maryland, which had ceded the land, improperly he believed, to the U.S. back in 1788.[13] In LES he served as treasurer for several years, but now, suddenly, he resigned (though still

remaining with the organization). Cooper suggested that the death of Marie and the pressures it brought "are probably responsible, at least in part." Albaugh was specifically concerned "that LES does not have sufficient income to meet all possible rising expenses in the future."[14] Was he thinking about obligations LES might be seen as having incurred in connection with the freezing?

In 1965 LES had made an offer, extending over several issues of the newsletter, to freeze persons for free,

William A. Albaugh, 1976 or earlier, from AMK (see Sources).

something Ettinger would now be quick to bring to the attention of Albaugh (see below). Included is the August, 1965 "appeal to anybody for a body for freezing," where a number of promises are made that might now prove particularly inconvenient. "We will accept any body for freezing even if the person has been dead for some time. …There will be no cost to you. LES can more than likely pay any costs that would occur. LES has extremely simple facilities and has a standing offer to freeze the first person free, or the second, or the third, etc. LES doesn't offer a fancy freezing, merely the scientifically simplest that will get that temperature down into the cryogenic ranges and keep it there. …"[15]

The conference, at any rate, was still on schedule, to be held at the Sheraton-Park Hotel, Washington, D.C., Saturday, October 28, 9:30 a.m. to 4:30 p.m., with the following day "open for visiting, discussion." Russ Van Norden among many others was one of the hopefuls, ever with an eye on the possibility of fundraising. Though Marie had been frozen on the West Coast by a California organization, the Cryonics Society of New York had also expressed sympathies. Its newsletter *Cryonics Reports*, started the previous year under the vigorous editorship of Saul Kent, who was also the CSNY Corresponding Secretary and would become a lifelong devotee of cryonics, offered space and encouragement for a fundraising appeal. (In fact Saul went well beyond this, contributing an editorial that outlined Miss Sweet's many humanitarian initiatives, a small part of which concerned cryonics, and making a further, impassioned appeal for help to fund her cryopreservation.[16]) A grateful Russ replied:[17]

Russ Le Croix Van Norden
70 Robley Road
Salinas California

October 14 1967

Saul Kent
Corresponding Secretary
Cryonics Society of New York, Inc.

Dear Saul:

I shall not try to plan this communication. I shall just write as the thoughts come to me.

I was glad beyond words to hear from you. It ties the whole together and gives me a sense of not being so alone.

I would hope that our initial exchange of letters would lead to detailed discussions of plans and methods of procedure which would make this idea of extended life a safer surer experience than eventuated in dear Marie's case.

I am not blind to the facts that adequate organization is a thing that does not develop to full efficiency in a new and untried field. Nor am I visionary enough to just think everything will eventually come about by sheer chance and wishful thinking no matter on how high a level.

I have no doubt that there will be individuals who will blame Marie for not taking more precautions for her own safety. I go over and over all the factors and I see evidence that within the limitations of LES and Cryonics she was doing her very best to promote better organization and watch out for her own welfare as well. The wonderful coordinating that she accomplished in my own case was truly remarkable. (I suppose you may have had some news of my hospitalization and my apparent complete recovery.)…

In a way I am glad that I am writing to you at this later date. I have not recovered from my grief and desolation but at least I can write with only tears in my eyes and not a complete surrender to my loss. . . . I have so little to offer to the [Cryonics] Idea as compared to Marie that I can only in small degree take over her efforts. And in financial support hardly anything at all. Of course I backed her up with faith, understanding and love.

It is indeed with mixed feelings that I remember her saying, "I feel that I am shirking my duty, I must get into Los Angeles and Santa Barbara for a few days to finish up and carry forward some of the things that must be done, my part in the peace movement, the Voice of Women, membership in LES and Bob Nelson's Cryonics of California." It was on these latter missions that skulking death stealthily took advantage of her while she slept. Had she been awake death would have been faced down and mighty glad to have retreated at least

temporarily…

We simply MUST, Saul, take every account of her safety and bring her back.

She counts on us and we cannot ignore the fact, except to our retarded progress, THAT WE DEPEND ON HER.

Perhaps you could outline in a general way what information would be effective for your use in your appeal for permanent storage for Marie. I will do my best to provide anything I can.

Again thanking you for your communication, I am

Sincerely
[signed] Russ Le Croix Van Norden

P.S. I have written a letter to Ev Cooper with notes and suggestions of what I thought to be a constructive nature but I have not heard one word from him. With Marie not active I am afraid that my thread of communication with LES is very thin indeed. Of course you will attend the conference on the 28th. Do not miss it, your influence is valuable.

Russ

In just two weeks the conference would start. Then the October issue of the newsletter came out, announcing it was not to be:[18]

OCTOBER 28TH CONFERENCE CANCELLED

Due to circumstances within our control, but quite unexpected nevertheless, and overwhelming, the Annual FWR Conference in Washington will be cancelled.

What reasons, good or bad, significant and superficial, serious and farcical, are adduced for the cancellation?

The main reasons came to the fore with the death and freezing of Marie Phelps-Sweet. First, an unexpected increase of mail came, much of which remains unanswered and a corresponding backlog of office work has accumulated. Second, a very nasty letter was received from a usually respected authority in the freezing movement accusing the President of LES of poor judgment, bad motives, stupidity, irresponsibility, etc., etc. a letter that a paranoid would consider a veiled threat. Third, the death and freezing of Marie Sweet apparently led to emotional strains and excesses. These will perhaps soften and cool in time. (On the other hand, think what could happen in the future when many freezings take place in a short period of time under less than ideal conditions?)

Fourth, the recent resignation of our Treasurer poses a replacement problem as well as minor items in our structure need tightening.

Fifth, and most important, we need facilities. As much as 5 days a week has been spent on this seemingly endless activity of evaluating land, talking to contractors, architects and others. This leaves little time for all the other work not to mention time for setting up a conference properly.

The Chinese peasants have a saying to the effect that a man is foolish to lift a stone just to drop it on his feet. Considering the criticism and the really mandatory tasks before us, it is better perhaps that we get our own house and operations in order, and carry out the conference at a later date.

Another conference did finally occur, as remarked above; more later.

THE NASTY LETTER AND WHAT LED UP TO IT

Cooper notes that a "very nasty letter" he received, from someone important in the movement, was one major reason he cancelled his conference. Understandably, the private details are absent, but the major details can now be filled in, thanks to the survival of some relevant documents. (Mike Darwin deserves special thanks for his copying and transmission of most of these materials, from old CSNY files. Other material was supplied by Robert Nelson.)

The nasty letter was written by Robert Ettinger.[19] Bob was furious for something Ev did when Marie Sweet was at the mortuary prior to her freezing and the problem was to find someone to take over this unusual case. An undertaker called Ev collect for advice. Ev thought the man ought to pay for the call and when he wouldn't, Ev, thinking he might be a crank caller, hung up on him. Bob was also mad at Russ Stanley when Russ was unable to contact Nelson after the freezing and got so frustrated he dared to suggest the whole thing was a hoax. Bob was mad about some other things too, which are detailed in his letter. First, here is Cooper explaining about the refused call, not to Ettinger but to Russ Van Norden and DeWilton Smith (Marie's son by a previous marriage, who also was sympathetic to the freezing).[20]

To: Russ Van Norden and DeWilton Smith
2520 State Street
Santa Barbara, Calif. 93105

August 30, 1967

Dear Russ and DeWilton,

Unless our information is entirely incorrect (I'm cautious because of what happened last time), you must know what we have heard concerning Marie's death. I would only hope the report I received yesterday is incorrect, but have to assume it true and act accordingly. All of us extend our sympathy and our hands and only hope we can help in a sensible

manner.

I am not clear who should direct things. I assumed that Marie simply wished to be frozen and who really is supposed to direct is irrelevant compared with getting her frozen and stored correctly. Thus I wrote the Coroner in Santa Monica and the insurance company last night airmail special delivery suggesting freezing as quickly as possible and asking further information. I also phoned Russ Stanley and Bob Johnson asking them to suggest the same and do whatever possible. This was yesterday afternoon when I first heard that a funeral director was trying to get hold of me. Incidentally that funeral director is not to be admired. Someone called from a Gates etc. & Gates collect. As I have had some prank calls collect from L.A. in the past I asked them to pay for the call. I thought if it was a reputable person they would pay and in this way I could weed out the prank collect calls. They refused to pay so I didn't talk to them but called Russ Stanley shortly thereafter to ask him to investigate. Such trivia in a time of crisis! Perhaps it makes no difference. For the important thing is to see Marie frozen and so stored as she wished. I assume that CryoCare can best store in the short run until LES has facilities that might be less expensive and safer in the long run. I have always assumed that dry ice storage is quite satisfactory in the very short run, say up to a month. Thus my suggestion, for what it may be worth, and I don't wish to claim much, is that dry ice (resupplied) around the body in any type of wrapping for insulation would do for days or weeks until further decisions can be made.

Bob Ettinger has been very active on the phone, perhaps as you know, trying to help. He phoned me several hours, or perhaps less, after I first heard. He indicated that you (Russ) were not available and I had been unable to reach DeWilton by phone. So, I assumed DeWilton had heard and rushed right for a plane.

So, I remain somewhat in the air as to who should direct things, not that that makes much difference. But I wish to help in any way from here on. And I have made my suggestions known if they can be of any use. Do write or call if you think I can be of any help or if there is any information I should have.

Sincerely,
[signed] Ev Cooper

Next we hear from Russ Stanley: his letter to Ev Cooper about his frustrations with Robert Nelson. He is returning the money LES sent earlier to be used for Marie Sweet's freezing expenses. He couldn't be sure Marie was even frozen.[21]

September 18, 1967

Dear Ev:

I am returning herewith your one hundred dollar check. I tried to find out if Marie's body is being kept in dry ice, but after making careful plans to meet Nelson at his home on Sunday [apparently September 17] he stood us up. We were to meet him at noon, then on Saturday he called and made it for 2:00PM. Bob's wife was home so we visited with her from 1:30PM until after 2PM, then we left for half an hour or so, and he had not returned at 2:45, nor did he call after we got home. It is about 25 miles from where I live and I hate to drive the freeway especially on a hot day.

Bob's wife did not know anything about it. She said Bob had left early Sunday morning to go SCOOBA diving (I think it is SCUBA). In view of the Glendale account, copy of which I am sending Mr. Ettinger, one would NOT pull a trick like that unless he just could not show us where he said Marie was being kept.

First, Bob had offered to move Marie's body to a permanent place he said he had rented.

Ev, again I say there might be an explanation, but it seems that anything so important as keeping her frozen would be foremost in his mind, especially on Sunday when he is not working.

Mr. Van Norden's son, who is a sports writer for the Times gave $200 (I picked up his check at the Times). His name is Glo – Glick. Mrs. Kline, Mr. Coco and I gave him $50.00 and promised more.

I'm not picking at him, but if this is a downright hoax, then I'd rather have no one [at all] than [someone like] Nelson. He has alienated himself from those who wanted to help, but demanded to know where the money was going.

None of us ever got Cards of membership. I didn't actually become a member, but gave him $200.00 re Bedford—he refused Pilgeram because Pilgeram demanded to do it right. And Sandra Stanley says she can no longer accept his treatment.

I'm heart-sick about this, but there seems no excuse and the above is a true account.

Regards,
[signed] Russ Stanley

Cc Mr. Ettinger: Above is explanatory. Enclosed is copy of Glendale story of Sept. 2, 1967.

The article referred to, in the Glendale *News-Press*, is shown below. (Illustration purporting to show Marie in her capsule is not included; "warts and all" *are* included, including the howler that "the body was gradually cooled to 174 degrees Fahrenheit." Overall, the article is informative, at least when persons who actually witnessed events are cited, but as usual with news reports must be used with caution. Another, and longer, article on the case was in the Santa Barbara *News-Press* the previous day.) The "Pilgeram" referred to is Dr. Laurence O. Pilgeram who was active in the early cryonics movement as a scientific advisor and gave a presentation at the 1971 Cryonics Conference held in San Francisco. He was cryopreserved at Alcor in April 2015.[22]

A young Russ Stanley, Earlham College, Ind. Yearbook, 1932, 59.

GLENDALE NEWS-PRESS, 111 N. ISABEL, GLENDALE, CALIFORNIA
SATURDAY, SEPTEMBER 2, 1967, VOL. 63—NO. 108

Woman Follows Frozen Trail of Glendale Man

By DICK CLEVER
News-Press Staff Writer

A 74-year-old Santa Barbara woman has followed the frozen trail blazed by the late Dr. James H. Bedford, the retired Glendale College professor who, upon his death from cancer, was frozen in an aluminum capsule for later revival.

The woman, Mrs. Russ LeCroix Van Norden, the second known to take the route, was found dead Sunday afternoon in a Santa Monica motel, the County Coroner's office reported. She had registered the previous day under her professional name of Marie Phelps Sweet, a civil rights and anti-war worker in Santa Barbara.

Carried a Card

An employe of Kingsley and Gates Mortuary in Santa Monica, which represented the coroner's office in recovery of the body, said the woman carried a card identifying herself as a member of the Cyonics Society of California and directing that her body be turned over to them.

"All I can say," said the mortuary employe, "is that it must be a pretty secret society. I called all up and down the West Coast trying to locate a representative until I was finally directed to a Mr. Hicks in Los Angeles."

"Mr. Hicks," said the employe, "is a student at the California College of Mortuary Science.

