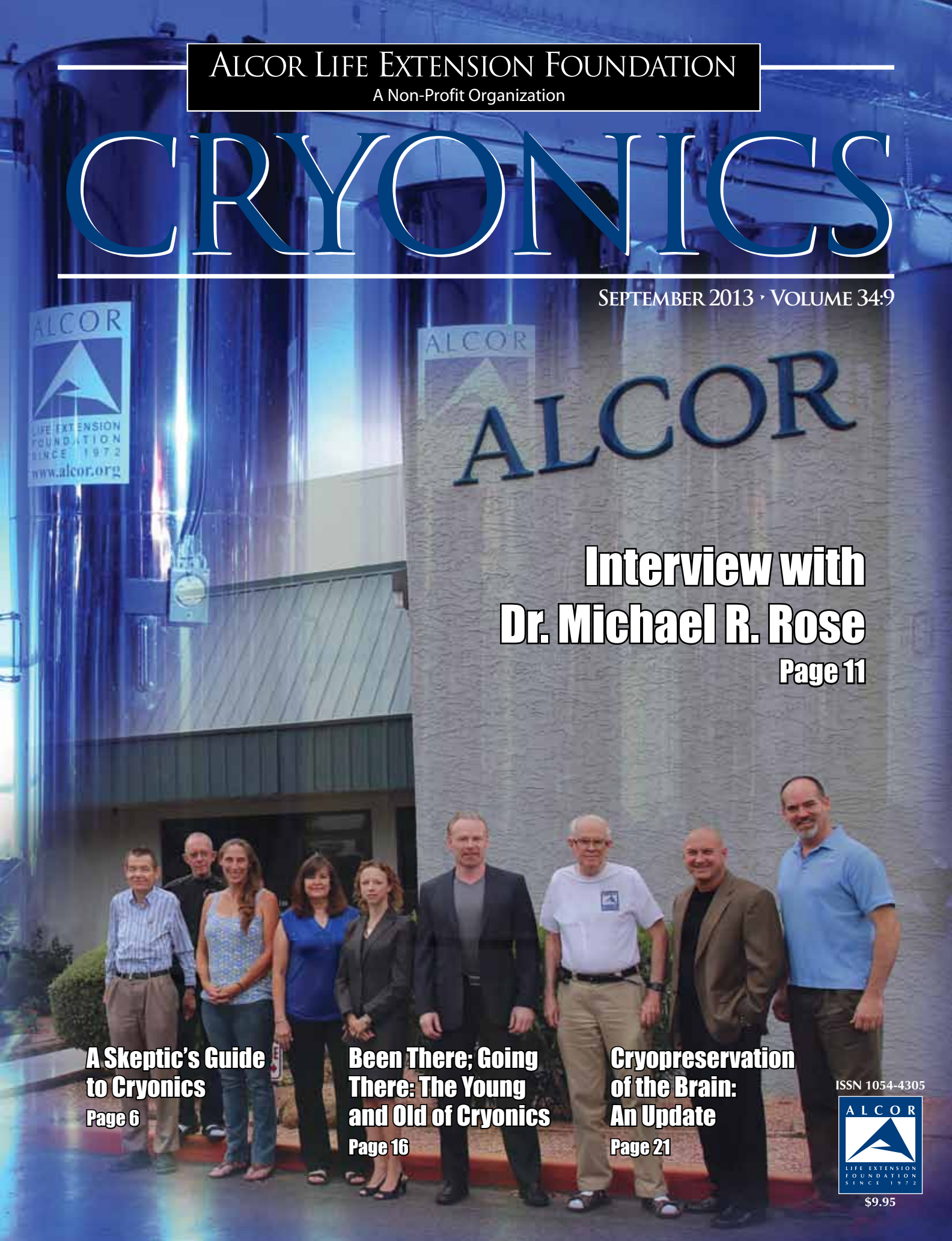
ALCOR LIFE EXTENSION FOUNDATION
A Non-Profit Organization

CRYONICS

SEPTEMBER 2013 · VOLUME 34:9



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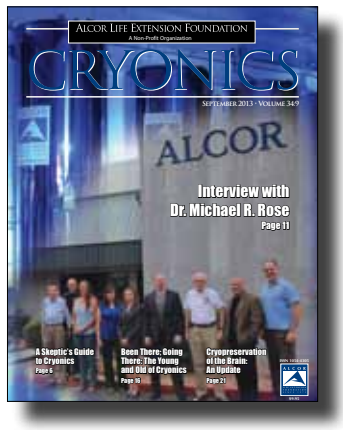

COLUMNS

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A Non-Profit Organization
CRYONICS

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Letters to the Editor

Dear Editor,

Re: Letter to the Editor from Dr. Robert Newport, *Cryonics* August 2013, Vol. 34:8
Re: The Valley of the Shadow of Death, Keegan Macintosh, *Cryonics*, June 2013, Vol. 34:6

I agree with both Keegan Macintosh and Robert Newport that use of the word "immortality" is problematic for a cryonics provider such as Alcor and should not be emphasized in promoting our services, which are intended as a stepping-stone to future medicine, not something of vaster scope. But I also disagree with certain enthusiasts who seem eager to dismiss the concept of immortality, and the related concept of infinity or the infinite, as completely irrational or meaningless. Mathematically the notion of an infinite set is well-established and unproblematic. (An infinite set is a set that can be put in one-to-one correspondence with a proper subset of itself. An example is suggested by the "Hilbert Hotel" with rooms numbered 1, 2, and so on, stretching endlessly. It can be completely full yet make a vacancy by sending the occupant of room 1 to room 2, the occupant of room 2 to room 3, and so on. That is to say, the set of all the rooms is put in one-to-one correspondence with the proper subset that leaves out room 1.) As a mathematician and aspiring mathematical immortalist philosopher I find the concept of immortality quite meaningful, rational, inspiring, and also indispensable. I hope to further elucidate ways it might be implemented and even be inevitable in the sort of reality in which we find ourselves, which might indeed be infinite by reasonable measures. I hope to do this in a way that still upholds cryonics as the desirable endeavor that I strongly feel it is. So I am one of those—and it's rather common—whose personal views are not fully endorsed or championed by the organization they are employed by. And this is appropriate, but also, I think that a lot of times media people like to ask questions where personal views do have value, apart from any "official" position the organization may take, as long these views are clearly understood for what they are.

Mike Perry, Ph.D.

Re: Letter to the Editor from Mark Plus, *Cryonics* August 2013, Vol. 34:8

In some respects I am in agreement with Mark yet not in all respects, and I think some additional points should be made. Basically I am concerned that we as an organization could go too far in our efforts to present cryonics as "not very different from conventional medicine so you don't need to get uneasy about it," and our efforts could backfire. In certain ways we *are* very different from conventional medicine and the public can easily see that so we put ourselves at a disadvantage if we try too hard to minimize it. The media will try to bring out this radicalness—they are looking for things that will arouse public interest—which especially puts us at risk if we try to sound too conservative. I think a happy medium should be sought between trying to sound almost-mainstream on one hand and, on the other, going to great lengths with speculative scenarios. Neither extreme is right. The happy medium however requires us to be open about the radical nature of what we are thinking that leads to what we are doing.

How are we irreducibly radical? In the serious hopes we have that motivate the difficult, expensive project we are involved in, to cryogenically preserve the newly deceased and store them indefinitely. These hopes are twofold. (1) We hope that cryogenic preservation or cryonics will ultimately prove reversible and thus serve as a bridge to future medicine. (2) We hope that future medicine will make it possible to restore the patient to a state of consciousness and good health, overcoming any diseases or disabilities they may have had beforehand. Implications of this are, for instance, that someone in their 90s who is cryopreserved will not simply be restored to the physiological state of the nonagenarian they were before, minus anything that today's mainstream judgment would consider "diseases." Instead, we also think, aging itself will be reversible or curable so our patient will enjoy a health status that is not possible today for their age group, thus a state of enhancement, not simply being cured of diseases. An aging cryonicist is not merely seeking to "finish their life" through cryonics but to enjoy this state of enhancement which will hopefully usher in a whole new life, something unprecedented in today's world. It's hard to imagine most of us *not* having this sort of ambition, whatever our present age may be.

To a reporter this may sound like we are aiming to become immortal supermen. As an organization we do not have to choose that terminology, but should also not flatly deny the possibility. We should be up front and not bashful about affirming at least enough of our radical position that the public can reasonably see it for what it is without having to "read between the lines" and then be resentful because we are not forthright. Some will no doubt be unhappy with us for this but I think we will do better overall. We are not going to convince everybody or most people to sign up for cryonics, barring substantial medical or scientific breakthroughs that do not seem imminent. We must not be too hasty and blame this failure, necessarily, on our coming across as more radical than we ought to be sounding. Trying to sugar-coat or "sanitize" our message excessively will, I think, actually cost us in terms of respect and credibility, both with the mainstream who do not find themselves personally interested, and even with others who do.

Another aspect of our radicalness is that we are not claiming that some magical "future science" of which we have no inkling will rescue us. Instead we are more specific, in particular thinking that nanotechnology has great potential for development and future benefit. Thus it might (and arguably should) enable or supply an essential ingredient to such future marvels as resuscitating cryonics patients (the kind we must deal with today and maybe for a while yet, with significant amounts of damage) and curing old age. I think it is better to affirm that we place some serious hopes in this prospect, and cite reputable references (such as Drexler's *Nanosystems* and the works of Robert Freitas on nanomedicine) than lapse into vague speculations in an effort to avoid sounding controversial.

Mike Perry, Ph.D.

QUOD INCEPIMUS CONFICIEMUS

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

A SKEPTIC'S GUIDE TO CRYONICS By Aschwin de Wolf

Can a case for cryonics be made on skeptical grounds? If we'd have to believe self-identified skeptics this is not only unlikely but cryonics, in fact, is a "logical" target for skeptical scrutiny. The most obvious approach for a skeptic is to demand "proof" for cryonics. Upon closer inspection, this apparently reasonable demand is rather odd. Let's start with a non-controversial definition of cryonics: cryonics is a form of critical care medicine that stabilizes critically ill patients at ultra-low temperatures to allow the patient to benefit from future advances in medicine. Now, what could this demand for "proof" consist of? Does the cryonics advocate need to provide proof that future developments in medicine *will* indeed be capable of treating the patient? How could such a proof be even remotely possible? The most scientifically responsible answer would be to say "I don't know." And this answer reveals something important about cryonics. The decision to make cryonics arrangements is a form of decision making under uncertainty. Asking for "proof" for such a decision makes little sense.

"Now wait a second," someone might add. "It is correct that we do not have absolute knowledge about the future but, surely, science must have *some* kind of bearing on the question of whether it is rational to make cryonics arrangements?" This much can be admitted. And if we actually look at the science (or the history of medicine) that is relevant to make informed decisions about cryonics we find a number of encouraging observations. Medicine is increasingly recognizing the rather arbitrary nature of death. From the first clumsy attempts to restore circulation and breathing in patients with sudden circulatory arrest to today's sophisticated protocols that employ aggressive CPR, hypothermia, and emergency cardiopulmonary bypass, our ability to resuscitate people from states in which they would have been previously been considered "dead" is moving towards ever-longer periods of circulatory arrest. In fact, in some advanced medical procedures, hypothermic circulatory arrest is *deliberately* induced. Such developments are backed up by histological research where it has been established that the neuroanatomical basis of identity does not just implode within 5 minutes of circulatory arrest. Observation of nature also supports the view that cessation of metabolism does not equal death.

"Well, I will admit that science and technology are constantly challenging our beliefs about death but the cryopreservation process itself causes irreparable injury to the patient," is a common rejoinder to this argument. But this puts our skeptical friend in a rather incoherent position. Having first recognized that we cannot have absolute knowledge about the future capabilities of science, (s)he does not feel the slightest contradiction in claiming that certain kinds of damage cannot be repaired by any future medical technology.

Contemporary cryobiology now informs us that if cooling rates are not too rapid, ice formation does not explode cells from the inside, that ice-free cryopreservation (vitrification) is possible, and that mammalian brain slices can be vitrified and rewarmed with good ultrastructural preservation and viability. The situation is even better than what we might hope for because even *if* the damage associated with cryopreservation was substantial, it might still be possible to *infer* the original state from the damaged state. As we are increasingly recognizing in such diverse fields such as forensic science and paleogenetics, it is actually *very*, *very* hard to destroy information to such a degree that nothing meaningful can be inferred from what is left.

Then why has cryonics traditionally gotten such a poor reception by people

who see themselves as "skeptics?" I suspect that some of it has to do with the fact that cryonics is traditionally associated with (religious) concepts such as immortality, very optimistic projections about the accelerating growth of science and technology, the technical feasibility of specific repair technologies (such as molecular nanotechnology), or mind uploading. But none of these ideas is an intrinsic part of the idea of cryonics. In its most basic form cryonics is just the recognition that what might be beyond the scope of contemporary medicine may be treatable in the future. No *specific* timeframe or technology is implied, or necessary. There are a lot of things that people in liquid nitrogen don't have, but one thing they do have is *time*.

Contemporary science can weaken or strengthen the case for cryonics but it cannot tell with absolute certainty what our medical capabilities in the remote future will be. Saying that some kind of damage cannot be repaired by *any* future science is not an exercise of critical thinking but ultimately an appeal to authority. How many times do we have to revise our views about death and forecasting before we recognize that we are playing a fool's game and that the proper, skeptical, approach is to refrain from dogmatic statements and naïve inductivism about such matters? The idea that, right here, right now, in 2013, we are at a time where we can make absolute certain claims about the future capabilities of science and technologies is preposterous. In absence of such knowledge we'd better refrain from doing harm and allow for the possibility that time will be on the side of cryonics patients. ■

A "Skeptic" on Cryonics: A Brief Case Study

Self-identified "skeptic" Dr. Michael Shermer wrote a column called "Nano Nonsense and Cryonics" (Scientific American, Sept. 2001) that includes a sensationalist description of cryonics with a number of factual errors:

"Cryonicists believe that people can be frozen immediately after death and reanimated later when the cure for what ailed them is found. To see the flaw in this system, thaw out a can of frozen strawberries. During freezing, the water within each cell expands, crystallizes, and ruptures the cell membranes. When defrosted, all the intracellular goo oozes out, turning your strawberries into runny mush. This is your brain on cryonics."

Since the early days of cryonics, standard procedure has been to circulate a cryoprotectant through the circulatory system of the patient to reduce ice formation. In fact, when Shermer wrote his column the Alcor Life Extension Foundation had not only published a study that showed good histological preservation of the brain with a high concentration glycerol solution but had also introduced the newer technology of vitrification to eliminate ice formation completely. Shermer's description of the effects of ice formation on cells is factually incorrect too, as anyone who would just casually study modern cryobiology could have discovered. Finally, one does not need to have a detailed understanding of cryonics protocols to realize that the fate of a thawed frozen brain has little to do with the resuscitation scenarios envisioned for molecular repair of the cryopreserved brain.

One can only speculate why Shermer did not inform himself about some basic facts about cryonics and cryobiology. One explanation is that there is no "cost" to being wrong about cryonics. If Shermer would make such careless statements about physics or chemistry his reputation would be much more likely to take a blow because there are numerous people who would identify these errors. Shermer also ridicules the immortalist and transhumanist activists associated with cryonics:

"I want to believe the cryonicists. Really I do. I gave up on religion in college, but I often slip back into my former evangelical fervor, now directed toward the wonders of science and nature. But this is precisely why I'm skeptical. It is too much like religion: it promises everything, delivers nothing (but hope) and is based almost entirely on faith in the future."

Such a perspective confuses the subculture of cryonics with the idea of cryonics itself. You can read religious aspirations into cryonics but you can also ignore them to look at the idea in its most charitable form.

Cryonics is an experimental medical procedure that allows people that cannot be sustained by contemporary medical technologies to reach a time when a treatment for their condition may be available. Such decision making under uncertainty has nothing to do with "faith" and "hope" but requires that we update our probabilities based on the available evidence from fields such as neuroscience, cryobiology, and molecular nanotechnology. While Shermer has later (rather unsuccessfully) attempted to qualify the statements made in his original article, his column is rather representative of how many critics of cryonics operate; mischaracterize its premises and procedures, avoid a discussion of the technical feasibility of molecular repair, and change the subject to psychological and philosophical issues. ■

CRYOCRASTINATION

By Max More and Chana de Wolf

Far too many people are risking permanent death because they perpetually procrastinate when it comes to making arrangements for cryopreservation. These are individuals who know that cryonics is a worthwhile bet, who can manage the cost, but who just don't get around to it. Maybe you—or someone you know—are one of these individuals?

One person I knew—someone who had long expressed his desire for a long and adventurous life—never got around to making cryonics arrangements, despite periodic urging on my part. He eventually developed a neurological disorder and became uninsurable. He died without being cryopreserved.

Another individual contacted Alcor several years ago and was sent an application form. After filling it out only partially, he pursued it no further. This was despite being in his late 80s and having plenty of resources to afford it. We heard from his relatives later when he was critically ill in hospital. In most such cases, we are unable to satisfy the criteria for last-minute cases. In this case, thanks to previous evidence of intent, funding being clearly available, and the support of the family, we were able to get him cryopreserved. However, leaving it until the last moment created a delay while we verified funding. This delay compromised the quality of his cryopreservation.

Procrastination is always a bad thing. If you put off doing something until later because you have a sound reason to do so, by definition it is not procrastination. Some psychologists have specified that for a behavior to be classified as procrastination, it must be counterproductive, needless, and delaying. Procrastination can mean putting off flossing, delaying getting your car serviced, or telling yourself you can begin to build your savings sometime in the future.

CAUSE OF CRYOCRASTINATION

Why do people put off making arrangements for their own cryopreservation? What can they—and we, as individuals and as an organization—do to spur them to cryo-completion?

