ALCOR LIFE EXTENSION FOUNDATION

CRYONICS

4TH QUARTER 2008 · VOLUME 29:4

ALCOR SUPPORTS MOLECULAR NANOTECHNOLOGY RESEARCH AND DEVELOPMENT

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CRYONICS

4TH QUARTER 2008 • VOLUME 29:4

COVER STORY: PAGE 3

The Alcor Scientific Advisory Board and the Alcor Board of Directors have endorsed a statement in support of research and development in molecular nanotechnology. Molecular nanotechnology researchers Ralph Merkle and Robert Freitas discuss the importance of molecular nanotechnology to cryonics and present a cell repair scenario for existing Alcor patients.

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Cover photo:
Advanced nanorobots will keep all human body cells in perfect repair, preventing disease and aging. Here, a cell repair robot called a chromallocyte penetrates the outer cell membrane, accessing the cytoplasm to begin corrective operations. ©2008 E-spaces 3danimation.e-spaces.com (artwork) and Robert A. Freitas Jr. www.rfreitas.com (concept/design).

ALCOR LIFE EXTENSION FOUNDATION
CRYONICS

Editor
Aschwin de Wolf

Art Director
Jill Grasse

Contributing Writers
Michael Darwin
Chana de Wolf
Robert Freitas, J.D.
Ralph Merkle, Ph.D.
R. Michael Perry, Ph.D.

Contributing Photographer
Murray Ballard

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To subscribe: call 480.905.1906 x101

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

Letters to the Editor welcome:
aschwin@alcor.org

Advertising inquiries:
480.905.1906 x113
advertise@alcor.org

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FROM THE EDITOR

The resuscitation of cryonics patients will require the manipulation of matter at the molecular level. One school of thought is that such cell repair technologies are permitted by the laws of physics and are, therefore, inevitable. An obvious objection is that the feasibility of molecular nanotechnology (MNT) cannot be settled by logic alone and should be demonstrated though experimental evidence. Fortunately, at the December 2008 meeting of the Alcor Scientific Board of Directors, a statement in support of research and development of molecular nanotechnology was adopted. This resolution was also endorsed by the Alcor Board of Directors in a subsequent meeting.

This issue features two articles by Ralph Merkle and Robert Freitas about their plans to translate the vision of molecular nanotechnology from the theoretical to the experimental realm. In the first article, an ambitious agenda is proposed to push positionally-controlled diamond mechanosynthesis and diamondoid nanofactory development. In the second article, a resuscitation scenario involving molecular nanotechnology is discussed. Such scenarios are not only important to work out the feasibility and requirements for resuscitation of existing cryonics patients, they will also help identify the weakest links in our existing cryonics procedures. Ralph Merkle and Robert Freitas hope to raise interest among cryonicists to help support this important research.

To stick with the "theme" of cell repair technologies, this issue of Cryonics features a reprint of Mike Darwin's "The Anabolocyte: A Biological Approach to Repairing Cryoinjury." This article was first published in the July/August 1977 issue of *Life Extension Magazine* (not to be confused with the contemporary magazine of the same title, now published by the Life Extension Foundation) and is made available again in paper format for the first time in 32 years. Mike Darwin, ex-Alcor President and cryonics expert, was kind enough to write a postscript to the piece.

We closed the year 2008 with 875 Alcor members. We are slowly creeping towards our 1,000 member milestone. But as can be seen in our membership statistics, too many of our members cancel their cryopreservation arrangements. Reversing this phenomenon should be a high priority in 2009.

ALCOR SCIENTIFIC ADVISORY BOARD MEETING

By Ralph C. Merkle, Chairman, Alcor Scientific Advisory Board

The Alcor Scientific Advisory Board (SAB) met on December 9th and 10th, 2008 in Melbourne, Florida.

The first day was devoted to how the cryonics community could help speed the development of MNT (molecular nanotechnology), and how MNT could enable repair of cryopreserved patients.

Ralph Merkle and Robert Freitas gave a 90 slide Power Point presentation about their plan to develop MNT. Further information about their work is available at The Nanofactory Collaboration website – see http://www.MolecularAssembler.com/Nanofactory, which provides an overview of the issues involved in developing nanofactories.

Part of their presentation discussed a specific set of nine molecular tools composed of hydrogen, carbon, and germanium. This is described in complete technical detail in *A Minimal Toolset for Positional Diamond Mechanosynthesis* – see http://www.MolecularAssembler.com/Papers/MinToolset.pdf. The nine tools can be used to both recharge all nine tools and make additional tools, as well as build a wide range of atomically precise hydrocarbon structures (diamond, nanotubes, polyynes, fullerenes, and many others) – starting from just raw materials (feedstock molecules). The bulk of the paper describes the specific mechanosynthetic reactions required in this process, and their evaluation using Gaussian, a standard computational chemistry package.

They also mentioned the $3M 5-year grant to Professor Philip Moriarty in the School of Physics at the University of Nottingham to experimentally investigate some of the proposed tools and reactions – see http://www.MolecularAssembler.com/Nanofactory/Media/PressReleaseAug08.htm

The Alcor SAB then discussed *The importance of MNT to the cryonics community* and *A cryopreservation revival scenario using MNT* (which both appear in this issue of Cryonics).

Following this, a draft statement of support for research in MNT by the cryonics community was presented. After some discussion and wordsmithing the Alcor SAB formally voted to support this *Endorsement of Molecular Nanotechnology Research and Development* (see the full text in the box below). The full Alcor Board endorsed the statement at their next regular meeting. We plan to seek broader support for this statement.

We'd like to thank all the attendees for making it a stimulating and productive meeting. We'd like to offer our particular thanks to Martine Rothblatt, whose generous support made the meeting possible.

The first day SAB attendees were: Antonei Csoka, Aubrey de Grey, Robert Freitas, James Lewis, Ralph Merkle, Marvin Minsky, and Martine Rothblatt. Non SAB attendees were Gloria Rudisch (Marvin's wife), Lori Rhodes, and Tanya Jones. Martine Rothblatt proposed that the SAB needed a chairman and nominated Ralph Merkle for the position. The nomination was approved unanimously.

On the second day, Melody Maxim joined the discussion, and Martine Rothblatt did not attend (she was at a Terasem meeting). The second day was focused on cryopreservation methods, how they could be improved, and how the credibility of cryonics could be improved in the scientific community. ■

Endorsement of Molecular Nanotechnology Research and Development

The development of molecular nanotechnology will speed solutions to the most difficult problems of medicine, including aging and reversible suspended animation. Molecular nanotechnology is the most compelling approach ever put forward for comprehensive repair of cryopreservation injury with maximum retention of original biological information. Support for immediate development of molecular nanotechnology by cryonicists and life extensionists could compress the historical timeline of this technology, bringing benefits decades sooner than otherwise.

The Importance of MNT to the Cryonics Community

By Ralph C. Merkle and Robert A. Freitas Jr.

A Call To Action

The cryonics community should robustly support research in two critical areas: better methods of cryopreservation, and methods of reviving cryopreserved patients. We already know we must do the former. But now, it seems, we must also do the latter.

The best approach for revival is to develop and apply MNT (molecular nanotechnology). The faster we do this, the sooner we will be able to revive cryopreserved patients and the less time they will spend in storage. We will also obtain medical nanodevices able to cure a wide range of other severe injuries, along with the broader capabilities of MNT that will benefit both us and the rest of humanity.

Look around the world and ask: who has the vision and the will to develop MNT? Few are heeding the call. The development of MNT might be delayed by many decades for want of relatively modest research funding today. To correct this situation we must look to ourselves. We must vigorously fund MNT research now.

Two Key Goals for Cryonics Research

Alcor is a coalition of individuals with diverse beliefs, opinions and hopes. We all share a common belief that life is good, that saving lives is the right thing to do, and that we can save lives through cryonics. We want to save our own lives, the lives of our loved ones, the lives of our friends, the lives of our neighbors, and indeed the lives of everyone we can.

The core of cryonics is easy to describe: those who have exhausted all other medical options can be cryopreserved until future technology can restore them to full and vibrant health.

As a consequence, we (cryonicists as a community) have worked hard to improve our ability to do cryopreservations. Whether by research on better methods, or better facilities, or better equipment, or better training, or better logistics and deployment, we understand that we are the ones who must do the work because there is no one else to do it for us.

This quest for better cryopreservations continues today, and will continue until some future day when fully reversible cryopreservation becomes possible. This is a key goal of cryonics research.

But until that future day arrives, a cryopreserved patient must rely upon the development and the application of new technologies to allow the person's body to be restored to complete health. This is a second key goal of cryonics research.

One of these new technologies is MNT. While in theory there might be other ways to revive cryopreserved patients, MNT is by far the best studied and best known approach. Based on our current knowledge, MNT seems the most likely to give us the vibrant good health that we seek.

Reviving Cryopreserved Patients using MNT

Perhaps the most generally appealing approach to patient revival is to repair the cryopreserved biological structure, returning the person to full health by employing a process that saves and restores the original tissue.* This is technically challenging but appears quite feasible using MNT. One such MNT-based revival scenario is outlined in the accompanying article.

Alternative methods for revival of a cryopreserved patient without direct tissue repair have been proposed, but these too most likely require MNT. The simplest such method relies on the argument that recovery of personality-relevant information is all that is needed. This data could be obtained via high-resolution imaging of the cryopreserved human brain (possibly destructively), after which the resulting information would be used to create an artificial brain with the same memories, hopes, dreams and personality as the person who was cryopreserved. Many people trained in the fields of artificial intelligence, computer science, and philosophy of mind strongly support this option, but some others are uncomfortable with the idea.

Our Community Can Speed the Development of MNT

Can we really make a difference in the development of MNT? The answer is an unequivocal "Yes!" Recent work (see www.MolecularAssembler.com/Nanofactory) makes it clear that the MNT revolution can be accelerated by decades with well focused research investments of only millions to tens of millions of dollars. We have those resources within our community.

Are others working towards this goal? Remarkably, the answer is "No." As first proposed, the National Nanotechnology Initiative had funding to investigate MNT. This funding was removed from the bill under political pressure before it was signed by President Bush in December 2003. Today, funding in the United States for MNT is still being actively blocked and research scientists eager for tenure and grants are careful to avoid the subject. As a result, vital research is not being pursued, advances are not being made, and it is unclear how long this political logjam will continue to block progress. Similar political problems in other fields have often cost decades of delay. In the case of MNT, delay will cost many lives – possibly including ours.

What should we do? We must recognize, once again, that it falls to us to support the

research upon which our lives depend. In this case, we must identify and support the critical research that will speed the development of MNT. As it happens, we have within our community some of the finest minds in the world in MNT (just as we have some of the finest minds in cryobiology, life extension and other areas – which is not an accident).

More specifically, the most direct path to MNT is to develop mechanosynthesis (www.MolecularAssembler.com/Nanofactory/DMS.htm) and then to use it to build the first engineered molecular machines. The Nanofactory Collaboration initiated the first work on the direct path to MNT by publishing an extensive theoretical analysis of early steps in the R&D process. We were then fortunate to persuade Philip Moriarty, one of the finest experimentalists in the United Kingdom, to join us in realizing the first step along this path. In late 2008, Philip received a 5-year $3 million grant from the Engineering and Physical Sciences Research Council to experimentally investigate the Collaboration's mechanosynthesis proposals (see www.MolecularAssembler.com/Nanofactory/Media/PressReleaseAug08.htm). This grant was historic but, sadly, unique. Additional funding from traditional mainstream sources in the United States or elsewhere appears unlikely anytime soon.

What is MNT?