"Mr. Hicks" reportedly handled the transfer of the woman's body to Cyro-Care, Inc., in Phoenix.

In Inglewood, Dr. B. Renault Able, of the Bedford Foundation, expressed his doubts as to the success of the attempt at preserving the woman's body.

Dr. Able, who directed the preparation of Dr. Bedford's body for freezing, said the freezing process should have taken place within 15 minutes of death.

When he prepared Dr. Bedford's body for preservation he kept pumping air into the man's lungs while applying ice packs to the corpse. This was done at the moment of Dr. Bedford's death to prevent brain damage through lack of oxygen.

Medical authorities said the woman had been dead four or more hours before she was found at the hotel and the brain was, undoubtedly, irreparably damaged.

Nonetheless, Mrs. Van Norden was sent to Phoenix to be enclosed in one of Cyro-Care's $3,000 to $10,000 capsules, which was apparently paid for by a $10,000 insurance policy of which the Cryonics Society was the beneficiary.

'Publicity Stunt'

Dr. Able labeled the case as a "publicity stunt" on the part of the Cryonics Society.

Dr. Able said "Mr. Hicks," whose first name he didn't know, had once requested to work with him in his life extension work.

"I don't want embalmers, Dr. Able said, "I want trained medical people."

Dr. Able said he was the only person in California with the knowledge and experience to carry out the freezing process.

When Dr. Bedford was frozen immediately after his death, his blood was replaced with dimethylsulfoxide (DMSO) and

—Turn to Page 2, Col. 2—

—Continued From Page 1-A—

glycerol to protect the tissues from damage.

Using dry ice, the body was gradually cooled to 174 degrees Fahrenheit.

The dry ice casket was transported to Phoenix by private means because the body was not legally embalmed.

It was not known whether Mrs. Van Norden's body was treated with DMSO.

Physicians and scientists who froze Dr. Bedford's body said there is a good chance the man will someday be revived if a cure could be found for the cancer that killed him.

No one could be found to comment on Mrs. Van Norden's chances.

Efforts to contact "Mr. Hicks" at the school and at his job proved fruitless. A co-worker said the man had had his home telephone disconnected.

Now for Ettinger's reply, addressed to Ev Cooper but cc'd to Russ Stanley and others. Cooper in the letter above says little about Nelson but is not critical either; perhaps by the time Ettinger sent his letter Cooper had hardened his position in conformity to Russ Stanley's and communicated the same to Ettinger, though this is speculative.[23]

Sep. 20, 1967

Ev Cooper
Life Extension Society
2011 N St NW
Washington DC 2036

Dear Ev

The problem of Marie Sweet's permanent disposition is one we'll have to collaborate on. As a preliminary, I must comment on what I consider the shameful attitude you and Russ Stanley are displaying toward Bob Nelson.

There is nothing to justify your suspecting him of a "hoax" in Marie's freezing; quite the contrary. Who froze Bedford? You? I? Russ Stanley? Bob and his team did. When Russ Van Norden was near death, who was on the spot? You? I? Russ Stanley? Bob and Jeff Hicks. And now with Marie, I wasn't there, and Russ Stanley wasn't there, and you managed to foul up the works with appallingly bad judgment, but Bob and Duffy and Hicks, with Brunol's advice, froze her. (If corroboration is required, which it isn't, I've spoken with Hicks and Duffy.) And if Russ Stanley or anyone else out there drops dead tomorrow, who is going to freeze him? You? You would advise the undertaker by mail to pile dry ice on him. I? Nobody but Bob's team.

On the matter of your refusing the collect call from the undertaker, by the way, I've been inclined to gloss it over, in view of your immense over-all contribution, and since we all make mistakes, but in light of your attitude toward Bob I can't help saying something. It was one of the most stupid and irresponsible things I've ever heard of. I'm sure you

don't get hoax collect calls every day in the week, and the drastic penalty for refusal if it was genuine should have been obvious. (That the undertaker was also at fault is beside the point.) It's even more ridiculous, if possible, since you say you later called Russ Stanley—you paid for a call anyway, after much delay.

You also seemed to want to freeze Marie without perfusion, simply because then you could have been in charge—by long distance—although this would probably have reduced her already slight chances by several orders of magnitude, as intimated in your conversation with me and your letter to DeWilton Smith.

As far as Bob's being late for an appointment with Russ Stanley is concerned, he shouldn't have inconvenienced Russ, but this isn't a federal offense. Bob has suffered monumental inconveniences.

Concerning the failure of Cryonics of California to make financial accounting and other information available to its members, this accusation may have some substance, and should be corrected. But the same thing is true of LES. I am a member of LES, and I know nothing of its financial and legal structure. In fact, I request this information now, in detail. Please send me copies of charter, by-laws, officers, directors, latest financial report, membership list, and any other pertinent documents. I'll reimburse you for the cost of the photocopies. (Minutes of all meetings, also.)

Despite all this, I'm sure you realize that everyone fully appreciates the past and continuing importance of your role and the debt we all owe you and Mildred. But the cold fact remains that you and I and most of the others have done more things wrong than right, and we've got to shape up. At the moment, one of our important particular problems is Marie (and her husband, who obviously may be in the same boat before too long).

When I spoke with Bill Albaugh, about the time of Marie's death, I reminded him of the LES offer to freeze someone free, and asked what LES could do for Marie, and especially whether you could store her; apparently, you are not ready to do anything. CSC is storing her temporarily, in dry ice in a leased building. Within a very few months we should make permanent arrangements, and store her in liquid nitrogen. I'm sure you don't wish to abandon her, in view of the confidence she placed in you and LES. We have to raise thousands of dollars, or the equivalent in pledges or/and services. Undoubtedly your people as individuals, and LES as an organization, will make the major contribution, in view of your numbers, but the Cryonics societies and people will also pull our weight. We are preparing a general appeal for the newsletter, Cryonics Reports, and will try to come up with other measures also. I trust you will also put your best efforts to it, if you have not already.

Best Regards,
[signed] Bob
Cc: Cryonics Society of California
Russ Stanley
Cryonics Society of New York

(My thoughts on all this: Definitely the freezing was no hoax. Cooper should not have hung up on the caller, though his reactions might be understandable if he'd gotten some prank calls. Nelson should not have gone scuba diving that day instead of seeing Russ. Otherwise I leave judgment to the reader.)

Not a hoax. The freezing of Marie Phelps-Sweet, starting 30 Aug. 1967. From left: Jeff Hicks, Dante Brunol, Richard Duffy. Photo courtesy of Robert Nelson.

THE WAY IT ENDED

The appeal to help Marie with donations appeared in the October issue of *Cryonics Reports*, the newsletter of CSNY. Ettinger contributed an eloquent essay, which I've reproduced below, omitting some details at the end concerning where to send funds and an introduction to some letters from Marie which are then excerpted.[24]

A Young Woman's Trust
By Robert C.W. Ettinger

In 1964 Marie Phelps-Sweet (Mrs. Russ Le Croix Van Norden) sent me two pictures of herself. One face showed 71 years of care, the other a young woman full of hope and vigor. As you may guess, she identified with the aspiring young woman, and regarded mirrors and late photographs as ugly lies. She was determined to help expose and defeat such fraud.

Today defeat seems closer to Marie than to the fraud. Her situation has worsened; it is precarious at best. She has passed through clinical death, been perfused and

frozen by the *Cryonics Society of California*, and now requires permanent storage until we reach a technological level capable of attempting her recovery. She did not make adequate arrangements, and so lies stricken and helpless, with only the will and resources of her relatives and friends to save her from the mindless enemy.

Her gallant husband has the will, but is nearly destitute of resources. The rest of us can find the resources, if we deem it worth-while. Let us soberly consider this question.

On the negative side, there are weighty factors. The circumstances of clinical death were unfavorable, conceivably justifying pessimism about Marie's chances and about the effect on our public image. Perhaps a sharp lesson on the penalties of inadequate preparation would be salutary for our membership; a grim reminder, that they can rely on no one but themselves for certain things, might spur them to complete their own preparations. And we certainly cannot afford a policy of assuming financial responsibility for everyone who wishes to be frozen.

Yet no one can say for certain that Marie's chance is zero, or even small; she was kept at relatively low temperature during most of the waiting period, and no one can prove that truly irreversible damage has occurred. Any scientist who criticizes this feeling solely on grounds of the delay is tacitly admitting that, with less delay, there is an appreciable chance; let him say it. In any case, our public image, in my opinion, depends overwhelmingly on one factor only—are we or are we not freezing people. Everything else fades into a vague blur of tiresome argument; in the long run, I am convinced, the only thing that will matter is whether we are acting. As for the grim reminder, it is already here; the effort required to save just one cannot fail to make its point.

Beyond all this are the intangible but paramount matters of morale and conscience. Marie is not just a statistic; she is one of us. We have spoken with her, corresponded with her, agreed with her, quarreled with her, admired her, occasionally laughed at her. She has worked with and for us, unsparingly, flagging sometimes (Who does not?) but always resurging. For our own integrity, as individuals and as organizations, we must acknowledge our moral responsibility. A friend and comrade cannot—*simply cannot*—be abandoned...

Some extracts of letters Marie wrote to Ettinger are then offered for the reader to sample. The charming quotation earlier about "freezeration" came from one of these. Here is another dated Aug. 23, 1964 that seems to have an eerie relevance beyond its time and circumstance:[25]

Even I, way out here on the outer rim, feel that all my energies should be devoted to this life extension advance. But how to do it escapes me at the moment. For the first time in my entire career, I yearn to be wealthy and free to endow an essential work. Formerly the idea of the responsibility of physical wealth made me shudder—in a world mad for the quick buck. Honesty, via which there are few if any millionaires, seemed to me the more precious value. Now it seems we have the power and method to change for the better. "Remove the fear of limited life—and remove the fear of greed and ruthlessness.". . . I want to *see it happen*—with all possible speed! Yet here I sit. More or less helpless, to speed things up.

As for Cooper, after the aborted October conference he struggled on, and did manage to acquire some land in Maryland with a pond and an old, ramshackle farmhouse. There he put up a laboratory building, with unfinished interior. He did hold a small "Fifth Annual FWR Conference" in June 1968, at the end featuring a tour of his property. That was about the extent of his progress. As the months went by after this the newsletters started appearing late. The last one was dated September 1969, mailed out around the end of that year. After that, Cooper effectively ended his involvement with cryonics and life extension, and spent more and more time sailing.[26]

At CSC's annual meeting on or about February 3, 1968, Russ Van Norden made one more valiant attempt to rally support. (I have supplied a title and slightly reworded the beginning attribution, along with the usual light editing as previous.)[27]

I Speak for Her

By Russ Le Croix Van Norden

On the occasion of the 1968 Annual Meeting of the Cryonics Society of California

I speak for her
Who now so stilled and quietly
[In frigid slumber] lies
Awaiting perilously the time
[Be it] short or long
[O]f her awakening

I speak for Marie who has tragically become famous as the first woman to be cryogenically suspended by her own unhesitating choice and decision and the consent of the one she held dearest [and of] her nearest

relative.

I say tragically because she had no premonition of her clinical death. I say tragically because the timing and the method and the preparation for reanimation and an extended life were not as yet perfected. I say tragically because the chances for her recovery have been jeopardized by the lack of cooperation in depth with those, all too few, who [have] worked almost beyond human capacity to safeguard the life of Marie and all of us.

I speak for Marie as she urges, even from her reluctant stillness, or perhaps because of her arrested activity, that you pledge yourself this day—this hour—to come forward in one great surge of strength and interest and personal concern, to do what you can, to do more than you can, to assure, in as great a degree as our present knowledge permits, that she have every chance to be with us again.

To assure that, should death mock you too, you will have a more favorable chance than Marie has had, I urge you to this resolve.

You who know her, know that I speak for her. Did not the Queen of Belgium commend her for putting [a great enthusiasm] into the Queen's message to the International Congress assembled for the drafting of a World Constitution?

And have not Senator Wayne Morse and Adlai Stevenson paused to listen to her impassioned plea for the dignity and worth of humanity? And [don't forget] Margaret Sanger and Eleanor Roosevelt, Narcissa Vanderlip and Florence Whitney, Ralph Bunche and Nelson Rockefeller: to these and others her love of life and her concern for human life [were manifest].

So I speak extravagantly. There are others who will speak for her, Robert Ettinger, Saul Kent, Ben Schloss, Judy and Wesley Walton, Russ Stanley, Ev Cooper, Bob Nelson.

All these have experienced her enthusiasm and her urgings for unity of purpose — and at times have felt the sharp insistent sting of her reproach at [the] lack of organized efficiency in this matter of life and death.

Your apathy now is unthinkable, as you move, slowly perhaps, but inevitably into the New Age, with heightened concern, for you are now [starting to witness] the next impact on the world of this revolutionary idea.

It is with understandable grief that I point out that Marie's clinical death has already been of tremendous import to the cause of Cryo[nics] and Life Extension.

And [so] I urge you, with all the urgency at my command, that you let no smallest neglect creep in to jeopardize the chance for her attempted recovery, when the time may come. For with this attempt, if it has even the slightest assurance of success, will come a world-wide surge of interest in [our cause].

Someone has said that Marie can do more for us than we can do for her.

Perhaps you build here now
A bold defense
Against the time
Of your own ceasing heart.

