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CRYONICS

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The Technology of Repair, Revival, and Rejuvenation

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False Modesty Hurts Cryonics

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The Future of *Cryonics* Magazine

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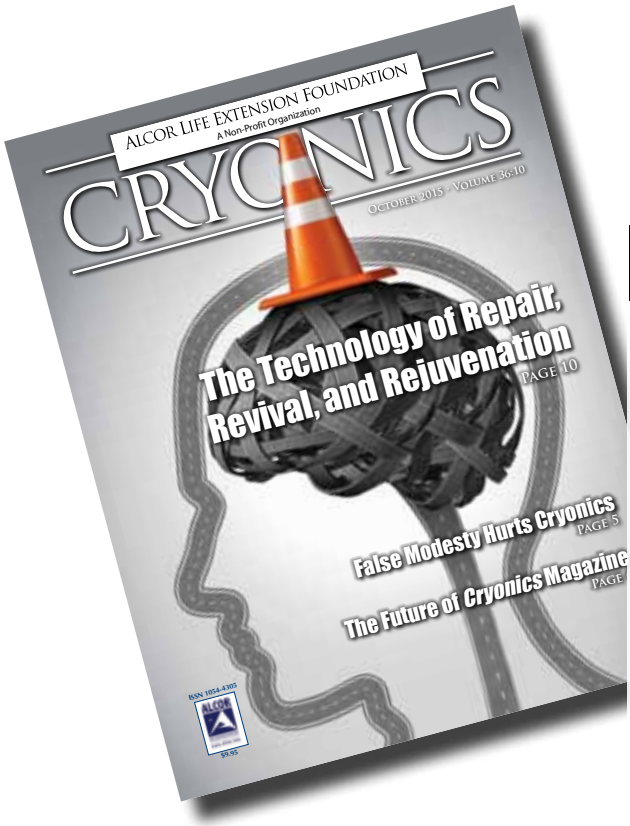

COVER STORY: PAGE 10

The Technology of Repair, Revival, and Rejuvenation
This ambitious paper reviews some of the proposals that have been made to try to solve the problem of revival, repair, and rejuvenation, including using nanotechnology as a part of this effort. Various cell and tissue repair devices are discussed as well as a cryobiological view of the subject of repair after exposure to cryogenic temperatures. Part I of a three-part series.

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CRYONICS

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QUOD INCEPIMUS CONFICIEMUS

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

FALSE MODESTY HURTS CRYONICS By Aschwin de Wolf

No credible cryonics organization would ever claim that if you get cryopreserved you *will* be resuscitated in the future. We tend to make more qualified claims and even include language in our cryopreservation contracts about the (potential) challenges that are associated with today's procedures. One counterproductive attitude that I have encountered since becoming involved in the field, however, is to think that we look more respectable and credible if we put the odds of success really low or claim that patients who were cryopreserved with older, cruder, technologies probably will not be revived. A typical statement goes like, "I think there is about a 2% chance that cryonics will work but I think it is a rational decision to make considering the potential benefits." When I hear statements like this I always wonder, "how do you arrive at such a probability estimate?" and "what kinds of damage do you exactly think irreversibly erase identity-critical information?" If you make strong statements about the (technical) feasibility of cryonics you'd better back them up.

I think that most of the time these low estimates have little rigorous reasoning or data behind them. True, some have attempted to produce formal probability estimates. While I consider these exercises useful for identifying the various challenges that will need to be overcome for cryonics to succeed, a major problem is that a lot of the individual probabilities that go into these calculations are not independent. For example, if we can produce stronger scientific evidence for brain cryopreservation, legal protections will improve, membership and financial stability will increase, etc. Also, is it reasonable to do probability estimates for things that are considered mainstream medical knowledge or common sense sociological prerequisites? For example, what kind of Alzheimer's researcher would discuss a potential new drug with the caveat that the drug will only be effective if the brain gives rise to the mind ("who knows, maybe it is a disease of the soul?"), or that civilized society should still exist to introduce such drugs to patients? There are *all kinds* of conditions that can be considered necessary for cryonics to succeed and if we assign all of these independent probabilities we will always end up with extraordinarily low numbers. No mainstream researcher talks about his / her aims like this.

Another important thing to recognize about likelihood estimates in cryonics is that many of the things that need to go right for cryonics to succeed are outcomes of our own actions. We cannot just sit down, calculate, and wait. We have to get up and do something about them. Cryonics is a field where individuals and small groups of individuals can still make a huge impact on the credibility and sustainability of the field.

Does false modesty about cryonics command more respect from scientists? I don't think so. If you think that cryonics causes irreversible damage, please explain this on a specific, molecular level. Claiming that today's cryonics procedures cause "damage" is not an argument against cryonics unless you can make a case for how this kind of damage leads to a condition where the original ultrastructure of the brain cannot be inferred from the damaged state. Information is hard to destroy and in cryonics damage is often produced concurrent with decreases in temperature that lock these changes in place. One quick rule about talking about damage in cryonics: ask for specifics, do not accept sweeping statements about "the brain." Ask how exactly this damage makes information irreversibly disappear. ■

The Future of *Cryonics* Magazine

By Aschwin de Wolf

This is the Afterword of *Preserving Minds, Saving Lives, The Best Cryonics Writings of the Alcor Life Extension Foundation,* a collection of the best *Cryonics* magazine writings of the last 40 years. This massive and beautiful book is being published in October 2015, and is available in both softcover and hardcover format. Copies can be purchased through Alcor right now!

Afterword

When Michael Darwin and Steve Bridge launched the IABS Newsletter in 1977 that later became *Cryonics* magazine, Alcor barely existed and magazines were the product of typewriters, time-consuming layout, and (hand-written) letters to the editor. As I write this in September 2014, Alcor employs 7 full-time staff members and 1 part-time staff member and has over 1,000 members with cryonics arrangements. And perhaps most importantly, Alcor has introduced a number of major technological advances that push the organization further in the direction of human suspended animation. These developments raise an important question. What is the role of *Cryonics* magazine today, and what can we expect from Alcor in the next 40 years?

It is undeniable that with the rise of the Internet and the widespread adoption of smart phones (a development anticipated in Frederik Pohl's 1969 cryonics novel The Age of the Pussyfoot) *Cryonics* magazine has changed as well. As important news and new developments in cryonics can now be disseminated to Alcor members in real-time, the importance of a (paper) magazine to keep members informed about these things appears to be lessened, especially for younger and computer-savvy people. But just as newspapers, magazines, and books continue to be published, publication of *Cryonics* magazine remains important for a number of reasons.

The requirement of publishing all important (proposed) changes at Alcor in the magazine ensures a sense of continuity and facilitates member involvement.

First of all, a formal publication can play an important role in the documentation and preservation of institutional knowledge (technological, logistical, and legal). The requirement of publishing all important (proposed) changes at Alcor in the magazine ensures a sense of continuity and facilitates member involvement. Secondly, the structured and serial nature of a publication allows it to be used to drive progress at the organization. When the editor, an Alcor official, or member believes in a specific improvement, a case can be made for it in the magazine that can be scrutinized and endorsed by other Alcor members and officials. And last, but not least, a (paper) magazine remains a popular format to publish long (technical) articles and highlight the human aspects of cryonics (such as member profiles). I will also add that I personally think that publication of a paper magazine is particularly important for Alcor because of its unique aspiration to both preserve and renew. Just think of the "magic" of being able to present a resuscitated patient with the latest paper issue of *Cryonics* magazine!

Not only has the production and presentation of the magazine changed, so has the content. As a general rule we should expect the contents of the magazine to reflect the current direction of the organization and it usually has done this. How do we conceptualize cryonics? How do we promote it? To what extent do technological advances change our perception of the feasibility of this endeavour? Can we be more specific about resuscitation and reintegration of our patients? Should we be satisfied with the current number of members? Have the demographics of cryonics changed, and what does this mean for how we present cryonics to the general public? Just think

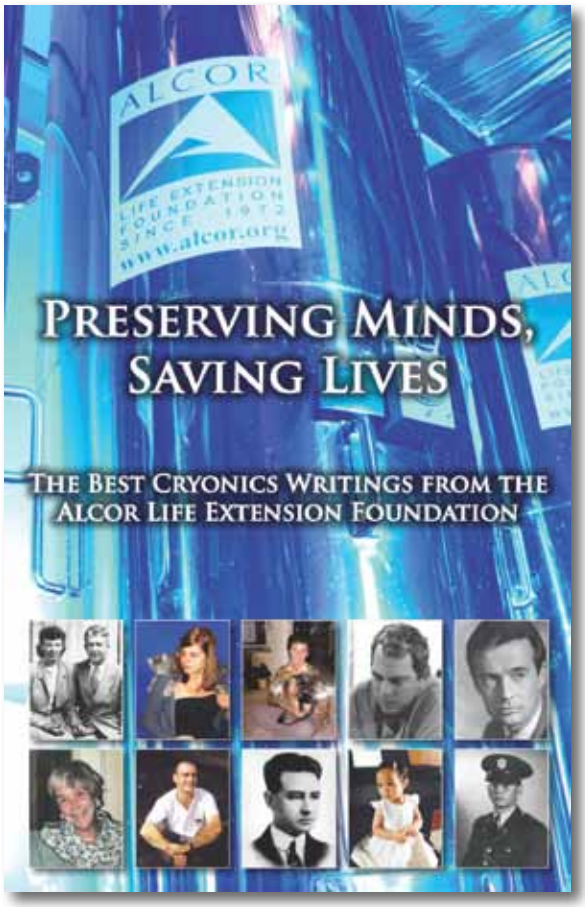
of all the articles you have read in this book with these questions in mind and it should have become evident that Alcor has evolved and will continue to evolve.