Many of the standard explanations of procrastination apply just as well to cryocrastination. We tend to put off taking desirable action because we discount future benefits while focusing on the effort required in the present. As the poster from the folks at Demotivator say, "Hard work often pays off after time, but laziness always pays off now." We put off doing the work, telling ourselves that we'll do it tomorrow, not taking into account that tomorrow we will be just as tempted to put of doing the work. We're not very good at predicting how we'll feel in the future—what psychologists call affective forecasting. We may predict that we'll feel more like tackling the sign-up process, and even feel good about putting off the task with the good intention of doing it later. We may imagine the process of completing the paperwork and making financial arrangements to be more tedious and time-consuming than it really is. And we may focus on the whole process, rather than breaking it down into relatively easy steps.

Other reasons for cryocrastination can be more justifiable and reasonable: The cryocrastinator may be concerned about the reaction of family and friends to the person committing to this unusual practice. The real financial costs will also deter some people. For anyone who is not particularly old and in good health, it's easy for them to believe that they can simply save money by signing up some time in the future, but before major health problems and threats manifest. But if you don't make arrangements *now*, then *when*? You may say you'll do it five years from now. But when that time comes, it will be easy to tell yourself that you're okay for another few years. And so on. Until it's too late. You've become uninsurable, or caught a deadly infection, or been in a fatal accident.

Cryonics tends to attract unusually intelligent people. A downside of this is that some smart people are very clever at inventing reasons not to make cryonics arrangements. Some of these people focus excessively on highly implausible dystopian scenarios, such as being revived only to be used for spare parts or as a slave. Not all dystopian scenarios are unrealistic, however. For example, many people are hesitant to make cryonics arrangements because they fear being resuscitated all by themselves in an unfamiliar world without friends or family. Clearly, cryonics organizations can do a better job here to communicate cryonics as a means for friends and family to stay together instead of facing the inevitable separation that comes with death. It is also important for a cryonics organization to offer vehicles

to take as much of what we own and care about with us.

Others who accept the workability of cryonics feel no urgency to make arrangements because of overconfidence in the rate of advance of anti-aging or uploading research. Even if such research yields dramatically life-extending results in the most optimistic time-frame, cryonics still makes sense in case you die early of accident or disease.

There are some people who claim to have conducted a utilitarian analysis and decided that the money could have a greater impact spent elsewhere. Those of us who are not utilitarians will find this logic uncompelling. We may believe we have a right and a responsibility to try to save our own lives and those of our loved ones, even if the same money spent elsewhere might produce greater net utility. (And consider that it might not in practice; cryonics organizations will use your money to cryopreserve you; most organizations will use your money for a variety of purposes, the results of which may not be effective.) Even utilitarians should honestly consider whether they would actually spend their money on those things. More likely, they will spend it on expensive coffee, books, or gadgets.

The "negative" utilitarian calculation also breaks down if cryonics is not just considered as an "egoistic" means for personal survival but also as an emerging experimental medical technology aimed at saving lives and reducing suffering of all people. Cryonics is still at a stage where making individual arrangements or becoming an Associate Member (see below) can lead to greater acceptance of the procedure, in particular if those who make arrangements are famous, and/or highly intelligent, creative, or productive individuals.

OVERCOMING CRYOCRASTINATION

If you or someone you know intends to become a member but finds the process daunting, an excellent way to start is to become an Associate Member. This is as easy and inexpensive as telling us that this is what you want to do, and authorizing a charge of $10 per month or $30 per quarter.

CRYOSHAME

By Aschwin de Wolf

Closely related (or a contributing factor) to cryocrastination is a phenomenon which I call "cryoshame." Cryoshame can manifest itself in, broadly, two forms. In its stronger, forward- looking manifestation, the idea of having cryonics arrangements is so psychologically embarrassing to the person that (s) he does not follow through with making arrangements. In its weaker form, the person has made cryonics arrangements but is rather embarrassed about them and does everything to hide this from friends, family, and colleagues.

Cryoshame in its strongest form can have different sources, ranging from clearly irrational to reasonable. Some people may think that making cryonics arrangements is an admission of defeat in the fight against aging. Although this outlook is understandable it is rather incoherent because making cryonics arrangements is not a form of defeat but one of the strongest strategies to fight aging. Remember that as long as there is disease and accidents there will always be a role for cryonics or similar biostasis technologies.

Another reason why some people might feel shame about having made cryonics arrangements is that a person may believe that money spent on cryonics cannot be spent on family or a good cause. There are multiple problems with this line of reasoning. To me it is not clear at all that having cryonics arrangements constitutes a financial cost because the prospect of much longer lifespans can make a real difference on traits such as optimism and the tendency to delay instant gratification in favor of more wealth accumulation. Furthermore—and this cannot be stressed enough—cryonics is not just a strategy for individual survival, but part of a social movement to change the scientifically backward ways we think about death. Widespread adoption of cryonics as a form of critical care medicine can prevent a lot of suffering, separation, and loss of important knowledge and skills.

In its milder form, cryoshame is the tendency to remain completely silent about one's cryonics arrangements. It is important to recognize that we should respect this choice. Having said this, many people who "hide" their cryonics arrangements may have erroneous ideas about how people will react to them. Unless you are a member of the Society for Cryobiology, the idea that having cryonics arrangements could constitute a threat to your career is mostly a product of the imagination. Yes, anonymous people on the internet can respond with great hostility, but most people are either indifferent or express sincere interest.

Some people are very uncomfortable with the idea of having cryonics arrangements because they are not non-conformist by nature. Not all cryonicists are interested in controversial ideas such as libertarianism or transgressive arts and do not move around in circles where cryonics is just another odd idea to add to the mix. I do not have a good solution to this but I think community building can be key here. If people are more likely to meet and socialize with other people with an interest in cryonics and life extension, it may be easier to talk about your own arrangements among "normal" people as well.

Cryoshame is a real phenomenon and closely related to cryocrastination. We should respect a person's choice to be private about having cryonics arrangements but when the reasons for doing so are implausible it is important to discuss them. After all, the more (supportive) people know about your cryonics arrangements the higher the likelihood that you will be cryopreserved under favorable conditions. ●

If you take one small additional step—signing and submitting the Declaration of Intent to be Cryopreserved—you will make it easier to become a full member in a hurry, should circumstances require it.

If you're ready to become a full member, break the process into small, clearly-defined steps. Here are most of the basic steps, each of which taken separately should be easy enough to tackle. Each of them can be further broken down. For instance, you might separate reading the Cryopreservation Agreement from making decisions and from filling it out.

- Fill out application form.
- Call an insurance agent to get a quote.
- Fill out the Cryopreservation Agreement.
- Fill out the Attachment 1 to Cryopreservation Agreement.
- Fill out the Consent for Cryopreservation.
- Fill out the Authorization of Anatomical Donation.
- Emergency Standby Provisions.
- Fill out the Relative's Affidavit (optional).
- Fill out the Buy-Back Agreement.
- Fill out the Credit Card Authorization Form.

Even if you have a clear Next Action defined, you may not get around to tackling it without a bit of prompting. Just as Ulysses had himself bound to the mast knowing that he would be unable to resist the call of the sirens, you might ask our Membership Administrator to call you once a week to check on progress, or to ask when you will take that next step. If you are friends with another Alcor member, you might ask them to make these check-in calls.

If you're not making good progress, you should think about the reasons why people cryocrastinate, as mentioned above, and try to honestly consider which reservations may be causing your own resistance and delay. Only by being consciously aware of those factors can you resolve them.

If you are already an Alcor member, do you know someone who is in the process of signing up? Would you like to help them get it done? If so, you might start by asking them to read this article. You could make an agreement with them to check on them at regular periods to see that they are moving forward. If you know them well and you think they are having doubts about the benefits of being revived in the future, think how you might emphasize the appeal for their particular personality type.

Are they motivated to seek new experiences? Returning to life in the future will open up many stimulating new experiences. Are they a highly conscientious type? Point out how returning to life with full physical and cognitive vigor will enable them to continue creating, producing, or convincing people. Are they highly relationship-oriented? Then stress how cryonics, if successful, will allow them to reconnect with family and friends (especially if they persuade their loved ones to make the same journey), and to know and love new people.

Some of you will think all this discussion is unnecessary, because you made your arrangements quickly and without fuss. Others will benefit from the suggestions provided here.

BEYOND MEMBERSHIP: OTHER TYPES OF CRYOCRASTINATION

Even those who don't delay making cryonics arrangements can still procrastinate in carrying out a number of other important tasks related to improving their chances of a good cryopreservation. Most of these tasks, perhaps tellingly, involve quite a bit of decision-making and paperwork. Yes, you have taken the largest step already by signing up, but you are taking a lot of unnecessary risks if you simply sit back, pay your membership dues, and never think another thing about it.

First and foremost, it is imperative for each cryonics member to solidify their arrangements with additional documents and/or video stating their intent to be cryopreserved. Talking with friends and family about your arrangements is also helpful. The point is to ensure that people are aware of your wishes so that it becomes difficult for anyone to argue otherwise when the time comes for your cryopreservation.

More formal end-of-life documents such as a will and advance directives are also extremely valuable. A will, or "last will and testament," is a legal document that sets forth your wishes regarding the distribution of your property when you die. This enables you to make it quite clear how you wish your assets to be distributed, which is especially important if you desire to distribute some of those assets to your cryonics organization.

Even if you have no risk of a third party preventing you from being cryopreserved, you may not be in optimal condition for cryopreservation if you do not take care to minimize certain risks. Particularly in certain medical scenarios, you may wish to avoid extreme life-saving attempts or measures that may place you at high risk of prolonged or repeated ischemic insult and brain damage. Executing an advance directive, or a "living will," allows you to document your wishes concerning medical treatments at the end of life. These are very personal decisions and may involve deliberations that can make us quite uncomfortable, but outlining your wishes here can mean the difference between cryopreserving *you* and cryopreserving what's left of you.

It is difficult to know what prevents members from completing these additional measures. Perhaps some think that making arrangements is enough. But many—one author of this article included—know better and still procrastinate for many years after completing arrangements. In this kind of situation, it may be imperative that you have a like-minded friend follow up with you on a regular basis until you have taken care of business.

For more specific advice on these matters, please read "How to Protect Your Cryonics Arrangements from Third Party Interference" by Rebecca Lively on the Alcor website. And don't forget that Alcor is always only a phone call away with lots of experience in how to best protect your arrangements. ■

INTERVIEW

DR. MICHAEL R. ROSE

The following interview with biogerontologist Michael Rose is the first in a series of interviews with prominent scientists in the field of aging. Questions were submitted by fans of the Alcor Facebook page and by the magazine editor.

Has your work in fruit flies been followed by similar experiments in rodents?

My work on the evolution of aging in response to changes in the first age of reproduction has been emulated with mice by Nagai, Lin, and Sabour (1995, Growth Dev Aging), who showed that you get the same qualitative results with rodents as with flies. This and other experiments manipulating the timing of reproduction in other species show that Hamilton's 1966 Forces of Natural Selection are the fundamental controls on aging. As for the full range of experiments in the Rose and Mueller labs on the evolution and cessation of aging, no one else has come up with such a complete range of experiments to test the hypothesis that Hamiltonian theory explains the onset, rate, and cessation of aging.

Can you briefly explain how evolutionary theory supports the idea that aging stops at a certain age?

Hamilton's forces start to fall after the start of reproduction, which is when aging starts. But Hamilton's forces eventually stop falling at late adult ages. If aging only occurs during or a bit after these forces are falling, then aging must eventually stop too. This means that mortality rates, fertility, and virility should all eventually reach plateaus at which they change only gradually. That is what we have found in our lab data with fruit flies.

What do you mean when you write that aging is not a "process?"

Evolution by natural selection produces physiological processes and morphological patterns that lead to growth and reproductive maturation. Growth and maturation involve physiological processes, but at root they are adaptations. Cells and whole organisms do not have a simple physiological process that drives them toward sex. After all, some animal species never have sex. But natural selection shapes some living things, or rather compels them, to mature. Likewise evolution by natural selection prevents aging in organisms and cells that reproduce by symmetrical division, because among them Hamilton's forces do not fall. Such living things do not have any physiological mechanisms that lead to aging, even when they have the same eukaryotic biochemical machinery as humans. But when Hamilton's forces fall, evolution produces life history patterns in which survival, reproduction, and function generally all fade during and shortly after the fall in these forces. Underlying these declines are specifics of gene expression, cell metabolism, cell proliferation, organ function, and structural wear and tear. Some of these features of aging involve physiological processes in cells, some don't. But there is no simple unitary "physiological process of aging." In exactly the same sense, modern day Darwinians believe that adaptation tunes physiological processes and involves physiological processes. But only modern day Lamarckians believe that evolutionary adaptation involves a core physiological process.

Leonid Gavrilov has said that his research indicates that the growth in mortality rate does not flatten out at any age. How confident are you of the flattening of the mortality curve at late ages in human populations?

There is a good reason why more recent human data are likely to fail to show the 90-something mortality plateau first shown by Greenwood and Irwin in 1939. That reason is that our diets have shifted from "organic" agricultural to industrial, with a number of novel additions to our diet, such as high-fructose corn syrup. Indeed, it would be a falsification of Hamiltonian theory if there were no such deterioration in our aging patterns as our lifestyles have diverged from the agricultural lifestyle that we have been selected to adapt to for some thousands of years, at least among most Eurasians. By contrast, the people whose patterns of death were studied by Greenwood and Irwin lived and died before this wholesale and radical change in diet.

Does natural selection act on human populations which have moved to environments in latitudes different from the ones their ancestors lived in, and does this force of selection stop past the reproductive years?

Natural selection will change direction in response to any environmental change which affects patterns of survival or reproduction. But the things that affect these patterns of survival, etc., are not

necessarily intuitively obvious. Adaptation to increased levels of sunshine is such an obvious pattern of adaptation, thanks to early deaths due to melanoma among individuals of Northwestern European ancestry in places like Brazil or Australia. But other shifts in selection will be more subtle. Because Hamilton's forces give rise to greater effects of natural selection at earlier ages, all such evolutionary adaptation will proceed faster at earlier ages compared to later ages.

How does your perspective on aging differ from that of SENS and those who think that aging is "programmed?"

SENS and most other thinking about aging is dominated by the hypothesis originally due to Aristotle that aging is produced by some type of physiological process, whether that process involves damage or a death program. In Hamiltonian thinking, aging is the de-tuning of adaptation during the first part of adulthood. As such, we see aging as a problem as complicated as that of evolutionary adaptation itself. Thus we expect that aging is due to many problematic nucleotide frequencies, distributed genome-wide, which in turn generate pleiotropic and epistatic effects of great complexity throughout the biology of aging organisms. There is an evocative Anglo-Saxon expression for this which I will bowdlerize as a "fecal hurricane."

Yet as complex as this genomic fecal hurricane is, natural selection can EASILY (and I mean to shout here) re-tune the genome to produce much nicer physiological weather, so long as it is forced to pay attention to the problem. This we can easily do in the lab with animals that have the compressed life cycles of a fruit fly, or even a lab mouse. And when we do that, we find that natural selection has been busy at MANY locations across the genome, a genomic croesus effect, in the language of Rose and Burke 2011 (Experimental Gerontology).

If cessation of aging may be possible by switching to a primal lifestyle and diet at mid-age for those of European descent, would switching back to lifestyle and diet of our closest non-human ancestors, chimpanzees (a mostly vegetarian diet) confer even greater benefits?

This is an interesting idea that I have been thinking about myself. The problem is that our brains require a lot of fatty acids to sustain themselves, since they are mostly fat themselves! In particular, they tend to be nutritionally limited by omega-3 fatty acids; omega-6 fatty acids are readily obtained from our normal diets. I have my doubts whether this limiting nutrient, among others, such as B12, can be supplied in sufficient quantities by a vegetarian diet. Furthermore, contrary to Goodall-derived images and impressions, chimpanzees are fairly voracious hunters, and eat a respectable amount of meat. We have probably been omnivores for millions of years, and it is unlikely that any of our ancestors were the vegetarian folivores that gorillas now are. Yet the question remains whether we could subsist well on a diet of insects, fruit, nuts, honey, and so on. The kind of data on diet and health that Richard Wrangham and Staffan Lindeberg collect seems to me to be relevant to this question.

It is not likely that many scientists are going to accept that aging stops if we do not understand the actual physiology of it. Can you tell us more about your recent work into characterizing the physiology of late-life aging?

In terms of Hamiltonian theory, the posing of this issue is itself fallacious. The cessation of aging is no more a physiological process than aging itself. We do, however, study physiological and other functional aspects of the transition from aging to late-life plateaus, one example being the article by Shahrestani et al. published in Rejuvenation Research in 2012. It turns out that late life is much more complex than aging itself. During aging, virtually every significant functional character deteriorates. After aging, some characters stabilize, others continue to decline at a similar rate, while yet others decline faster than they do during aging. This is not only complex, it is what we have called "paradoxical." It turns out that evolution does not like to conform to our simpler intuitions. Just like physics. If you want simple stories, stick with fiction and the glib stories of pop science writing, the latter really being fiction in a different guise.

If aging also stops in humans, at which age do you expect this to be? Would you expect to see no noticeable difference between "young" and "old" supercentenarians?

The ages at which aging stops in the populations of any species will depend on their histories of adaptation, inbreeding, and environmental exposure. But as a general rule, I expect the course of aging to be much worse among individuals living lifestyles for which they are poorly adapted. Thus I expect patterns of aging to be worse among people who live in outer space, who live seated in front of computer screens and steering wheels all day, or who use large quantities of pharmaceuticals and other novel supplements, including street drugs.

There are so few supercentenarians that they are not useful subjects for scientific prediction or analysis. To do science with late life, you need very large samples, because there is so much statistical noise. That is why we work with very large fruit fly cohorts in our research. In addition, humans do not live lives over which scientists can sustain long-term manipulations. This makes human data still worse.

Aside from changes in diet and lifestyle, what kind of near-term anti-aging biotechnologies do you think follow from your recent work on the cessation of aging?

My opinion is that aging is far too complicated to be re-tuned at the molecular level, given present knowledge. But I do think that repair at the tissue level is a reasonable prospect, chiefly because it involves exploiting capacities of cell lineages that natural selection has already built. So adjusting diet and lifestyle are for me like taking proper care of your car, changing the oil regularly,

changing the transmission fluid when you need to, keeping up your tire pressure, etc. But when you get into a biomedical accident, like a clot or a tumor, excision and repair should proceed at a tissue or organ level. If you are healthy enough generally, you have a better chance of coming home from the repair shop (i.e. the hospital). In a few select cases, some chronic medications might be useful, but I have my doubts about almost all of them, except possibly aspirin. Interestingly, the benefits of aspirin for our chronic health were found only serendipitously, which says a lot about the biochemical and molecular biological insights which are the foundation of modern pharmaceutical research.