As for Marie herself, while initially there was widespread sympathy in the small cryonics movement, the financial contributions were meager. In an interview in the November 1967 *Cryonics Reports* Nelson noted the LES standing offer "to freeze anyone at their expense," suggesting that Marie's plight offered "an ideal opportunity" since she had been a "leading contributor."[28] But lacking capability, LES could offer no help. For about a year and a half Marie was maintained on dry ice at Joseph Klockgether's mortuary, Robert Nelson coming in regularly to replenish the supply. Her fate though precarious might possibly have been different had other, underfunded patients not joined her to increase the burden of would-be funders. In the end there were three others: Russ Stanley, Helen Kline, and Louis Nisco. With Nisco, who alone among the three was not frozen by Nelson's group but by Cryo-Care in Phoenix, there was a capsule, paid for by Nisco's daughter.[29]

Klockgether did not want people maintained indefinitely at his mortuary, including those on dry ice. In desperation in March 1969 Nelson had the Nisco capsule opened, an interior support removed from the inner container, and the other three put in. In May 1970 the capsule with its four frozen occupants was taken to the Oakwood Memorial Park Cemetery in Chatsworth. The capsule by report did not perform well but had a leaky vacuum jacket which increased the boiloff rate and the expense of maintenance. The daughter meanwhile had stopped payments. With no funds coming in and little in the way of outside interest the capsule was finally abandoned and its four occupants including Marie were lost. Later five other cryonics patients would be lost at the Chatsworth facility under mostly similar circumstances, where funds and interest, particularly on the part of initially grief-guided relatives, had dried up. (Sadly, the cost-saving measure of conversion to neuropreservation—saving the head and discarding the rest—does not seem to have been considered.[30])

As for Russ Van Norden, in October 1970 he remarried, to Alzada M. Knutson Cannom, a noted painter. His interest in cryonics, so fervent in the weeks and months after Marie's freezing, waned and he left the movement, dying in 1975.[31] CSNY in its career froze seven people, starting in July 1968. All were eventually returned to relatives when they did not want to continue payments. All these too would be lost, including one who was transferred to the Chatsworth facility. Only

James Bedford of the early cases (before 1974) remains cryopreserved today.[32]

The early years of cryonics taught bitter lessons. Cryonics organizations today are on a sounder financial footing that so far has prevented the sort of meltdowns that sadly used to be almost routine. We have hope that our patients will indeed remain safely at low temperature until technology of the future can be brought to bear on their needs. Is there any hope for the others who didn't make it, or maybe were never frozen at all, a vast throng? A question to ponder. ■

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

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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).

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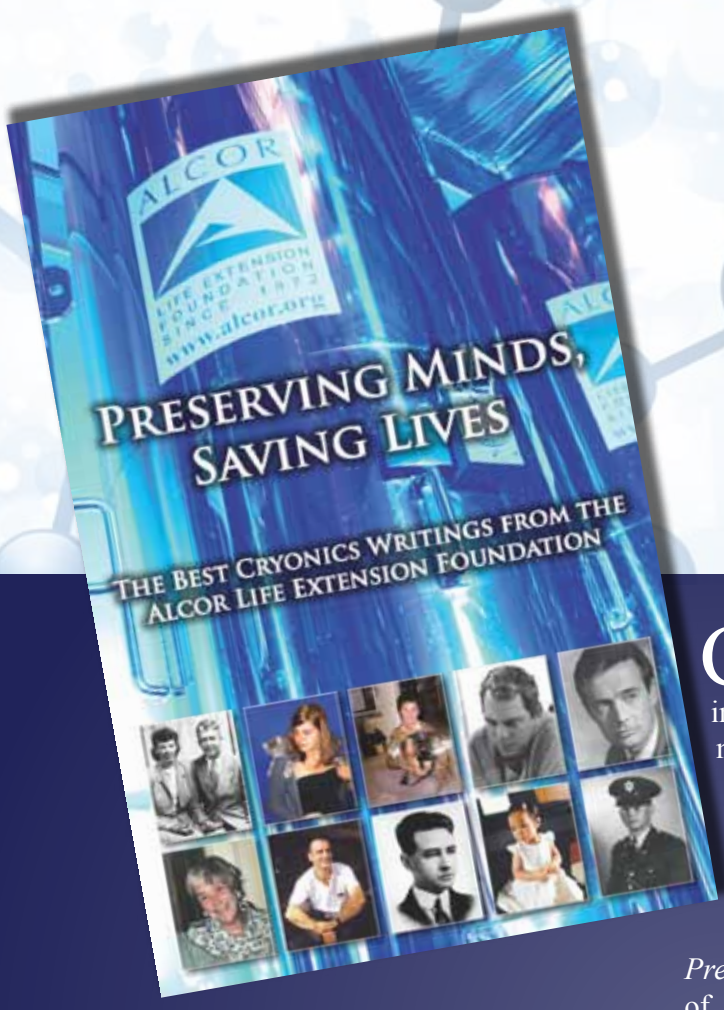
Preserving Minds, Saving Lives

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.

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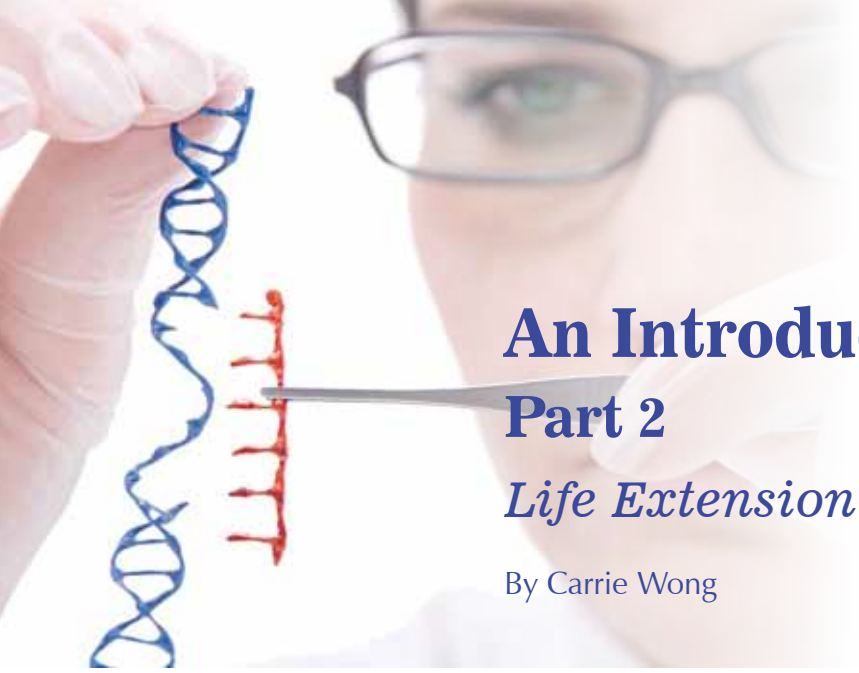
"Society's failure to take cryonics seriously is a tragedy that is probably costing countless lives. Alcor, notably via its magazine, is leading the fight to change that."

– Aubrey de Grey, Ph.D.
Biomedical Gerontologist and Chief Science Officer of the SENS Research Foundation

"Alcor appears to be the leading organization in the application of cryonics in medicine. I'm proud to be a part of this effort."

– Michael D. West, Ph.D.
Stem Cell Scientist and Chief Executive Officer of BioTime, Inc.



An Introduction to CRISPR: Part 2

Life Extension and Genetic Engineering

By Carrie Wong

In my previous article, Part I: An Introduction to CRISPR, I outlined some of the exciting new technological advances in the past few years. Scientists working with CRISPR-Cas9 have discovered they are able to precisely alter any DNA with unprecedented accuracy. This new gene-editing tool is being researched as a potential cure to many life-shortening diseases such as HIV-1, Hepatitis, cancer and even genetic diseases. It is still early days for gene therapy in anti-aging, however a number of interesting developments have taken place in the past couple of years.

BIOVIVA SCIENCE – RADICAL LIFE EXTENSION

Last year, Liz Parrish, the CEO of BioViva made headlines by undergoing gene therapy to combat aging on a molecular and genetic level. She is currently undergoing two types of therapies, one of them to increase her muscle mass and the other to increase her telomere length. She bypassed FDA regulations and started her own clinical trial, with herself as the patient. She will be getting independent 3rd party reviews of her baseline and progress in the development of muscle mass and telomere length as well as other biomarkers for aging. In her Reddit AMA, she cited a number of tests she has undergone "… MRI and a panel of blood and tissue testing including work on telomere length with Spectracell and Life Length and epigenetic testing."

Sarcopenia is the degenerative loss of skeletal muscle mass, quality and strength as a result of biological aging. Through BioViva, Parrish aims to treat this condition of aging with proven therapies that are currently being used to counteract diseases that cause a lack of muscle development. Parrish herself does not suffer from any chronic diseases and has bravely volunteered to undergo these treatments to combat aging[1].

"I suffer from biological aging as a disease. We all do. This is something we need to work on, very quickly if we want to have a future." – Liz Parrish Interview[1]

Parrish has described the therapy she is undergoing to increase muscle mass in a few interviews. She compares her treatment to one currently being conducted on boys with the condition of muscular dystrophy at the Nationwide Children's Hospital in Columbus[2]. For this specific therapy, she is getting Adeno-Associated Virus (AAV) vectors directly injected into her muscles that deliver follistatin into her system[3]. AAV works by injecting its payload DNA into human cells, finding its way to the cell nucleus and copying itself into a specific place on the chromosome. The AAV DNA strand is modified to eliminate the genes coding for proteins that allow AAV to replicate. In this modified form, AAV can infect a cell, but once inside it cannot reproduce and infect more cells. AAV is currently being used in many clinical trials around the world and has been established for decades[4].

In Parrish's treatment, the AAV would carry the Follistatin into her cells. Follistatin inhibits the myostatin pathway and the myostatin pathway inhibits the development of muscle-mass. By inhibiting myostatin, she would increase her own muscle mass and combat sarcopenia. Muscular dystrophy is not caused by one specific mutation; rather it can be caused by the deletion of the DMD gene, single point mutation, exon duplications or even exon deletions[3]. Because of this, researchers did not aim to correct the precise mutation that causes muscular dystrophy, but to find another path to stimulating muscle growth. Follistatin has the additional benefit of controlling muscle mass through an independent pathway that does not rely on the myostatin pathway.

Just last year, a study was published on using CRISPR-Cas9 to inhibit myostatin in dogs[5]. Researchers were able to create canines with muscle hypertrophy, in other words, an overdevelopment of muscles. Parrish used the more established method, AAV vectors, to deliver her gene therapy, but in the future, CRISPR-Cas9 could be a very efficient and cost effective cure for Sarcopenia.

GENETICALLY ENGINEERING TELOMERES

Telomeres are the tips that cap our DNA. They protect chromosomes from deterioration and fusion with neighboring chromosomes, and make it possible for cells to divide. Our cells can only divide about 50 to 70 times, with telomeres getting progressively shorter with each division until the cells become inactive or die[6]. Telomere shortening has been linked to the aging

process and the use of telomerase in labs has kept human cells dividing far beyond their normal limit. Along with many other life-extension researchers like Bill Andrews, Parrish also believes altering telomeres is one crucial component in reversing aging. This claim is not without controversy; other scientists believe that shortened telomeres are the result of aging and do not cause aging. Many scientists currently treat telomere length as a biomarker of aging, rather than a fundamental cause of aging[7]. Improvements in diet, exercise and stress management were found to lengthen telomeres[7]. Individuals with cancer and other chronic conditions have shortened telomeres which suggest that relative telomere length reflects the general state of health on a cellular level.

In the lab, scientists have been able to increase the lifespan of mice by 13-24% using gene therapy to deliver the genetic materials to activate telomerase[8]. In this experiment, they used Adeno-Associated Virus (AAV) as a telomerase-delivery tool. The AAV vector delivers TERT, the limiting factor in the telomerase complex to activate the enzyme telomerase. The treated mice experienced beneficial health and fitness effects including increase insulin sensitivity, neuromuscular coordination and several molecular biomarkers of aging[8]. The treated mice did not develop cancer at a higher rate than the control. Similarly, Parrish is using AAV to deliver the telomerase (TERT) to lengthen her telomeres. The life-extension community follows her progress with great interest. However, some have reservations because Parrish circumvented regulation and the scientific community to carry out her own experiment[2]. In addition, she is the only one in the study and that presents a conflict of interest and the results may not be credible to the medical establishment despite pursuing third-party testing.

