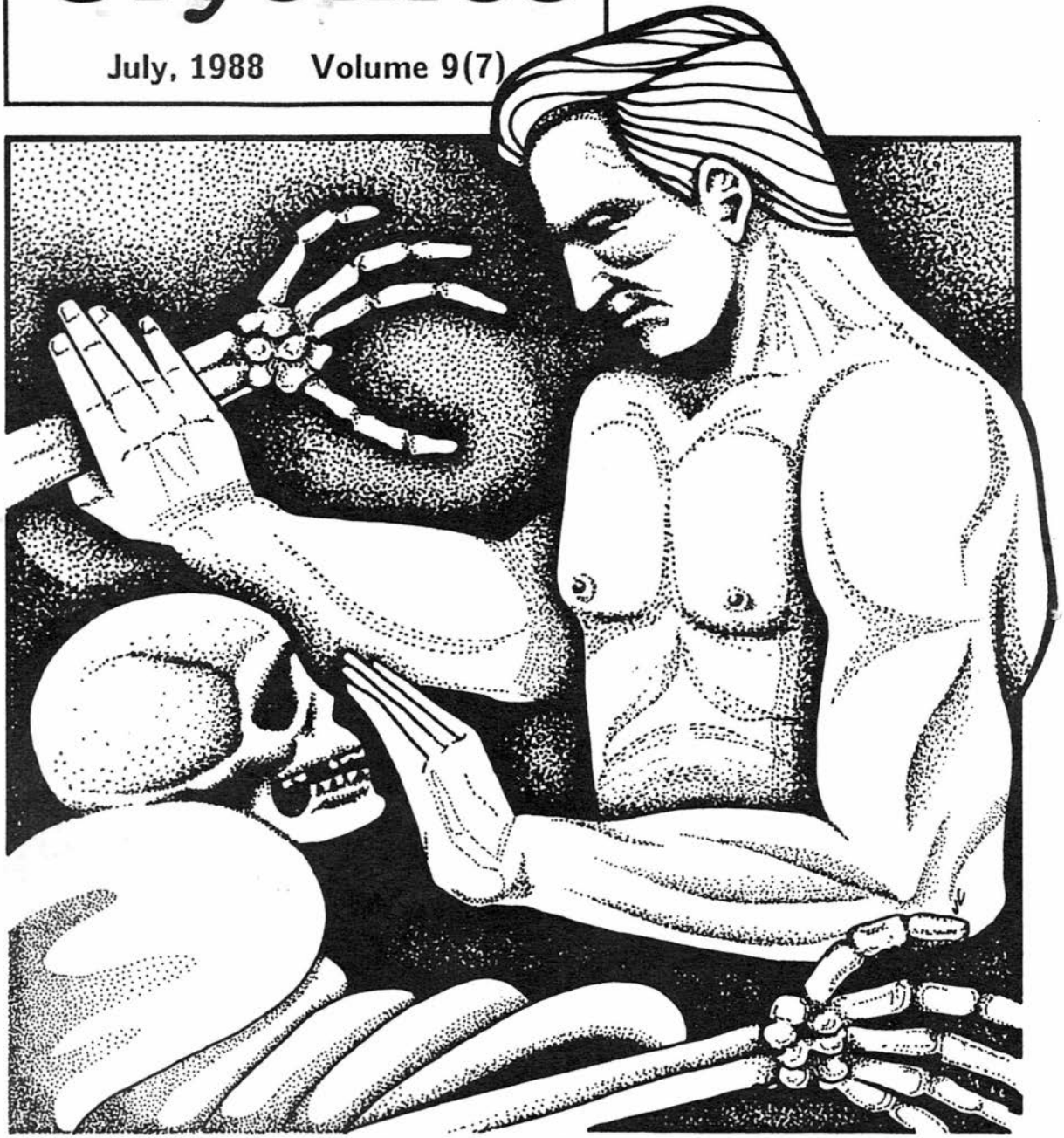
Cryonics

July, 1988 Volume 9(7)



LIFE *AGAINST* DEATH

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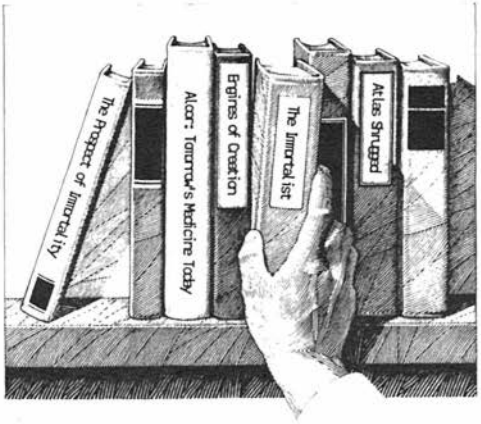
EDITORIAL MATTERS



In this month's issue is an article entitled *Cell Repair Technology*, by Brian Wowk. It is very similar in format to two previous articles which have recently appeared in *Cryonics* (*The Cryobiological Case For Cryonics* and *Nanotechnology*) which deal with some technical aspects of cryonic suspension. In case you are wondering, these articles are in fact chapters from a forthcoming book on Alcor and cryonics authored by Brian and Mike Darwin. Future issues of *Cryonics* will see more material from the book printed in the pages of the magazine. The book is to be titled: *Alcor: Tomorrow's Medicine Today* and it is hoped it will be ready for release before the end of the year. The sections which have appeared to date have been technical appendices which support the main text. Immediately following *Cell Repair Technology* is *Revival: A Hopeful Scenario*, a speculative look at resuscitation that will also appear in the book. Any comments or suggestions on this material from our readers would be greatly appreciated.

Errata - Picture Credits

The cover picture for last month's *Cryonics* was shot by Steve Harris. For last month's article on the recent cryonic suspension, the operating room photos were by Saul Kent and the transfer procedure photos were by Steve Harris. Thanks, guys!

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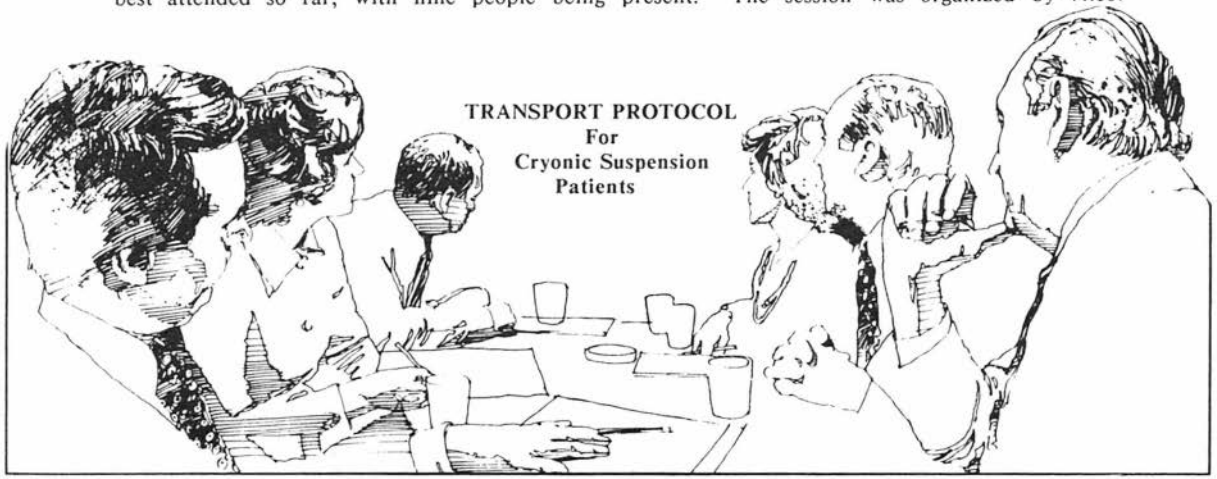
SAN JOSE TRAINING SESSION

On the weekend of June 25-26 Jerry Leaf and Mike Darwin conducted a suspension training session for Northern California Alcor members (Alcor-NC). The session was the best attended so far, with nine people being present. The session was organized by Alcor



Northern California Coordinators Thomas Donaldson and Cathy Woof. The purpose of the training was to provide an update on changes in the transport protocol, build CPR, heart-lung resuscitator, and drug administration skills and review Alcor administrative procedures for accessing and transporting suspension patients.

The session went very well, although the usual "final exam" consisting of a 100-question written test and a physical evaluation of HLR skills was not possible, since the Riverside Police Department has our exam and evaluation materials. Once new tests are generated, a short one-day workshop to test skills levels will be administered. Jerry and Mike urged the Bay Area group to meet and work on their HLR skills several times prior to the "final".

In addition to the training session there was a social evening open to all interested parties, which was held at Hobee's Restaurant in Sunnyvale. This gathering was well attended (14 people present) and resulted in some stimulating discussion about the current legal/political situation as well as the usual debates about the long term future of cryonics and its long term utility. (Will there always be a need for cryonics? Thomas Donaldson says "Yes!").

But the instruction was hardly one-sided. Quite a number of useful suggestions were offered by the Bay Area people. A number of these suggestions are likely to be of use to other Coordinators. Most are fairly simple and straightforward and we'll share them here.

Paperwork. Lee Corbin raised the issue of access to suspension paperwork. In an emergency, the Coordinator may not be able to get quick access to a member's suspension paperwork. A number of possible solutions to this problem was proposed. First and simplest is for members in an area with a Coordinator to have a set of the key documents on file with the local Coordinator. The documents needed are: 1) Consent For Cryonic Suspension, 2) Authorization of Anatomical Donation, 3) Durable Power of Attorney For Healthcare and 4) Testamentary Directions (the Will). The Coordinator should designate an alternate Coordinator and make sure that the alternate has a key to the Coordinator's home as well as instructions on where to find rescue gear and paperwork.

A second solution is to get Alcor a FAX machine. Almost every hospital has FAX facilities and Alcor should have them too. A FAX would enable Alcor Southern California (ASC) to dump a member's suspension documents to a hospital or local FAX facilities in only a few minutes. If someone else out there thinks this would be a good idea, please buy Alcor a FAX machine. They cost about $600 on the low end and Bay Area member Roger Gregory says he'll take responsibility for acquiring one if the money is there. If you can help with this please call Thomas Donaldson for information at (408) 732-4234.

A Death Certificate party was also suggested. Since cryonics procedures cannot start before declaration of legal death, a Death Certificate is necessary. The requirements for a Death Certificate in California are particularly rigid, with *absolutely no* corrections, line-throughs, or erasures being tolerated. Much of the information on the certificate can be pre-filled-in, such as the member's name, birthplace, spouse's name, mother's

maiden name and place of birth, and so on. This is something that local members can easily do if they have access to a high quality typewriter. Copies of the pre-filled-in certificates can thus be held by the Coordinator so that all the physician needs to do is fill in the cause, place, and time of "death" and sign it.

Equipment. Lee Corbin also suggested the use of cooling blankets to increase the rate of patient cooling during transport. At first glance this idea seemed impractical since heater/cooler units are very heavy and require electricity to operate, and the blankets are bulky and very expensive. But Mike Darwin brainstormed a solution to the problem on the spot. Low cost disposable blankets are now available (and Alcor has a case of them) and a cooler unit could be made from a small trash can, a submersible fountain pump and a few plastic fittings. The can could then be filled with ice and some water as the heat exchange fluid. This would make available about 1/3rd more of the patient's body surface for cooling (since it is in practice impossible to get ice packs *under* the patient). Such a unit would be lightweight, inexpensive, easily portable, and *very* effective.

This is something that other Alcor Coordinators in Indiana, Florida, and England can easily put together. In fact, if the Alcor-NC folks put one together they might even be persuaded to build a few more for other Coordinators and make enough of a "profit" to pay for their own.

Frank Rothacker suggested streamlining the transport kits in order to make them as simple and straightforward to use as possible. Some efforts will probably be made by Alcor-Riverside in this direction. Meanwhile Alcor-NC member Arel Lucas will work with the Woof-Donaldsons to reorganize the transport kit and label the medications box to facilitate quick identification of critical medications and IV supplies.

It was also decided to set up the HLR with either another oxygen input line to facilitate prompt switch-over from one oxygen source to another (such as from hospital wall oxygen to portable cylinder oxygen) and/or to replace the existing quick disconnect system altogether.