Can you tell us how your work in evolutionary biology and aging has affected your own health, diet, and lifestyle decisions?

Up until early 2010, when I realized that there could be an interaction between adaptation to agriculture and Hamilton's Forces, my research had no appreciable impact on my health, diet, or lifestyle decisions. Since that realization, I have systematically tried to live in a scientifically accurate "paleo" manner. Concretely, that means the following:

- not eating foods that contain ingredients derived from milk, grass crops, or legumes
- otherwise eating as diverse a diet as I can manage; no insects yet, though
- avoiding sitting for prolonged periods
- walking as much as possible
- avoiding bright light at night
- avoiding air travel
- actively sustaining a social circle of family and friends

Less concretely, I no longer view aging as an immutable wall of death that we slam into at great speed. With the transition to a paleo lifestyle, I am now experiencing a more gentle loss of function than before, with surprising functional recoveries and stabilizations. Though I am approaching 60 years of age, I am much more optimistic about remaining ambulatory and coherent. I don't expect to live forever, but I also don't expect to have my life as cruelly devastated by aging as I did before. ■

Michael Rose went to the University of Sussex in 1976 for his doctoral studies on aging in Drosophila melanogaster. There he began his work on the evolution of aging and created Drosophila stocks with postponed aging by selection for later reproduction. In 1991, his ***Evolutionary Biology of Aging*** *appeared, offering a view of aging that was a complete departure from the views that have dominated the aging field since 1960. In 1997, Rose was awarded the Busse Research Prize by the World Congress of Gerontology. His recent academic books, all edited or written with others, include* ***Methuselah Flies (2004), Experimental Evolution (2009),*** *and* ***Does Aging Stop? (2011).*** *He has written a popular science book about aging,* ***The Long Tomorrow (2005),*** *and has a non-academic website 55theses.org. Further information and links to publications can be found at his University of California, Irvine, Faculty Profile page.*

Marlene Zuk's *Paleofantasy*

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A REVIEW OF MARLENE ZUK'S BOOK "PALEOFANTASY"

In 1844, Robert Chambers anonymously published his book *Vestiges of the Natural History of Creation*. This work was the effort of an intelligent layman who was drawing attention to the possibility of biological evolution, in contradistinction to the veiled creationism which dominated British biology at that time. The chief intellectual forerunner for Chambers was Lamarck, particularly his 1809 book *Philosophical Zoology,* who had already received considerable drubbing from the likes of Georges Cuvier and Charles Lyell. Naturally enough, the academic establishment of the day pounced on the work, with later evolutionists like Thomas Henry Huxley poring scorn on *Vestiges* for its amateurish biology and its far-fetched invocation of the widely-discredited idea of "transmutation," as evolution was generally called then.

By an interesting historical parallel, we are facing another evolution controversy in the popular press: what evolution tells us about the ideal diet and, more generally, lifestyle for human health and longevity. After a few relatively academic forays into this topic by the likes of Eaton and Konner (1985; *New England J. Medicine*), a spectrum of physicians and health advocates, even a lapsed economist, have followed suit in suggesting that adult humans remain adapted primarily to a "stone-age diet," with significant quantities of meat and only minor quantities of foods derived from grains or milk. This is the "paleofantasy" that Zuk refers to in her title.

The chief scientific assumption that undergirds paleoadvocacy is that there has been too little time during the Neolithic era, since the adoption of extensive agriculture, for humans to become adapted to the predominant consumption of agricultural food products. This assumption in turn is in keeping with the evolutionary psychology doctrine of our Environment of Evolutionary Adaptedness ("EEA"), in which it is supposed that our behavior is to be explained in terms of selection pressures which prevailed on the African savanna more than 20-40 thousand years ago. There is a point in Zuk's book where she recounts her public confrontation with Loren Cordain on this central point:

> .. **Why, I asked Cordain, has this inability to properly digest all these common foods persisted? Surely it should have been selected out of the population.**
>
> **He was taken aback. The answer was obvious, he responded. The sensitivity had been occurring only since the advent of agriculture, so humans haven't had an opportunity to adapt yet. I frowned. "Plenty of time," I said.**
>
> **"But it's only been ten thousand years," he said.**
>
> **"Plenty of time," I repeated.**
>
> ***Zuk, 2013, p.114***

This is the gravamen of Zuk's book: evolution has had plenty of time to adapt humans to agriculture (at least

among populations with long-agricultural ancestry), over the last 200-400 generations of large-scale agriculture. As our lab has been one of those which has supplied the warrant for this point of view, let us digress, much as Zuk does for most of her book, to explain this point.

In our laboratory, like many others which practice experimental evolution on model organisms, about 100 generations of sustained selection is enough to produce extensive adaptation to novel environments, diets, etc. Authors like Cordain are thinking like Darwin, who famously emphasized the extreme gradualness of the action of natural selection in producing evolutionary change. Zuk makes her case primarily using examples from the studies of natural selection in the wild, covering everything from crickets to sparrows to Australian cane toads to finches to guppies. Repeatedly

she draws attention to the evidence for European adaptation to milk consumption among adult humans, particularly the continued activity of the lactase enzyme in European populations, the enzyme that breaks down the principal sugar in milk, lactose. Toward the end of her book, she even brings in the genomic analysis of high-altitude adaptation among native Tibetans, as a kind of coup de grace.

Our view is that Zuk is both right and wrong in this, her central criticism of the paleo movement. She is almost certainly correct that the majority of young people who have long-agricultural ancestry are well-adapted to the extensive consumption of foods like wheat and rice. That is because natural selection is very powerful at early ages, and there has been enough time to adapt agricultural populations to their characteristic diets. Indeed, this was our view up until 2010, given our lab's success with producing marked adaptation to novel environments over dozens of generations among the fruit fly populations that we study.

But the problem that Zuk fails to appreciate is that the forces of natural selection fade out with adult age. Very long sustained selection, say for a million years, will probably build extensive adaptation to a pattern of nutrition or activity deep into the life history. This kind of adaptation to a new source of food is particularly likely for primates, most of which have fairly omnivorous diets, and especially for our species, which has been processing, cleaning, and cooking much of its food for at least a million years. [We say this because cleaned and cooked food is much more digestible.] There *has* been enough time for humans to become well-adapted to the often-cooked omnivorous diet that we have consumed for most of the last million years, as contended by Caleb Finch *(The Biology of Human Longevity; Inflammation, Nutrition, and Aging in the Evolution of Lifespans;* 2007, Academic Press) and Richard Wrangham (e.g. *Catching Fire; How Cooking Made Us Human;* 2010, Profile Books). However, it should be said that this diet is not an endless churrascaria, in which one meat dish is followed by another, with mere side dishes of vegetables or fruit. Rather, much of our long-ancestral diet featured the consumption of cooked roots and tubers, along with insects, eggs, honey, and most anything else that could have had its nutrients extracted and its toxins destroyed by some type of cooking, fermenting, etc.

"While the pop-paleo literature is based on erroneous and superficial scientific reasoning, its popularity is based on one simple recurring fact: a lot of people with chronic, but not usually life-threatening, health problems experience relief by taking the advice of Cordain and his ilk with respect to diet and exercise."

So we will concede several points to Zuk. The paleo low-carb venison-killed-with-a-bow diet which she so enthusiastically skewers is not the definitive solution to human health for all people at all ages. Among long-agricultural populations, like those of most of Eurasia, young to youngish people are probably well adapted to agricultural diets. The Olympics make little sense otherwise. And as for the ridiculous specificity of some paleofantasies, particularly those concerning evolutionary-psychology inspired advice about philandering males and submissive females, we too feel little but amusement.

But we fear that Zuk is scoring points off hapless authors like Cordain and de Vany chiefly to mark out territory for evolutionary biologists and their proximal colleagues. This is unselfconsciously revealed by Zuk's own foray into evolutionarily-based lifestyle advice, in her Chapter 8 on child rearing. There she writes much as an anthropologist might, mixing her interpretation of the published literature with her own opinions about appropriate child-rearing. We don't mean to question any of her conclusions on this topic, only to point out how similar it is to the dietary advice of people like Boyd Eaton or Loren Cordain. And in so doing, Zuk is following the same tradition and practices as great controversialists like Thomas Henry Huxley, first in his attacks on the amateur Chambers and later in his equally aggressive defense of Darwin, after he had switched sides where evolution was concerned.

While the pop-paleo literature is based on erroneous and superficial scientific reasoning, its popularity is based on one simple recurring fact: a lot of people with chronic, but not usually life-threatening, health problems experience relief by taking the advice of Cordain and his ilk with respect to diet and exercise. Not incidentally, from our point of view, many of these people are no longer young, and have often been suffering from their chronic health problems for decades. During the period leading up to their paleo-conversion, many of these individuals have received the best medical advice available, to little benefit. It's like the obviousness of Lamarck's evolutionary hypothesis to the young Alfred Russel Wallace, the amateur naturalist who independently discovered the theory of evolution by natural selection in 1858.

As we have outlined in a recent book *(Does Aging Stop?* Mueller, Rauser, and Rose; 2011, Oxford), the mathematics and experimental evolutionary biology of aging imply that populations which have undergone a major dietary or lifestyle change will rapidly adapt at early ages, but not at later ages. We have further gone to the trouble of breaking down the reasoning behind this for a Cordain-level audience at our website 55theses.org. And we are now actively engaged in both theoretical and experimental research in our laboratory on the details of such age-dependent failures to adapt. But our provisional conclusion, to put it simply, is that Zuk is correct for young people, but wrong for the middle-aged and older.

If you are over forty years of age and have a long-agricultural ancestry, you should take the advice of Cordain and his ilk, albeit with some caution. If you do *not* have such ancestry, you should go paleo right away. But if you are young, despite your agricultural ancestry, you still aren't adapted to Twinkies and a Coke. Even Zuk would concede that. ■

INTERVIEW

BEEN THERE; GOING THERE:
THE YOUNG AND OLD OF CRYONICS

Steve Bridge and Keegan Macintosh interview each other.

Steve Bridge is 64 years old and has been involved in cryonics for 37 years. He has been an Alcor Director and was Alcor's President from 1993-1997. He is currently an Alcor advisor and a Co-Manager of Cryonics Property, LLC, which owns the building that houses Alcor and its patients. Steve is a librarian in Indianapolis, Indiana, where he lives with his family.

Keegan Macintosh is 29 years old and has been involved in cryonics for 3 years. Keegan has a fine arts degree and a law degree from the University of British Columbia, and is Executive Director of the Lifespan Society of British Columbia, a community interest group in the field of life extension. He is also a board member of the Cryonics Society of Canada, and the Institute for Evidence Based Cryonics. Keegan lives in Vancouver, Canada, with his family.

Keegan: So, first things first—how did you initially learn about cryonics?

Steve: I've told this story many times, so I'll make this version short. I first read about a cryopreservation—James Bedford's, I think—in *Argosy Magazine* while getting a haircut while I was in college. I also ran across an article in *Science Digest* at some point, so I knew it was called "cryonics," not "cryogenics." I knew what cryogenics was too, because my father worked in the artificial insemination field, using cattle sperm frozen in liquid nitrogen. So I was primed to believe that cold temperatures could preserve life. But I didn't think about the feasibility or reality of cryonics until I met Mike Darwin at a science fiction club gathering in 1976 in Indianapolis, Indiana.

Several of us were arguing about economics of the future, when Mike (who was the new guy at the meeting that night) said, "That won't be true once cryonics becomes popular." Someone else said, "Oh, that's REALLY science fiction." Mike answered, "No, it's not. I've frozen two people." He said it just loudly enough that it penetrated every other conversation in the room and everyone else stopped talking. Over the next year or so, several of us talked about cryonics for dozens of hours, but it took me a year or so before I said that I was on board with it. Then we started a local cryonics group called The Institute for Advanced Biological Studies, Inc. Our attorney suggested that we use a generic name like that for a couple of reasons. If this whole cryonics thing didn't work, we still had a company that could be used for something else. And it was good to remember that we were in conservative Indiana, where merchants and medical supply companies might refuse to do business with some company that sounded weird. IABS later merged with Alcor in California and Mike became Alcor's president for several years.

What was your first connection to cryonics?

Keegan: Well, it is such a longstanding staple of science fiction by now that I think I've always been aware of it on some level, but I did not realize until three summers ago just how seriously it was being pursued. And that discovery was basically accidental! All I remember is that I was link surfing through Wikipedia (probably on the subjects of consciousness and the brain, though I don't recall exactly) and stumbled onto an article on cryonics, and from there I discovered the rest of the life extension movement. On the cryonics side of things, I was very impressed by the demonstration of reversible whole organ vitrification by Greg Fahy and Brian Wowk at 21st Century Medicine, and looking more broadly, I was seriously excited by the work of Aubrey de Grey and the SENS Foundation. Both subjects grabbed me right away and I set out to find local groups in life extension and cryonics. Vancouver has a reputation for being a very health conscious city, so I figured life extension would be part of that. I was surprised to find nothing at my University or in Vancouver. And I was even more surprised to learn that I just happened to live in one of the few jurisdictions in the world (if not the only jurisdiction) to prohibit the sale of cryonics arrangements.

As I dug into this more I discovered the writings of Ben Best, then the president of Cryonics Institute. Ben was also a former

resident of B.C., and longtime director and President of the Cryonics Society of Canada, and had expended a lot of energy over the years trying to get that law repealed. So, in part because of this connection, I gravitated to CI and joined them within a year. Since there was a lack of a local community organized around cryonics and life extension, my intense interest drove me to stand outside the student union building at U.B.C. collecting signatures to start a cryonics and life extension club there, and I also started coordinating a local cryonics and life extension discussion group / task force that came to call itself CryoBC, and later on gave rise to Lifespan Society.

Steve: I have known Ben Best for a long time, and I think many of us admire the amount of useful work and thought he put into CI while he was President.

Keegan: Yes—I am a big fan. But getting my arrangements with CI was partially financially motivated, too, as I was still a law student with two more years left to go. I also very much wanted to attend the Teens and Twenties cryonics event and Suspended Animation conference in Florida that year (2011), so I figured the quickest way to get everything set up was to get as small a life insurance policy as I could. Ultimately, that policy still turned out to be large enough for neuropreservation arrangements with Alcor, so, with the utmost respect for CI and its efforts to keep cryonics very financially accessible, I changed my arrangements to Alcor in early 2012. I decided Alcor was a better fit for me in several ways, especially being here in British Columbia, far from Michigan and far from most other Canadian CI members that I knew, who are mostly in Ontario, much closer to CI.

Steve: I am curious about how fast you seem to have jumped into cryonics. Some people talk about "the click effect" where it all makes sense immediately. My experience has been that most people require many exposures to the idea of cryonics and chances to ask the many questions they have. It is so different from the world view of most people. It took me a full year of fairly intensive conversations and reading what little was available.

Keegan: Actually, I see it more often the other way—most of the cryonicists I have encountered so far have been of the "it just clicked" variety. When I attended the Teens and Twenties conference in Florida last year, almost all of those younger people said that they had made the decision very quickly.

Steve: Do you think there is a generational difference taking place? After all, when I first met Mike Darwin, there was no internet and there was very little serious or even sensible writing about cryonics in the media. One-on-one conversation was essential.

Keegan: Well, look at the way I found out about it. Once I discovered the Wikipedia entry on cryonics, I had immediate, instantaneous access to a huge amount of information about it—the history, the science, the magazines, the contracts—it's all right there… I am still a major advocate of one-on-one conversation in cryonics advocacy, but in my case I didn't really "speak" to anyone already involved before I made up my mind that I wanted to make cryonics arrangements. But also, from what I can tell, many of the younger cryonicists are "digital natives," often computer programmers with at least some knowledge of AI research, whose outlook on the human body and brain are highly mechanistic—a world-view that lends itself pretty easily to considering cryonics an experiment with reasonable odds of success over the long term, and a fantastic potential outcome.

Steve: I love that phrase "digital natives;" it implies that you are much more a citizen of the internet than you are limited to any one location.

Keegan: Yes. But global thinking still has to get off the internet and into the material world eventually (in many, many places!), and that's where smaller-scale, community interest groups come in.

Steve: So you said you had started life extension groups in B.C. How do you spread your ideas? What kind of promotions do you do?

Keegan: I started with the university club, attracting attention at the start-of-year club fair with a booth that would have looked more at home at a high-school science fair. I almost can't believe anyone actually came to those earliest club meetings I ran, because it was honestly just me with paper handouts on something life extension- or cryonics-related, talking about it for an hour and then going for coffee/beer/etc. But a small committed group came out every other week, and we gained some momentum in the club's second year, putting on presentations open to the university public, with significantly higher production values.

Now, I do similar work with Lifespan Society, organizing film screenings, nature walks and hikes (we can't forget the beneficial impact of exercise!), hosting speakers and small conferences, and so on. I also write a column for *Cryonics* magazine, which started out focusing on legal issues in cryonics and life extension, but is starting to expand out from there now. But despite all that, I still feel very new at this.

Having been President of Alcor, no doubt you have a wealth of outreach experience yourself?

Steve: I have given hundreds of talks, interviews, and radio and TV presentations on cryonics over the years. I have spoken to 4th graders and several senior citizens groups, MENSA, a Jewish college, death and dying classes, science clubs, etc. My favorite might be talking with high school students. They often have just developed their first "worldview," and the more fragile it is, the more tightly they hold onto it. I know it will be broken and reformed many times in their lives, but I enjoy giving them all of this new information while they are young. You never know which of them will carry that knowledge into to the future and become a supporter.

What are you going to be doing in cryonics in the future? Having graduated from law school, will you have legal involvement?