The ultimate goal of Alcor aiming at human suspended animation provides an important benchmark to measure our progress and to identify future "repair" scenarios.

As was indicated in the Introduction, the articles collected in this book are not a "neutral" selection of writings that have appeared in the magazine over the last 40 years. While ensuring not to omit any classic and important writings, we have deliberately selected those articles that reflect the current perspective on cryonics that guides Alcor. In a nutshell, this means a strong emphasis on cryonics as an evidence-based extension of medicine, and less emphasis on any associated philosophies or grandiose visions. This does not mean that we do not recognize the value of such writings, but we think it evident that the widespread adoption of any new medical technology requires that it should be presented in a manner that is non-objectionable to most people. As I have said on occasion, "cryonics is controversial enough; let's not make it more controversial."

So what can we expect in the next 40 years of Alcor? I am not a big proponent of making bold predictions but I think it reasonable to expect that we will see a further increase in membership (provided costs are kept under control), a more diverse membership, new advances in cryopreservation technologies, changes in long-term care conditions, and a much stronger emphasis on resuscitation and reintegration.

Although the envisioned, almost limitless, capabilities of future medicine sometimes weakens the desire to make rapid technological progress in our field, cryonics needs an ideal to aim for. That ideal is human suspended animation. If the process of cryopreservation (or any credible preservation technology) can prevent a patient from deterioration without adding further injury, the only technical objection to cryonics would be to claim that a disease can never be cured in the future, and who could reasonably claim that? Human suspended animation remains a formidable challenge; but now that we are on the path of eliminating ice formation and fracturing, the remaining scientific, technological, and logistical challenges can be identified, i.e. conducting our procedures in an environment that excludes further ischemic injury (something we already know how to do in ideal circumstances), designing vitrification solutions with negligible toxicity that avoid excessive dehydration, and developing safe re-warming technologies. The ultimate goal of Alcor aiming at human suspended animation provides an important benchmark to measure our progress and to identify future "repair" scenarios.



I will close this afterword on the topic of resuscitation and reintegration. While Alcor undoubtedly remains the leading cryonics organization in terms of advancing new technologies, there has been an increasing recognition that most people reject cryonics for personal and social reasons—as opposed to scientific and technological ones. To some extent we have ourselves to blame for this because we have not devoted a whole lot of time to specific resuscitation scenarios and the great benefits of remaining alive and reaching the future. One thing I expect to see more in the magazine, and other Alcor media, is a stronger engagement with concerns about loss and alienation. Clearly, we cannot promise that all will be well in the future; but we can offer a counter-weight to the often dystopian discourse about human enhancement and paradigm-shifting technologies. Most of all, it is important to convey that cryonics is not just a technology to avoid individual oblivion but a means of families, friends, and loved ones to remain together. When people read our magazine, or peruse the Alcor website, we do not only want them to think that human cryopreservation is a good idea, but that we have also put a lot of work into giving members the legal and technological tools to preserve their memories, assets, and most of all, the people dear to them in order to head into this future prepared and together. And what a future it will be! ■

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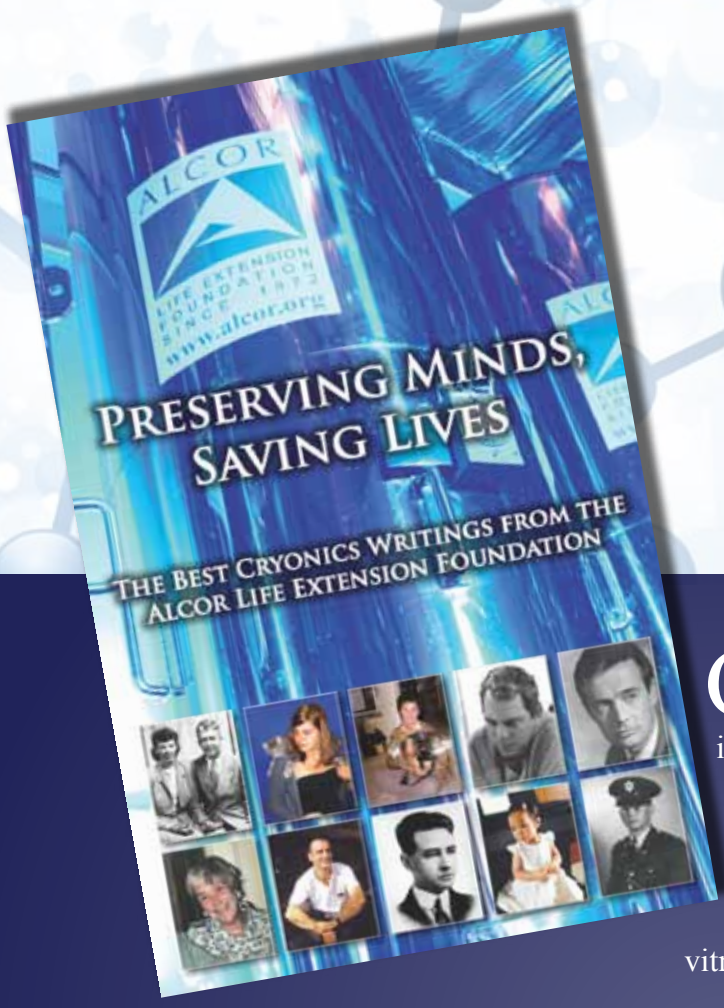
Preserving Minds, Saving Lives

The Best Cryonics Writings of The Alcor Life Extension Foundation



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

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

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

This book presents some of the best cryonics writings from *Cryonics* magazine from 1972 to 2012. There are clear expositions of the rationale behind cryonics, its scientific validation, and the evolution of Alcor procedures. Also covered are repair and resuscitation scenarios, philosophical issues associated with cryonics, and debates within the cryonics community itself.

Preserving Minds, Saving Lives

The Best Cryonics Writings of The Alcor Life Extension Foundation

Featuring stimulating articles from the pages of *Cryonics* magazine by Steven Harris, Hugh Hixon, Saul Kent, Mike Darwin, Stephen Bridge, Thomas Donaldson, Aschwin de Wolf, Brian Wowk, Michael Perry, Ralph Merkle, and many others.

Here are some of the classic articles that shaped cryonics thought and Alcor policy over the past three decades.

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THE TECHNOLOGY OF REPAIR, REVIVAL, AND REJUVENATION

PART I

By York W. Porter

Cryonics is a concept wherein individuals who are clinically dead are placed at liquid nitrogen temperature (-196 degrees Celsius) where they remain essentially unchanged. The assumption of cryonics is that those individuals can be revived, repaired, and rejuvenated by future scientific knowledge and procedures. This paper reviews some of the proposals that have been made to try to solve the problem of revival, repair, and rejuvenation, including using nanotechnology as a part of this effort. Various cell and tissue repair devices are discussed as well as a cryobiological view of the subject of repair after exposure to cryogenic temperatures.

Author's Note: What follows is, to some degree, a chronological account of revival, repair, and rejuvenation scenarios and thoughts throughout the years in cryonics, as well as some general thoughts and information about nanotechnology itself. The information available on these subjects is fairly extensive so it isn't possible, in a single article or book chapter, or in several volumes for that matter, to cover every twist and turn in the history of things, as well as detailed explanations of each concept/objection, etc. As was pointed out extremely well in the book (and television series) *Connections* by James Burke, most ideas, if not all, don't arise in a vacuum and there are always interweavings in the "tapestry of history." Also, one needs to keep in mind that many papers in many fields, not only cryonics, are "upgrades" from previous work of the same author not "written from scratch."

In the example of Thomas Donaldson, for instance, it should be noted that in 1976 he wrote of modified biologically based repair systems in a paper entitled, "A Brief Scientific Introduction to Cryonics."[1] This seems to form the basis for his later expositions on the subject.

There is also the phenomenon of people thinking along the same general lines but coming up with unique and separate solutions. Mike Darwin's thought on the "anabolocyte" developed independently of Donaldson's musings on biologically-based repair systems even though both occurred within a year or so of each other.

Due to these scholarly concerns and the enormous amount of material to go through, what is written below should be a "start" rather than "ending" to efforts in reading on this interesting, important topic.

The Prospect of Immortality

In his seminal book, *The Prospect of Immortality*[2], Robert Ettinger predicated his revolutionary thesis on a known fact and also an assumption. The fact, true now as then, is that individuals can be placed at ultra-low ("cryogenic") temperatures immediately after clinical death, with essentially no further deterioration once they reach those temperatures.

The assumption was, and remains, that at some future point in time, scientific progress will make it possible to revive, repair, and rejuvenate those stored individuals to a state reflecting youthful good health. This would include dealing with any damage that the processes involved in cryonics caused the individuals, as well as the harmful effects of aging and the diseases and/or trauma they suffered before their clinical death.

In a talk personally heard by the author, Ettinger stated quite frankly and honestly that, at the time of writing his book, he didn't (and, of course, couldn't) *know* that the assumption was correct. But he postulated it based, in part, on the enormous progress that science had made during the decades preceding his writing. That progress, plus Ettinger's own observations as a scientifically trained and thorough investigator, holding masters' degrees in both physics and mathematics, led him to make his postulate with a high degree of confidence and reasonableness.

From the time of Ettinger's birth, in December 1918, to the time he was writing *Prospect*, in the early to mid-1960s, civilization had developed in astonishing ways. The "scientific miracles" of high-speed computers, moon rockets, supersonic jet aircraft, international telecommunications, and medical advances ranging from penicillin to organ transplants, as well as many others, were either already a

reality or just on the horizon. The ability of science to continue to progress to further heights of capability seemed an easy leap in logical reasoning.