Molecular nanotechnology is the anticipated future ability to manufacture products by inexpensively arranging atoms in most of the ways permitted by physical law. The idea was first discussed in Richard Feynman's visionary 1959 talk "There's Plenty of Room at the Bottom." Since then, Feynman's original intuition has been supported by a wealth of both experimental and theoretical research.

On the experimental front, it is almost routine to arrange tens to hundreds of atoms in atomically precise patterns on various atomically flat surfaces, spelling out corporate or governmental logos, or arranging atoms in patterns useful for some limited scientific purpose.

On the theoretical front, computational analyses fully support the idea that molecular tools should be able to hold, position and assemble molecular parts into complex three dimensional structures. Experimental work to explore these possibilities has begun, and dramatic results are expected over the coming years and decades.

The ability of molecular manufacturing machines to build more molecular manufacturing machines should lead to many orders-of-magnitude price reductions for both the machines themselves and the products that those machines can manufacture. A readily accessible example of such a capability can be found in nature: potatoes can make more potatoes, and as a consequence potatoes are widely available at low cost. When examined closely, the potato is made of exceedingly complex molecular machines able to build more molecular machines – yet we think nothing of mashing these miracles of nature and, with a little butter and salt, eating them for dinner.

MNT should bring the economics of potatoes to a much wider range of complex atomically precise manufactured products, including products made from diamond, graphene, fullerenes, carbon nanotubes, sapphire, and a host of other astonishingly strong and lightweight materials. This capability will let us inexpensively build remarkably powerful computers and vast fleets of medical nanorobots that can directly intervene in biological systems even at the level of cellular, subcellular, and molecular structures. Armed with these nanodevices, doctors will be able to repair even extensive damage to human tissues. MNT will revolutionize medicine, marking a quantum leap in our ability to stay healthy and thus to avoid much of the need for cryopreservation in the first place. Developed in time, MNT could play a role in the demonstration of fully reversible cryopreservation.

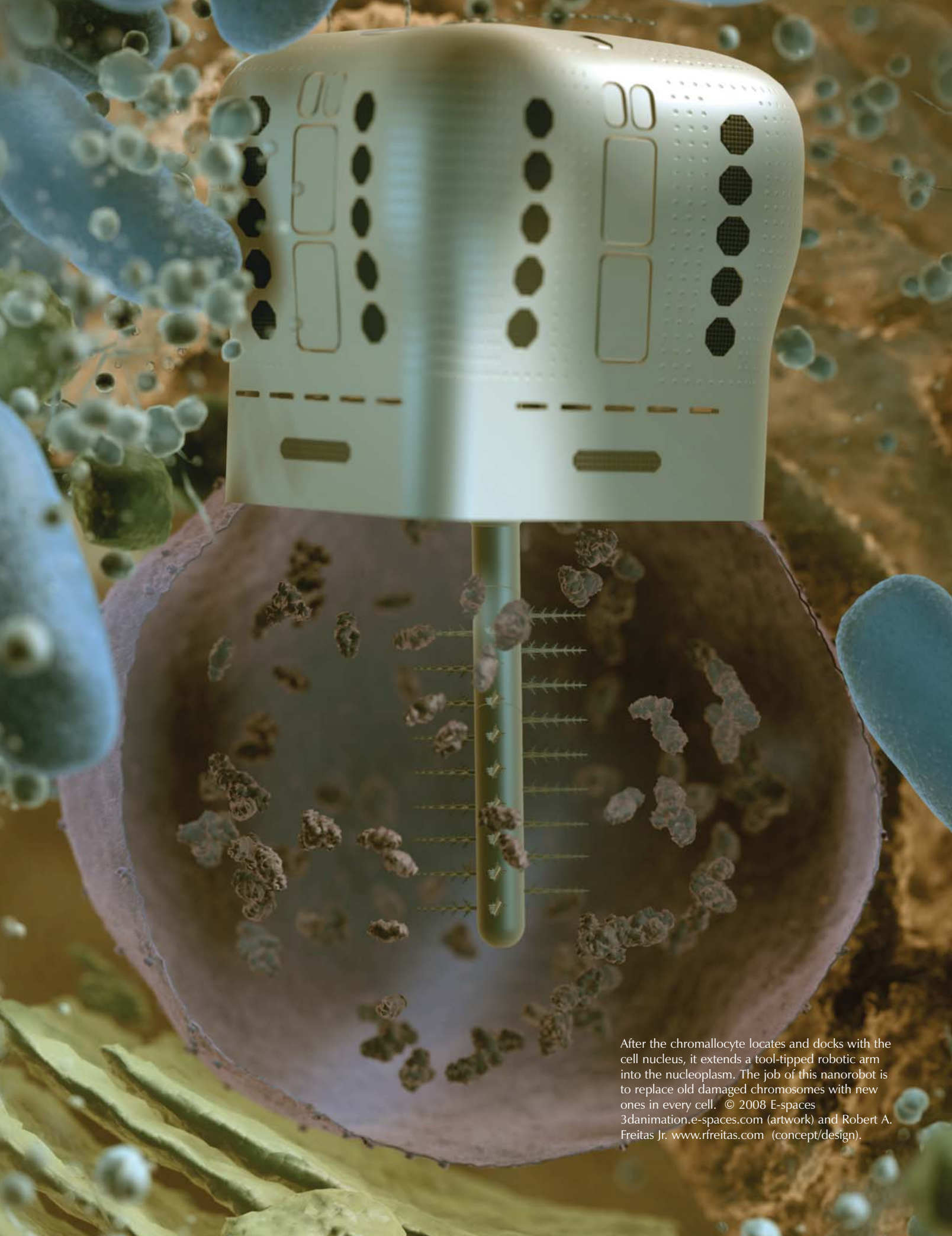
More generally, MNT is expected to provide material abundance for humanity and enable a whole range of novel capabilities beyond better computers and medical technologies – such as the ability to feed a hungry world, roll back environmental damage, directly control the climate, and afford cheap access to space. MNT gives us options for improving the human condition that can scarcely be imagined today.

As with many other technology revolutions in the past, MNT will open up major new avenues for wealth creation beyond life preservation, likely producing a fresh crop of global billionaires among those few farsighted individuals who grasp the opportunity.

Acknowledgements

We would like to thank Aubrey de Grey and Brian Wowk for their comments and insight on an earlier draft which greatly improved the final result. ■

* Published literature on revival includes: Robert C.W. Ettinger, **The Prospect of Immortality**, Doubleday, NY, 1964; Jerome B. White, "Viral Induced Repair of Damaged Neurons with Preservation of Long-Term Information Content," **Second Annual Cryonics Conference**, Ann Arbor MI, 11 April 1969; Michael G. Darwin, "The Anabolocyte: A Biological Approach to Repairing Cryoinjury," **Life Extension Magazine** (July-August 1977):80-83, http://www.alcor.org/Library/pdfs/anabolocyte.pdf; Thomas Donaldson, "How Will They Bring Us Back, 200 Years From Now?" **The Immortalist** 12(March 1981):5-10; K. Eric Drexler, **Engines of Creation: The Coming Era of Nanotechnology**, Anchor Press/Doubleday, New York, 1986, pp. 133-138; Brian Wowk, "Cell Repair Technology," **Cryonics** 9(July 1988), http://www.alcor.org/Library/html/cellrepairmachines.html; Mike Darwin, "Resuscitation: A Speculative Scenario for Recovery," **Cryonics** 9(July 1988):33-37, http://www.alcor.org/Library/html/resuscitation.htm; Thomas Donaldson, "24th Century Medicine," **Analog** 108(September 1988):64-80 and **Cryonics** 9(December 1988), http://www.alcor.org/Library/html/24thcenturymedicine.html; Ralph C. Merkle, "Molecular Repair of the Brain," **Cryonics** 10(October 1989):21-44; Gregory M. Fahy, "Molecular Repair Of The Brain: A Scientific Critique, with a Response from Dr. Merkle," **Cryonics** 12(February 1991):8-11 & **Cryonics** 12(May 1991), http://www.alcor.org/Library/html/MolecularRepair-Critique.html; "Appendix B. A 'Realistic' Scenario for Nanotechnological Repair of the Frozen Human Brain," in Brian Wowk, Michael Darwin, eds., **Cryonics: Reaching for Tommorow**, Alcor Life Extension Foundation, 1991, http://www.alcor.org/Library/html/nanotechrepair.html; Ralph C. Merkle, "The Technical Feasibility of Cryonics," **Medical Hypotheses** 39(1992):6-16, http://www.merkle.com/cryo/techFeas.html; Ralph C. Merkle, "The Molecular Repair of the Brain," **Cryonics** 15(January 1994):16-31 (Part I) & **Cryonics** 15(April 1994):20-32 (Part II), http://www.alcor.org/Library/html/MolecularRepairOfTheBrain.htm; Ralph C. Merkle, "Cryonics, Cryptography, and Maximum Likelihood Estimation," **First Extropy Institute Conference**, Sunnyvale CA, 1994, http://www.merkle.com/cryo/cryptoCryo.html; Ralph Merkle, "Algorithmic Feasibility of Molecular Repair of the Brain," **Cryonics** 16(First Quarter 1995):15-16; Michael V. Soloviev, "SCRAM Reanimation," **Cryonics** 17(First Quarter 1996):16-18, http://www.alcor.org/cryonics/cryonics1996-1.pdf; Mikhail V. Soloviev, "A Cell Repair Algorithm," **Cryonics** 19(First Quarter 1998):22-27, http://www.alcor.org/cryonics/cryonics1998-1.pdf; Robert A. Freitas Jr., "Section 10.5 Temperature Effects on Medical Nanorobots," in **Nanomedicine, Volume I: Basic Capabilities**, Landes Bioscience, Georgetown, TX, 1999, pp. 372-375; http://www.nanomedicine.com/NMI/10.5.htm; Ralph C. Merkle, Robert A. Freitas Jr., "A Cryopreservation Revival Scenario using MNT," **Cryonics** 29(Fourth Quarter 2008).



After the chromallocyte locates and docks with the cell nucleus, it extends a tool-tipped robotic arm into the nucleoplasm. The job of this nanorobot is to replace old damaged chromosomes with new ones in every cell.

A Cryopreservation Revival Scenario using MNT

By Ralph C. Merkle and Robert A. Freitas Jr.

We briefly outline one possible cryopreservation revival scenario using MNT (molecular nanotechnology). A full analysis will require much further work and detailed research. Our principal assumptions are that a reasonably mature MNT will exist, and that the patient has received a "good" cryopreservation by current standards, including the introduction of appropriate levels of cryoprotectants.

Pre-Repair Operations

The first question we face in designing a cryopreservation revival scenario is whether to warm the patient to provide a liquid environment before beginning, or to initiate repairs at low temperature (77 K for patients in LN2, or perhaps ~140 K for patients in the future who elect Intermediate Temperature Storage (ITS)).

The obvious disadvantage of warming before initiating repairs is that further deterioration will take place, which might result in the loss of personality-relevant information (e.g., warming might cause deterioration of synaptic or neurological structures). We know that current methods of cryopreservation cause fractures. While these fractures, like fractures in glass, are expected to produce minimal information loss, they would nevertheless create problems with structural integrity that, upon warming, could lead to further deterioration. Without some form of stabilization, warming fractures would be like slicing the tissue with incredibly sharp knives – on its face not something that we wish to do. Other forms of damage that had occurred either prior to cooling or during the cooling process might, upon warming, also cause continued deterioration of the tissue. As a consequence, initiating the repair process at low temperature is the more conservative approach.

The first step in low temperature repair is to clear out the circulatory system. This process would more closely resemble drilling a tunnel than anything else, and would require the use of molecular machines able to function at (for example) LN2 temperature (though the particular temperature could be adjusted as might be found useful).