Keegan: Well, I'm definitely active right now in the renewed effort to do something about the anti-cryonics law here. However, I'm very fresh out of law school (so fresh I'm not quite a lawyer yet!), so we are working with much more experienced legal counsel on that. As for my future in the courtroom on cryonics matters, well, on the one hand my undergrad was in theater, and a background in the performing arts is certainly an asset when it comes to public, persuasive speaking. But on the other hand, that same background in theater leads me to be more interested in finding common ground and agreement wherever possible—though obviously there are times when you have to stick up for what you believe in as well. So I guess I can't say for sure right now what exact function I'm going to play over the years—it will probably change from time to time as well.

Steve: I am very interested that you were a theater major. That's my background, too. I was a speech-theater major at DePauw University and thought I was going to be a theater director and teacher. But working with community theater, I finally realized I didn't like dealing with the large but fragile egos of actors. The drama was everywhere, not just on stage. I thought about law, but became a librarian instead, when I realized that I had always been the one my friends came to for help doing library research. My mind was built that way.

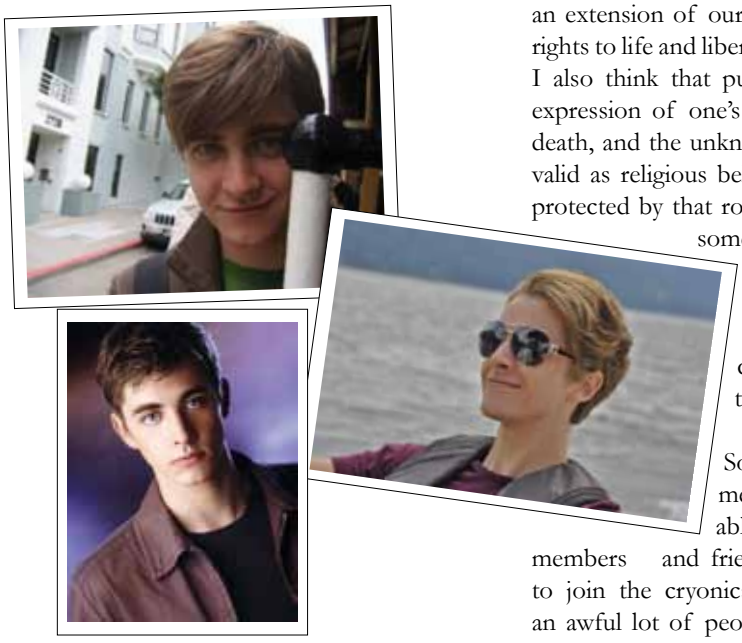
Keegan: How has the theater background helped you in cryonics?

Steve: Of course, I use theater in doing programs for children at the library and I gave many library talks to adults for the library, and even did radio and television. When I became Alcor's president, I thought it was ironic that I had given up on theater because I couldn't deal with the crazy egos of actors, and now I had to deal with the equally crazy (and more intense) egos of cryonicists. Mike Darwin used to think it was comical that critics would accuse cryonics of being a cult. He couldn't get more than 2 people at a time to agree on anything, including whether it was day or night. I guess we should expect that from the early generations of cryonicists, especially. The reason they were able to look at cryonics at all was that they had been saying "No" to conventional thought all of their lives. As we learned, that doesn't mean they start saying "Yes" to everything when they join an organization.

Part of the reason I was chosen to be Alcor's president was that some people saw me as a person who could get along with the varied personalities in Alcor. It was said that I was well-named, because what they needed was a "Bridge." But speech and theater also prepared me for being comfortable giving talks, expressing ideas, and dealing with radio and television. Sometimes I even advised TV crews on how to set up their shots. It's all theater, isn't it?

Keegan: Definitely. Law, too—and I don't mean that in a particularly cynical way. And come to think of it, my theater background probably had something to do with my attraction to cryonics as well. I'm very fond of the Greek classics and Shakespeare, with their impossibly high stakes, larger-than-life characters, and hard philosophical problems. So as you might imagine, the story of cryonics thus far sucked me in right away.

Also like you, I definitely got experience working with strong and varied personalities as an actor. I strongly feel that "Bridge"-making will be critical for the future success of cryonics. I don't think this will work with one group of cryonicists trying to defeat other groups—not that that is what is actually going on at the organizational level… just the tone of discussions on the mailing lists now and then. But I am very encouraged by recent fund-raising efforts to help cryonicists who are in trouble. I was fortunate to meet Kim Suozzi at the October Alcor Conference. She was an amazingly brave and positive woman, and I am excited to see this spirit of cryonics charity continuing with Aaron Winborn, as it reflects well on the community.



What do you want to see as your lasting contribution to cryonics, Steve?

Steve: I suspect that most of my contributions have already taken place. I have been an editor of Cryonics, major editor of several editions of Alcor's Cryopreservation paperwork, Alcor Director, Alcor President, major mover and writer of the Patient Care Trust, Co-Manager and incorporator of Cryonics Property, LLC, and I led Alcor's move to Scottsdale. I am still involved and hope to add a few more things. I hope, finally, to have my own cryopreservation be influential (long may it be delayed!). Since I did so many interviews as Alcor's President, I hope that some reporters will still be out there who remember me and will wish to give that some positive publicity.

Mostly, I hope that what I have done in 35 years has contributed to cryonics being easier for people in your generation to understand and to become involved with.

But you're young. You certainly have a lot of contributions yet to come. What do you think your focus will be?

Keegan: This is related to the work we are doing on the situation in B.C., but I would like to see cryopreservation recognized as an extension of our constitutional human rights to life and liberty, here and elsewhere. I also think that pursuing cryonics is an expression of one's beliefs regarding life, death, and the unknown, that is equally as valid as religious beliefs, and it should be protected by that route as well. Those are some of the loftier goals—at the ground level, I'm excited to see my local life extension community continue to take root and grow.

Some Alcor and CI members have been able to persuade family members and friends, spouses at least, to join the cryonics movement. But for an awful lot of people, it seems like they are going alone into the future. What do your friends and family think about your involvement?

Steve: I have a lot of friends in cryonics; but they are all people who were cryonicists first. I have not talked any close friends or family members into joining Alcor. Well, there was one girlfriend, but when we broke up, she dropped her membership. My wife is not interested, either. I have several family members who find cryonics very interesting, including my father (who used liquid nitrogen, remember) and a brother-in-law who is an attorney and who has read Alcor's paperwork and the Patient Care Trust. They are supportive but not participants. But I have so many friends in Alcor (and CI, too) that I don't think of myself as going alone into the future.

One good thing for me in my non-cryonics life: Most of my friends thought of me as an intelligent, interesting person before I told them about cryonics, so most of them just saw my involvement as one more interesting thing about me. I have lost no more than two friends in my life over cryonics; but I have gained more than 100 friends because of it (including you, now!). I think I have come out ahead.

Has anything changed in that regard in your generation?

Keegan: I don't think this is generational, so much as personal: I don't think my friends and family are capable of being surprised by the directions my life takes anymore. Some are more skeptical than others, but all have been supportive overall, especially now that life extension and cryonics activism has become my work. So, happily, I haven't lost any valued relationships on account of my involvement in cryonics, and have certainly forged many new ones. That said, none of my family or pre-existing friends have decided to follow me down the rabbit hole just yet—though I haven't been trying too hard to persuade them. It's difficult, especially with older family members, because you don't want to alienate the very people with whom you likely have the least time left (if you're not successful in persuading them, that is). This will be a survivor's guilt many of us early adopters will have to learn to cope with, I suspect. That is, if everything works out according to plan.

Steve: That pretty much matches my feelings, too.

But what about just living longer? I know that one of the mottoes of the life extension movement is "Die young, as late as possible," meaning, of course, to live long but stay youthful. "Die young" brings

up romantic images of actors and rock stars dying young, and then the second part puts a clever twist on it. We might re-word it as "Get cryopreserved, as late as possible," although I admit it doesn't have the same snappy ring to it. We assume that cryopreservation knowledge and technology will continue to progress, so that it would seem that you improve your odds of success if you can live as long as possible first. You'll get better treatment AND be closer to a time when resuscitation will be possible.

Under the influence of cryonicist friends for 3 decades, I've tried to eat carefully (not carefully enough, I'm sure), take various supplements (what I can afford), and get vigorous exercise (a lot less the last three or four years, though). I have never smoked or used illegal drugs, I don't drink much alcohol, and I wear seatbelts. But I've never taken on any kind of rigorous life extension diet. I am fortunate not to have any serious health issues—or maybe I have done enough of the right things to stave them off for now.

But you're the Executive Director of a "lifespan society." Surely you have a more carefully worked-out strategy?

Keegan: To be honest, your strategy sounds more worked-out than plenty of longevity enthusiasts I know. I can't say I've lived as "clean" a life as you have (and I don't think many could), but I've still been called a nun in the past on account of my no-meat, no-alcohol, no-smoking lifestyle. Vegetarianism is a moral choice for me, primarily, but I do note that little-to-no meat consumption is common to the longest-lived human populations, at least from what I've read. I tried reincorporating alcohol into my diet starting several months ago—red wine, specifically, as I couldn't ignore the well-evidenced benefits of 1.5 glasses a day. Unfortunately, I have realized that my impulse control is no better developed now than it was three years ago when I cut out alcohol in the first place, so I think there's a strong chance I will become a teetotaler again soon. I can always try again in a few more years.

Exercise-wise, I find gyms and that style of "working out" really boring. I greatly enjoy dancing, though, and took up ballet in my late twenties because it is as stimulating mentally and creatively as it is fantastic exercise. I've also recently discovered that I'm one of those obnoxious Vancouver people who truly enjoys the Grouse Grind (a particularly grueling staircase-up-a-mountainside). Taking the gondola back down the mountain after an early-morning hike is a great way to start the day.

So as you can see, my longevity strategy isn't perfect, but I do try to make sure I'm not just talk, even if I take the odd step back before taking another two forward.

Steve: Keegan, it has been great to talk with you. I see a lot of connections between us. I think as cryonicists we are much more alike than the difference in our ages would suggest. If this thing works, the age difference will be our least important characteristic anyway. If we are both cryopreserved at 90, but I was born 35 years before you, and you are revived 20 years before me, and both are revived as young persons in excellent health, what age numbers could anyone give us?

Keegan: Well, my current plan is to just keep turning 29 over and over again—so I guess I'll see you at 29?

Steve: Hah—and many more. Here's to our future. ■

COOLER MINDS PREVAIL

CRYOPRESERVATION OF THE BRAIN: AN UPDATE

By Chana de Wolf

INTRODUCTION

As all cryonicists understand, the one absolutely necessary component of the human body that must be preserved in order for one to be successfully resuscitated from cryonics is the brain. The last major review of the state of brain cryopreservation can be found in "The Cryobiological Case for Cryonics," published in the March 1988 *Cryonics*. This article will very briefly touch on that report (please, find and read the entire piece on the Alcor website) then supplement it with progress in the field since then.

One of the most important points that "The Cryobiological Case for Cryonics" makes is that because biological systems are composed of different cell types "it is difficult to extrapolate from one biological system to another in terms of predicting the details of its cryobiological behavior." And because traditional cryobiologists have largely ignored the brain, we must endeavor to seek out information and run experiments that focus specifically on the brain.

Fortunately, the results of such investigations have been promising. In 1988 we were already able to state that "wherever either brain structure or brain function has been evaluated after freezing to low temperatures and thawing, robust preservation has almost always been demonstrable provided at least some minimal attention was paid to providing cryoprotection…" This is remarkable, and is backed up by numerous examples ranging from the landmark hamster-freezing experiments of Lovelock and Smith in 1956 to the cat-brain EEG studies of Suda and colleagues in the 1970s, both demonstrating a return to function in living adult animal brains after freezing.

Lovelock and Smith used no cryoprotectants in their experiments, freezing and then resuscitating hamsters from high subzero temperatures of around 3 to 5ºC. Suda et al., on the other hand, used low concentrations of glycerol (~15%) to cryoprotect cat brains before freezing at 20ºC, 60ºC, or -90ºC and storing them for periods ranging from 5 days to 7.25 years. Amazingly, Suda reported recovery of single-unit and EEG activity in these brains. In general, neural function was better when brains were stored at higher temperatures for short periods of time, and worsened when stored at lower temperatures for longer periods of time.

Later on in the 1980s, Fahy and colleagues reported excellent histological preservation of the cerebral cortex and hippocampus after cryoprotection with 3M or 6M glycerol and slow freezing to dry ice temperature (79ºC), demonstrating that cryoprotection and freezing is capable of preserving the cellular structure of the brain as well.

Also included, but not reviewed here, are positive results from living fetal and adult human and animal brain tissue, living human and animal isolated brain cells, and post-mortem human and animal brains. These experiments all provide evidence supporting the conclusion "that brain structure and even many brain functions are likely to be reasonably well preserved by freezing in the presence of cryoprotective agents," and ushering in a new era of research in cryopreservation of the brain.

MOVING BEYOND BASIC CRYOPROTECTIVE PROTOCOLS

In the earliest days of cryobiology (the 1950s), cells and very small tissue samples were cryoprotected by diffusion—literally, soaking the sample in glycerol or DMSO. But larger systems, such as organs and whole organisms, are difficult to cryoprotect in this way and cells are damaged by rapid exposure to high concentrations of cryoprotectant. It was quickly recognized that the first obstacle can be overcome by utilizing the circulatory system of an organ to more rapidly introduce cryoprotectants to cells (i.e., perfusion). Osmotic shock can be overcome to some degree by introducing the cryoprotectant solution in a controlled fashion, starting with a low concentration and gradually moving to higher concentrations, and toxicity can be reduced by doing these procedures at low temperatures.

There were many reasons to believe that results from tissue and organ experiments could be applied to whole organisms, so Alcor began employing such a "cryoprotectant ramp" protocol in cryonics cases in the 1980s. Prior to that glycerol was introduced rapidly, resulting in a shorter perfusion and ending in a lower terminal concentration of cryoprotectant. Upon recommendation of a respected cryobiologist, Alcor also decided to increase the concentration of glycerol to 7.5M, which constitutes a practical limit in terms of viscosity and perfusion times. In 1993, Darwin et al. performed a series of

experiments to validate the new protocol's effectiveness in improving cryoprotection (and minimizing freezing damage) of patients.

In these experiments, the researchers carried out simulated cryonics cases on dogs, followed by cooling and storage at -90ºC. A cryoprotectant ramp was used in one group of dogs, while another group was perfused according to an older protocol. After 18 months, the dogs were rewarmed and brain samples were examined using light and electron microscopy.

In general, a higher degree of ultrastructural preservation was observed in the brains of dogs that underwent a longer, gentler perfusion of cryoprotectant. Though there was still evidence of damage in these animals, it was considerably less than that observed in those treated with the simpler protocol. The results were published in the article "Effect of Human Cryopreservation Protocol on the Ultrastructure of the Canine Brain" (Darwin et al., 1995), in which very detailed descriptions and photographs are provided. This article may be found on the Alcor website.

IMPROVED TECHNOLOGIES AND CRYOPROTECTANTS

In the meantime, progress towards ice-free cryopreservation of cells, tissues, and organs (including the brain) was made during the 1980s and 1990s. Most notable was Dr. Gregory Fahy's development of vitrification as an approach to cryopreservation. Vitrification, which means "turning into a glass," occurs when water is cooled too fast to form ice crystals. Fahy proposed that vitrification can also occur when a tissue is loaded with so much cryoprotectant that the entire volume of the tissue becomes a glassy solid during cooling, without any freezing at all. The advent of vitrification was a major leap forward in cryopreservation technology, and Alcor eventually implemented this approach in cryonics cases.

Though it eliminates mechanical freezing damage caused by ice crystals, the very high concentrations of cryoprotectant necessary for vitrification are toxic to cells. Over time, the composition of cryoprotectant solutions has also changed considerably from mono-agents like glycerol to solutions consisting of multiple cryoprotectants, polymers, and synthetic "ice blockers." Much of this work was done with the goal of reducing cryoprotectant toxicity and relaxing the cooling rates necessary to vitrify and rewarm complex organs.

Vitrification as an approach to cryopreservation of various cells and tissues has now been validated in numerous experiments and peer reviewed papers. Of greatest interest to cryonics is a study published by Pichugin, Fahy et al., in 2006. In their paper, "Cryopreservation of rat hippocampal slices by vitrification," the researchers vitrified thin slices of rat brain using an advanced vitrification solution, VM3, containing penetrating cryoprotectants, non-penetrating polymers and "ice blockers" in a carrier solution designed to maintain viability and mitigate chilling injury. Slices treated with VM3 showed excellent ultrastructural and histological preservation after vitrification as compared to frozen-thawed slices. But, more importantly, the previously VM-3 vitrified tissue also exhibited a K+/Na+ ratio in the same range as control (untreated) slices, providing evidence of retained cellular viability. The vitrification solutions that have been used by Alcor to date (B1C, B2C, and M22) reflect the discoveries that have been identified in this and other 21st Century Medicine, Inc., papers.

This progress in cryopreservation of brain slices goes a long way toward establishing the credibility of cryonics as a legitimate scientific and medical endeavor, but an even more convincing statement could be made if we are able to provide evidence of functional recovery of previously vitrified brain tissue. Such evidence would include recovery of spontaneous and/or organized neural activity, or maintenance of a previously trained neural response, such as long-term potentiation (LTP). Starting at the first Suspended Animation conference in May 2007 researchers at 21st Century Medicine, indeed, began disseminating preliminary results showing that organized neural activity has been recovered in previously vitrified brain slices.

But even successful observation of LTP after cryopreservation provides only indirect evidence for memory maintenance. Alternatively, post-burst after hyperpolarization (AHP) of hippocampal CA1 neurons may be characterized after cryopreservation of animals that have successfully acquired a hippocampal-dependent (memory) task. The demonstration of reduced AHP and accommodation in hippocampal neurons after acquisition of such a task and subsequent cryopreservation of the brain would be a huge step in the direction of proving that memories can be cryopreserved.

Beyond slices, recovery of *whole brain* electrical activity (EEG) after vitrification and storage at cryogenic temperatures would further provide strong empirical evidence that cryopreservation is a means of saving human lives. In 2012 my own company, Advanced Neural Biosciences (ANB), developed, to our knowledge, the first small animal EEG model for cryobiology research and we have been successful in recovering EEG activity after cooling and rewarming from 0°C. Our next, and more difficult, challenge will be to extend these results to high-subzero temperatures, and ultimately, to cryogenic temperatures.

