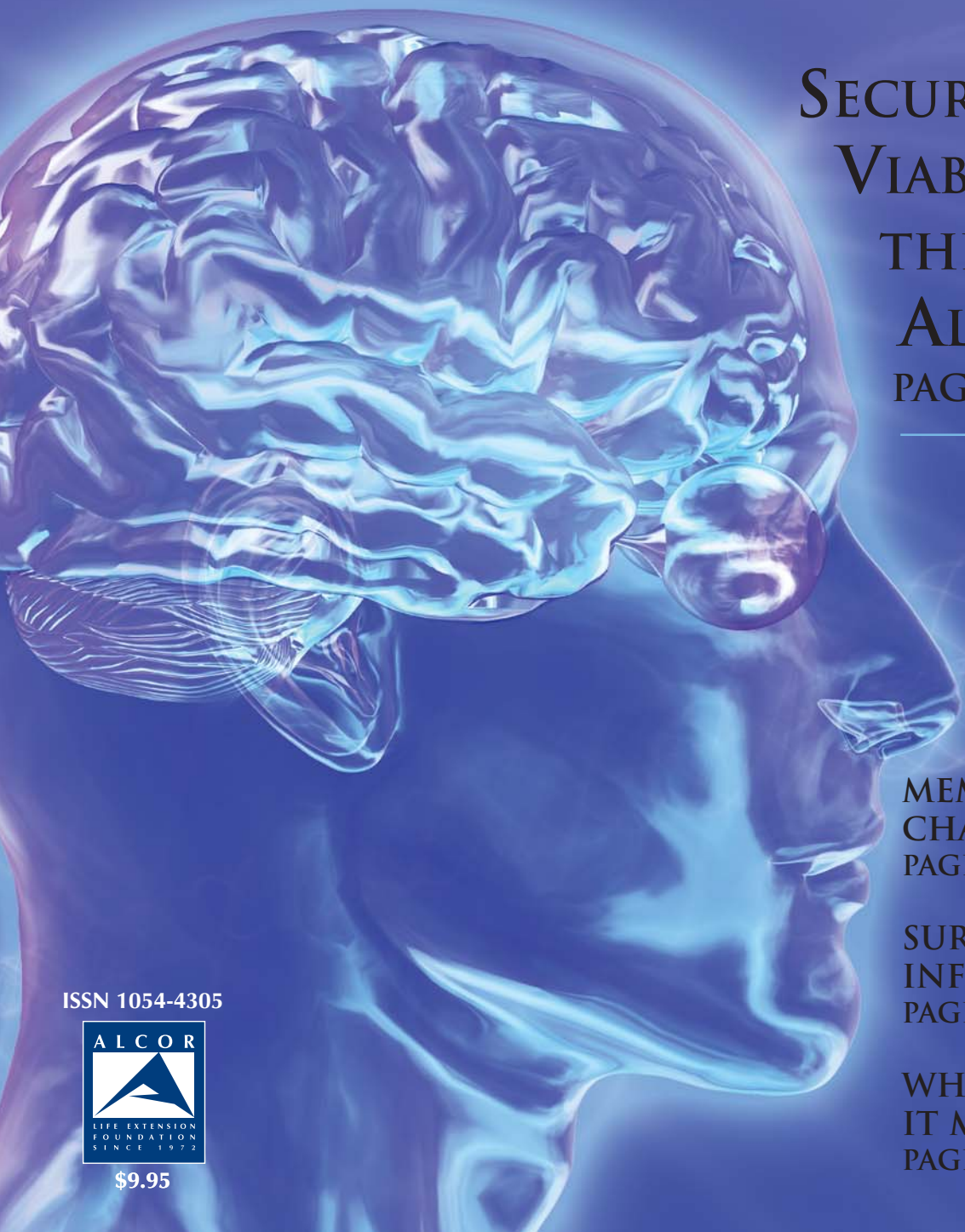
ALCOR LIFE EXTENSION FOUNDATION

CRYONICS

2ND QUARTER 2007 • VOLUME 28:2

IS YOUR BRAIN YOUR "SELF"?



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LIFE EXTENSION FOUNDATION

October 5-7, 2007

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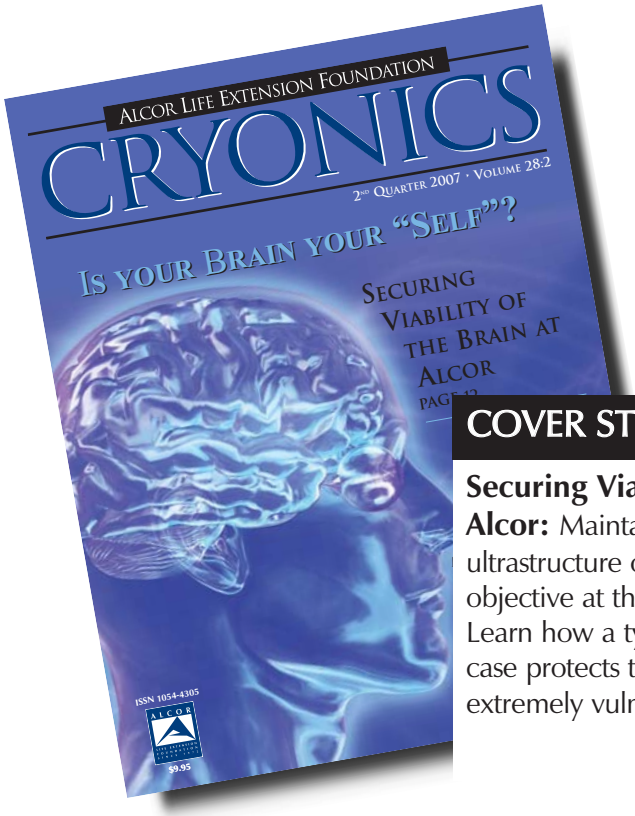

COVER STORY: PAGES 12-15

Securing Viability of the Brain at Alcor: Maintaining the viability and the ultrastructure of the brain is a prime objective at the Alcor Foundation. Learn how a typical cryopreservation case protects the brain, an organ extremely vulnerable to injury.

INSIDE CRYONICS

ALCOR LIFE EXTENSION FOUNDATION
CRYONICS

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FROM THE EDITOR

After weeks of writing, a proposal for Alcor's research laboratory is carefully proofread, then sent for consideration by the research committee. Months of phone calls and emails culminate in half a dozen newly approved Alcor members. Fifty organization-wide projects on a central list are prioritized during a meeting of the management team. All of this, and more, occur in a typical day at the Alcor Foundation.

With no shortage of directions the organization is growing – of areas requiring the staff's attention – seldom is there an opportunity to outwardly acknowledge the existence of the innate understanding amongst the Alcor staff and leaders as to why our daily efforts matter so much.

It is better cryopreservations for our members that we seek, right? True enough. Alcor's relentless emphasis on better brain cryopreservation continues with this issue ("Securing Viability of the Brain at Alcor", pg. 12). And central to Alcor's success at this is the skill of its employees. So we invite you to learn a little more about Alcor's research associate, Chana de Wolf, who also recently joined as a member of the organization (pg. 8).

But what is it about a better brain cryopreservation that is so very important?

The Alcor philosophy holds that the brain is the center of the person, harboring all the individual's memories and essential personhood. But does that personhood – that "self" – continue to exist after cryonics? Beginning on page 16, Ben Goertzel, Ph.D. questions the affair at the core of so many decades of effort by the Alcor Foundation ("What is a Self that it Might be Revived?") with further introspection offered by Max More, Ph.D. ("Survival through Inference", pg. 10).

This issue of *Cryonics* only touches on the deeper importance of Alcor's mission, as seen from just a few perspectives. As always we invite our readers to send letters to the editor on this topic or others of interest.

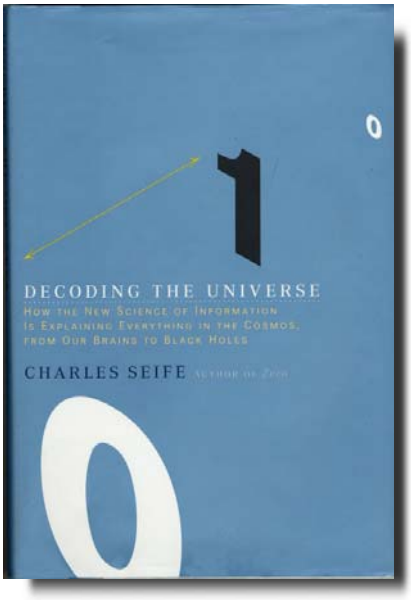
Register for the 7th Alcor Conference: www.alcor.org

DECODING THE UNIVERSE: HOW THE NEW SCIENCE OF INFORMATION IS EXPLAINING EVERYTHING IN THE COSMOS, FROM OUR BRAINS TO BLACK HOLES

By Charles Seife, New York: Viking, 2006

BOOK REVIEW BY R. MICHAEL PERRY, PH.D.

As transhumanists and immortalists we look to the time when advancing technology grants us major new options, including, we think, maybe even an end to death. As the centuries roll forward, if all goes well, we will naturally be concerned about where it's all heading. Many of us are actually interested now, and many recent books have addressed this rather daunting subject. Physics, astronomy, and other scientific pursuits are providing fresh and startling insights, as these writings inform us. Though we still have to admit that really solid answers are lacking and may be for some time, there is no denying that these books are arresting and thought-provoking. Among other things they often delve into what it is that makes us what and who we are, that is to say, issues of personal identity and survival, which are of special interest to immortalists.

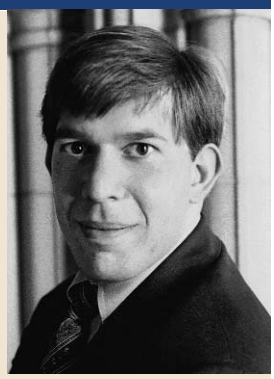


Decoding the Universe by Charles Seife is a recent offering in this "cosmological" genre and it champions a view of reality in which information is dominant. The book is written for a general audience and offers an easy introduction to information theory and what can be seen as its subsidiary, thermodynamics, along with essential rudiments of quantum theory and the special theory of relativity. No math or physics beyond a limited high school level is assumed. Concepts are explained through entertaining historical anecdotes and other pleasant and interesting routes.

Overall, we are treated to a view of reality that is grounded in non-controversial science but extends far into speculative, but fascinating, territory. The universe—our "Hubble bubble"—is in effect one vast quantum computation—and it is not alone. We, in turn, are software entities within this one computation, though in fact we are replicated elsewhere too, in other Hubble bubbles. These, in turn, exist in infinite profusion and come in all possible varieties, a tiny but still infinitely numerous fraction of which match ours exactly, others in varying degrees. The many-worlds view of reality is defended on grounds of it being necessary to harmonize quantum mechanics with special relativity, which forbids faster-than-light transmission of information. Life, including ourselves, is a "complex dance to duplicate and preserve information"; our brains and thus our minds and our selves are information-processing systems of a certain type and nothing more.

In approaching such a writing as this, it is important to keep in mind the speculative character of the more interesting conclusions. Some wiggle room is provided if, on some issue, you have reason to doubt; it is not denied that the picture could change significantly with new discoveries, as in the recent finding of an accelerating universe. Another consideration is that, like most popular authors, Seife is not transhumanist or immortalist and seems indifferent to the prospects of greatly increasing the quantity or quality of the individual's life through advancing technology. In a way that is a plus, however, because his generally hopeful view of reality and our present situation is untainted by a bias toward the conclusions we would especially want to see.

What about the really big picture, then? Where are we headed overall; what is our ultimate fate? Though Seife resists being dogmatic, in fact he is fairly firm on this one issue, and also, for once, not hopeful. Thermodynamics and more general informational considerations suggest that ultimately every living thing in our universe must die a permanent death and all that we may have accomplished by way of civilization will be destroyed, including every record of anything we have ever seen or done. True, this will require a cosmological time scale, billions or trillions of years or more, but ultimately it seems that all must be lost and that life overall is pointless. At least this would be the conclusion for those who adhere to the viewpoint that material essence is what is truly important. With a broader view, however, the picture interestingly changes when you allow a multiplicity of sometimes-identical universes—though the author does not develop this theme. Nor does he spend a great deal of time on his ultimate-doom scenario, for which we should at least have a long time to work at finding ways to address. Mindful of that (for it is important to me, if not for everyone), I was able to focus on the main contents of the book, which I found rewarding. ■



Charles Seife

Besides *Decoding the Universe,* CHARLES SEIFE is the author of *Alpha & Omega,* and *Zero*. The latter won the PEN/Martha Albrand Award for First Nonfiction and was named a *New York Times* notable book. Formerly a journalist with *Science* magazine, Seife has also written for *New Scientist, Scientific American, The Economist, Science, Wired UK, The Sciences,* and numerous other publications. He holds an M.S. in probability theory and artificial intelligence from Yale University, and is an associate professor of journalism at New York University. He lives in New York City.

(Source: *Decoding the Universe* dust jacket.)