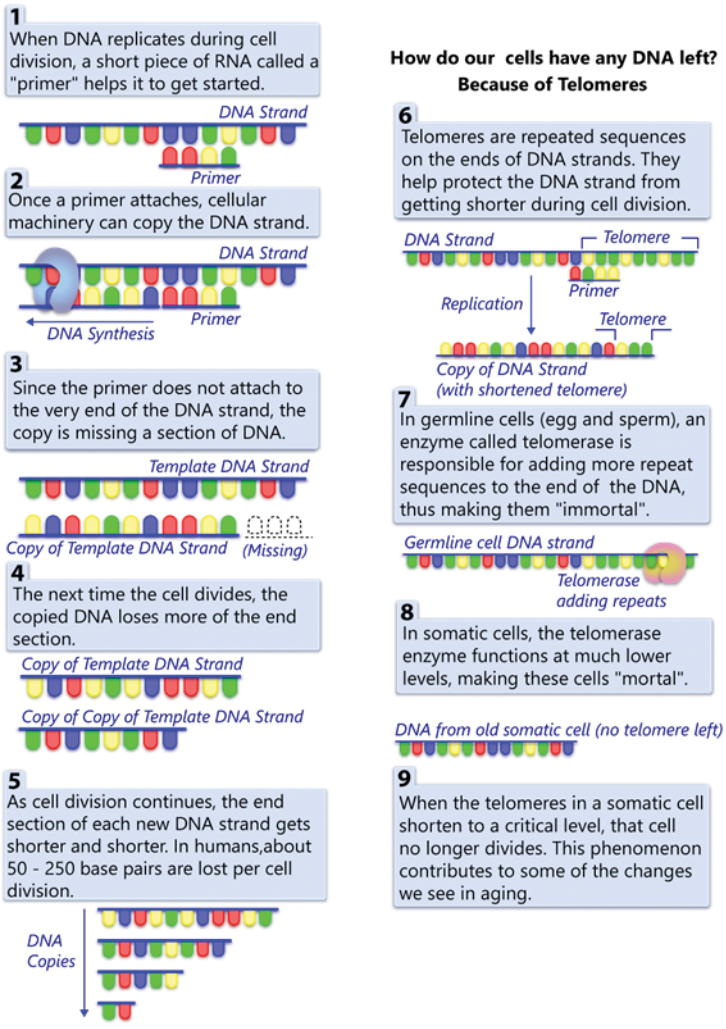


Figure 1: How telomeres work to protect the DNA strand from getting shorter after each division.[6]

Last year, researchers at Stanford University School of Medicine published exciting results showing a unique way to extend the length of the human telomeres by up to 1,000 nucleotides[9]. This represents an increase of 10 years in the human cell life cycle. They did this with human skin and muscle cell cultures in the lab. Researchers used modified messenger RNA (mRNA) containing TERT to activate the telomerase[9]. This is a major breakthrough in the delivery of TERT because they did not use viral vectors. The advantage of using this new technique is that there is a reduced immune response. Even though AAV only triggers a small immune response, this new technique is even more effective. The mRNA-technique allows the TERT-encoding message to activate telomerase but dissipates after 48 hours[10]. This prevents runaway cell division and replication like in cancers. Not only is it a safer way of activating telomerase, it works very rapidly to add a significant number of telomeres. In 24-48 hours, the delivered TERT extends the telomeres by 1,000 nucleotides.

MITOCHONDRIAL HEALTH & AGING

Mitochondria are the powerhouses of cells. They generate the supply of chemical energy, also known as adenosine triphosphate (ATP) which is used in cell function. In addition, the mitochondria are involved in maintaining the control of the cell growth cycle, cellular differentiation and cell death. When the mitochondria are under attack, cells fragment and take apart these "power stations," strip out the damaged pieces and reassemble them once again, into usable mitochondria[11]. However, this entire process of fragmentation and reformation isn't possible without an "emergency alert" in the form of the enzyme AMPK.

Impaired AMPK is linked to a wide range of diseases including obesity, metabolic

syndrome, and inflammation. There is also research suggesting that some benefits of calorie restriction may be caused by AMPK activation[12]. Effective control of mitochondrial metabolism and turnover is crucial for healthy cellular function and healthy aging. AMPK is a key nutrient sensor with the ability to regulate whole-body metabolism. AMPK is activated when there is energy stress, for example, low energy intake during calorie restriction. AMPK activation impacts the activity of the FOXO, the sirtuin and mTOR signaling pathways, which have been tightly linked to CR and increased longevity and healthspan[12].

Interestingly, there is a link between metformin, caloric restriction and AMPK restoration of mitochondrial dysfunction[13]. For decades, the Life Extension Foundation (LEF) has been recommending the intake of metformin for its anti-aging benefits[14]. One of these benefits, outlined at LEF, is activation of AMPK to restore mitochondrial function. In my previous article, I briefly noted that the FDA had recently approved clinical trials for metformin as a potential anti-aging drug, despite having banned LEF from such testing a number of years ago.

Impaired AMPK is tied to a number of diseases related to mitochondrial dysfunction, including fibromyalgia. Fibromyalgia is a musculoskeletal chronic pain condition that affects up to 5% of the general population[13]. Additional symptoms include fatigue, headache, sleep disturbances and depression. Researchers believe impaired AMPK is one cause of fibromyalgia and they suggest either metformin or caloric restriction as a potential therapeutic approach to activate AMPK.

Just this year, researchers released a study using CRISPR gene-editing tools to prove that AMPK alone is enough to trigger mitochondrial fragmentation and reassembly[11]. Scientists at the Salk Institute used CRISPR to delete AMPK in cells. They then introduced toxins to the mitochondria, and found that the mitochondria did not fragment. Typically the toxins that damage mitochondria would trigger fragmentation, but after removing AMPK, there was no effect. As a follow-up experiment, they looked at way to chemically turn on AMPK without attacking the mitochondria and found that activating AMPK, by itself, was enough to cause fragmentation[15]. In summary, AMPK is a main regulator of mitochondrial stability, coupling fission to selective removal and signaling to the cell to initiate the creation of new mitochondria to replace the damaged ones[15].

There are recent studies indicating that the sensitivity of AMPK to cellular stress declines with aging and this could impair the maintenance of mitochondria[16]. Increased AMPK activity has been shown to extend lifespan in lower organisms. In conclusion, AMPK is a crucial regulator of energy metabolism, both at the cellular level and in regulating the aging process through several established pathways.

ORGAN REJUVENATION AND TRANSPLANTATION

George Church is an eminent professor of Genetics at Harvard Medical School and a founding member of the Wyss Institute for Biologically Inspired Engineering. He's a prominent life-extension advocate and has publicly supported the cause of curing aging in many interviews over the years. Church is also credited with being one of the first to develop and use CRISPR-Cas9 in human cells, publishing his research at around the same time as Feng Zhang[17]. Zhang, Doudna and Charpentier are widely credited with discovering and developing the CRISPR-Cas9 gene-editing tool; however there are many scientists like Church who clearly made significant contributions[17].

There is a major shortage of donor organs and scientists have been searching for a way to grow human organs in pigs. However, these efforts were limited by the fact that there are viruses embedded in the pig's genomes that could cause diseases in human recipients[18]. Last year, George Church and his colleagues broke the record for the most genes edited at once using CRISPR-Cas9. Impressively, they inactivated 62 genes in pig embryos and neutralized the pig's endogenous retroviruses (PERVs)[18]. PERVs are viruses embedded in the pig's genome and in the past, scientists were unable to inactivate them using older gene therapies including RNA vaccines and zinc finger nucleases[19]. In their experiment, Church and his colleagues disrupted all copies of the PERV genes in a pig's kidney cell line[19]. Following this, they did in vitro experiments to see if their modified kidney cell line would transmit PERVs to human cells. They found that the modified kidney cells only produced minimal amounts of PERV particles. By measuring and comparing viral activity with controls, they found a 1000 fold reduction in the ability of this virus to transmit into human cells[19]. Church and his team have taken this to be a proof of concept for the ability to inactivate PERVs for the clinical application of pig to human transplantation.

CONCLUSION

In just a few short years, gene therapy has advanced leaps and bounds. CRISPR and other methods of implementing gene therapy are progressing quickly. Researchers are wasting no time in applying known therapies to animals and human cell cultures in the lab. Some life extensionists, like Parrish, have taken it a step further and started experimenting on themselves. Others, like Church, have become the leading lights at major institutions in applying gene therapies to commercial ventures which may pave the way to replacing old or failed organs when we need them. ■

ABOUT THE AUTHOR

Carrie Wong is a young Canadian cryonicist. She graduated in 2011 with a degree in geology from The University of British Columbia and worked in gold exploration for a few years. In addition to writing for Cryonics Magazine, she is also writing for geologyforinvestors.com and running a cartography business.

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The Technology of Revival, Repair, and Rejuvenation: Part 4

Nanomedicine and Cryonics

By York W. Porter

FURTHER WORK BY ROBERT FREITAS, RALPH MERKLE, ERIC DREXLER AND OTHERS

Freitas obtained a Juris Doctor in 1978 from the Santa Clara School of Law. Starting out his working career with an interest in space exploration, he published the first space political advocacy handbook. His work involved the searches for extraterrestrial artifacts (SETA) and intelligence (SETI). He next extended his interest in space exploration by participating in a 1980 NASA study to determine the feasibility of manufacturing facilities in space. Combining the talents of educators and NASA engineers, this very intriguing work concentrated heavily on using machine intelligence. As the final report said: "Such systems will complement human activity in space by accomplishing tasks that people cannot do or that are otherwise too dangerous, too laborious, or too expensive."[120]

The NASA work focused on self-replicating space factories. While seeming at first glance to be far removed from cryonics or medicine, in fact there are many common elements. Artificial intelligence could control devices at rates far beyond human response times and the brain's processing speed. Mechanisms could replicate themselves as needed for particular tasks. Control devices could possibly be in one location with the actual working devices in another. Space factories would benefit from such innovations, but so could the nanoscale devices that will be needed to repair, revive and rejuvenate cryonics patients. The outcome of the job may be different, but the basic approach and skills are still the same.

In the early 1990s Freitas worked on the concept of respirocytes. (The complete paper is at http://www.foresight.org/Nanomedicine/Respirocytes.html.) Though covering a rather different subject from space factories, there are many parallels, as suggested by the section titles. (A sample: "Power," "Communications," "Sensors," and "Onboard Computation.") These in turn would be clearly relevant to patients undergoing cryonics procedures, including restoration to healthy functioning someday via anticipated nanotechnology or other means.

Current repair techniques require that the tissue be metabolizing and functioning, so inactive or structurally intact but non-functioning tissue is declared 'dead.' Nanotechnology will let us repair non-functioning tissue, leading us to reexamine the concept of clinical death used in medicine today.

Freitas encountered the subject of nanotechnology in a somewhat circuitous way: "The first time I ever thought about atomic-scale engineered objects was probably in 1977-78, when I was working on my first treatise-length book project (*Xenology*). In Chapter 16 of that book, I hypothesized that 'using molecular electronics with components on the order of 10 Å in size, 10^{10} microneurons could be packed into a space of a few microns which would be 'small enough to hide inside a bacterium.'"[121] [exact online reference for this quote: http://www.xenology.info/Xeno/16.4.1.htm#p28]

Drexler's book *Engines of Creation* came out in 1986 but Freitas had temporarily left the field and apparently didn't see it until later. Fortunately, Drexler continued to write on the subject and Freitas did come across Drexler's book *Unbounding the Future: The Nanotechnology Revolution.*

UNBOUNDING THE FUTURE

Having written *Engines*, Drexler wanted to bring the concept of nanotechnology to a wider audience. *Unbounding the Future*, written in collaboration with Chris Petersen and Gayle Pergamit, was one such attempt. Among its many forceful and challenging conclusions is this: "A short summary of what molecular nanotechnology will mean is *thorough and inexpensive control of the structure of matter*. Pollution, physical disease, and material poverty all stem from poor control of the structure of matter. Strip mines, clear-cutting, refineries, paper mills, and oil wells are some of the crude, twentieth-century technologies that will be replaced. Dental drills and toxic chemotherapies are others."[122]

Although Drexler tackled several subjects in his book, a chapter entitled "Nanomedicine" is of special interest for those involved in cryonics. Various nanotech-based procedures that should prove useful in restoring breathing, functioning humans to optimum health (including aging reversal) do also apply to cryonics patients. If one can achieve

the thorough and inexpensive control of matter that Drexler and his co-authors claim and then apply that level of control to the human body, the body has to run, it has absolutely no choice. If the configuration is one of youth and good health, it will "run" in that manner. If the configuration is one of disease and old age, it will "run" that way (as long as it can). In the case of youth that is regained by the use of medical nanorobots, one should be able to maintain that state through proper nanoscale devices.

The maintenance of living structures that is done, albeit imperfectly, by the body's own inborn nanotech, is already rather incredible and "miraculous." Despite its virtues, however, the whole system crashes in the end, through one pathway or another, but mainly as a complication, directly or indirectly, of aging. We then have cardiac arrest followed, in most cases, by the dissolution of brain structures that form specific patterns that are unique to each individual. Our bodies took a long time to develop, billions of years if you count the entire history of life on earth, and did so, as far as we can tell, through naturally occurring but undirected processes. Pretty impressive results for sure, but we think we can do better, especially when we can bring our conscious and machine-augmented intelligence to properly bear on the remaining issues that eventually bring about our demise. *Unbounding the Future* points out, though, how limited current therapies and repair strategies are:

"Better tools could provide both better knowledge and better ways to apply that knowledge for healing. Today's surgery can rearrange blood vessels, but is far too coarse to rearrange or repair cells. Today's drug therapies can target some specific molecules, but only some, and only on the basis of type. Doctors today can't affect molecules in one cell while leaving identical molecules in a neighboring cell untouched because medicine today cannot apply surgical control to the molecular level."[123]

Nanomedical devices can be seen today as providing great promise to deal with diseases that have proved to be, while treatable, still incurable – the scourge of AIDS is a case in point. As with diabetes, which long predated it, the life of victims can be greatly extended, but one hopes in both cases that a complete cure can be developed.