CHALLENGES IN BRAIN CRYOPRESERVATION

While there have been significant advances in cryonics over the last 40 years, there also remain significant barriers to meeting the goal of reversible brain cryopreservation. Among the most important to address include cryoprotectant toxicity, brain dehydration, fracturing, and ischemia.

When a cryoprotectant solution is introduced to tissues, more than 50% of the water inside of cells is replaced by cryoprotectant molecules (which cannot freeze). Such a high concentration of cryoprotectant, while preventing freezing, comes with its down-sides. Cryoprotectant toxicity, discussed briefly earlier, is the trade-off for eliminating the mechanical damage caused by freezing via the use of high concentrations of cryoprotectants. Add low temperatures to the equation and many of the things we know about the toxicity of such agents at ambient temperatures don't apply anymore, making the situation that much more complicated.

What we now know is that higher lipophylicity correlates with higher toxicity, as does strong hydrogen bonding (probably by disrupting the hydration shell around macromolecules). Other important discoveries include the reduction of toxicity when two highly toxic cryoprotectants are combined, such as DMSO and formamide. In general, however, our understanding of the mechanisms of cryoprotectant toxicity remains incomplete.

Brain dehydration following cryoprotection is another vexing issue.

Dehydration of the brain is observed in cryonics in cases when cryoprotective perfusion is started and the blood-brain-barrier (BBB) is still intact. Because it is only seen when circulatory access is uncompromised, brain dehydration is often thought of as an indicator of a "good perfusion."

The BBB, a network of endothelial cells forming tight junctions around capillaries, functions to separate the circulating blood from the brain extracellular fluid and thereby prevent unwanted and potentially dangerous bacteria and molecules from entering the brain. Unfortunately, that includes some components of cryoprotectant solutions, and the osmotic imbalance this causes during perfusion can result in dehydration. In good cryonics cases, dehydration of up to 50% total brain volume has been observed.

It is currently not known what degree of dehydration still permits recovery of function in the brain, but research by Yuri Pichugin at the Cryonics Institute suggests that opening the blood brain barrier may permit higher viability of brain slices after cryoprotective perfusion of the whole brain. Intuitively, however, severe dehydration of the brain would be preferable to avoid if possible, especially since we don't know *how much* dehydration is compatible with reversal.

Another well-known issue in the cryopreservation of mammalian organs and human cryopreservation is fracturing, or "cracking," caused by thermal stress during cooling. Thermal stress occurs because different parts of the tissue cool at different rates, resulting in different rates of thermal contraction. In vitrified samples, fracturing occurs mostly between the glass transition temperature (the temperature at which the cryoprotectant solution and tissues vitrify, around -120ºC) and liquid nitrogen temperature (-196ºC).

Alcor has observed fractures in the bodies and brains of patients removed from cryopreservation either by court order or for transfer and conversion to neuropreservation. Measurement of fracturing events using an acoustical monitoring device has enabled Alcor to plot events during the cooling process. In "Systems for Intermediate Temperature Storage for Fracture Reduction and Avoidance," Brian Wowk reports that "acoustic events consistent with fracturing were found to be universal during cooling through the cryogenic temperature range. They occurred whether patients were frozen or vitrified. If cryoprotection is good, they typically begin below the glass transition temperature (123°C for M22 vitrification solution). If cryoprotective perfusion does not go well, then fracturing events begin at temperatures as warm as 90°C." Preliminary inspection of fracturing events at Alcor suggests the newer generation of vitrification agents produce fracturing at lower temperatures than the older (glycerol) protocols, with the lowest first fracturing temperature being recorded at -133°C.

One approach to limit or eliminate fracturing is Intermediate Temperature Storage (ITS) in which the patient is stored at a temperature (slightly) below the glass transition temperature of the vitrification solution but above liquid nitrogen temperature.

Finally, ischemia remains a major obstacle to successful cryopreservation. Ischemia, or a lack of blood flow to tissues, is experienced globally (throughout the whole body) when the heart stops, as is legally required for cryonics procedures to begin. This lack of blood flow kicks off a biochemical chain reaction known as the "ischemic cascade" ultimately leading to cell death and tissue deterioration. And while some terminal patients may have a cryonics standby team at the bedside to minimize ischemic damage, many others are not so lucky. Some cryonics members die alone and may experience several hours, or even days, of ischemia at ambient temperatures. Even in cases with rapid stabilization there can be substantial periods of cold ischemia prior to the patient arriving at Alcor.

In a series of experiments in the early 1990s, Darwin et al. examined histological, ultrastructural, and gross structural preservation of the brains of both non-ischemic cats and cats that underwent 24 hours of warm and cold ischemia (30 min normothermic / 24 hours water ice temperature) prior to cryopreservation with glycerol. Compared to non-ischemic animals, cats perfused following ischemia exhibited significant perfusion impairment (areas of the body and brain that were not perfused at all) and more fracturing.

Experiments at Advanced Neural Biosciences certainly corroborate the above findings, and add to them. Over the past several years, we have extensively investigated the effects of both warm and cold ischemia on cryoprotection and cryopreservation of rat brains. In general, we have found that ischemia is positively correlated with perfusion impairment and ice formation (mostly in non-perfused areas). Cold ischemia, we have found, is much more amenable to intervention than warm ischemia, especially if the patient's blood is replaced with an organ preservation solution such as Alcor's MHP-2—our best performing solution to date. We also found some intriguing preliminary evidence that perfusion with a high viscosity cryoprotectant was successful in (partially) overcoming ischemia-induced perfusion impairment. Having said all this, extended periods of warm and cold ischemia are not compatible with maintaining viability of the brain, no matter how good the cryoprotectant is. One potential solution is to introduce "field vitrification" in which the vitrification solution is introduced at a remote location and the patient is shipped on dry ice to the cryonics facility for further cool-down.

Another challenge in the practice of cryonics has been the lack of feedback concerning the effectiveness of cryoprotection protocols in human cases. Alcor has recently begun to take advantage of imaging technologies in order to assess cases. The Alcor CT Scan Project kicked off in December 2011 with the scans of two neuropatients (one cryoprotected and one "straight frozen"). Such scanning can provide valuable feedback regarding the quality of perfusion and cryoprotection of the brain and enables the direct comparison of brains cryopreserved after various patient scenarios such as immediate stabilization vs. long periods of warm or cold ischemia.

Similarly, Alcor would like to obtain very small brain biopsy tissue samples from patients prior to cryogenic cool-down and long-term storage. One pending question is whether CT scans and brain biopsies should be done routinely for all patients, and, if so, whether this should be on an opt-in or opt-out basis.

INTO THE FUTURE

Brain and whole body cryopreservation research is ongoing both at 21st Century Medicine (21CM) and Advanced Neural Biosciences (ANB). At 21CM, an ambitious research program aimed at understanding and improving brain preservation is currently in progress. Among the issues that 21CM are studying are the ideal composition

of cryoprotectants and carrier solutions for the brain, the relationship between perfusion protocols and ultrastructure, and the effects of various methods to open the blood brain barrier. While 21CM has made a number of important discoveries in brain preservation, the publication of a new peer reviewed paper on this topic is pending the resolution of proprietary issues.

At ANB, we are currently utilizing electroencephalography (EEG) in rats to assess the potential for functional recovery of the whole brain after cryopreservation. As discussed, we are taking an incremental approach, first cooling and resuscitating rats from temperatures just below those causing cardiac arrest (around 25°C), then from 0°C, and later from increasingly lower subzero temperatures requiring introduction and removal of cryoprotectant.

Our whole brain cryopreservation research uses two distinct models: (1) whole body resuscitation and (2) isolated brain perfusion. We aim to push the whole body model down to the lowest temperatures possible but will switch to the isolated brain (or head) model when we reach the (short-term) limits of that model. The advantage of the whole body resuscitation model is that we not only recover whole brain electrical activity but heart and respiratory function, too. Like 21CM we are also seeking a better understanding of the effects of brain dehydration on viability because we expect that severe dehydration will become a limiting factor in recovering brain function after cooling to cryogenic temperatures, and perhaps even at high subzero temperatures.

CONCLUSION

Although both Alcor and the Cryonics Institute introduced their most recent vitrification solutions in 2005 and the last peer reviewed journal article about brain cryopreservation was published in 2006, research in this area continues and progress is undeniably being made. Building upon observations of good structural preservation of brain cells and tissues in the 70s and 80s, the goals for such research programs are well-defined and involve obtaining ever-better structural preservation and the recovery of viability and, ultimately, recovery of function after cryopreservation of whole brains.

The accomplishment of each of these goals could provide more evidence to uphold the argument that cryonics patients are not dead by contemporary medical criteria and helps to validate cryonics as an evidence-based procedure for preserving terminally ill patients in a state of suspended animation until they can be successfully treated. More than any other advances in cryobiology to date, the functional recovery of a whole brain, either isolated or within an organism, will allow cryonics organizations to stand on solid scientific ground and to focus more energy on improving preservation methods for at-risk patients and less energy on arguing whether cryonics is a viable technology.

A timeline is provided below to identify research and developments that have contributed to progress in brain cryopreservation. ■

CHRONOLOGY OF PAPERS AND DEVELOPMENTS RELEVANT TO BRAIN CRYOPRESERVATION

1966

Suda I, Kito K, Adachi C. "Viability of long term frozen cat brain in vitro," Nature, 212, 268-270 (1966).

1974

Suda I, Kito K, Adachi C. "Bioelectric discharges of isolated cat brain after revival from years of frozen storage," Brain Research, 70, 527-531 (1974).

1984

Fahy GM, Takahashi T, Crane AM. "Histological cryoprotection of rat and rabbit brains," Cryo-Letters, 5, 33-46 (1984).

1993

Hixon H. "Getting to 8M glycerol and other problems," Cryonics, 14(11), 21 (1993).

(Transition of Alcor to high molar glycerol solutions)

http://www.alcor.org/cryonics/cryonics9311.pdf

1995

Darwin M., Russell S., Wakfer P., Wood L., Wood C. "Effect of Human Cryopreservation Protocol on the Ultrastucture of the Canine Brain." Originally published by BioPreservation, Inc., as BPI Tech Brief 16 on CryoNet and sci.cryonics, May 31, 1995

http://www.alcor.org/Library/html/braincryopreservation2.html

2000

Chamberlain F. "Vitrification arrives: New technology preserves patients without ice damage," Cryonics, 21(4), 4-9 (2000).

(Introduction of vitrification solution for neuropatients at Alcor)

http://www.alcor.org/cryonics/cryonics2000-4.pdf

2004

Fahy GM, Wowk B, Wu J, Paynter S. "Improved vitrification solutions based on the predictability of vitrification solution toxicity," Cryobiology, 48(1):22-35 (2004).

Lemler J, Harris SB, Platt C, Huffman T. "The Arrest of Biological Time as a Bridge to Engineered Negligible Senescence,"Annals of the New York Academy of Sciences, 1019, 559-563 (2004).

2005

"New Cryopreservation Technology," Alcor website (2005).

(Introduction of M22 for both neuropatients and whole body patients at Alcor)

http://www.alcor.org/Library/html/newtechnology.html

Best B. "The Cryonics Institute's 69th Patient," Cryonics Institute website (2005).

(Introduction of VM-1 at the Cryonics Institute)

http://www.cryonics.org/reports/CI69.html

2006

Pichugin Y, Fahy GM, Morin R, "Cryopreservation of rat hippocampal slices by vitrification," Cryobiology, 52, 228-240 (2006).

2007

Announcement of recovery of organized electrical activity after vitrification of brain slices by 21st Century Medicine, Suspended Animation Conference, Fort Lauderdale, Florida.

2012

Advanced Neural Biosciences establishes small animal EEG model for cryobiology research.

2013

Fahy GM, Guan N, de Graaf IA, Tan Y, Griffin L, Groothius GM. "Cryopreservation of precision-cut tissue slices," Xenobiotica, 43(1):113-32 (2013).

(Examination of precision-cut tissue slices of vitrified rabbits, including the brain)

IN PERPETUITY

GETTING THE WORD OUT

By Keegan Macintosh

For this month's column, I have been asked to write about how to start a viable and well-attended local life extension group. I suppose the reason I am qualified to write on this subject is because I have been working on precisely that for the past three years, ever since I first learned about life extension and cryonics. However, I certainly didn't know how to do such a thing when I started out, so as much as I would love to provide a step-by-step recipe for the successes we have had in Vancouver, so much has been done by trial and error that the best I can do is communicate some of the things I believe have been instrumental in what we have managed to accomplish so far with Lifespan Society of British Columbia. So, without further ado:

Indulge your obsession… at least at first. If you are still in that highly energetic, early phase in your interest for life extension, just go with it! Read everything you can about the topics that interest you, including what the critics and detractors have to say, so that you can credibly educate others on the subject. Learn the answers to the typical objections—but be gentle when you repeat them, you don't want to scare people off by treating them like they're stupid for not being so sublimely rational as you are. Aim to become *the* person others are referred to in order to learn more about cryonics/SENS/supplements/your topic of choice.

Some attendees of our mini-conference in December, 2012, discussing life extension and cryonics.

Make yourself available. It's easy—just offer to take people out for coffee! Even once you have a group going, many people will find the idea of going to a group composed entirely of unknown people somewhat intimidating (I know I do!). If people reach out to you about life extension or cryonics, tell them about your group but also offer to meet them for coffee/beer/whatever. Many of Lifespan's current members are people I had a one-on-one conversation with about life extension and cryonics over the last three years.

Listen. One major piece of advice I have for anyone interested in life extension advocacy is to really listen to the people you talk to about these subjects, and learn to understand why they are interested. Don't make the mistake of assuming that their reasoning, their philosophy, their politics are either the same as yours, or else wrong. Of course many of us tend to think that way privately, but if you allow yourself to be permeable to other viewpoints (even as you intentionally challenge mainstream beliefs by holding your divergent beliefs publicly), you could be surprised by others' capacity to grab onto new ways of thinking. Arguing with the intent to have someone

Lifespan members and volunteers at our booth at the Vancouver Mini Maker Faire in June 2013.

change their mind *publicly* is almost always a losing battle, and is more about the arguer's ego being around to see its own triumph of reason than it is about the desired effect of changing the way people think. Ask questions and answer questions, but do so softly and humbly.

Reach out and meet up. One of the earliest things I did after becoming interested in cryonics was make contact with someone through the Cryonics Society of Canada mailing list, who I knew lived reasonably close to me, and offer to host him and any other likewise interested people he knew from the area to meet me in the boardroom of my condominium to discuss local developments. The majority of us are still involved with what became Lifespan Society, and are still meeting regularly three years later. I really think in-person meetings are key, even if the group starts small and it seems like the same discussion could be done over email. If you don't know anyone in your area yet, check out the regional sections of larger forums, like longecity.org, or by posting an invitation to meet on a mailing list. There is also a list of regional cryonics groups at the back of this magazine, which is a good place to start.

Don't just talk. Now, I would say that this movement is still in a sufficiently early stage that simply meeting live and talking about it *is* progress, but even the most passionate supporters can get bored sitting around a table discussing the same points over and over. So the next step is to build some kind of activity around the conversation (the true content) to adhere to. As an example, at Lifespan we host movie nights where we screen documentaries, videos of conference presentations, or even just thematically-related films, and then discuss them afterwards. These have proven very popular. We also had a night out at the theater recently, when the opportunity arose to see a play that touched on themes of radical life extension, transhumanism and the Singularity. We also hold nature walks and hikes, which, as a life extension group, puts our money where our mouth is by integrating some physical activity into our meetings.

Start a local mailing list, or online forum. Larger mailing lists and social networks are fantastic places to learn and to meet people, but once you reach a critical mass in your local meetings, it will become unwieldy to coordinate these via direct emails (people getting dropped from the cc's, etc.). Get yourself a space where you can talk about local issues with local people without worrying about spamming outsiders. Some people who may not be as comfortable discussing these topics on large public fora may open up on a smaller, locally-oriented list as well. Google and Yahoo groups are both good for this, though if you're fairly privacy-oriented, you may want to look for alternatives.

Set goals. The group's keeners will want to be able to make progress on particular ideas, and while public meet-ups are very valuable for growing your network, they are not the best venue for objective-driven meetings with agenda, etc., because every newcomer ends up needing to be brought up to speed before they can contribute meaningfully. Sometimes also the topic of discussion may be of a sensitive nature, or there might be people who would like to attend, but are a reluctant of being publicly affiliated with "controversial" ideas, and would rather there was someone playing gatekeeper to the more serious meetings. Float a date, book a room (or if you have a big enough space yourself, volunteer your place), and circulate agenda items on your local mailing group.

Infiltrate your local university. Obviously, in this case it helps if you happen to be a university student, as I was when I first became aware of life extension. But if you aren't a student, nor do you know one, you could strategically host a public meet-up at a venue on campus and advertise there. Students are often looking for volunteer experience for their resumes, and many universities have a club 'incorporation' system which grants student organizations access to club grants, and use of university venues at reduced rates or even free. Undergraduate students are comparatively easy to get excited about life extension, probably because they haven't been in the "system" long enough to become doctrinally entrenched and

Registered Dietician Ketti Goudey giving a presentation on the Loma Linda lifestyle of longevity.

hyper-skeptical. If anything, the revolution in medicine that Aubrey de Grey's and others' visions of life extension represent makes science feel exciting again, giving students a taste of what it might have felt like to be a budding scientist during the Space Race.

Infiltrate other groups. Find related groups, such as humanists, transhumanists, or rationalists, and start attending their meetings. There are very good arguments for separating life extension advocacy from all the "-isms" it has historically been attached to, but that said, groups devoted to these ideologies are still good places to meet people who are more likely than the average person on the street to get excited about life extension. The cross-pollination can work both ways, exposing your existing members to a forum where they can discuss things they may be interested to talk about, but that is outside the scope of your life extension group.