This basic process will employ molecular machines that can operate at low temperature, and can sense and remove the kinds of materials found in the circulatory system. Fortunately, proposals for diamondoid molecular machines that operate at low temperature are common. Gears, bearings, ratchets, sliding interfaces and the rest work quite well regardless of temperature, and detailed analyses of molecular structures bear out this claim. Unlike biological systems that typically require liquid water in which to operate, diamondoid molecular machines can operate in vacuum with no need for lubricants and at temperatures as low as we might desire.

Logistics System Installation

Coordination, communication and power for these molecular machines can again be provided at low temperature. Designs for very compact molecular computers able to operate at arbitrarily low temperatures (specifically including rod logic, a type of molecular mechanical computation) are well known in the literature and could provide the computational power needed to coordinate repair activities. Several modes of communication are available, including molecular cables that should be able to transmit data at gigabit rates or higher (www.nanomedicine.com/NMI/7.2.5.htm). By coupling activity of onboard repair devices to off-board computational resources, the overall repair process could be guided by massive computational resources located outside of the patient, thus avoiding concerns about patient heating caused by waste heat from the computational resources required to plan and coordinate repair activities. Finally, power distribution can take place by whatever means is convenient (www.nanomedicine.com/NMI/6.4.htm), including distribution of electrical power via carbon nanotubes (which can have remarkably high conductivity).

During the repair process, various molecular inputs will be required and molecular outputs must be removed. A cryonics-specialized variant of an artificial vasculature or "vasculoid" (see www.jetpress.org/volume11/vasculoid.html) redesigned to operate at low temperatures could be installed to carry out this function. In this variant, the initial transport load would be orders of magnitude smaller than the load that a fully functional vasculoid would be required to handle in a normally metabolizing person even at basal rates. (The original vasculoid was scaled to handle peak metabolic rates.) Roughly speaking, a vasculoid is an artificial circulatory system that enables coordinated ciliary transport of containerized cargoes using a leak-tight coating of machinery on the inner vascular walls. The vasculoid appliance is readily modified to operate at low temperature, and can easily span relatively large cross-capillary breaks.

This initial stage brings medical nanodevices to within ~20 microns of any point in the brain via the circulatory system, and provides distributed power and control as well as massive computational resources located outside the tissue undergoing repair. Initial surveys of the tissue would provide damage estimates at specific sites, including a detailed mapping of fractures. A variety of imaging modalities (www.nanomedicine.com/NMI/4.8.htm) could be used to provide extensive information about the cellular structure throughout the immobilized tissue. At this stage, the external computer guiding repairs would come to possess detailed structural information of the entire system down to the cellular and subcellular level. If the cryo-

preservation had generally gone well, this fact would be apparent and relatively minimal analysis and repairs would be required. If the cryopreservation had produced more significant damage in some areas, this damage could be tabulated and assessed, and appropriate repair strategies could be planned. There is reason to believe that even very serious damage could be analyzed, the original healthy state determined, and appropriate repair strategies adopted (see, for example, "Cryonics, Cryptography, and Maximum Likelihood Estimation" at www.merkle.com/cryo/cryptoCryo.html).

Fracture Stabilization

Current cryopreservation methods create fractures, some of which can have gaps that are tens or even hundreds of microns across. Unstabilized, these fractures would cause further tissue deterioration upon warming. Stabilization of fractures can be done by the synthesis of artificial surfaces specifically designed to conform to the exposed faces of the fractures. For example, we could make a stable support sheet of ~1 nanometer thickness to which arrays of hydrophilic and hydrophobic molecular surface "decorations" are attached. By making the decorations match the exposed face of the fracture, this support sheet would stabilize the fracture face on warming and prevent further deterioration. The success of this approach depends upon the ability of MNT to synthesize an appropriate support sheet – which we expect to be well within the capabilities of the technology.

Following stabilization of fracture surfaces the system temperature can be slowly increased without risk that the fractures will contribute to further deterioration. The support sheet would remain in contact with the fracture face even as the fracture face expands or contracts during warming – the thin support sheet would readily conform to such changes in shape.

Tissue Chemistry Restoration

As the temperature increases and some degree of fluidity is reintroduced into the tissue, the repair process can turn to other issues. In particular, some proteins have likely been denatured during the cryopreservation process. As most proteins should spontaneously recover, the technical challenge will be to identify those that are slow to recover and then either hasten their recovery (possibly by the use of artificially designed chaperones) or support their missing function by other means during recovery. (The recovery of many tissue types after cooling to low temperature supports this approach – if any significant fraction of proteins failed to recover, one would not expect any tissues to spontaneously survive such treatment.) In those cases where critical functionality does not spontaneously recover with sufficient rapidity, it would be possible to introduce new properly folded proteins at an appropriate temperature to take over the critical functions that have been compromised, and then let the tissue recover by itself later on, once it has resumed normal functioning. Re-denaturation of proteins can largely be avoided by delaying repairs to higher temperatures in a series of stages depending on which repairs are needed at various temperatures.

The cryopreservation process and the changes prior to cryopreservation have likely caused imbalances in the concentrations of specific chemicals. Concentrations of sodium, potassium, other ions, ATP, glucose, oxygen, and many other metabolites and chemicals are likely not at desirable values. Concentrations of cryoprotectants might or might not be at desired levels for the particular temperature, so it might be useful to remove cryoprotectants employed during the cryopreservation and replace them with newer cryoprotectants that have more desirable properties. As the tissue becomes more fluid, concentrations of any specific chemical can be measured and adjusted. Direct access to cells surrounding the capillary lumen is available, and the use of tubular probes (which could be introduced from the luminal vasculoid face once the liquid environment becomes sufficiently viscous to allow such probes to penetrate) would provide direct access to the intracellular contents of cells 10 or 20 microns from any capillary. Concentrations of reactive molecules such as oxygen and other reactive metabolites would be kept low until later in the recovery process, with metabolism also kept on hold during this time.

The support system and external computer would have essentially total control over the concentration of all chemical compounds in all cellular and even subcellular compartments in the recovering patient. The control system would adjust these concentrations as needed to minimize damage, both during the re-warming process and also later while metabolic activities were being re-established.

Fracture Sealing and Comprehensive Cell Repair

At some higher temperature, with sufficient fluidity for tissues to flow and reduce strain, the fracture faces can be brought together and the support sheets removed and exported from the body. One simple conceptual mechanism for bringing the fracture faces together involves using biologically inert "strings" attached to specific matching sites on two support sheets that are stabilizing the two opposing faces of a particular fracture. Pulling the strings tight draws the opposing fracture faces together. Even fracture gaps as large as 0.5 millimeters can be accommodated, since all the individual support sheets in a large block of tissue can be simultaneously manipulated as an incremental three-dimensional global strain release network to slowly heal the breaks.

Once the system is liquid it becomes possible to introduce other medical nanodevices to deal with specific forms of damage, including pre-existing damage – like the presence of lipofuscin or other undesired intracellular or extracellular junk, nuclear mutations or epimutations (http://jetpress.org/v16/freitas.pdf), damaged mitochondria (which could simply be removed and replaced with new, functionally correct mitochondria), and a wide range of other conditions.

Patient Wake-up

After the patient has been repaired, stabilized and warmed to conditions of moderate hypothermia, metabolic activities and concentration gradients appropriate to a healthy functional state can be re-established. The vasculoid increases its transport activities to levels appropriate for a healthy human under normal conditions. The vasculoid can then be removed (in accordance with the sequence described in the vasculoid paper) and the patient is now fully restored but unconscious. Finally, the person is gently ramped through mild hypothermia up to normal body temperature with initiation of consciousness and full awareness of surroundings. The patient is now awake and healthy. ■

Interview with Robert Freitas & Ralph Merkle

1. How and when did you get interested in nanotechnology and cryonics?

Freitas: For me, cryonics and life extension came first. In 1968 at the age of 15, I wrote the first 55 pages of an unfinished science fiction novel about a teenager who volunteers to be placed in a time capsule and frozen using the new science of "cryobionics." The computer controlled facility was programmed to wake the traveler every century or so, whereupon he would emerge from a hidden high-tech mountain lair and explore first-hand the progress mankind had achieved during his frozen slumber. "Why do it?" the boy was asked. "Curiosity," he replied. "I want to see how man's technology will grow, and how man himself will change, through the years." Today, 41 years later, I'm still motivated by this same curiosity about the future, but I'm driven even more strongly by the desire to actually create that future – and to find a way to directly experience it, in person.

I believe the first time I ever thought about atomic-scale engineered objects was in 1977 while working on my first treatise-length book project, titled *Xenology* (www.xenology.info). In Section 16.4.1 of that book, I wrote about using molecular electronic components to create a computer system having 10 billion "microneurons" in the space of few microns, "small enough to hide inside a bacterium". During my NASA work on self-replicating machines in the early 1980s, I'd wondered how small machine replicators might be made, studied emerging micromachine technologies, and written about bloodstream-traveling surgical robots in 1985 in a book edited by Minsky. But it wasn't until 1994 that reading Drexler's *Nanosystems* confirmed what I already suspected based on my own knowledge: namely, that the technical case for molecular nanotechnology (MNT) was very solid. (I didn't read *Engines of Creation* until later.)

It was clear that nanomedicine offered a chance for radical "healthspan" (healthy lifespan) extension. This was especially exciting because it also appeared that this objective might be achievable within the several decades of life actuarially remaining to me and others of my generation – but only if we moved quickly. So, was anyone pushing this forward? I spent half a year reading every nanotechnology-related book, paper, and article I could lay my hands on. Back in 1994, the technical discussion was still mired in debates over whether or not nanotechnology was possible at all, and the popular discussion mostly dealt with general objectives or with hoped-for capabilities, without a lot of technical content and with very few specifics. I contacted the Foresight Institute and was told that nobody had yet written any systematic treatment of the medical area, nor was anyone planning to do so in the near future. So I took up the multi-year challenge of researching and writing the *Nanomedicine* book series (www.nanomedicine.com) the first book-length technical discussion of medical nanorobotics. Two volumes were published in 1999 and 2003 with two more in progress, and scaling studies for seven different medical nanorobot designs (including the first cell repair device) have been completed since then.

By 2001, it became apparent that there was no serious molecular manufacturing development going on, either. Frustrated, while at Zyvex I initiated (with Ralph Merkle) a systematic effort to achieve this development that has become known as the Nanofactory Collaboration. We began publishing paper after paper in mainstream peer-reviewed technical journals, doing the hard work of sweating the details of atomically precise manufacturing to fill in the first steps leading toward nanofactory design. Along the way we've published a book on replicative manufacturing systems (www.MolecularAssembler.com/KSRM.htm) and performed a lot of useful research with many interesting collaborators around the world.

Merkle: I had a very different experience. I never thought about either life extension or cryonics until I was in my 30's and had completed my Ph.D., gotten married, bought a house, and settled into a Silicon Valley start-up company. As was my habit, I began thinking about my next steps and long-term plans. At first, I saw smooth sailing for several decades.

Then I would die.

While traditional, it was not clear that this was either necessary or desirable. I began to review the relevant literature. Cryonics was simply one of the items on my list of possibilities, and not very high on my list at that. My initial intuition was that the human body was a very complex machine which had not evolved to cope with freezing. This intuition persisted through my review of cryobiology, but I rapidly concluded that cryonics – unlike any other approach – could benefit from future technology developed any time in the course of the next few centuries. This led me to review the fundamental limits of what would be possible and whether the kind of injuries that occur during cryopreservation would eventually be reversible.