Still, the assumption remained an assumption and, in light of the fact that no such repair mechanism has yet been devised, still remains just that: a postulate which forms the second part of Ettinger's world-changing idea. Here I will review some of the advances in thinking and technology that occurred around the time of writing of the original book, and some which have developed since.

Richard Feynman's Talk

The first "solid ground" that can be said to underlie the work of Ettinger appeared independently back in 1959, before Ettinger had finished the first version of his book (in 1962). In an after-dinner talk[3] that wasn't about cryonics at all, Dr. Richard Feynman, who would share the 1965 Nobel Prize in Physics, outlined some basic principles that would powerfully reinforce the cryonics assumption.

At the time of Feynman's presentation, most people, when talking of machines, thought about all the visible-sized devices that were (and are) in everyday use, from watches, food mixers, and vacuum cleaners to cars, airplanes, and ships. Further, most people's thoughts about them tended toward "the larger and more powerful, the better and more impressive." Even Ettinger in his book wrote of "huge surgeon-machines working twenty-four hours a day for decades or even centuries…"[4] to revive, repair, and rejuvenate an individual and, in particular, the brain, "cell by cell, or even molecule by molecule in critical areas."[5] Ettinger would generally be seconded by later thinkers in the "molecule by molecule" repair capabilities that should become available, but the size of the "surgeon machines" would probably shrink too, they averred, quite a lot in fact.

Though it may be natural to think of there being "plenty of room at the top" (as in, "the sky's the limit"), Feynman turned it around that December evening in '59. Titling his after-dinner talk, "There's Plenty of Room at the Bottom," he pointed out that, while a lot of technological progress had been made in miniaturizing devices and processes, more could be done, a whole lot more. "Electric motors that are the size of the nail on your small finger"[6] and "a device on the market ... by which you can write the Lord's Prayer on the head of a pin"[7] were just "the most primitive, halting step in the direction I intend to discuss."[8] Progress was just beginning.

Not just the Lord's Prayer, Feynman speculated, but the whole *Encyclopedia Britannica*, all 24 1,000-page, double-column, fine-print volumes of the then-current edition, might be written on the head of a pin. He talked about whether computers that were then taking up entire rooms of floor space could be shrunk down toward something like the human brain, or—who could say? Like Ettinger he spoke of robot surgery, but in terms of independent units that would work inside the body itself. One of his bolder statements anticipates full-blown nanotechnology: "But I am not afraid to consider the final question as to whether, ultimately—in the great future—we can arrange the atoms the way we want: The very atoms, all the way down! What would happen if we could arrange the atoms one by one the way we want them (within reason, of course; you can't put them so that they are chemically unstable, for example)?"[9]

Could it be done? Feynman was optimistic: "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big."[10]

Feynman clearly deserves credit as one of the principal founders of the field now known as "nanotechnology"—manipulating objects in a direct fashion on the molecular/atomic scale; proper apportioning of credit is something for historians to decide. In any event, his 1959 talk has generated, at least retrospectively, a lot of interest among those now working in the field. His remarks still stand out in both their basic points and in demonstrating the creative thinking of the man himself.

There the matter remained, at least in terms of what Robert Ettinger would postulate just a few years later. No immediate connection was made between Feynman's talk and cryonics. Ettinger wrote about "giant" surgeon-machines working "molecule by molecule" if they had to, but surely it would be make sense to make them smaller.

Jerry White's 1969 Proposal of a "Repair Virus"

For those cryopreserved in the early days, friends, family and advocates could take comfort that at least time was "stopped." You had time to figure out what could be done for the ones you cared about, while they were "on hold." Just what would be done, though, remained elusive even as a topic of speculation. Which brings us to Jerome B. "Jerry" White. White was an early and long-term cryonics activist (now a cryonics patient) who attended a conference on the subject held at Ann Arbor, Michigan in April, 1969, about five years after the commercial publication of Ettinger's book.

There White gave a presentation entitled, "Viral Induced Repair of Damaged Neurons with Preservation of Long-Term Information Content."[11] The gist of it was that viruses, which really are little machines, could be modified and specially programmed to interact with cells in a beneficial way, resulting in cell repair. It appears to be the first serious attempt to formulate a repair scenario in cryonics. A fledgling beginning, yes, but you had to start somewhere if Ettinger's idea was ever to be made to work.

White's paper begins with what is, at least to this author, a lengthy and technically complicated excursion, not lacking relevance of course, into work of Alan M. Turing and John von Neumann, who are well-known luminaries in the fields of computer science and cellular automata. The upshot is that, indeed viruses can be seen as little machines that could be modified in various, information-intensive ways, that is to say, programmed, to realize a wide variety of behaviors. While we normally think of viruses as things to avoid, there is no reason in principle they couldn't behave well, and in fact quite beneficially, when introduced into our tissues, particularly if there is something wrong that needs fixing. So different fields can help each other. In this case the specialties of computation and cellular automata are shown, or at least strongly suggested, to be relevant in biology—not that the problems are solved. But in words sometimes attributed to Louis Agassiz, the famous 1800s science teacher, (paraphrasing) "Once you study one thing, you find it is ultimately connected with everything else."

White, in moving on to more concrete matters, points out that, in the repair of damaged cells, each damaged molecule that forms the cell can be dealt with in one or more of basically three ways:

1. Repair of the portion or "unit" of the molecule that is damaged and restoration of the unit *in situ* (in its original place) inside the cell itself, in effect making the damaged unit of the molecule "brand new" in terms of its molecular/cellular utility. This may happen either by the work of a biological enzyme or by modifying the damaged section to alleviate its detrimental effects.
2. Removal of the damaged unit from the molecule and replacement with an undamaged unit, which then allows the molecule to function in its intended way and location.
3. If the unit could not be repaired or removed the cell might "work around" the damage in some way.[12]

White then brings up a difficulty. The basic proposal of cryonics is to stop further deterioration by storing patients at cryogenic temperatures. Cryopreservation, however, with procedures available at the time of White's paper (and, hopefully, to a lesser degree for procedures used today), adds an amount of damage itself. This leads one to conclude the obvious need for, as White put it, "Concrete proposals for carrying out repair on the molecular level."[13]

White proposes that this be a two-pronged approach with both "a suitable enriched environment"[14] and an "augmented control program."[15] The augmented control program would make improvements in the body's genetic material through alterations in the DNA. (Thus it would have to be managed carefully!) One prospect for aiding the successful repair and revival of human tissue would be to try to use what DNA is left in the body's cells to help decipher what the original "blueprint" would have been for the whole organism. (Note: in terms of damage concern, liquid nitrogen is sometimes used as a cell lysing or perforating agent to extract DNA from the cell itself for later analysis and use.) L. K. Lozine-Lozinskii (*Studies in Cryobiology* [1974], p. 207) reports that DNA from the bacterium *Bacillus subtilis* was subjected to temperatures from -6 to -269 Celsius for 24 hours (liquid nitrogen is -196, absolute zero is -273) with no change "...in the biological activity of the DNA." According to the same source, taking DNA to ultralow temperatures (i.e., presumably below -269) "...provoked a disruption of the secondary structure of the molecules" but "[g]ross changes in the structure of DNA occur only as a result of repeated cycles of freezing and thawing."

While the subject is complex, in a nutshell, the primary structure of DNA is the nucleotide sequence. The secondary structure is the "double helix" shape and the particular configuration it takes. The ability to look at these structures gives one a great deal of information about things. (One side of the double helix alone determines the other side by the matching base elements: adenine pairs only with thymine, guanine only with cytosine.)

Very likely not exactly the same section of DNA will be damaged in each cell, so by analyzing many millions of possibly damaged DNA fragments found in a body, the original, complete sequence or genome might be reconstructed with confidence. This should hold if even one tenth of one percent of the DNA survives its journey to liquid nitrogen temperature relatively intact (and the cited reference seems to indicate a far higher percentage).

However derived, with the knowledge of an individual's particular genome, and with enough computational power, it should be a relatively simple matter to figure out "what goes where" and whether a particular part is damaged and how. (That's the theory, anyway. Practice, of course, may well be another thing. More about that and the promise of nanotechnological repair later).

This doesn't mean that the DNA will repair itself or anything else unaided. Body mechanisms do exist to help maintain DNA and repair it, but the DNA doesn't have "built in" cell-repair capabilities, all on its own. What it does have is the ability to read the "blueprint" of what the organism "should" be like, in the organism's basic and youthful form, and how such "repair capabilities" as exist should be formed and how they should function.

Imagine, if you will, a group of highly trained mechanics coming upon a vast wrecking yard of various devices of transport: cars, buses, planes, whatever. The mechanics are instructed to "fix it"—get the "fleet" of all these vehicles (or what once were vehicles) operational again. So what do they do? First, inspect the scene. The existence of thousands and thousands of parts, in various states of disassembly and/or disrepair, would certainly start giving useful clues. Our mechanics could then begin piecing out "what goes with what," how certain components fit together, what gear turns what gear, etc. Further imagine that during their attempts to utilize this treasure trove of parts, they also accidentally stumble upon a further treasure trove in the form of a complete set of factory blueprints, shop manuals, diagrams and videos that show exactly what component in each type of vehicle went with what. Such a find might, of course, greatly simplify and accelerate the repair process.

In the case of individual parts, our mechanics should also be able to recognize what parts are defective and take steps to fix each defect. While it might be possible for them to even make improvements upon the "natural order" of the things they found, it should, in any event, be relatively simple and feasible to use the existing parts and the blueprints of them to make the older technology work as well as it once did.