One simple item the group discovered they needed was an armboard to prevent flexion of the patient's arm with the IV in it during transport. This is a simple thing to make -- consisting of a thin piece of wood or plastic (a 16 inch length of 1 x 4 lumber is about right) with an infant's disposable diaper taped around it for waterproofing and padding. The armboard can then be taped onto the patient's arm above and below the elbow to keep the arm extended and protect the IV catheter from being kinked off or pushed through the vessel wall if the arm is inadvertently flexed.

Other items the group discussed acquiring were an "H" oxygen cylinder (by rental) and a cart for transporting it into and out of the hospital, a newer "improved" version of the Esophageal Gastric Tube Airway, and a Velcro strap for preventing the cylinder wrench from banging on the oxygen tanks and waking up all the other patients on the hospital nursing floor during transport.

Administrative. A number of useful administrative things to do were also identified. Several commercial air ambulance services which had already been contacted will be contacted again to negotiate final credit terms so that Alcor-NC patients can flown to Alcor-Riverside quickly.

Alcor-NC will also obtain a copy of the National Funeral Directors Association's

(NFDA) *Redbook* which contains the listings for thousands of mortuaries and removal services coast-to-coast. With this, they can facilitate making arrangements with local mortuaries/removal services for pickup and transport of patients.

Local sources for crushed ice, oxygen, and other needed supplies will also be identified and credit accounts set up so that emergency supplies can be quickly delivered or picked up in an emergency.

Alcor-NC will also contact the local Coroner's office for a list of reportable deaths in the Bay Area counties where members live -- and perhaps also write letters to and/or arrange meetings with the local coroners, where appropriate.

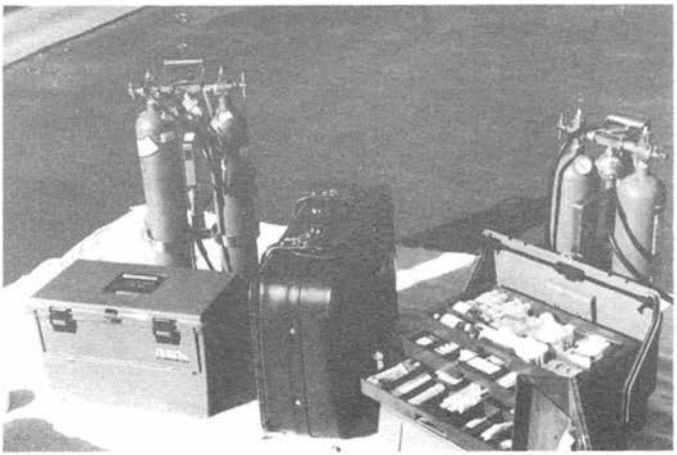
Most impressively, Thomas Donaldson and Cathy Woof have agreed to take Emergency Medical Technician training courses and get their EMT certification. This will mean that every Alcor rescue team or Coordinator with the exception of Florida will have a certified professional in charge!

Finally, Arel Lucas, who is a medical transcriptionist with work experience in both hospitals and a coroner's office, agreed to generate a mock-up of a patient's hospital chart, along with a brief tutorial on how to read it. In addition, she has promised to generate a brief course on reading lab values to go with the chart. Arel is willing to make this available to other Alcor Coordinators for copying costs. You can contact Arel at (408) 978-7616.

Many of the things that came out of the San Jose session are things many members living distant from Alcor can do. We urge you to consider doing them. Some months ago we suggested that members write or drop by their local Coroner's or Medical Examiner's Office and pick up their list of "Reportable Deaths" and send Alcor a copy. To date we have exactly **zero** of these. This is something easy and simple that *you* can do. *Do it*!

As for the other Coordinators, we urge you to talk with each other. Pass suggestions and thoughts around. We will also be having a Coordinator's Meeting at the next national meeting Alcor holds -- if not before.

Special thanks to those who attended: Lee Corbin, Thomas Donaldson, Roger Gregory, Keith Henson, Arel Lucas, Naomi Reynolds, Frank Rothacker, Jim Stevenson, and Cathy Woof.



A CORONER'S CASE IN NORTHERN CALIFORNIA?

Shortly after the suspension of American Cryonics Society member Violet Jones occurred, Alcor personnel began to hear rumors that there was a potentially serious conflict with the Alameda County Coroner brewing. Reportedly the Coroner was accusing Trans Time of improperly taking possession of Mrs. Jones after legal death was pronounced and of moving her to the Trans Time facility without proper authorization from the Coroner. Mrs. Jones died from complications (reportedly a fat embolism) after a fall and surgery for a broken hip. Any death which is in any way a result of an accident is automatically a Coroner's case in most counties and requires that the Coroner consent to removal and disposition of the remains.

According to several sources within Trans Time and ACS president Jack Zinn, the attending physician obtained permission from the Coroner's office to release the patient to Trans Time personnel. Reportedly, Trans Time had spoken with the Coroner's office by phone some weeks *before* Mrs. Jones's legal death.

Shortly after the suspension, and apparently when Trans Time went to file the Death Certificate and apply for the VS-9, the Coroner's office again became involved. Chief Deputy Coroner Ray Young, who is in charge of the investigation into Mrs. Jones's death, denied that anyone in his office gave permission to release Mrs. Jones to Trans Time. Accompanying this article is a copy of an article which appeared in the Riverside *Press Enterprise.*

There is at least one inaccuracy in the article. The clause in Mrs. Jones's will relating to taking possession of the remains within 18 hours of death was not operational

* * *

Alameda coroner feuds with cryonics firm

By DON BABWIN
The Press-Enterprise

Coroner's officials in Alameda County say a cryonics organization in Northern California moved the remains of an 87-year-old woman from a hospital to its facility after being told not to.

As Violet Jones' body lies in cryonic suspension waiting to be thawed at some future date, the coroner's office is preparing a report alleging that Trans Time Inc. sidestepped the law to avoid what cryonicists fear most — an autopsy.

"We were not called until she was already moved" to Trans Time from the hospital March 13, said Chief Deputy Coroner Ray Young, who said the report should be submitted sometime next week. "They acted contrary to our instruction."

Meanwhile, Trans Time president Arthur Quaife said a doctor, whose name he could not recall, called the coroner's office after Jones died and before she was taken to the nearby Trans Time facility in Emeryville. And, he said, the coroner's office gave permission to move the body. He declined further comment, saying he did not want to argue with the coroner's office via the media.

The media, he said, are what caused much of the trouble for Alcor Life Extension Foundation in Riverside. Alcor received national attention when it was learned that 83-year-old Dora Kent's head had been removed at its facility last December. The death remains under police investigation.

Young said Quaife's statements about a doctor calling the coroner's office are ridiculous. "There's no reason for a deputy to say 'Take the body' because he did not know all the facts," said Young. "We don't do that."

When Jones died, the hospital released her body after getting a phone approval from Quaife, said Young. Young said Quaife had no authority to give that approval.

Officials at Alameda Hospital in Alameda were not available to comment yesterday.

Young said a nurse claimed she received approval from the coroner's office to move the body. But Young insisted that nobody at the coroner's office gave any such approval.

Jackson Zinn, the president of the American Cryonics Society, an organization which contracts with Trans Time, said Trans Time operated wholly within the law. The woman, he said, had been a long-time member of Trans Time for years, had signed a declaration prohibiting an autopsy.

But, Young said, just because the coroner takes the body does not necessarily mean an autopsy will be conducted. He said the woman's will included a clause whereby, if her body was not turned over to Trans Time within 18 hours of her death, her estate would be awarded not to the cryonics organization, but to her daughter and granddaughter.

The Press-Enterprise Saturday, June 4, 1988 A-3

since it had been stricken by a codicil to the will executed some months before her suspension. Reportedly several of the deputy coroners involved in the investigation said menacing and contradictory things at the start of the investigation, including statements to the effect that they were going to "break her will"..

According to Mr. Young, the current status of the case is that the Alameda County Coroner's office is nearing completion of their investigation and is preparing to hand the case against Trans Time over to the District Attorney for prosecution. Mr. Young has stated that Trans Time does not appear to have legal authority to hold human remains and that it is not licensed to take custody of or prepare human remains since the organization does not have licensed professionals such as morticians or physicians on staff. Young said it would be up to the District Attorney to decide what to do about the case.

* *

ALCOR SUSPENSION MEMBERSHIP GROWTH

Recent months have seen a steady rise in the number of people joining Alcor both as Suspension Members and as Associate Members. It has been suggested that each month we publish a tally of the membership so that members and nonmembers alike can gauge our growth and progress (or lack thereof). There has been much ballyhooing of membership growth in the cryonics community as a whole. We think it a fine idea to quantify that growth, at least as far as Alcor is concerned. Not just to establish how far we've come, but how also how far we have to go. While the numbers below are encouraging by cryonics standards, they are pitiful in any absolute sense. We need more Suspension Members, more Associate Members and more support from everyone.

Before we list our members it is important to define what *exactly* a Suspension Member or Associate Member *is*:

An Alcor Suspension Member is a person who has made all necessary legal and financial arrangements for cryonic suspension with Alcor.

An Alcor Associate Member is someone who has subscribed to *Cryonics* magazine and is evaluating further involvement with cryonics or who is just interested in keeping abreast of developments in the field.

Our current membership status is:

108 Suspension Members
178 Associate Members

ALCOR MODIFIES SUSPENSION CONTRACTS

At the June 12th meeting of the Alcor Board of Directors, several important resolutions were adopted relating to suspension contracts which have very significant implications. The need for these changes became increasingly apparent as (relatively) large numbers of new people began to sign up. A fair number of these people wanted to add complex restrictions on conditions of revival, restrictions which could create serious liability or conflicts of interest for Alcor, or which call for judgment beyond the current or foreseeable scope of Alcor's expertise.

A few potential Suspension Members have wanted to place restrictions on the social conditions under which they should be revived such as "revive me only if there is world peace..." or "revive me only if I can have Sophia Loren's looks and figure..."

There are many problems with such conditions and restrictions regarding revival, not the least of which is *making the judgment calls some of them demand*! For instance, when is there world peace? And more to the point, just how serious can someone be about staying alive if they place such restrictions on their recovery? Can you imagine telling a surgeon "Don't wake me up from the anesthetic unless the SALT III Treaty is ratified?"

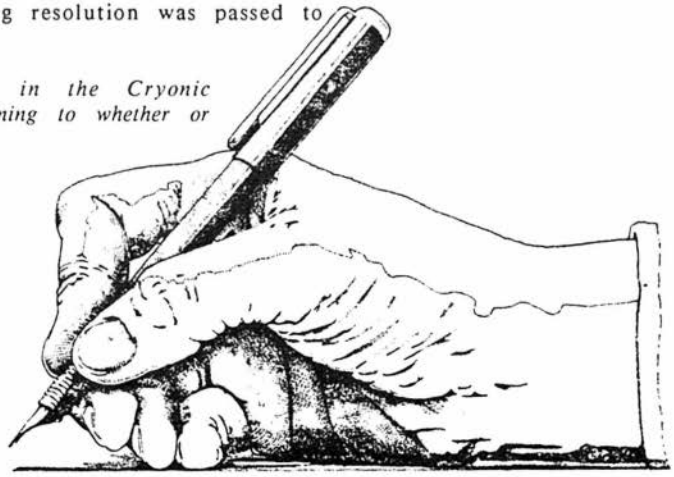
But beyond these considerations the presence of reanimation clauses raises issues of fraud. The Cryonic Suspension Agreement makes clear that there is no known probability for success, and our opinion is that cryonic suspension must be considered a long shot gamble at best. Inclusion of clauses about world peace or cosmetic surgery capabilities are not conducive to defending such a position and people who insist on them are almost certainly liabilities rather than assets in these tough times for cryonics.

To solve these problems the Board adopted the following resolution:

"A Cryonic Suspension Agreement shall not be amended to include conditions or circumstances pertaining to revival. Prospective members may have included in their files a written statement concerning their preferences for revival; such a statement will not be binding on Alcor."

Another problem relating to the Agreement has been the inclusion of vague or nonobjective language relating to when and under what circumstances suspension should *not* be carried out. The following resolution was passed to address this issue:

"All conditions included in the Cryonic Suspension Agreement pertaining to whether or not to proceed with cryonic suspension must be clear, objective, and specific. Alcor shall have the final authority to decide if the conditions obtain."



Some prospective members have wanted to appoint a person to make a decision as to whether or not to proceed. This option was deemed to be unacceptable by Alcor and is

now prohibited.