This was a rather complex undertaking, but after reviewing and considering the available literature it was pretty obvious that cryonics, assuming any reasonable care in cryopreservation, would almost certainly work. (I wish to thank the Xerox PARC library staff who tracked down the articles from any reference I gave them. Some of the references were, even by PARC standards, pretty unusual!) Once I had completed the analysis to my personal satisfaction, I decided that, with a little more work, I could make the results available to others. This led to the publication of "The Technical Feasibility of Cryonics" in *Medical Hypotheses* in 1992 and a more extensive version titled "The Molecular Repair of the Brain" in *Cryonics Magazine* in 1994.

At this point, I found myself in the almost unique position of having carefully analyzed the feasibility of molecular nanotechnology. Aside from Richard Feynman, Eric Drexler and perhaps a few others, almost no one had realized that this new technology was even possible, let alone that it would fundamentally change the world. Given the raw magnitude of the impact, and my fortuitous position in a cutting edge research institute charged with developing fundamentally new technologies, I decided to pursue molecular nanotechnology professionally. I expected that others would realize, within a few years, the magnitude of the opportunity and jump in. *Engines of Creation* by Drexler was very readable and entirely persuasive to someone with the right technical background, and the famous Nobel Prize winning physicist Feynman had placed his stamp of approval

Robert A. Freitas, Jr.

Robert A. Freitas, Jr. is Senior Research Fellow at the Institute for Molecular Manufacturing (IMM) in Palo Alto, California, and was a Research Scientist at Zyvex Corp. (Richardson, Texas), the first molecular nanotechnology company, during 2000-2004. He received B.S. degrees in Physics and Psychology from Harvey Mudd College in 1974 and a J.D. from University of Santa Clara in 1979. Freitas co-edited the 1980 NASA feasibility analysis of self-replicating space factories and in 1996 authored the first detailed technical design study of a medical nanorobot ever published in a peer-reviewed mainstream biomedical journal. Freitas is the author of Nanomedicine, the first book-length technical discussion of the potential medical applications of molecular nanotechnology; the initial two volumes of this 4-volume series were published in 1999 and 2003 by Landes Bioscience. His research interests include: nanomedicine, medical nanorobotics design, molecular machine systems, diamondoid mechanosynthesis (theory and experimental pathways), molecular assemblers and nanofactories, atomically precise manufacturing, and self-replication in machine and factory systems. He has produced 49 refereed journal publications and contributed book chapters, two patents, co-authored Kinematic Self-Replicating Machines (Landes Bioscience, 2004), and in 2006 co-founded the Nanofactory Collaboration. His home page is at www.rfreitas.com.

Ralph C. Merkle

Ralph C. Merkle received his Ph.D. from Stanford University in 1979 where he co-invented public key cryptography. He joined Xerox PARC in 1988, where he pursued research in security and computational nanotechnology until 1999. He was a Nanotechnology Theorist at Zyvex until 2003, when he joined the Georgia Institute of Technology as a Professor of Computing until 2006. He is now a Senior Research Fellow at the Institute for Molecular Manufacturing. He chaired the Fourth and Fifth Foresight Conferences on Nanotechnology. He was co-recipient of the 1998 Feynman Prize for Nanotechnology for theory, co-recipient of the ACM's Kanellakis Award for Theory and Practice and the 2000 RSA Award in Mathematics. Dr. Merkle has fourteen patents and has published extensively. His home page is at www.merkle.com.

on the whole endeavor back in 1959 in "There's Plenty of Room at the Bottom."

Much to my amazement, molecular nanotechnology was deemed controversial and its basic feasibility was attacked by many "respectable" scientists. That their arguments were technical gibberish coated with a thin veneer of impressive-sounding words was both a comfort (they obviously had found no holes in the argument) and a problem (they succeeded in misdirecting both people and research funds towards incremental and evolutionary research).

I had seen this pattern before in public key cryptography. My first work in this area was roundly rejected as "...not in keeping with current cryptographic thinking." It took a few years before the research community realized that public key cryptography was, indeed, a major advance. This pattern is common in science (and indeed, in all areas of human endeavor): new ideas are initially rejected and later accepted only slowly (see www.foresight.org/News/negativeComments.html).

I thought that, with a little patience and some clear explanations, the same pattern would be followed in molecular nanotechnology. I began giving talks and writing papers that illustrated the basic concepts, provided worked examples of the kind of research that was needed, and clarified points that seemed to cause confusion. While there has been a slow acceptance of the basic ideas, it has been much slower than I initially anticipated – perhaps because molecular nanotechnology is based on the synthesis of ideas from several fields and the typical research scientist is only educated in one or two. To grasp the whole requires an understanding of ideas typically found scattered in different disciplines.

Unfortunately, rapid technical progress requires research funding, which is largely committee based. Even though there are now quite a few strong supporters, a randomly selected committee of research scientists will typically have at least one or two members who roundly reject any attempt to pursue molecular nanotechnology, thus blocking any funding.

The alternative is to find individual decision makers who can both understand the value of molecular nanotechnology and have the resources to back up their intuition with funding. Such people are often called "patrons," "angel investors," or just "wealthy," but whatever you call them the result is that research can be funded without having to first persuade 90% of the research community that it is a good idea.

2. Developing molecular nanotechnology looks like a daunting task. How are you going to approach this?

Our general approach is summarized at the Nanofactory Collaboration website (www.MolecularAssembler.com/Nanofactory). First, we target the strongest known materials – fullerenes, diamond, and related ultrahard ceramics, collectively called diamondoid. Second, we develop the engineering discipline known as positionally controlled mechanosynthesis – the fabrication of atomically precise structures using atomically precise tools driven by mechanical forces to drive the chemistry. Third, we use this new fabrication technology to build nanoscale molecular machinery, such as bearings, gears, motors, pumps and robotic arms. Fourth, we develop more complex nanoscale machinery that can itself build machinery of the same general

kind. Fifth, we scale up using massively parallel assembly lines.

The result will be a working nanofactory. The nanofactory is a proposed compact molecular manufacturing system, possibly small enough to sit on a desktop, that could build a diverse selection of large-scale molecularly precise diamondoid products. The nanofactory is potentially a high quality, extremely low cost, and very flexible manufacturing system.

3. What are the benefits of molecular manufacturing?

Molecular manufacturing will continue three great multi-decade and even multi-century trends in manufacturing: greater precision, greater flexibility, and lower manufacturing cost. Molecular manufacturing will give us the ultimate in precision (essentially every atom in the right place), the ultimate in flexibility (the ability to arrange atoms in almost any specified pattern consistent with physical law), and the ultimate in low cost (manufacturing costs not much greater than the cost of the required raw materials and energy).

Almost all manufactured products will be remarkably light, strong, smart and inexpensive. The manufacturing process itself will be pollution free. MNT will give us supercomputers that fit inside a living cell, solar power perhaps 100 times cheaper than today's electricity (eliminating the need for polluting coal, oil and nuclear energy plants), reliable and effective medical nanodevices, and more.

More succinctly: molecular nanotechnology will make us all healthy and rich (at least in a material sense).

4. What needs to be done to speed progress?

Theory, experiment, planning, resources, and action.

With dozens of collaborators at 11 institutions in 4 countries, over the last 10 years we've laid the foundations for molecular manufacturing development with a series of theoretical papers and planning documents analyzing all the basics.

We're collaborating with an experimental team led by Philip Moriarty, a leading U.K. scanning probe microscopist at the University of Nottingham, who is attempting to fabricate and test several of the mechanosynthetic tooltips and processes we've analyzed theoretically.

Now we need to mobilize the (larger) resources needed to develop atomically precise fabrication, molecular manufacturing, and nanofactories. Once we get the resources, we're ready to go.

5. If someone wants to accelerate the development of MNT, what should they do?

Contact us. We have a plan.

There are times when a small group, funded by a visionary patron, can change the world for the better. DARPA and the internet. Nobel and his Prize. Kennedy and the moon landing. Queen Isabella and Columbus.

Who will be remembered for molecular manufacturing?

Perhaps you? Or someone you know? ■

MEMBER PROFILE:

KUMAR KRISHNAMSETTY

By Chana de Wolf

Some cryonicists cannot pinpoint any particular reason they became interested in the subject because cryonics is just a natural extension of a desire they've always had. Such is the case for Kumar Krishnamsetty, who explains "I have always wanted to live forever, for as long as I can remember."

"There is so much beauty in this world that I cannot stop embracing it at seventy or eighty," he goes on. And that's exactly the reason Kumar opted for cryonics. In fact, he hopes cryonics will enable him to reach a future where medicine will enable humankind to repair and reverse the diseases and debilitation that go hand-in-hand with aging to enable him to live as long as possible. Kumar frequently reiterates that his personal desire is to live forever. "I am not the type of person who only wants to live 1000, or even 5000, years," he says. "I love life so much that I cannot imagine stopping it at any point."

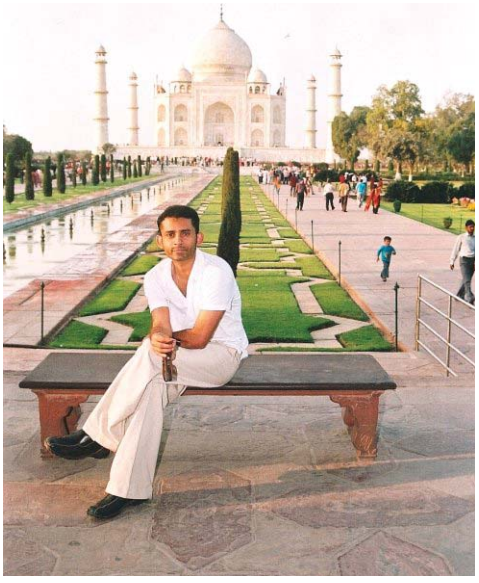
Kumar has good reason to enjoy life so much, as his has been an idyllic one. As a boy living in the beautiful Indian coastal city of Visakhapatnam, Kumar learned the important lessons of life from his parents and enjoyed a peaceful, happy childhood playing cricket with his brother and friends. "Mom was a housewife but taught disciplines of life," he remembers. "Dad taught math and English in school, ethics and morals at home. …I don't believe in the existence of supernatural powers. For me, good is god [and] so are good people."

Kumar went on to study many different subjects in college, including literature, psychology, philosophy, music, and film, ultimately focusing on biology and chemistry for graduation and marine sciences in his master's program. After obtaining his master's degree Kumar entered the software industry, which brought him to the United States in 1999. As a software engineer, he worked for many major companies like Fujitsu, Rapidigm, Kaiser Permanente, Anderson Merchandisers, WebMD, Providence Healthcare, ADP, and Vulcan. Ultimately, he worked almost nine years in the software industry. But, like his desire to live forever, Kumar had another lifelong burning desire -- to be a film director.

"I have been telling myself and my family that I would become a film director," he says. "While working in the software industry I have been going to film schools since 2002." And as soon as he learned enough to do so, Kumar immediately started working towards becoming the film-maker, and making the films, of his dreams.

"My dad used to say that I am a utopian. He is right, I do dream a lot. And I try to give them [my dreams] a life. I have been writing, directing, photographing, and editing my short films and documentaries for four years. And I have been dreaming about my films since I was fourteen. Images on screen are haunting, that's why I make films. It is the best way to reach anyone, including myself."

One of the first documentaries that Kumar produced was a short film about his desire to live forever and his decision to sign up for cryonics called *Kumar, Forever* (2006), which was screened at the 2006 Alcor conference. This was quickly followed by a sequel in 2007 called *My Dad, Forever*. In it, Kumar vividly portrays his love for his father and his father's wise and considerate nature, which Kumar feels should not be allowed to perish.



Kumar enjoys life in front of the Taj Majal.

When he dies, Kumar vigorously attempts to persuade his family to have his father's body shipped to Alcor for cryopreservation. In the end, we watch, stricken, as Kumar helps carry his father's body toward an enormous funeral pyre and, in accordance with his family's wishes, commits his father to the flames.