If you are under 30, and interested in cryonics, I would highly recommend getting funding arrangements in place, for all the usual reasons of course, but also to attend the Teens and Twenties cryonics gathering in Florida. Having attended in 2010, I can say with certainty that you are unlikely to meet a more interesting group of young persons. The gathering draws young scientists and researchers, philosophers, actors, musicians, and cryonics professionals, and there are scholarships available for cryonicists under 30 to pay full or partial costs of travel and attendance, generously provided by the Life Extension Foundation.

Find something to rally around. One of the most challenging aspects of life extension activism is that it is such a broad concept in the first place (even before considering the differences of opinion as to what exactly counts as life extension *within* the community itself!). Here in B.C., our need to better clarify what exactly the notorious anti-cryonics law means for cryonicists in the province, and our desire for the government to justify its existence have, since the inception of our local community, served as rallying points around which the other parts have coalesced. But a good rallying point doesn't have to be reaction against government intervention. Perhaps there is someone in your area in a situation like Kim Suozzi, or Aaron Winborn, who is interested in cryonics, but due to circumstances (likely immediate need) cannot afford it. Whatever your objective, if you can convince the larger community of its value, you may find that they have a sufficient stake in what you are doing to provide much-needed financial support.

Get Help! At some point, it will simply not be possible for you to do everything yourself. If you are in school, or working, you will need help keeping meetings and events happening, and growing. Start developing these kinds of relationships early on, so you never get to the point of burning out—or even if you do, there are others able to take the reins for a while. And then, once you're ready, incorporate! Not only is this a sign that you have officially 'arrived' as an organization, but it's also a good idea if your activities are starting to get more attendance, and especially if they're getting more… adventurous (from a liability perspective). It's also difficult to attract significant funding without a corporate identity and bank account. Take advantage of free or low-cost local resources available to fledgling non-profits. The local university chapter of Pro Bono Students of Canada was immensely helpful to Lifespan early on, connecting us with lawyer supervision for drafting our incorporating documents, as well as doing some legal research for us on the B.C. anti-cryonics law.

Conclusion. In writing this, I came to realize how many of the suggestions I have could be lumped under the heading of "networking." I don't consider myself to be a very effective networker—and if someone asked me for my feelings on networking in the abstract, I would probably tell them I positively abhor it… and that is usually the truth! But in life extension I found a topic that captivated me so completely that I did quite a lot of networking over a relatively short period of time without really realizing it. So I guess it all goes back to the top item in the list: indulge your obsession (within reason). Fuel your passion, and the rest will come naturally. ■

Keegan Macintosh is Executive Director of the Lifespan Society of British Columbia, where he is working to address issues of access to life extension technologies (keegan@lifespanbc.ca).

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INTERVIEW

CRYONICS MAGAZINE EDITOR ASCHWIN DE WOLF

By Stephen Cave

This magazine generously reviewed my book *Immortality: The Quest to Live Forever and How it Drives Civilization* in the November/December 2012 edition. But the reviewer argued that I didn't properly understand cryonics—so I decided to speak to a leading expert. This interview, with *Cryonics* magazine's editor Aschwin de Wolf, is the result. Parts of the interview appeared originally in *Aeon Magazine* (http://www.aeonmagazine.com)

WHAT IS CRYONICS?

Cryonics is sometimes described as "medical time travel"—is that how you see it?

Yes, that is a good characterization. What sets cryonics apart from other medical procedures is not uncertainty (which is an element of many experimental medical treatments) but the temporal separation of stabilization and treatment. Cryonics reflects the recognition that a disease considered terminal today might be treatable in the future.

DOES/WILL CRYONICS WORK?

What is the largest (or most complex) organism (or tissue) that has been successfully cryopreserved and revived (or reversibly vitrified)?

A rabbit kidney has been vitrified and successfully transplanted with long-term survival. Another major achievement that supports the practice of cryonics is the successful vitrification and functional recovery of rat hippocampal brain slices.

In terms of whole organisms, tardigrades and certain insect larvae have been successfully recovered after cryopreservation at low sub-zero temperatures.

What breakthroughs in cryopreservation are still required? When do you think they might come?

Recovery of organized electrical activity in the whole brain (EEG) after vitrification and rewarming would provide further support for the practice of cryonics. This may be achieved in about 5 to 10 years. Long term, the aim should be true suspended animation of a mammal.

It is important to recognize, however, that the damage associated with today's cryonics procedures only excludes meaningful future resuscitation if the original state of the brain cannot be *inferred*. Damage-free cryopreservation would be sufficient, but it is not necessary, to justify practicing cryonics today.

Cryonics depends upon faith in technological progress and social stability (such that well-disposed scientists and physicians in the future will be both able and inclined to revive cryonics patients). Why do you believe the future will be so utopian?

In my opinion, it is more reasonable to ask why anyone would make decisions on the premise that medical progress would come to a screeching halt. Cryonics patients have time, and successful resuscitation does not necessarily require fast or accelerated progress. Cryonics does not rest on a utopian, but on a very conservative, premise.

Resuscitation of cryonics patients is the foremost responsibility of a cryonics organization. That is why organizations like Alcor set aside substantial amounts of money in a separate trust to allow for the maintenance and eventual resuscitation of the patient.

SOCIAL ACCEPTANCE

Why do you think cryonics is not more popular?

It would be tempting to say that cryonics is not more popular because most people do not think it will work. The problem with this explanation is that hundreds of millions of people believe in all kinds of things for which there is no strong empirical evidence at all, such as astrology. In addition, when faced with a terminal prognosis people have a really low threshold for believing in the most implausible treatments. If the popularity of cryonics would be a function of its scientific and technical feasibility, we should have seen major increases in support when new technologies, such as vitrification, were introduced.

The most likely explanation, in my opinion, is that people fear social alienation and solitary resuscitation in an unknown future.

In fact, writers such as Arthur C. Clark, who strongly believed that cryonics will work, personally admitted as much. This is a real challenge for cryonics organizations but there is a growing interest in topics such as reintegration of cryonics patients.

Do you think there might be a tipping point in its popularity? What might bring such a tipping point about?

Scientific and technological breakthroughs in cryobiology (suspended animation) and cell repair will certainly help, but if fear of the future holds most people back there may not be such a tipping point. It is possible, however, that in certain demographical groups making cryonics arrangements will be recognized as the normal, rational, thing to do. Something like this is already happening in subcultures that are interested in human enhancement or reducing bias in decision making.

Do you think there will be a day when cryonics is the normal procedure for treating those with diseases incurable by contemporary medicine?

Yes, or at least some kind of long term stabilization procedure will be used for people who cannot be treated by contemporary medicine. I find it hard to imagine that people will persist in burying or burning a person just because there is no treatment today. That is just irrational and reckless.

PHILOSOPHY AND LEGAL STATUS OF CRYONICS

Are those who are currently cryopreserved, in your view, actually dead?

No. But I do not think we can just claim that they are alive in the conventional sense of the word either, although that may change if we can demonstrate that cryopreservation can preserve viability of the brain.

If not, what state do you consider them to be in?

If the original state of the brain, what some scientists call the "connectome," can be inferred and restored, cryonics patients are not dead in a more rigorous sense of the word. Their identities are still with us in an information-theoretical sense.

What legal status do you think those who are cryopreserved should have?

They should have much stronger legal status than the deceased have today. While a meaningful philosophical/technical distinction could be made between conventional patients and cryonics patients, I think we need to err on the side of caution and give them the same kind of protection as other patients with terminal diseases.

At the very least, obstacles to conducting good human cryopreservation in hospitals should be eliminated because a lot of reservations people have about cryonics are not intrinsic features of the procedure but the results of cryonics organizations being forced to practice cryonics as a form of emergency medicine.

When should it be legal for someone to have themselves cryopreserved (eg, any time? when diagnosed with a terminal illness? or only when brain-dead according to current definitions? etc.)?

If a patient has been diagnosed as "terminal," that is basically an admission of the physician that (s)he has exhausted contemporary medical treatment options. At that point it is prudent to identify other means of saving the patient's life, including stabilizing them at lower temperatures for *future* treatment. This is particularly important if the patient is in a condition where continued metabolism will progressively destroy the brain. Such a procedure would be the opposite of assisted suicide because its aim would be to preserve life, not to end it.

ETHICAL CONSIDERATIONS

The overpopulation problem: if a few generations of people do all have themselves cryopreserved, then when technology permits them to be revived and healed, will there not be an enormous population boom? How will this be managed?

There are several responses to this question. The most obvious one is to draw attention to the fact that today's socio-economic debates in the West are about the consequences of a decline in population in the future as a consequence of people having fewer children.

It is also important to recognize that cryonics does not operate in a sociological, psychological, and technological vacuum. If support for the procedure changes so will our views on reproduction and sustainability.

Of course, it should not even be assumed that future generations will be confined to one planet (Earth).

What do you say to the idea that death gives meaning or shape to life?

Cryonics is not a permanent cure for death. There may always be catastrophic events that could irreversibly kill a person or whole populations. In fact, it may never be possible to know that we will not die for the simple fact that this would require absolute knowledge about the infinite future.

Having said this, no, I do not think that death gives meaning to life. That is just an admission that the things that matter do not have intrinsic value but are experienced with mortality as a framework. Neither introspection nor observation of ordinary life suggests this.

In fact, I suspect that short human life-spans have an adverse effect on morality because it fosters instant gratification and indifference about long-term reputation and/or consequences.

On the other hand, do you think we are morally obliged to practice cryonics (as we might be to try to prolong life in other ways)?

My qualified answer is "yes." If we believe that the aim of medicine is to preserve life and reduce suffering, cryonics is a logical extension of this thinking. Cryonics is not only a rational response to the recognition that science and technologies can evolve, but it also can be important to stabilize devastating cases of acute brain trauma.

YOU

When did you first become interested in life-extension technology?

In my case, my interest in life extension was a consequence of making cryonics arrangements.

When did you first hear about cryonics? When did you sign up for it?

I first read about cryonics on the internet in the mid-1990s. The idea seemed quite reasonable to me but I did not consider it as something that had direct personal relevance to me at the time. This changed in 2002 when a rather trivial medical condition prompted me to think more seriously about my remaining life and mortality. I read a lot of cryonics literature in a short period of time, attended the Alcor conference that autumn, and finalized making cryonics arrangements in January 2003.

Do you proselytize among friends and acquaintances? Have you had much luck in persuading others to sign up for cryonics?

Unless I know that a person has a strong interest in making cryonics arrangements, I generally do not explicitly try to persuade them. This is partly because I do not want people to get defensive in response to the idea. In cases where I know that the person is very open to cryonics, I put more effort into it. I think I have been successful in persuading around 4 people to make cryonics arrangements. There may be more that I am unaware of because of all the writing that I do.

Are you pursuing life-extension practices in the hope that you won't need to be cryopreserved?

Yes. As most people with cryonics arrangements, I have a strong interest in life extension and rejuvenation research. I am not very optimistic about short-term breakthroughs so I try to eat healthy, exercise, and avoid dangerous activities and excessive stress.

What is your educational background?

I graduated in political science at the University of Amsterdam and have a strong interest in economics and philosophy as well. Over time my academic interests have mostly shifted to biology and neuroscience—also because of the experimental research that I am involved in.

What is your involvement with Alcor or other cryonics institutes/firms?

I have been an Alcor member for 10 years and have been employed in cryonics either as an employee or on a contract basis since 2004. My main activities right now are to conduct neural cryobiology research in my lab at Advanced Neural Biosciences and to edit Alcor's monthly magazine, *Cryonics*.

I have always had a good relationship with the other major cryonics organization, the Cryonics Institute, too. In fact, without its support, and its individual members' support, our research would not have been possible.

What would be your best guess for the year when you will be revived by the scientists of the future? What might the world look like then?

I do not think that there is a uniform year for all cryonics patients. Much will depend on the condition of the patient and prevailing technologies and capabilities at the time. For a typical patient, I doubt we are going to see meaningful resuscitation attempts before 2075.

If the past is any guidance, the (far) future will be a combination of things that have always been with us and things we cannot even imagine right now. I suspect that the most characteristic change in the future will be a seamless integration of human technology and biology and greater control over the aging process. ■

PROTOCOLS IN CRYONICS:
PREHISTORY AND EARLY HISTORY

By R. Michael Perry

In cryonics the goal is to preserve the patient at legal death in the best manner possible, for eventual restoration to a healthy, functioning state. As practiced today, and when performed under good conditions, the preservative process consists of several steps: (1) standby, (2) stabilization, (3) cryoprotection, (4) transport, (5) cryogenic cooling (cooldown), and (6) long term storage. *Standby* means attention given to the patient before death is pronounced, most importantly, monitoring the patient so that further steps can be started as soon as possible after pronouncement. When that has occurred the first goal is *stabilization*: rapid, above-freezing-temperature cooling, cardiopulmonary support, medications administration and washout (replacement of body fluids) with "base perfusate" as preliminary to the next step. This in turn is *cryoprotection*—perfusion or replacement of fluids (base perfusate if washout was done previously, otherwise, body fluids) in tissues to reduce or eliminate freezing injury. These steps are important: in particular, without cryoprotection, the patient is just straight-frozen and brain tissue will be heavily freeze-damaged into "neural rubble" creating a possible very serious or even insuperable obstacle to future reanimation efforts. (It should also be noted that stabilization and cryoprotection are not necessarily cleanly divided; cooling can take place concurrently with cryoprotection, for instance.)

Another preliminary (usually) to cryogenic cooling is to *transport* the patient from a hospital or other "field" setting to a cryonics service provider where the remaining steps (stabilization and/or cryoprotection, if not done already; cooling and long term storage at low temperature) are carried out. The need for preliminaries to cryogenic cooling was recognized early in the cryonics movement, even before anyone had been cryopreserved. Looking at this early history, one is impressed by the sophisticated thinking that emerged so early, coupled with some very encouraging experimental results involving animal models, even though the practice of cryonics had few takers when it did get started, and progress all around was slow and uncertain. The summary of these times I've attempted here is not intended as a technical article—far from it—or a comprehensive survey either. I've mainly focused on standby, stabilization and cryoprotection, emphasizing certain details that seemed most important and likely to be of interest to readers.

"The need for preliminaries to cryogenic cooling was recognized early in the cryonics movement, even before anyone had been cryopreserved."

Robert Ettinger, who proposed the idea of freezing people for eventual reanimation in *The Prospect of Immortality* (commercially published June 1964), recognized the needs that his proposal would create well before the first actual cryopreservation occurred or any organizations to accomplish it existed. Only scant, though definite, attention is given to what is now called standby: "If you have a dying relative, you can probably give him his best chance by obtaining skilled medical help, planned in advance, to prepare, perfuse, and freeze the body." If such help is not available, "more desperate measures are required,"[1] though these are not specified. Considerably more space is devoted to post-pronouncement procedures, mainly cryoprotection, with the conclusion that perfusing the tissues (replacing the blood and other body fluids) with a glycerol solution would be the best available preliminary to cooling to low temperature. A precedent was found in procedures used for maintaining harvestable organs for transplanting.[2]

Not long after the publication of *Prospect* there was a contribution from the other main originator of the cryonics idea, Evan Cooper, who also created the first cryonics-promoting organization, the Life Extension Society or LES, based in Washington, D.C. The October 1964 issue of the LES newsletter has an article, "Perfusion, Cooling, and Freezing the Human Body," which offers a protocol for cryoprotection, though recognizing that many matters remained to be decided at that early stage. But preliminary suggestions are given for basic perfusion—cannulating the vasculature (inserting tubing) and pumping a cryoprotective

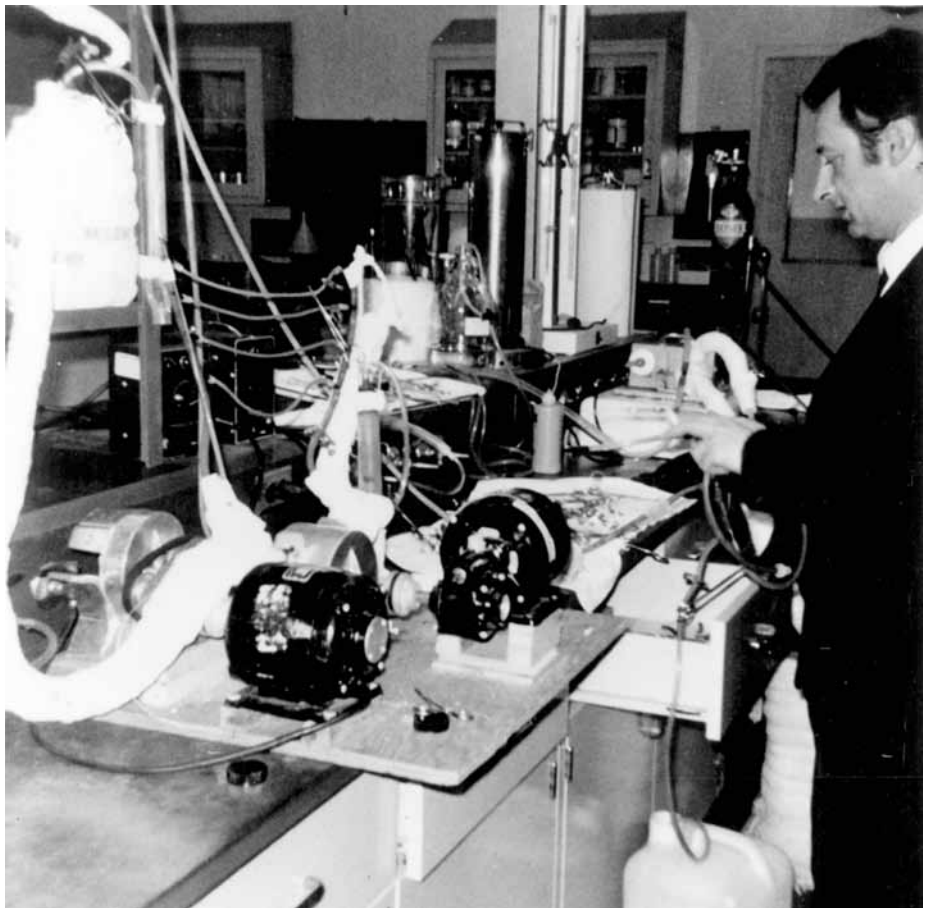
solution into the body while body fluids are withdrawn. Concurrent to this is cooling of the body through use of a heat exchanger (mixing stabilization and cryoprotection). Recommended protective agents are dimethyl sulfoxide (DMSO) or glycerol in a suitable medium such as physiological saline or Ringer's solution.[3]

The cryoprotective properties of glycerol had been discovered in the 1940s, mainly by British researcher Dr. Audrey U. Smith, in association with Sir Alan Parkes and Dr. Christopher Polge.[4] They found that individual cells, such as mammalian sperm cells, could be treated and stored at low temperature (79°C, dry ice temperature) then warmed and retain viability, which did not happen without this cryoprotectant. By the 1960s the usefulness of glycerol had been demonstrated with larger tissue masses, specifically the brain which is of paramount importance in cryonics. In 1965 Dr. Isamu Suda and colleagues of Kobe University, Japan, reported an experiment in which a cat brain was perfused with a glycerol solution and stored at 20°C for 203 days, then warmed and exhibited a nearly-normal brain wave pattern.[5] The partial revival (under anesthesia) was brief and limited, but the experiment energized the nascent cryonics movement and would inspire the author of a protocol associated (loosely) with the first cryopreservation under controlled conditions, that of James Bedford in January 1967.