A few Suspension Members already have language in their Cryonic Suspension Agreements which would be prohibited per the above. A decision was made *not* to alter the terms of these agreements -- they will be left intact for the foreseeable future.

* *

LESS RESTRICTIVE CRITERIA FOR BRAIN DEATH?

by Mike Darwin

Electroencephalographic Activity
After Brain Death

Madeline M. Grigg, MD; Michael A. Kelly, MD; Gustavo G. Celesia, MD; Hema W. Ghobrial, MD; Emanuel R. Rosa, MD

A Fifty-six consecutive patients clinically diagnosed as brain dead were seen at Loyola University Medical Center, Maywood, Ill, from January 1984 through May 1986. Eleven (19.6%) of the 56 patients had electroencephalographic (EEG) activity following the diagnosis of brain death. The mean duration of the observed EEG activity was 35.6 hours (range, two to 158 hours). Three patterns of EEG activity were observed: (1) low-voltage (4 to 20 μV) theta or beta activity was recorded in nine (16.1%) patients as long as 72 hours following brain death. Neuropathologic studies in one patient showed hypoxic-ischemic neuronal changes involving all cell layers of the cerebral cortex, basal ganglia, brain stem, and cerebellum; (2) sharp-like activity (a mixture of synchronous 30 to 40 μV theta and delta activity and 60 to 80 μV, 10 to 12 Hz spindle-like potentials) was noted in two (3.6%) patients for as long as 158 hours following brain death. Pathologic studies in both cases demonstrated ischemic necrosis of the brain stem with relative preservation of the cerebral cortex; and (3) alpha-like activity (monotonous, unreactive, anterior predominant, 25 to 40 μV, 9 to 12 Hz activity) was observed in one (1.8%) patient three hours following brain death. Regardless of activity on the EEG, none of the patients recovered. The occurrence of EEG activity following brain death would suggest reliance on the EEG to confirm brain death may be unwarranted. The use of the EEG as a confirmatory test of brain death may be of questionable value.

(Arch Neurol 1987;44:948-954)

The reliability of the electroencephalogram (EEG) to confirm brain death remains a controversial subject.[1] A recent survey of American neurologists and neurosurgeons noted that 65% of the respondents considered an isoelectric EEG necessary before brain death could be declared.[2] Many hospitals, including ours, require an isoelectric EEG to establish a diagnosis of brain death. The occurrence of EEG activity following brain death has been noted,[3-6] but is regarded as an infrequent occurrence. We are not aware of a systematic study to determine how often EEG activity persists in patients who fulfill all clinical criteria[7-9] for brain death. This article describes the experience in our institution of 56 consecutive cases of brain death.

PATIENTS AND METHODS

A total of 56 cases of brain death occurred at Loyola University Medical Center, Maywood, Ill, between January 1984 and May 1986. Every patient with this diagnosis had at least one EEG recording after they fulfilled clinical criteria for brain death.

The medical records were reviewed to confirm that each patient met the clinical criteria for brain death before the EEG recording. All patients were examined by attending neurologists or neurosurgeons. The clinical diagnosis of brain death was established when the following were found: (1) the primary cause of the coma was known and sufficient to explain the observed state, (2) the irreversibility of the state was confirmed by its persistence for longer than six hours, (3) hypothermia (rectal temperature, <32.0°C), hypoxia (arterial oxygen pressure tension, <55 torr), and hypotension (systolic blood pressure, <90 mm Hg) were not present, (4) following cardiovascular shock, vital signs had been stabilized for a period of longer than 12 hours before testing, (5) toxic drug overdose were performed in those cases where the underlying cause was not proven (if drug intoxication, neuromuscular paralysis, or anesthetic effects were suspected, or the underlying cause was not certain, a period of reasonable observation [usually >48 hours], drug levels, and a nuclear cerebral blood flow study were performed), and (6) the clinical examination for brain death, performed and repeated at appropriate time intervals following the coma, demonstrated (a) no response to painful and auditory stimulation, (b) no spontaneous movements, (c) absent pupillary light, corneal, oculocephalic, oculovestibular (cold caloric), cough, gag, and respiratory reflexes, and (d) no spontaneous respiration.

Apnea testing was performed on 36 (64.2%) of 56 patients. Patients were preoxygenated with 100% oxygen for a period of ten minutes, then disconnected from the ventilator for a period of four to ten minutes while 6 to 10 L/min of oxygen was administered through intratracheal catheter. Four patients were excluded from this study because spontaneous respirations were observed during apnea testing. Two

Accepted for publication April 13, 1987.

From the Departments of Neurology (Drs Grigg, Kelly, and Celesia) and Neuropathology (Drs Ghobrial and Rosa), Loyola University of Chicago, Stritch School of Medicine, Maywood, Ill.

Reprint requests to Department of Neurology, Loyola University of Chicago, Stritch School of Medicine, 2160 S First Ave, Maywood, Ill, 60153 (Dr Grigg).

948 Arch Neurol—Vol 44, Sept 1987

Brain Death—Grigg et al

Recently a paper by Madeline Grigg, *et al* in the journal *Archives of Neurology* (September 1987, p. 948-954) re-evaluated the use of ECS as a method for determining brain death. In every case where the patient met clinical criteria for brain death (i.e., no response to painful and auditory stimuli; no spontaneous movements; absent pupillary light, corneal, oculocephalic, oculovestibular, cough, gag, and respiratory reflexes; and no spontaneous respiration) they did not recover even though residual EEG activity was sometimes present.

This is a significant finding because a recent survey of American neurologists and neurosurgeons found that 65% of the respondents considered an isoelectric EEG (i.e., flat EEG or the presence of ECS) to be essential to establishing a diagnosis of brain death. A confirmed diagnosis of brain death would be required on a brain-injured, respirator-supported patient before respirator support could be disconnected and cryonic suspension

One of the major medical horrors we face as cryonicists is *death* (note I did not say deanimation or ametabolic coma) by respirator support after a brain injury. Currently, when a patient suffers a brain injury that results in cessation of breathing from stroke, cerebral hemorrhage, head trauma, or ischemia secondary to cardiac arrest he is put on a respirator. This is done in order to buy time to allow for reversal of the underlying disease process and recovery of the patient. If brain swelling and the acute problems which accompany any brain injury can be overcome, then it is possible that the patient might recover.

In theory, anyway.... In practice, most patients who require respirator support for an acute brain injury do not survive, and end up being pronounced "brain dead" and taken off a respirator. In most medical settings a final determination of brain death is made on the basis of EEG activity. Unfortunately for cryonicists, this is something of a nightmare because total cessation of brain electrical activity (electrocerebral silence (ECS)) often does not occur for many hours after extensive areas of the brain have stopped receiving any blood flow and because the usual criteria for pronouncing brain death are two EEG readings demonstrating ECS at least 24 hours apart. After 24 hours of no blood flow at normal body temperature, massive breakdown and destruction of brain cell structure will have occurred -- rendering the chances for a successful outcome of cryonic suspension of the patient negligible.

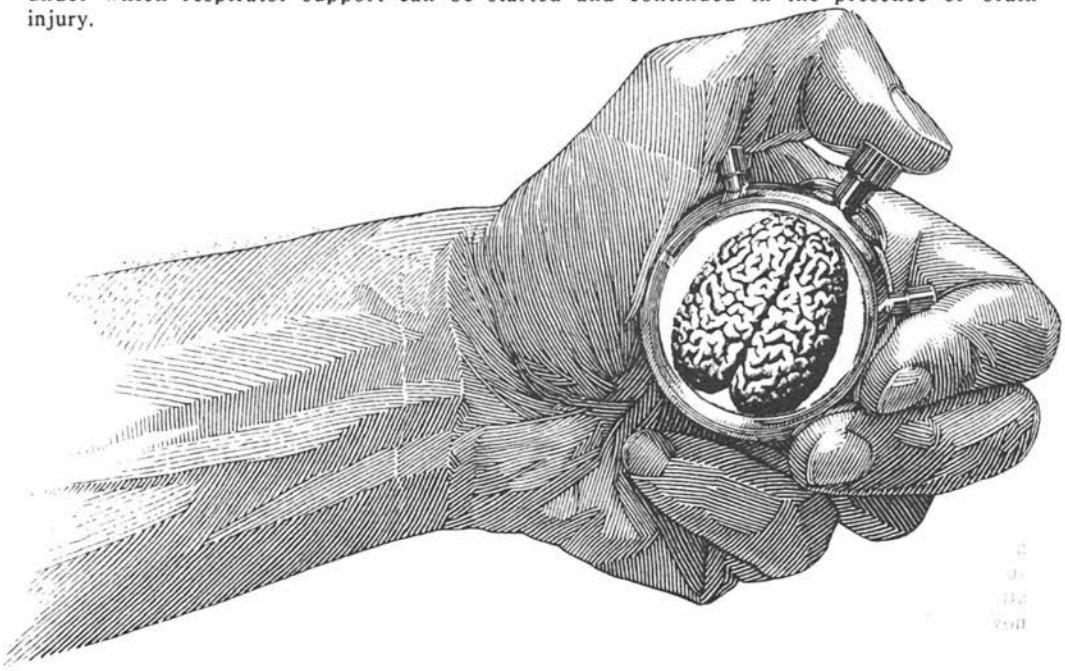
begun.

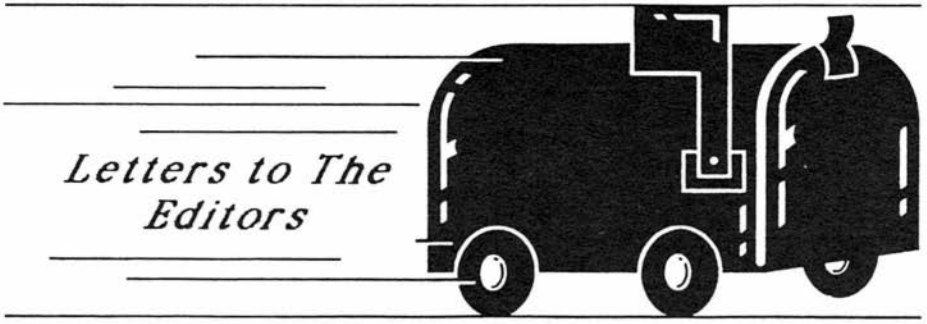
Madeline Grigg and her colleagues conclude that less stringent clinical criteria are probably more appropriate for determining brain death:

> *"Even if one requires cessation of all functions of the entire brain to fulfill a diagnosis of brain death, this does not imply, or require, the death of each and every neuron. Brain death is present when a* critical *number of neurons have been irreversibly damaged, such that all the integrative neuronal capacities of the brain are lost. The presence of EEG activity after clinically determined brain death demonstrates that the clinical criteria of brain death may be fulfilled before the death of every cell within the brain has occurred. However, residual bioelectric activity, possibly derived from patchy islands of electrophysiologically active cortical or subcortical brain tissue, need not be regarded as reflecting integrated neuronal function.*
>
> *The relatively frequent occurrence of EEG activity after brain death would suggest reliance on EEG to confirm brain death may be unwarranted. The presence of EEG activity in patients who are clinically brain dead does not change the final mortal outcome. The advocacy of the EEG as a confirmatory test of brain death may be of questionable value.".*

This is good news for cryonicists. What it means is that clinical criteria for pronouncing brain death are probably going to increasingly be used, and that means that cryonics patients in a brain injury induced coma may in many instances be taken off respirator support far sooner than if EEG criteria were being used.

Of course, the best defense against this kind of treatment in the first place is a carefully worded *Durable Power of Attorney for Healthcare* which specifies the conditions under which respirator support can be started and continued in the presence of brain injury.





To the Editors,

I read Brian's article, *The Death Of Death In Cryonics* (June, 1988) with a big feeling of *deja vu*. In his letter, Brian suggests that we not use the word "deanimation" because it is a "euphemism for death", and that we don't say that cryonics is freezing dead people, but that it involves a different view of when people are dead.

I don't think that changing our language will really affect our public relations problems, such as they are. Essentially, so long as I am frozen and revived it doesn't concern me whether or not my suspension is referred to as "frozen storage of meat" or "cryostasis". But I feel that history should be *remembered*, and there is an issue of fact.