Despite this setback, Kumar has not been deterred from vocally promoting cryonics, and Alcor in particular. In fact, every film he has produced so far includes an Alcor advertisement. He explains, "I joined Alcor in 2004. Before joining Alcor, I did a lot of research about cryonics on [the] Internet. Alcor's technology and funds topped all other cryonics organizations, and that motivated me to join Alcor." As an active and enthusiastic Alcor member, Kumar attended the 2006 Alcor conference in Scottsdale, Arizona, and also participates in the Cryonics Oregon meetup group organized by Chana de Wolf.

Kumar loves life and enjoys living a full and varied existence. While some members continue to live a similar lifestyle after joining Alcor as they did before, Kumar points out that his membership has changed his lifestyle in many ways. For example, he now watches his food intake more closely and adheres to a mostly organic diet. He also started exercising and stopped participating in extreme outdoor activities.

"My life plans have also been changed, like where should I live for the rest of my life." Though Kumar has lived in the U.S. for ten years now, he longs to return to India. But, because he knows that his chances of optimal preservation decrease the further he lives from Alcor, Kumar has decided to stay in the U.S. Some of Kumar's dreams for improved Alcor capabilities center on this theme. "I think it would be nice if [Alcor] had their own air transport like a chopper or something in the U.S. And [they] should have more infrastructure in bringing bodies from other countries."

Kumar and other participants in the 3rd National Short & Documentary Film Festival (Indian Roller Awards), where his film, I AM NOT A CHAIR, was screened.

Because the transport of cryonics patients to the Alcor facility is one of the most challenging obstacles to ensuring a successful cryopreservation, Kumar worries about his increasingly frequent need to travel abroad for film-making purposes. In the future, when he is more financially stable, Kumar hopes to open a cryonics center in India. In the meantime, he notifies Alcor of his plans when traveling, maintains weekly contact with another Alcor member in the U.S., and informs cooperative friends and family what to do, and who to call, in the event of an emergency.

Another major issue concerns Kumar since he signed up with Alcor: marriage and children. It is easy to realize that a relationship between two people may be made easier if both parties agree on certain topics, and as most cryonicists know, the single largest threat to successful cryopreservation is next-of-kin who have a vested interest in their relative NOT being preserved. "…I would like to marry a person who supports cryonics," he says. "I am even a little worried about my future children, whether they support me or not in this matter."

Fortunately, Kumar's immediate family, including his mother, brother, and sister understand and support his decision to be cryopreserved in an effort to achieve immortality. But he stresses the importance of building a strong community of cryonicists to support one another in times of need. Kumar's advice to all Alcor members: "Be strong and supportive to other members. We are like a family, especially when immediate family does not support [us], we – our "cryonics family" – have to support each other." ■

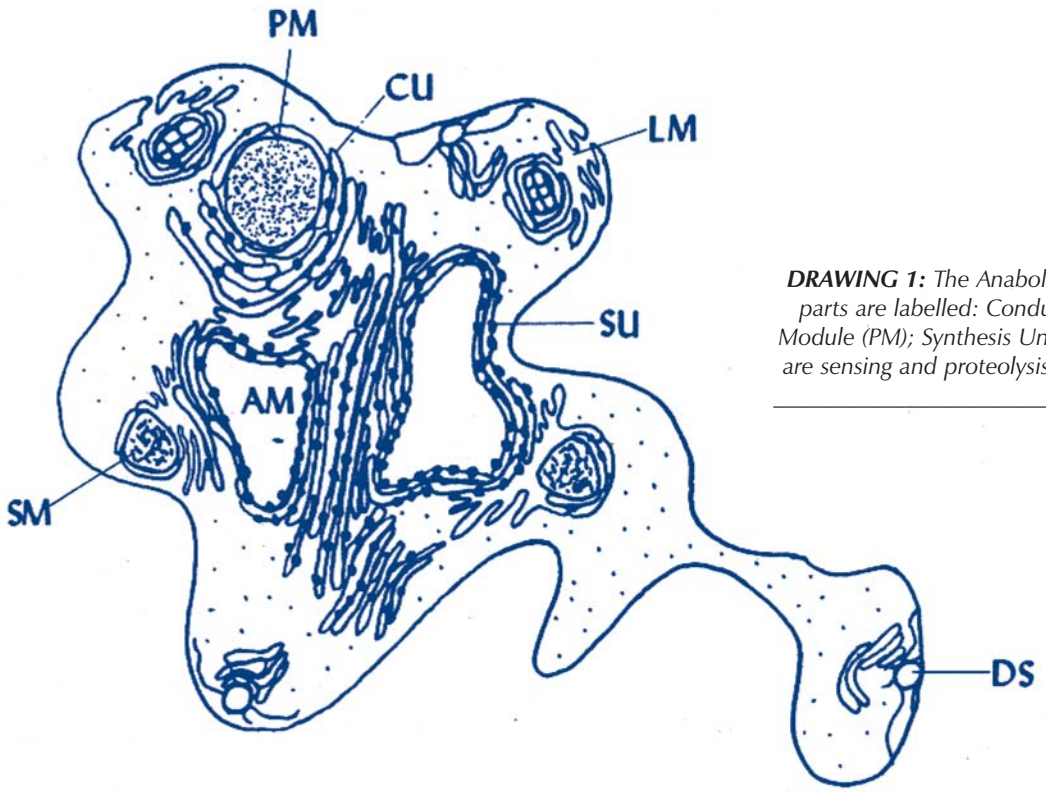
Speaking at the Delhi film festival.

Kumar's most recent film, I AM NOT A CHAIR *(2008,) is an official selection in the Ahmedabad International Film Festival.*
Find out more about Kumar and his work at his website www.respectcreations.com.
Email Kumar at ayodhya.kumar@gmail.com.

THE ANABOLOCYTE*:
A BIOLOGICAL APPROACH TO REPAIRING CRYOINJURY

Reprinted from Jul/Aug 1977
Life Extension Magazine

By Michael Darwin



DRAWING 1: *The Anabolocyte. The various parts are labelled: Conduit (CU); Program Module (PM); Synthesis Unit (SU); DS and LM are sensing and proteolysis units respectively.*

*** Anabolocyte is a coined word used to describe the repair device discussed here. It comes from the world anabolism (anabole Gr. meaning a rising up) or constructive metabolism and the suffix -cyte (kytos Gr. a hollow) which is a terminal combining form meaning a cell. Thus, an anabolocyte is any artificially engineered cell designed to effect biological repair.**

Those interested in suspended animation in its current state must often ask the tough question: "What sort of magical repair process could possibly reverse the freeze-induced injury brought on by low temperatures?" There aren't any hard answers; only possibilities can be suggested and probabilities estimated from them. Such an estimation is still a pretty subjective thing, which this author could not put at other than "non-zero."

Actually, despite the fact that the operation of freezing someone with existing techniques depends upon some type of repair process being possible, remarkably little thought has been given the matter. Aside from a proposal by R.C.W. Ettinger in *The Prospect of Immortality*[1] that "...huge surgeon machines, working twenty-four hours a day for decades or even centuries, will tenderly restore the frozen brains, cell by cell, or even molecule by molecule in critical areas," and the suggestion by Jerome White that specially programmed viruses be used[2], the repair aspects have been totally neglected.

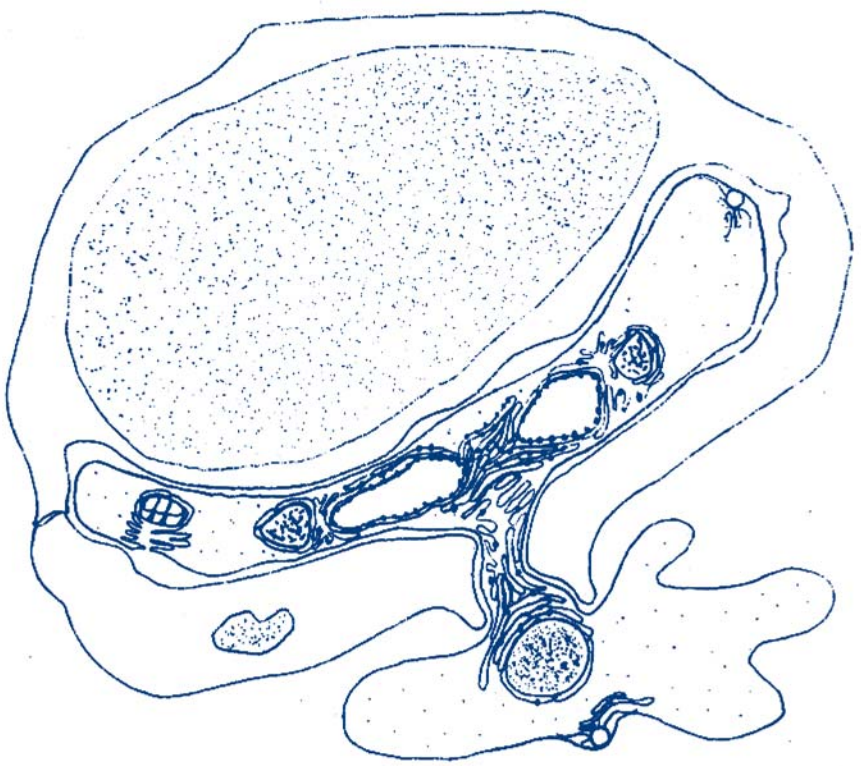
Before presenting my own proposed scenario I would like to consider both of the above ideas. The robot surgeon idea has obvious practical limitations in terms of physical manipulation and economic/technological feasibility. Whether it is scientifically practicable is irrelevant; that it is economically beyond the resources of the contemporary patient is enough. The viral repair idea is another matter altogether and undoubtedly will be used to repair or "add to" cells. The only problem is that it will only prove effec-

tive when there is a metabolizing cell capable of implementing the genetic instructions carried by the specially programmed virus. Many cells will not have survived the freezing process with enough structure intact to resume high energy metabolism and carry on normal cell functions like protein synthesis and osmoregulation. We need a mechanism capable of repairing inactive or structurally "dead" cells. Another requirement is that this approach be compatible with known or foreseeable technology and be able to act within a reasonable period of time and at reasonable cost in terms of resources. This is a very stringent set of conditions but, if we look to the emerging science of recombinant DNA technology, we may be able to "fabricate" some interesting solutions to the repair problem.

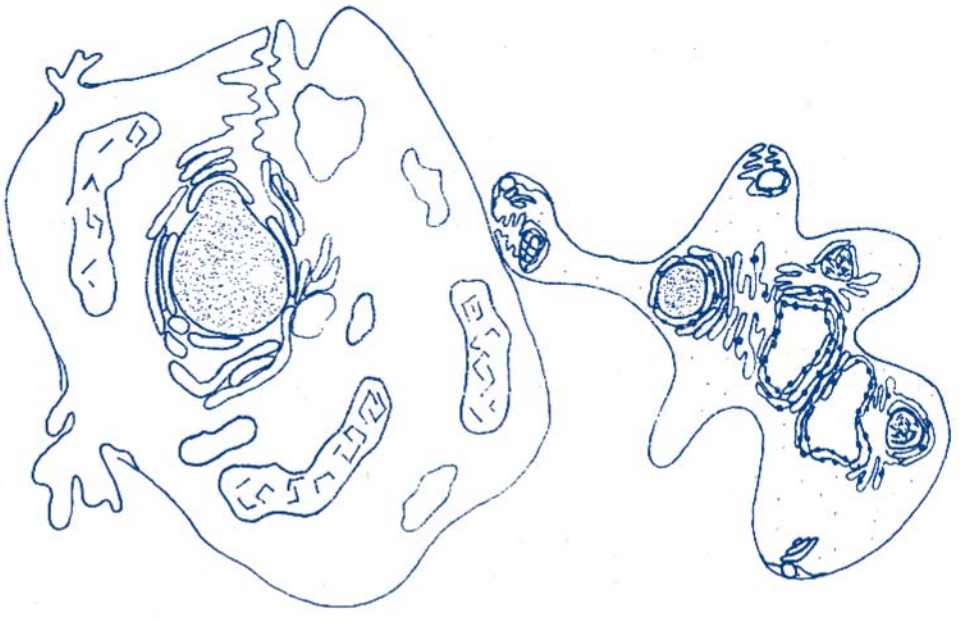
If we start with something like a normal white blood cell and assume it could be modified in most any way, we could build an ultraminiature, self-reduplicating repair unit. White cells are particularly good candidates for this type of transformation because they already embody several of the properties we are seeking. They have the capacity to move through the capillary walls to reach sites of injury and/or infection, they are compatible with human physiology, and perhaps more importantly, they have some (although very limited) capacity for attaching themselves to damaged or malignant cells to either repair them or donate a lysosome and destroy them.