An example of improvement (hopefully) would be to take cars from, say, the 1960s, when carburetors were mainly in vogue, and modify them (objections of diehard classic car buffs notwithstanding) to be fuel-injection. One might also upgrade aircraft of earlier eras from prop-driven to jet powered, and the like. That said, however, the alternative of just restoring every conveyance to its original, assembly-line condition would be open too.

To return to the biological problem, the existence of relatively intact DNA, or the ability to figure out that state from numerous partial samples, allows the same sort of option. It would give future "body mechanics" the ability to determine, from the myriads (or they may possibly need much less) of slightly different blueprints of the cell, as well as their own knowledge of normal human physiology, how things should fit together and work in a normal, healthy state.

In Jerry White's proposal, this genome can further be augmented by appropriate "control instructions" written directly into the DNA by viral insertion. In this manner, otherwise irreversible injury might be

repaired. White proposes, with considerable insight for a paper written in 1969:

> Since a cell is formed and maintained under genetic control, it is reasonable to suggest that genetic control also be used to carry out degrees of repair greater than those the cell in its damaged condition could by itself provide. For each degree of damage greater than the normal regenerative abilities of a cell, a suitable enriched environment and augmented control program should be provided. The control program should be augmented as such, in the form of additional genetic information which will enable the cell to carry out emergency repairs, such as of a damaged membrane, gather nutrients from the environment, and restore normal functioning according to the standard control program.[16]

Where Ettinger in *Prospect* envisioned "giant surgeon machines" doing the work, White imagined "natural processes," albeit greatly augmented, using the built-in control mechanisms as modified by intelligent guidance. The use of a virus to "inject" the needed DNA strand into the affected cell(s) is outlined in his proposal.

Modern, advanced medical procedures are similar, yet the reality of modern medicine is still that, in most cases, it is the "wisdom of the human body" with its built-in repair and recovery mechanism that makes the difference. Modern medicine mainly provides the conditions for that "body wisdom" to exert itself and give time for the patient to heal on his own. White's proposal is an ingenious variation of this that would add more capability than Nature originally provided.

White then goes to a lengthy, in-depth explanation of how his viruses would work to add extraneous DNA to the natural strand inside human cells and otherwise enhance the DNA's ability to direct the repair of cellular damage. Such repair would be particularly critical in neurons which are, of course, the most important cells in the human body.

White begins the last section of his paper:

> The general method outlined here has its obvious use in the repair of nervous tissues especially human. Repair of all types of damage—caused by factors mechanical, chemical, pathological, aging, freezing, thawing, and so on—is intended.[17]

and concludes with:

> I hope that the method cursorily outlined here is still concrete enough to encourage those who are concerned with problems of repair of brain damage, whatever its origin.[18]

For its time it was an outstanding effort, a real attempt to put some solid underpinnings to Robert Ettinger's assumption. It was a major step toward showing that cryonics was a reasonable thing for individuals to do, and it offered a well-thought out proposal as to how Ettinger's assumption might one day be realized.

Mike Darwin and the Anabolocyte

Eight years went by. Then, in the July/August 1977 *Life Extension Magazine*, Michael G. Darwin outlined a proposal for an artificially engineered white blood cell that he called the "anabolocyte." By then a well-known cryonics activist himself, Darwin had actually thought up the concept several years before, after participating in an early cryopreservation that didn't go as well as planned (to say the least). It led Darwin to consider the formidable problem of how the enormous number of cells in the human body might be repaired after undergoing the procedures associated with cryonics. As Darwin put it: "After a restless night worrying over this problem I came up with the idea of genetically engineered leukocytes that would be able to either repair or replace damaged cells and tissue."[19] Thus the idea of the anabolocyte was born.

"Leukocyte" is a slightly technical name for what lay people call a "white blood cell." Since most of the time one is dealing with more than one of them, a brief abbreviation of the plural, as used in medical circles, is "WBCs." These blood cells are an integral part of the human body, acting as the body's defense against infection and against foreign substances of various kinds (the "wood splinter" being a pretty common example) in which thousands and thousands of them rush to an affected area and try to maintain body integrity by eliminating the intruding object or substance. The resulting area will occasionally build up to the "abcess" stage that can result in its need to be lanced and drained (and the offending object removed, if possible) as hordes of the WBCs sacrifice themselves to the "greater good" of the body as a whole.

WBCs also have particular properties of movement referred to as "amoeboid." Rather than being passively carried along the route of the bloodstream like their cousin the red blood cell, they can wriggle or crawl along on their own. Squeezing through much, most, or all of the available volume, depending on where they are, they are constantly on the lookout for "bad guys" in a "cops and robbers" coexistence with things that shouldn't be there.

Mike Darwin was concerned that Jerry White's proposal would be problematic. It needed a living, functioning cell to allow the injection of DNA-modifying substances; only then could enhanced repair procedures begin. In a four-page article that included several drawings by the author, Darwin elucidated an interesting scenario about how injured and even non-functioning human cells might be repaired and restored to their original condition using a humanly engineered, advanced type of WBC. As he put it: "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."[20] Combining some Greek words he arrived at the name "anabolocyte" for this type cell which would engage in constructive metabolic activities. With other adaptation of terminology the modified nucleus became the "Program Module." Darwin goes on to give an interesting account of how damaged cells could be repaired in a several-step process, commenting that:

> 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.[21]

Darwin further breaks the problem down by subdividing the proposed anabolocyte into components such as the "Synthesis Unit" where organelles (the subcellular structures that carry out cell functions) are manufactured for transfer into the damaged cell. The "Storage Module" in turn is a "depot" for molecules that provide energy and also for "raw materials" for the construction of needed structures. Other proposed components are mentioned. However,

> 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.[22]

Impressive as it is, the account understandably omits many details that would be needed for any actual implementation. But it helps make a plausible case that cryonics is not just "wishful thinking." It was another milestone attempt to seriously ponder how Ettinger's assumption might be realized.

Darwin's effort also reminds us that we don't always have to "reinvent the wheel." Ettinger's "huge surgeon machine" was a postulated, super-sophisticated device that would work on the body. In the replacement and repair of subcellular structures, where one needs a general solution, i.e., needing *a* mitochondrion instead of "that particular mitochondrion," Nature has already provided a mechanism for their construction along with that of other cellular and subcellular organelles. Darwin's proposal is to make use of that already existing natural capability to the advantage of cryonics.

In a slight extension of Darwin's thinking, one can envision, perhaps, a group of cells cloned for no other purpose than to act as a "warehouse" of needed subcellular components for use by the anabolocyte in its repair efforts. Whatever the particulars one thinks up, the general concept of the anabolocyte was, like Jerry White's exposition, an attempt to further add concrete underpinnings to Ettinger's crucial assumption.

Thomas Donaldson's Article: "How Will They Bring Us Back, 200 Years From Now?"

Thomas Donaldson was a Ph.D. mathematician and additionally a cryonics activist who wrote extensively about the subject. Some of his writings appeared in *The Immortalist*, mouthpiece of The Immortalist Society, an organization that got its start in the 1960s as the Cryonics Society of Michigan (and still exists today). In the March 1981 issue Donaldson tackles, in some detail, a biological approach to dealing with repair issues for individuals who have been cryopreserved. Believing that finding the answer to how to revive patients from their storage at cryogenic temperatures would probably take several centuries, Donaldson offers a number of intriguing ways to begin dealing with this problem.

In 1981 cryobiologists might note that cells stored at ultra-low temperature were damaged, and ponder some general mechanisms for causing this damage. Yet, as Donaldson put it in his article, "... even in micrographs of the most severely disrupted cells, we can see without difficulty what the cell was once and what it *ought to be*," adding: "The case is very strong that all the information required to rebuild it is STILL PRESENT."[23] (emphasis original).

Both these points, of course, tie in powerfully with Robert Ettinger's assumption that future science would be able to repair virtually any damage a cryopreserved patient might have incurred. It didn't matter whether this damage was from illness and/or injury prior to arrest, or from the ravages of aging coupled with and in addition to whatever damage the cryonics procedure itself had caused. So long as the "time stopping" effect of ultra-low temperatures was employed, *eventually* science should be able to deal with it.

At bottom, if the information about how the cell "should be" is still present, and the structures of the cell, albeit injured and/or damaged, are still present, it then simply remains to figure out what tools and mechanisms of repair are needed to restore the cell to a healthy and youthful state. Not necessarily an easy task, of course, but the existence of the cells in a state of damage, coupled with the information needed for their repair and the lengthy time which cryogenic temperatures allow individuals to be stored, provides a reasonable possibility that cryonics will ultimately succeed.