The *original reason* for introducing the term "deanimation" was specifically to give a name for the state which Brian now wants to rename as an "ischemic coma". I defined it that way in my early (1976) cryonics bibliography, which was for a long time reprinted by both Trans Time and Alcor. The word and its meaning were not original with me. I believed (and still believe) that I was encapsulating the state of cryonics thought about what we were doing.

And of course, even from the beginning we've had problems about freezing "dead people". Since I did a lot of publicity in Australia in those days, I'd like to bring up my own experiences. *Never* did I myself describe cryonics as freezing the dead for hope of future revival. I always tried to draw a distinction between *our* notions of death (which I think was basically what Brian described) and the common notion. *But* what would always happen would be that the *reporter* would explain us as seeking to revive the dead, as freezing the dead, and so on.

One major difficulty which we found was that we were very rarely allowed to speak for ourselves. It would always be a situation of a newspaper holding us at arms length: I never got to write the article explaining cryonics, even with a rebuttal by establishment medicine. I was always presented with a reporter who knew little about cryonics, and who was going to act as an *interpreter*. I had no control whatever over what this reporter would say. Since I was already quite well able to write my own articles telling about cryonics, this arms-length attitude was very galling.

I believe that things are better now, mainly because we are getting a more serious and well educated hearing. There can be many reasons for this, and certainly we are more successful now in conveying our ideas. But my own memory of the situation is that *our* attitude has not changed, and "deanimation" was exactly the word we chose to use for what now some want to call "ischemic coma".

Do I feel that we should still use "deanimation"? Not necessarily. "Ischemic coma" is fine, too. What I do want to say is that this change won't really cause any special change in public attitudes. Public attitudes *are* changing, of course. But terminology and our ideas about death have nothing to do with that change.

"Deanimation" was *not* a euphemism for death. I sincerely hope that 20 years from now, we won't be adopting yet another word ("ischemic stasis", perhaps) for the concept because people have come to feel that "ischemic coma" was just one more euphemism for death. Hopefully by that time many more people will be educated about cryonics, and word chopping won't be needed. The act itself will explain itself.

Thomas Donaldson
Sunnyvale, CA

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LIFE *AGAINST* DEATH

Conference Report by Saul Kent

photographs by Hugh Hixon

The recent *LIFE Against DEATH* conference on Memorial Day weekend (May 27-30, 1988) at the Red Lion Inn at Ontario Airport may have been an historic turning point in the cryonics movement. After 23 years of trying to persuade people to join various cryonics groups, we may finally have found a formula for success.

About 100 people attended the conference. Many of them left before the cryonics presentations on Sunday and Monday. There were also about 15-20 Alcor members in attendance. Of the remaining 40 or 50 people, a good number of them had little or no knowledge of cryonics before being exposed to the idea that weekend.

When the weekend was over, however, eight people had paid Alcor $300 apiece and had begun to sign up as suspension members. Several of these new members said they would be signing other family members up, and eight other people expressed interest in signing up with Alcor in the near future.

This represents an unprecedented increase in membership for Alcor or any other cryonics organization!

Here is a run-down of the conference program, which was moderated by Saul Kent, President of the *Life Extension Foundation.*

The Program

On Saturday, there were talks by life extension doctors and scientists. Sunday was devoted to the science and practice of cryonics, following by a free-wheeling panel discussion. On Monday, many of the participants toured the Alcor facility in Riverside and then enjoyed a social gathering at Saul Kent and Jo Ann Martin's residence.

Nutrition And Exercise

The first speaker on Saturday morning was Dr. Garry Gordon, a well-known physician from Sacramento, California, who specializes in "alternatives" to traditional medical therapies. Dr. Gordon explained that he uses nutrition to both prevent *and* treat the diseases of aging. He focused much of his attention on the therapeutic use of electricity in medicine and on changes that occur in mineral metabolism with advancing age.

Dr. Gordon observed that the vast majority of Americans are deficient in magnesium, which is essential for cardiovascular function, and that it's vital to see to it that dietary calcium is absorbed into the bones (where it's needed) and not into the blood vessels, where it contributes to atherosclerosis, heart disease, and stroke.

Dr. Gordon is an authority and long-time advocate of intravenous EDTA chelation therapy, which he has used for many years in the treatment of the diseases of aging. At this year's meeting, he presented evidence that oral EDTA therapy (which is far less expensive) can provide many of the same benefits as intravenous therapy.

Designing A Personal Life Extension Program

The next speaker was Stephen Arnold, a Beverly Hills physician, who has been helping his patients design and evaluate their own personal life extension programs.

Dr. Arnold opened his presentation by discussing some of the principles he uses in attempting to minimize the risks and maximize the benefits of a life extension program. He explained how regular blood testing can guide the physician in determining the appropriate dietary regimen for each individual, and how he uses these tests in his practice.

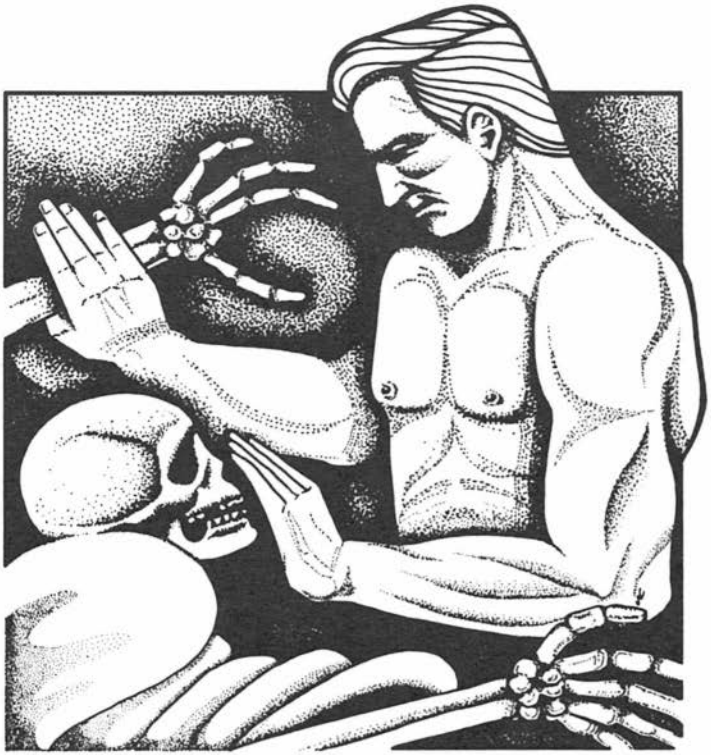
He then called four life extensionists from the audience, with whom he has been working for the past several years. As each of them told their own story, Dr. Arnold pointed out the differences in their programs and discussed the reasons for these differences. It soon became clear that there is no "ideal" life extension program for everyone and that professional guidance is important in the pursuit of a longer, healthier lifespan.

The Benefits Of Muscle Power

Dr. Hans Kugler, the authority on several popular books on health and longevity, then discussed the benefits of weight-training and other techniques to increase strength and muscularity. He pointed out that one of the characteristic features of aging is a progressive decline in muscle mass, strength, and flexibility, and that a well-designed muscle-building program can help to improve the quality of your life and to stave off some of the physical deficits of aging.

Life Extension Research

In the last presentation before dinner, Steve Harris, a medical doctor who conducts life extension research in Roy Walford's program at UCLA Medical Center, discussed the results of recent studies in nutrition and medicine that have implications for health and longevity.



Dr. Harris points out, for example, that -- despite all the hoopla about the "benefits" of taking aspirin to help prevent heart attacks -- there is also evidence that chronic use of aspirin may *increase* the risk of stroke. He recommended against aspirin therapy for heart disease until more research enables us to better evaluate the effects of the drug on cardiovascular function.

Dr. Harris also examined Roy Walford's food restriction studies, which have extended the maximum lifespan of laboratory animals, and discussed the possibility that these findings might be applicable to humans. He discussed efforts to combine the benefits of dietary restriction and antioxidant therapy and why he (and Walford) have decided to investigate the effects of *Coenzyme Q-10* in food-restricted animals. (This work is being supported by a grant from the *Life Extension Foundation*.)

Participating In A Study

It was announced that Dr. Harris would be evaluating the results of a blood test that was offered free of charge to all conference participants. The specimens gathered at the conference were used to measure blood cholesterol and HDL levels, in addition to other functions. A few days after the conference, a questionnaire prepared by Dr. Harris was mailed to everyone who participated in the blood test study. Dr. Harris will report on the results of the study in a future issue of *Life Extension Report*.

The Frontiers Of Research

Saturday evening was devoted to exciting new technologies that are critical in the struggle against aging and death. The first of these technologies is hypothermia. Research in hypothermia has contributed to improved methods of cryonic suspension, and will, it is hoped, eventually lead to the perfection of suspended animation as well as a variety of other clinical services and products.

Jerry Leaf, President of Cryovita Laboratories, which shares facilities with Alcor, discussed the results of a series of recent dog experiments in which the animals had their body temperature lowered to just above the freezing point for several hours and then were

successfully brought back to normal functioning.

Intent on the vision of the future. Fred Chamberlain, Angalee Shepherd, Steve Bridge.

An Alternative To Freezing

Hypothermia experiments indicate that life can be restored after a substantial slowdown of biologic function, but they do not represent true suspended animation, which requires virtual cessation of all biologic activity at much lower temperatures for long periods of time. Scientists have not been able to achieve suspended animation because of damage caused by the formation of ice when they go below the freezing point of liquids in biologic tissues, organs, and organisms.

In recent years, however, a new technology called vitrification has been evolving, which enables them to reach super-low temperatures in biologic systems without the formation of ice. Vitrification uses a combination of chemical cryoprotection and high pressure to preserve tissues and organs in a solidified "glassy" state.

The world's foremost vitrification researcher is Dr. Gregory M. Fahy of the American Red Cross, who was unable to attend the conference. The results of Dr. Fahy's vitrification studies with rabbit kidneys was presented by Mike Darwin, who noted that these studies appear to be leading to a viable method of long-term preservation of kidneys, hearts, and livers for transplantation. Even more exciting, explained Darwin, is the prospect of using vitrification to achieve perfect preservation of the human brain for future reanimation (in a new body).

Repairing Brain Damage In The Future

Today's freezing methods (as used in cryonic suspension) are far from perfect. The damage that results from freezing has caused many scientists to be highly skeptical about the possibility of bringing those now in suspension back to life in the future.

This skepticism is beginning to be eroded by a new dimension in technology that appears to be on the horizon -- the creation of machines capable of operating on the atomic level (nanotechnology). Recent advances in fields such as electronics, artificial intelligence, protein engineering, and physical microscopy have led some scientists to envision the creation of incredibly tiny machines that will enter directly into damaged cells and repair them.

The development of cell repair machines could enable future scientists and doctors to repair the damaged brains of frozen patients, a critical step in efforts to bring them back to life. Such machines might also be used to repair cells damaged by the aging process (and any other causes), which could lead to the achievement of physical

immortality.

Seeing On The Atomic Level

Mark Voelker, a Ph.D. candidate at the University of Arizona at Tucson, conducts research with the scanning tunneling microscope -- a remarkable new machine invented in 1981 by IBM scientists in Zurich, Switzerland, which permits the visualization (and manipulation) of individual atoms.

Voelker made the vision of nanotechnology seem highly realistic by showing photographs of individual atoms as seen through the scanning tunneling microscope, and by explaining how the microscope can be used to manipulate atoms. He also revealed that progress in scanning tunneling microscopy is accelerating rapidly, and that he'll be attending a conference this summer, which will feature 300 papers on the subject.

The Cryonics Frontier

After dreaming of visions of future cell repair machines, the conference participants returned on Sunday morning to hear about the recent suspension of Dora Kent's brain, the repair of which will require highly advanced cell repair machines.

The audience heard from Saul Kent (her son) and several officers of Alcor about how Dora Kent's brain almost didn't make it into the future because of misguided efforts by the Riverside County coroner to autopsy it. Everyone was spellbound by the remarkable tale of how Alcor sidestepped the autocratic boots of the Coroner to gain legal protection for Dora Kent (and the other patients in suspension), and how (in response) the Coroner has been trying to destroy Alcor and its leaders by falsely accusing them of homicide and grand theft.

Angalee Shepherd and Brenda Peters at the sales table.

The Value Of Cryonic Suspension

The next speaker, Mike Darwin of the Alcor Life Extension Foundation, discussed the value of cryonic suspension. Darwin explained why he thinks cryonics can work (even with today's unperfected freezing methods), why he thinks it's important for people to sign up for the procedure right now, and why he thinks Alcor offers the best cryonics services in the world.