When *Unbounding the Future* came out, cryobiologist Gregory Fahy was in charge of the Organ Cryopreservation Project at the American Red Cross's Jerome Holland Transplantation Laboratory. Fahy has written: "Calculations imply that molecular sensors, molecular computers, and molecular effectors can be combined into a device small enough to fit easily inside a single cell and powerful enough to repair molecular and structural defects (or to degrade foreign structures such as viruses and bacteria) as rapidly as they accumulate…There is no reason such systems cannot be built and function as designed."[124]

FREITAS' REACTION TO *UNBOUNDING THE FUTURE*

Unbounding the Future, Freitas tells us, was inspirational:

"Having fully absorbed the MNT paradigm, I immediately realized that medicine would be the single most important application area of this new technology. In particular, nanomedicine offered a chance for significant healthspan (healthy lifespan) extension. It also appeared that this objective could possibly be achieved within the several decades of life actuarially remaining to me and others of my generation."[125]

(Freitas, like this author, was born in 1952).

Freitas then took the "next logical step":

"But was anyone pushing it forward? I contacted the Foresight Institute and learned that nobody had yet written any systematic treatment of this area, nor was anyone planning to do so in the near future. So I took up the challenge of writing *Nanomedicine*, the first book-length technical discussion of the potential medical applications of molecular nanotechnology and medical nanorobotics."[126]

PRODUCTION OF *NANOMEDICINE*, VOLUMES I, II, AND III

Originally planning a single volume, in 1994 Freitas began his herculean task of trying to write what might be called a "magnum opus." The "single volume" approach was abandoned for what would be a three-volume set. Volume I, while couched in the language of the physical and biological sciences, would not be specialized toward clinical medicine. Volume II would be pitched toward an audience of systems and control engineers, research physiologists, clinical laboratory analysts, biotechnologists, and biomedical engineers doing applied research. In Volume III, Freitas hoped to deal with the clinical aspects of the subject.

And the word "herculean" might be an understatement. Freitas reports that he initially hoped to get Volume I out in 1999, Volume II in 2002, and Volume III in 2005. As for what actually happened, Volume I was published in October 1999, while, rather than publishing Volume II as one volume, it was decided there would be Volume IIA and Volume IIB. Volume IIA appeared in October 2003. As of 2016, Volumes IIB and III are still in the works. This is hardly to be disparaged in view of the numerous projects, books, and papers Freitas has worked on in the intervening years, as well as the hours upon hours necessary to turn out even one volume of *Nanomedicine*. As Freitas put it in an interview early in the project "… the problem is that I'm exploring largely uncharted territory, trying to assemble a primitive map of the terrain while avoiding the intellectual equivalent of quicksand and wild animals. There aren't any street signs or rest stops along the road — heck, there aren't many roads. Even working 16-hour days like I do, the process takes years."[127]

BASIC THRUST OF VOLUMES I/IIA OF *NANOMEDICINE*

Volumes I and IIA of *Nanomedicine* are a magnificent tour de force, establishing the foundations of the new field of medical nanorobotics. Brevity requirements limit what we can cover to only a few points, but Eric Drexler's remarks in the Foreword to Freitas' Volume I are well worth repeating:

"Current repair techniques require that the tissue be metabolizing and functioning, so inactive or structurally intact but non-functioning tissue is declared 'dead.' Nanotechnology will let us repair non-functioning tissue, leading us to reexamine the concept of clinical death used in medicine today."[128]

This paragraph is, of course, directly related to cryonics. Proponents have claimed, ever since its inception, that people utilizing cryonics—"patients"—are not "dead" in the final and permanent sense, but just beyond the capabilities of present technology to help. Future technology,

as exemplified by the great potential of nanotechnology and nanomedicine, very likely will not be so limited.

The distinction is much like the difference between the concept of "clinical death" and "biological death" which is taught in cardiopulmonary resuscitation (CPR) classes. Any patient needing CPR must be unconscious and at the point of clinical death, with heart and lung activity stopped or diminished to the point of ineffectiveness. This is the first guidepost of "clinical death." They are not thought to be, however, at the point of "biological death" which is considered, quite understandably, as a much hazier point in time, after which no resuscitative efforts are going to be effective or useful.

To cryonicists who work in healthcare (and there are several), a cryonics patient is essentially no different from a patient who arrives at the hospital emergency room in full-fledged cardiac arrest. In this case, heart and respiratory activity have stopped. Normally electrical activity of the brain will also cease within 30 or 40 seconds. The only difference is that with cryonics, the patient has a reasonable (though not guaranteed) chance at successful revival (with repair and rejuvenation) when technology catches up to the challenge. The chances of successful revival in many present day cases of cardiac arrest are, even with the most modern day "high-tech" equipment and treatment, pretty dismal. Cryonics acts as an "ambulance to the future" which is exactly what a person in this condition needs, especially in view of the generally poor outcome of present therapy for this life-threatening situation.

As Freitas puts it in terms of even normal medical procedures:

"*Nanomedicine* will involve designing and building a vast proliferation of incredibly efficacious molecular devices, and then deploying these devices in patients to establish and maintain a continuous state of human healthiness."[129]

Similarly, the devices Freitas describes will not only be able to fix medical conditions after they have occurred but also preventively correct medical problems before they become significant, depending on the design and combination of devices used. They thus could stand, if need be, as "health sentinels," able to intervene *before* significant problems occur. Today, even the best "healthcare strategies" founder after a few decades due to the steady encroachments of aging, injuries, or longstanding health problems—and the patient arrests, no matter what interventions are tried. Likely the watchful armada that indefinitely postpones this outcome could be attained with devices analogous to the body's own nanomedical foot-soldiers, only hopefully much better and more intelligently designed.

Such devices, with reasonable adaptations or extensions, should be up to the task of repair and rejuvenation of cryonics patients, so they too can enjoy indefinitely extended lives. Such advances will require human and artificial intelligence diligently applied, starting from scientific knowledge and well established engineering design principles largely arrived at in the past century or two. Freitas in *Nanomedicine* makes an excellent and weighty case for the feasibility of such sweeping advances. The development of these devices, as in the also important work of learning how to store organs at cryogenic temperatures, will proceed irrespective of any efforts to push forward the concept of cryonics itself. Indeed, even if cryonics didn't exist, the two areas of organ preservation and nanotechnology would be pursued in their own right, though cryonicists and other interested supporters can help hasten progress and time of application through lobbying as well as research.

Freitas' proposal at first might seem to be "just science fiction" but he has to deal with the realities of the biological and physical world in making his concepts work and has to make sure that "everything we need" is included in the design. Resources that cannot be "found along the way" must be brought along unless there is some reasonable way to develop them in vivo or in situ or to utilize existing in vivo/in situ materials and processes. (As he notes, power might be provided for medical "nanorobots" in the form of glucose and oxygen readily available in the bloodstream.) So his designs must be both reasonable and also accurately based on known physical, chemical, and biological principles and facts, and they must also be in line with reasonable and safe engineering capabilities and practice.

At the same time, as far as possible, his system must be self-contained, much as in the Apollo moon landings of some decades ago. It was a daunting task, but he made progress. As Freitas himself puts it:

"The typical medical nanodevice will probably be a micron-scale robot assembled from nanoscale parts. These parts could range in size from 1-100 nm (1 nm = 10^{-9} meter), and might be fitted together to make a working machine measuring perhaps 0.5-3 microns (1 micron = 10^{-6} meter) in diameter. Three microns is about the maximum size for bloodborne medical nanorobots, due to the capillary passage requirement."[130]

He goes on to say:

"Carbon will likely be the principal element comprising the bulk of a medical nanorobot, probably in the form of diamond or diamondoid/fullerene nanocomposites, largely because of the tremendous strength and chemical inertness of diamond. Many other light elements such as hydrogen, sulfur, oxygen, nitrogen, fluorine, silicon, etc. will be used for special purposes in nanoscale gears and other components."[131]

Nanomedicine, Volume I, is a technical book; for example, in one section we find:

"Mathematically, the positional uncertainty of a single carbon atom of mass $m_C = 2 \times 10^{-26}$ kg bound in a single C-C bond of stiffness $k_C = 440$ N/m may be crudely estimated from the classical vibrational frequency $\nu_C = (k_C/m_C)^{1/2} = 1.5 \times 10^{14}$ Hz. This sets the zero-point vibrational bond energy $E_C = h \nu_C / 2 = 4.9 \times 10^{-20}$ J = $k_C \Delta X_C^2 / 2$ where $h = 6.63 \times 10^{-34}$ J-sec (Planck's constant) and $\Delta X_C \sim 0.015$ nm is the maximum classical amplitude of the bound carbon atom (roughly the same as the 3 dB point for the gaussian wavefunction, notes J. Soreff). Thus ΔX_C is just ~5% of the typical atomic electron cloud diameter of ~0.3 nm, imposing only a modest additional constraint on the fabrication and stability of nanomechanical structures. (Even in most liquids at their boiling points, each molecule is free to move only ~0.07 nm from its average position.)"[132]

The list goes on of Freitas' thoughts relating to nanoscale medical devices. Human body fluids would not influence a medical nanorobot's internal operations, he tells us. The physical appearance of a human injected with these devices wouldn't change either. He also considers how to remove the robots from the body, if desired, once their task was completed. One such approach, involving his proposed

"respirocytes," would couple high tech filtration and centrifugation.

Concerns that nanorobots would be affected adversely by the body's already existing immune system are dealt with. First, we already have medical devices (for example, pacemakers) that in normal use are immunologically inert. Medical nanorobots may similarly be constructed so as not to cause response. In a "twist" that involves even further improvement along these lines, Freitas says:

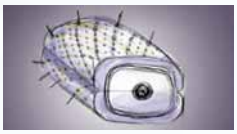
"Passive diamond exteriors may turn out to be ideal. Several experimental studies hint that the smoother and more flawless the diamond surface, the less leukocyte activity and the less fibrinogen adsorption you will get. … However, even if flawless diamond surfaces alone do not prove fully bioinactive as hoped, active surface management of the nanorobot exterior can be used to ensure complete nanodevice biocompatibility. Allergic and shock reactions are similarly easily avoided."[133] Freitas' *Nanomedicine* Vol. IIA (2003) is a book-length discussion of all these "biocompatibility" issues. [ref = http://www.nanomedicine.com/NMIIA.htm]

Freitas further points out that medical 'bots do not need a human level of intelligence in order to operate. Further, they should be of the kind that do *not* replicate themselves. There would be no good reason to place a replicating device inside a human body since it would be just as feasible (and safer) to manufacture all devices needed outside the body. "Replicators," Freitas adds, "will almost certainly be very tightly regulated by governments everywhere." [134]

Freitas indicates that glucose and oxygen may be a source of energy. One other way of powering nanoscale devices should be from acoustic energy that is applied externally (and probably in a clinical setting) via an ultrasound device. Freitas mentions other possible sources of power. With *Nanomedicine* in particular, he offers a serious, in-depth proposal to do something really great: using technology to vastly alleviate human illness and suffering and to do it in a way that is entirely plausible. Virtually all of it will also have direct and strongly positive implications for Ettinger's 1960s "assumption" in *Prospect of Immortality*: that technology can eventually rehabilitate a cryonics patient, even if imperfect methods must be used. Freitas is also responsive to the urgent need for progress now: "My professional goal for the last two decades has been, and continues to be, to help make life-extending medical nanorobotics technologies happen as fast as humanly possible."[135]

THE CONCEPT OF THE CHROMALLOCYTE

In 2007, Freitas published in the *Journal of Evolution and Technology* a very important and interesting study, "The Ideal Gene Delivery Vector: Chromallocytes, Cell Repair Nanorobots for Chromosome Replacement Therapy." Here Freitas tackles an important aspect of medical nanorobots, the design of a device that has as its purpose to do actual work on human genetic material itself, inside an individual cell.



(Artist's Rough Basic Conception of Chromallocyte With Motility Grapples Extended)

He comments: "This is the first full technical description of a cell repair nanorobot ever published. The nanorobot design addressed in the paper is a very important one—it is perhaps the key nanorobotic system for anti-aging and life extension applications."[136]

Freitas called this proposed medical nanorobot a "chromallocyte" (pronounced "crow-MAL-oh-site"). His proposal for how to develop the device has aptly caused excitement in the nanotechnology community and among others interested in cryonics. The successful construction of such a device, with its ability to interact with the body's molecular architecture, would greatly accelerate development of other similar devices. As soon as any one such device was available and accepted for what it could do, the race would be on to develop more of them and to fully and completely extend the range of their medical and other applications. But it will have to be implemented by humans, aided to whatever degree by modern engineering tools including, no doubt, artificial intelligence that can zero in on the particular problems of nanotechnology. Specialized software already exists, for instance, to help in the design of nanotechnological devices. As with NASA in the 1960s, problems will no doubt arise on the way toward full-fledged development (but so also may now-unforeseen opportunities). What Freitas said about so-called "nanofactories" seems quite applicable:

"It has been my experience that when you sweat the technical details, you start discovering all sorts of hidden roadblocks, detours, and needed workarounds/redesigns that were not recognized or anticipated from the outset. You'd be surprised at how many seemingly plausible diamond mechanosynthesis reactions turn out not to work so well upon closer inspection. I expect the universe to remain equally recalcitrant…"[137]

THE BASIC FUNCTION OF THE CHROMALLOCYTE

Freitas' chromallocyte is a medical nanorobot that would go into the body's cells and deal directly with genetic anomalies, whether inherited or acquired. It would do its work by replacing problematic versions of DNA with corrected, error-free versions. Freitas refers to this as "chromosome replacement therapy or CRT." It should be noted that each chromosome includes a mass of protein that is about equal to the mass of the DNA. In the nucleus of a cell there is very little (if any) free DNA. Chromatin is, then, the combination of the DNA and protein in the nucleus of non-dividing cells. Freitas' CRT method would thus upgrade the entire nuclear store of chromatin. (Today's working technique of CRISPR-Cas9 seems to be a decided step toward something of this nature; research on this and related technology is ongoing and vigorous.)