EXECUTIVE DIRECTOR'S REPORT

Programming Alcor's ACPS

People are the cornerstone of any successful organization, and Alcor is no exception. It is the people here, everyday striving to brighten our future, who keep my confidence surging forward, even on difficult days. But nobody is perfect, people make mistakes. Human error cannot be avoided, and machines can often improve upon our limitations. If there's one area that undeniably warrants the pursuit of perfection, the elimination of all detectable sources of error, it is the cryopreservation process.

Alcor's contract programmer, Joel Andersen, is in the final phases of programming the Advanced Cryoprotective Perfusion System. He has a BS in Physics and many years of experience with LabVIEW, including working for National Instruments and authoring their introductory manual.

Alcor's ACPS will enable unprecedented computer-control of vital aspects of the cryopreservation process:

- Perfusion pressure and flow rate
- Perfusion and environmental temperatures
- Perfusate concentration

And a few other tricks up our sleeve that we will discuss more fully following successful testing.

As this goes to press, we are entering the final phase of programming an automated perfusion system, the ACPS (Advanced Cryoprotective Perfusion System). Cryoprotective perfusion is necessary for an ice-free preservation, and with the ACPS, Alcor will gain unprecedented capabilities and flexibility in its operating room. The system features full data collection capabilities and complete programmable control of vital aspects of the cryopreservation process. The ACPS is being programmed in LabVIEW, a high level language for data collection and instrument control sold by National Instruments. Both whole body and neuropreservation cases will benefit from use of this system, which will grow with us as new technologies are implemented.

Annual Financial Statements

Some unfortunate circumstances have precluded Alcor's Certified Public Accounting firm from finishing their review of Alcor's books for 2005. The review is nearly a year late, due to turnover within the accounting firm. The unexpected resignation of the accountant assigned to Alcor thrust us back to square one in the middle of the review. Because changing accountants in the middle of a review is like changing lawyers in the middle of a trial, expensive and to be avoided if at all possible, we opted to restart the review process from the beginning. After the lengthy delay, we are now nearing completion of the review.

Point and Click…and Beyond

In every issue of *Cryonics* magazine, members and supporters are urged to visit sites frequented by other Alcor members. This is important. It is a prime source of insight into the issues affecting the membership. Not long ago, members in Canada made an impassioned plea on the AlcorUnited forum for Alcor to establish toll-free phone access from Canada, a request that has now been resolved. I want to thank those members for using this communication tool for the betterment of themselves and Alcor.

While the ease of information flow is a definite perk of sites like AlcorUnited and the Alcor News blog, only so much interaction is possible in a point and click environment. We want to get you talking, in person. An online social networking product called Meetup.com makes that possible, and easy. Simply click on "Start a Meetup Group." Then ask D'Bora Tarrant at Alcor (dbora@alcor.org) to announce your group page to members in your area. They can then register for your group and receive regular bulletins.

Of course, one of the best events for meeting people – including the Alcor staff – is at the 7th Alcor Conference starting October 5th (see inside front cover for details). Registration is now open at the early bird rate of $295 through July 31st. This program brings even more life extension news you won't get at any other conference, including presentations by Dr. Michael West of

Advanced Cell Technology who explores the potential of regenerative medicine and Chris Heward of the Kronos Science Laboratory, with information about the Kronos study of "anti-aging" interventions. This all-new program offers behind the scenes demonstrations of Alcor equipment. Visit our website today for descriptions of speaker presentations, sponsorship opportunities, and a limited-time offer for a special group room rate at the Hilton Scottsdale Resort, where the conference will be held.

Check it out for yourself:

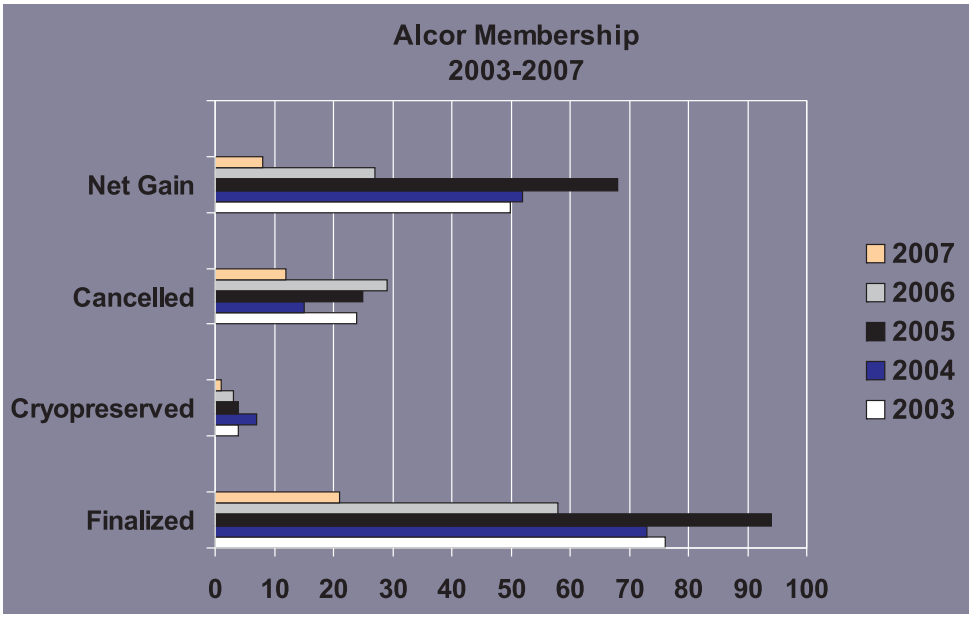
AlcorUnited: **www.alcorunited.org**
Alcor News blog: **www.alcornews/weblog**
Phoenix Cryonics Meetup: **http://cryonics.meetup.com/45/?gj=sj2**
7th Alcor Conference: **www.alcor.org**

And don't miss the newly released Alcor conference DVD: **www.shop.alcor.org**

Strength in Numbers

In June 2006, Alcor achieved an impressive milestone: over 800 members worldwide. Fast-forward to June 2007. With only 823 members, it is apparent that membership growth has slowed over the past year.

Looking at it from a bigger perspective, even after over three decades of operation, the organization's membership roster still represents a drop in the bucket considering the vast growth that is possible. Lengthy, sometimes heated, conversations result in speculation over the reasons why so few have opted to participate in the cryonics experiment. Yet our strategy is simple: keep educating the public about our mission, while continually improving our ability to achieve that mission.



Sincerely,

Stephen J. Van Sickle

ADVANCES IN CRYOPRESERVATION

By Gregory M. Fahy, Ph.D., Chief Scientific Officer, 21st Century Medicine, Inc.

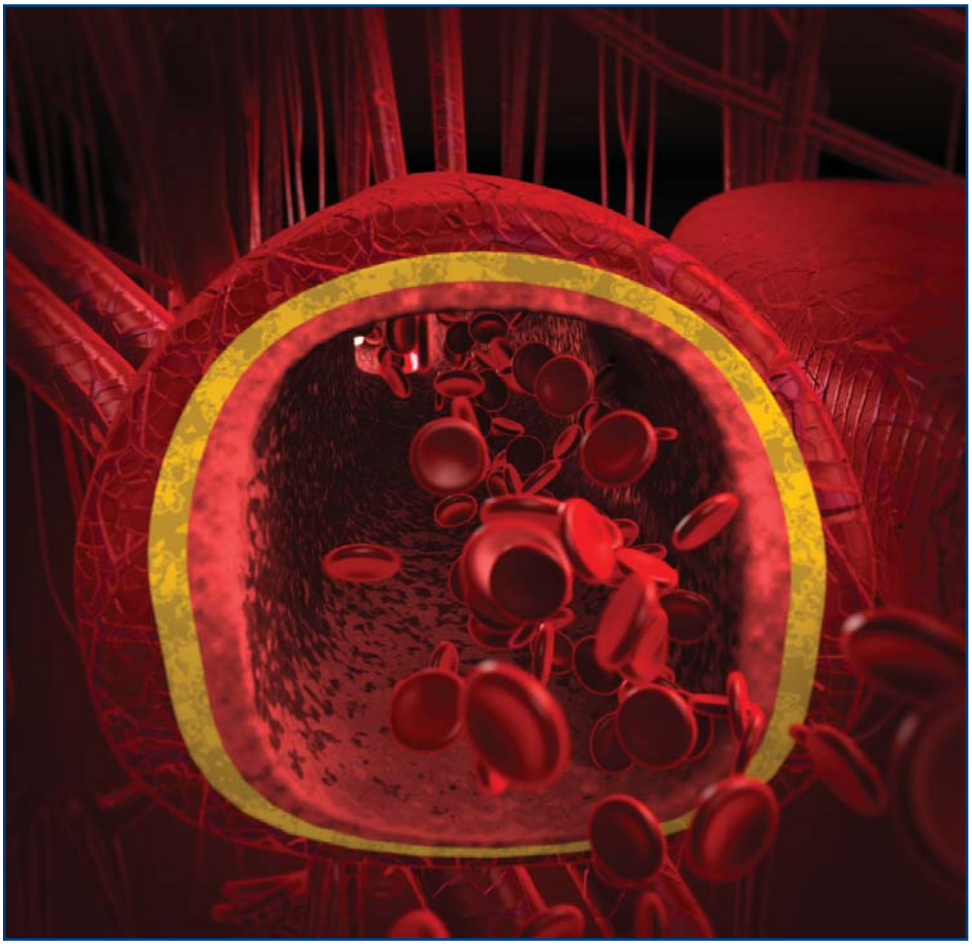
OVERCOMING CRYOPROTECTANT TOXICITY

The biggest problem of vitrification of most cells, tissues, and organs under laboratory conditions is surely cryoprotectant toxicity. Vitrification replaces the structural damage caused by ice with the biochemical damage caused by cryoprotectants. The more the toxicity of vitrification solutions can be controlled, the better this tradeoff will be.

Toxicity has implications for more than whether a given cell is likely to function after cryoprotectant exposure or vitrification and rewarming. The toxic effects of cryoprotectants also seem to be manifested by increased capillary permeability during the introduction of cryoprotectants by perfusion. At 21st Century Medicine, we have seen large differences in damage to the microcirculation between more toxic and less toxic cryoprotectant solutions (unpublished results). Leaky blood vessels cause tissue swelling which, in turn, reduces tissue perfusion rates and therefore slows down cryoprotectant distribution into the tissues. The latter, in turn, requires longer perfusion times, which then allows more time for toxicity to become worse, and more time for the vascular system to become even more damaged. In short, a vicious cycle is set up that is much better to avoid if at all possible. This would be doubly important for vascular beds that might already be weakened or damaged by disease or warm and/or cold ischemia prior to perfusion with cryoprotectants.

There are significant differences between the toxicities of different common cryoprotective agents, and it matters very much which ones are chosen. One example will illustrate the point.

For many years, I used propylene glycol (also known as PG, or 1,2-propanediol) as an agent that has a remarkably strong glass-forming tendency when mixed with water in concentrations as low as 30 or 40 percent by weight [1]. Thanks to PG, I was able to develop a vitrification solution that I called VS41A [2] (and that others later renamed VS55 [3]). VS41A contained just 2.21 molar PG [4] (or about 16.2% by volume) and, for that reason, had a reasonably good vitrification tendency and was used in attempts to vitrify rabbit kidneys [5]. However, this solution was lethal when perfused at -3°C [5-7], and when kidneys were perfused with it even at 20°C and then transplanted, only half to two-thirds of them would survive [7], and all of them would show substantial damage to surface blood vessels visible after the kidneys were transplanted and reperfused with blood [5].



In 1998, I noticed that the glass-forming tendencies of vitrification solutions were inversely correlated with their toxicities. In other words, the lower the concentration needed to vitrify, the more toxic the solution was at that concentration. Based on that, I replaced the strongly glass-forming PG with the weakly glass-forming ethylene glycol in VS41A and the result was a dramatic reduction in toxicity [8]. When kidneys were perfused at -3°C with a variation of this solution that had the same total concentration as VS41A (over 8.4 molar), they suffered no damage whatsoever [8]!

There was another trick that also made the new solution (VMP) so successful, and that was the inclusion of formamide. Not to be confused with formaldehyde, formamide is a very low-viscosity and very poor glass-forming agent (again, ironically, the latter is good!) and penetrates cells extremely rapidly compared to all other reasonably non-toxic cryoprotectants [9]. But an even more important advantage of formamide is that it has the miraculous property of having its toxicity "neutralized" by dimethyl sulfoxide [4] (DMSO; Figure 1), so that increasing the total concentration of the solution can actually dramatically REDUCE total toxicity. Other agents such as ethylene glycol do not have this toxicity-neutralizing effect (unpublished results). Although toxicity neutralization is not powerful enough by itself to allow DMSO and formamide to be used as the only two agents for vitrifying living tissues, it does allow the combination of formamide and dimethyl sul-

foxide to contribute little or no toxicity to the complete vitrification solution.

The discovery that DMSO blocks the toxicity of formamide was ironic, because formamide was used initially due to the belief that it could neutralize the toxicity of DMSO [10, 11], which turned out not to be the case [11]. Remarkably, formamide by itself is one of the most toxic cryoprotectants around (Figure 1). It is not, however, carcinogenic despite inaccurate statements to the contrary that have crept into the literature in some places.