Darwin argued that, although scientific efforts to extent the human lifespan through aging control will eventually succeed, the timetable for this success is uncertain. His conclusion was that making arrangements for cryonic suspension should be

the first order of business for anyone seriously interested in extending his or her lifespan.

A New Legal Document

Darwin's talk was followed by a brief discussion by Saul Kent of a new trust agreement he's developing to protect the assets of individuals after they are frozen. This agreement provides for co-trustees to look after individual interests -- a bank to manage financial assets and a three-person committee to make decisions about future reanimation.

Sign-Up Session

For the rest of the afternoon, the conference participants were given the opportunity to sign up for cryonic suspension services with Alcor and to ask questions about any aspect of cryonics. Tables were provided in an adjoining room where individuals could discuss their interest in cryonics privately on a one-to-one basis with Alcor personnel.

Investing In Life Extension

The Sunday evening session on life extension investments by Saul Kent only lasted about half an hour because Mr. Kent could only provide limited information on the subject. Mr. Kent explained that he had been unable to make as much progress as hoped for in his efforts to start new life extension companies because of unanticipated recent problems.

He mentioned a proposed low temperature biology company for which a business plan is currently being written and several ideas he has for companies to develop new anti-aging technologies.

An Impromptu Panel Discussion

To fill the time left after the investment session an impromptu panel discussion was organized. The panel members were Saul Kent, Mike Darwin, Keith Henson (a founder of the L-5 Society, for space colonization), and Ted Kraver, Ph.D., an engineer and businessman.

Kraver began by relating some of his more colorful experiences in the 1960's as an owner of the first company (the Cryo-Care Equipment Company) to offer cryonics storage equipment. He revealed that his company had frozen a woman (who

The Panel Discussion: Mike Darwin draws back as the subject of identity is dragged out again. L to R, Mike, Keith Henson, Ted Kraver, and Saul Kent.

was subsequently buried) in 1966, before the suspension of Prof. James H. Bedford, who most people believe was the first person frozen for future reanimation.

This was followed by a discussion of whether or not individuals restored to life after cryonic suspension would retain their identity, and opinions were expressed concerning the degree of memory retention required of the maintenance of an individual's identity.

Finally, several members of the audience told about their own personal involvements in the life extension movements. They explained when and how they became interested in extending their own lifespan and why they decided to sign up with Alcor.

A Tour Of The Alcor Facility

On Monday morning, Memorial Day, about 40 people were transported to the Alcor Cryonic Suspension Facility in Riverside, where they had the opportunity to see the equipment used in the cryonic suspension process, to view the storage units containing patients now in cryonic suspension, and to have their questions answered.

A Celebration Of Life

Afterwards, the visitors were taken (a few miles) to Saul Kent and Jo Ann Martin's 2.4 acre residence to celebrate their desire for a longer, healthier life. For the rest of the day, they ate, frolicked in the spa and pool, played volleyball on the lawn, watched videotapes on life extension, and enjoyed life and the company of immortals.

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STAR TREK: THE NEXT GENERATION ...OR DEGENERATION?

Max T. O'Connor reviews the Star Trek episode: "The Neutral Zone"

Star Trek: The Next Generation has been a huge commercial success, relieving fears that it wouldn't be able to match the popularity of the old show. Yet, while it is a financial and popular success, it is a moral and philosophical failure. Not that the old series was sound in these areas -- even there we saw an interstellar empire occupied in bullying individuals and cultures who only wanted independence, and all under the much spoken about but little respected doctrine of non-interference. In almost every episode we were subjected to the spectacle of 23rd century medicine (in the form of Dr. McCoy) declaring "He's dead, Jim!" within seconds of anyone's deanimation. There was never any attempt at resuscitation, not even by primitive CPR, and certainly not by technology that should have been developed over three centuries. Deathism was also displayed in episodes where superpowerful and immortal beings were portrayed as evil or misguided and inevitably ended up being punished or dying -- as in the cases of Charlie X, Apollo, Khan, and numerous others.

Despite these faults (and the philosophically ludicrous reason versus emotion theme running throughout) the old series had a more vital feel to it, a vibrant elan that is missing from the *Next Generation*. Kirk was a captain who could easily and intelligently make decisions and unhesitatingly take action in the face of terrible odds. Captain Picard, by contrast, is a wimp. He is a short, insignificant man who has little presence, and who is unable to make an independent decision. He invariably has to hold lengthy consultations with his crew about what to do and appears to spend much of his time agonizing, worrying, and being helpless. We are frequently told that he is one of the best captains in the Federation, yet we are not convinced.

As Ayn Rand noted in her book *The Romantic Manifesto*, one of the marks of good art is that rather than *tell* you the nature of a character, the creator *shows* you so that you can experience it first hand. Another difference from the original Star Trek is that the original crew was able to call each other by their first names. Surnames and titles were unnecessary because they shared a common purpose and were motivated to pursue it. In the new Star Trek, Picard is almost always "Captain" (unless a sense of sympathy or humanity or weakness is to be invoked in his character, in which case he become "Jean-Luc") and the rest of the crew also needs the security of these linguistic and conventional barriers.

In the time between the 23rd and 24th centuries, humanity *still* hasn't been able to develop nanotechnology. Nor do they routinely use cryonics (or any other suspended animation technique). Despite this, they do now have technology able to restore anybody to life who is in an ischemic coma ("dead" to use the outmoded term) so long as their neural structure is undamaged.

They have not, however, learned how to repair any kind of damage to the brain. You might think that this is a major improvement over the old series and that it shows that deathism is on the wane in the universe of the 24th Century - but wait! The full extent of the disgusting death-orientation of The Next Generation's culture is on obscene display in the episode "The Neutral Zone", which uses cryonics as a theme. In this episode Data (the android who takes over Spock's role) discovers an old Earth-launched spaceship containing three people in cryonic suspension.

We are told by the Enterprise's physician, Dr. Crusher, that "cryonics was a fad which disappeared in the mid-21st Century", and that it was an activity engaged in by people who "foolishly were terrified of dying". Data beams the three suspension patients on board without Picard's permission and to his annoyance: "But Data, they were already dead. What more could have happened to them?"

When Dr. Crusher informs the Captain that she has revived them, he is even *more* annoyed since he is now forced to treat them as living people. It is apparent that Picard wishes they had been left in the old spacecraft to die when it fell apart, as it was soon to do. The three cryonauts are revived *only* because of Data's curiosity and because Picard was too busy to ensure that they died.

One of the few good things about the episode is that it portrays cryonics as *working*! Of course, as in all these stories, it only works for a few special cases -- most of the storage units failed, killing the occupants. The writer of the episode, Maurice Hurley, seems to want to make the personalities of the patients seem undesirable, and yet they are not so unlikeable, particularly the two who chose cryonics for themselves.

One of the three was suspended by her husband, who was into "anything new and foolish" -- though she's forced to admit that this wasn't so foolish after all. It is she who has the hardest time adjusting, though even she is coping by the end of the episode. Another character is a happy-go-lucky good-ole-boy country singer who just wants to have

a good time and single-mindedly pursues that end. He tells us that he had strong doubts about cryonics working, but that there was nothing better to do with his money -- such a statement showing him to be more intelligent than almost everyone else of his time. The final time traveler is the Hard-Nosed Greedy Capitalist. He knew it would work and made arrangements for his financial security upon his anticipated revival. The writer tries to make us unsympathetic to him (to fit in with the socialist tone of the series) but, due to his competence, his determination to understand and control his new environment, his foresight, his obvious intelligence, and his emotional strength, I had to like the man despite his poor manners.

It is a mystery how Dr. Crusher was so easily able to revive the patients from their ametabolic coma when they certainly have no nanotechnology. Perhaps we are to suppose a perfect suspension technology. Though lacking nanotech, they do have a magical alternative which can synthesize anything you want (such as food or musical instruments). Yet the crew shows little imagination in their use of this technology. The whole conception of the future employed in the series is flawed and inconsistent. We are to suppose the ability to cross the galaxy in weeks, to repair damaged bodies (but *not* damaged brains!), to transport people and materials by a teleportation device, and to synthesize anything desired. Yet people still die of old age at about the same time as we do now; there is no use of cryonics to save people despite it being clearly workable; and there is absolutely no use of technology to expand personal intelligence, to improve control over one's mental states, or to increase one's physical abilities.

One of the crew is blind and wears special glasses that enable him to see many things inaccessible to others -- *so why isn't everyone using these*? What's worse is that they are continually being offered the chance to have fantastic new powers, greatly improved perceptual capacities, and vastly expanded intelligence. Commander William Riker (who is called "No.1" despite being second in command) [This is a common term for the Executive Officer of a ship. The XO is typically second in command (captain-in-training) and is responsible for the state of the ship. The ship's captain deals with the world outside. - Ed.] was offered virtually unlimited powers by the alien "Q" Being and yet, like the others, rejects them, apparently on the grounds that this would be wrong or unnatural, or on the basis of some other mindless rationalization for his fear and his failure of philosophical outlook.

You may have the impression that I dislike this show. *You're right.* I dislike it for its immorality, its deathism, its statism, its cowardice, and its lack of imagination. And yet I continue to watch it for the experience of advanced technology, superior special effects, the occasional reasonable story, and sympathy for the inquisitiveness and benevolence of the android Data -- the most truly human of the characters.

It's unfortunate that cryonics had to appear in such an unsympathetic context, though it received better treatment than I would have expected. The 24th Century, in the Star Trek universe, is a disappointment. Perhaps Star Trek: The Final Generation will be better.

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Welcome Back Mr. Fox

A Review by Max T. O'Connor

"Welcome Back Mr. Fox" is a 15-minute film that was recently shown on the Arts and Entertainment cable television channel in the "Short-Stories" series. Ostensibly its theme is cryonics, though the underlying theme is our control (or lack of it) over our fate and the importance of mutual aid. Cryonicists will find this film both hilarious and uncomfortable. Since some of you may get to see it in the future (it was video-taped) I will refrain from revealing the essential details even though that will make it difficult to explain its impact.

The central character is Mr. Robert Fox, a film producer who died in 1968 of lung cancer. He wakes up in a hospital, assuming it to be 1968 after having had surgery. His consciousness returns (earlier than expected) and, feeling discomfort, he calls for a doctor. An orderly appears (Matthew) and starts pressing various buttons on the bed, not knowing how to operate it. This results in such great pain that Mr. Fox thinks Matthew is trying to kill him and shouts for his own doctor, not realizing that there have been some changes.

Dr. Craig (the Chief Surgeon) and Dr. Franz (the Head Psychiatrist) enter and he is informed that Dr. Segall's surgery on Mr. Fox was unsuccessful, and that he was declared legally dead and then frozen, and that it is now the year 2008. His life insurance paid $50,000 for a whole body suspension, but all is not well. Fox asks "Why can't I move my arms or legs?". Dr. Craig replies that "Every suspension carries with it certain...complications." We only later discover the full truth hinted at in this statement.

In the meantime. another recently recovered suspension patient, "Debbie", comes to and comes over to talk to Fox. She is clearly an inadequate and neurotic person, but she wants to be friends with Fox and hopes that they can help each other. It soon becomes clear (though it is never stated) that she had cut her wrists in a suicide attempt before her suspension. This scene shows us just how nasty Fox is. Debbie, after being rebuffed, says "I'm just trying to be friendly," to which Fox spits "Friends like you I don't need...You're pathetic. Now that I'm alive for a second time, you think I'm going to waste my time baby-sitting someone like you?" Mr. Fox also continually abuses and threatens the orderly, Matthew, in order to get his own way. He later comes to regret his unpleasant treatment of these two when the horror and helplessness of his situation is revealed.

I can't say much more without spoiling it for future viewers. The performances are superb. Ed Phillips as Mr. Fox is very unlikeable but quite believable, and does an excellent job at conveying contempt, confidence, anger, and sheer horror. There is some well-crafted photography too, as when we zoom in on Fox screaming at the moment of horrible discovery. The very calmness and condescending and reassuring tone of the psychiatrist when he tries to comfort Mr. Fox somehow makes the situation all the more unpleasant. At the end of the film the actors make just a few simple words convey so much. "No" moans Fox as he shakes his head. "Yes" replies Dr. Franz in a sickly, soft, and reassuring tone. "Noooooooo!" screams Mr. Fox, reflecting his terror and helplessness.

