

ALCOR LIFE EXTENSION FOUNDATION

# CRYONICS

FOCUS ON NANOTECHNOLOGY

WINTER 2006 · VOLUME 27:1

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## NANOMEDICINE AND CRYONICS

NANOTECHNOLOGY

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# OPEN LETTER

# CRYONICS

At the Life Extension Conference in Atlanta, Georgia, on November 5, 2005, the Immortality Institute unveiled an Open Letter endorsing the scientific basis of cryonics. It is now signed by more than 60 scientists, physicians, and ethicists. Signatories encompass all disciplines relevant to cryonics, including Biology, Cryobiology, Neuroscience, Physical Science, Nanotechnology and Computing, Ethics and Theology.

*To whom it may concern,*

*Cryonics is a legitimate science-based endeavor that seeks to preserve human beings, especially the human brain, by the best technology available. Future technologies for resuscitation can be envisioned that involve molecular repair by nanomedicine, highly advanced computation, detailed control of cell growth, and tissue regeneration.*

*With a view toward these developments, there is a credible possibility that cryonics performed under the best conditions achievable today can preserve sufficient neurological information to permit eventual restoration of a person to full health.*

*The rights of people who choose cryonics are important, and should be respected.*



**The full list of signatories and their credentials is available at [www.cryoletter.org](http://www.cryoletter.org). Current signatories include:**

Gregory Benford, Ph.D.  
Alexander Bolonkin, Ph.D.  
Nick Bostrom, Ph.D.  
Kevin Q. Brown, Ph.D.  
Professor Manfred Clynes, Ph.D.  
Daniel Crevier, Ph.D.  
Antonei B. Csoka, Ph.D.  
Aubrey D.N.J. de Grey, Ph.D.  
Wesley M. Du Charme, Ph.D.  
João Pedro de Magalhães, Ph.D.  
Thomas Donaldson, Ph.D.  
Christopher J. Dougherty, Ph.D.  
K. Eric Drexler, Ph.D.  
Robert A. Freitas Jr., J.D.  
Mark Galecki, Ph.D.  
D. B. Ghare, Ph.D.  
Ben Goertzel, Ph.D.  
Peter Gouras, M.D.  
Amara L. Graps, Ph.D.  
Raphael Haftka, Ph.D.

David A. Hall, M.D.  
J. Storrs Hall, Ph.D.  
Robin Hanson, Ph.D.  
Steven B. Harris, M.D.  
Michael D. Hartl, Ph.D.  
Henry R. Hirsch, Ph.D.  
Tad Hogg, Ph.D.  
James J. Hughes, Ph.D.  
James R. Hughes, M.D., Ph.D.  
Ravin Jain, M.D.  
Subhash C. Kak, Ph.D.  
Professor Bart Kosko, Ph.D.  
James B. Lewis, Ph.D.  
Marc S. Lewis, Ph.D.  
Brad F. Mellon, STM, Ph.D.  
Ralph C. Merkle, Ph.D.  
Marvin Minsky, Ph.D.  
John Warwick Montgomery, Ph.D.  
Max More, Ph.D.  
Steve Omohundro, Ph.D.

Mike O'Neal, Ph.D.  
Yuri Pichugin, Ph.D.  
Peter H. Proctor, M.D., Ph.D.  
Martine Rothblatt, Ph.D., J.D., M.B.A.  
Klaus H. Sames, M.D.  
Anders Sandberg, Ph.D.  
Sergey V. Sheleg, M.D., Ph.D.  
Stanley Shostak, Ph.D.  
Rafal Smigrodzki, M.D., Ph.D.  
David S. Stodolsky, Ph.D.  
Gregory Stock, Ph.D.  
Charles Tandy, Ph.D.  
Peter Toma, Ph.D.  
Mark A. Voelker, Ph.D.  
Roy L. Walford, M.D.  
Mark Walker, Ph.D.  
Michael D. West, Ph.D.  
Ronald F. White, Ph.D.  
James Wilsdon, Ph.D.  
Brian Wowk, Ph.D.

Special thanks to Immortality Institute Chair Bruce Klein for hosting and managing this important document. Scientists, physicians and researchers who would like to support this letter are asked to contact [support@cryoletter.org](mailto:support@cryoletter.org).

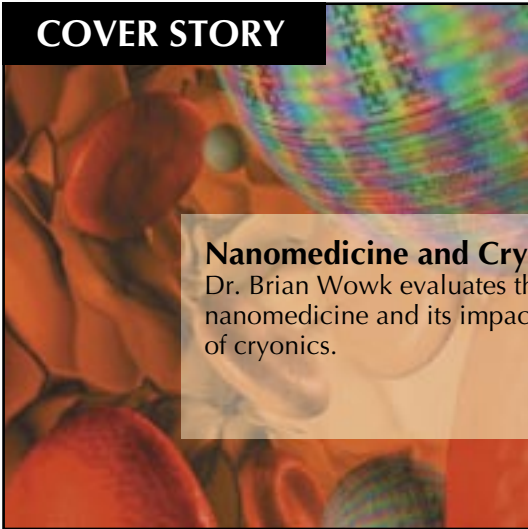


# CRYONICS

WINTER 2006 · VOLUME 27:1

## FOCUS ON NANOTECHNOLOGY

### COVER STORY



#### Nanomedicine and Cryonics:

Dr. Brian Wowk evaluates the impending maturity of nanomedicine and its impact on the history and future of cryonics.

## PAGE 9

Cover Image: Vik Olliver—*Iridescent respirocytes float through a small artery in the company of numerous red blood cells.*

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Get to know the man who is helping invent the future

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## FROM THE EDITOR

### CRYONICS GETS A MAKEOVER

There are plenty of makeover shows on TV today; one is even called “Extreme Makeover.” We hope that you will agree that this issue of *Cryonics* qualifies as an extreme makeover and, we believe, it is now better than ever.

Members have always enjoyed reading *Cryonics*. When our marketing consultants, WalshCOMM, conducted member telephone interviews last year, members said that they really looked forward to each issue. We also learned that members would like to see some key improvements: better graphics, more variety in articles, more reliability and consistency in the publication schedule. In addition, many members voiced a desire that *Cryonics* take on a more professional look and feel in order to serve as a marketing tool that can be passed along for increasing membership.

We heard you loud and clear. Over the past few months, we have embarked on a journey to incorporate your ideas and desires into the new *Cryonics*. First, we engaged WalshCOMM to redesign the cover and page layouts. Next, we adopted a seasonal calendar of four issues—winter, spring, summer and fall. While we have reduced the number of issues each year, we have improved quality and increased content through a better layout that allows more information per page.

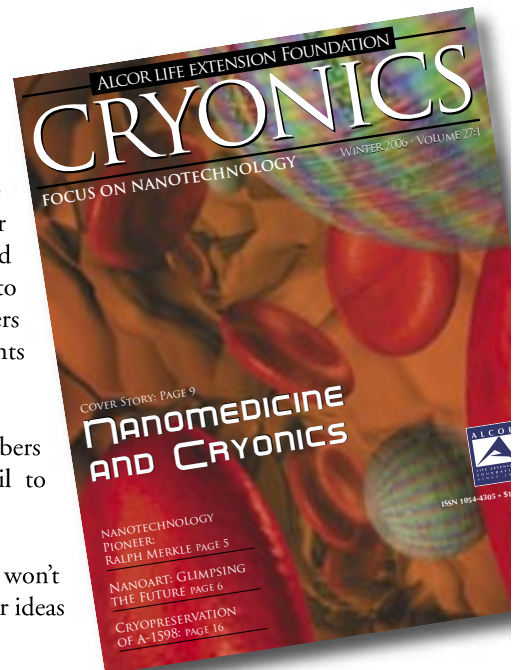
Our member research also revealed that you value the Case Summaries that are prepared after each cryopreservation; however, the delay in receiving these summaries due to the magazine publication dates was a concern. Thus, we will be posting the entire Case Summary on the website in a timely manner and providing a brief synopsis in the quarterly publications. This change serves two purposes—getting the information to you as quickly as possible and saving valuable space in the magazine for articles of interest to a broader audience.

*Cryonics* will now have an editorial board, made up of staff, members and consultants who will set an editorial calendar, solicit articles from experts, review submissions and make final edits and content decisions. The editorial board will ensure that articles are fair, accurate and interesting. At this time, we have openings for volunteers who would like to serve on the editorial board. If you are interested, please contact Jennifer Chapman at 877-462-5267 ext. 113.

Each issue will have a theme and, to the extent possible, feature articles will relate to the theme. Regular columns—member and patient profiles, TechNews, the Executive Director’s Report and Case Summaries—will provide a forum for sharing information relating to Alcor and our industry. We will be adding a “Letters to the Editor” feature in hopes that members and other readers will share their thoughts about *Cryonics*.

We welcome submissions from Alcor members and readers; please send them by email to Jennifer Chapman at [jennifer@alcor.org](mailto:jennifer@alcor.org).

As with anything new, we know that we won’t get it all right the first time. We invite your ideas for continuing improvements.



# Executive Director's Report

2006 is a year of many hopeful expectations, but if 2005 is any indication of what is to come, perhaps we're wise to just expect the unexpected!

With so many worthy endeavors underway and under discussion, we can only continually strive to represent the wants and needs of our members and other supporters while conquering the many unique and unpredictable challenges that come our way.

One such challenge we are tackling is the legal case in Florida where relatives contested the cryopreservation of one of our patients based on an alleged deathbed change of heart and estate will. Alcor has agreed to settle this case, and we are getting uncontested custody of the patient, the cryopreservation funding, and about two-thirds of our attorney's fees. Sadly, it appears that the trust the member had established is completely broken, and the vast majority of the proceeds will be distributed to the daughters who were very nearly successful in having the member cremated before Alcor was even aware he was in trouble. This should serve as a warning that such trusts are extremely fragile, and it can be very dangerous to include wording in them that gives anyone financial incentive to interfere with a cryopreservation.

Turning challenges into successes seems to be our strong suit of late. In the wake of last year's financial difficulties, we have made strides to put into place policies and procedures that better safeguard our finances. For starters, we hired a part-time bookkeeper, Sheila Kimbrell, who is a long-time friend of our Membership Coordinator, Diane Cremeens. Sheila's expertise in accounting spans 20 years, and she is a current board member of the Arizona Society of Practicing Accountants ([www.aspaacct.org/index.htm](http://www.aspaacct.org/index.htm)), a member of the National Society of Accountants, and a former president of the North Valley Business Network ([www.nvbnetwork.com](http://www.nvbnetwork.com)).

Ms. Kimbrell is now operating under a set of newly instituted financial controls put in place to offer greater protection to the organization. These controls were suggested as a result of an accounting review performed

by an outside accounting firm. Here are the highlights of the controls now in place:

- Our administrative assistant opens all incoming mail and keeps a log of all incoming funds for review by the Executive Director and COO;
- All incoming bank and credit card statements are sent directly to the Executive Director for review before going to the bookkeeper;
- A third party makes the deposits prepared by the bookkeeper;
- All outgoing checks and relevant invoices are reviewed by both the COO and the Executive Director before signature;
- A third party mails all outgoing checks;
- All blank checks are kept locked in a separate room from the bookkeeper and are issued only as needed. All voided checks are accounted for;
- The bookkeeper cannot sign checks, as has been our long-standing policy;
- Spot checks of accounting activities are routinely conducted by the COO, Treasurer, and Chairman of the Board;
- An employee honesty insurance policy is in place;
- The COO directs the bookkeeper about bill payment priorities.