We have found at 21st Century Medicine that other amides such as urea can also have their toxicity blocked by DMSO [12] (Figure 2). This was also seen by a Russian lab [13], which found that urea-induced denaturation of a vital molecular pump that is found in all cell membranes and transports sodium out of cells and also transports potassium into cells (the so-called Na+,K+-ATPase) could be prevented by DMSO. However, a thorough and thus-far unpublished examination of all possible candidate amides by 21st Century Medicine indicates that formamide is the optimal agent for both toxicity neutralization and the other favorable properties of viscosity and permeability.

21st Century Medicine continues to investigate opportunities for developing even less toxic vitrification solutions and has uncovered a number of intriguing new leads that remain unpublished.

Next time, we'll have a closer look at other obstacles to successful vitrification, and how they are slowly but surely being overcome. ■

Figure 1

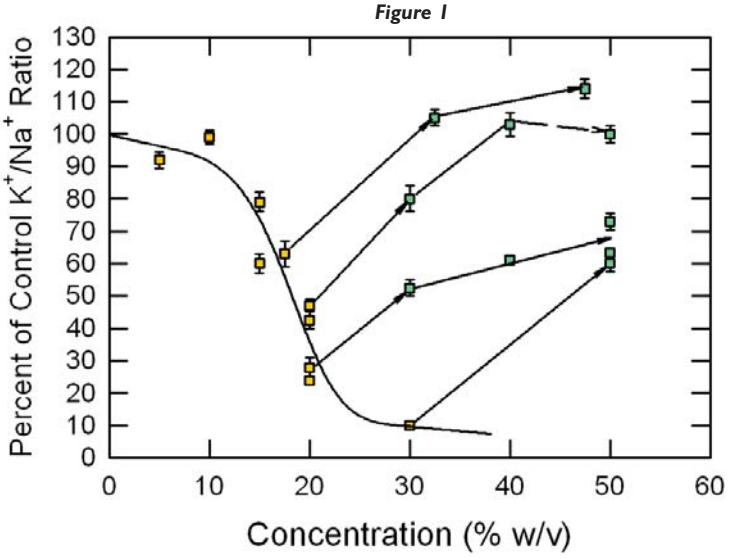
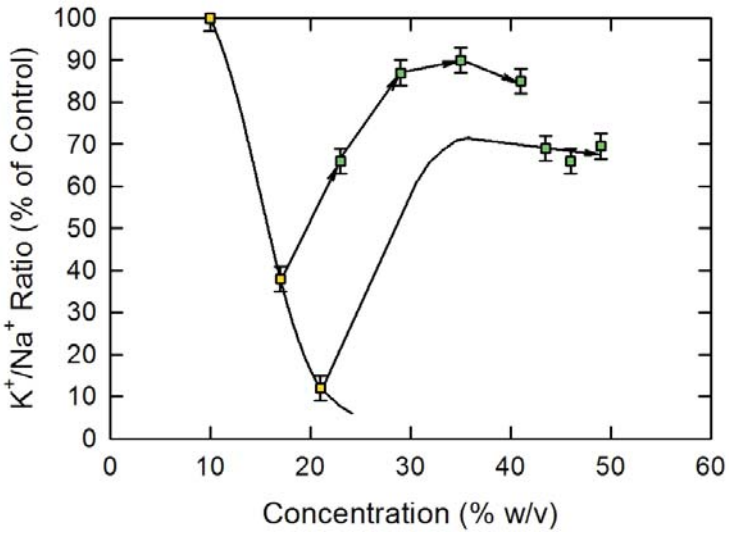


Figure 2



Figures 1 & 2: The finding that the toxicity of amides like formamide and urea can be 'neutralized' by dimethyl sulfoxide (DMSO) to form non-toxic solutions of very high total solute concentrations is very advantageous for the creation of superior vitrification solutions. Figure 1 shows the toxicity of formamide in rabbit renal cortical slices (orange points) and the reversal of this injury by adding DMSO to the stated concentrations of formamide (indicated by arrows leading to the green points), thereby increasing the total concentration of the solution to the concentrations indicated for the green points. Toxicity was measured by the ability of kidney slices to accumulate potassium (K+) and to extrude sodium (Na+) and thereby increase the ratio of K+ to Na+ in the slices (the K+/Na+ ratio). The ability to maintain a normal K+/Na+ ratio is fundamental to the viability of virtually every living cell. Figure modified from [4]. Figure 2 shows the toxicity of urea in rabbit renal cortical slices (orange points) and the reversal of this injury by the addition of DMSO as in Figure 1 (green points). Figure modified from [12].

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MEMBER PROFILE: CHANA DE WOLF

By Deborah Johnson

Photo by Murray Ballard.

"It all comes down to providing patients with the best cryopreservation possible," says Chana de Wolf, Alcor's research associate since September 2006, who joined as a member of the organization in February 2007. Chana is responsible for creating the new cardiopulmonary bypass lab at Alcor, and she appears to be the right person at the right time. Her undergraduate, graduate and doctoral work has honed her research skills.

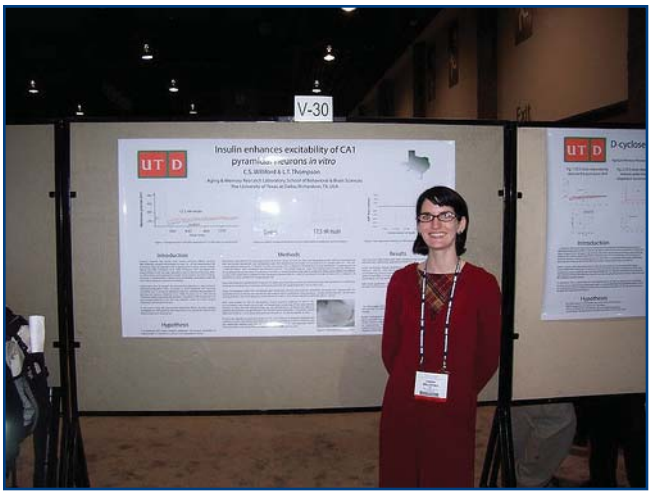
Her journey from the small East Texas town of Athens to Alcor was an interesting spiral, to say the least. In 1994, as young as age 14, her love of science was apparent. After her family moved from Athens to Waco, she was placed into her high school's gifted and talented science program. Chana speaks of it fondly and says she relished the experience. "My teacher encouraged my exploration of neuroscience in particular," she recalls. At only 14-years-old, she already had a burgeoning interest in the brain, which was nurtured through a long-term research project for class.

The challenges of the project led her to the then-neophyte Internet. That's where Chana managed to find a primitive bulletin board system and connect with a scientist who would become her mentor over the following years. "He was working on a new clinical concept; penetrating the blood-brain barrier via the olfactory route with agents that could help prevent neurodegeneration," comments Chana. "He" turned out to be William H. Frey II, the co-founder and director of the St. Paul-Ramsey Alzheimer's Research Center. Not surprisingly, Chana's 10th grade science project – on monitoring the effectiveness of intranasal administration of horseradish peroxidase (HRP) – won first prize.

The following year Chana was admitted to the Texas Academy of Mathematics and Science (TAMS), a prestigious early-entrance residential college program for advanced math and science students. There, she was able to connect with other students like herself and earn college credit for her advanced studies.

But her experience at TAMS was short-lived. After only a year, Chana left Texas and was able to use her college credit to gain admittance to Temple University in Philadelphia. Upon completion of her junior year at Temple, she returned to Texas to finish up her bachelor of science at the University of North Texas, in Denton.

"In the late 1990s universities knew about neuroscience – it was the 'Decade of the Brain' – but there weren't many programs focused on it yet," Chana comments. So she created her own curriculum. In 2001, she received her bachelor of science in experimental psychology with a minor in biology and honors thesis in cognitive neuroscience ("Detection of symmetry in depth: Effects of increasing skew angle"). "Experimental psychology was fascinating and really gave me a good background in experimental design, but ultimately I found the focus on cognition, with little regard for biology or neuroanatomy, too abstract for my tastes," Chana explains. "Fortunately, by the time I was ready for graduate school, neuroscience programs were becoming commonplace."



Chana with her poster presentation at the Society for Neuroscience conference in 2005.

By 2003 she had earned her master of science in cognition and neuroscience from the University of Texas at Dallas, where she worked in the Neurophysiology of Aging and Memory laboratory. There, she performed single-cell electrophysiology of brain slices, with a specific interest in determining how insulin receptors affect neuronal excitability in the hippocampus, a structure important for the consolidation of memories. Chana remarks, "I'm glad I took a sort of circuitous route. I have learned a lot and feel that I have a good background to pursue my interests and to work here at Alcor."

Chana balances her keen interest in science with lighter endeavors, like flying kites. She especially enjoys power-kiting and loves visiting windy beaches and flying out over the water. And she's also quite enamored of her dogs – Darwin and Monkey. Darwin is a 5-year-old Boston terrier and Monkey is a 3-year-old pit bull.

Chana will now be sharing her time with her new husband, Aschwin de Wolf. They were married on April 7, 2007. Aschwin, previously an employee of Suspended Animation, Inc., pulled up stakes in Florida and has joined Chana, Darwin and Monkey in their home in Phoenix. "Since we share a love of cryonics and met at the Alcor conference, it's only fitting that we brought an element of that to our wedding," Chana says. "David Pizer served as our officiant and Steve Van Sickle made liquid nitrogen ice cream for all our guests at the ceremony."

Chana first discovered cryonics and Alcor through her long-standing dedication to protecting the right to control one's own body. While she has an interest in body modification in general, her academic bent lead her to study the capabilities of technology to improve the quality of human life.

"Then I looked up Alcor," Chana remarks. "And I became interested in Alcor right away." It didn't take long for her to pursue membership with Alcor. "I think it is important for a researcher in the field to be as involved in cryonics as possible," she says. "Being a member is the best way to remind myself of the personal aspect of cryonics – that every other member and patient is a person who wants the same thing I do – and to convey that involvement to others."

Chana and Aschwin de Wolf wed in an outdoor ceremony on April 7, 2007.

Today, she is working toward creating a sustainable research lab at Alcor. "I want to establish a framework where basic, cryonics-relevant research is performed at Alcor," Chana comments. Alcor's research and development department is striving to increase visibility and credibility. Chana knows from her academic background that it's imperative to publish research findings in peer-reviewed publications. She hopes that after the cardiopulmonary bypass lab is established, it will yield publishable results.

"I am so excited to be able to bring my expertise in different fields to the research lab at Alcor," she says. "There's always room for improvement." ■

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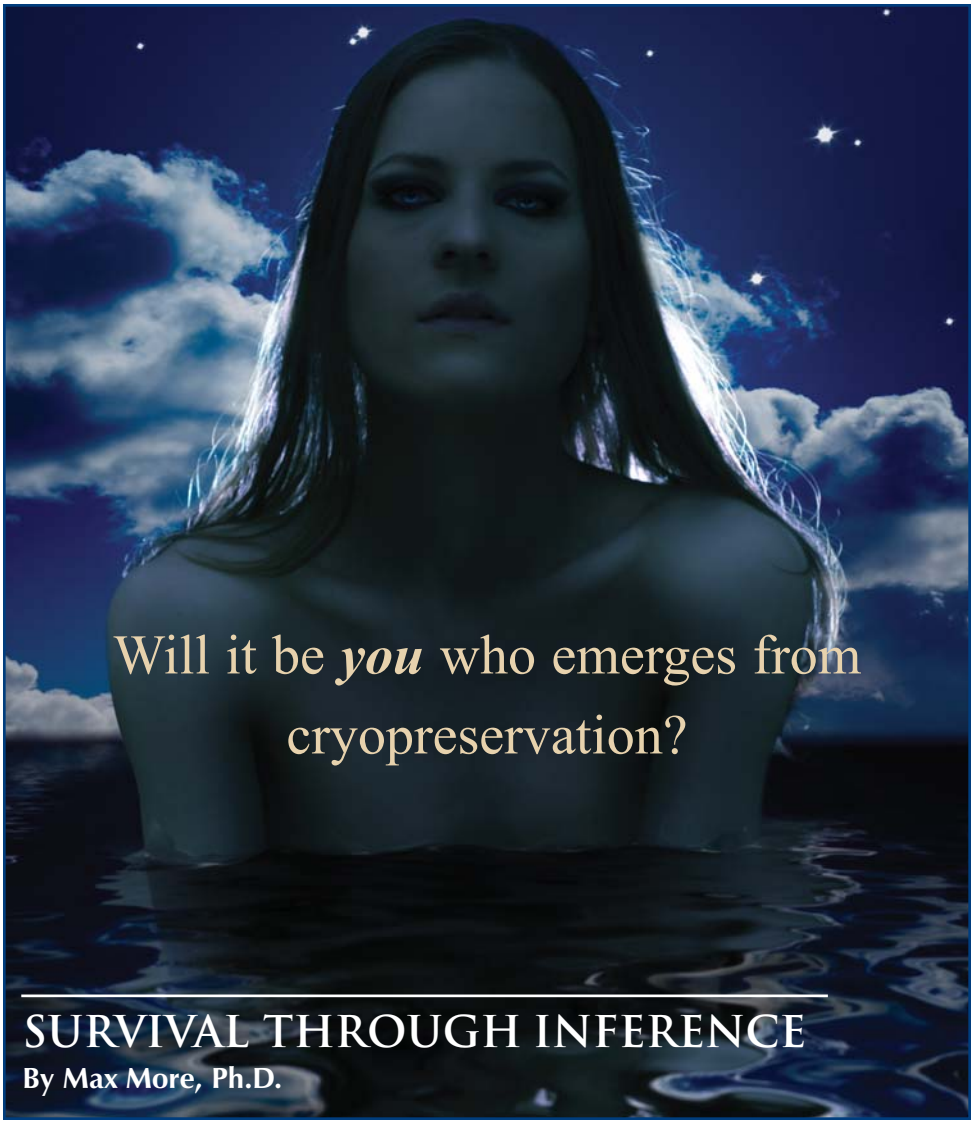

SURVIVAL THROUGH INFERENCE

By Max More, Ph.D.