We can't exactly thank Writer-Director Walter W. Pitt III for a positive and uplifting film about cryonics, though it is definitely entertaining, amusing, and uncomfortable. I had to reassure myself that the scenario of the film was very unlikely to occur in reality and that it is more like the neurotic and unfounded fears of non-cryonicists who want an excuse, any excuse, for avoiding their responsibility towards themselves. It would be nice to see a film as well made and as clever as this which had a positive angle on cryonics for a change. Perhaps we will have to make it ourselves.

The article on Nanotechnology *(*Cryonics, *May, 1988) outlined how present trends in protein engineering, microtechnology, and other fields are leading to sophisticated means for engineering on the molecular level -- means for assembling atomically-precise structures of any desired complexity. This future field of molecular engineering is called* nanotechnology. *Following this article is a speculative scenario for the revival of a cryonically suspended patient using many of the ideas discussed in this article.*

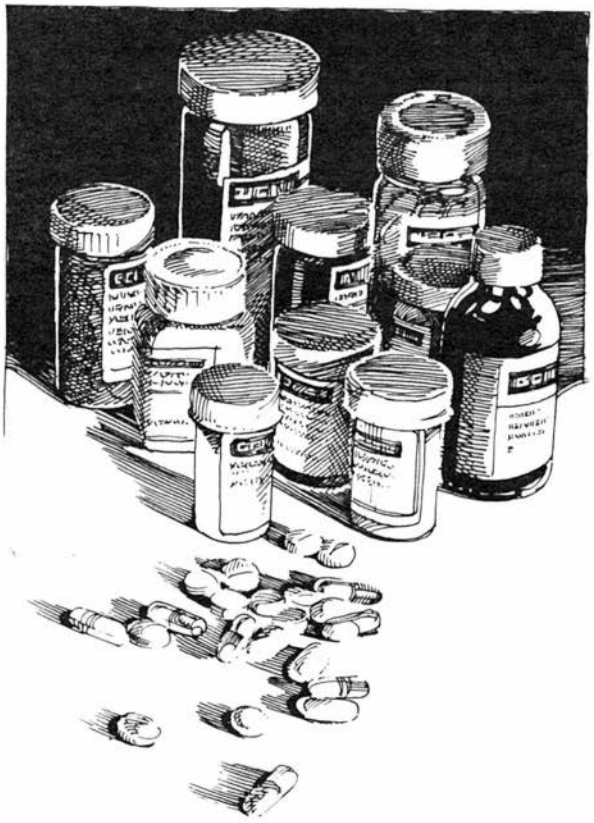
* * *

CELL REPAIR TECHNOLOGY

by Brian Wowk

"So you're talking about being able to put on the order of 1,000 Motorola 68000 CPU's in the volume of a bacterial cell."

--- Eric Drexler, Research Affiliate,
MIT Artificial Intelligence Laboratory



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

Beyond Drugs

What kind of medical advances will molecular engineering bring? Simple extrapolation of present trends in biotechnology would lead one to expect a greatly expanded range of drugs and other bioregulatory compounds. Indeed, mature nanotechnology will allow inexpensive manufacture of *any* molecule that does (or could) exist in nature.

Yet a larger medicine chest is only the most obvious -- and least

significant -- medical implication of nanotechnology. More profoundly, nanotechnology will render obsolete drugs as we know them today.

The use of drugs (simple chemicals) in medicine epitomizes the difference between today's medicine and tomorrow's. Drugs do not heal patients; *drugs merely assist patients in healing themselves.* Drugs are useless when injuries greatly exceed natural healing capacities (particularly when tissues are rendered non-functional by injury). In fact, caring for patients with drugs is not unlike trying to repair and maintain an automobile using just simple fuel additives!

If today's drugs are the medical equivalent of fuel additives, then tomorrow's nanotechnology will be the equivalent of a complete repair shop for the human body. Advanced means for engineering at the molecular level will lead not only to complex new molecules (drugs), but to complex aggregates of molecules -- *molecular machines* -- with unprecedented medical functions. Among these functions will be abilities to vastly augment, and even bypass natural healing processes (by repairing cells and tissues directly), thus freeing medicine from its historic reliance on innate healing capacities.

Cell Repair Systems

How can medicine repair individual cells? By learning to manipulate the most basic components of cells -- atoms and molecules.

What kind of technology will allow medicine to do this? One that is not substantially different *in kind* compared to "technology" already existing in nature. Natural cells and organisms already perform extremely complex feats of molecular synthesis, manipulation, repair, and replacement as part of their normal function. As biologists gain more complete understanding of cell growth and development in the decades ahead, a variety of powerful techniques for augmenting natural healing processes will become available. Foreseeable developments include the use of synthetic growth factors and morphogens for inducing complex tissue regeneration, and even the introduction of novel genetic programs for reversing cellular and tissue injuries for which natural healing mechanisms do not exist. No doubt these techniques will have broad application in the control and reversal of ischemic and freezing injuries which are irreversible at present.

Even more powerful technologies are foreseeable over the long term. With a view toward advanced molecular engineering capabilities, this article will frame a "brute force" argument for the reversibility of almost any biological injury. It will be argued that practical devices are theoretically possible that, if necessary, could perform complete *atom-by-atom* characterization and repair of tissue.

What tools could possibly be small enough to repair cells in such detail, and how could we ever build them? The answers are: Tools like those that cells already use to repair and maintain themselves, which we will build much as cells do.

Cells maintain themselves using a variety of molecular machines (machines constructed to molecular specifications), including enzymes for fine operations and cytoskeletal structures for grosser manipulations. Nanotechnology will allow us to build any of these molecular machines (and more), and to assemble them in ways not seen in nature -- ways that achieve complex medical objectives. Among these objectives will be sophisticated cell repair.

Baseline Capabilities

The development of nanotechnological cell repair systems can, in part, be viewed as

the creation of artificial microorganisms for medical purposes. (Indeed, experimental usage of modified retroviruses for gene therapy today is a kind of cell repair technology.) It therefore follows that appropriately designed medical microbes, or *cell repair devices*, could *at a minimum* do anything that natural cells and their components are known to do today.

Access

White blood cells show that molecular machines can leave a patient's blood stream and move through tissues in a very general manner. Cell repair devices with non-antigenic (or immune compatible) exteriors will therefore similarly be able to similarly reach most any cell in the body.

Viruses demonstrate that systems of molecular machinery can penetrate cell membranes and enter their interiors. More dramatically, successful transplantation of cell nuclei by today's biologists demonstrates that cells can often naturally recover from even extreme membrane and cytoplasmic trauma. Repair devices the size of ordinary organelles will therefore be able enter the interior of cells and move about freely without causing significant harm. (Note that this does not even consider the potential of repair devices to *themselves* repair structures they disturb.)

Disassembly

Digestive enzymes show that molecular machines can disassemble large molecular aggregrates. Repair devices incorporating tools analogous to these enzymes will therefore be able to perform *controlled* disassembly of cell structures as part of analysis and repair processes.

Analysis

The ability of antibodies to distinguish among proteins, the ability of enzymes to distinguish among potential substrates, and many other biological processes demonstrate that molecular machines can recognize specific kinds molecules on the basis of shape and charge distribution. Cell repair devices will therefore be able to employ sets of tools for identifying and analyzing biomolecules by touch. Since larger cell structures generally contain biomolecules unique to them, repair devices will be able to similarly identify these structures by "feeling" them.

Reassembly

The molecular synthesis machinery of natural cells shows that damaged cell structures can be rebuilt and/or reassembled by molecular machines. Indeed, cell replication is direct proof that every structure in a cell can be assembled from even simple nutrient molecules by molecular machinery.

Functional Integration

The above discussion shows that every basic capability required for a sophisticated cell repair technology is already demonstrated in nature. Molecular tools already exist (and undoubtedly others are possible) that could be implemented in future medical devices to allow controlled disassembly, analysis, and repair of cell structures at the molecular level. It remains for advancing molecular technology (which at a highly advanced point will become true nanotechnology) to integrate these tools into microscopic devices capable of advanced medical functions.

The inherent feasibility of constructing such cell repair devices can be viewed in terms of their chemical stability. My article on nanotechnology argued that progress in protein engineering (and other fields) is leading to a technology base that will eventually be broad enough to assemble molecular structures of arbitrary complexity. Therefore, as long as the cell repair hardware proposed in this article is *chemically stable*, it should eventually be *manufacturable*.

Thus we appear to already have all the basic components needed for cell repair devices, and are only awaiting the means to assemble them. In the meantime, we can use current physical, biological, and engineering knowledge to outline the possible nature of these devices -- and their ultimate capabilities.

Control

Although not strictly necessary for many repair tasks, the most broadly powerful way to control the activities of a cell repair device would be to equip it with an onboard nanocomputer. Theoretical design concepts suggest that data storage densities on the order of a gigabyte per cubic micron (one thousandth the volume of a typical cell) may be achievable in computers built to atomic specifications. *This is sufficient storage to characterize an entire cell in complete molecular detail* (see notes). While packing a mainframe computer inside a cell may seem like overkill, knowing that this may be possible provides the security of knowing that nanotechnological cell repair systems could fix virtually anything.

Consider aging for example. We do not at present know all the changes that occur in cells with aging, although they are probably quite extensive. Regardless of how extensive, however, none would escape detection by a nanocomputer-equipped repair system capable of entering a cell and probing its entire molecular inventory. On the basis of such complete characterization (and general comparison with data obtained from similar young cells) onboard software could determine what repairs were necessary to return an aged cell to a youthful state. Once repairs were completed, the repaired cell would be in every way indistinguishable from a young cell. Indeed, it would once again *be* a young cell.

Communications

Many repair tasks (especially ones as extensive as cryoinjury repair) will require communications between widely distributed devices both within and outside of cells. Rather than lugging a cubic micron nanocomputer all over a cell to perform repairs, for example, it would seem simpler to have the computer supervise the operation of many smaller devices from a central location in the cell.

One possible communications system would use serial data channels two to three nanometers in diameter consisting of sheathed carbyne rods. Carbyne is a polymer consisting of carbon atoms joined by alternating single and triple bonds (a molecular structure exploited extensively in theoretical nanocomputer designs). Since the speed of sound in carbyne is over ten kilometers per second, a mechanical signal transmission rate of a gigabaud (billion bits per second) seems a conservative performance estimate for such channels. Many other communication schemes suitable for cell repair systems are also conceivable, such as electrically conductive channels or diffusible chemicals analogous to morphogens and hormones in nature.

As well as providing a means for coordinating repairs within the body, it should also be noted that these communications channels could be used to transfer data processing tasks to computers *outside* the body. This might be useful in instances of extremely severe brain injury (such as a day of ischemia), when inferring the correct pre-injury state becomes a problem too complicated for *in-situ* computers. A communications system consisting of just one gigabaud channel per cell could, for example, transmit a complete atom-by-atom description of a biostatic brain (assuming one byte per atom) to external computers in less than a month. Thus, data processing requirements will never be a fundamental obstacle to solving biological repair problems.

Power

Like natural cells, cell repair devices will require power to perform their activities. For most diagnostic and repair tasks, tapping into the same chemical energy sources as natural cells (such as glucose/oxygen and ATP) should be sufficient. As long as repair processes proceeded at a pace comparable to normal cell functions, utilization of these chemicals need not overtax natural supplies.

Repair of non-functional tissue presents a problem. Tissues with blocked circulation or failed metabolism could not naturally supply energy to fuel repair processes. One possible solution would be an active transport system, similar to axoplasmic transport in nerve cells. Fibrils originating at distant sites could penetrate inactive tissues and cytoplasm to power repair devices by moving nutrients in a conveyor system through hollow interiors. Raw materials for repairs and fibril growth could be similarly supplied.

In fact, a network of trophic fibrils raises the possibility of powering cell repair devices by an entirely *non-biological* means: electricity. Part of the fibril structure could incorporate an insulated organic conductor, such as doped polyacetylene (which could serve communications needs as well). Electrochemical processes within the repair device could then continuously recycle a chemical energy currency, such as ATP, which would directly energize enzymatic repair functions. Alternatively, nano-scale electrostatic actuators or enzymes with electric field-sensitive conformational states might be able to make direct use of electric power for performing repair tasks.