Major efforts were undertaken in the final months of 2005 to get all of our internal billing completely reconciled before the end of the year. Through sheer determination, we ended the year on an extremely high note. All lines of credit are completely paid off, all outstanding bills are paid in full, and a 2006 budget has been created with oversight by the Board of Directors. 2006 starts with a clean slate and strong direction.

And the march of progress continues. On the technical side, work has resumed on a number of the engineering development projects approved by the Research & Development committee, including the



Intermediate Temperature Storage (ITS) monitoring project and the annealing test project. The ITS Neuropod purchased from 21<sup>st</sup> Century Medicine is in an operational capable dewar and undergoing long-term testing at operating temperatures of -140°C. Research for improving our whole body technology (vitrification) is also underway.

All of us here at Alcor want to keep communications open and information flowing. Hopefully this memo has shed some light on our current activities and ambitions. You are each encouraged to stay connected by subscribing to Alcor News, our free electronic newsletter ([www.alcornews.org](http://www.alcornews.org)), and networking with other Alcor Members on AlcorUnited ([www.alcorunited.org](http://www.alcorunited.org)).

May 2006 be prosperous for all!

Sincerely

A handwritten signature in dark ink that reads "Stephen J. Van Sickle". The signature is written in a cursive style.

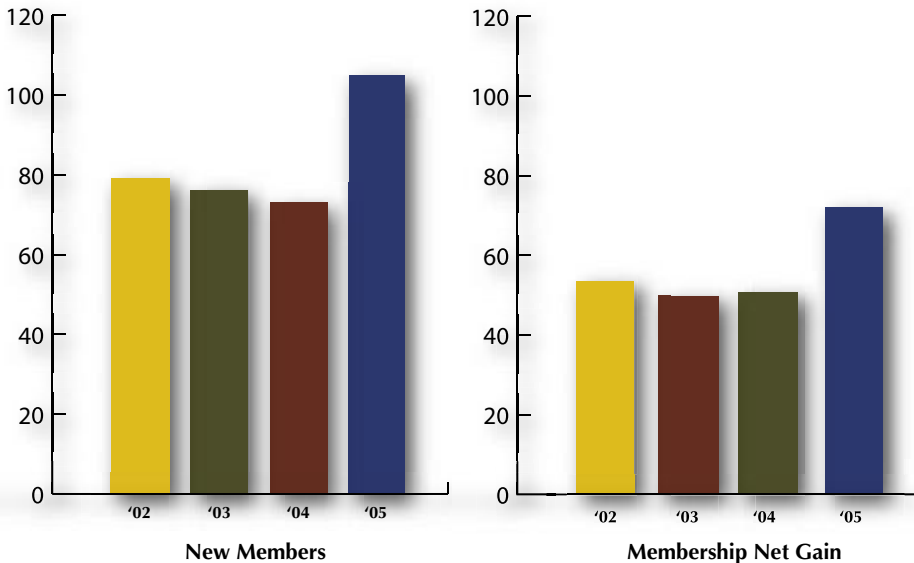
Stephen J. Van Sickle  
Executive Director



# MEMBERSHIP STATUS

By Diane Cremeens

**2005 was a great year for membership growth. We ended the year at 10%, a growth rate that has not been achieved since 2002:**



**With members in 9 countries worldwide, interest in cryonics continues to span the globe:**

Country	Members	Applicants	Subscribers
Argentina	0	0	1
Australia	8	2	0
Austria	0	0	1
Canada	29	4	7
France	0	0	1
Germany	2	1	2
Italy	0	2	3
Japan	0	0	1
Mexico	2	0	0
Monaco	2	0	0
Netherlands	3	0	1
Spain	0	1	0
Sweden	0	0	1
Switzerland	1	0	2
U.K.	18	5	2
USA	707	53	129
Totals	773	68	151

Contact the author at: [diane@alcor.org](mailto:diane@alcor.org)

## Building Alcor's Identity

By Deborah Johnson

In 2005, our marketing efforts focused on evolving the identity of Alcor away from notoriety and toward recognition and acceptance as a legitimate and respected scientific organization.

The first major accomplishment toward that goal was the production and distribution of the 30-minute Alcor documentary "The Limitless Future". In addition to playing an important role in educating members and potential members about Alcor, the documentary is distributed, upon request, to journalists and media outlets to provide a solid background about Alcor. We also created B-roll footage for media to use.

Worldwide media interest in Alcor remains strong. Journalists from around the globe continue to request interviews and tours with Alcor for both print and broadcast stories. In the past 12 months, we fielded media requests from Africa, Brazil, Canada, England, France, Germany, Greece, Israel, Japan, Russia, Spain, and, of course, the United States.

In light of the demand for interviews and our intent to further our identity as a scientific organization, we developed guidelines for vetting journalists. Only those who represent serious scientific or news organizations are even considered. For example, we have turned down many requests from American production companies asking Alcor to be the next reality series program, ala "Orange County Choppers". At the other end of the spectrum, however, we are currently working closely with a major production company from England on the definitive documentary about Alcor for National Geographic Television and Channel 5 in the UK.

Media promotes public education, but we know that one-on-one contact is one of the most effective avenues of gaining respect and growing membership. We continue to offer regular facility tours and are improving their "look" and content. We held CryoFeast gatherings in four states across the US and Canada and are looking at ways to do more outreach in 2006. All of this allows us to be in a position to more aggressively pursue potential members. ■

Contact the author at:  
[djohnson@walshcomm.com](mailto:djohnson@walshcomm.com)



# MEMBER PROFILE: RALPH MERKLE PH.D.

## NANOTECHNOLOGY PIONEER

By Deborah Johnson

You may not know it, but you're very familiar with Ralph Merkle's work. Do you use the internet, subscribe to cell phone service, have a bank account? Have you ever served on the battlefield? If you answered yes to any of these questions, you have done so with the help of Ralph's inventions for security in cyberspace.

Back in the '70s, well before most of us had heard about the Internet or could even imagine it as a possibility, Ralph was imagining and inventing technology that would one day allow all of us to make secure transactions anywhere in the world via cyberspace.

But, that's not surprising. Being ahead of the curve is one of the hallmarks of Ralph's life and career. With undergraduate and graduate degrees in Computer Science from Berkeley, he received his Ph.D. in 1979 from Stanford where he co-invented public key cryptography. In 1980, he began as a manager of compiler development at a Silicon Valley start-up called Elxsi Corporation. Then in 1988, he joined the Xerox Palo Alto Research Center and pursued research in a burgeoning field called nanotechnology.

"In the late '80s, there was an awesome vista of technological advancement," he reminisces. "I was just beginning to scratch the surface of what was possible."



©1995 Peter Menzel www.menzelphoto.com

Today, he is an undisputed expert and globally recognized for his work in nanotechnology. He holds 11 patents, including the fundamental patents on many of the major technologies in cryptography and cryptographic protocols. In 2003, he joined Georgia Tech as a Distinguished Professor.

Ralph became attracted to cryonics and life extension in the 1980's. He knew that technological advancements would one day make it possible to preserve humans and then restore them to health. So, he simply picked

*"It's like trying to explain to the ancient Romans about heart transplants, walking on the moon and flying over oceans."*

up the yellow pages and looked under "cryo." He found the American Cryonics Society and sought to learn what it was all about. "At ACS, I kept hearing about some terrible company called Alcor," says Ralph with a smile in his voice. "So, I figured I ought to check out who ACS thought was such stiff competition."

Not long after, he joined Alcor and signed up for his own cryopreservation. "It looked like this would work, from a technical perspective," he says, "and I liked the stability of Alcor and that it was an established facility."

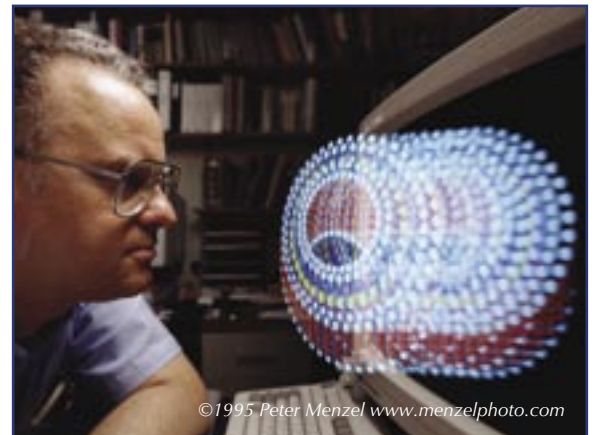
Advancements in both the reality and the theory of nanotechnology have further bolstered Ralph's confidence in the theory that substantially extending life by cryopreservation is a given. But not everyone understands. "Sometimes," he says, "I imagine it's like trying to explain to the ancient Romans about heart transplants, walking on the moon and flying over oceans."

Along with his wife, Carol Shaw, Ralph enjoys cycling along the 39-mile Silver Comet Trail northwest of Atlanta. They enjoy dining out and sampling a variety



**Ralph Merkle, Ph.D.**  
Alcor member since 1989  
Distinguished Professor, Georgia Tech  
Married 1983, wife Carol Shaw

of cuisines; including dim sum, Japanese cuisine, stroganoff and good, old southern fried chicken (although Ralph admits that fried chicken is a rarity, since it's not very healthy). Not surprisingly, he also loves playing with computers.



©1995 Peter Menzel www.menzelphoto.com

Ralph has served on the Board of Directors for Alcor for over eight years. If you would like more information on Dr. Ralph Merkle visit his web site at [www.merkle.com](http://www.merkle.com). For more information on cryonics go to [www.merkle.com/cryo/](http://www.merkle.com/cryo/) and for a plethora of information about nanotechnology, go to the site created by Ralph at [www.zyvex.com/nano/](http://www.zyvex.com/nano/). ■ Contact the author at: [djohnson@walshcomm.com](mailto:djohnson@walshcomm.com)

# NANOART: GLIMPING THE FUTURE



**Name:**  
Gina Miller

**Occupation:**  
Nanotechnology Industries,  
Animator & web designer

**Education:**  
Certified by Discreet in "3DS Max  
5 Fundamentals", "Special Effects &  
Combustion" and "Character Studio"

**Alcor affiliation:**  
Member since 2002

**Images available at:**  
[www.nanogirl.com/index2.html](http://www.nanogirl.com/index2.html)

**Contact Gina Miller:**  
[nanogirl@halcyon.com](mailto:nanogirl@halcyon.com)

## NANOARTIST PROFILE: GINA MILLER

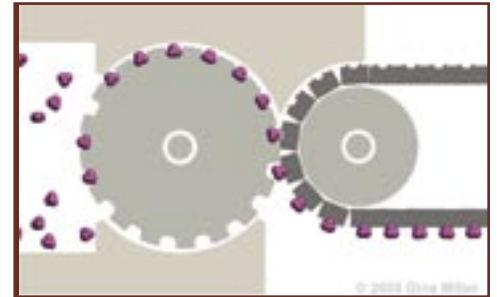
By Jennifer Chapman

Gina Miller was first introduced to nanotechnology in the early 1990's while watching her local Public Broadcasting Service station, which was airing the "FutureQuest" series narrated by Jeff Goldblum. Each segment focused on one particular advanced technology of the future, one of those being nanotechnology. Miller describes her reaction as "sheer enlightenment" after sitting for hours pondering all the future applications of this technology. Years later, Miller is still fascinated and is actively using her artistic training and talents to create artwork that may one day bridge the gap between imagination and actual future technologies.