Introduction

This article is a lightly edited version of a piece that appeared in *Cryonics* magazine in 1992. It was the eighth of twelve "Immortalist Philosophy" columns that I wrote for *Cryonics* magazine, starting in December 1990 and concluding—appropriately enough—with "The Terminus of the Self (Part 2)" in 1995. In an earlier installment, "The Third State," I argued that we need a term that denotes the condition of someone in the space between the "first state" of normal conscious function and the "second state" of (permanent and irreversible) death. We can understand cryonic suspension patients as being in this Third State.

My last two columns on "The Terminus of the Self" asked the question: At what point, or under what conditions, do you cease to exist? The installment you are about to read falls in between those two columns. It considers some of the factors that determine whether or not the person who emerges from (imperfect) cryopreservation would count as *you*.

If you are the kind of individual who derives a perverse intellectual pleasure from pondering these issues—and let's face it, you wouldn't have read this far if you weren't—you might like to explore this account of personal identity and survival at more length. All the *Cryonics* columns came out while I was working on my dissertation, *The Diachronic Self: Identity, Continuity, Transformation*. If you find yourself comfortable reading this article, you will find the full, formal dissertation no less readable. If you're so inclined, you can find the full text at: <http://www.maxmore.com/ disscont.htm>

Persistence of Psychological Connections

Attempts to defeat the inevitability of death through cryonics or other, theoretically possible forms of biostasis will be frustrated if the process fails to preserve *enough* of what makes us who we are. According to the psychological criterion for personal continuity (or identity), the person who is revived from cryopreservation is the same person as the one who went into cryopreservation if and only if they are *psychologically continuous*. A and B are psychologically continuous if they are connected by overlapping chains of *strong psychological connectedness*. Strong connectedness means that there are *enough* direct psychological connections. How many is enough is fairly arbitrary; we might say that continuity requires earlier and later stages of a person to share at least 50% of the number of psychological connections that would normally exist over the course of a day. (A lower limit will also be set by empirical factors, such as the minimum degree of continuity needed for the continuation of a *coherent* personality at all.)

Direct psychological connections include memories (from the "inside") of the earlier person's experiences persisting in the later person. Direct psychological connections include more than memory, though memory had been the most prominent factor in most discussions of personal identity; another form psychological connections take is the *persistence of a disposition*. If the person revived from cryopreservation exhibits the same dispositions as the earlier individual, then we have grounds for believing them to be distinct temporal stages of the very same person.

A third type of connection exists between *an earlier intention and the later execution of the intention*. For example, the resuscitated person goes on a hike up Mons Olympus on Mars on the anniversary of her first mountain climb, and does this because she had decided to do this years before being cryopreserved. This would be evidence for the persistence of the very same person.

Inferred Psychological Connections

So, for us to survive cryopreservation, our memories, dispositions, and intentions must persist. Damage or destruction to these psychological connections resulting from the cryopreservation procedure must be repaired or reversed whenever possible. Now, suppose that all neural traces of memories (dispositions, intentions) have been lost. Perhaps too much time elapsed between declaration of (legal and clinical) death and cryopreservation. The purpose of this article is to pose the question: If there are no existing neural traces to repair, is our survival assured just as well through *inferred*

and reimplanted memories? I will suggest that the answer should be: Yes, they *are* as good.

There are two reasons why someone might fear that implanted memories might not be as good as "real" memories. First, the concern might be about the etiology of the memories—where they came from and what caused them. Assume we replace your lost or damaged memories by gathering information from various sources external to your brain and then altering your neural weightings so that you will have access to the implanted memories.

This is obviously a very different process than the one which normally causes us to lay down memories. In the typical case, sense impressions or internal neural processes lead to the formation of internal representations of experience. But, when memories are implanted, someone is gathering information about what your memories probably were about from sources like your friends and associates, your diaries, known activities, lists of the books you read, and copies of your daily schedules and to do lists. Information gathered from these sources might then be fed into an algorithm that tells the memory engineer what adjustments to make to the patient's brain.

The persistence of psychological connections indicates whether a person is the same before and after cryopreservation. A revived person who hikes on Mons Olympus on the anniversary of her first mountain climb is showing persistence of intentions. This is just one of the indicators of whether a cryopreservation was successful or not.

Though these typical and extraordinary sources of memory are very different, their results might be qualitatively indistinguishable. If the memory engineer successfully recreates your missing memories (or gets close enough), why should you be concerned about their causal history? In wanting to survive as the same person, what matters is the persistence of psychological continuity and connectedness, but not its cause. In the future, perhaps just a decade or two from now, we might use neural-computer interfaces and microelectronic or nano-mechanical devices attached to our brains to store memories. If these devices were integrated into our cognitive functioning, then the memories stored in the mechanisms would be just as much ours as those stored in the usual fleshy mechanisms of the brain.

Second, someone might believe that implanted memories are inferior to "the real thing" because they believe that the two types of memory would be qualitatively different. It is often thought that memories are much like internal photographs. It might seem that inferred and implanted memories would not be experienced as internal pictures and so could not be the same.

This way of thinking about memory is undermined by evidence that our internal representations are not like pictures at all. Cognitive psychologists have devised clever tests to determine what is really happening in the case of individuals with eidetic ("photographic") memories. The subjects are convinced that when they access a memory of something they have seen, such as a page of a book, they are looking at a determinate image. However, it took the subjects much longer to access the words at the end of the page than near the beginning, suggesting that they had to sequentially process the information rather than scan across an internal page.

Another hint that our memories are not picture-like, but are reconstructions of what we expect to remember, is the evidence demonstrating how expectation influences recall. In one experiment, subjects were shown a brief flash of a struggle between a white and a black man, one of whom was brandishing a knife. Most subjects "remembered" the black man holding the knife, though in fact it was held by the white. Their memory was not a sharp picture in their head but an internal reconstruction of what they thought they had seen. You may have come across many cases of false memories—instances where you seem to remember events from a viewpoint that you couldn't have had (such as outside your body) or events that never happened.

If our typical memories are reconstructed or inferred rather than pictorial representations, then memories inferred from unusual sources and implanted in the brain should be just as good. This is good news for cryonicists, allowing us another degree of freedom when considering possibilities for restoration of personality. ■

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Max More, Ph.D.

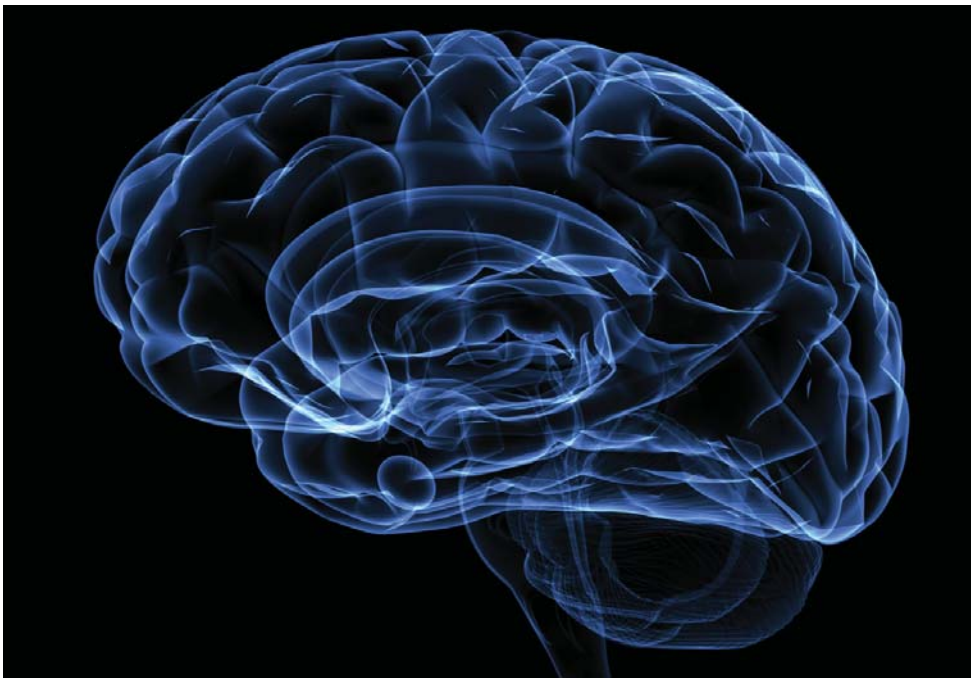
Dr. Max More is an internationally acclaimed strategic philosopher widely recognized for his thinking on the philosophical and cultural implications of emerging technologies. His contributions include founding the philosophy of transhumanism, authoring the transhumanist philosophy of extropy, and co-founding Extropy Institute.

"We have a dreadful shortage of people who know so much, can both think so boldly and clearly, and can express themselves so articulately. Carl Sagan managed to capture the public eye but Sagan is gone and has not been replaced. I see Max as my candidate for that post."

(Marvin Minsky)

SECURING VIABILITY OF THE BRAIN AT ALCOR

By Aschwin de Wolf



The main objective that guides care at Alcor is to maintain viability and preserve the ultrastructure of the brain during all procedures. Because of its high metabolic demand and low capacity for energy storage, the brain is extremely vulnerable to injury caused by lack of blood flow (cerebral ischemia). The ability to secure viability and good ultrastructural preservation of the brain is therefore an excellent measure of the current state of the art in cryonics. Because identity and memory are assumed to reside primarily in the brain, both whole body and neuropreservation members would agree that this organ should be given preferential treatment.

This article will briefly describe all the steps involved in a typical cryopreservation case and discuss how far we have come in achieving this objective at Alcor.

Structure versus Viability

One distinction that is often made in cryonics is that between ultrastructure and viability. In this context viability means that the brain is able to resume function upon reversal of some, or all, of the procedures employed in cryonics. Preservation of ultrastructure refers to preservation of the detailed structure of a cell, tissue, or organ that can be observed by electron microscopy. Naturally, these two concepts are related. For example, if an organ were straight frozen (placed into liquid nitrogen without cryoprotectant perfusion) after a long period of warm ischemia, we would expect to find poor ultrastructure and, therefore, poor viability. But there can also be examples where good preservation of ultrastructure does not necessarily guarantee a good outcome in terms of viability. Examples of this would be procedures that result in good preservation of ultrastructure but which cause mitochondrial failure, denatured proteins, or massive activation of apoptosis (programmed cell death).

Terminal Patients

One aspect often neglected by cryonics writers is that many patients who present for cryonics go through a prolonged terminal period before cryonics stabilization procedures are initiated. During this period the patient may experience a number of pathological conditions such as shock, respiratory distress, dehydration, electrolyte imbalances, systematic inflammation, upregulation of coagulation factors, multiple organ failure, intracranial pressure, and activation of apoptosis. Consequently, the objective of stabilization, explained further below, is much more difficult to achieve or may even be defeated *before* the cryonics team gains access to the patient.

Because Alcor will not treat the patient before legal pronouncement of death, it is largely the patient's responsibility to execute the proper paperwork to ensure that medical treatment during the agonal phase will not be detrimental to achieving a good cryopreservation. Examples that come to mind are to have a Do Not Resuscitate (DNR) order in place to avoid multiple resuscitation attempts (with associated cycles of ischemia-reperfusion injury) and to express a desire for certain supplements during palliative care. Where the cryonics organization *can* make a difference during this period is in being guided by the "premortem" condition of the patient when starting stabilization procedures such as promptly restoring fluid volume and vascular tone after a patient has been pronounced dead.

Stabilization

Stabilization procedures at Alcor consist of three different interventions: cardiopulmonary support, induction of hypothermia, multi-modal medications treatment, and in remote cases, blood washout and substitution with an organ preservation solution. Stabilization of the patient is one part of Alcor's protocol where a number of cryonics authors have explicitly stated that cerebral viability by contemporary medical criteria should be the objective [1]. In this vein, Alcor and associated research companies have done research to demonstrate that securing cerebral viability during stabilization is a realistic objective.