Meanwhile attention had focused on another possible cryoprotectant, dimethyl sulfoxide (DMSO), largely due to the promotional efforts of Dr. Stanley W. Jacob at the University of Oregon Health Sciences Center Medical School.[6] DMSO has cryoprotectant properties comparable with glycerol, allowing recovery of functioning cells from cryogenic storage, and apparently had a remarkable ability to penetrate tissues. (For example, some reported that if a small amount of the clear, runny liquid were placed in the hand, a few minutes later a garlic-like taste would be noted as the substance penetrated the body all the way up to the tongue.)[7]

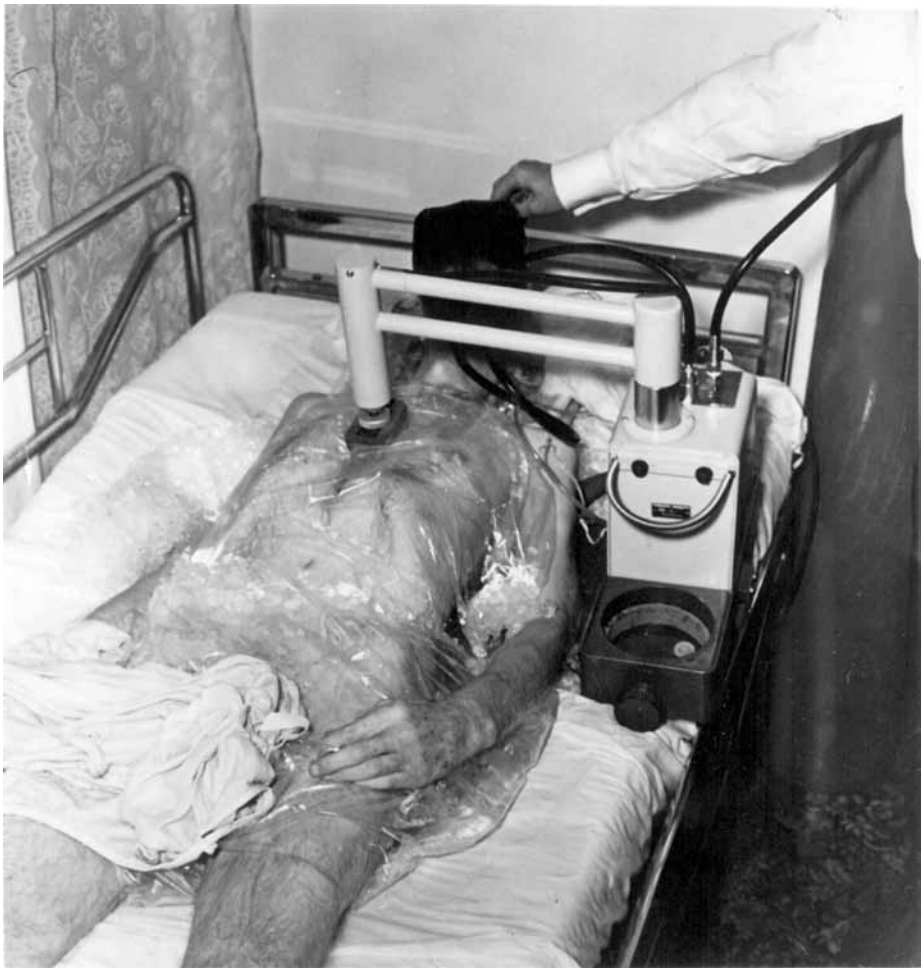
The 73-year-old Dr. Bedford, a retired psychology professor stricken with cancer, had gotten interested in cryopreservation and contacted Robert Ettinger. As the end approached the Glendale, California, resident assisted by his son, Norman, made arrangements for freezing with the newly-formed Cryonics Society of California headed by Robert Nelson. Equipment and supplies for the pending case were hurriedly assembled.[8] Bedford meanwhile was moved to a nursing home when his physician at the hospital would not cooperate on the freezing, and another, more sympathetic M.D., B. Renault Able, agreed to take over care. It was perhaps a stroke of luck that Dr. Able was present on Jan. 12 and could sign the death certificate promptly when the patient arrested at 1:15 p.m. and then begin stabilization. The end had come unexpectedly soon and a mortuary that was to have helped also withdrew its offer of support[9] so compromises and improvisations were inevitable. Heparin was administered to impede clotting, and artificial respiration and heart massage were used to keep oxygenated blood circulating while the patient was cooled with and then packed in ice.[10]

Dr. Able had to go out on an emergency call[11] and another physician arrived who in this case was also a biophysicist, Dr. Dante Brunol (full name: Mario Dante Bruno-Lena[12]). Brunol, after some delay and indecision, instigated and took charge of the cryoprotection, assisted by another scientist, Dr. Robert Prehoda, with Robert Nelson helping with the more routine tasks. A cardiac compression and lung ventilation machine that had been sent by Robert Ettinger, the Westinghouse Iron Heart, was used to facilitate circulation of the perfusate.[13] (Early published accounts say this substance was 15% DMSO in Ringer's solution[14]). The perfusate in this case was injected without removal of blood,[15] unlike later, more sophisticated



Robert Nelson, private communication, 25 Mar. 2007.

Dante Brunol, laboratory setting. Dark objects mounted on board, foreground, are roller pumps as would be used in perfusion.



Robert Nelson, private communication, 25 Mar. 2007.

James Bedford cryopreservation, January 12-13, 1967. Iron Heart piston rests on Bedford's chest, oxygen cylinder stands at right.

cryoprotections. However, injection was specifically into one or the other of the carotid (neck) arteries which it appears was intended to facilitate protection of the brain[16] (see below). Surviving details of what happened, as with most of the early cases, are scanty; though seemingly clear in these broad outlines. (At least Bedford's frozen remains are still maintained in liquid nitrogen—at Alcor since the 1980s—so someday much more should be learned about this first case, hopefully along with a successful reanimation!) In any case Bedford received standby, stabilization, and cryoprotection. Admittedly all three were quite limited, as judged in the glaring light of hindsight; still the whole affair was a landmark in early cryonics history.

About a month after the freezing, Brunol completed a protocol for perfusion and freezing that was printed as an appendix in Robert Nelson's 1968 book, *We Froze the First Man,* which recounts the Bedford freezing.[17] The book, mainly focusing on the dramatic rather than the technical elements of this first real cryonics case[18], refers inaccurately to the protocol as "the method" that was used in the freezing, though also cautioning that "theory and practice are widely divided here." Actually there were major discrepancies between what Brunol and assistants did and the written protocol—see below. Presumably Brunol felt justified in the choices that were made, based on the conditions at hand. As he said afterward, "I only had a few days to prepare the equipment for the freezing. Therefore, in my opinion, the method used for Dr. Bedford was very far from being satisfactory."[19] Aside from this, in fact Brunol's written protocol is a landmark of early cryonics literature, worth studying both for its general outlook and philosophical touches, and for the details of his proposed procedure, which, allowing for variations and refinements, have served as guidelines or food for thought ever since.

"A landmark event of this time was the 1972 perfusion and freezing of Clara Dostal by CSNY which introduced glycerol in appreciable concentrations and produced no edema."

Here I briefly I mention Brunol's overall rationale for proceeding with freezing even though successful revivals from such a state had not occurred (other than Suda's results). Many scientists thought (and the attitude persists today) that "freeze now" advocates were going too far and human cryopreservations should not occur "until the process is perfected." Brunol in introductory remarks to his protocol notes that "Professor Suda successfully revived a cat brain after six months of storage in a frozen state" then offers a touching rebuttal to those who would postpone efforts to save human lives through a similar approach. "How can I tell a dying man, begging for life: 'I cannot do anything for you. The lack of financing did not permit experiments in freezing large animals; therefore, it would be unscientific to attempt to send your body to future generations in the best condition of conservation. I am sorry, but I do not want to ruin my reputation.' A wealthy man does not have anything to lose in being frozen and I hope that future generations will be able to repair the damages produced by my method."[20] (The unwealthy can also take part, as cryonics organizations have carefully provided for, after some initial, disastrous mistakes in which funding ran out and patients were lost.)

Brunol's protocol has three stated objectives: (1) protection of the brain, (2)

avoiding formation of ice crystals in the still-living cells and avoiding hypersalinity, and (3) avoiding diffusion (loss) of chemicals from the cells and damage due to enzymes and microorganisms. The protocol first calls for heparinization to prevent clotting (this is stabilization), then perfusion of cryoprotectant through the femoral (thigh) arteries using a pump, with outflow (effluent) through the femoral veins to a reservoir where it will be discarded. This is an "open circuit" perfusion. (With "closed circuit" perfusion the effluent liquid is recirculated, a strategy sometimes used to help achieve a uniform concentration of cryoprotectant where the patient might have already been perfused with open circuit.) At first the outflow of the open circuit will mainly consist of blood and other body fluids; as perfusion proceeds the body fluids are increasingly diluted so that the effluent more nearly is just perfusate. A second perfusion is proposed for the lungs, in which the inflow is through the veins and the outflow through the arteries, "after the temperature reaches 10°C." Perfusion overall is intended both to cryoprotect and to cool the body,[21] again combining stabilization and cryoprotection.

"Standbys in the early days were haphazard, as they still often are; properly done cryopreservations, including standby and other preliminaries, are possible only for people who make arrangements in advance and do not die suddenly and unexpectedly."

In the case of Bedford it appears the cooling happened beforehand, via packing the body in ice. Cryoprotectant was introduced into the body by repeated injections with a syringe and was circulated via external heart massage. As noted the injections, or some sizable fraction of them, appear to have been into the left or right carotid artery, and possibly into the interior carotid branches that feed directly into the brain, to facilitate protection of this most-important organ. Overall, however, it can be asked whether much perfusate was actually introduced. Bedford's freezing may have been little better than a straight freeze, as even some later cases with better cryoprotective procedures using DMSO (see below)—someday this question should be answered as noted.

After Bedford the next cryonics case was of Marie Phelps-Sweet (Mrs. Russell Le Croix Van Norden, who though married liked to be known as Miss Sweet) in late August 1967, also carried out by the Cryonics Society of California (CSC) under Robert Nelson. The 74-year-old Miss Sweet was found in her hotel room some hours after death from a heart attack and thus received no standby. Her situation was complicated by the lack of formal arrangements or funding for cryopreservation even though she had been active in the infant cryonics movement for several years and was well-known and well-liked. After her body was discovered it was stored in a mortuary refrigerator (at 30°F) for several days before being transferred to the CSC offices in Los Angeles. There the body was perfused with DMSO-containing cryoprotectant by a mortician, Jeff Hicks, using an embalming pump, then frozen. (Dante Brunol, too, was reportedly involved.) As usual there is much that critical hindsight can argue against this crude process. Yet it did in one way advance the state of the art above the Bedford freezing: consistent with standard embalming practice, perfusate was not merely injected but body fluids were removed and replaced. It also established the precedent that mortuary personnel would direct the perfusions; this would be the norm at cryonics organizations for years to follow.[22]

The next cryopreservation that was not simply a straight freeze was of Helen Kline, in May 1968, also a CSC case. Miss Kline had both standby and cryoprotection (reportedly with perfusion, using a DMSO solution) in a hospital setting, with Jeff Hicks and another mortician, Joe Klockgether, in charge.[23] Reportedly there were substantial improvements

Alcor archives.

Cryopreservation of Fred Chamberlain Jr. From left: Fred Chamberlain III (son), wearing recording apparatus; Allen McDaniels, M.D.

over the previous case of Miss Sweet, including use of a kidney dialysis machine to better control temperature prior to the introduction of cryoprotectant.[24] Hicks would soon withdraw from cryonics—he was disillusioned with Nelson and what Hicks thought was an unscientific, uncritical and deceptive approach to human freezing—but Klockgether would continue with the CSC cases (and much later assist with Alcor cases in the area)[25].

After this the action shifts eastward. Steven Mandell, a member of the Cryonics Society of New York but not prominent in the organization, died suddenly in July 1968 and was perfused and frozen by that organization. A mortician, Fred Horn, handled the perfusion (as with later CSNY cases), working with Paul Segall and others of CSNY's volunteer staff. In this case the choice of cryoprotectant was glycerol (20% in Ringer's solution), because Segall was impressed by the Suda results using glycerol.[26] From this point glycerol-based cryoprotectants would become the norm in CSNY while organizations on the West Coast (not just CSC) would long adhere to DMSO.

The next cryonics case, the following September and once again with CSC, illustrates both the good and bad sides of standby and other cryonics operations under hardship. Russ Stanley was a well-known cryonics activist in the Los Angeles area. When, at age 59, he succumbed to a heart attack it was in a hospital ICU with a sympathetic staff who knew about and accepted his wishes to be cryopreserved. But his treatment was compromised because no M.D. could be found to supervise the perfusion, and the staff would not proceed on their own. Hours went by. Finally the patient was turned over to a mortician (Joe Klockgether), who completed the task of perfusion (with a glycerol solution, 20% in Ringer's as with Mandell, unusual for CSC) and proceeded with the cooldown to dry ice temperature.[27]

Standbys in the early days were haphazard, as they still often are; properly done cryopreservations, including standby and other preliminaries, are possible only for people who make arrangements in advance and do not die suddenly and unexpectedly. Other than James Bedford and Helen Kline it appears that there were essentially no standbys until 1976, and few after this until the 1980s. A notable standby, late in the period we are considering, was of Fred Chamberlain Jr. in July 1976. The father of Fred III who, with his wife Linda, had founded Alcor in 1972 (as a California organization), the elder Mr. Chamberlain had been ailing for years and his son and daughter-in-law were prepared for his time of need. (Fred Jr. was also the first Alcor case and the first neuro case. Like most of the other early California patients he was perfused with a DMSO solution.)[28]

Actually the Chamberlains worked very hard on Fred Jr.'s case and, by implication, other cases after him, even founding Alcor itself in the process, a cryonics membership organization, along with a sister corporation, Manrise, to assist with the technical aspects of cryopreservation. (Alcor eventually also assumed the functions of Manrise, which has long been inactive.) This startup occurred in the early 1970s after an initial involvement and disillusionment with CSC. (In fact the Chamberlains shared Jeff Hick's concerns about Nelson and his operations, which would end in a luridly publicized failure a few years later, though they were also determined to stay in cryonics and "make it work," come what may.) It is impossible to do justice to the Chamberlains' efforts and determination in a short space here, but I mention briefly that, being acutely aware of a need for an adequate cryopreservation protocol, they responded with *Instructions for the Induction of Solid State Hypothermia in Humans*.[29] Running to several hundred pages and replete with diagrams, figures and illustrations as well as much explanatory material, this first comprehensive manual on cryonics procedures modifies and vastly expands Brunol's treatment (and a revision of it by Peter Gouras).[30]

"About a month after the freezing, Brunol completed a protocol for perfusion and freezing that was printed as an appendix in Robert Nelson's 1968 book, We Froze the First Man, *which recounts the Bedford freezing."*

Finally it was realized that DMSO, for all its penetrative properties, had the very serious drawback during perfusion that it caused edema (swelling) of the body to the point that the procedure had to be stopped prematurely and any cryoprotection was greatly compromised.[31] (Thus it may be that many of the earliest cryoprotections were essentially straight freezes, along with Bedford's. This point, though, is largely mooted since, of those cryopreserved prior to 1974, all but Bedford were eventually thawed and lost.) A landmark event of this time was the 1972 perfusion and freezing of Clara Dostal by CSNY which introduced glycerol in appreciable concentrations and produced no edema. It also established an important precedent in the careful, scientific documentation and analysis of the procedures that were used.[32] More years of trial and error followed but by the 1980s glycerol had gained the upper hand and was used by all the active cryonics organizations. This continued until around 2000 when new cryoprotectants were developed that more effectively reduced ice formation. These in turn, however, abandoned glycerol in favor of the once-discredited DMSO[33] so that now, combined in the right proportions with other ingredients, the latter has made a striking comeback and displaced its longtime rival.

Thus far little has been said about one important topic, the equipment used in stabilization and cryoprotection. In the early days, though, these procedures were dominated by mortuary practice and equipment for embalming (including the venerable Turner Porta Boy pump) was most often used. The Chamberlains in fact pioneered the use of in-house-designed equipment for Fred Jr. since, among other things, his status as a neuro simplified the necessary operations.[34] Today the major U.S. cryonics organizations use their own equipment for higher-end cases, but the full story of when and how it came into being will have to wait. In any case, there is a feeling to distance cryonics from the funeral industry and affiliate it as far as possible with the medical establishment—for is it not experimental medicine? Yes, but in our zeal to affirm this there is danger I think in going too far. The funeral industry has done us great service in the past and we are still dependent on them for important services. We are not a funerary practice but we are not really conventional medicine, either. A golden alternative—between, around, and beyond the two—is what we are really about and this should be reflected in our approach to the world at large. ■

I thank Hugh Hixon for consultations and proofreading during the writing of this article, and also Aschwin de Wolf for helpful suggestions.
—R.M.P.