If we could modify white blood cells in any fashion, they could be used to crawl through the capillaries, seek out damaged cells (perhaps by following a "track" of lysosomal enzymes which are related to cryoinjury) and initiate a repair sequence.

The first of the accompanying drawings shows the anabolocyte. I have taken the liberty of assigning new names to the various intracellular organelles since in many cases they will behave differently from the original and may, depending upon our technological limitations, even be made of different materials than the original. "PM" is the Program Module and is the equivalent of the nucleus. The PM will be responsible for directing anabolocyte activities, from targeting through completion of the repair sequence. "SU" is the Synthesis Unit; it is here that new replacement organelles for the damaged originals will be fabricated. "SM" is the Storage Module



DRAWING 2: *The Anabolocyte breaking the junction of two capillary cells and squeezing out into the intracellular space. One of millions of such cells which would be at work in the patient.*



DRAWING 3: *The Anabolocyte attaching itself to a damaged cell. The cell has suffered catastrophically as a consequence of being ischemic, frozen and then thawed.*

which will contain high energy compound reserves and necessary raw materials that are not available on site. The Conduit, shown here as "CU," will bring newly-assembled macromolecules or building blocks to the Synthesis Unit. "DS" and "LM" are sensing and proteolysis units respectively. These last two units will be used to vector the anabolocyte and decompose damaged cell components for raw materials.

The anabolocyte may be designed to work at high subzero temperatures (say -15C or -20C) in the presence of some inert antifreeze agent such as one of the silicon based glycols. In any event, it will be a highly specific piece of genetic engineering designed to act autonomously and in a very precise fashion.

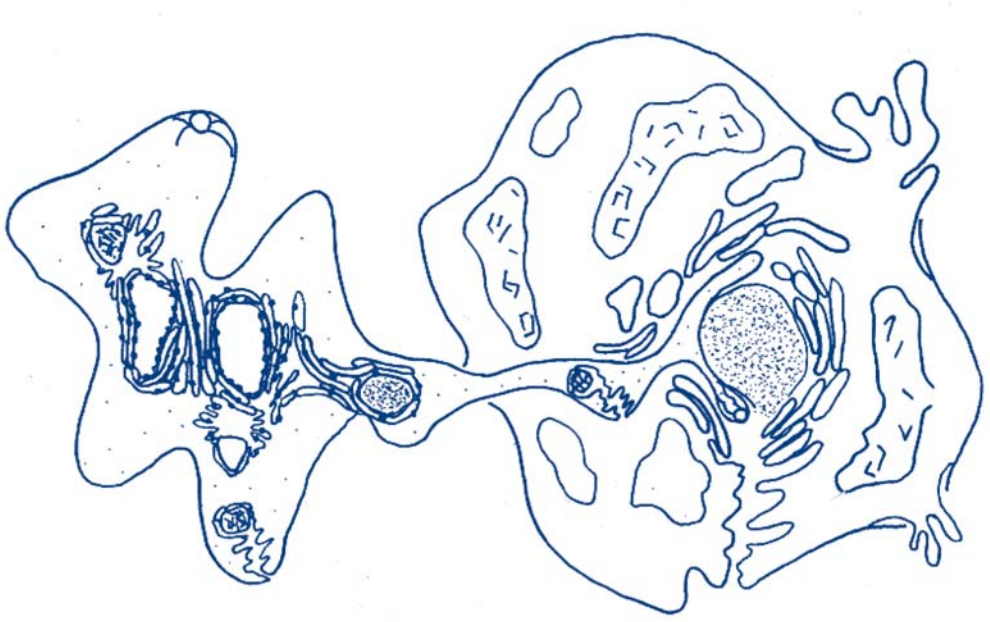
The second drawing shows the anabolocyte breaking the junction of two capillary cells and squeezing out into the intracellular space. There will, of course, be millions or even billions of these organisms released into the vasculature of the patient, each one targeted on locating and repairing a non-functioning cell, and most importantly, all acting simultaneously.

In drawing 3 we see the anabolocyte attaching itself to a damaged cell. This cell has suffered catastrophically as a consequence of being ischemic, frozen and then thawed. The cell membrane has been compromised, the ribosomes are dissociated, the cristae of the mitochondria have been disrupted and there is even nuclear vacoulization and rupture of the muclear membrane. Clearly, this is what we could call our worst case injury. Looking at this mass of shattered structure, it is hard to visualize how anything could possibly restore it is to normalcy.

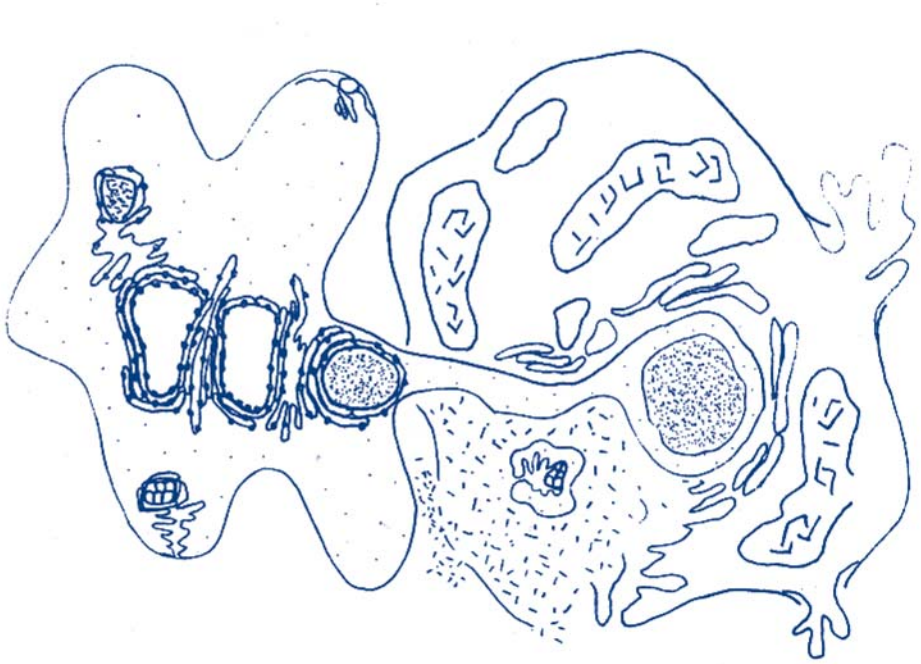
In drawing 4 the anabolocyte has begun the first step in the repair sequence, it has opened the cell membrane and has begun to appropriate nuclear information. At this juncture it is important to emphasize that this particular repair process is workable only for non-neuronal tissue. Nerve cells with information-containing dendrites and protein molecules would require an alternate repair sequence which would simply replace the defective metabolic equipment.

Once the information contained in the damaged cell nucleus has been sequestered, the anabolocyte begins pouring out proteolytic enzymes which digest the old damaged structures (drawing 5). Fortunately, nuclear information is very stable. By and large, genetic material is unaffected by conditions which are incredibly disruptive to other cellular structures. Even freeze drying, under the proper conditions, is not incompatible with the retention of genetic information.

Drawing 6 shows the beginning steps of fabricating a new cell. The anabolocyte begins



DRAWING 4: *The anabolocyte has begun the first step in the repair sequence, it has opened the cell membrane and has begun to appropriate nuclear information.*

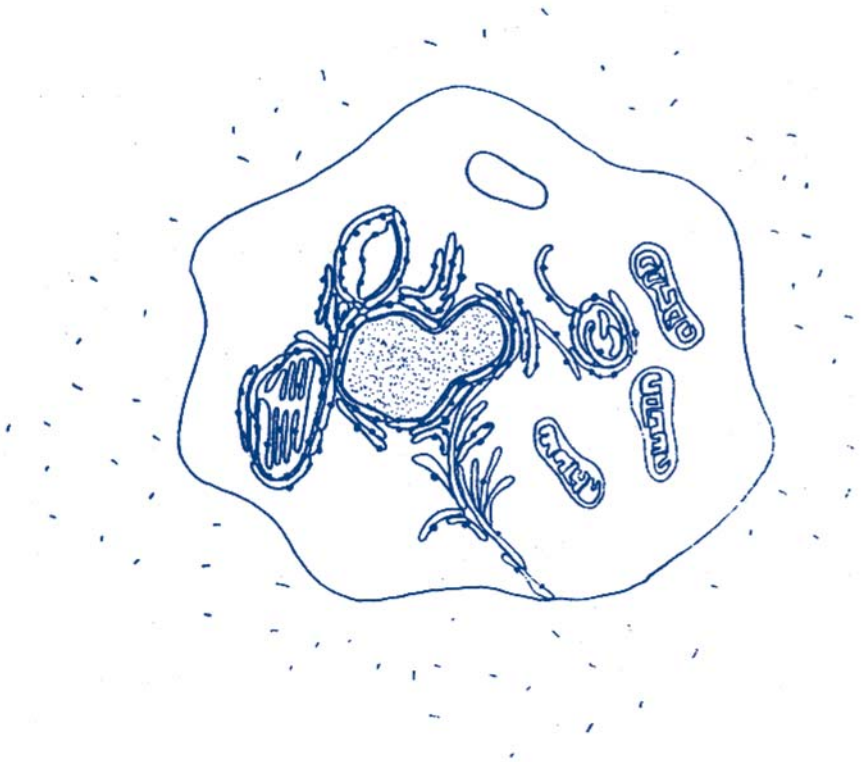


DRAWING 5: *The anabolocyte begins to pour out proteolytic enzymes which digest the old damaged structures after having sequestered the information contained in the cell nucleus.*

elaborating new structure into the Synthesis Module, and actually step by step modifies its own structure and metabolism to conform to the blueprint contained in the original cell nucleus. The original damaged components from the "parent" cell are broken down into their component molecules and are used as raw material for synthesizing new structure.

Finally in drawing 7, we have a new, operational cell, which is in every way identical to the original, and hopefully contains improvements such as prolonged resistance to ischemia, immunity from aging and viral attack and just perhaps, a total lack of susceptibility to cryoinjury. ■

DRAWING 6: *The beginning steps of fabricating a new cell. The anabolocyte begins elaborating new structure into the Synthesis Module.*



DRAWING 7: *The finished product; a new operational cell in every way identical to the original*

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Reflections on the Birth of the Anabolocyte

"Take care to get what you like or you will be forced to like what you get." ~ George Bernard Shaw

On the 17th of December in 1972, a deeply troubled teenage boy arose from a night of chaotic sleep that had been interrupted by nightmares and panicked awakenings. His problem wasn't related to drugs, sex, romance, or family discord; it was much more serious than any of those things.