Two groundbreaking experiments provide evidence that securing viability during stabilization might be achieved with current technologies. In the late 80s and early 90s Darwin, Leaf et al. demonstrated that induction of ultra-profound hypothermia (temperatures lower than 5°C) in conjunction with

Mike Darwin sits with Enkidu as the canine gains strength the day following complete blood washout and cooling to ~ 5°C. Photo courtesy of Michael Darwin.

blood washout and substitution with an organ preservation solution is reversible in a canine model. Dogs were revived from up to 5 hours of low flow perfusion with an organ preservation solution called MHP-2[2]. In the mid 90s Darwin, Harris et al. successfully resuscitated dogs from up to 17 minutes of normothermic cardiac arrest using a large number of medications and tight post-resuscitation regulation of hemodynamics[3].

Impressive as these results are, a number of caveats need to be taken into account. First, as mentioned previously, the typical patient who presents for cryonics has gone through a prolonged terminal period. How realistic is it to expect a similar outcome under such conditions? Second, current Alcor procedures are not identical to the protocol that was investigated during these experiments. For example, in remote cases the organ preservation solution is used in a static (no flow) fashion instead of constantly perfusing the patient at low flow during transport to Alcor. In the case of the normothermic cerebral resuscitation experiments it is also important to note that the dogs were pre-heparinized prior to cardiac arrest (heparin is administered *after* cardiac arrest in cryonics cases) and that resuscitation doesn't involve a long period of external chest compressions as is the case in cryonics stabilization. Finally, some techniques that are possible during experimental work in a laboratory – such as rigorous medications administration, tight control over hemodynamics and sophisticated monitoring – are currently not available to cryonics organizations.

Cryoprotectant Perfusion

The objective of securing viability during cryoprotective perfusion can be broken down into two stages. During the initial phase, following surgery to obtain vascular access, the patient's blood (or the organ preservation solution in a remote case) is flushed out. Because this phase is not fundamentally different from remote blood washout, securing cerebral viability should be possible in principle, provided that the transition from stabilization to initiation of OR procedures is structured in such a fashion that that there is (1) no major interruption in circulation or (2) no marked rise in temperature. Unlike the first condition, the latter condition is not only a practical challenge but a clinical challenge as well. Effective washout is a function of temperature and this presents a delicate trade-off between the risk of ischemic injury produced by elevated temperatures and the benefit of reduced washout times.

A related problem is encountered in the second phase of perfusion during which a cryoprotective agent is gradually introduced to the patient. Classical cryoprotective agents like glycerol do not penetrate cell membranes verywell at lower temperatures (close to 0°C). To compensate for this fact, a deliberate elevation of temperature was required during glycerol-based cryoprotection. Although this was a rational choice (considering the alternative of extremely long perfusion times), the introduction of a very concentrated cryoprotective agent at relatively high temperatures likely compromised cerebral viability as a result of increased ischemic exposure and cryoprotectant toxicity. Alcor's current cryoprotective agent is no longer based on glycerol and includes components such as DMSO, which have improved permeability at lower temperatures.

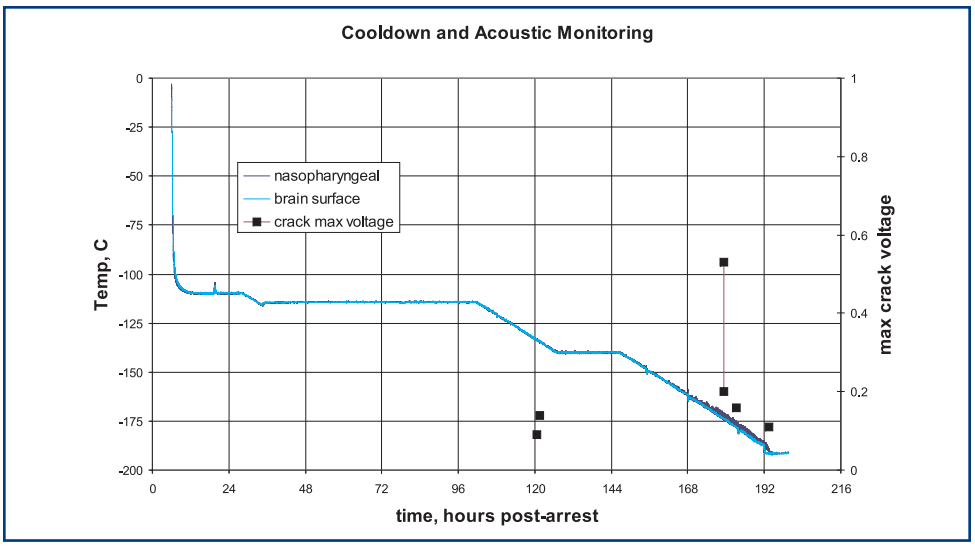
The real limiting factor for maintaining viability of the brain is that all currently-known cryoprotectants have toxic effects when whole brains are exposed to them long enough to prevent ice formation and achieve vitrification during cooling. At the time of writing, the M22 cryoprotectant mixture used by Alcor is the least toxic vitrification solution ever published for use in large organs[4]. However, it is still not sufficiently non-toxic to permit reversible cryopreservation of the whole brain. Another reason why cerebral viability might be compromised during introduction of cryoprotectants is that, under "ideal" circumstances, the cryoprotectant induces an extreme degree of brain shrinking which may compromise vascular and cellular integrity and even set the stage for apoptosis upon resuscitation. Overcoming these problems will require further advances in basic research.

Cryogenic Cooldown and Long-Term Care

Because we can deduce that cerebral viability is lost during the later stages of cryoprotective perfusion, we know that cerebral viability can no longer be maintained during cryogenic cooldown and long-term care of the patient. In general, if cerebral viability is lost at some earlier phase, it cannot be restored during any later phase of cryonics procedures. Consequently, the emphasis from that point will be on preserving ultrastructure as best as possible. During cryogenic cooldown this means cooling at least fast enough to inhibit any ice formation, which is currently 0.1°C/minute for the cryoprotectant M22. A cooling rate of ~ 0.4°C/minute can be achieved for an organ as large as the human brain. Since an adequate cooling rate can be achieved to prevent ice formation in the brain, the remaining issues of immediate concern include cryopreservation-induced injuries independent from ice formation like chilling injury and thermal stress at lower temperatures.

Chilling injury involves injury caused by exposure to low temperatures and includes cell membrane phase transitions and protein denaturation. Although M22 was designed to prevent chilling injury in large organs, this problem has not been investigated in cryonics patients. Aside from the practical problems in identifying chilling injury during cryoprotective perfusion and cooldown, it may be hard to distinguish the effects of chilling injury from the injury caused bywarm ischemia, cryoprotectant toxicity, and osmotic shock. Moreover, chilling injury may be relatively benign compared to other problems during cryopreservation, such as the risk of ice formation and thermal stress.

Below the glass transition temperature (-123.3°C for M22) the vitrification solution turns into a glass and is limited in its ability to further contract as the temperature is further lowered, causing tissues to fracture as a result. Thermal stress not only presents an obvious obstacle to maintaining viability, but fracturing also compromises the objective of securing uniform ultrastructure of the brain. In light of the expectation that recent vitrification solutions will inhibit ice formation in cryonics patients, eliminating fracturing has become a more urgent priority for Alcor. One alternative would be to provide long-term care for patients at higher temperatures, just below the glass transition point. Another alternative



Graph indicates tissue fracturing that occurred below the glass transition temperature (-123.3°C for M22) during the cryogenic cooldown of a recent Alcor patient (2006).

would be to develop an "annealing" protocol that will inhibit or minimize thermal stress by keeping a firm control over temperature descent[5].

Leaving social, political, and legal threats to Alcor patients aside, the final challenge to securing cerebral viability for cryonics patients is the effect of long-term care on the patient. Although viability and ultrastructure have already been compromised by current procedures at this point, there is no reason to believe that long-term care at liquid nitrogen temperature (-196°C) would produce adverse effects over very long periods of time (exceeding thousands of years)[6]. At the temperature that Alcor's patients are currently maintained, time has effectively been halted. Open to more debate is the long-term risk of maintaining patients at intermediate temperatures (slightly under the glass transition temperature) because, at temperatures down to 20°C below the glass transition temperature, ice nucleation may still be a risk for cryopreservation. These nanoscale nucleators may not present a direct threat to patients *during* long-term care, but they may present a bigger challenge during rewarming of the patient in the future.

Assessing Viability

How do we know if cerebral viability is being maintained during a cryonics case? At this point most evidence for what is possible with current technologies has come from experiments on healthy animals under controlled laboratory conditions. In light of the fact that cryonics procedures do not occur under such tightly controlled circumstances, claims that viability can be secured up until the later stages of cryoprotective perfusion are highly theoretical.

Currently the only means available to cryonics organizations to get an idea about how well cerebral viability is being maintained during stabilization and cryoprotective perfusion are confined to physiological observation, temperature data, qualitative end tidal CO_2 and peripheral oxygen saturation readings and, in rare cases, pre-pronouncement and post-pronouncement blood gases and electrolytes. For example, a case where cerebral viability is maintained would typically have all or most of the following characteristics: prompt start of stabilization procedures after legal pronouncement of death, adequate cerebral perfusion generated by mechanical chest compression (or extracorporeal perfusion) and administration of vasoactive medications, and rapid induction of hypothermia.

The CO2SMO enables Alcor to obtain continuous quantitative data on the efficacy of cardiopulmonary support.

During a number of landmark cases at Alcor and CryoCare blood gases and temperature data have been collected that seem to indicate that viability may have been maintained during stabilization[7]. However, when reading these case reports it should be kept in mind that more subtle ischemic changes may have occurred that still present a threat to viability such as mitochondrial damage, excessive free radical damage, activation of apoptosis, or neurological pathologies associated with induction of ultra-profound hypothermia and extracorporeal perfusion. Consequently, blood plasma should be examined to look for more specific biomarkers of brain injury.

From initiation of cryogenic cooldown to long-term patient care, measurements of viability are no longer possible and Alcor confines itself to optimizing preservation of ultrastructure. During cooldown Alcor uses an acoustic monitoring device to monitor the presence of fracturing in the brain. This device uses an electronic sensor that registers vibrations that are assumed to correspond with fracturing events. After cryogenic cooldown the only available method to determine whether any ice has formed is direct observation of the surface of the brain. Naturally, during long-term care at liquid nitrogen temperatures neither measurements of viability or ultrastructure can be taken in real time.

Discussion

One may wonder why Alcor makes such an effort to maintain cerebral viability during stabilization if it is invariably lost during cryoprotective perfusion and cryogenic cooldown. The straightforward answer is that by securing viability at an early stage, better preservation of ultrastructure can be achieved at a later stage. Cardiac arrest sets the stage for a number of pathophysiological events that may interfere with optimal circulation of the cryoprotective solution during the later stages of cryonics procedures including, but not limited to, intravascular blood clotting, production of inflammatory vascular adhesion molecules, free radical formation and capillary- and cell membrane leakage. Notable differences in cryoprotective perfusion have been observed between patients that experienced a long period of warm and/or cold ischemia and patients who received prompt stabilization and minimal transport times.

A related but more subtle issue is whether Alcor's stabilization protocol could benefit by changing the objective of stabilization from securing cerebral viability to optimizing cryoprotective perfusion. Typically one would expect that interventions that are adequate to secure viability will also confer benefits during cryoprotective perfusion, but there at least three caveats to this perspective that need to be considered.