"Inevitably, the science in my life came full circle with the art. I had worked on computer generated images but there came a point where I decided I wanted to make a bigger impact. I wanted to transition to 3D animation." As a traditional artist, this new focus was the opposite end of the spectrum, but after intensive research Miller created the Nanotechnology Industries web portal ([www.nanoindustries.com](http://www.nanoindustries.com)) which is home to the Nanogirl News service ([www.nanoindustries.com/emaillist.html](http://www.nanoindustries.com/emaillist.html)). During her research, Miller discovered the relationship between nanotechnology and cryonic suspension and signed up to become a member of the Alcor Foundation.

Using 3D animation, Miller has been capable of illustrating concepts and objects that are moving and fully functional using the same real world dimensions that the viewer lives in. This is extremely useful for visually demonstrating future applications of emerging technologies. Miller became certified as an animation artist and soon started on her first nanotechnology specific animations.

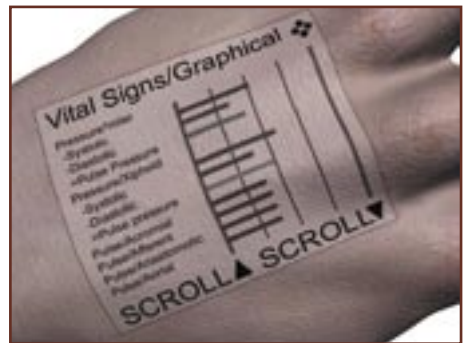
In March of 2005, Miller began corresponding with Robert A. Freitas Jr. about animating his proposed programmable dermal display from his book *Nanomedicine, Volume I: Basic Capabilities*. Of this experience, Miller remarks, "It was a privilege that an author and scientist of his importance agreed to work with me. Our entire collaboration together utilized only email as the means of communication



Early nanotechnology image by Miller from "Rotary", based on schematic designs by K. Eric Drexler, Ph.D. in *Nanosystems: Molecular Machinery, Manufacturing, and Computation*.

which, looking back, is quite amazing." The animation was finished in September of 2005. See the next page for more about this project.

Miller is enthusiastic about the animation process and about capturing an author's vision using animation techniques. When asked about her future goals, Miller said she looks forward to more opportunities to work on animation projects related to advanced technologies. She stated, "It's easy to do, to imagine a world with cures for diseases, a world without hunger, a world without pollution, a world with less suffering than the world we live in today." For more art by Gina Miller, visit: [www.nanogirl.com/index2.html](http://www.nanogirl.com/index2.html). ■



### Programmable Dermal Display

Photons emitted by pixel bots would produce an image on the surface of the skin. This pixel bot array could be programmed to form any of many thousands of displays, each capable of relaying information between the user and the large population of medical bots that roam the user's body.

*"Patients will be able to check their own medical condition any time of day or night, wherever they may be, in great detail without the need to visit the doctor or a testing lab. The available data will be enormous in quantity, intricately detailed, updated as often as the patient wishes or is practicable, and stored permanently within data nodes located inside the patient's body."*

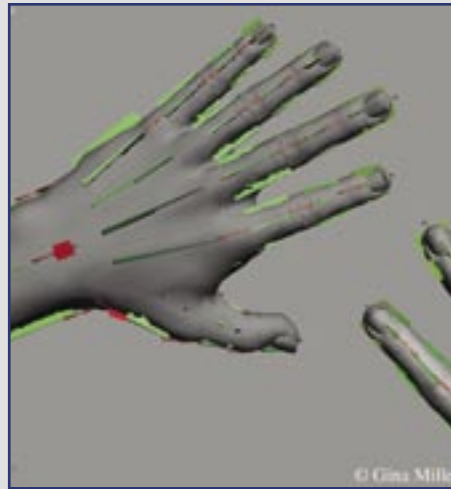
*~Robert A. Freitas Jr. describing his programmable dermal display illustrated by Gina Miller*



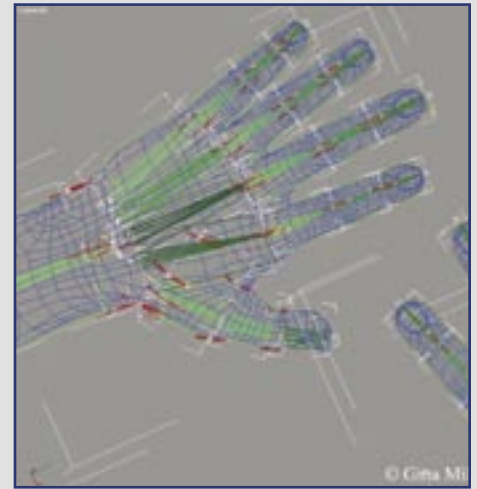
## A SNEAK PEAK: MAKING OF THE PROGRAMMABLE DERMAL DISPLAY ANIMATION



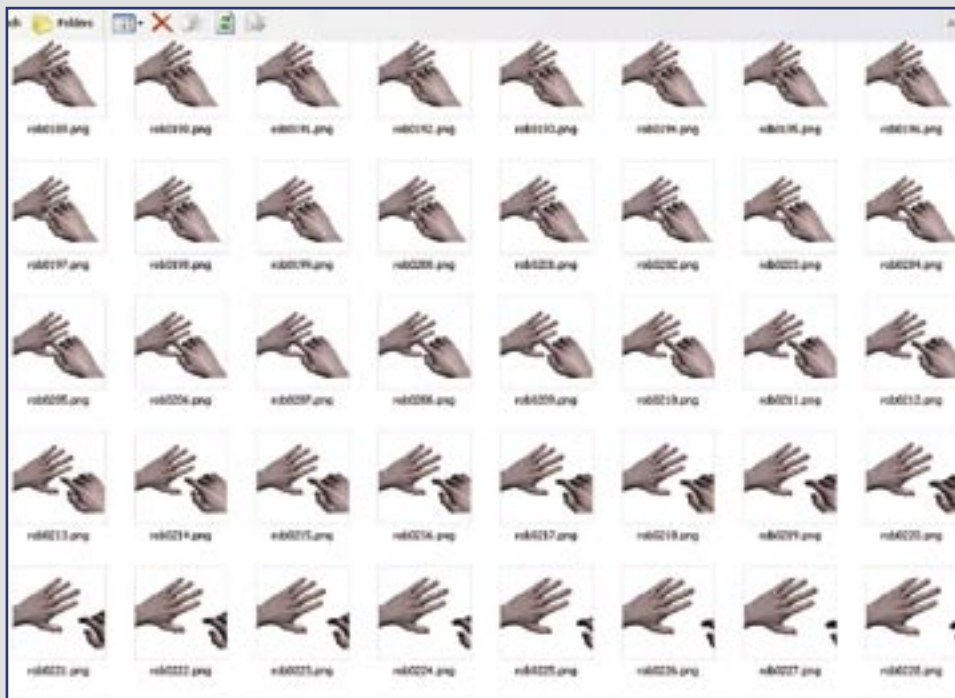
Miller began with a photo realistic image of a hand. Using an image editing program, she drew the base outline of each display screen on the top of the hand, then imported each screen's individual base into a compositing program and two-dimensionally animated all of the movements.



The actual hand model work was done using a 3D animation program where the 2D hand animations were applied to the 3D hand.



After the materials were added, the individual bones were each animated for the movements of the fingers and positioning of the hands.



The single images were then sequentially compiled together to make an animated movie.

To download the full dermal display movie:

[www.nanogirl.com/museumfuture/dermaldisplay.htm](http://www.nanogirl.com/museumfuture/dermaldisplay.htm)



**Name:**  
Mike Gallagher

**Occupation:**  
Previously an industrial designer, now a student in the Biomedical Visualization program at the University of Illinois, Chicago

**Education:**  
B.A. from Pennsylvania State University (1991) & M.I.D. from Pratt Institute (1996)

**Alcor affiliation:**  
General interest

**Images available at:**  
[www.foresight.org/Nanomedicine/Gallery/Artist/Gallagher.html](http://www.foresight.org/Nanomedicine/Gallery/Artist/Gallagher.html)

**Contact Mike Gallagher:**  
mrg001@mindspring.com

## NANOARTIST PROFILE: MIKE GALLAGHER

For Mike Gallagher, art had always been a pastime growing up but usually within the confines of the classroom. Having spent most of his extracurricular time with music and sports, much time was not left for art outside of school. In college at Penn State, Gallagher continued to dabble in the arts, creating mostly sculptural works in a variety of mediums. His first truly formal art experience took place after college, when he enrolled in a drawing class at the Corcoran School of Art in Washington, D.C. Ever since, drawing and image-making have been a passion, and he continues to pursue and develop his passion to this day.

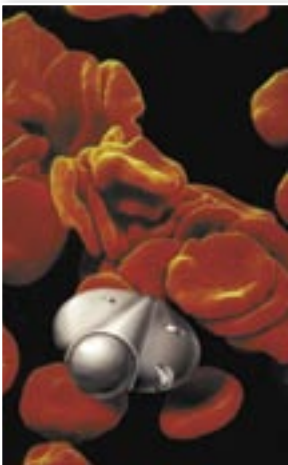
It was science fiction literature that peaked Gallagher's interest about nanotechnology in the '90s. "Nano as a subject was an offshoot of the larger cyberpunk movement in science fiction. Because of its 'newness' and theoretical nature at the time, nanotechnology was often used as a vehicle within the sci-fi stories of the time." Gallagher describes the endless possibilities of nanotechnology as the impetus of his growing interest. "From an ecological perspective, the idea of breaking down and reusing or recreating a material at the molecular level without 'manufacturing' as we know it today is a great idea. Medically, the concept of working on the body at its cellular level, or with the 'building blocks' of the body, is fascinating. Design-wise, a material that can change function and form has the limitless possibilities mentioned earlier. These are a few of the applications that have captured my attention."

As part of a thesis project that revolved around science fiction literature, industrial

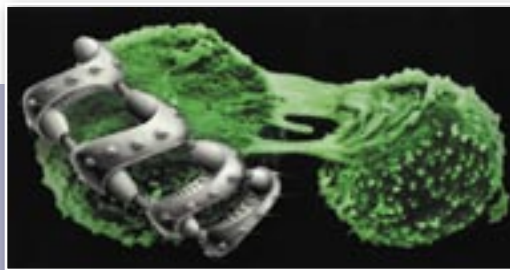
design, and visualizing the future, Gallagher designed a handful of images inspired by nanotechnology, which now exist in the Foresight Institute's Nanomedicine Art Gallery. The images have been used by organizations and individuals around the world as supplements to a number of different articles and for presentations on a variety of topics.