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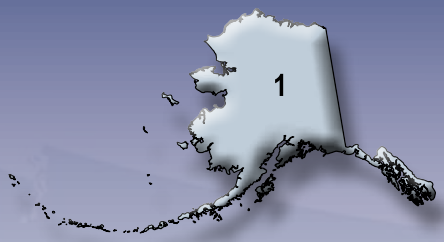
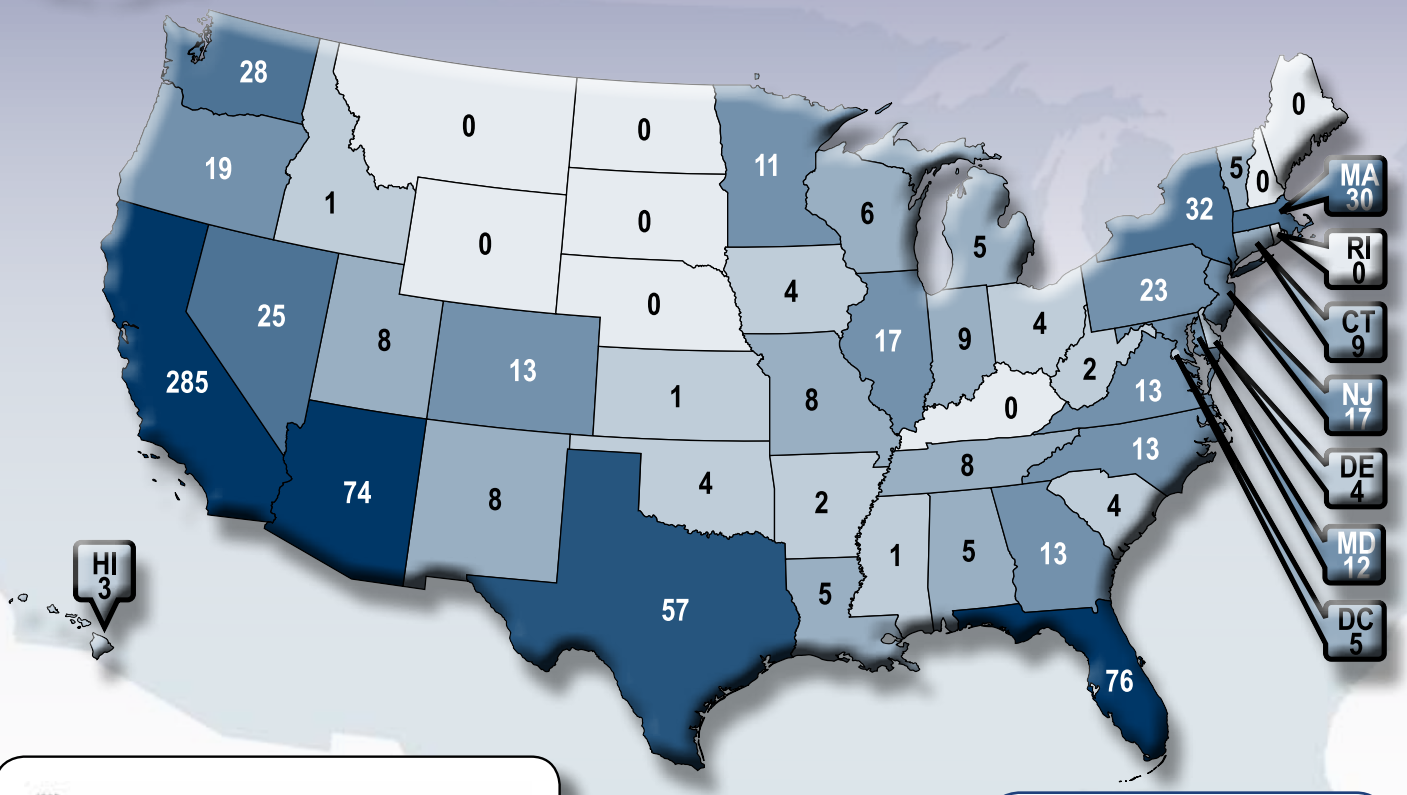
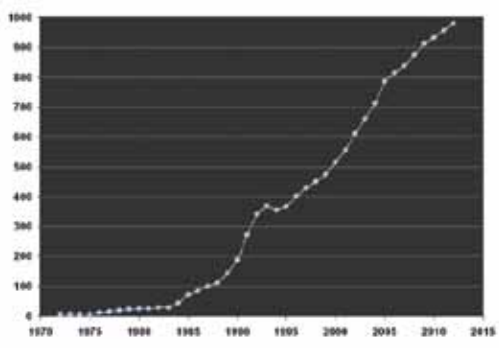
Membership Statistics

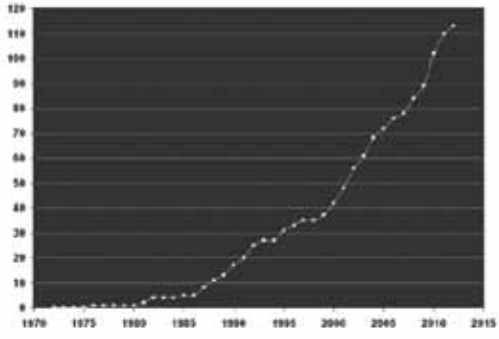


2013	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Members	981	983	985	974	980	982							
Patients	114	115	117	117	117	117							
Associate	37	40	42	44	45	49							
Total	1132	1138	1144	1135	1142	1148							





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
Aruba	2	0
Australia	13	2
Canada	43	2
Denmark	2	0
France	0	0
Germany	4	0
Israel	1	1
Italy	2	0
Lebanon	1	0
Luxembourg	1	0
Mexico	4	0
Monaco	2	0
Netherlands	2	0
New Zealand	2	0
Norway	1	0
Portugal	4	0
Spain	2	1
Thailand	3	0
United Arab Emirates	1	0
United Kingdom	22	2
TOTAL	**112**	**8**

VASCULAR BENEFITS OF A Mediterranean Diet

VALIDATED IN HUGE NEW STUDY

A large, rigorous study published in the ***New England Journal of Medicine*** confirmed the health benefits of those who switch to a **Mediterranean diet** rich in **omega-3 fish oil** as well as protective nutrients called polyphenols found in **olive oil**, fruits, vegetables, nuts like walnuts, and wine.[1] The study ended early because the benefits were so overwhelming, with startling benefits for vascular health, that it was considered unethical to continue to deprive the control group.[1]

In addition to the health-promoting benefits of vegetables and fruits with their abundance of polyphenol nutrients, the Mediterranean Diet group took at least **4 tablespoons** of polyphenol-rich extra-virgin **olive oil** a day.[1]

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Starting in **2005**, Life Extension members began taking a supplement (***Super Omega-3***) that provided potent concentrations of **fish oil** and **olive polyphenols** like hydroxytyrosol and oleuropein. This supplement also provided standardized **sesame lignans** to support the beneficial effect of omega-3 fatty acids in the body.[2]

Olive oil contains polyphenol nutrients that have demonstrated wide-ranging health benefits.[3-5] The recommended twice daily dose of **Super Omega-3** supplies a similar polyphenol content to that found in **4 to 6 tablespoons of olive oil.**

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A bottle containing 120 softgels of **Super Omega-3 EPA/DHA with Sesame Lignans and Olive Fruit Extract** retails for $32. If a member buys four bottles, the price is reduced to **$21** per bottle. If **10 bottles** are purchased, the cost is **$18.68** per bottle. (Item #01482)

The daily dose (four regular size softgels) of Super Omega-3 EPA /DHA with Sesame Lignans & Olive Fruit Extract provides:	
EPA (eicosapentaenoic acid)	1,400 mg
DHA (docosahexaenoic acid)	1,000 mg
Olive Fruit Extract [std. to 6.5% polyphenols (39 mg), 1.73% hydroxytyrosol/tyrosol (10.4 mg), 0.5% verbascoside/oleuropein (3 mg)]	600 mg
Sesame Seed Lignan Extract	20 mg

Item #01482

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CAUTION: If you are taking anti-coagulant or anti-platelet medications, or have a bleeding disorder, consult your healthcare provider before taking this product.

Supportive but not conclusive evidence shows that consumption of EPA and DHA omega-3 fatty acids may reduce the risk of coronary heart disease. IFOS™ certification mark is a registered trademark of Nutrasource Diagnostics, Inc. These products have been tested to the quality and purity standards of the IFOS™ program conducted at Nutrasource Diagnostics, Inc.

To order the most advanced fish oil supplement, Super Omega-3 EPA/DHA with Sesame Lignans and Olive Fruit Extract (with or without enteric coating), call 1-800-544-4440 or visit www.LifeExtension.com

How Computers Can Learn Better

At the Association for Uncertainty in Artificial Intelligence's annual conference this summer, researchers from MIT's Laboratory for Information and Decision Systems (LIDS) and Computer Science and Artificial Intelligence Laboratory will present a new reinforcement-learning algorithm that, for a wide range of problems, allows computer systems to find solutions much more efficiently than previous algorithms did. The paper also represents the first application of a new programming framework that the researchers developed, which makes it much easier to set up and run reinforcement-learning experiments. Alborz Geramifard, a LIDS postdoc and first author of the new paper, hopes that the software, dubbed RLPy (for reinforcement learning and Python, the programming language it uses), will allow researchers to more efficiently test new algorithms and compare algorithms' performance on different tasks. It could also be a useful tool for teaching computer-science students about the principles of reinforcement learning.

Larry Hardesty / MIT News Office
29 May 2013
http://web.mit.edu/newsoffice/2013/machine-learning-algorithm-outperforms-predecessors-0529.html

Fish Study Raises Hopes for Spinal Cord Injury Repair

Scientists have unlocked the secrets of the zebra fish's ability to heal its spinal cord after injury, in research that could deliver therapy for paraplegics and quadriplegics in the future. A team from Monash University's Australian Regenerative Medicine Institute (ARMI), led by Dr Yona Goldshmit and Professor Peter Currie, discovered the role of a protein in the remarkable self-healing ability of the fish. The findings, detailed in *The Journal of Neuroscience*, could eventually lead to ways to stimulate spinal cord regeneration in humans. Professor Currie said when the spinal cord is severed in humans and other mammals, the immune system kicks in, activating specialized cells called glia to prevent bleeding into it. "Glia are the workmen of nervous system. The glia proliferate, forming bigger cells that span the wound site in order to prevent bleeding into it. They come in and try to sort out problems. A glial scar forms," Professor Currie said. However, the scar prevents axons, threadlike structures of nerve cells that carry impulses to the brain, of neighboring nerve cells from penetrating the wound.

Monash University
30 May 2013
http://www.monash.edu.au/news/show/fish-study-raises-hopes-for-spinal-cord-injury-repair

New Resin for Making Electrodes uses Lasers for 3-D Micromolding

A new resin material that can be molded into complex, highly conductive 3-D structures with features just a few microns across has been developed by Tokyo Institute of Technology and C-MET, Inc. Combined with state-of-the-art micro-sculpting techniques, the new resin holds promise for making customized electrodes for fuel cells or batteries, or biosensor interfaces for medical uses. The research team, which includes physicists and chemists from Yokohama National University, presents its results in a paper just published in the Optical Society's (OSA) open-access journal *Optical Materials Express*. "One of the most promising applications is 3-D microelectrodes that could interface with the brain," says Yuya Daicho, graduate student at Yokohama NationalUniversity and lead author of the paper. These brain interfaces, rows of needle-shaped electrodes pointing in the same direction like teeth on combs, can send or receive electrical signals from neurons and can be used for deep brain stimulation and other therapeutic interventions to treat disorders such as epilepsy, depression, and Parkinson's disease.

Kurzweil AI
31 May 2013
http://www.kurzweilai.net/a-new-material-for-3d-printing-electrodes

U.S. Surgeons Implant Bioengineered Vein

In a first-of-its-kind operation in the United States, a team of doctors at Duke University Hospital helped create a bioengineered blood vessel and transplanted it into the arm of a patient with end-stage kidney disease. The procedure, the first U.S. clinical trial to test the safety and effectiveness of the bioengineered blood vessel, is a milestone in the field of tissue engineering. The new vein is an off-the-shelf, human cell-based product with no biological properties that would cause organ rejection. Using technology developed at Duke and at a spin-off company it started called Humacyte, the vein is engineered by cultivating donated human cells on a tubular scaffold to form a vessel. The vessel is then cleansed of the qualities that might trigger an immune response. In pre-clinical tests, the veins have performed better than other synthetic and animal-based implants. "This is a pioneering event in medicine," said Jeffrey H. Lawson, M.D., PhD, a vascular surgeon and vascular biologist at Duke Medicine who helped develop the technology and performed the implantation.

Duke Medicine News and Communications
6 Jun. 2013
http://www.dukehealth.org/health_library/news/surgeons-at-duke-university-hospital-implant-bioengineered-vein

Plan for First Head Transplant in Man

The June issue of *Surgical Neurology International,* the renowned open-access neurosurgical journal, to be released shortly, carries the executive project for the first head transplant in man, code-named HEAVEN/GEMINI (Head Anastomosis Venture with Cord Fusion). According to the anonymous reviewers, the article "opens a brand new field for contemporary medical science." The project is authored by Turin (Italy)'s neuroscientist and functional neurosurgeon Dr. Sergio Canavero. U.S. neurosurgeon Robert Joseph White (1926–2010) performed an operation to transplant the head of one monkey onto another's body on March 14, 1970. Unfortunately, the technology to repair the severed spinal cord was unavailable and so the monkey could not regain motor independence. Controversy followed and strong opposition mounted from several quarters. However, Dr White maintained that human head transplantation could take place early in the XXI century. According to Dr Canavero, the technical hurdles have now been cleared thanks to cell engineering.

Dr. Sergio Canavero / Turin Advanced Neuromodulation Group / Pressbox.co.uk
9 Jun. 2013
http://www.pressbox.co.uk/detailed/Science/announcing_plan_for_first_head_transplant_in_man_1205861.html

Artificial Spleen Offers Hope for Faster Sepsis Diagnosis and Treatment

Taking advantage of recent advances in nanotechnology and microfluidics, researchers at Harvard University's Wyss Institute for Biologically Inspired Engineering have made significant progress toward a device that could be used to rapidly remove pathogens from the blood of patients with sepsis, a potentially life-threatening condition that occurs when an infection is distributed throughout the body via the bloodstream. The new system effectively acts as an artificial spleen, filtering the blood using injectable magnetic nanobeads engineered to stick to microorganisms and toxins. After the beads are injected, blood is removed and run through a device that uses a magnetic-field gradient to extract the nanobead-bound germs. Then the blood is returned to the body. At a scientific conference at Harvard Medical School last week, Donald Ingber, one of the technology's inventors and the director of the of the Wyss Institute, said his group has been encouraged by preliminary results from tests of the blood-cleansing therapy in rats. The worst cases of sepsis can lead to the failure of multiple organs.

Mike Orcutt / MIT Technology Review
13 Jun. 2013
http://www.technologyreview.com/news/515886/artificial-spleen-offers-hope-for-faster-sepsis-diagnosis-and-treatment/

Printing Tiny Batteries

3D printing can now be used to print lithium-ion microbatteries the size of a grain of sand. The printed microbatteries could supply electricity to tiny devices in fields from medicine to communications, including many that have lingered on lab benches for lack of a battery small enough to fit the device, yet provide enough stored energy to power them. To make the microbatteries, a team based at Harvard University and the University of Illinois at Urbana-Champaign printed precisely interlaced stacks of tiny battery electrodes, each less than the width of a human hair. "Not only did we demonstrate for the first time that we can 3D-print a battery, we demonstrated it in the most rigorous way,"said Jennifer Lewis, Ph.D., senior author of the study. Lewis led the project in her prior position at the University of Illinois at Urbana-Champaign, in collaboration with co-author Shen Dillon, an Assistant Professor of Materials Science and Engineering there. The results were published in today's online edition of Advanced Materials.

Wyss Institute / Harvard University
18 Jun. 2013
http://wyss.harvard.edu/viewpressrelease/114

Carbon Nanotube Harpoon Catches Individual Brain Cell Signals

Neuroscientists may soon be modern-day harpooners, snaring individual brain-cell signals instead of whales with tiny spears made of carbon nanotubes. The new brain cell spear is a millimeter long, only a few nanometers wide and harnesses the superior electromechanical properties of carbon nanotubes to capture electrical signals from individual neurons. "To our knowledge, this is the first time scientists have used carbon nanotubes to record signals from individual neurons, what we call intracellular recordings, in brain slices or intact brains of vertebrates," said Bruce Donald, a professor of computer science and biochemistry at Duke University who helped developed the probe. He and his collaborators describe the carbon nanotube probes June 19 in *PLOS ONE*. "The results are a good proof of principle that carbon nanotubes could be used for studying signals from individual nerve cells," said Duke neurobiologist Richard Mooney, a study co-author. "If the technology continues to develop, it could be quite helpful for studying the brain."

Ashley Yeager / DukeToday (Duke University, Durham, NC)
19 Jun. 2013
http://today.duke.edu/2013/06/brainharpoon

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.

SCOTTSDALE:

This group meets the third Friday of each month and gatherings are hosted at a home near Alcor. To RSVP, visit http://cryonics.meetup.com/45/.

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 on odd-numbered months. Facility tours are held every Tuesday 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 (408) 245-4928 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

Cryonics Northwest holds regular meetings for members of all cryonics organizations living in the Pacific Northwest.

For information about upcoming meetings and events go to: http://www.facebook.com/cryonics.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 Chana de Wolf: chana.de.wolf@gmail.com

ALCOR PORTUGAL

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

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:

We meet at least quarterly for training, transport kit updates, and discussion. For information: Steve Jackson, 512-447-7866, sj@sjgames.com.

UNITED KINGDOM

There is an Alcor chapter in England. For information about meetings, contact Alan Sinclair at cryoservices@yahoo.co.uk. See the web site at www.alcor-uk.org.

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 $10/month (or $30/quarter or $120 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 ($10/month or $30/quarter or $120 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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