First, there are interventions that can secure viability if executed promptly and correctly but that can frustrate cryoprotective

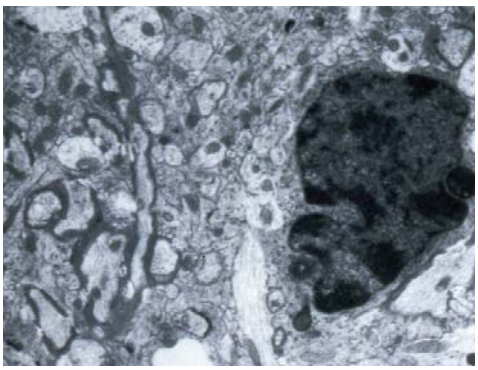


Figure 1

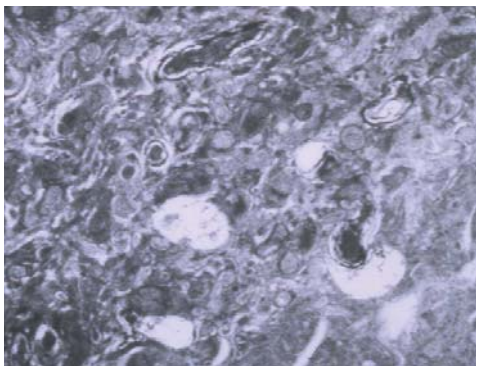


Figure 2

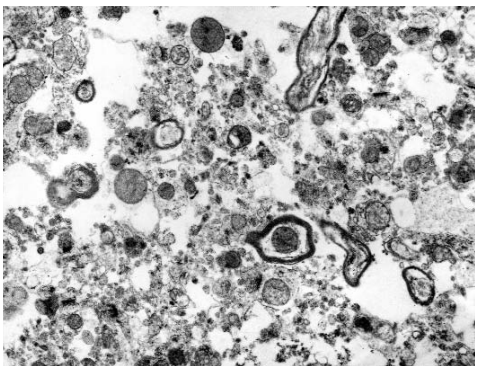


Figure 3

Figures 1-3: In the 1980s Mike Darwin et al. performed a number of feline experiments to investigate the effects of Alcor's cryopreservation procedures under different conditions. Figure 1 shows a control brain (cerebral cortex) that was washed out and perfused with Karnofsky's fixative. Figure 2 shows a brain after cryopreservation with 3.0 M glycerol at -196°C and rewarming. Figure 3 shows a brain after 30 minutes of normothermic ischemia, 24 hours packing in ice, cryopreservation with 3.0 M glycerol at -196°C and rewarming. Figure 2 shows typical results after cryoprotection and freezing: dehydration of cell structures but reasonably good preservation of cell membranes and intracellular architecture. By contrast, after ischemia, glycerolization, freezing and thawing, Figure 3 shows massive disruption of cell ultrastructure, and all that is visible in this photo (which is representative) is disorganized cellular debris. Images courtesy of Michael Darwin.

perfusion at a later stage in the absence of such a careful approach. Ventilating a patient with 100% oxygen is an example of an intervention that might be moderately beneficial in terms of viability but can also seriously frustrate adequate distribution of the cryoprotective agent in the brain as a result of injury to the circulatory system and cell membranes (a condition known as "reperfusion injury"). Second, there are only a finite number of pharmacological interventions that a cryonics organization can be expected to do and a choice needs to be made between interventions that increase the probability of *short-term* recovery and a protocol that is specifically designed to preserve ultrastructure through all phases of cryonics procedures. This choice is especially important in light of the fact that Alcor's medications protocol reflects a *normothermic* recovery model to mitigate a number of pathophysiological events that should also be inhibited by rapid induction of hypothermia. Third, Alcor's organ preservation solution, MHP-2, has never been investigated for prolonged static use or in the presence of serious ischemic and reperfusion injury. In general, results obtained in a recovery model need to be validated in a model that reflects the typical patient pathologies and practical limitations of a cryonics standby team.

Should viability of the brain be the golden standard for cryonics care anyway? We can imagine a scenario where a cryonics patient can be successfully resuscitated but with impaired personality and memories. For example, it is a well established fact that the CA1 region of the hippocampus in the brain is highly vulnerable to even the shortest interruptions of cerebral blood flow. This region of the brain is often associated with encoding and storing memories. Cryonics would benefit from a deeper understanding why certain regions of the brain are so vulnerable to oxygen deprivation to guide research into procedures that minimize injury to vulnerable cells in the brain.

Getting a better understanding of the efficacy of current procedures, and improving upon them, is one of the objectives for reviving the ambitious research agenda that cryonics pioneers Jerry Leaf and Mike Darwin pursued at Alcor. Alcor is also investigating a number of technologies that will improve cardiopulmonary support, rapid induction of hypothermia, optimize control and data collection during cryoprotective perfusion, and reduce fracturing during cryogenic cooldown.

Despite the renewed focus on evidence-based cryonics and new technologies, one of the major limiting factors in securing viability and good ultrastructure is the quality of standby and stabilization procedures. This objective requires a concerted effort between Alcor and its members ranging from forming new local cryonics groups to making substantial investments to distribute good stabilization equipment in many parts of the country. ■

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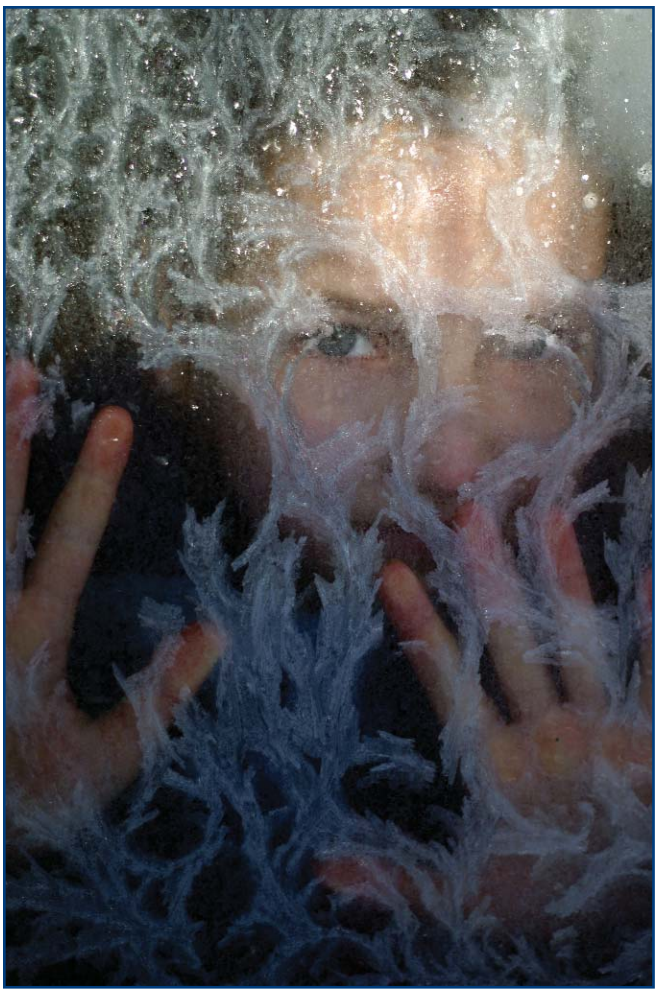


WHAT IS A SELF THAT IT MIGHT BE REVIVED?

By Ben Goertzel, Ph.D.

The simplest cryonic revival scenarios don't pose any philosophical conundrums. You get your whole body cryopreserved, you get repaired with nanotechnology and revived -- and then, to quote the classic pop tune, "Whoomp, there it is!" You're back again, alive and awake just like you always were – albeit woken up from a particularly long and cold sleep.

Other plausible revival scenarios are more problematic, however. What if only your brain is preserved, and is then revived and placed in a different body: How much of your self is really in the brain versus the body? What if the brain and/or body are damaged during the cryopreservation or revival process, so that full information regarding the-person-you-used-to-be isn't preserved ... and the gaps need to be filled in using one or another mechanism? What if, rather than reviving your physical brain and/or body, a decision is made to scan the information out of your brain and/or body and read it into an abstract data representation – which can then be used to incarnate you in a robot body, or a piece of computer software, etc.? All these alternate scenarios raise conceptual problems regarding the nature of self and mind. Most centrally: Under which circumstances is the revived being "really you"?

What is this "you" that I'm talking about? Or, putting it more personally, what is this "I" that "I" think "I" am? It's not the particular cells in my body right now, of course – these cells are continually dying and getting replaced by other cells (though at age 40, and lacking advanced life extension technologies, I'm unfortunately at the stage where more dying than replacement is going on.) Obviously it's something to do with the pattern of arrangement of these cells. But what, specifically? What is this pattern that is the self? What is the self that it might be revived?

Pushing the point even further, there is the possibility that future scientists may be able to revive present people solely from data such as diary entries, questionnaire answers, and videos of real-life behaviors. With this in mind, Martine Rothblatt[1], William Sims Bainbridge[2] and others are working on convenient methods for capturing and storing this sort of data. The idea is that, from all this information, an AI program may eventually be able to solve the "inverse problem" of figuring out: What sort of person would be most likely to give rise to this set of data? Supposing you were recreated from this data – in software, in a robot body, or even in a cell-by-cell simulacrum of your current biological body, built with advanced future nanotechnology. Would this recreation be you? Or would it be a cleverly constructed copy of you?

It's worth noting that "continuity of self" is different from "continuity of consciousness." We do after all lose consciousness every night when we sleep – and then awaken a "new person," yet convinced that we're a continuation of the old person who occupied our body the previous day, then so rudely aborted its consciousness and succumbed to the desire to sleep.

So we humans, in our everyday lives, already lack continuity of consciousness. But we have continuity of self. My goal in this essay is to enlarge upon the latter concept a little bit. What is "continuity of self"? How does the human brain/mind achieve it? Under what conditions is it likely to be pre-

served through the revival process following cryopreservation? Under what conditions is it likely to be preserved through other posthuman transitions such as uploading? What is the self that it might be revived and persist with continuity even through an interruption in the stream of consciousness associated with it?

Continuity versus Constancy

A different way to pose the same question is to focus on the distinction between *continuity* of self and *constancy* of self.

To reinforce this distinction, in a prior essay[3] I have envisioned a future version of myself called FutureBen, who lives ten billion years and increases his intelligence by a factor of ninety-seven quintillion. (Occasionally I consult him for advice in difficult moments, but he's never answered me yet!) His human body was shed after a few thousand years of life – and he's placed the episodic memories of his first century of life in a very-rarely-accessed portion of his memory, since it's really not very interesting compared to some of the things that have happened to him since.

FutureBen may be contrasted with his best mate FutureBush, an analogous being who evolved out of current US President George W. Bush – and who, after ten billion years of existence, has diverged similarly far from his early human roots.

My contention is that, after ten billion years of growth and change on the part of both of these minds, 2007 Ben may be no more similar to FutureBen than to FutureBush (and of course, 2007 Bush may be no more similar to FutureBush than to FutureBen). Perhaps these two future hyperbeings will even exchange ancient episodic memories, so that each of them will have complete first-person memories of the other one's life. So what difference does it make that FutureBen happened to evolve out of Ben Goertzel instead of George W. Bush, PeeWee Herman, or for that matter, one of the roaches in 2007 Ben Goertzel's kitchen?

And yet, intuitively, it does feel to me (2007 Ben) like FutureBen still retains some essential Ben-ness about him. He may be very different from me, but he's still a future version of me. But in what does this "essential Ben-ness" consist? The key to the Ben-ness of FutureBen can't lie in the *state* of FutureBen ten billion years hence – it must lie in the *path by which he evolved*.

The key question to ask in evaluating FutureBen's Ben-ness is, I suggest: Was there *continuity of self* on the pathway from 2007 Ben to FutureBen? Was there a common thread of perceiving-oneself-as-being-Ben-Goertzel, or not? If there was continuity of self along the evolutionary path, then FutureBen really is a future Ben, and not just some other mind who is (for whatever humanly incomprehensible hyperbeing reason!) laying false claim to Ben-ness.

But, what does "continuity of self" really mean?

To understand this notion in a serious way, we need to plunge a little deeper into psychological systems theory, and ask ourselves: What is this thing called the self?

What is This Thing Called Self?

I have long been fascinated by the nature of the self, and for reasons beyond the transhumanist issues raised above. Purely from an everyday-human-life perspective, I can think of few more critical topics: Which of our behaviors are not governed to some extent by those portions of the psyche that we label "self"? Human psychological theory[4] teaches us that self is a complex organic construct that arises in a mind out of the combination of various simpler structures and dynamics and their interaction with each other and the world.

The neurobiology of self is as yet poorly understood and provides limited guidance in trying to understand the "self" phenomenon. Yet, it does have some powerful lessons. Many of these have been synthesized by Thomas Metzinger in his masterful work *Being No One*[5] which marshalls diverse neuropsychological data and speculations with a goal of understanding how the brain creates what Metzinger calls the "phenomenal self." Put simply, the phenomenal self is not "what the mind is" but rather "what the mind thinks it is." Metzinger makes strong arguments that the human brain contains various specialized sub-units that, combined together, enable the construction of a coherent self-model, useful for guiding the thoughts and actions of the human organism.

The phenomenal self – the "I" that I conceive when thinking about myself – is not "what I really am"; it's a model constructed within my mind, for practical purposes, with a loose, though essential, connection to the actual underlying psychological reality.

Steven Mithen[6] has argued that the critical step in the evolution of humanity was the emergence of a "general-intelligence" module capable of synthesizing the inputs and outputs of the already existing specialized-intelligence modules focused on areas such as vision, sociality, tool-building and music. I suspect that one key aspect of the emergence of this general-intelligence module was a massively expanded and deepened capability for self-modeling.

"The phenomenal self is not 'what the mind is' but rather 'what the mind thinks it is.' It's a model constructed within my mind with a loose, though essential, connection to the actual underlying psychological reality."

In computer science terms, the fusion of these previously separated, cognitive modules in the early human mind incurred a dramatic "combinatorial explosion" – a flowering of possible combinations between ideas, habits and patterns corresponding to different, previously separate modalities. In order to pare down this combinatorial explosion, the early human mind must have needed to "know what it was doing" to a previously unprecedented extent.

Before the integrative transition Mithen identifies, self-modeling may have been restricted mainly to the social module of the brain, hence concerned mainly with the immediate relationship of self to other. The transition to the modern, integrative mind may have largely consisted of a transition to a more modern and comprehensive self, integrating a model of the organism's reasoning, perceiving, tool-building and socializing behaviors. Modeling all these sorts of behav-

iors together is essentially a corequisite for enacting these sorts of behaviors together in a purposeful and coordinated manner.