Gallagher describes the concept behind creating the images for his thesis as the idea that "visualization is an important step in moving an idea from words into reality. Through the creation of believable imagery, scientific ideas can become tangible and move concepts closer to reality. These images are seeds of the future, intended to give people a glimpse of the possibilities that nanotechnology can offer." Reactions to his work have all been very positive, with the most common response being that people always ask for more.

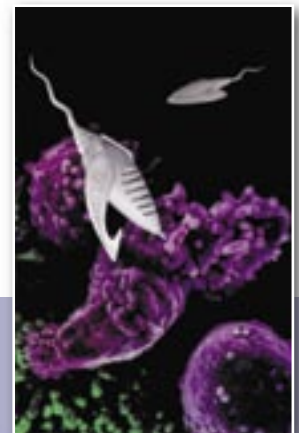
As for cryonics, Gallagher is "very thankful there are people pursuing it as a field of study. Where and how it develops should be interesting to see, and I'm sure there will be many positive outcomes." He also appreciates the challenging philosophical and ethical questions that are raised, but says that, "(u)ltimately, no matter what my opinions or feelings are, people should have a choice, and cryonics is providing that." ■



**Nanomedical probot:**  
A nanotechnological object capable of cellular observation and analysis without causing bodily harm



**Nanomedical transbot:**  
A nanotechnological object facilitating cellular transport within the body and removal from the body



**Nanomedical destrobot:**  
A nanotechnological object capable of "search and destroy" functions for the elimination of harmful or diseased cellular organisms

# NANOMEDICINE AND CRYONICS

By Brian Wowk, Ph.D.

Nanomedicine is the medical application of nanotechnology, which is the emerging technology for manipulating matter on the nanometer or atomic scale. Although nanomedicine originally referred to advanced cell repair technology made possible by molecular nanotechnology, the term has been diluted in recent years to include microscopic medical devices and nanoparticle drug delivery systems. This article will discuss nanomedicine in the original molecular nanotechnology sense, rather than short-term “low tech” forms of nanomedicine.

Nanomedicine is a developing technology that may reach maturity later this century. When mature, it is expected to be a collection of methods and tools for essentially doing surgery on the cellular and molecular levels to fix broken parts inside cells and grow new cells and tissue when necessary. It has been described as a general “repair shop” for the human body.

## Treating Disease, Aging, and Cryopreservation Injury

The prospect of nanomedicine is the most powerful argument there is for the reversibility of aging and reversibility of human cryopreservation. Whatever changes disease, aging, and cryopreservation cause, the changes are ultimately modifications in the composition and arrangement of molecules inside the body. Undesirable modifications to molecules can be reversed by technologies capable of working with molecules, provided enough information is available about the original person and his/her specific molecular makeup. In principle, health and youth can be restored and maintained indefinitely by technologies for general molecular repair and maintenance.

Similarly, technologies for general molecular repair seem to assure the success of cryonics, at least superficially. Molecular and cellular repair could theoretically restore to health a human body found in almost any condition. However, there are limits to the outcome of such restoration. When damage is so severe that memory and personality in-



Cell Rover, Courtesy of artist: Forrest Bishop

*Just microns in length, the bio-engineered cell rover swims through the human body performing useful medical tasks such as drug delivery, waste product or toxin removal, cell targeting, intracellular transport and cellular repair.*

formation within the brain have been erased, the restored person will be a new person. The original person will be gone. Nanomedicine will not be omnipotent.

## History of Nanomedicine and Cryonics

Although the word “nanomedicine” was first used by Eric Drexler, Christine Peterson, and Gayle Pergamit in their 1991 book, *Unbounding the Future*, basic ideas of nanomedicine have an older history. Not surprisingly, cryonics figures prominently in this history. The biological repair needs of cryonics, especially in the early days, were so great that cryonics stimulated a lot of thinking about future medical capabilities. The oft-repeated accusation that cryonicists froze people “without any idea” how to revive them has never been true.

Papers by cryonicists discussing nanomedical ideas go back as far as the 1960s. Key ideas were the use of engineered viruses and microbes as “repair devices” injected into the

body in great numbers, and that enter tissues and cells to affect molecular repairs. Control of growth and development for tissue regeneration was another anticipated development.

During the 1980s, Eric Drexler introduced the powerful new paradigm of molecular nanotechnologies; foreseeable technology for “three-dimensional positional control of atomic and molecular structure to create materials and devices with molecular precision.” Interestingly, repair of frozen tissue was highlighted as an application in the first published paper on molecular nanotechnology in 1981. Cryonicists were quick to appreciate the importance of this work. At a time when there were fewer than 100 people in the world signed up for cryonics, almost 10 percent of the acknowledged reviewers of the 1986 nanotechnology book, *Engines of Creation*, were cryonicists. Numerous articles and papers discussing the application of molecular nanotechnology to cryonics followed (see reference list on page 12).

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*“The arrangement of the atoms in our cells and of the cells in our bodies determines who we are as well as how we feel, whether we are sick or well, and ultimately whether we are alive or dead.”*

~Michael Darwin in *Cryonics: Reaching for Tomorrow*, 1989

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## Meet Robert Freitas

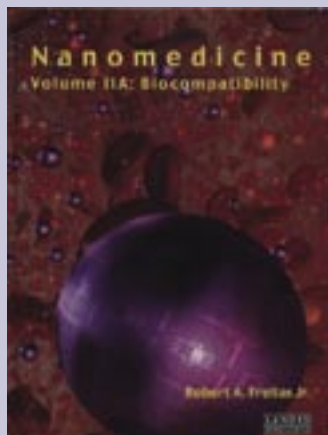
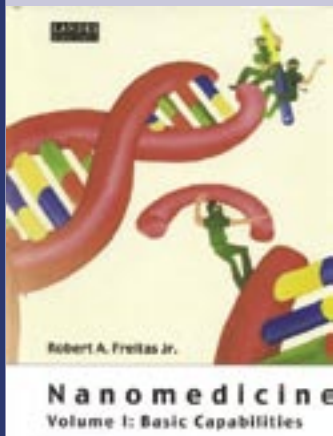


Robert A. Freitas Jr.

Robert A. Freitas Jr., J.D., published the first detailed technical design study of a medical nanorobot ever published in a peer-reviewed mainstream biomedical journal and is the author of *Nanomedicine*, the first book-length technical discussion of the medical

applications of nanotechnology and medical nanorobotics. Volume I was published in October 1999 by Landes Bioscience while Freitas was a Research Fellow at the Institute for Molecular Manufacturing (IMM) in Palo Alto, California. Freitas published

Volume IIA in October 2003 while serving as a Research Scientist at Zyvex Corp., a nanotechnology company headquartered in Richardson, Texas, during 2000-2004. Freitas is now completing Volumes IIB and III and consulting on molecular assembler design as Senior Research Fellow at IMM.



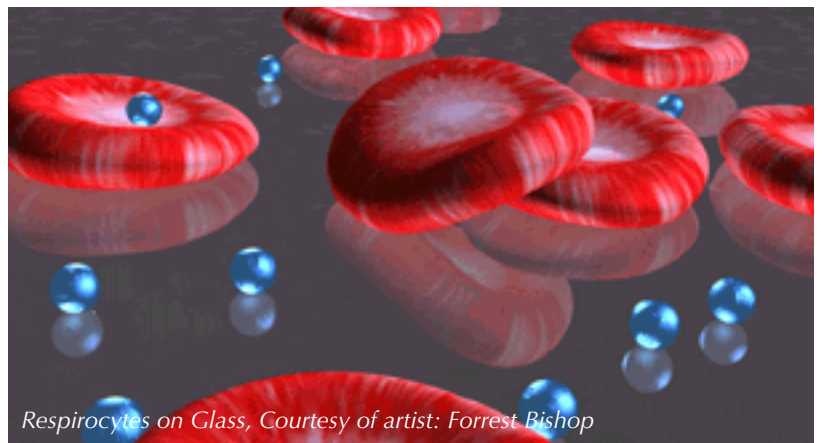
## Nanomedicine Today

The name now associated with nanomedicine more than any other is Robert A. Freitas Jr. Freitas is a Senior Research Fellow at the Institute for Molecular Manufacturing in Palo Alto, California, and holds degrees in physics, psychology, and law (JD). Freitas is the inventor of the “respirocyte”, an artificial red blood cell that in 1998 became the subject of the first technical design study of a medical nanorobot to be published in a peer-reviewed mainstream medical journal. He has since published studies on three other theoretical nanorobots, the microbivore (artificial white cell), clottocyte (artificial platelet), and vasculoid (artificial vascular system). A video animation showing Freitas’ nanorobots roving through the blood stream was recently featured on the CBS television show “60 Minutes” in conjunction with an interview of biogerontologist Aubrey de Grey.

Freitas is most well-known as the author of *Nanomedicine*, the first book-length technical discussion of the medical applications of nanotechnology and medical nanorobotics, published in 1999. He has since completed and published the second of four planned volumes of the *Nanomedicine* book series. This second volume is a book-length treatment of the question of biocompatibility of nanomedical devices. Both volumes of *Nanomedicine* are freely available online at the Nanomedicine Book Site ([www.nanomedicine.com](http://www.nanomedicine.com)). A description of a repair scenario for cryonics patients will appear in Chapter 29 of *Nanomedicine, Volume III: Applications*.

Freitas has also done pioneering work in the general field of molecular manufacturing, especially positional diamond mechanosynthesis, replicative manufacturing systems, and diamondoid nanorobotics. In 2004, he completed with Ralph Merkle the book, *Kinematic Self-Replicating Machines* (Landes Biosciences 2004), which is also available freely online ([www.molecularassembler.com/KSRM.htm](http://www.molecularassembler.com/KSRM.htm)). He is a founding member of the editorial boards of the journals *Nanomedicine*, *International Journal of Nanomedicine*, and *Journal of Computational and Theoretical Nanoscience*. He has written nearly 100 technical papers, book chapters, or popular articles on a diverse set of scientific, engineering, and legal topics.

In 2004, Alcor recognized the invaluable continuing contributions of Robert A. Freitas Jr. to the field of nanomedicine by awarding a \$20,000 grant to the Institute for Molecular Manufacturing Robert Freitas Research Fund. Some of the work made possible by this grant is shown on the reference list on page 12. Alcor encourages everyone who appreciates the importance of nanomedicine to cryonics to consider contributing to this fund. In Robert’s own words, “(b)asically, I’m doing everything I can to move medical nanorobotics implementation along as fast as humanly possible.”



Respirocytes on Glass, Courtesy of artist: Forrest Bishop

Red blood cells lie on a glass plate with respirocytes scattered randomly about nearby. The image is a simulated view of a blood sample taken from a future trauma patient who received therapeutic respirocyte doses at an accident scene. Each single respirocyte in the scene can control nearly the same amount of available oxygen as all eight red cells combined.