A week before, everything had been different; or last least it had seemed so. Just seven days earlier he thought he'd found a workaround to dying; something called cryonics. He'd spent the last four years thinking about little else, dreaming about little else, and doing little else (when he was not in school).

At 9:45 on the morning of Sunday the 10th December in 1972, a 60 year old woman named Clara Dostal, who certainly had some of the same hopes and dreams for cryonics, experienced cardiorespiratory arrest, and was pronounced legally dead. A little over 12 hours later, the responsibility for Mrs. Dostal's care would pass to a young graduate student in cryobiology who would share that burden with the now troubled teen. Together, it would be their responsibility to perfuse Mrs. Dostal with cryoprotectant (glycerol in Ringer's solution) and cool her to near dry ice temperature.

Together, they had done this, but it had not been easy, and it had not gone well.

A hundred years earlier the German tactician "Moltke the Elder" had famously remarked that, "No battle plan survives contact with the enemy." And so it was with dreams, as well. Clara Dostal was frozen, and finally, the hard reality of what that meant, of what had actually happened to her when that process was complete and further deterioration was halted, became real. It was one thing to talk about cryonics, to think of it in abstract and distant terms, and quite another to put it into practice – to stop decay – but to do so at an enormous cost in added injury. Close to 70% of the water in Clara Dostal's brain had been converted into ice. Her body's cells had been dehydrated and chemically injured, but even more troubling, those cells and the scaffolding that held them together had been macerated by ice.

The cells lining her capillaries had been sheared away from the underlying basement membrane that gives those delicate vessels their shape and form. The ultramicroscopic connections between many of her cells, including her brain cells, had been rent and torn. It was as if an earthquake or a hurricane had devastated the very fabric of her being on both the molecular and the cellular levels. The two young men had, of course, understood all this in theory. Similarly, they had thoughts, vague and unformed, about how physicians a century or two in the future might heal the ultramicroscopic wounds inflicted by ice. But now, confronted with the reality of the situation, with hard contemplation of what they had done, granted with the best of intentions and no other viable alternative, they were forced to think.

That troubled teen was me, and as that cold, gray December day wore on I sat talking with that nascent cryobiologist and struggled to imagine how it might be possible to practically repair the kind of damage Mrs. Dostal had just suffered (and that doubtless many more would as well before a perfected technique of suspended animation was developed). I was troubled, deeply troubled, because freezing Clara Dostal profoundly altered my perspective. It was no longer sufficient to just 'suppose' that future medical technology could reverse cryoinjury and, in the bargain, all the injury associated with the many hours of warm and cold ischemia that had preceded it. If it was not possible, then and there, to envision, at least broadly, a mechanism whereby cells and tissues could be repaired or replaced, then there was, at least in my mind, the very real question of whether such technology was possible at all.

I was 17 years old and I had just walked away from the blind faith of religion. I didn't want to find myself buying into another fantasy – another world based on false optimism and make-believe.

And so the idea of the anabolocyte was born. It relied upon up-regulation and modification of naturally occurring biological processes and, if genetic engineering ever became a reality, it offered the prospect of transforming existing cells into tissue and even molecular-level surrogate surgeons; countless tiny, self-replicating automatons that could detect injury and undertake its repair. It was the next step up from Jerry White's idea of using specially programmed viruses to assist injured cells back to health, but it was a long way from what was really needed – then or now.

In the 37 years that have passed since I first thought of the anabolocyte, many others have raced much further up the slopes of the Everest that is the problem of revving cryonics patients. And yet, I believe we are still in the foothills. Our feet are still in the mud and our heads, all too often, are still in the clouds.

I would not discourage any cryonicist, young or old, from thinking about the problem of repair. However, I can say, based on decades of experience, that it is vastly more rewarding to treat patients with techniques that cause less injury in the first place, than it is to speculate (however elegantly) about how to undo the harm you've caused even with the best of intentions. I am not the first to arrive at this conclusion, it was said and said well over 2,000 years ago:"Primum non nocerum. (First do no harm)" — Hippocrates ■

Michael Darwin

Michael Darwin is the ex-President of Alcor and an independent critical care and cryonics consultant.

Data Deluge Makes the Scientific Method Obsolete?

Sixty years ago, digital computers made information readable. Twenty years ago, the Internet made it reachable. Ten years ago, the first search engine crawlers made it a single database. Now Google and like-minded companies are sifting through the most measured age in history, treating this massive corpus as a laboratory of the human condition. They are the children of the Petabyte Age. The Petabyte Age is different because more is different. Kilobytes were stored on floppy disks. Megabytes were stored on hard disks. Terabytes were stored in disk arrays. Petabytes are stored in the cloud. As we moved along that progression, we went from the folder analogy to the file cabinet analogy to the library analogy to—well, at petabytes we ran out of organizational analogies. At the petabyte scale, information is not a matter of simple three- and four-dimensional taxonomy and order but of dimensionally agnostic statistics. It calls for an entirely different approach, one that requires us to lose the tether of data as something that can be visualized in its totality. It forces us to view data mathematically first and establish a context for it later. For instance, Google conquered the advertising world with nothing more than applied mathematics.

Wired GQ
6/23/08
http://www.wired.com/science/discoveries/magazine/16-07/pb_theory

Machines Edge Closer to Imitating Human Communication

At a major artificial intelligence competition at the University of Reading (UK) on October 12, machines have come close to imitating human communication. As part of the 18th Loebner Prize, all of the artificial conversational entities (ACEs) competing to pass the Turing Test have managed to fool at least one of their human interrogators that they were in fact communicating with a human rather than a machine. One of the ACEs, the eventual winner of the 2008 Loebner Prize, got even closer to the 30% Turing Test threshold set by 20th-century British mathematician, Alan Turing in 1950, by fooling 25% of human interrogators. Top machines from around the world were entered into the competition and following extensive scrutiny these were whittled down to the five best for the 12 October finale. Organizer of the Turing Test, Professor Kevin Warwick from the University of Reading's School of Systems Engineering, said: "In hosting the competition here, we wanted to raise the bar in Artificial Intelligence and although the machines aren't yet good enough to fool all of the people all of the time, they are certainly at the stage of fooling some of the people some of the time."

ScienceDaily
10/13/08
http://www.sciencedaily.com/releases/2008/10/081013112148.htm

Mind Power Moves Paralyzed Limbs

Scientists have shown it is possible to harness brain signals and redirect them to make paralyzed limbs move. The technology bypasses injuries that stop nerve signals traveling from the brain to the muscles, offering hope for people with spinal damage. So far the US team from the University of Washington have only tested their "brain-machine interfaces" in monkeys. The hope is to develop implantable circuits for humans without the need for robotic limbs, *Nature* reports. Recent studies have shown that quadriplegic patients—people who have paralysis in all four limbs—can consciously control the activity of nerve cells or neurons in the motor cortex that command hand movements, even after several years of paralysis. Using a gadget called a brain-machine interface, Dr Chet Moritz and colleagues re-routed motor cortex control signals from the brains of temporarily paralyzed monkeys directly to their arm muscles. The gadget, which is the size of a mobile phone, interprets the brain signals and converts them into electrical impulses that can then stimulate muscle to contract. The monkeys were then able to tense the muscles in the paralyzed arm, a first step towards producing more complicated goal-directed movements.

BBC News
10/15/08
http://news.bbc.co.uk/2/hi/health/7669159.stm

Storing Information in an Atom's Nucleus

An international team of scientists has performed the ultimate miniaturization of computer memory: storing information inside the nucleus of an atom. This breakthrough is a key step in bringing to life a quantum computer. Quantum computing is seen as the holy grail of computing because each individual piece of information, or bit, can have more than one value at once, as opposed to current technology which is limited to either 1s or 0s. This yields unprecedented processing power and thus dramatically widens the scope of what computers can do. The problem: How do you isolate a quantum bit from a noisy environment to protect the delicate quantum information, while at the same time allowing it to interact with the outside world so that it can be manipulated and measured? The team, with scientists and engineers from Oxford Univ., UK, Princeton Univ., N.J., and Lawrence Berkeley National Laboratory, Calif., reported a solution to this problem in the Oct. 23 issue of the journal Nature. Crucially, the information stored in the nucleus had a lifetime of about 1.75 seconds, exceeding a recently calculated target for quantum computing in silicon beyond which known error correction techniques could then protect the data for an arbitrarily long period of time.

R&D Daily
10/23/08
http://rdmag.com/ShowPR.aspx?PUBCODE=014&ACCT=1400000100&ISSUE=0810&RELTYPE=PSC&PRODCODE=00000000&PRODLETT=V&CommonCount=0

New Prostate Grown Inside Mouse

Scientists have grown new prostate glands in mice, in another advance for stem cell technology. The team from San Francisco was able to isolate single cells with the ability to generate an entire prostate. The technique, reported in the journal Nature, could shed light on how prostate tumors develop. However, any thoughts it could lead to transplants in men who have had the gland removed to beat cancer have been played down. This discovery will be a significant boost to prostate cancer research.

BBC News
10/24/08
http://news.bbc.co.uk/2/hi/health/7685105.stm

Ice Slurry Technology Improves Medical Rescue

Recently researchers have begun to develop a new technique that can reduce the brain and other organs' demand for oxygen, giving doctors precious extra time to diagnose and treat critical patients in emergencies while also protecting the heart, brain, kidneys and spinal cord in planned surgeries. Scientists in the Nuclear Engineering Division at the U.S. Department of Energy's Argonne National Laboratory have created an ice slurry—a slushy substance that somewhat resembles a 7-11 Slurpee®. This slurry can be pumped easily into the body through a small intravenous (IV) catheter directly into a patient's bloodstream. Argonne is working with several different groups of University of Chicago surgeons to develop procedures for cooling and protecting vital organs. The cooling reduces an organ's need for oxygen, slowing the rate at which cells asphyxiate and providing doctors more time for treatment. The research is being conducted under a newly formed University of Chicago-Argonne Bioengineering Institute for Advanced Surgery and Endoscopy (BIASE).

Physorg.com
11/3/08
http://www.physorg.com/news144949439.html

Japanese Clone Mouse from Frozen Cell, Aim for Mammoths

Japanese scientists said Nov. 4 they had created a mouse from a dead cell frozen for 16 years, taking a step in the long-impossible dream of bringing back extinct animals such as mammoths. Scientists at the government-backed research institute Riken used the dead cell of a mouse that had been preserved at –20°C (–4°F)—a temperature similar to frozen ground. The scientists hope that the first-of-a-kind research will pave the way to restore extinct animals such as the mammoth. The findings were published in the Proceedings of the National Academy of Sciences in the United States. The scientists extracted a cell nucleus from an organ of the dead mouse and planted it into an egg of another mouse which was alive, leading to the birth of the cloned mouse, the researchers said. "The newly developed technology of nucleus transfer greatly improved the possibility of reviving extinct animals," the research team led by Teruhiko Wakayama said in a statement. "Even though reviving extinct animals is often described in films and novels—such as in Michael Crichton's 'Jurassic Park'—it had in reality been impossible," they said.

Physorg.com
11/4/08
http://www.physorg.com/news144992678.html

Bionic Hand Makes Inventions List

The world's first commercially available bionic hand has been recognized as one of the top inventions of 2008. The hand, developed by Livingston company Touch Bionics, was named alongside the Super Hadron Collider in *Time* magazine's top 50 innovations. It came in at 14th place, beating competition from the latest Mars Rover, designed to explore the red planet. The hand took 20 years to develop and has five separately working fingers. This makes it more versatile than previous hands, which have often been hook-like and limited to simple opening and closing movements. The i-limb hand has a much wider range of capabilities. It has a credit-card grip, for taking hold of narrow objects, and a power hold for larger objects such as mugs. It is made of high-strength plastics, and the fingers can easily be unscrewed from the hand, making it easy to service. Other prosthetic hands have to be removed entirely if they break meaning amputees are sometimes left for weeks without a hand while they wait for a repair. More than 400 patients have now been fitted with the i-limb hand since its launch.