The Self-Creation of the Self

All of this leads up to the main point I want to make about the self. The way I have come to conceptualize self, in the course of my study of human cognition and my work on designing and building AGI systems, is as an attractor of two key high-level cognitive dynamics that I call "forward synthesis" and "backward synthesis," which together perpetuate the creation of the self. These are subtle ideas in the theory of mind that can't be comprehensively reviewed in a summary article like this one, but I'll try my best to get across the gist of them, before turning back to issues of revival and self-continuity.

Forward synthesis is basically the process of building up new ideas, concepts and relationships out of existing ones. It's the "lego block" aspect of intelligence – which often results in mental content that appears wildly new, in spite of actually being grounded in unexpected combinations of prior mental content.

In the human brain, this is related to the process of "cell assembly formation,"[7] in which connections between neurons get reinforced, resulting in the formation of groups of neurons that "act as wholes," representing various forms of knowledge and habitual behavior. Groups may merge together to form new groups-of-groups, culminating in complex dynamic neural structures that Edelman[8] has called "maps."

Backward synthesis on the other hand is the process of taking an idea, concept or relationship and figuring out how it might be produced. A simple example of this is parsing a sentence: In the parsing process, one is figuring out what combination of grammatical rules might produce the target sentence. Whereas sentence generation is forward synthesis: one is putting together a number of pieces to form a novel composite.

In general, beyond the domain of vision, we don't have a good idea of how the human brain carries out backward synthesis processes. Formal neural networks utilize an algorithm called "backpropagation"[10] for this purpose, but it's clear the brain doesn't work this way. Edelman[11] has proposed that the brain carries out backward synthesis using a variant of evolutionary learning, a hypothesis that relates brain function to AI algorithms such as genetic programming[12].

Put simply: forward synthesis combines, and backward synthesis explains (explains how something can be produced via combination). My hypothesis is that these are the basic action-patterns of intelligence. The structures of the mind are then defined as "attractors" of the forward and backward synthesis processes[13]. That is, the mind consists of a set of ideas and relationships that mutually produce each other in interconnecting networks of combination and explanation.

This notion that the ideas in a mind mutually produce each other is a "cognitive-systems-theory" version of Maturana and Varela's notion of "autopoiesis"[14] or self-creation. A mind is a self-creating system, not physically but on the level of mental forms and patterns. Each mental pattern is built up by combination and/or explanation from other mental patterns, in a continual flow of circular activity. And one of the things created within this process of self-creation is *the self*.

Continuity of Self

So, if "self" is an attractor of cognitive forward and backward synthesis processes ... what then is "continuity of self"? What does it mean for FutureBen ten billion years from now – or the Ben who will wake up tomorrow morning – to be a continuation of the Ben who exists right now, today, writing these words?

The truth, I propose, is a simple one. Suppose we have two minds existing at different times – for total generality, let's call them BeforeMind and AfterMind. Suppose BeforeMind and AfterMind both have active, effective phenomenal selves, based on intelligent self-modeling. And suppose BeforeMind's self-model includes a model of AfterMind; and AfterMind's self-model includes a self-model of BeforeMind.

What I suggest is that, if

- BeforeMind and AfterMind have reasonably similar self-models, and
- BeforeMind and AfterMind's self-models both include the idea that AfterMind is a continuation of BeforeMind

then, in a pragmatic sense, we do have continuity of self in the transition from BeforeMind to AfterMind. There's nothing more to it than that.

Revival and Beyond

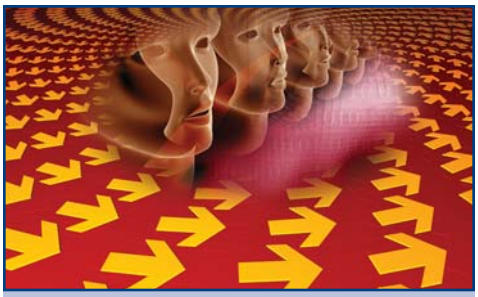
But what does this tell us in practice, about various forms of revival? Not that much – but it gives us a framework for asking the right questions.

One interesting question is how much of the self depends on the body beyond the brain. If you transition to being a brain in a vat – or a simulated brain in a file directory – how much continuity of self is there? The best guide we have to understanding this issue is the experience of quadriplegics. Quite clearly, when someone becomes paralyzed and loses feeling in their body, they do experience continuity of self. This doesn't prove an uploaded mind, lacking a body, would also

FORWARD AND BACKWARD SYNTHESIS IN VISION

In vision processing, forward synthesis is related to the neural connections directed from the retina to the conceptual cortex, which combine elementary patterns recognized in the visual scene into more and more complex patterns, then matching the ultimate result against memory. It appears this may be the only sort of process involved when we recognize objects in rapidly presented images[9].

On the other hand when we have more leisure to study an image we seem to also use backward synthesis – once we get a crude idea of what objects may be in the image, we then make a guess for what the object might be (a cat! a shovel! etc.) and look for low-level visual clues in the picture that might validate that hypothesis, i.e., we try to figure out how to build compounds out of the data that might validate our hypothesis.



THE PHENOMENAL SELF: IS IT REAL?

The phenomenal self of an organism is an attractor of the following dynamic:

1. Use backward synthesis processes to explain what the organism must be, in order to display the behaviors observed
2. Embody these explanations as mental content
3. Use forward synthesis to combine this mental content to form new mental content, comprising new ideas about the organism's nature
4. These new ideas affect the organism's behavior, which is observed, leading us back to Step 1

The mind tries to explain itself, incorporates these explanations into itself, and then behaves differently based on its new understanding of itself ... then tries to explain itself again ... and so on. In this process, it never understands itself completely (never explains itself to itself fully exactly or accurately), but it builds a better and better understanding, eternally playing a game of catch-up because as its understanding changes, its behavior inevitably changes as a result.

Phenomenal self, by its very nature, is a biased approximation model, not an underlying reality. The phenomenal self is a model that approximates reality, and continually seeks to modify reality so as to make itself into a better approximation of reality. So the question of continuity of self must be addressed on the level of models, not on the level of underlying realities.

experience continuity of self – but it makes it seem quite likely. This line of thinking is promising for "neuro only" cryonics patients.

Regarding the prospect of being successfully revived in spite of brain damage incurred during cryopreservation or revival, the story is a bit more ambiguous. It all depends on how much damage there is to what regions of the brain. Metzinger, in *Being No One*, surveys multiple instances of self-model malfunctions ensuing from damage to various parts of the brain. We would need to understand the human brain far better to understand exactly which sorts of brain damage pose exactly how much risk of destroying continuity of self.

Most interesting to me is thinking about the possibility of rapid evolution beyond the human condition, after uploading one's mind into a computer or some other more flexible substrate. Theoretically, it seems quite possible for a mind to preserve continuity of self through a series of very radical transitions, thus beginning as a human and winding up an incomprehensibly advanced hyperbeing like FutureBen and FutureBush.

Those who have read Ray Kurzweil's book *The Singularity is Near* or otherwise encountered Vernor Vinge's notion of a technological Singularity, may be wondering how the notion of self-continuity fits in. The Singularity is a predicted period in human evolution – maybe occurring in the middle of this century, if Kurzweil is correct – at which technological change occurs so fast that the human mind can't keep up with it: in the time

THE "SELF" IN THE NOVAMENTE AI SYSTEM

Dr. Goertzel has over 20 years experience in Artificial Intelligence (AI) R&D and commercialization. He holds a Ph.D. in mathematics from Temple University, is the former CTO of a thinking machine company, Webmind, and has held several university positions in mathematics, computer science, and psychology in the U.S., New Zealand and Australia. He has written of over 70 research papers and journalistic articles and is the author of 8 scholarly books dealing with topics in cognitive sciences and futurism.

Goertzel is the principle architect of the Novamente Cognition Engine, a software product and development firm aimed at bridging the gap between narrow and general purpose Artificial Intelligence. Ongoing research brings the company's Novamente Cognition Engine closer each month to powerful Artificial General Intelligence (AGI). So will he be able to create an AI that has a self?

"The 'self' concept is critical to my work on AGI technology: If one wants to make AI software programs that are more than just specialized problem-solvers – that are capable of entering new situations and flexibly figuring out how to achieve their goals – then one needs these programs to understand who and what they are, and how they relate to the world around them. That is, the programs need to have 'selves'. And, how to supply an AI program with a self is not at all obvious.

The emulation of the process in software can proceed by building an AI system capable of powerful forward and backward synthesis-based cognition, and set it the task of explaining and creatively understanding its own self and acting based on this understanding. In the Novamente AI system[15], there are a number of different forward synthesis processes, including 'forward chaining probabilistic inference'[16], conceptual blending[17], and map formation (which creates new mental content representing mental items that have frequently been utilized together, thus roughly emulating the neural process of cell assembly formation). Backward synthesis is carried out by a number of algorithms, including backward-chaining probabilistic inference and a probabilistic evolutionary learning system called MOSES[18]."

it takes for a human to breathe, some faster-moving AI comes up with yet another revolutionary scientific or technical innovation. The Singularity, if it happens, has amazing potential to transform human life and to carry mind beyond the confines of humanity. As the Singularity dawns, we may each be faced with a choice: to remain human, or to allow ourselves to grow and change into something fundamentally more intelligent and powerful, and fundamentally different.

It seems to me, however, that there may be limits on the rate of change possible for a mind that wants to preserve continuity of self. Continuity of self may rule out full subjective participation in Singularity. If BeforeMind is supposed to be able to model AfterMind effectively, before AfterMind exists, this takes a certain amount of time and effort on BeforeMind's part – and the speed with which this modeling will be possible will depend on how intelligent BeforeMind is. In other words, it might be faster for me to transform myself into something I don't intuitively understand, than to first understand something well enough to incorporate it into my self-model, and then transform myself into that thing. So, potentially, post-Singularity the intelligence of wholly newly created beings may surpass that of beings that advance slowly enough to preserve continuity of self.

This brings up another sort of question: Who really cares about continuity of self? The *importance* of continuity of self is, of course, an issue of ethical and aesthetic values rather than scientific facts or theories. Perhaps post-Singularity, "self" itself will come to seem unimportant, and the evolution of intelligence will consist of the iterative launching of a series of minds unconnected by any self-continuity.

But right now, speaking as a mere human being, I find myself feeling that where the continuation of my life is concerned, continuity of self is both valuable and sufficient. It is a critical and essential aspect of the kind of immortality I would like to see available to myself and my loved ones – and anyone else who wants it. ■

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Tech News R. Michael Perry, Ph.D.

Imaging Pinpoints Brain Regions That "See The Future"

Until recently there's been little research into cognitive processes underlying a form of mental time travel—the ability to clearly imagine or "see" oneself participating in a future event. Now that is changing, thanks to efforts of Karl Szpunar and colleagues at Washington University in St. Louis. Comparing images of brain activity in response to the "self-remember" and "self-future" event cues, the researchers found a surprisingly complete overlap among regions of the brain used for remembering the past and those used for envisioning the future. "In our daily lives, we probably spend more time envisioning what we're going to do tomorrow or later on in the day than we do remembering, but not much is known about how we go about forming these mental images of the future," says Szpunar. "Our findings provide compelling support for the idea that memory and future thought are highly interrelated and help explain why future thought may be impossible without memories." Findings of Szpunar's group were scheduled to appear online Jan. 1 in *Proceedings of the National Academy of Sciences*.

Science Daily
1/7/07
http://www.sciencedaily.com/releases/2007/01/070102092224.htm

Carbon Monoxide Protects Lung Cells against Oxygen-induced Damage

Researchers at the University of Pittsburgh have demonstrated that low-dose carbon monoxide administered in conjunction with oxygen therapy markedly inhibits oxygen-induced damage to lung cells. These findings, being reported in the Jan. 19 issue of the *Journal of Biological Chemistry*, have significant implications for the treatment of acute respiratory distress syndrome, or ARDS, according to the study's authors. ARDS is a life-threatening medical condition in which patients experience severe shortness of breath and oxygen starvation. Although ARDS often occurs in people who have lung disease, even people with normal lungs can develop the condition as the result of severe trauma or an infection. In fact, it is the number one killer of patients in intensive care unit facilities in the United States. Treatment for ARDS primarily involves hooking the patient up to a mechanical ventilator and giving them almost pure oxygen (95 percent oxygen and 5 percent carbon dioxide). However, recent studies in animals have shown that prolonged exposure to an elevated level of oxygen, or hyperoxia, can cause long-term lung injury that resembles ARDS.

Science Daily
1/20/07
http://www.sciencedaily.com/releases/2007/01/070118130002.htm

Scientists "Reverse" vCJD Signs

Symptoms of prion diseases, such as the human form of mad cow disease, vCJD (variant Creutzfeldt-Jakob disease), can be reversed if treated early, a study of mice suggests. Medical Research Council experts found memory and behavior problems could be tackled by stopping production of the proteins corrupted in such diseases. However, writing in *Neuron*, they warn the usefulness of the work for humans depends on having a test for vCJD. A UK expert, Professor Roger Morris of King's College, London, said it was "potentially very important work." vCJD, BSE in cattle (bovine spongiform encephalitis or "mad cow" disease) and scrapie in sheep are all caused by a buildup of abnormally shaped versions of proteins called prions in the brain.