## Nanomedicine Goes Mainstream

By the late 1990s, nanomedicine was beginning to be taken seriously by mainstream scientists. According to the book *Nanomedicine*, in 1997 a panel of U.S. Department of Defense health science experts known as Military Health Service Systems (MHSS) 2020 concluded in its final report:

*"If a breakthrough to a [molecular] assembler occurs within ten to fifteen years, an entirely new field of nanomedicine will emerge by 2020. Initial applications will be focused outside the body in areas such as diagnostics and pharmaceutical manufacturing. The most powerful uses would eventually be within the body. Possible applications include programmable immune machines that travel through the bloodstream, supplementing the natural immune system; cell herding machines to stimulate rapid healing and tissue reconstruction; and cell repair machines to perform genetic surgery."*

The U.S. National Institutes of Health (NIH) now incorporates nanomedicine as an explicit part of its strategic roadmap for medical research. The NIH nanomedicine web page says:

*"What if a broken part of a cell could be removed and replaced with a miniature biological machine? What if pumps the size of molecules could be implanted to deliver life-saving medicines precisely when and where they are needed? These scenarios may sound unbelievable, but they are the long-term goals of the NIH Roadmap's Nanomedicine initiative that we anticipate will yield medical benefits as early as 10 years from now.... This knowledge will lead to the development of new tools that will work at the 'nano' scale and allow scientists to build synthetic biological devices... and miniature devices to destroy the infectious agents or fix the 'broken' parts in the cells."*

<http://nihroadmap.nih.gov/nanomedicine/>

## Future of Nanomedicine

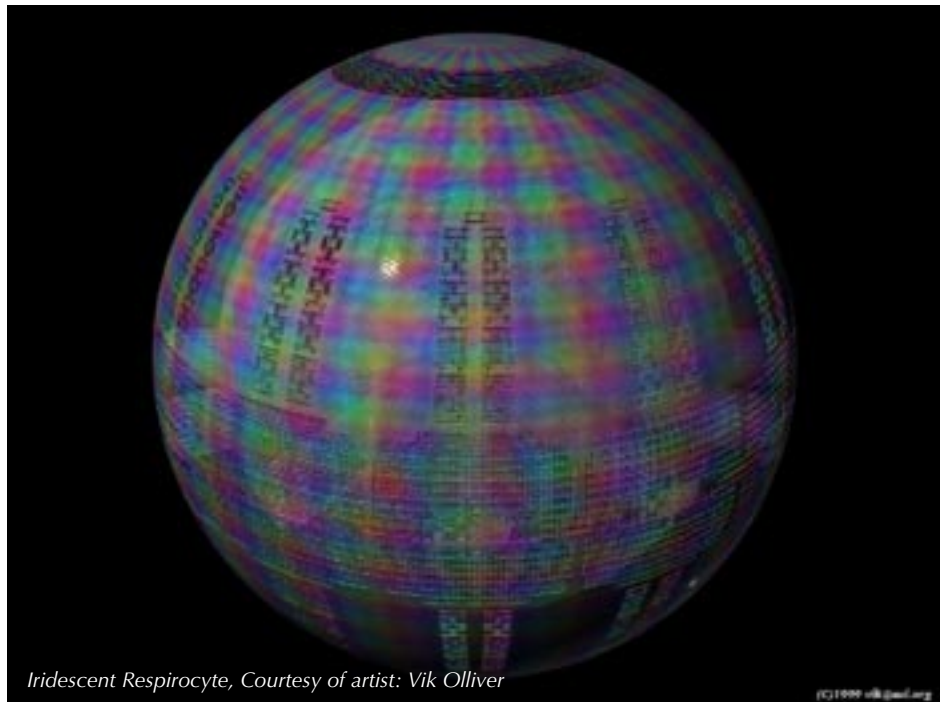
Nanomedicine has come a long way since the first speculations about cell and tissue repair appeared in the 20<sup>th</sup> century. Many capabilities previously regarded as science fiction are now widely anticipated by a growing number of scientists. Although the meaning of the word has been partly diluted by the inclusion of near-term microtechnologies, the long-term vision of sophisticated cell repair remains intact.

Nanomedicine is now in a situation similar to nanotechnology in that the word has been "mainstreamed" and, to some ex-

tent, hyped, creating near-term expectations for capabilities that may still lie in the farther future. As with nanotechnology, many things that aren't nanomedicine will be called nanomedicine. Many goals of nanomedicine will be achieved by technologies that aren't called nanomedicine; they will be called tissue engineering, gene therapy, and other technologies not invented yet. Yet they will still be

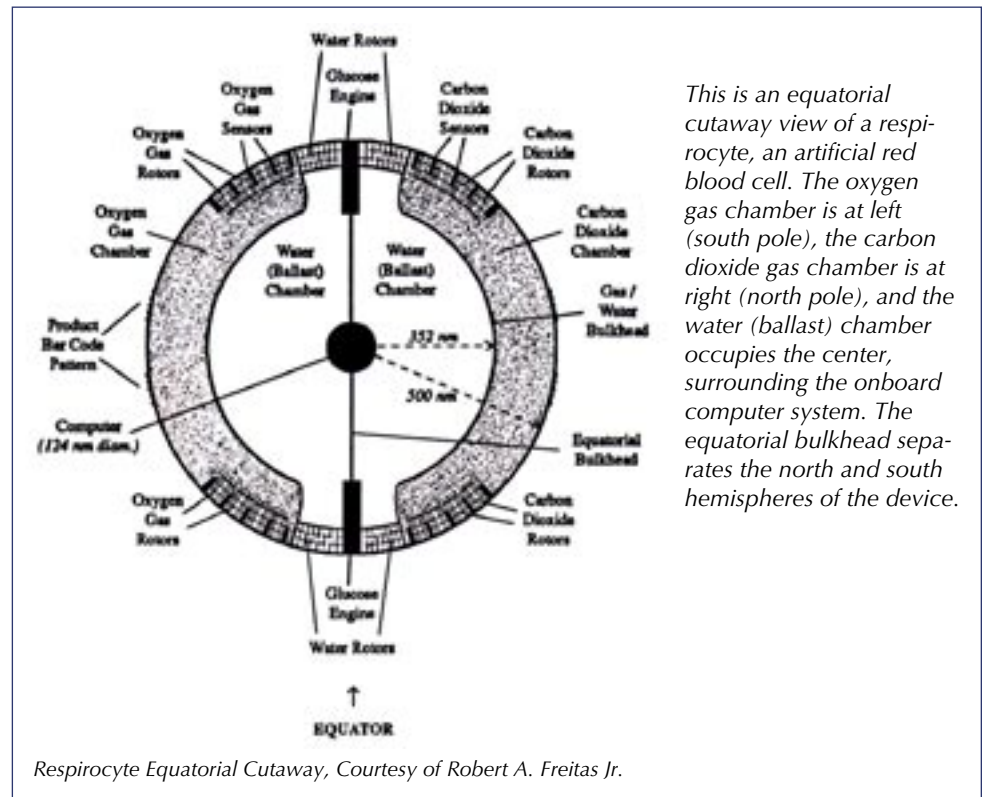
part of the long march of medicine toward the limits of what is theoretically possible. General control over the molecular constitution of the human body is that theoretical limit and the limit that tells us disease, aging, and cryopreservation are all in principle reversible. ■

Contact the author at: [wowk@21cm.com](mailto:wowk@21cm.com)



*Iridescent Respirocyte, Courtesy of artist: Vik Olliver*

*This is a single respirocyte in iridescent colors, showing the circumpolar concentric-circle bar coding and a conventional 12-fold pumping station layout.*



*This is an equatorial cutaway view of a respirocyte, an artificial red blood cell. The oxygen gas chamber is at left (south pole), the carbon dioxide gas chamber is at right (north pole), and the water (ballast) chamber occupies the center, surrounding the onboard computer system. The equatorial bulkhead separates the north and south hemispheres of the device.*

*Respirocyte Equatorial Cutaway, Courtesy of Robert A. Freitas Jr.*



# To Learn More About Nanotechnology

## Selected Web Links

**Foresight Institute Nanomedicine Page**  
[www.foresight.org/Nanomedicine/](http://www.foresight.org/Nanomedicine/)

**Nanomedicine Book Site**  
[www.nanomedicine.com/](http://www.nanomedicine.com/)

**Robert Freitas Homepage**  
[www.rfreitas.com/](http://www.rfreitas.com/)

**Nanotech.biz Interview with Rob Freitas**

Part 1: [www.nanotech.biz/i.php?id=robertfreitas](http://www.nanotech.biz/i.php?id=robertfreitas)

Part 2: [www.nanotech.biz/i.php?id=robertfreitas2](http://www.nanotech.biz/i.php?id=robertfreitas2)

**U.S. Government Nanomedicine Page (NIH)**

<http://nihroadmap.nih.gov/nanomedicine/>

**Molecular Repair of the Brain**

[www.alcor.org/Library/html/MolecularRepairOfTheBrain.htm](http://www.alcor.org/Library/html/MolecularRepairOfTheBrain.htm)

**A Door to the Future**

[www.foresight.org/EOC/EOC\\_Chapter\\_9.html](http://www.foresight.org/EOC/EOC_Chapter_9.html)

**24th Century Medicine**

[www.alcor.org/Library/html/24thcenturymedicine.html](http://www.alcor.org/Library/html/24thcenturymedicine.html)

**Resuscitation: A Speculative Scenario for Recovery**

[www.alcor.org/Library/html/resuscitation.htm](http://www.alcor.org/Library/html/resuscitation.htm)

**Nanomedicine Art Gallery**

[www.foresight.org/Nanomedicine/Gallery/index.html](http://www.foresight.org/Nanomedicine/Gallery/index.html)

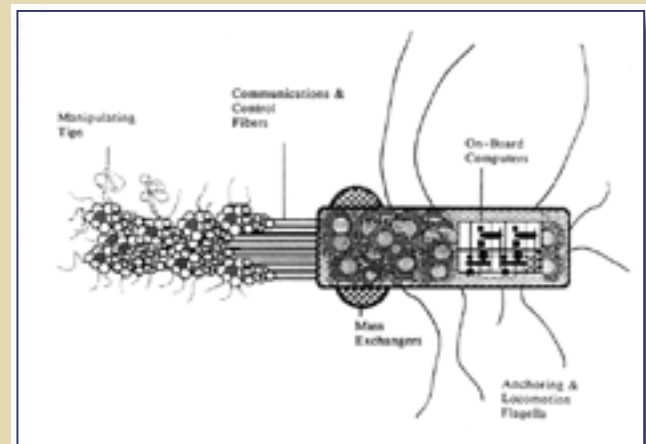
**Early Cell Repair Papers and Books by Cryonicists**

- Jerome White, "Viral Induced Repair of Damaged Neurons with Preservation of Long-Term"