Thomas Donaldson approached this problem beginning with the fact that there already exist "machines" that do, at least in general, the types of work that are required. They are biological in nature and are called *enzymes*. Enzymes are protein molecules that are involved in thousands of reactions in a cell. As Donaldson explains in the article:

> They operate because they have a particular structure, which will actually grasp a molecule of one reactant and when after thermal motion brings them into contact with the other reactant, will release it. Their analogy to machines goes even further: some enzymes actually are designed so that they will be turned off and not act if too much of the chemical product exists; others will have many complex responses to many different chemicals in their environment. In short, they are machines the sizes of molecules.[24]

Donaldson then goes on to explain that he expects several centuries will be needed for the chemical research necessary to develop, as he puts it, "...our own enzymes bearing little if any relation to those made by living cells."[25] Upon that development, Donaldson predicts that machines of many sizes, from the smallness of bacteria and human cells to much larger constructions, would ultimately be possible. It was, so to speak, a hybrid of biological and man-made capabilities somewhat like Michael Darwin had written of a few years earlier. Donaldson adds, referring to repair machines of the microscopic variety: "All of these could act, of course, at the

same time (in a microscope, a brain under repair would appear to swarm with repair bacteria!)."[26]

(**Author's note:** In March 2008, a team from the University of Washington, Seattle and the Weizmann Institute of Science, Israel developed a manmade enzyme that, though falling far short of Donaldson's prediction, had never before been seen in nature).[27]

K. Eric Drexler and *Engines of Creation*

One of the most exciting developments in cryonics occurred in 1986, when a scientist by the name of K. Eric Drexler published a book with the intriguing title *Engines of Creation*.[28] Drexler talked yet again in this engaging volume about the possibility of being able to control matter directly on the atomic scale, similar to Richard Feynman a quarter-century before. Long before that and since then science had, of course, produced a large number of useful and varied substances, ranging from medicines like penicillin, to alloys, plastics and other materials that pervade our modern life. Mostly, though, it was by a "mix and stir" method involving large masses of material, perhaps with heating, hammering or other macroscale intervention, but without any ultrafine control.

What Drexler proposed was something entirely different. His efforts, outlined both in *Engines of Creation* and in more depth in technical publications, dealt with a basically new concept, fleshing out the earlier ideas of Feynman with more specifics. It would, once again, be the ability to take individual atoms and molecules and combine them in any order and arrangement that the laws of science allowed, and do so with a precision that, to date, no feasible process could match.

Drexler proposed that this could be carried out through devices that were generally called "assemblers." Assemblers were going to be tiny, programmable devices that would enable one to take Atom A and place it with Atom B, add Atoms C, D, and E, etc. in whatever order, placement, and orientation one wished, all consistent with physical laws. The resulting molecule would be "assembled" in a similar sense to the way we think of manufactured goods that we make on a macroscale.

The result, from a molecular standpoint, would be a structure that, in a way, would mimic how living organisms are constructed. It would be built "from the ground up," atom-by-atom and molecule-by-molecule, as opposed to the "mix and stir" method. If (and it was, and is, a big *if* but one with numerous and world-changing consequences) it could be done, the resulting structures could be quite complex and precise, consistent, again, with physical laws.

Although some have called Drexler "the founding father of nanotechnology," it is obvious that Feynman deserves part of the credit. Drexler did, however begin to lay more specific foundations under the generalities Feynman had talked about. In doing so, Drexler also helped put more specific foundations under the postulate on which Ettinger had rested his case for cryonics.

Cryonics offered hope for the dying that, by their being stored at extreme low temperature with its "suspension" of time, future science and technology could furnish them revival, repair, and rejuvenation. Ettinger's book was a selection of the Book of the Month Club, a then-popular way for books of importance to make their way to the general public. Isaac Asimov, a well-known science and science-fiction writer, had reviewed Ettinger's work before its publication and pronounced it reasonable. Numerous media appearances followed the commercial publication of the book in June 1964, and it seemed at first that cryonics would "take off" on its own and soon become part of normal societal activity. Not so, unfortunately. Only a relative handful, about 2,000 people today worldwide (most in the United States), are signed up for the practice, with about 300 people cryopreserved. Cryonics organizations, though continuing to gain members and place people in cryostasis or "cryonic suspension," still struggle for mainstream acceptance.

Even Drexler struggled with cryonics when he first heard about it. In the January 1986 issue of Alcor's publication *Cryonics*, Drexler notes that he had previously been acquainted with cryonics and didn't get very interested in it. In fact, he thought: "It's a nice idea, but it probably won't work. They're probably a bunch of crazies."[29] Years later, after his thinking in nanotechnology had matured, he began to see the logic of Ettinger's approach. In the same article Drexler continues:

> So then I went and dug out a copy of Ettinger's *The Prospect of Immortality* from the MIT library, and there, lo and behold, I found out that these crazy cryonics people not only were right, but they even knew why they were right, that in the future we're going to have molecular repair technology. Ettinger wrote of repairing cells molecule-by-molecule if need be. Of course, he didn't have the numbers to demonstrate this, and there was still the question of how we would get there. But he had the basic physical perception that we'd develop molecular-level repair machines, and that doing this doesn't conflict with any physical law.[30]

Drexler, having the courage of his convictions, mentions cryonics in *Engines of Creation*, notably in Chapter 9, "A Door to the Future." He uses the more general term "biostasis" to refer to any reasonable attempt to preserve the structure of the human body after clinical death but allows, in one observation well-appreciated by cryonicists, that "Robert Ettinger has apparently identified a workable approach to biostasis."[31]

Drexler's writings, coupled with his known expertise in nanotechnology, gave cryonics supporters a useful tool in their discussions and added to the arguments that cryonics is a reasonable thing to do. Ettinger's insight that molecular repair would someday be feasible was augmented with powerful new thinking as to how it could happen. It became harder for skeptics to argue that cryonics was *not* something one ought to do. It showed that cryonics was not, as its critics were sometimes wont to say, "an act of faith," or "just wishful thinking." It made crystal clear that cryonics is based on reasonable premises that are, at bottom, grounded in scientific fact. As Dennis Kowalski, now president of the (Ettinger-founded) Cryonics Institute, once told me: "Nanotechnology changed cryonics from 'It may work' to 'It probably will work'." Such a small change is, of course, all the difference in the world.

Brian Wowk's 1988 Paper on Cell Repair Technology

A native of Winnipeg, Canada, Brian Wowk earned undergraduate, Masters and Ph.D. degrees in physics-related majors from the University of Manitoba, and now is a U.S. citizen and a well-known medical physicist and cryobiologist. Along with Greg Fahy he developed key technologies in cryopreservation, including taking part in the first successful vitrification and transplantation of a mammalian kidney.

For the July 1988 *Cryonics* Wowk contributed a very interesting article, "Cell Repair Technology," where he notes:

> In particular, it will be argued in broad technical terms why nanotechnology implies a medicine capable of reversing not only any organic disease (including aging), but also a host of supposedly irreversible injuries, including *severe freezing injury, ischemic injury*, and even *destruction of all non-brain tissues*. In short, a foreseeable future technology will be presented which would seem to give present cryonics practice a reasonable (perhaps even good) chance of success.[32]

With these intriguing and stirring words early on, a very readable paper begins on the enormous medical promise of the concept that Drexler had championed. It seemed quite applicable to keeping cells (and therefore tissues and whole organisms) in a healthy condition to begin with and/or returning them to a healthy condition when they become sick and/or damaged.

Wowk points out that normal biological processes have, in general, involved the very capabilities that will be needed to deal with any of the problems mentioned in the previous paragraph. No doubt novel approaches will be needed also, but this remains only a difference in kind not in principle. The goal is still, as in the natural efforts of cells themselves, to return cell structure, via the appropriate positioning of atoms and molecules, to what would be found in nature in existing healthy cells and to do this, if need be, atom-by-atom.

Present mechanisms that attempt to maintain homeostasis ("steady state") in human cells and tissues, as well as in the human body as a whole are quite impressive in their abilities, but it should be remembered that they developed through natural but "blind" processes that were millions of years in the making. The ability to direct and/or improve on those processes through intelligent intervention should lead to repair capabilities well beyond what would be necessary for solving the problems of cryonics. As Wowk puts it in his paper:

> Nanotechnology will mean no more guesswork, uncertain cures, or untreatable organic conditions; medicine will finally be equal to the task of understanding and controlling the body in terms of its most fundamental machine components—atoms and molecules.[33]

Wowk in his proposals uses terminology somewhat reminiscent of Thomas Donaldson, calling the repair mechanisms "medical microbes or *cell repair devices*."[34] Whichever terminology one prefers, Wowk's or Donaldson's "repair bacteria," the concept is still fundamentally the same: devices that are subcellular in size and intelligently designed to restore individual cells or groups of cells into a youthful and healthy condition.

Wowk, in his 1988 effort, goes into a great deal of detail about the baseline capabilities (access, disassembly, analysis, reassembly) that exist in cells and which, therefore, need to be present in cell repair devices. He further talks about control, communications, power needed, and operations at cryogenic temperatures. He also discusses practical consequences: the new capabilities would be applicable not just to cryonics patients but also the more conventionally ill. It was an outstanding effort.

In 2006 Wowk made an addendum to the paper stating he wished, in retrospect, that he had more adequately credited Eric Drexler for developing the basic thought of molecular manufacturing and its obvious implications in terms of biological repair. Nobody's perfect but we can credit Wowk's original paper (even) for the impressive tour de force it is, in approaching the important problems of cryonics.

Ralph Merkle Becomes Involved in Cryonics

Ralph Merkle was born in 1952 and is in some ways a "latecomer" to cryonics. Merkle studied computer science at the University of California, Berkeley and received a Ph.D. in electrical engineering at Stanford University in 1979. He is well known as a co-inventor of public key cryptography. Destined to eventually collaborate with Eric Drexler at Xerox Palo Alto Research Center, Merkle had not really given cryonics much thought until in his 30s, when he had completed his doctorate and "married, bought a house, and settled into a Silicon Valley start-up company."[35]

In spite of considerable personal success, Merkle began thinking about the future course of his life and the inescapable fact that, like everybody else, he would be dead within a few decades. He then began, as many scientifically minded people do, with an examination of the available literature on our mortality. At first, as he puts it (emphasis added):

> 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*."[36]

At this point Merkle's literature search and thinking somewhat paralleled the combination of earlier writing by Ettinger and that of Drexler. The basic possibility of putting people "on hold" through cryogenic storage was coupled with the promise of future resuscitation methods based around nanotechnology. The details of how it would all be done were, understandably vague—"advanced" nanotech was still in very a primitive state.