BBC News
2/1/07
http://news.bbc.co.uk/2/hi/health/6314877.stm

GM Mosquito "Could Fight Malaria"

A genetically modified (GM) strain of malaria-resistant mosquito has been created that is better able to survive than disease-carrying insects. It gives new impetus to one strategy for controlling the disease: introduce the GM insects into wild populations in the hope that they will take over. The insect carries a gene that prevents infection by the malaria parasite. Details of the work by a US team appear in *Proceedings of the National Academy of Sciences* journal. The researchers caution that their studies are still at an early stage, and that it could be 10 years or more before engineered insects are released into the environment. "What we did was a laboratory, proof-of-principle experiment; we're not anywhere close to releasing them into the wild right now," co-author Dr Jason Rasgon from Johns Hopkins University in Baltimore, Maryland, told BBC News.

A transgenic mosquito carrying a gene that confers resistance to the malaria parasite. The GM mosquitoes could be identified by their green fluorescent eyes.

Image: Marrelli, M., et al. "Transgenic malaria-resistant mosquitoes have a fitness advantage when feeding on Plasmodium-infected blood." PNAS 2007 104: 5580-5583. Copyright 2007 National Academy of Sciences, U.S.A.

BBC News
3/19/07
http://news.bbc.co.uk/2/hi/science/nature/6468381.stm

HIV Protein Enlisted to Help Kill Cancer Cells

Cancer cells are sick, but they keep growing because they don't react to internal signals urging them to die. Now researchers at Washington University School of Medicine in St. Louis have found an efficient way to get a messenger into cancer cells that forces them to respond to death signals. And they did it using one of the most sinister pathogens around — HIV. "HIV knows how to insert itself into many different types of cells," says senior author William G. Hawkins, M.D., assistant professor of surgery and a member of the Siteman Cancer Center at the School of Medicine and Barnes-Jewish Hospital. "A por-

tion of the HIV protein called TAT can transport biologically active compounds into cells. TAT is small, but it can move massive molecules." In an article published online in January 2007 in the *Annals of Surgical Oncology*, the researchers describe using TAT to pull a protein called Bim into cancer cells. TAT alone cannot cause AIDS and has no adverse health effects. Bim acts as a tumor suppressor and causes cancer cells to die through apoptosis, a process by which cells "commit suicide."

Science Daily
2/11/07
http://www.sciencedaily.com/eleases/2007/02/070210173653.htm

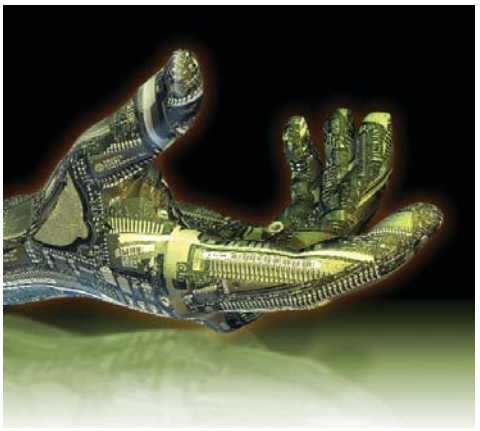
Private Rocket Rides into Space

Privateer Elon Musk has launched his budget rocket, Falcon-1, from the Kwajalein Atoll in the South Pacific. The 21m-long vehicle lifted off at 1810 California time Mar. 20 (0110 GMT Mar. 21) and rose to an altitude of 320km (200 miles). Mr. Musk, who co-founded the internet financial system PayPal, wants to lower the cost of access to space. The flight did not achieve all its goals, but he said it demonstrated the vision of his Space Exploration Technologies Corporation (SpaceX). The mission was the second attempt to loft the rocket; the first, in March 2006, ended when a fire fed by a fuel leak led to the shutdown of the main-stage engine just 29 seconds after lift-off. On the latest flight, the second stage did not achieve its full speed, again because of an early shut down of the engine, this time because the vehicle began an unexpected roll. Mr. Musk said he thought this problem should be easy to fix however. An operational satellite launch is planned for later this year.

BBC News
3/21/07
http://news.bbc.co.uk/1/hi/sci/tech/6474021.stm

Robotic Age Poses Ethical Dilemma

An ethical code to prevent humans abusing robots, and vice versa, is being drawn up by South Korea. The Robot Ethics Charter will cover standards for users and manufacturers and will be released later in 2007. It is being put together by a five member team of experts that includes futurists and a science fiction writer. The South Korean government has identified robotics as a key economic driver and is pumping millions of dollars into research. "The government plans to set ethical guidelines concerning the roles and functions of robots as robots are expected to develop strong intelligence in the near future," the ministry of Commerce, Industry and Energy said. Other bodies are also thinking about the robotic future. Last year a UK government study predicted that in the next 50 years robots could demand the same rights as human beings.



An ethical code to prevent humans from abusing robots, and vice versa, is being drawn up by South Korea.

BBC News
3/7/07
http://news.bbc.co.uk/2/hi/technology/6425927.stm

Blood Groups "Can Be Converted"

Scientists have developed a way of converting one blood group into another. The technique potentially enables blood from groups A, B and AB to be converted into group O negative, which can be safely transplanted into any patient. The method, which makes use of newly discovered enzymes, may help relieve shortages of blood for transfusions. The work, led by the University of Copenhagen, is reported in the journal *Nature Biotechnology*. Using incompatible blood during a transfusion can put a patient's life in danger.

BBC News
4/2/07
http://news.bbc.co.uk/1/hi/health/6517137.stm

Progress toward Rabies Cure

Vaccines against the rabies virus can prevent development of the illness after a bite by an infected animal. But until recently doctors could hold out no hope for patients who failed to get immunized soon after being bitten. Once the symptoms of rabies appeared—normally within two months of the bite—death was inevitable, in a week or less. Promising new research by Drs. Rodney Willoughby, Jeanette Vasquez-Vivar, Keith Hyland, and Charles Rupprecht offers new hope for a cure of rabies. The researchers have discovered a deficiency of a vitamin-like molecule in rabies patients. The molecule, biopterin, can be supplemented and promises to make rabies even more treatable than it was in 2004 when 15-year-old Jeanna Giese became the first—and so far only—unvaccinated patient to survive after developing symptoms.

Science Daily
3/26/07
http://www.sciencedaily.com/releases/2007/03/070326152603.htm

Heart Valve Grown from Stem Cells

British scientists have grown part of a human heart from stem cells for the first time. Heart surgeon Sir Magdi Yacoub, who led the team, said doctors could be using artificially grown heart components in transplants within three years. His researchers at Harefield hospital managed to grow tissue that works in the same way as human heart valves. Sir Magdi told *The Guardian* newspaper a whole heart could be produced from stem cells within 10 years. The team which spent 10 years working on the project included physicists, pharmacologists, clinicians and cellular scientists. Previously, scientists have grown tendons, cartilages and bladders, which are all less complex.

BBC News
4/2/07
http://news.bbc.co.uk/1/hi/health/6517645.stm

MEETINGS

About the Alcor Foundation

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

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

ARIZONA

Scottsdale:
Alcor Board of Directors Meetings—Alcor business meetings are generally held on the first Saturday of every month starting at 11:00 am MST. Guests are welcome. For more information, contact Alcor at (480) 905-1906 ext. 101.

Scottsdale/Phoenix:
Alcor Tours
Tours are held at Alcor at 2:00 pm every Tuesday and Friday.
Call Alcor (877) 462-5267 ext. 101 to schedule an appointment or email dbora@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 Marek (Mark) Galecki at (408)245-4928 or email Mark_galeck@pacbell.net.

DISTRICT OF COLUMBIA

Life Extension Society, Inc. is a cryonics and life extension group with members from Washington, D.C., Virginia, and Maryland. Meetings are held monthly. Contact Secretary Keith Lynch at kfl@keithlynch.net. For information on LES, see our web site at www.keithlynch.net/les

MASSACHUSETTS

Boston:
A cryonics discussion group meets the second Sunday of each month. For more information, contact David Greenstein at (508) 879-3234, e-mail: davidsgreenstein@juno.com.

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.

NEVADA

Las Vegas:
There are many Alcor members in the Las Vegas area. If you wish to meet and socialize, contact Katie Kars at (702) 251-1975. This group wants to get to know you!

WASHINGTON

Seattle:
For information on Northwest meetings, call Richard Gillman at (425) 641-5136 or join the e-mail group CryonicsNW at http://groups.yahoo.com/group/CryonicsNW

UNITED KINGDOM

There is an Alcor chapter in England. Its members are working diligently to build solid emergency response, transport, and cryopreservation capability. For information about meetings, contact Andrew Clifford at andrew@banknotes.ws. See the web site at www.alcor-uk.org.

Host a Meeting in your area.

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!

NEW ENGLAND

A New England area group meets regularly. For meeting dates and to be included in the group email list please contact either David Greenstein at 508-879-3234 or davegre2000@yahoo.com or Bret Kulakovich at 508-946-4626 (8am-8pm EST) or alcor@bonfireproductions.com.

WHAT IS CRYONICS?

Cryonics is an attempt to preserve and protect the gift of human life, not reverse death. It is the speculative practice of using extreme cold 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 30-minute DVD documentary "The Limitless Future"
- A fully illustrated color brochure
- A sample of our magazine
- An application for membership and brochure explaining how to join
- And more!

Your free package should arrive in 1-2 weeks.

(The complete package will be sent free in the U.S., Canada, and the United Kingdom.)

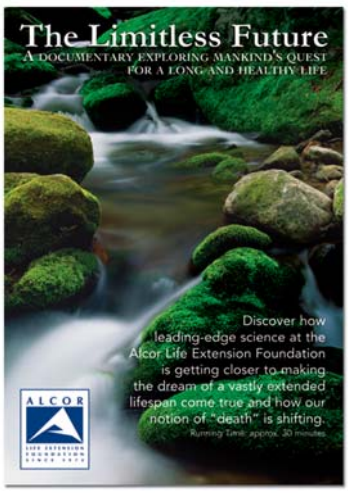
HOW DO I ENROLL?

Signing up for a cryopreservation is easy!

Step 1: Fill out an application and submit it with your $150 application fee.
Step 2: You will then be sent a set of contracts to review and sign.
Step 3: Fund your cryopreservation. While most people use life insurance to fund their cryopreservation, other forms of prepayment are also accepted. Alcor's Membership Coordinator can provide you with a list of insurance agents familiar with satisfying Alcor's current funding requirements.
Finally: After enrolling, you will wear emergency alert tags or carry a special card in your wallet. This is your confirmation that Alcor will respond immediately to an emergency call on your behalf.

Call toll-free today to start your application:
877-462-5267 ext. 132
info@alcor.org
www.alcor.org

ALCOR
LIFE EXTENSION FOUNDATION
SINCE 1972



The Limitless Future
Get your FREE copy of Alcor's 30-minute DVD documentary by visiting the "Free Information" section of our website

Will You Be Alive and Healthy

10...20...30 Years from now?

Your best chance at achieving future immortality is to protect your precious health now so you can benefit from future medical breakthroughs. Staying informed about the latest health discoveries can mean the difference between life and premature death.

And the **Life Extension Foundation** can be your passport to the future. As the largest anti-aging organization in the world, we are dedicated to finding scientific ways to prevent disease, slow aging, and eventually stop death.

For more than two decades, Life Extension has been at the forefront of the movement to support revolutionary anti-aging research that is taking us closer to our goal of extending the healthy human life span indefinitely. We inform our members about path-breaking therapies to help keep them healthy and alive.

Join today and you'll receive these life-prolonging benefits:

- **A subscription to *Life Extension* magazine** ($59.88 yearly newsstand value)...Over 100 full-color pages every month are filled with medical research findings, scientific reports, and practical guidance about using diet, nutrients, hormones, and drugs to prevent disease and slow aging.
- Access to a toll-free phone line to speak with **knowledgeable health advisors**, including naturopathic doctors, nutritionists, and a cancer expert, about your individual health concerns. You can also receive help in developing your own personal life extension program.
- **Discounts on prescription drugs, blood tests, and pharmaceutical quality supplements** that will greatly exceed your membership dues. You'll receive a directory listing the latest vitamins and supplements, backed by scientific research and available through a unique buyers club.

FREE BONUS!

- ***Disease Prevention and Treatment* book** ($49.95 cover price) ...this hardbound fourth edition provides novel information on complementary therapies for 133 diseases and illnesses—from Alzheimer's disease to cancer, from arthritis to heart disease—that is based on thousands of scientific studies.

Life Extension Foundation funds advanced vitrification and gene-chip research. Your $75 membership fee helps support scientific projects that could literally save your life.

Call 1-866-820-4967 today.

LIVE Healthier & Longer

LifeExtension℠ FOUNDATION

Join today. Call toll-free 1-866-820-4967. Or visit www.lef.org/pim