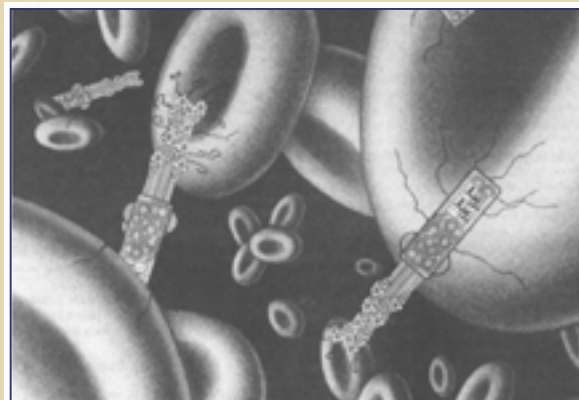
## Summary of Nanomedical Capabilities Needed for Recovery of Cryonics Patients

- Cell, tissue, and organ regeneration
- Repair/replacement of denatured or damaged biomolecules
- Repair of damaged cell membranes and organelles
- Bioartificial life support environments to maintain isolated tissue and organs, especially the brain, while vital organs are regenerated
- Solid state tissue analysis and repair at cryogenic temperatures for repair of freezing injury and fracturing with minimum information loss (Solid state repairs might not be necessary for cryonics patients preserved by vitrification to prevent ice formation and kept at temperatures warmer than liquid nitrogen to prevent fracturing)

*This image is a conceptual drawing of a nanotechnological-derived cell repair device. The scenario for repair calls for repair devices engineered to atomic precision with a complete or nearly complete ability to characterize and order biological matter at the molecular, cellular, and tissue levels.*



*Courtesy of the Alcor Life Extension Foundation.  
Artist, Michael G. Darwin*



*Courtesy of the Alcor Life Extension Foundation.  
Artist, Michael G. Darwin*

*This image shows cell repair devices evaluating red blood cells after infusion of transport liquids carrying a wide assortment of molecular structures useful in reconstruction of biological tissues.*



Information Content," paper presented at the Second Annual Cryonics Conference, Ann Arbor, Michigan, 11 April 1969.

- Robert C.W. Ettinger, *Man Into Superman*, St. Martin's Press, NY, 1972.
- Thomas Donaldson, "A Brief Scientific Introduction to Cryonics," unpublished privately circulated discursive bibliography, 1976; revised version reprinted by Alcor Life Extension Foundation, 1978.
- Michael Darwin, "The Anabolocyte: A Biological Approach to Repairing Cryo-injury" (*Life Extension Magazine*, pp. 80-83, July/August 1977)
- Thomas Donaldson, "How Will They Bring Us Back, 200 Years From Now?" (*The Immortalist*, Vol. 12, pp. 5-10, Mar. 1981)
- Thomas Donaldson, "24th Century Medicine" (*Analog Science Fiction/Science Fact*, September 1988, and *Cryonics*, pp. 16-34, December 1988)

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### Papers Discussing Application of Molecular Nanotechnology to Cryonics

- K. Eric Drexler, "Molecular Engineering: An Approach to the Development of General Capabilities for Molecular Manipulation" (*Proc. National Academy of Sciences (USA)* 78: 5275-5278, 1981)
- K. Eric Drexler, "Molecular Technology and Cell Repair Machines" (*Cryonics*, December 1985 and January 1986) paper presented at the 1985 Lake Tahoe Life Extension Festival, Lake Tahoe, California, 25 May 1985.
- K. Eric Drexler, "A Door to the Future," in *Engines of Creation*, Anchor Books, 1986.
- Brian Wowk, "Cell Repair Technology" (*Cryonics*, pp. 21-30, July 1988)

- Mike Darwin, "Resuscitation: A Speculative Scenario for Recovery" (*Cryonics*, pp. 31-37, July 1988)
- Gregory Fahy, "Realistic Scenario for Nanotechnological Repair of the Frozen Human Brain," in *Cryonics: Reaching for Tomorrow*, Alcor Life Extension Foundation, 1991.
- Ralph Merkle, "The Technical Feasibility of Cryonics" (*Medical Hypotheses* 39: 6-16, 1992)
- Ralph Merkle, "Molecular Repair of the Brain" (*Cryonics*, January and April 1994)
- Ralph Merkle, "Cryonics, Cryptography, and Maximum Likelihood Estimation" Proceedings of the First Extropy Institute Conference, Sunnyvale, California, 1994.

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### Recent Nanomedicine Work of Robert A. Freitas Jr. Supported by Alcor

#### Lectures:

- "Pathway to Diamond-Based Molecular Manufacturing," Invited Lecture delivered at the First Symposium on Molecular Machine Systems at the First Foresight Conference on Advanced Nanotechnology, 22 October 2004, Washington, DC. [www.MolecularAssembler.com/Papers/PathDiamMolMfg.htm](http://www.MolecularAssembler.com/Papers/PathDiamMolMfg.htm).
- "Nanomedicine and Medical Nanorobotics," Invited Lecture delivered at the First Foresight Conference on Advanced Nanotechnology, 23 October 2004, Washington, DC.

#### Papers

- "What is Nanomedicine?" *Nanomedicine: Nanotech. Biol. Med.* 1(March 2005):2-9. [www.nanomedicine.com/Papers/WhatIsNMMar05.pdf](http://www.nanomedicine.com/Papers/WhatIsNMMar05.pdf)
- "Current Status of Nanomedicine and Medical Nanorobotics (Invited Survey)," *J. Comput. Theor. Nanosci.* 2(March 2005):1-25. [www.nanomedicine.com/Papers/NMRevMar05.pdf](http://www.nanomedicine.com/Papers/NMRevMar05.pdf)

- "Progress in Nanomedicine and Medical Nanorobotics (Invited Chapter)," in Michael Rieth, Wolfram Schommers, eds., *Handbook of Theoretical and Computational Nanotechnology*, American Scientific Publishers, Stevenson Ranch, CA, 2005. In press (October 2005).
- An updated final version of the medical nanorobotics "microbivores" scaling study was published in the *Journal of Evolution and Technology* in April 2005. <http://jetpress.org/volume14/Microbivores.pdf>.
- "Nanotechnology, Nanomedicine and Nanosurgery (Invited Editorial)," *Intl. J. Surgery* 3(December 2005):1-4. [www.nanomedicine.com/Papers/IntlJSurgDec05.pdf](http://www.nanomedicine.com/Papers/IntlJSurgDec05.pdf)

Pending:

- Four papers on diamond mechanosynthesis.

#### Books

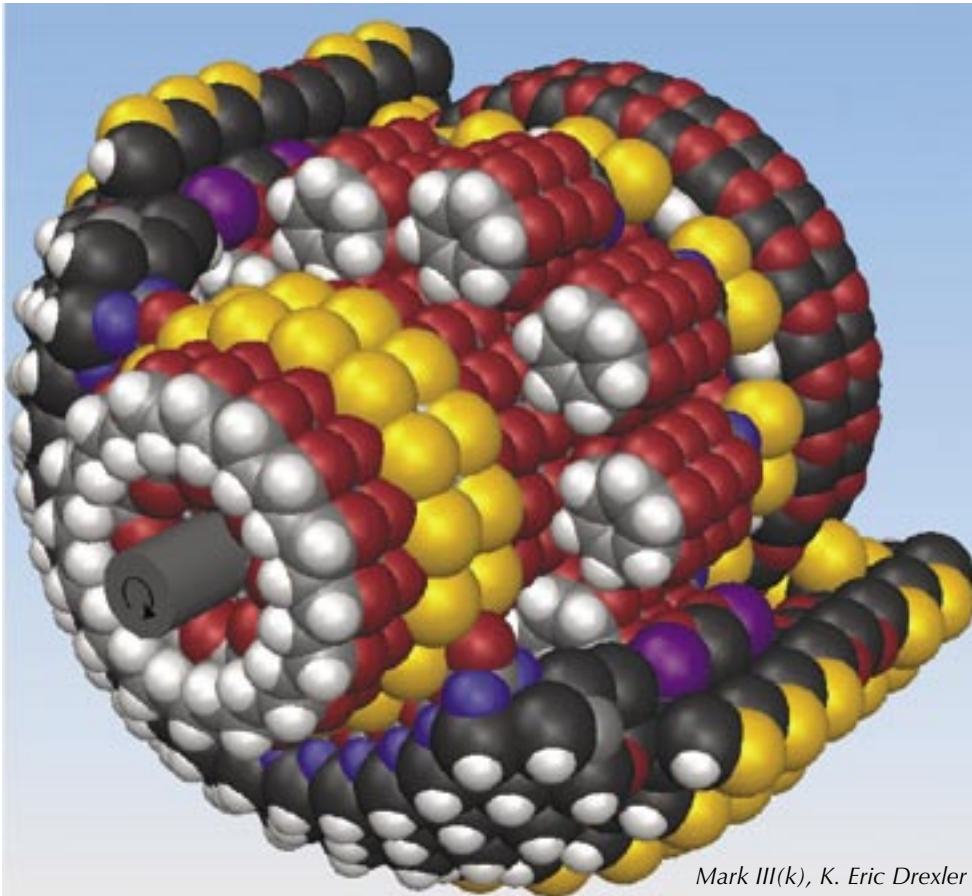
- *Kinematic Self-Replicating Machines* (Landes Bioscience, 2004); Freitas was lead author and Ralph Merkle was co-author. [www.MolecularAssembler.com/KSRM.htm](http://www.MolecularAssembler.com/KSRM.htm)
- *Nanomedicine Vol. I* and *Nanomedicine Vol. IIA* (freely available online) [www.nanomedicine.com](http://www.nanomedicine.com)

Pending:

- Textbook on nanomechanical engineering in collaboration with J. Storrs Hall.
- *Nanomedicine Vol. IIB* and *Nanomedicine Vol. III*.

#### Patents

- Robert A. Freitas Jr., "A Simple Tool for Positional Diamond Mechanosynthesis, and its Method of Manufacture," U.S. Provisional Patent Application No. 60/543,802, filed 11 February 2004; U.S. Patent Pending, 11 February 2005. [www.molecularassembler.com/Papers/DMSToolbuildProvPat.htm](http://www.molecularassembler.com/Papers/DMSToolbuildProvPat.htm)



Mark III(k), K. Eric Drexler

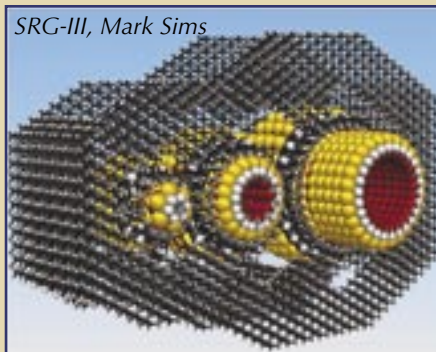
## nanoENGINEER-1

Somedays scientists will build nanosystems like those discussed and shown in this issue of *Cryonics* magazine. But first they have to be designed. nanoENGINEER-1 is a computational modeling tool specifically intended to enable scientists and engineers to do just that.

Unlike traditional CAD software used today, nanoENGINEER-1 is a 3D program “exclusively for nanomechanical engineering.” It is also an open source project. Sponsored by Nanorex, a Detroit company, the first live demonstrations for the general public were offered in 2005 at the 13<sup>th</sup> Foresight Conference in San Francisco. It is scheduled for release early this year.