Merkle added much to the public discussion with his paper "Molecular Repair of the Brain" in the October 1989 *Cryonics*.[37] This was followed in 1992 by "The Technical Feasibility of Cryonics," which appeared in the peer-reviewed

journal, *Medical Hypotheses*.[38] Early in this second paper Merkle makes a telling point: "Perhaps the most important question in evaluating cryonics is its technical feasibility: will it work?"[39] A little further down he adds (combining two paragraphs and adding emphasis):

> Before we can decide whether future medical technology can repair freezing injury, we must consider what fundamental limits constrain such technologies. Human tissue and human beings are made of atoms. Whether a person is healthy or ill, alive or dead, depends entirely on the arrangement of those atoms. The fundamental purpose of medicine is to cure the ill and heal the sick. Put another way, *the purpose of medicine is to change arrangements of atoms that are "unhealthy: to arrangements of atoms that are "healthy."*[40]

Phrased this way, it is obvious that the limits of future medical technology depend on the limits of our ability to control the structure of matter. The better our tools for doing this, the better our medical technology can be. Echoing the clarity of Ettinger and Drexler in their thinking about cryonics, Merkle focuses on the central problem of the correct repositioning atoms as the pathway to resuscitation—then goes on to subdivide the problem into three basic issues:

1. Where are the atoms?
2. Where should they go?
3. How do we move them from where they are to where they should be?[41]

The attempt to provide some answers to these very basic questions results in some pretty in-depth thinking that is far beyond the scope of this article—but I summarize. Merkle delves, among other things, into (1) what computational power would be necessary to accurately identify and describe the position of every atom in a human brain, (2) a definition of death that Merkle refers to as "information theoretic death," and (3) a repair scenario he describes as "off-board repair." A brief synopsis of each point follows.

In dealing with (1), Merkle concludes that it is possible to use 1,000 atoms (at most) for digitally encoding the needed description and addressing information to locate a single atom in the brain. The total for all the brain would thus be about 1,000 times the volume of the brain itself. (This would hold assuming, for example, that the storage medium, like the brain, had about the density of water, a common value for many substances, and atoms roughly the size of the brain's, also reasonable.) This works out to be, according to Merkle's calculations, a needed storage device about a cubic meter in size.

"Information-theoretic death" (2) is a concept Merkle introduces whereby death is not considered to have occurred until "the structures in the brain that encode memory and personality have been so disrupted that it is no longer possible in principle to restore them to an appropriate functional state."[42] This definition means that if those structures can be realistically repaired, using either the existing atoms in the structure or, if necessary, atoms from outside the structure (as occurs in many, if not all, normal bodily repair mechanisms), then the person cannot be considered actually "dead."

Sometimes, of course, death would make an appearance. Suppose someone is at the center of a thermonuclear explosion and completely vaporized. That person is truly and fully "dead" since there is no longer a way to figure out what essential brain structure they had. The application of nanotechnology to cryonics, or anywhere else for that matter, can't be expected to solve every problem.

Someone whose structures are completely preserved can be thought of as "alive," however, even though they may have reached the point that conventional medicine would declare them "clinically dead" (i.e., heart, lung, and brain activity have ceased). The ability to repair any nonfunctioning structures and return them to normal activity would be equivalent to a situation in present day society where someone after cardiac arrest is "brought back to life" by resuscitative efforts.

"Off board repair" (3) can be thought of as disassembling the brain down to whatever level is needed (cellular, sub-cellular, molecular and/or atomic) to repair it, then reassembling the brain with all the structural elements in the proper place so as to reestablish normal functioning. This assumes, of course, that in Ralph Merkle's perspective, "information theoretic death" has not occurred. There is still enough information to infer the original brain structure with reasonable fidelity.

From the foregoing it is pretty evident that the technology for cryonics to work will probably be neither simple nor, at first glance, obvious. Based on the 1992 paper, and just some routine thinking, this sort of endeavor would have to involve a load of sophisticated computation, shading to advanced general intelligence. The three basic questions must, of course, be answered and answered well. Merkle acknowledges in his paper that his proposed "off board repair," despite his lavished attentions, is not necessarily the *only* workable approach for the problem it's intended for. As he writes near the end:

> A wide range of approaches other than the one considered here are feasible. The present method is not proposed as the "right" or "best" method, it is proposed as a conceptually simple and feasible method. A single feasible method of repairing freezing injury establishes the effectiveness of cryonics, regardless of the methods that are eventually implemented.[43]

In short, this paper shows that one doesn't have to conjure up *all* the revival, repair, and rejuvenation possibilities that might conceivably work, for cryonics to be considered a rational approach to the problem of human mortality. It only has to be shown that one such pathway or mechanism is feasible. If that one pathway can be developed, then cryonics must be taken seriously as a means of life extension.

As was stated more reservedly earlier in the paper:

> Examination of likely future technical capabilities supports the argument that unprecedented abilities are likely to be developed. Restoration of the brain down to the molecular level should eventually prove technically feasible.[44]

Merkle's 1994 "Upgrade"

Merkle reworked and expanded the 1989 and 1992 papers into "Molecular Repair

of the Brain" which appeared as a two-part serial in *Cryonics* (January, April 1994).[45] Details again will need to be highly abridged, but a few salient point are worth noting.

First is that the basic "fact" that underpins cryonics continues to hold true, as Merkle noted in all three of the writings we have considered:

> Tissue preserved in liquid nitrogen can survive centuries without deterioration. This simple fact provides an imperfect time machine that can transport us almost unchanged from the present to the future: we need merely freeze ourselves in liquid nitrogen.[46]

In the 1994 paper Merkle quotes cryobiologist (and cryonics critic) Dr. Peter Mazur in support:

> "Cryobiologists are often asked how long cells can remain viable at -196 degrees C, the temperature of boiling liquid nitrogen (which is the usual cryogenic fluid). The answer is clear—more than 1,000 years. The reason is that direct ionizations from background radiation are the only source of damage at such temperatures. Ordinary chemical reactions cannot occur." Mazur then goes on to state: "The pertinent question then is not storage stability, it is how can one get cells down to -196 degrees C and back without killing them."[47]

(The person interested in cryonics would change this query just slightly and say "… how can one get cells down to -196 degrees C and back and have them be in a living and healthy state"? A very small change in wording, perhaps. But it implies that the pertinent question may not be whether they are "killed" by exposure to ultra-low temperatures, i.e., totally and forever beyond help, but whether it is simply that our present methodology at revival may just be too crude to revive them. Future methods may not be so limited.)

As for some cryobiologists who are trying to find ways to store human organs in the belief, rather than certainty, that it can ultimately be accomplished, Merkle says it best, again, in all three papers: "Perhaps the most important question in evaluating this option is its technical feasibility: will it work?"

Here, again, Merkle hits the crux of the matter. It doesn't matter what one's philosophical leanings are, or political views, or what one may think of the wisdom of a particular action, the bottom line for pursuing the storage of human organs is the same as for human organisms (cryonics): a belief that the effort will, *ultimately*, be successful. If that belief is based on reasonable premises, that is to say, in Merkle's excellent words, if no "fundamental limits constrain such technologies," then the pursuit of any goal that will be beneficial to human life and health and improve human living conditions is a reasonable goal.

There may turn out to be practical limits that would preclude such a goal, such as an excessive energy requirement—as an absurd example, if the revival, repair, and rejuvenation of a human being took more than the expected energy output of the sun over its whole lifetime. (Maybe then you would just use other stars as well; there are lots of them!) No such limitations are known to exist, however. Cryonics, as far as we can see, is worth pursuing. ■

This article is an updated version of a chapter which appeared in the book *The Prospect of Immortality: Fifty Years Later* edited by Charles Tandy, Ph.D. Readers interested in a copy of the book may check on Amazon.com

About The Author

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

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3 Fe.
4 E, 38.
5 E, 38.
6 Fe.
7 Fe.
8 Fe.
9 Fe.
10 Fe.
11 Wh.
12 Wh, 11, author's paraphrase.
13 Wh, 11.
14 Wh, 11.
15 Wh, 11.
16 Wh, 11.
17 Wh, 16.
18 Wh, 16.
19 Fr.
20 Da, 15.
21 Da, 15.
22 Da, 16.
23 Do2, 5.
24 Do2, 6.
25 Do2, 6.
26 Do2, 8.
27 We.
28 Dr1.
29 Dr2, 22.
30 Dr2, 22.
31 Dr1, 136.
32 Wo, 22.
33 Wo, 27.
34 Wo, 24.
35 FM, 9.
36 FM, 9.
37 Me1.
38 Me2.
39 Me2, 6.
40 Me2, 6-7.
41 Me2, 8.
42 Me2, 9.
43 Me2, 15.
44 Me2, 14-15.
45 Me3.
46 Me2, 6.
47 Ma.

REDUCE YOUR ALCOR DUES WITH THE CMS WAIVER

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

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

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

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

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

Become An Alcor Associate Member!

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

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

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

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

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

Superior-Absorbing CURCUMIN

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Non-GMO

Item # 01808

Curcumin has turned into a nutrition **superstar** because of the enormous health-promoting effects it provides for almost every organ system.[1,2]

However, most curcumin extracts are neither well ***absorbed*** nor well retained in the body.