DNA is the "master chemical" of the body. Maintaining a fresh and "correct" version of this controlling substance should optimize the cell's own nanoscale ability to maintain maximum health, which in turn should optimize the body's health overall. With the addition to the mix of regular maintenance procedures and appropriate cell repair via medical 'bots, all as needed to maintain optimum health and vigor, the functioning of an organism should be brought under control that is undreamed of even in today's "high tech" medical endeavors.

Many diseases that both plague individuals and add to the considerable and growing cost of medical treatment today, result from the body's gradually losing control over its own cellular machinery. An example is the slowly increasing

incidence of cancer as one gets older. In youth, normal body processes tend to identify abnormal cells and eliminate them. With loss of cell control due to genetic alterations and/or errors that accumulate with time, the incidence of cancer rises steadily with each passing decade of life.

The chromallocyte would also perform an "extra" correction to eliminate any genetic defect that was present from conception. Even cancer cells themselves could be dealt with by correcting their genetic anomalies to make them "normal" again and not prone to unchecked replication.

Freitas speculates about the prospects of additional help as provided by respirocytes, microbivores[ref = http://www.jetpress.org/volume14/freitas.pdf], and other nanoscale devices, leading to indefinite youth:

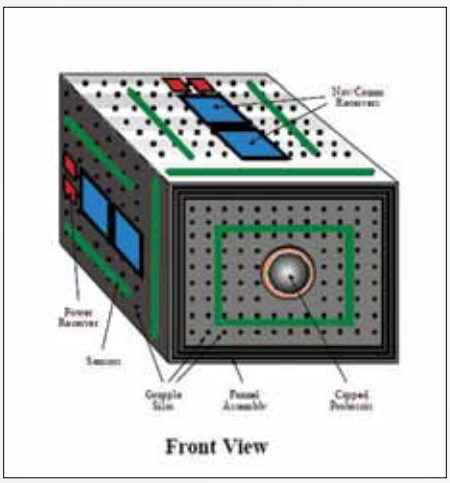
"Related medical nanorobots with enhanced tissue mobility could similarly consume tumor cells with unmatched speed and surgical precision, eliminating cancer. Other devices could be programmed to remove circulatory obstructions in just minutes, quickly rescuing even the most compromised stroke victim from near-certain brain damage. …The implications for extension of healthy lifespan are profound. Perhaps most importantly, chromosome replacement therapy could be used to correct the accumulating genetic damage and mutations that leads to aging in every one of your cells. With annual checkups and cleanouts, and some occasional major cellular repairs, your biological age could be restored once a year to a more or less constant physiological age that you select. Nanomedicine thus may permit us first to arrest, and later to reverse, the biological effects of aging and most of the current medical causes of natural death, severing forever the link between calendar time and biological health. … This sounds almost miraculous, but getting there is primarily an engineering and R&D challenge."[138]

SOME DETAILS ABOUT THE CHROMALLOCYTE

The chromallocyte is, of course, a highly technical device and it will not be possible to go into much depth here. Freitas' original article on the chromallocyte is recommended for those seriously interested.[139] What *will* be covered here is, I hope, a fascinating nontechnical introduction; any errors of interpretation or representation are entirely my own.

Projections show the chromallocyte will consist of about 4 trillion atoms and be a boxlike shape with dimensions about 3 x 4 x 5 micrometers. (Note: 1 micrometer = 1 micron; different authors prefer one term or the other.) A human hair by comparison is about 75 micrometers thick; a red blood cell is about 8 micrometers across, and a cell nucleus is about 5-10 micrometers across. The chromallocyte in particular should be able to penetrate the nucleus enough to carry out its work.[140] Its volume will be less than one percent of a typical cell volume, though up to around a quarter of the nucleus's volume.

The "front end" of the chromallocyte is what Freitas calls the Proboscis. This essential part sits in the center of one of the 3 x 4 micrometer "box ends" (see schematic illustration). It has two major functions, to gather and clear out old, error-laden chromatin in the cell, and to insert fresh, corrected chromatin back in.



Gathering and clearing out old chromatin proceeds as follows. The chromallocyte inserts itself into the nucleus of the cell. (There are sensors on the Proboscis to prevent excessive extension through the far wall of the nucleus.) After biochemically blocking various normal cellular responses and triggering chromatin detachment inside the nucleus, the Proboscis is extended to the proper length, and some tines are deployed and placed in a chromophilic configuration to attract the chromatin. The Proboscis then is rotated to spool up the chromatin, like thread being wound up on a bobbin. (Special care is taken to insure that the Proboscis is rotated slowly enough and is well anchored enough that the torque developed by spooling will not cause damage to the structures the Proboscis is anchored to, especially the nuclear membrane.)

Besides the Proboscis there is a second important part of the chromallocyte, an assembly that resembles, to some degree, the collapsible drinking cups available at sporting goods stores and which is called the "Funnel." (See the illustration below.) This part can be extended and deployed to initially act as a gathering site for chromatin. It can then surround and seal both the Proboscis and the spooled up chromatin that is wrapped around it. (After the Funnel forms the seal, the surface chromophilicity is switched off and the tines on the Proboscis are retracted.)

Artist's illustration of chromallocyte with the "Funnel" and "Proboscis" extended

One safeguard after spooling up the old chromatin is to release an enzyme to digest stray strands of DNA that might have escaped the spooling process. The enzyme is then recaptured. It will help insure that no old DNA or even intact genes that might remain could possibly interact with the new chromatin to be injected or could find their way to neighboring cells or could duplicate DNA that is being injected, and/or cause presently unforeseen problems by remaining in the cell undergoing CRT.

At the appropriate time after the preceding steps, new chromatin is injected into the nucleus through a bore in the center of the Proboscis, which then acts like the familiar hypodermic needle. The new chromatin is held in a third, very important component, two storage tanks located at the base of the chromallocyte, called the North and South Vault, respectively. (Some logistical details dictate that precisely two vaults are convenient here.) The active injection of the new chromatin into the nucleus is accomplished, if need be, by pumps and water purges. This will help in capturing old chromatin by the partial

vacuum that forms as new chromatin is forcibly pumped from the storage tanks. The old, spooled up, chromatin "waste" enclosed in the Funnel ends up in the storage tanks where it remains until the entire chromallocyte is removed from the patient's body.

This process is also helped to a successful conclusion by changing the chromophilic tines configuration of the Proboscis to a chromophobic one. The pressure brought about by the Funnel being gradually, mechanically retracted helps squeeze the old chromatin toward the base of the chromallocyte. To aid in the process, an enzyme that helps break down the old chromatin (and which is then reacquired by the chromallocyte mechanism similar to the recapture of enzymes used to deal with "stray" DNA or intact genes) might be used. It would make the old chromatin more fluid and insure that no unwanted residual material remains attached to the Funnel interior, the Proboscis exterior, or any other part of the device that has been in contact with "used" chromatin.

By a lucky happenstance of nature, if the new chromosomes to be injected are divided into "odd" and "even" numbered pairs, the volume needed to store each set in the base of the chromallocyte turns out to be almost identical. Thus two storage tanks of about 20 cubic microns each turns out to be sufficient and both will fit nicely on either side of the base of the chromallocyte. Vault unloading can be pulsed between the North and South Vaults to vary the sequence of chromosomes to be injected, although the chromosome sequence within one vault was fixed at the time of loading.

Mechanisms such as a diaphragm or some sort of piston driven device may be needed to insure, in part, that old and new chromatin remain separated during the entire extraction/injection process. These might also help prevent water leakage around the chromatin, help provide smooth passage of new chromatin, and also serve as a barrier if an enzyme was needed to break up and decrease the viscosity of the old chromatin.

Telescoping "grapples" are kept in the body of the chromallocyte and can be deployed to latch on to individual cellular fibrils or other structures in their vicinity. They will also help the chromallocyte penetrate both vascular walls and cell or nuclear membranes since, as Freitas puts it, "molecular handholds" are abundant. At the end of the grapples are reversible footpads. This combined arrangement provides the means of motion for the chromallocyte. "Silos" in the body of the chromallocyte to store the grapples, capped with irislike covers, help keep the chromallocyte exterior smooth to reduce resistance as the chromallocyte moves through a liquid or semiliquid environment.

In case the device finds itself detached from all fibrous moorings (having to "swim for its life"), there are two possible strategies. First, the Proboscis can be extended to search for mooring structures within reach of the chromallocyte grapples. Second, if this fails, the grapples can be used as "cilia" to produce forward motion like a paramecium. The grappling mechanism itself was previously described in Freitas' work on the microbivore. [ref = http://www.jetpress.org/volume14/freitas.pdf]

The "brain power" for the chromallocyte is twofold. Onboard will be a computer similar to that of the microbivore. The chromallocyte computer will have extra memory due to the greater demands placed on it. Greater reliability and safety are called for since failure of the chromallocyte could have more serious consequences than failure of the microbivore. In addition, through ultrasound signaling, a physician can send/receive signals to/from the chromallocyte. Most of the time, however, the device will operate semi-autonomously.

While the microbivore had an oxyglucose fuel cell system, the larger chromallocyte has less free space onboard and resources for energy production in its environment inside cells will be limited. Thus power for the chromallocyte will be sent externally via ultrasound waves and received through ten external receptors located on the chromallocyte surface, providing a tenfold redundancy that is, where possible, a standard design feature of the device. (The surface will also have to have receptors and transmitters for acoustic signaling from/to external sources.) For onboard energy storage, each chromallocyte will be equipped with ten diamondoid flywheels to provide ample redundancy. Internal power distribution will be through diamondoid cables.

New chromatin will be manufactured using "generic" human genetic information coupled with a chromallocyte-based "microbiopsy" of at least one hundred cells of the target organ. This will reveal how the individual's genomic structure differs from the general population's. The information can then be incorporated into the new, "corrected" chromatin to be inserted into the target organ's cell nuclei. All cells of the target organ need to have the same basic genetic structure. If necessary, an additional "microbiopsy" of the organ or others may be made if further genetic information is needed before the actual replacement of chromatin begins.

Freitas prooposes that a basic mission for a chromallocyte will occur in five phases and take about seven hours, including patient preparation and recovery room time. The first phase will consist of an organ survey. Navigational guides and information necessary to help the chromallocyte do its job are put in place using a navigation grid and navigational aiding nanorobots. In this way the organ's structure is mapped and each cell to receive CRT is assigned an address. (It should be noted that the chromallocyte is not to be a standalone device but part of an extensive system, including "navicytes" – navigational nanorobots – coupled with chromatin/chromallocyte nanofactories and other things that must be present to assist the chromallocyte in doing its work.)

For the next phase samples of DNA are collected from the target organ via the microbiopsy and analyzed to determine corrections that need to be made. The upgraded DNA is then manufactured in a specialized desktop device outside the patient's body and loaded into the chromallocytes' twin vaults as described above. Up to a trillion or more chromallocytes are prepared in this way as needed, each programmed to the unique address of one target cell.

For the third phase the patient is placed on an ultrasonic vibrating table with gel interface to facilitate sound transmission, to both power the chromallocytes and allow for 2-way signalling. The patient is sedated and either respirocytes are injected or hypothermia is used to greatly reduce oxygen demands, allowing for a slower pulse rate and reduced blood velocity conducive to the chromallocytes' work.

At the fourth phase the chromallocytes are introduced, one for each nucleus to receive the CRT procedure. Additional or recharged respirocytes are added as needed. Microbivores stand sentinel to insure

the sterility and safety of the procedure by dealing with bacteria or viruses that might have been accidentally introduced and also any non- or poorly functioning chromallocytes. Other devices will have been deployed as needed for navigational or other purposes. The chromallocytes assisted by all other devices complete their mission. Those not needed to be left in the patient return to their insertion point to be removed from the patient's body.

Finally, for the fifth phase the patient is removed from sedation and normal vital signs are restored. Before the patient is discharged double checks are made to insure that any nanodevices not intended to be left in place have been removed.

Some caveats are noted for the CRT protocol with suggested remedies. The body's cells have numerous feedback mechanisms which protect them from injury or death. Injury that the cell's defenses respond improperly to can trigger programmed cell death (called "apoptosis"). Some activities of the chromallocyte could trigger such response. Freitas proposes as a possible remedy to release engineered apoptosis inhibitors into the cell. A kind of cellular anesthesia would result where self-destruction is put on hold. The inhibitors would only act long enough for the chromallocytes and other devices to do their work and then be disabled and removed.

As an additional safety precaution, chromallocytes will not be allowed to "free float" in the body. They will be limited to vascular surfaces when traversing the bloodstream, both during infusion at the beginning of the procedure and in extraction from the body at the end. In the case of a failure and immobilization of a chromallocyte in a cell, the usual outcome would be the death of the cell and eventual ejection of the inert device into the extracellular medium. Natural body processes and/or devices such as the microbivore or scavenger nanorobots would then take care of the problem. This event should be extremely rare due to the built in redundancy and design strength safety factors of chromallocyte systems. Freitas is careful to choose a robust design approach, with built-in redundancies and extra strength to reduce the likelihood of failure to minuscule levels. Research and development will, in any event, provide feedback for any possible alterations the design may need.