Cryogenic Operation

One particular application of future cell repair technology -- recovery of today's cryonic suspension patients -- will optimally require repairs at cryogenic temperatures (temperatures below -100°C). Operations best performed at these temperatures would include inhibiting metabolic enzymes (until repairs were completed), locking loose structures in place, and analyzing ice crystal positions to aid in proper restoration of mechanically disturbed cell structures. In fact, warming present-day suspension patients before disruptive ice crystals could be properly analyzed might even be fatal (i.e., lead to irreversible loss of critical identity information).

Fortunately, a variety of design possibilities exist for cryogenic repair devices. One possibility would be molecular machines similar to natural cells, but with water replaced by a cryogenic solvent. Some natural enzymes are known to retain their function in liquid ammonia, others in supercritical carbon dioxide, thus demonstrating that water does not have a monopoly on support of biological processes. Artificial enzyme systems based on natural peptides, or other polymers with protein-like conformational properties, could in principle operate in cryogenic solvents such as tetrafluoromethane, or perhaps even liquid nitrogen. Although conventional biochemistry is nonexistent at these

temperatures, faster alternate chemistries could be exploited.

In fact, chemistry (in the sense of forming and breaking chemical bonds) is not even necessary for the operation of some molecular machines. The rod logic systems which underlie current (theoretical) nanocomputer designs, for example, are a clockwork of precisely-configured molecular components interacting *mechanically*, not chemically. Not only is random jostling (heat) unnecessary for the operation of such a system, it is a *handicap*. Repair devices of this sort -- molecular machines resembling conventional machines on a nanoscale -- would find ultra-low temperatures an ideal operating environment.

Of course, regardless of how they operate internally, repair devices will have to make chemical changes to tissues they are repairing. Yet even this does not require high temperatures in the ordinary sense. Molecular tools driven by electrical (or low-temperature chemical) actuators could provide *localized* kinetic energy for forming or breaking chemical bonds. Indeed, by suitably "banging" or "grabbing" target molecules it is possible to create effectively any "temperature" at a single reaction site. Thus a fairly wide range of biological repair processes could in principle be carried out at cryogenic temperatures, thereby giving future cell repair technology a greater degree of versatility -- and present cryonics practice a greater chance of success.

Practical Consequences

Assuming future molecular engineering capabilities (nanotechnology), this article has sketched the outlines of a medical technology which would operate at the most fundamental level of living things -- the molecular level. What would be the *practical* implications of a technology which could take apart, analyze, and repair cells like so many machine parts?

Ultimate Medicine

Disease, whether its causes be internal or external, is a malfunction of the human body -- a breakdown that detracts from well-being. Curing, not just alleviating, disease has always been a difficult task for medicine: both the tools and the knowledge required to effectively repair the body have been lacking. Thus medicine has historically been (and largely still is) an uncertain art, with very limited understanding of disease processes, and even less understanding of how to intervene in them. Indeed, physicians today are in a predicament similar to that which would be faced by 18th-century engineers trying to maintain a 20th-century automobile: repairs would be crude at best, and breakdown inevitable.

Like primitive engineers faced with advanced technology, medicine must "catch up" with the technology level of the human body before it can become really effective. What is this "technology level"? Since the human body is basically an extremely complex system of interacting molecules (i.e., a molecular machine), the technology required to truly understand and repair the body is molecular machine technology -- nanotechnology.

Mature nanotechnology will mean an ability to routinely design and build "machines" as intricate as our cells from scratch. A natural consequence of this level of technology will be the ability to analyze and repair the human body as completely and effectively as we can repair any conventional machine today. Nanotechnology will mean no more guesswork, uncertain cures, or untreatable organic conditions; medicine will finally be equal to the task of understanding and controlling the body in terms of its most fundamental machine components -- atoms and molecules.

Future medicine will attain this degree of understanding and control through cell repair systems based on technologies and devices like those outlined in this article -- microscopic devices able to roam throughout cells and tissues diagnosing and repairing problems at the cellular and molecular levels. Since disease is a malfunction of the body, and since the body functions by means of molecular machinery, it follows that molecular-level medicine will be able to cure any disease.

This observation particularly applies to the most prevalent and deadly disease on earth today -- *aging*. Whatever biological changes underlie aging, they must involve changes in molecules, and must therefore be amenable to control by molecular-level medicine. It seems clear that cell repair technology would allow one's biological age to be not only arrested, but *reversed*, and even adjusted at whim. These are the implications of a technology able to repair and maintain the body at a molecular level. *With sufficiently advanced repair technology our bodies need never deteriorate or break down as they do today.*

Injury Repair

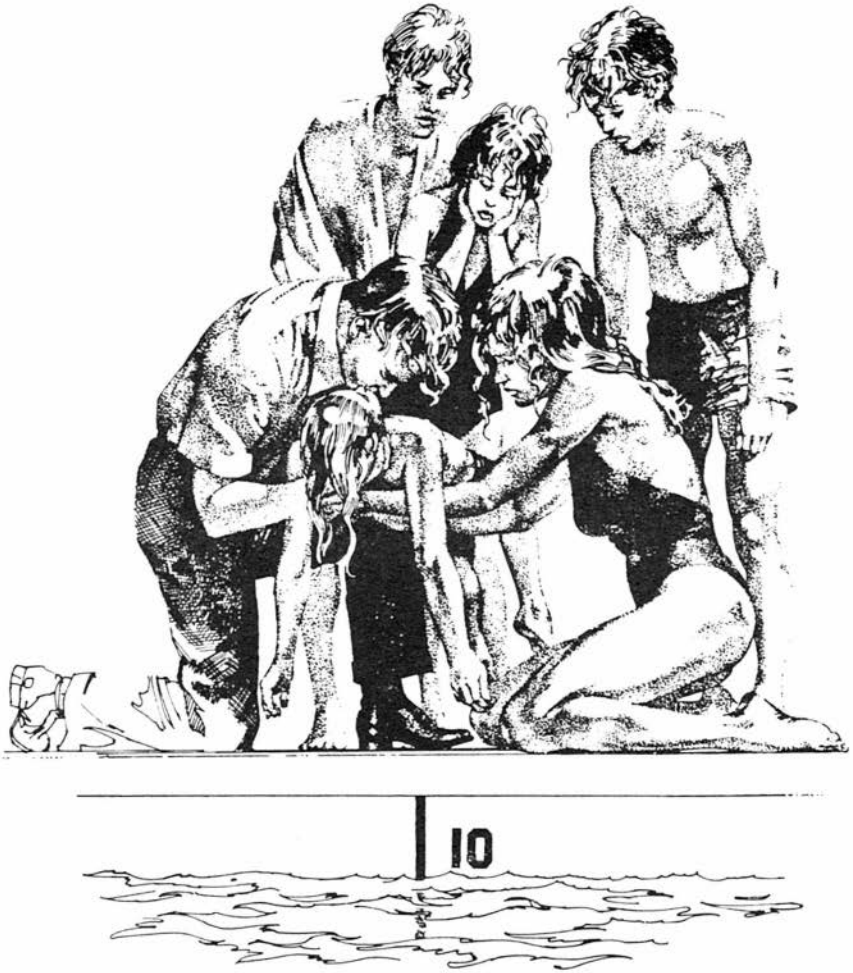
Cell repair technology will allow a variety of powerful approaches for reversing injuries that cannot be healed naturally.

On a basic level, cell repair technology will naturally mean an ability to repair individual cells. This will be particularly important for cells which contain crucial, irreplaceable information, such as brain cells. On this level, the potential of cell repair technology appears quite broad. Even when cells are rendered completely non-functional by poison, infection, ischemia, freezing injury, and indeed any other injury, repair devices will always be able to enter cells, assess the situation, and restore the cells to a healthy condition matching an inferred pre-injury state.

On another level, cell repair technology will also mean a very general ability to *replace* cells. Cell repair devices will be able to exercise complete control over cell growth and development: they will be able to control and modify cell DNA in sophisticated ways to achieve virtually any desired growth objectives. Among these objectives will be many kinds of healing not seen in nature, such as healing of major injuries, severed spinal cords, and even replacement of lost brain tissue. More ambitiously, regrowth of lost limbs, organs, and even *entire bodies* is implicitly possible with complete control over cell growth and development. (After all, nature already demonstrates an ability to grow these items from scratch.)

Indeed, the biological repair potential of cell repair technology appears so vast that it might just be simplest to ask whether there is anything this technology *couldn't* fix.

The answer to this question becomes apparent as one contemplates the effect of increasingly extensive repairs to the body. It is possible to imagine instances of repair so extensive that the healed patient would no longer be the "original" patient. Specifically, this will occur when injuries begin to impinge on a patient's *brain*. Although cell repair technology appears capable of reversing any injury, it will not be able to restore brain information lost during injury. Brain information loss will pose a fundamental limitation for future medicine -- and the ultimate dividing line between life and death.



Fatalities

The only causes of death for 22nd century medicine will be severe injuries *directly* to the brain.

Offhand, this might not seem plausible: wouldn't, say, drowning or gunshot wounds to the heart be fatal? No, these injuries can cause cardiac arrest and ensuing coma, but they are not in themselves fatal. Oxygen starvation, cessation of circulation, even complete collapse of normal tissue metabolism does not mean a person is really dead.

Consider a patient whose ischemic (non-functional) body is recovered several hours after drowning. Although such a patient would be relegated to a morgue today, this would be unthinkable in an era of cell repair technology (or even today, with cryonic suspension available). With the basic structure of the person's brain still intact, cell repair devices could be deployed throughout the body to repair cellular injuries caused by the

hours of absent blood flow. After several days of repairs conducted at deep hypothermic temperatures (to prevent further deterioration), staged restart of metabolism would be performed by selective unblocking of metabolic enzymes as the patient was warmed. The patient would then emerge from his coma in perfect health, with perhaps mild amnesia as the only remnant of what had happened. Indeed, not until decomposition led to major loss of brain structure would drowning victims, or other victims of protracted ischemia (absent blood flow), be beyond recovery by cell repair technology. (The apparent persistence of brain structures critical to memory and identity after hours of ischemia will be discussed in a forthcoming article.)

A significant point about future fatalities (one particularly relevant to appreciating cryonics) is *how* it will be known when patients are beyond recovery: in most cases, it won't be known. As long as some brain structure remains, it will *always* be possible to reconstruct a patient's brain and body on the basis of persisting information. The success of such reconstruction -- the extent to which to the patient's life would be saved -- would depend on how much memory and personality could be salvaged by the repair process. Only if complete loss of memory and personality were evident *after* repair (and perhaps not even then) would the original patient likely be regarded as dead.

Thus death (as rare as it will be) will have a radically different character in the future. There will never be "dead" bodies, only lost bodies, ischemic bodies, or amnesiac bodies following extensive injury repair. A future variation on a contemporary cliche might be, "Where there's brain structure, there's hope."

Lifespan

With disease, aging, and primitive medicine all unpleasant memories, just how long people could live in a nanotechnic era is very much an open question.

Many books about "life extension" quote 600 years as a probable life expectancy if aging were ever eliminated (a figure arrived at on the basis of "fatal" accident statistics). Yet this figure cannot be accepted as valid: it assumes fatal accidents to consist of injuries causing cardiac arrest -- no consideration is given to advanced means of reversing ischemic injuries following cardiac arrest (as discussed above). Indeed, if people were routinely fitted with emergency transmitters to facilitate prompt rescue in the event of severe injury (say, within several hours of cardiac arrest), the only causes of death in an era of advanced cell repair would be immediately -- and *dramatically* -- destructive accidents. Just how destructive such accidents might have to be is suggested at the end of the next and final section.

Homo Perfectus

All discussion thus far has focused on the potential of nanotechnology for restoring and maintaining health. Yet technologies as powerful as those described here cannot help but invite an additional line of inquiry: What might we do to our bodies *beyond* just healing them?

Consider the potential of nanocomputers for not just repairing the nervous system, but for *augmenting* it. A nanocomputer one cubic millimeter in volume could hold one billion gigabytes of data -- more information than in all the world's libraries at present. Implanting such a computer within the brain, and routing its output to visual centers, would be the ultimate in library service -- all of human knowledge available for instant mental lookup.

Then there is also the *physical* side of nanotechnology. The physical capacities of our body are the result of blind choices of evolutionary development, not optimum design. These capacities are often far from the limits of what is theoretically possible.