Check out the growing gallery of animated images rendered with nanoENGINEER-1: [www.nanoengineer-1.com](http://www.nanoengineer-1.com)

Above is the MarkIII(k), a planetary gear created using nanoENGINEER-1 by K. Eric Drexler. A planetary gear couples an input shaft via a sun gear to an output shaft through a set of planet gears (attached to the output shaft by a planet carrier). The planet gears roll between the sun gear and a ring gear on the inner surface of a casing.



SRG-III, Mark Sims

The SRG-III is the third parallel-shaft speed reducer gear created by Mark Sims. A hybrid of the SRG-I and SRG-II, it is the first molecular gear train ever designed. With 15,342 atoms, the SRG-III is the single largest nanomechanical device ever modeled in atomic detail.

## Leafy Green Vegetables May Help Keep Aging Brains Sharp

According to a recent report in the *American Journal of Clinical Nutrition*, folate, a B vitamin found in foods like leafy green vegetables and citrus fruit, may protect against cognitive decline in older adults. The research was conducted by scientists at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University. A team led by Katherine L. Tucker, PhD, studied a group of Boston-area men who were members of the ongoing Normative Aging Study (NAS). Tucker and her colleagues found that men with more folate in their diets showed significantly less decline in verbal fluency skills over the course of three years.

*ScienceDaily*

9/26/05

[www.sciencedaily.com/releases/2005/09/050926082256.htm](http://www.sciencedaily.com/releases/2005/09/050926082256.htm)

## Cervical Cancer Vaccine Proves Effective

Final-stage clinical trials of a cervical cancer vaccine developed by University of Queensland (UQ, Australia) scientists, have shown the drug to be 100 percent effective. The results of the Phase III trials were announced by international pharmaceutical company Merck & Co. which is developing the product under the trade name Gardasil. It was the pioneering research work of Professor Ian Frazer from UQ's Centre for Immunology and Cancer Research (CICR) that led to the development of the vaccine. Cervical cancer is one of the few human cancers that is known to be directly caused by a viral infection (from human papilloma virus, HPV) and is the second leading cause of cancer among women.

*Research Australia*

10/10/05

[www.eurekalert.org/pub\\_releases/2005-10/ra-ccv100905.php](http://www.eurekalert.org/pub_releases/2005-10/ra-ccv100905.php)

## Targeted Drug Delivery Achieved With Nanoparticles

Ground-breaking results from researchers at Harvard Medical School and Massachusetts Institute of Technology disclosed at the 13<sup>th</sup> European Cancer Conference (ECCO) have shown for the first time that targeted drug delivery is possible using nanoparticle-apatamer conjugates. Nucleic acid ligands (referred to as aptamers) are short DNA or RNA fragments that can bind to target antigens with high specificity and affinity. In the field of cancer nanotechnology, aptamers have the potential to act as targeting molecules—directing the delivery of nanoparticles to tumor-antigens present on the surface of cancer cells. In general terms, therapeutic nanoparticles are specially designed delivery vehicles that can encapsulate a drug within them and release the drug in a pre-determined and regulated manner which can vary from a sudden release to a slow release over a period of several years. Using prostate cancer as a model disease, nanoscale targeted drug delivery vehicles were developed, which can target and kill prostate cancer cells with high specificity and efficiency.

*ScienceDaily*  
11/02/05

[www.sciencedaily.com/releases/2005/11/051102084747.htm](http://www.sciencedaily.com/releases/2005/11/051102084747.htm)

## Nanotube Sheets Promise Cornucopia

University of Texas at Dallas (UTD) nanotechnologists and an Australian colleague have produced transparent carbon nanotube sheets that are stronger than the same-weight steel sheets and have demonstrated applicability for organic light-emitting displays, low-noise electronic sensors, artificial muscles, conducting appliques and broad-band polarized light sources that can be switched in one ten-thousandth of a second. Carbon nanotubes are like minute bits of string, and untold trillions of these invisible strings must be assembled to make useful macroscopic articles that can exploit the phenomenal mechanical and electronic properties of the individual nanotubes. In the August 19 issue of the journal *Science*, scientists from the NanoTech Institute at UTD and a collaborator, Dr. Ken Atkinson

from Commonwealth Scientific and Industrial Research Organization (CSIRO), a national laboratory in Australia, report such assembly of nanotubes into sheets at commercially useable rates.

*ScienceDaily*  
8/19/05

[www.sciencedaily.com/releases/2005/08/050819131626.htm](http://www.sciencedaily.com/releases/2005/08/050819131626.htm)

## Whole Frozen Ovary Transplanted

Scientists working with sheep have for the first time developed embryos from whole ovaries which were transplanted after being frozen and then thawed. The journal *Human Production* reported that eggs obtained from two such ovaries produced early sheep embryos. Dr Amir Arav and his team at the Institute of Animal Science in Bet Dagan, Israel, tested whether ovaries from eight sheep could survive the freezing (cryopreservation) and thawing process. They chose to study sheep because their ovaries are similar to those of humans. Five of the eight frozen and thawed ovaries were successfully transplanted. Two yielded eggs. One produced more than four eggs four months later. From these the researchers were able to make early sheep embryos.

*BBC News*  
9/14/05

<http://news.bbc.co.uk/1/hi/health/4244750.stm>

## Researchers Clear Crucial Step to Quantum Computing

The speed of light may be thought of as being a constant, around 300,000 kilometers a second, but researchers at the Laser Physics Centre have set a world record for slowing light down enough to capture it, for over a second, in a crystal. It is a crucial step in the development of the next generation of computers--that is to say, quantum computers. Light, according to Dr Matthew Sellars, is very good at transmitting information. However, it is very, very fast and just zips off unless you find a way to hold it for a while. Dr. Sellars and his team are working to develop memory for quantum computing, a new way

of storing and processing information that would be drastically faster and more powerful than existing computers. Using two laser beams and a crystal, the team at the Research School of Physical Sciences and Engineering slowed down light from 300,000 kilometers per second to a mere few hundred meters per second.

*PM*

8/30/05

[www.abc.net.au/pm/content/2005/s1449548.htm](http://www.abc.net.au/pm/content/2005/s1449548.htm)

## Vitrification Progress in Cryobiology and Cryonics

At the 2005 meeting of the Society for Cryobiology held in Minneapolis in July, 2005, Dr. Gregory Fahy, Chief Scientific Officer at 21<sup>st</sup> Century Medicine in Rancho Cucamonga, California, reported long-term survival of a transplanted kidney cooled all the way to -135°C (-211°F) and back, using vitrification chemicals to prevent freezing. Banking of human organs at those temperatures could revolutionize the field of transplantation. One organ, however, that does not get much attention in cryobiology is the brain. Partially successful brain freezing experiments were first reported in a 1966 issue of *Nature* by Isamu Suda. Follow-up work demonstrated weak recovery of brain electrical activity from a cat even after seven years of frozen storage. Experiments such as these helped motivate the nascent field of cryonics. In 2004, the Alcor Life Extension Foundation published a paper in the *Annals of the New York Academy of Sciences*, showing for the first time that a whole brain could be vitrified. Their brain results were obtained using the same chemical solution, called M22, that 21<sup>st</sup> Century Medicine used in their kidney preservation experiments.

*What We Now Know*  
9/27/05

[www.howestreet.com/story.php?ArticleId=1575](http://www.howestreet.com/story.php?ArticleId=1575)

■ Contact the author at: [mike@alcor.org](mailto:mike@alcor.org)



# CASE SUMMARY: CRYOPRESERVATION OF A-1598

On Friday, October 7, 2005, a 60-year-old diabetic Alcor member was discovered unconscious in his California home by his significant other, also an Alcor member. No one knows how long he had been lying there, but paramedics were immediately called to the scene. He was evaluated and treated at his local hospital. Alcor's northern California transport team members were among the first responders to the emergency call. Several local team members were deployed to the hospital with stabilization equipment while an Alcor Central team was dispatched along with its emergency transport vehicle from Arizona.

A standby was performed and lasted for several days. Doctors initially suspected that this member may have fallen, hit his head and suffered some brain damage. An MRI revealed that brain damage might have indeed been present, although it probably resulted from a medical condition other than the fall. When it became apparent that the member was not recovering, his significant other made arrangements for an air ambulance to safely transport him to a hospice located in Arizona within five miles of Alcor's facility. Once he arrived in Scottsdale, Alcor Central's transport team was immediately de-

ployed to assess the situation further. Quick deployment was crucial because it was merely eight hours after landing at the airport that the member's heart stopped. He had family, friends, and Alcor personnel at his side when the moment came.

The patient stabilization began immediately. The cryoprotection was begun a little over an hour later and proceeded smoothly, with few complications. Vitrification of the brain was achieved; and the subsequent cooling resulted in few fractures being detected, and those were at the lowest temperatures ever recorded. This was one of the best cryopreservation procedures ever implemented at Alcor.

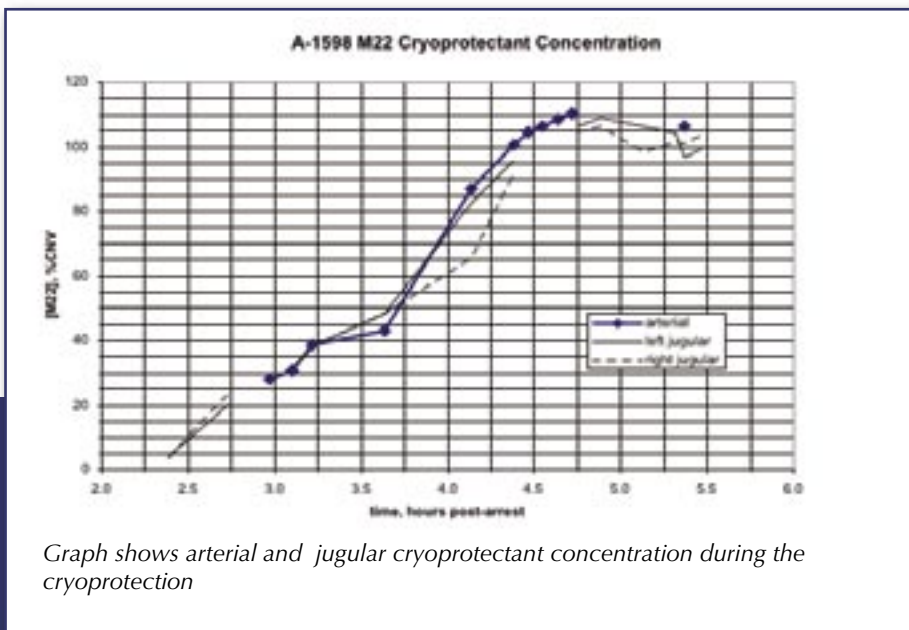
First and foremost, the efforts of this member's significant other to get him into a local hospice contributed tremendously to the quality of the subsequent cryopreservation. Alcor was able to begin its procedure immediately with some assistance from the hospice staff, and team members provided care within Alcor's emergency transport vehicle during the rapid transit to Alcor. In the end, this patient received the best M22 perfusion to date largely due to the fact that he was close to Alcor when he needed to be.