Numerous internal and external sensors (temperature, chemical, pressure) will aid the chromallocyte in effectively and safely carrying out its work. These were previously proposed for the microbivore, showing how subsequent designs can benefit from prior work. The chromallocyte is larger than the microbivore and is expected to use about twice the number of sensors.

Cryonics cannot be considered just "an act of faith," as some of its critics used to say, but must be considered, instead, very clearly and very much "an act of reason."

RALPH MERKLE AND ROBERT FREITAS' JOINT EFFORTS

Ralph Merkle and Robert Freitas are world-class authorities in nanotechnology. It is not surprising that their paths would cross, with opportunities for joint ventures. Space limitations again will bound our coverage, but a couple of items can be mentioned.

KSRM: In 2004, Freitas and Merkle teamed up on a book, *Kinematic Self-Replicating Machines*, which dealt with the ability of automated systems to replicate themselves without direct human intervention. The volume opens with a history of the field all the way back to Descartes (much as *Nanomedicine* starts with an extensive review of the history of medical practices). It then discusses the difference between self-replication and self-reproduction, talks about safeguards to insure that replicating processes remain under control, and considers more generally the strong and essential need for public safety in regard to replicating machinery.

Nanofactory Collaboration: In Robert Freitas' own words from a few years back:

"Several years ago, Ralph Merkle and I founded the Nanofactory Collaboration to coordinate a combined experimental and theoretical R&D program to design and construct the first working diamondoid nanofactory, which could then build medical nanorobots. This long-term effort must start by developing the initial technology of positionally controlled mechanosynthesis of diamondoid structures using engineered tooltips and simple molecular feedstock. Our Collaboration has led to continuing efforts involving direct collaborations among more than two dozen researchers at a dozen organizations in 5 countries—the U.S., U.K., Russia, Australia, and Belgium. A dozen peer-reviewed papers are published or in progress as of 2008."[141]

(Those interested in further info can go to: http://www.molecularassembler.com/Nanofactory/)

Freitas further observes:

"The development pathway will be lengthy and difficult. First, theoretical scaling studies must be used to assess basic concept feasibility. These initial studies would then be followed by more detailed computational simulations of specific nanorobot components and assemblies, and ultimately full systems simulations, all thoroughly integrated with additional simulations of massively parallel manufacturing processes from start to finish consistent with a design-for-assembly engineering philosophy. Once molecular manufacturing capabilities become available, experimental efforts may progress from component fabrication and testing, to component assembly, and finally to prototypes and mass manufacture, ultimately leading to clinical trials."[142]

The road may be long, as even Freitas affirms, but at the same time it is a road that can be traveled. With constant feedback from each of the steps, nanoscale automata will emerge and find increasing application in medicine along with other fields.

OTHER WORKERS IN NANOTECHNOLOGY/THE IMPACT ON CRYONICS

There are, in addition to Drexler, Merkle, and Freitas, other researchers who are trying to push nanotechnology forward with all due diligence and speed. Cryonicists will surely benefit from those efforts even as advances in other fields also help the practice of cryonics (cryopreservation of human organs for transplantation, for instance). Those involved both in and outside of cryonics must become aware of these technologies, at least at a journeyman level, and push political and social leaders to favor them, which means making sure, in the first instance, that the leaders themselves are well-informed. The benefits are such that we can expect a feedback effect –

benefits leading to more research leading to still more benefits and so on. Society in general and cryonics in particular should both stand to gain immensely.

The whole thrust of the entire effort in this article (printed in this magazine in several parts) has been to expound on the technology of revival, repair, and rejuvenation, as far as cryonicists are concerned. This comes down, in a nutshell, to a couple of points analogous to those Robert Ettinger made in *The Prospect of Immortality* many years ago:

1. Persons placed in cryogenic storage stay that way – just as they were when the procedure was finished. No significant change in their state once they reach those ultra-low temperatures will occur. With future developments in cryobiology and cryonics, it is reasonable also to hope that "damage free cryonics" will eventually be practiced.

2. Whether damage free cryonics ever becomes a reality or not, the development of nanotechnology (which might better be termed "nanoengineering") will result in the great and fundamental ability of human beings to manipulate matter at the molecular and atomic scale. Biological structures will then be modifiable in such a way and with such economy as to enable us to restore them to a functioning state, including structures that aren't functioning at all. The restoration will ensure the full youthful health and vigor of the cryonics patient, and may offer options beyond our imagining today.

As Ralph Merkle, in his Afterword to Freitas' Volume I *Nanomedicine*, so well put it:

"The future capabilities of nanomedicine give hope and inspiration to those of us who still have decades of life to look forward to, but some are not so fortunate. Many others who rightfully should live several decades more might find that chance cuts short their expected time. Heart attacks and cancer can strike us down even in the prime of our lives. They do not always wait their turn and politely arrive only when expected. How can today's dying patient take advantage of a future medical technology that is as yet only described in a handful of theoretical publications? How can we preserve the physical structure of our bodies well enough to permit that future medical technology to restore our health?

"The extraordinary medical prospects ahead of us have renewed interest in a proposal made long ago: that the dying patient could be frozen, then stored at the temperature of liquid nitrogen for decades or even centuries until the necessary medical technology to restore health is developed. Called cryonics, this service is now available from several companies. Because final proof that this will work must wait until after we have developed a medical technology based on the foundation of a mature nanotechnology, the procedure is experimental. We cannot prove today that medical technology will (or will not) be able to reverse freezing injury 100 years from now. But the patient dying today must choose whether to join the experimental group or the control group. The luxury of waiting for a definitive answer before choosing is simply not available. So the decision must be made today, on the basis of incomplete information. We already know what happens to the control group. The outcome for the experimental group has not yet been confirmed. But given the wonderful advances that we see coming, it seems likely that we should be able to reverse freezing injury – especially when that injury is minimized by the rapid introduction through the vascular system of cryoprotectants and other chemicals to cushion the tissues against further injury." [143]

In closing: the case for cryonics, as made by Robert Ettinger back the 1960s, was a reasonable one to begin with. This four-part article has outlined some reasonable scenarios for how the revival, repair, and rejuvenation of cryonics patients may be carried out. It would happen through technologies that are not yet fully developed, but still are based on solid scientific and engineering thinking and principles. A cryonics patient has already had something very bad happen to them: clinical death. Other than the cost of the procedure, which can often be reasonably managed through life insurance, they have nothing to lose and everything to gain by taking advantage of this revolutionary concept.

Numerous well-trained and properly credentialed people have gained knowledge in quite a number of cryonics-related fields. There can be little doubt, therefore, that cryonics is a reasonable thing to do. On the contrary, failure to avail oneself of this concept continues, with the passage of years and piling up of more and more solid evidence in its favor, to be perhaps the most unreasonable life choice one can make. The odds in favor of the modified "Pascal's Wager" cryonicists are making continue to get better with each passing day. The alternative to cryonics (or some effective form of biostatic preservation) continues to stay the same: oblivion and personal extinction. The choice, then, is clear and simple. Cryonics cannot be considered just "an act of faith," as some of its critics used to say, but must be considered, instead, very clearly and very much "an act of reason." ■

About The Author

York W. Porter, born in 1952, attended Berea College in Berea, Kentucky for two and a half years and, in Fall 1974, began working in a rural Kentucky hospital in the Department of Radiology. Diversifying through the years, Mr. Porter worked for one year on an ambulance crew and spent several years in a hospital laboratory setting, plus about a year doing respiratory therapy work. He has worked fairly continuously in the field of medical radiography, serving as a staff tech at various times in four rural Kentucky hospitals, primarily in the fields of general radiography and computed tomography. He also works on rare occasions at a Magnetic Resonance Imaging (MRI) center. He presently holds certifications as a Kentucky EMT-B and as a Licensed Radiation Operator (Kentucky's phrase for an x-ray tech). He is the President of the Immortalist Society, at the time of this writing, and serves as Executive Editor of its "house publication," *Long Life Magazine*.

SOURCES (REFERRED TO IN ENDNOTES, BELOW)

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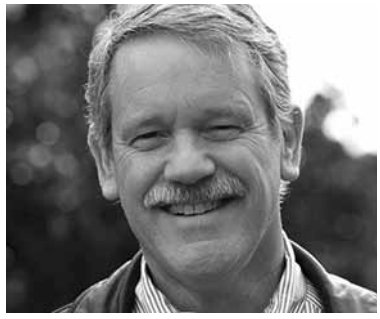
ENDNOTES

120	FG.	128	ED.	135-137	RF6.	142	RF5.
121	RF4.	129	RF2.	138	RF8.	143	RM.
122-124	DPP.	130-131	RF1.	139	RF7.		
125-126	RF4.	132	RF2.	140	CT.		
127	RF3.	133-134	RF1.	141	RF8.		

Interview with Robert A. Freitas



Conducted in March 2016 by Aschwin de Wolf

"Another strategy I've employed to get medical nanorobotics work out the door is to publish material intended for the last two books in the NM series as stand-alone papers or book chapters as I get time to finish them…"

1. Can you tell us what the status is on your Nanomedicine book series?

RF: It's been diffcult to find the multiple years of full-time effort to finish books that look to be even longer than the earlier ones in the series. I'm still accumulating material for the remaining two books, but have been spending a lot of time working on the implementation side of things, publishing major papers on mechanosynthesis (e.g., http://www.molecularassembler.com/Papers/MinToolset.pdf, http://www.molecularassembler.com/Papers/TarasovSep2013.pdf), quantum chemistry studies on the stability of small diamondoid nanoparts (e.g., http://www.molecularassembler.com/Papers/TarasovFeb2012.pdf), and so forth. Another strategy I've employed to get medical nanorobotics work out the door is to publish material intended for the last two books in the NM series as stand-alone papers or book chapters as I get time to finish them, as for example http://www.nanomedicine.com/Papers/NanorobotControl2009.pdf,http://arxiv.org/pdf/1202.0568v2, and http://www.nanomedicine.com/Papers/Aging.pdf). Along these lines, I'm just now finishing up a very long paper on the nanorobotic cure for Alzheimer's disease (in preparation for more than a year) that I might be ready to publish in a few more months.

2. What experimental work in molecular nanotechnology are you most excited about?

RF: The experimental work that isn't being done yet on mechanosynthesis. Several not-quite-MNT areas remain interesting, such as the fast developing fields of DNA nanotechnology and DNA origami which have self-assembled a variety of interesting nanoscale mechanical components (http://www.foresight.org/nanodot/?p=6467), including most recently a 3-piece rotary mechanism (http://www.foresight.org/nanodot/?p=7011). 3D printing is perhaps the most rapidly growing area in all of manufacturing. Commercially available additive 3D manufacturing systems can fabricate structures with <100 nm feature sizes (e.g., http://www.oldworldlabs.com/#!3d-printers-from-old-world-labs/cw3p), and beam-based methods (e.g., https://www.ornl.gov/news/new-electron-microscopy-method-sculpts-3-d-structures-atomic-level) can sculpt structures with feature sizes <10 nm (~50 carbon atoms wide). Perhaps the most amusing recent development is the international NanoCar Race, scheduled for Autumn 2016, which is being hailed as "the first-ever race of molecule-cars" (http://nanocar-race.cnrs.fr/indexEnglish.php). It's not exactly nanorobots, but it's focusing attention in the right direction.

3. Does the accelerated pursuit of molecular nanotechnology constitute the most efficient anti-aging strategy?

RF: Good question. Yes. To paraphrase a bit from my anti-aging paper, folding in your question: In my view, nanotechnology will play a pivotal role in the solution to the problem of human aging, and the accelerated pursuit of molecular nanotechnology constitutes the most efficient anti-aging strategy. It is true that purely biotechnological solutions to many, and perhaps most, of the major classes of age-related damage may be

found, but we have no guarantee that biotechnology will find solutions to *all* the major classes of age-related damage. If treatments for one or more of the numerous major sources of aging are not found, we will continue to age – albeit at a slower rate – and possibly with little or no substantial increase in the average human lifespan. Medical nanorobotics, on the other hand, can almost certainly offer convenient solutions to all known causes of age-related damage and other aspects of human senescence, and most likely can also successfully address any new causes of senescence that might remain undiscovered today (http://www.nanomedicine.com/Papers/Aging.pdf). Medical nanorobotics is the ultimate "big hammer" in the anti-aging toolkit. Its development – as fast as humanly possible – is our insurance policy against the risk of a failure of biotechnology to provide a comprehensive solution to the problem of aging. And nanorobotic medicine, once developed, probably enables superior treatments for all aspects of aging – especially the most difficult aspects – as compared to the methods of biotechnology.

"In my view, nanotechnology will play a pivotal role in the solution to the problem of human aging, and the accelerated pursuit of molecular nanotechnology constitutes the most efficient anti-aging strategy."

4. Do you think biological viruses (or white blood cells) can be modified to do general cell repair work?

RF: It's not impossible that biological viruses (or white blood cells) could be modified to do general cell repair work at human body temperature, but I've focused exclusively on preferable systems made of stronger materials that are capable of faster and more precise motions, and that have deterministic atomically precise designs with onboard computers that can execute lengthy complex activity programs controlled by a myriad of sensor-driven conditionalities.

Biological viruses and white cells can't function at cryogenic temperatures. This excludes them from much of the necessary revival work on existing cryopreserved patients, for whom fracturing may be a major issue.