Life Extension®'s curcumin supplements utilize a patented preparation of curcumin that can reach up to **7 times higher** concentration in the blood than standard curcumin![3]

As the graphs on this page illustrate, the **400 mg** of curcumin in either of our formulas supply the body with the equivalent of **2,500 mg** of most commercial curcumin products.

In recent studies comparing the effects of standard curcumin against Life Extension's turmeric extracts, researchers observed:[4,5]

- Nearly twice the support for immune health and approximately **2 times** the support for healthy inflammatory response.
- Almost double the free radical-fighting support. A separate study indicated that curcumin extract provided powerful support for heart health.

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TWO CURCUMIN FORMULAS TO CHOOSE FROM

Those who want a curcumin standalone can order a bottle of 60 vegetarian capsules of **Super Bio-Curcumin**® (Item #00407) for $38. If a member buys four bottles, the price is reduced to **$26.25** per bottle. Each bottle lasts a typical user two months.

Those seeking additional support against cell changes that promote prolonged functional inflammatory response may choose **Advanced Bio-Curcumin® With Ginger & Turmerones**.

While both of these formulas provide the superior ***absorbing*** curcumin, **Advanced Bio-Curcumin® With Ginger & Turmerones** also contains:

- ***Turmerones*** to increase the amount of curcumin inside cells.[6]
- ***Ginger***, which provides complementary health benefits.
- ***Phospholipids*** that further enhance absorption.[7]

A bottle of 30 softgels of **Advanced Bio-Curcumin® With Ginger & Turmerones** (Item #01808) retails for $30. Your price is reduced to **$20.25** per bottle. The suggested dose for either of these highly ***absorbable*** curcumin supplements is one capsule daily.

CAUTION: Do not take if you have gallbladder problems or gallstones. If you are taking anticoagulant or antiplatelet medications, or have a bleeding disorder, consult your healthcare provider before taking this product.

Compared with Plant-Bound Curcumin with Piperine[3]

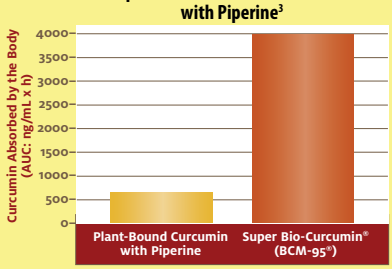

Chart 1. Super Bio-Curcumin® showed 6.3 times greater bioavailability (absorption and sustainability over eight hours) in humans compared with plantbound curcumin with piperine (as measured by the area under the curve [AUC] in a plot of blood levels against time, that is, the total amount of curcumin absorbed by the body over eight hours).

Absorption of Super Bio-Curcumin® in Humans Compared with Conventional Curcumin[3]

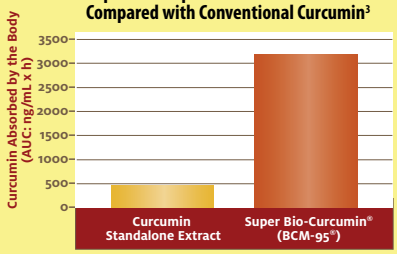

Chart 2. Super Bio-Curcumin® showed 6.9 times greater bioavailability (absorption and sustainability over eight hours) in humans compared with conventional curcumin (as measured by the area under the curve [AUC] in a plot of blood levels against time, that is, the total amount of curcumin absorbed by the body over eight hours).

Absorption of Super Bio-Curcumin® in Rats Compared with Conventional Curcumin[8]

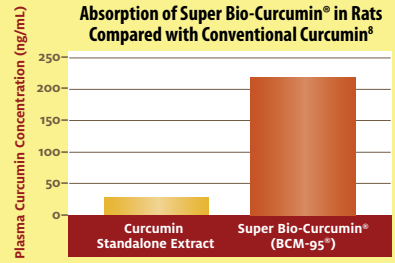

Chart 3. Bioavailability in rats fed with 7.8 times higher than conventional curcumin.

To order either of these products, call 1-800-544-4440 or visit www.LifeExtension.com

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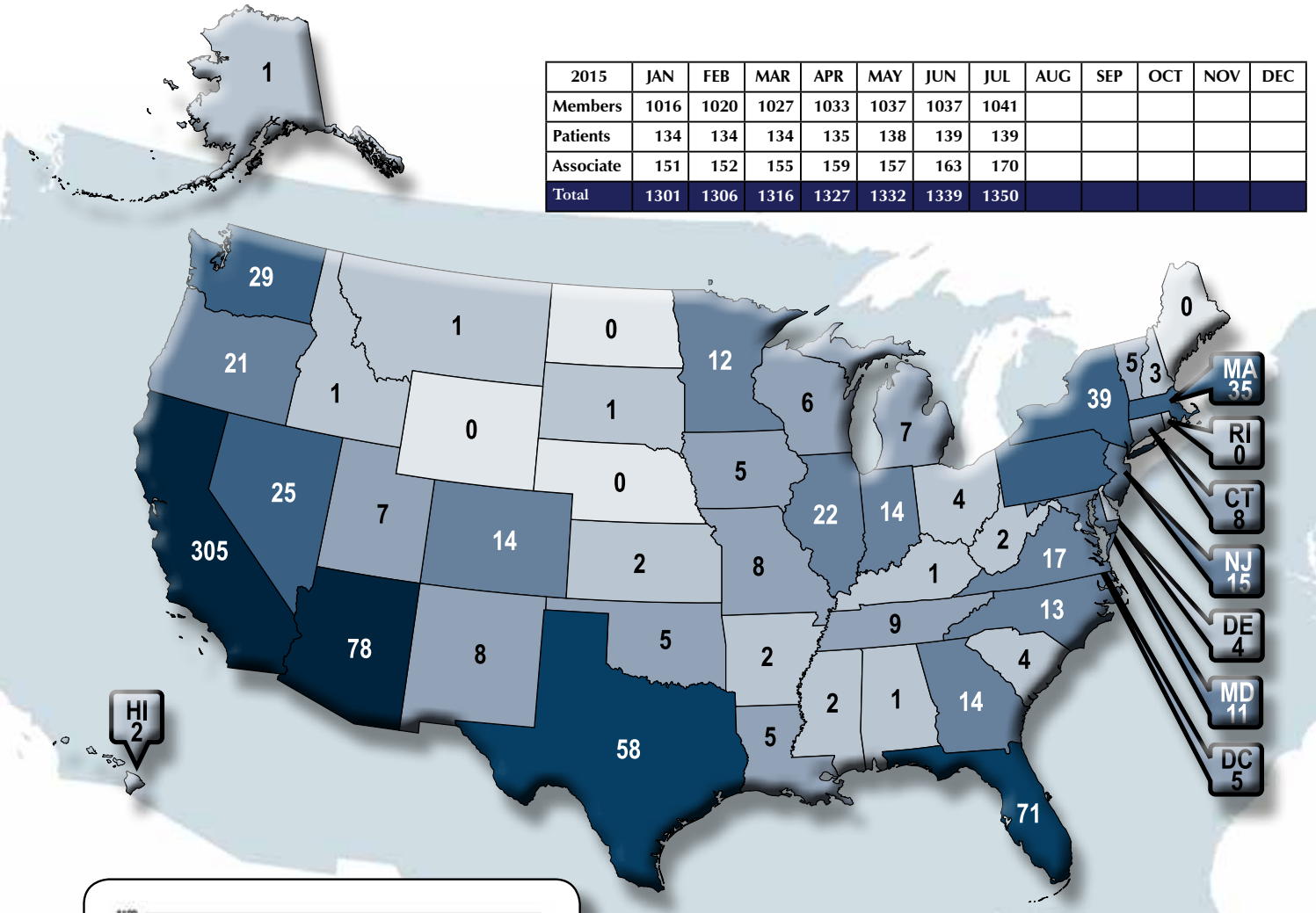
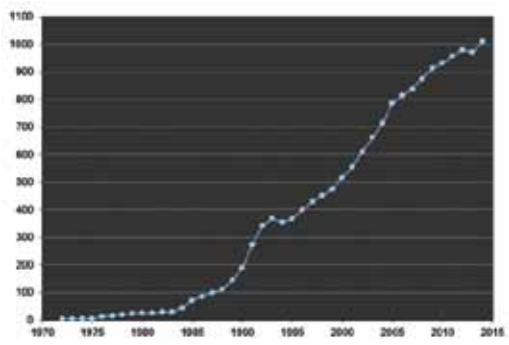
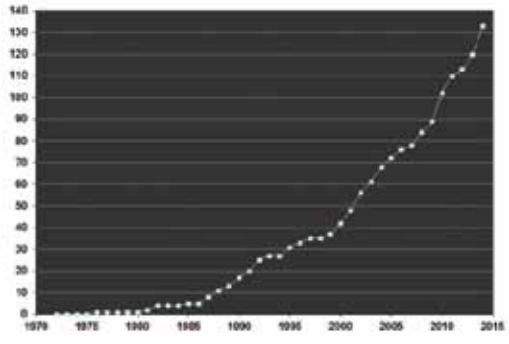
Membership Statistics

2015	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Members	1016	1020	1027	1033	1037	1037	1041					
Patients	134	134	134	135	138	139	139					
Associate	151	152	155	159	157	163	170					
Total	1301	1306	1316	1327	1332	1339	1350					





Number of Alcor members



Number of Alcor patients

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

International

Country	Members	Patients
Australia	11	3
Canada	42	2
China	0	1
Germany	7	0
Hong Kong	1	0
Israel	1	1
Italy	3	0
Japan	4	0
Mexico	4	0
Monaco	1	0
Netherlands	2	0
New Zealand	1	0
Norway	1	0
Portugal	4	0
Singapore	1	0
Spain	3	1
Thailand	3	1
United Arab Emirates	1	0
United Kingdom	25	2
TOTAL	115	11

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From supporting **heart health** and **brain function** to balancing the **inflammatory** response, there is no debating the broad-spectrum benefits of **omega-3** fatty acids.[1-3]

There are hundreds of fish oil supplements on the market, but only one incorporates lifesaving findings to provide optimal omega-3 and olive extracts, along with sesame lignans, in one formula—**Super Omega-3** from **Life Extension**®!