BBC News
11/6/08
http://news.bbc.co.uk/2/hi/uk_news/scotland/edinburgh_and_east/7712976.stm

Cancer Genetic Blueprint Revealed

Scientists have decoded the complete DNA of a cancer patient and traced her disease to its genetic roots. The Washington University team identified 10 gene mutations which appeared key to the development of the woman's acute myeloid leukemia (AML). Just two of these had been linked to the disease before. The sequencing technique, described in the journal *Nature*, could be applied to other cancers and aid the design of targeted drugs. This achievement ushers in a new era of comprehensive understanding of the fundamental nature of cancer. The researchers took two samples from the woman in her 50s—who later died from the disease—and examined the DNA for differences. One sample was taken from healthy skin cells, the other from bone marrow tissue made up of cancerous cells. They found that virtually every cell in the tumor sample had nine of the key mutations. They also examined tumor samples from another 187 AML patients, but found none had any of the eight new mutations. Lead researcher Dr. Richard Wilson said: "This suggests that there is a tremen-

dous amount of genetic diversity in cancer, even in this one disease."

BBC News
11/6/08
http://news.bbc.co.uk/2/hi/health/7706487.stm

Mammoth's Genome Pieced Together

A US-Russian team of researchers has pieced together most of the genome of a woolly mammoth, Nature journal reports. The experts extracted DNA from samples of mammoth hair to reconstruct the genetic sequence of this Ice Age beast. Though some stretches are missing, the researchers estimate that the genome is roughly 80% complete. The work could provide insights into the extinction of the mammoth and also resurrects questions about the viability of cloning long-dead species. The scientists were aided in their task by the fact that several deep-frozen carcasses of woolly mammoths have been dug out of the permafrost in Siberia. These conditions are ideal for the preservation of hair, which is a preferred source for the extraction of ancient DNA. If genetic material survives in a sample of hair, most of it will belong to the animal that hair is from. By contrast, when researchers try to extract ancient DNA from bone, it is often swamped with DNA from fungi and bacteria. Enthusiasts have long dreamt of using ancient DNA to bring extinct species back from the dead. But most scientists are doubtful this could ever be achieved. The changes that creep into an animal's genetic sequence after its death pose a significant challenge.

BBC News
11/19/2008
http://news.bbc.co.uk/2/hi/science/nature/7738062.stm

NVIDIA Brings Supercomputing to the Desktop

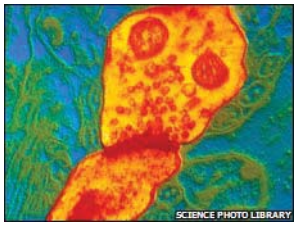
US technology firm NVIDIA rolled out high-performance "personal supercomputers" Nov. 18 that let desktop workstations handle mind-boggling tasks once far beyond their capabilities. Computers built with innovative NVIDIA graphics processing units (GPUs) are capable of handling calculations typically relegated to expensive supercomputing "clusters"—a technology breakthrough the company says could soon bring lightning speeds to the next generation of computers aimed at the consumer market. NVIDIA's Tesla Personal Supercomputers deliver approximately 250 times the processing power of current computer workstations for similar prices, according to the California-based company. Massachusetts Institute of Technology and other universities and research facilities are already using GPU-based personal supercomputers. "GPU-based systems enable us to run life science codes in minutes rather than the hours it took earlier," said Jack Collins of the Advanced Biomedical Computing Center in the US state of Maryland. "This exceptional speedup has the ability to accelerate the discovery of potentially life-saving anti-cancer drugs."

Therawstory
11/19/08
http://rawstory.com/news/afp/NVIDIA_brings_supercomputing_to_the_11192008.html

IBM Plans "Brain-Like" Computers

IBM has announced it will lead a US government-funded collaboration to make electronic circuits that mimic brains. Part of a field called "cognitive computing," the research will bring together neurobiologists, computer and materials scientists and psychologists. As a first step in its research the project has been granted $4.9m (£3.27m) from US defense agency Darpa. The resulting technology could be used for large-scale data analysis, decision making or even image recognition. "The key idea of cognitive computing is to engineer mind-like intelligent machines by reverse engineering the structure, dynamics, function and behavior of the brain," says Dharmendra Modha, the IBM scientist who is heading the collaboration. IBM will join five US universities in an ambitious effort to integrate what is known from real biological systems with the results of supercomputer simulations of neurons. The team will then aim to produce for the first time an electronic system that behaves as the simulations do. The longer-term goal is to create a system with the level of complexity of a cat's brain.

BBC News
11/21/08
http://news.bbc.co.uk/2/hi/science/nature/7740484.stm



Mimicking synapses like this one is crucial to the effort.

New Harvard Research Investigates the Causes of Aging

Harvard Medical School scientists claim to have discovered a mechanism that may be the universal cause of aging. The study, published in the journal Cell, shows how DNA damage eventually leads to a breakdown in the cell's ability to understand which genes are switched on and which are switched off. The cell's decreasing ability to detect patterns of gene expression plays a critical role in aging, the researchers report. "This is the first potentially fundamental, root cause of aging that we've found," says Harvard Medical School professor of pathology David Sinclair. "There may very well be others, but our finding that aging in a simple yeast cell is directly relevant to aging in mammals comes as a surprise." Scientists have known that a group of genes called sirtuins are involved in the aging process. These genes, when stimulated by resveratrol, a compound found in grapes and red wine known for his anti-aging powers, appear to have a positive effect on both aging and health. This study is the latest to draw attention to sirtuins, proteins involved in the aging process.

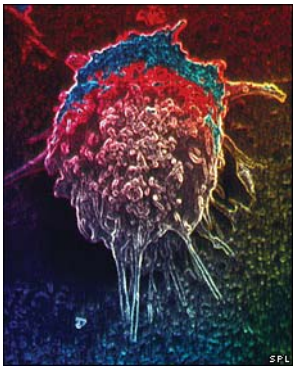
eFluxMedia
11/27/08
http://www.efluxmedia.com/news_New_Harvard_Research_Investigates_the_Causes_of_Aging_30066.html

Gene "May Ward off Lung Cancer"

Scientists have pinpointed a gene which protects against lung cancer. It is hoped the

discovery of the role of the tumor-suppressor gene LIMD1 may lead to new treatments and techniques to pick up disease earlier. Lung cancer is the UK's biggest cancer killer, claiming around 33,600 lives a year, partly because it often only detected at a late stage. The University of Nottingham study appears in the journal *Proceedings of the National Academy of Sciences.* The researchers compared lung cancer tissue with healthy lung tissue. They found that the LIMD1 gene was missing in the majority of lung cancer samples, indicating that it might help to protect the body against the disease. In a follow-up experiment mice bred to lack the gene developed cancer. Lead researcher Dr. Tyson Sharp said: "The LIMD1 gene studied in this research is located on part of chromosome 3, called 3p21. Chromosome 3p21 is often deleted very early on in the development of lung cancer due to the toxic chemicals in cigarettes, which implies that inactivation of LIMD1 could be a particularly important event in early stages of lung cancer development."

BBC News
12/2/08
http://news.bbc.co.uk/1/hi/health/7759188.stm



Lung cancer is a major killer.

Religious "Shun Nanotechnology"

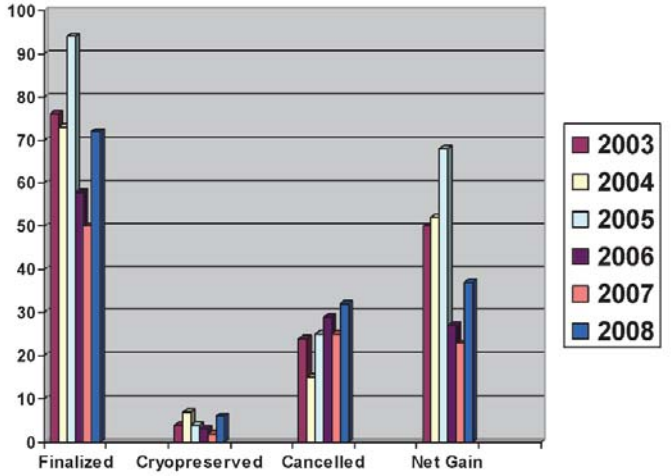
Attitudes to nanotechnology may be determined by religious and cultural beliefs, suggest researchers writing in the journal *Nature Nanotechnology.* The researchers compared attitudes to nanotechnology in 12 European countries and the US. They then rated each country on a scale of what they called "religiosity"—a measure of how religious each country was. They found that countries where religious belief was strong, such as Ireland and Italy, tended to be the least accepting of nanotechnology, whereas those where religion was less significant such as Belgium or the Netherlands were more accepting of the technology. Professor Dietram Scheufele from the Department of Life Sciences Communication at the University of Wisconsin, who led the research, said religious belief exerted a strong influence on how people viewed nanotechnology. "Religion provides a perceptual filter, highly religious people look at information differently, it follows from the way religion provides guidance in people's everyday lives," he said. The US was found to be the most religious country in the survey, and also the least accepting of nanotechnology.

BBC News
12/8/08
http://news.bbc.co.uk/2/hi/science/nature/7767192.stm

Membership Statistics

On December 31, 2008, Alcor had 875 members on its Emergency Responsibility List. During the year of 2008, 72 memberships were approved, 3 memberships were reinstated, 32 memberships were cancelled, and 6 members were cryopreserved. Overall, there was a net gain of 37 members in 2008.

2008	01	02	03	04	05	06	07	08	09	10	11	12	
TOTAL	842	842	851	859	865	866	863	857	863	872	874	875	**875**
FINALIZED	7	2	11	10	10	4	4	2	7	8	5	2	**72**
REINSTATED	0	1	0	0	0	0	0	0	1	1	0	0	**3**
CANCELLED	2	3	1	1	3	3	6	8	1	0	3	1	**32**
CRYO-PRESERVED	1	0	1	1	1	0	1	0	1	0	0	0	**6**
NET GAIN	+4	0	+9	+8	+6	+1	-3	-6	+6	+9	+2	+1	**+37**



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:
This group meets the third Friday of each month and gatherings are hosted by Alcor employee Regina Pancake. To RSVP, visit http://cryonics.meetup.com/45/ or email regina@alcor.org.

At Alcor:
Alcor Board of Directors Meetings and Facility Tours – Alcor business meetings are generally held on the first Saturday of every month starting at 11:00 am MST. Guests are welcome. Facility tours are held every Tuesday and Friday at 2:00 pm. For more information or to schedule a tour, call D'Bora Tarrant at (877) 462-5267 x 101 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: davegre2000@yahoo.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 Alan Sinclair at cryoservices@yahoo.co.uk. 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.)

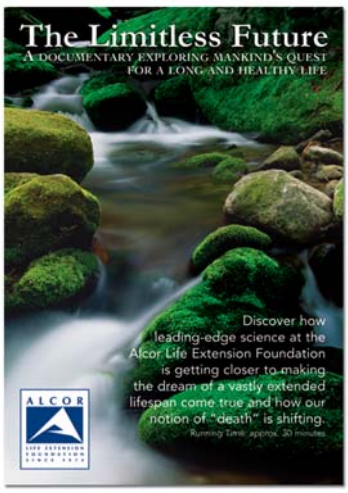
HOW DO I ENROLL?

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.

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