The challenges in this case were part hu-

man error, part equipment deficiencies. First, the patient was too large for Alcor's mechanical cardiopulmonary support devices. Alcor was required to continue manual compressions using the Ambu Cardiopump. Although having the Ambu Cardiopump available enabled Alcor to continue circulating much-needed oxygen and stabilization medications, it was less effective than the mechanical cardiopulmonary support would have been.

Another challenge was discovered during a routine vascular resistance test conducted during the cryopreservation process, where a cannula was discovered to be clamped. This surgical oversight resulted in slightly less shrinkage in the right brain hemisphere, but the hemisphere is still believed to have achieved target concentrations needed to vitrify. Continuing with routine checks performed at regular intervals and improving the surgical training available to team members will avoid unintended oversights of this type.

Finally, the crackphone device was temporarily unavailable for monitoring this patient's cooldown because it was being used with another patient. As Alcor grows, dual capability for multiple patients needs to be expanded to include all aspects of the cryopreservation procedure. ■



Graph shows arterial and jugular cryoprotectant concentration during the cryoprotection

To ensure more timely release of information, we will be posting the entire Case Summary on the website. Only a brief synopsis will be provided in this quarterly publication. See the Library Section of our website or visit this link: [www.alcor.org/Library/index.html#casereports](http://www.alcor.org/Library/index.html#casereports)

# PATIENT PROFILE: LEONARD ZUBKOFF

By R. Michael Perry

At the time of his untimely demise and cryopreservation in 2002, the 44-year-old Leonard Zubkoff lived in Crystal Bay, Nevada. World-renowned for his expertise in computer architecture and operating systems, he was also an entrepreneur who had become wealthy, with a talent for understanding how to interface with people as well as computer hardware. He had a reputation for being as generous as he was wealthy, and he had many friends both in and outside of cryonics. Having put so much energy into his projects with so much success, he had decided to take up some other interests more in earnest, including the outdoors he loved. To tour it in proper fashion he trained to be a helicopter pilot and was close to receiving his license. On August 29, 2002, he was flying over a lake with an experienced instructor, in the Misty Fjords National Monument Wilderness near Ketchikan, Alaska. For reasons unknown, but possibly relating to air turbulence, the copter took a flip-dive into the cold water, landing upside down; the two aboard were casualties mainly by drowning. His cryopreservation was brain-only, starting with a mandatory autopsy in Anchorage before his remains were reluctantly released by the medical examiner and transported to Alcor.

Leonard's career started in 1975 when he entered the University of Rochester, New York. He double-majored in mathematics and physics and graduated summa cum laude in only three years. He continued graduate study in computer science at Carnegie-Mellon University in Pittsburgh and earned a Master of Science degree in computer science. At CMU he developed algorithms and protocols for high-speed communications between time-shared computers and remote terminals over phone lines. His programs were used in computer centers at Carnegie-Mellon, the Massachusetts Institute of Technology, and Stanford University. In 1985 Leonard was recruited by Lucid, Inc., of Menlo Park, California. He served as Principal Scientist, specializing in porting technology, performance, and machine and operating-system level architectures. In 1994 he joined

Oracle Corporation in Redwood Shores, California. While there his interests shifted to open-source software and operating systems. In 1998 Leonard joined VA Linux (now VA Software) of Fremont, California, as Chief Technical Officer. In the open-source-based Linux, Leonard found an operating-system project where he could apply his passions for excellent craftsmanship and quick response. He improved Linux stability and performance on multiprocessor systems and on systems with large disk arrays and worked with chipset and motherboard vendors to improve their designs for the Linux market.

Leonard had a keen interest in future technologies and joined the Foresight Institute in 1989. He was taken with the idea that molecular machines could someday repair cellular and even molecular damage and had joined Alcor in 1988. Leonard was an active member of Alcor's cryopreservation team for many years and provided assistance with Alcor's computer systems. He became an Alcor Advisor to the Board of Directors in June 2002.

Leonard was prominent in the world of science fiction fandom and filk—music invoking a science-fiction or fantasy theme. He founded Dandelion Digital to provide state-of-the-art digital recordings of filk music. Dandelion Digital released seven albums.

In what were to be Leonard's last months, he enjoyed being out-of-doors close to the home he loved in Crystal Bay, as well as taking a new interest in keeping his body healthy. Leonard began taking nearly daily hikes into the Sierra Nevada peaks surrounding his home. He went so far as to buy a GPS and record every hike he took. Leonard always knew exactly where he was and where he had been. It fitted with his looking forward to the future.

Leonard had requested of his friends that they not mourn if he died in a helicopter accident, one request that proved impossible to honor. There was nothing but deep sadness, sorrow, and despair in letting him go, even though he was doing something he loved and understood the risks. To those of us at Alcor he was a benefactor, a mentor,



Leonard Zubkoff

Leonard talked about hiking the entire rim trail in the Crystal Bay area. He was looking forward to flying his helicopter to the vicinity of the highest point in each of the 50 United States, then walking, hiking, or climbing to the top of each one. These hikes and climbs were the subjects of many conversations and contemplations. Every day he was home Leonard spent time looking out the windows toward Lake Tahoe along the shoreline of Crystal Bay, where the beautiful snow-topped peaks reflected in the water. He would often comment on how the lake never looked the same and how the unique and gorgeous storm clouds gathered above it.

and a friend, and his contributions, expertise, and inspiring personality are missed. And of course he was a cryonicist, whom we intend to restore someday, if it proves possible.

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This article was partly excerpted from articles in *Cryonics*, 3rd Qtr. 2002, 14-15, particularly an unsigned piece based on a press release at [www.puffin.com/puffin/lnz/pressrelease.htm](http://www.puffin.com/puffin/lnz/pressrelease.htm) (also unsigned) and an untitled article by Karla Steen. Another source was an FAA report contained in CryoNet message #19986 posted 4 Sep 2002 by "Driven FromThePack." ■

Contact the author at: [mike@alcor.org](mailto:mike@alcor.org)

Alcor continues to draw worldwide attention from the media. In January, an article appeared on the front page of *The Wall Street Journal*. The focus of the article was how cryonics patients plan to retain their wealth while in cryonic suspension and included several interesting interviews with businessmen who are making plans to hold onto their wealth. As a result of this article, Alcor members Trudy and David Pizer were invited to do an interview for "Good Morning America". In addition to mentioning personal revival trusts, the broadcast also showed the human side of cryonics. The piece opened with the co-anchor, Charles Gibson, referring to Trudy and David as "perfectly reasonable people who say they just love life" and ended with David saying affectionately to Trudy, "when I told her I want to be with you forever, I meant it."

To see these stories about Alcor and others, visit: [www.alcor.org/press/newsstories.html](http://www.alcor.org/press/newsstories.html)



## A Cold Calculus Leads Cryonauts To Put Assets on Ice

With Bodies Frozen, They Hope to Return Richer; Dr. Thorp Is Buying Long

By ANTONIO REGALADO

You can't take it with you. So Arizona resort operator David Pizer has a plan to come back and get it.

Like some 1,000 other members of the "cryonics" movement, Mr. Pizer has made arrangements to have his body frozen in liquid nitrogen as soon as possible after he dies. In this way, Mr. Pizer, a heavy-set, philosophical man who is 64 years old, hopes to be revived sometime in the future when medicine has advanced far beyond where it stands today.



David Pizer

And because Mr. Pizer doesn't wish to return a pauper, he's taken an additional step: He's left his money to himself.

With the help of an estate planner, Mr. Pizer has created legal arrangements for a financial trust that will manage his roughly \$18 million in land and stock holdings until he is re-animated. Mr. Pizer says that with his money earning interest while he is frozen, he could wake up in 100 years the "richest man in the world."

Though cryonic suspension of human remains is still dismissed by most medical experts as an outlandish idea, Mr.



photo by Deborah Johnson

Alcor members Trudy and Dave Pizer being interviewed in Alcor's patient care bay for ABC's "Good Morning America." The story about personal revival trusts, which aired January 25, 2006, can be seen on the Alcor website.



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# 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 cryotransport technicians on-call around the United States. Alcor's Arizona facility includes a full-time staff with employees present 24 hours a day.

## ARIZONA

### Scottsdale:

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

### Scottsdale/Phoenix:

#### Alcor Tours

Tours are held at Alcor at 10:00 am and 2:00 pm every Tuesday and Friday. They are hosted by our President (10:00 am) and Chief Operating Officer (2:00 pm). Call Alcor (877) 462-5267 ext. 101 to schedule an appointment or email [dbora@alcor.org](mailto:dbora@alcor.org).

## 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!

## Host a Meeting in your area.

If you're 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!

## CALIFORNIA

### Los Angeles:

Alcor Southern California Meetings  
For information on Southern California meetings, call Peter Voss at (310) 822-4533 or e-mail him at [peter@optimal.org](mailto:peter@optimal.org). Although monthly meetings are not held regularly, there is no shortage of Los Angeles Alcor Members you can contact via Peter.

### San Francisco Bay:

Alcor Northern California Meetings will be held quarterly: January, April, July, October, and there will also be a CryoFeast once a year. For information on Northern California meetings, call Marek (Mark) Galecki or email [Mark\\_galecki@pacbell.net](mailto:Mark_galecki@pacbell.net) Home (408)245-4928

## 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>

## 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](mailto:kfl@keithlynch.net). For information on LES, see our web site at [www.keithlynch.net/les](http://www.keithlynch.net/les)

## MASSACHUSETTS

### Boston:

A cryonics discussion group meets the second Sunday of each month. For more information, contact Tony Reno by phone at (978) 433-5574, or e-mail: [tonyreno@concentric.net](mailto:tonyreno@concentric.net). Information can also be obtained from David Greenstein at (508) 879-3234, e-mail: [davidsgreenstein@juno.com](mailto:davidsgreenstein@juno.com).

## TEXAS

### Dallas:

North Texas Cryonauts, please join 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.

## UNITED KINGDOM

There is an Alcor chapter in England. Its members are working hard to build solid emergency response, transport, and suspension capability. For information about meetings, contact Andrew Clifford at [andrew@banknotes.ws](mailto:andrew@banknotes.ws) or sue hopkins1@virgin.net. See the web site at [www.alcor-uk.org](http://www.alcor-uk.org).

## WHAT IS CYRONICS?

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Cryonics is an attempt to preserve and protect the gift of human life, not reverse death. It is the speculative practice of using 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?

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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, [www.alcor.org](http://www.alcor.org) is one of the best sources of detailed introductory information about Alcor and cryonic suspension. We also invite you to request our **FREE** information package on the "Free Information" section of our website. It includes:

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## HOW DO I ENROLL?

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Becoming a cryopreservation member is easy! Simply fill out an application and submit it with your \$150 application fee. You will then be sent a set of contracts to sign with witnesses. Most people use life insurance to fund their cryopreservation. Cash prepayment is also accepted. Alcor's Membership Coordinator can provide you with a list of insurance agents familiar with satisfying Alcor's current funding requirements. After enrolling, you will wear emergency alert tags or carry a special card in your wallet. This is your confirmation that Alcor will respond should we ever receive an emergency call on your behalf.

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