Fish Oil + Olive Extract

Research confirms that a combination of **fish oil** and **olive oil** may support a healthy inflammatory response better than fish oil alone.[4] And only one omega-3 product incorporates the benefits of both fish oil and olive extract into a single novel formula called **Super Omega-3**. Each four softgel serving supplies the equivalent amount of **4** to **6 ounces** of polyphenol content found in **extra virgin olive oil**.

+ Sesame Lignans

Studies show that when added to fish oil, **sesame lignans** safeguard against oxidation and direct fatty acids toward pathways that help with inflammatory reactions.[5]

= Health Benefits of a Mediterranean Diet

No other commercially available fish oil supplement contains this level of essential fatty acids, sesame lignans, and olive fruit polyphenols.

Super Omega-3 uses a proprietary process to produce a pure, stable, and easy-to-tolerate fish oil that exceeds the standards set by international rating agencies, ensuring any pollutants are reduced to a virtually undetectable level.

Super Omega-3

Item #01982 • 120 softgels • **Non-GMO**

	Retail Price	Your Price
1 bottle	$32	**$24**
4 bottles	—	**$21 each**
10 bottles	—	**$17.05 each**

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Note: While the health benefits of omega-3s from fish oil are universally recognized, the critical importance of olive oil in maintaining healthy vascular function remains largely overlooked.

To order **Super Omega-3**, call **1-800-544-4440** or visit **www.LifeExtension.com**

502.62H A1 0815

Breakthrough Bionic Leg Prosthesis Controlled By Subconscious Thoughts

Biomedical engineering company Ossur has announced the successful development of a thought controlled bionic prosthetic leg. The new technology uses implanted sensors sending wireless signals to the artificial limb's built-in computer, enabling subconscious, real-time control and faster, more natural responses and movements. The sensors are implanted in the limb stump's remnant muscles The sensor-with-computer allows the limb to act faster and smoother. The technology works with a variety of Ossur bionic limbs, using sensors wirelessly connected to the prosthesis. Prosthetics controlled by muscle impulses have been around since the late 1960s, but the technology has severe limitations. It works by laying sensors on the skin of the vestigial limb, which pick up electrical impulses that control, for example, an artificial arm. The trouble is, these sensors pick up impulses from more than one muscle. This degrades performance, requires a lot of practice to operate properly, and makes the prosthesis slow, imprecise, and frustrating to use.

David Szondy, Gizmag
24 May 2015
http://www.gizmag.com/ossur-first-mind-controlled-bionic-leg-prosthesis/37614/

Planarian Regeneration Model Discovered by Artificial Intelligence

An artificial intelligence system has for the first time reverse-engineered the regeneration mechanism of planaria—the small worms whose extraordinary power to regrow body parts has made them a research model in human regenerative medicine. The discovery by Tufts University biologists presents the first model of regeneration discovered by a non-human intelligence and the first comprehensive model of planarian regeneration, which had eluded human scientists for over 100 years. The work, published in the June 4, 2015, issue of *PLOS Computational Biology*, demonstrates how "robot science" can help human scientists in the future. "Our goal was to identify a regulatory network that could be executed in every cell in a virtual worm so that the head-tail patterning outcomes of simulated experiments would match the published data," said the paper's first author, Daniel Lobo. Lobo and senior author Michael Levin developed an algorithm using evolutionary computation to accurately predict the results of published laboratory experiments.

TuftsNow
4 Jun. 2015
http://now.tufts.edu/news-releases/planarian-regeneration-model-discovered-artificial-intelligence

Injectable Device Delivers Nano-View of the Brain

It's a notion that might have come from the pages of a science-fiction novel—an electronic device that can be injected directly into the brain, or other body parts, and treat everything from neurodegenerative disorders to paralysis. Sounds unlikely, until you visit Charles Lieber's Harvard University lab. Led by Lieber, an international team of researchers has developed a method of fabricating nanoscale electronic scaffolds that can be injected via syringe. The scaffolds can then be connected to devices and used to monitor neural activity, stimulate tissues, or even promote regeneration of neurons. The research is described in a June 8 paper in *Nature Nanotechnology*. Said Lieber, "This opens up a completely new frontier where we can explore the interface between electronic structures and biology. For the past 30 years, people have made incremental improvements in micro-fabrication techniques that have allowed us to make rigid probes smaller and smaller, but no one has addressed this issue—the electronics/cellular interface—at the level at which biology works."

Peter Reuell, Harvard Gazette
8 Jun. 2015
http://news.harvard.edu/gazette/story/2015/06/injectable-electronics-promise-sharper-view-of-brain/

Genome's 'Dimmer Switches' Should Shed Light on Hundreds of Diseases

Release Date: June 15, 2015
FAST FACTS:
Up to one-fifth of human DNA acts as dimmer switches for nearby genes, but scientists have long been unable to identify precisely which mutations in these genetic control regions really matter in causing common diseases. Now, a decade of work at Johns Hopkins has yielded a computer formula that predicts with far more accuracy than current methods which mutations are likely to have the largest effect on the activity of the dimmer switches, suggesting new targets for diagnosis and treatment of many diseases. A summary of the research will be published online June 15 in the journal *Nature Genetics*. "Our computer program can comb through the genetic information from a specific cell type and predict which 'dimmer switch' mutations are most likely to alter the cell's gene activity, and therefore its function," says Michael Beer, Ph.D., associate professor of biomedical engineering at the Johns Hopkins University School of Medicine.

Johns Hopkins Medicine
15 Jun. 2015
http://www.hopkinsmedicine.org/news/media/releases/vulnerabilities_in_genomes_dimmer_switches_should_shed_light_on_hundreds_of_complex_diseases

Futuristic Brain Probe Allows for Wireless Control of Neurons

A study showed that scientists can wirelessly determine the path a mouse walks with a press of a button. Researchers at the Washington University School of Medicine, St. Louis, and University of Illinois, Urbana-Champaign, created a remote controlled, next-generation tissue implant that allows neuroscientists to inject drugs and shine lights on neurons deep inside the brains of mice. The revolutionary device is described online in the journal *Cell*. Its development was partially funded by the National Institutes of Health. "It unplugs a world of possibilities for scientists to learn how brain circuits work in a more natural setting," said Michael R. Bruchas, Ph.D., associate professor of anesthesiology and neurobiology at Washington University School of Medicine and a senior author of the study. The Bruchas lab studies circuits that control a variety of disorders including stress, depression, addiction, and pain. Typically, scientists who study these circuits have to choose between injecting drugs through bulky metal tubes and delivering lights through fiber optic cables. Both options require surgery.

Eurekalert! / NIH / National Institute of Neurological Disorders and Stroke
16 Jul. 2015
http://www.eurekalert.org/pub_releases/2015-07/nion-fbp071615.php

New Material Forges the Way for "Stem Cell Factories"

If you experience a major heart attack the damage could cost you around five billion heart cells. Future stem cell treatments will require this number and more to ensure those cells are replaced and improve your chances of survival. Experts at The University of Nottingham have discovered the first fully synthetic substrate with potential to grow billions of stem cells. The research, published in the academic journal *Advanced Materials*, could forge the way for the creation of 'stem cell factories'—the mass production of human embryonic (pluripotent) stem cells. The £2.3m research project, "Discovery of a Novel Polymer for Human Pluripotent Stem Cell Expansion and Multilineage Differentiation," was led by Morgan Alexander, Professor of Biomedical Surfaces in the School of Pharmacy and Chris Denning, Professor of Stem Cell Biology in the School of Medicine and funded by the Engineering and Physical Sciences Research Council (EPSRC). The material could provide an off-the-shelf product for clinical use in the treatment of the heart, liver and brain.

ScienceDaily / University of Nottingham, UK
22 Jul. 2015
http://www.sciencedaily.com/releases/2015/07/150722101938.htm

A Roadmap to Resuscitation

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

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

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

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

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

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

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

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

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

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

MEETINGS

ABOUT THE ALCOR FOUNDATION

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

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

ARIZONA

FLAGSTAFF:

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

PHOENIX
VALLEY OF THE SUN:

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

AT ALCOR:

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

CALIFORNIA
LOS ANGELES:

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

SAN FRANCISCO BAY:

Alcor Northern California Meetings are held quarterly in January, April, July, and October. A CryoFeast is held once a year. For information on Northern California meetings, call Mark Galeck at (650) 969-1671, (650) 534-6409 or email Mark_galeck@pacbell.net.

FLORIDA

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

NEW ENGLAND
CAMBRIDGE:

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

PACIFIC NORTHWEST

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

BRITISH COLUMBIA (CANADA):

The contact person for meetings in the Vancouver area is Keegan Macintosh: keegan.macintosh@me.com.

OREGON:

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

ALCOR PORTUGAL

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

TEXAS
DALLAS:

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

AUSTIN/CENTRAL TEXAS:

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

JAPAN

Cryonics meetings are held monthly in Tokyo. Send queries to grand88(at)yahoo.com.

UNITED KINGDOM

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

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

What is Cryonics?

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

How do I find out more?

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

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

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

How do I enroll?

Signing up for a cryopreservation is easy!

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

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

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

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

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