5. Should we expect the repair of cryonics patients to be conducted at cryogenic temperatures?

RF: The early stages in the repair of cryonics patients will most likely be conducted at cryogenic temperatures, although some of the anticipated procedures may be performed upon warming as noted in http://www.alcor.org/Library/html/MNTscenario.html.

"Biological viruses and white cells can't function at cryogenic temperatures. This excludes them from much of the necessary revival work on existing cryopreserved patients, for whom fracturing may be a major issue."

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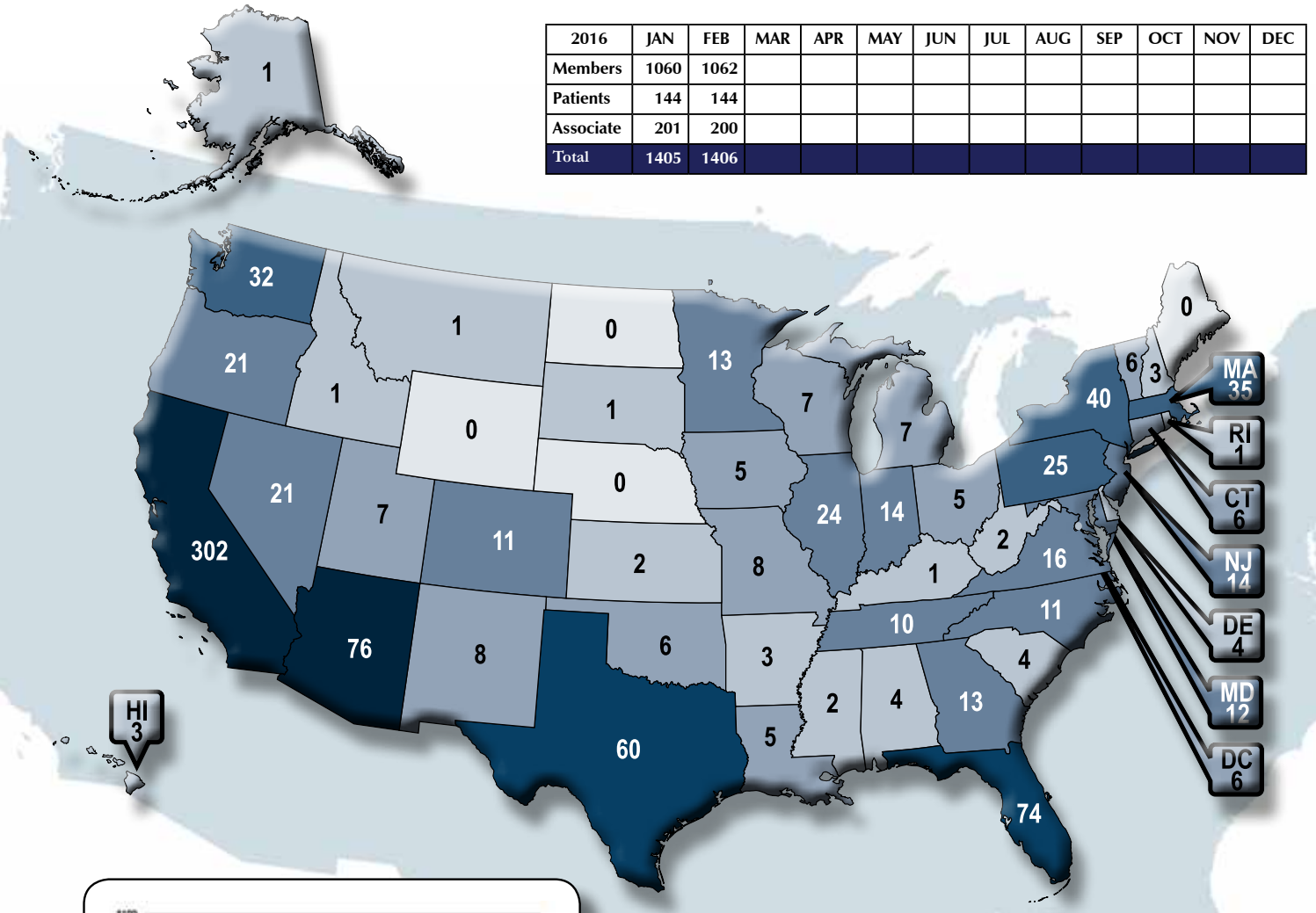
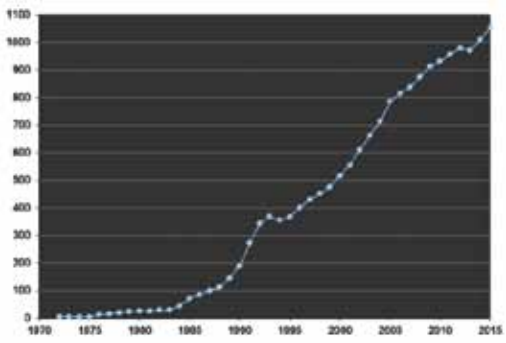
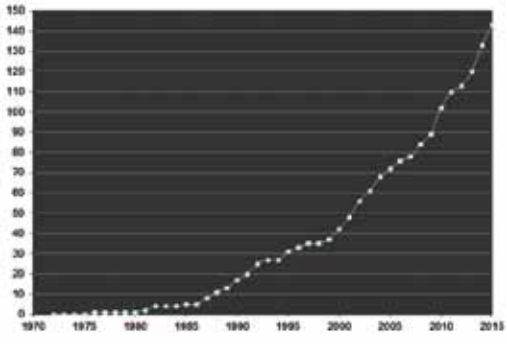
Membership Statistics

2016	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Members	1060	1062										
Patients	144	144										
Associate	201	200										
Total	1405	1406										





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

Country	Members	Patients
Australia	13	3
Canada	49	2
China	0	1
Germany	8	0
Hong Kong	1	0
Israel	1	1
Italy	3	0
Japan	4	0
Mexico	4	0
Monaco	1	0
Netherlands	1	0
New Zealand	1	0
Norway	1	0
Portugal	4	0
Singapore	1	0
Spain	3	1
Thailand	4	1
United Arab Emirates	1	0
United Kingdom	26	3
TOTAL	**126**	**12**

Artificial Implantable Kidney

Vanderbilt University Medical Center nephrologist and Associate Professor of Medicine Dr. William H. Fissell IV, is making major progress on a first-of-its kind device to free kidney patients from dialysis. He is building an implantable artificial kidney with microchip filters and living kidney cells that will be powered by a patient's own heart. "We are creating a bio-hybrid device that can mimic a kidney to remove enough waste products, salt and water to keep a patient off dialysis," said Fissell. Fissell says the goal is to make it small enough, roughly the size of a soda can, to be implanted inside a patient's body. The key to the device is a microchip. "It's called silicon nanotechnology. It uses the same processes that were developed by the microelectronics industry for computers," said Fissell. The chips are affordable, precise and make ideal filters. Fissell and his team are designing each pore in the filter one by one based on what they want that pore to do. Each device will hold roughly fifteen microchips layered on top of each other. "They're also the scaffold in which living kidney cells will rest," said Fissell.

Amy Wolf / Vanderbilt University
12 Feb. 2016
http://news.vanderbilt.edu/2016/02/vu-inside-dr-william-fissell%E2%80%99s-artificial-kidney/

Neuroscientists Reverse Autism Symptoms

Autism has diverse genetic causes, most of which are still unknown. About 1 percent of people with autism are missing a gene called Shank3, which is critical for brain development. Without this gene, individuals develop typical autism symptoms including repetitive behavior and avoidance of social interactions. In a study of mice, MIT researchers have now shown that they can reverse some of those behavioral symptoms by turning the gene back on later in life, allowing the brain to properly rewire itself. "This suggests that even in the adult brain we have profound plasticity to some degree," says Guoping Feng, an MIT professor of brain and cognitive sciences. "There is more and more evidence showing that some of the defects are indeed reversible, giving hope that we can develop treatment for autistic patients in the future." Feng is the senior author of the study, which appears in the Feb. 17 issue of *Nature*. The paper's lead authors are former MIT graduate student Yuan Mei and former Broad Institute visiting graduate student Patricia Monteiro, now at the University of Coimbra in Portugal.

Anne Trafton / MIT News
17 Feb. 2016
http://news.mit.edu/2016/neuroscientists-reverse-autism-symptoms-0217

Better Survival of Implanted Cells Improves Healing of Bone Fractures

To treat a complicated, non-healing bone defect, surgeons often use an implant with living cells to promote bone repair, but the implanted cells have a small chance of surviving because they are not prepared for a lack of oxygen and nutrients at the fracture site. Scientists from KU Leuven have now improved survival of these bone cells by preconditioning them to withstand the harmful environment before implantation. Their findings were published in *Cell Metabolism*. When breaking an arm or leg, your body can repair the fracture itself in most cases. However, the body's repair capacity is not sufficient in large bone fractures or defects, which often fail to heal without help. To support bone generation, researchers worldwide are now developing living implants, consisting of cells seeded on supporting structures made of biological material. Unfortunately, many obstacles still need to be tackled before we have a functional living implant, explains Professor Geert Carmeliet of the Clinical and Experimental Endocrinology Unit. …

KU Leuven (Belgium)
19 Feb. 2016
http://www.kuleuven.be/english/news/2016/better-survival-of-implanted-cells-improves-healing-of-bone-fractures

Scientists Use Light to Alter Memories of Cokehead Mice

Researchers from the University of Oxford have rewritten positive memories associated with cocaine in mice. The achievement could expand our understanding of memory, while demonstrating that it's possible to neurologically reverse ingrained bad behavior, such as drug addiction. Neuroscientists Stéphanie Trouche and David Dupret from Oxford's MRC Brain Network Dynamics Unit trained mice to prefer a particular location using cocaine. Then they altered those positive associations using optogenetics—a genetic technique in which living brain cells can be manipulated or controlled with light (typically via fiber optic cables). The mice lost their preference for the cocaine-associated environment, suggesting their memory had been rewritten. The results of this experiment can now be found in *Nature Neuroscience*. The study affirms the engram theory of memory consolidation, suggesting that our memories are stored as biophysical or biochemical changes in the brain in response to external stimuli and experiences.

Gizmodo
22 Feb. 2016
http://gizmodo.com/scientists-use-light-to-alter-memories-of-cokehead-mice-1760548705

Skin Cells Modified to Kill Cancer

In a first for medical science, University of North Carolina at Chapel Hill pharmacy researchers turn skin cells into cancer-hunting stem cells that destroy brain tumors known as glioblastoma—a discovery that can offer, for the first time in more than 30 years, a new and more effective treatment for the disease. The technique, reported in *Nature Communications*, builds upon the newest version of the Nobel Prize-winning technology from 2007, which allowed researchers to turn skin cells into embryonic-like stem cells. Researchers hailed the possibilities for use in regenerative medicine and drug screening. Now, researchers have found a new use: killing brain cancer. "Patients desperately need a better standard of care," said Shawn Hingtgen, Ph.D., an assistant professor in the UNC Eshelman School of Pharmacy and member of the Lineberger Comprehensive Care Center, who led the study. The survival rate beyond two years for a patient with a glioblastoma is 30 percent because it is so difficult to treat.

University of North Carolina, Chapel Hill
24 Feb. 2016
http://uncnews.unc.edu/2016/02/24/unc-chapel-hill-researchers-make-groundbreaking-discovery-use-skin-cells-to-kill-cancer/

Building Living, Breathing Supercomputers

A discovery may open doors to a new generation of small-size supercomputers, each about the size of a book, powered by the substance that provides energy to all the cells in our bodies, Adenosine triphosphate (ATP). That is what an international team of researchers led by Prof. Nicolau, the Chair of the Department of Bioengineering at McGill University, Montreal, believe. They've published an article on the subject this week in the Proceedings of the National Academy of Sciences (PNAS), in which they describe a model of a biological computer that they have created that is able to process information very quickly and accurately using parallel networks in the same way that massive electronic super computers do. Except that the model bio supercomputer they have created is a whole lot smaller than current supercomputers, uses much less energy, and uses proteins present in all living cells to function. "We've managed to create a very complex network in a very small area," says Dan Nicolau, Sr. with a laugh. He began working on the idea with his son, Dan Jr., more than a decade ago…

Katherine Gombay / McGill University
26 Feb. 2016
http://www.mcgill.ca/newsroom/channels/news/building-living-breathing-supercomputers-259294

A Roadmap to Resuscitation

Successful rejuvenation 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 list is a list of landmark papers and books that reflect ongoing progress towards the resuscitation 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(January 1994):16-31 (Part I) & *Cryonics* 15(April 1994):20-32 (Part II).

Ralph C. Merkle, **"Cryonics, Cryptography, and Maximum Likelihood Estimation,"** First Extropy Institute Conference, Sunnyvale CA, 1994.

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, pp. 685-805.

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

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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.

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PHOENIX
VALLEY OF THE SUN:

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 Lisa Shock at lisa@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.

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.

PACIFIC NORTHWEST

A Yahoo mailing list is also maintained for cryonicists in the Pacific Northwest at http://tech.groups.yahoo.com/group/CryonicsNW/.

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 Cryonauts, please sign up for our announcements list for meetings (http://groups.yahoo.com/group/cryonauts-announce) or contact David Wallace Croft at (214) 636-3790 for details of upcoming meetings.

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
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- 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?

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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.
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- Access to post in the Alcor Member Forums
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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

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