Consider muscle function. Microstructured materials analogous to muscle tissue have been designed as part of contemporary efforts to better understand nanotechnology. One particular design consists of electrostatic motors 50 nanometers in diameter driving a matrix of fine diamond fiber. The resultant material has the tensile strength of steel, and could efficiently deliver *megawatts* of mechanical power per cubic centimeter (see notes). By replacing ordinary muscle with material of this sort we could (conservatively) increase our physical strength hundreds of times.

Finally, not only could we make ourselves stronger and smarter with nanotechnology, we could also make ourselves *tougher*. How much tougher? By replacing connective and skeletal proteins with covalent carbon microstructures (a necessary prerequisite for greatly increased strength) tough enough to routinely survive some of the most destructive accidents known today -- even aircraft accidents.

Perhaps most remarkable of all, none of these changes would require any dramatic change in our external appearance.

NOTES AND REFERENCES

"So you're talking about..."; is a quote from *Molecular Technology And Cell Repair Machines*, a talk delivered by K. Eric Drexler at the 1985 Lake Tahoe Life Extension Festival on May 25, 1985. (Transcript available directly from Alcor.)

My article on nanotechnology argued that the technology base required to assemble molecular structures as complex as cell repair devices is essentially unavoidable if technological progress continues through the next century. Relevant arguments and references will not be repeated here.

A typical cell contains several billion macromolecules of perhaps 100,000 different types -- arranged in a decidedly non-random pattern. By employing specialized coordinate systems and data structures suited to natural cellular organization, a gigabyte (one cubic micron of nanocomputer storage) should be more than adequate to hold a complete molecular description of a cell. (See the article on nanotechnology (May, 1988) for a more detailed discussion of projected nanocomputing technologies.)

"none would escape detection..."; It is a virtual tautology that any molecular changes significant enough to adversely affect normal cell operation would not escape detection by molecular-level repair systems.

The two proposed design strategies for cryogenic repair devices (enzymes in a cryogenic solvent vs. precisely-configured molecular machinery) are respective examples of *type O* and *type M* molecular technology. Type O (organic) technology refers to molecular machines patterned after natural cells (bags of reacting chemicals), whereas type M (mechanical) technology refers to molecular machines patterned after conventional macromachines on a nanoscale (arrays of inert mechanically interacting components). Low temperature behavior is only one respect in which these two technologies differ. Further fundamental differences are explored in *Biological and Nanomechanical Systems: Contrasts in Evolutionary Capacity*, by K. Eric Drexler, in *Artificial Life*, edited by Christopher Langton, Addison-Wesley, 1988.

One extremely important point made in the above essay is that type M technology is completely incapable of harmful mutation. While natural microorganisms (type O molecular machines) have a high evolutionary capacity (indeed, they have evolved to evolve), type M molecular machines will be no more capable of evolution than household appliances. (Alterations in structure would generally result in outright breakdown rather than a change in basic function.) Thus, while cell repair devices are often described as artificial "microbes" to aid in visualizing them, it should be realized that they will be more like miniature conventional machines than true life forms. As such, they will pose no danger whatsoever to the environment or other human beings (unless they are deliberately designed to do so).

Synthetic muscle with power densities of megawatts per cubic centimeter would in practice always be limited by power and heat dissipation constraints. Yet even within these constraints fantastic feats of strength would be possible. In an anaerobic burst of effort, a nanotechnological "super human" could for example lift a 4,000 pound automobile over his/her head with a body temperature rise of only 2°F, and energy consumption of 100 calories -- less energy than in a typical candy bar (assuming *only* 10% efficient conversion). This is not comic book fantasy, but firm physical calculation. For more detailed discussion of a "muscle" design which would make this possible, see pp. 258-259, *Engines Of Creation*, by K. Eric Drexler, Anchor Press/Doubleday, Garden City, NY, 1986.

RESUSCITATION: A SPECULATIVE SCENARIO FOR RECOVERY

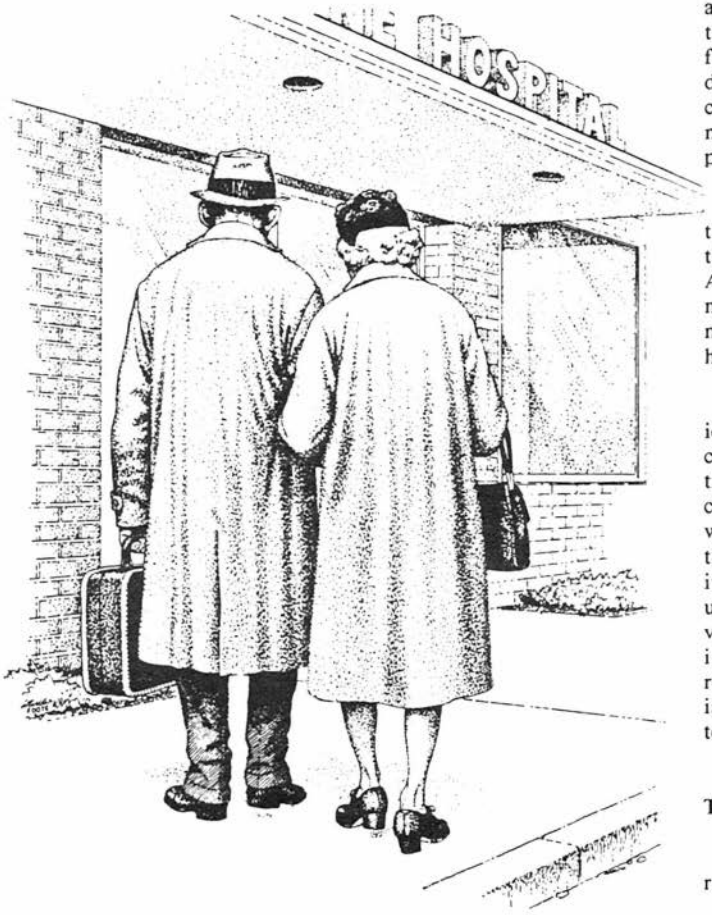
by Mike Darwin

What follows is a purely speculative exploration of how revival might be carried out. It is presented here to help visualize many of the cell repair ideas presented in the previous sections. (A more detailed technical examination of cell repair concepts can be found in the article on Nanotechnology *in the May, 1988* Cryonics *and the article on* Cell Repair Technology, *immediately preceeding this article.)*

* * *

Prelude

It has been a long, hard battle. First youth slipped away to be replaced by old age, with all its limitations. Finally, inside some nameless cell, a change occurs. A few atoms become misarranged and the instructions governing the cell's operation and replication suffer a critical error. The error propagates as the cell begins to divide blindly. Millions, then billions of copies of the errant cell are made. Vital structures are displaced and damaged, toxic molecules are spewed forth, resulting in the death of countless normal cells and the inability of many others to perform properly.



Chemotherapy and radiation therapy fail to stem the rising tide of cancer. A man is dying and there is nothing that 20th century medicine can do to reverse his decline.

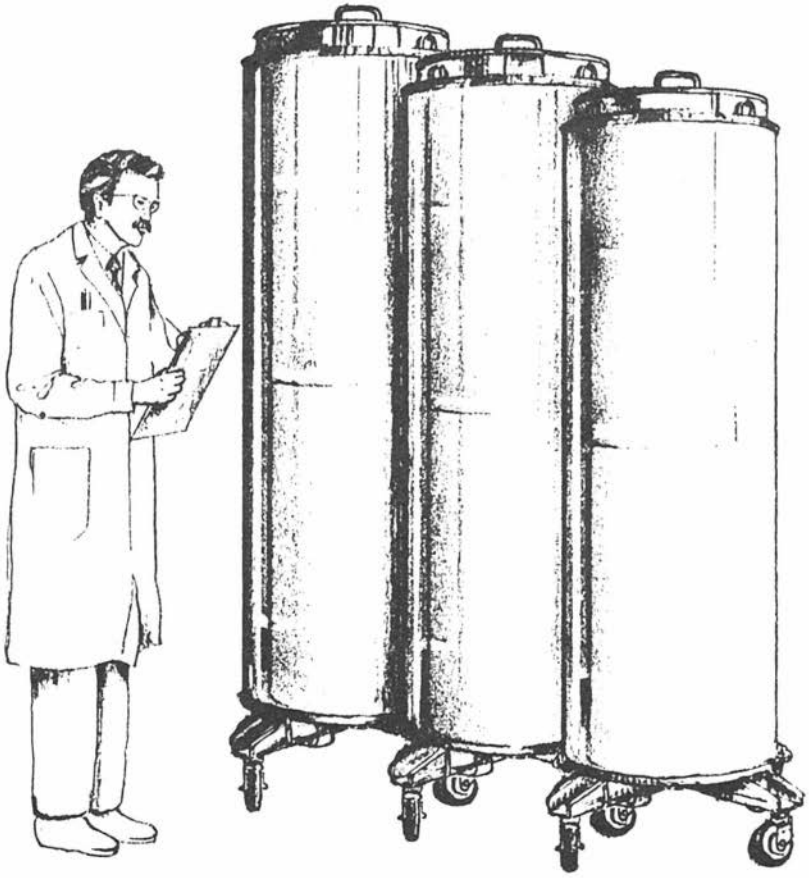
A heart stops. A physician gives up and pronounces death. But it is not the end. Unlike most of his contemporaries, the old man with the stilled heart and the malignancy which caused it has looked into the future unflinchingly -- with vision and foresight. Waiting outside the hospital room where the patient lies is a cryonics transport team.

The Journey Begins

The transport team restores circulation and

breathing with CPR, connects the patient to a portable heart-lung machine and begins cooling him. He is taken to a cryonics facility where he is connected to another heart-lung machine, more elaborate than the first. Gradually, a little less than half the water in his body is replaced with cryoprotective drugs. He is cooled to the boiling point of liquid nitrogen and placed within a protective vault to continue his march through time -- unchanging.

The chemistry inside the man's cells is stopped. Time is stopped for him. But not for the rest of the world. Outside his frozen sanctuary, the march of time goes on. Countless other terminal patients are abandoned, and allowed to slip away forever. Not all, however. Less than a decade after his entry into cryonic suspension another patient joins him: his wife.



The decades slide by. Driven by medical, military, and industrial pressures, human technology increasingly comes to grips with engineering on a molecular level. Physicians wishing ever better ways to monitor their patients demand smaller and smaller devices which researchers are increasingly able to deliver. The demand for ever smaller and

faster computers with increasingly compact memories leads to the development of very small electronic devices. The need to repair living tissue that has suffered trauma and disease results in increasingly sophisticated medical therapies and surgical tools. Within two decades from the time the patient entered suspension a cure for his cancer is developed. The molecular basis of cancer is unraveled, and medicine becomes equal to the task of turning off the genes which cause errant cell division and lead to tumor growth and death.

But the patient in suspension cannot be revived yet. His problem is not so much the cancer as it is the injury inflicted by the immature technology that was used to suspend him. He must continue to wait. Fortunately, chilled to the temperature of liquid nitrogen, he can wait for centuries if need be.

Revival

A little more than 100 years has passed since darkness enveloped the dying man in the hospital. A full-fledged technology of cell repair is now available. Ultra-sophisticated microscopic repair devices routinely patrol human tissue, repairing injury and destroying disease organisms. Indefinite youth and good health are the birthright of everyone.

The patient from the 1980's is removed from the icy vault that has held him for over a century. Slowly his temperature is raised to -130°C, and his head is separated from the rest of his aged, diseased body with a high speed surgical saw and transferred the fluid-filled receiving chamber of the revival unit. The fluid in the receiving chamber is tetrafluoromethane; a compound which is liquid even at -130°C. The revival unit appears a combination of living creature and inorganic machine. An Artifical Intelligence, its "brain" contains the sum of all human medical knowledge, which it keeps updated with its link to the worldwide medical information net.

Connections are established between the patient's neck and the revival unit. Repairs begin. Countless millions of microscopic devices designed to operate at low temperatures begin to clear out ice from the patient's blood vessels. As they proceed, they assemble behind them fine fibers of electrically conductive polyacetylene which supply power to the ice removal devices. Later these fibers will serve as communications links as well.

Once the circulatory system of the patient is free of ice, billions of nanocomputers (cell-sized computers) are moved into strategic positions along the network of conducting fibers. These interconnected computers will coordinate both short-range and long-range repair activities (such as repair of gross fractures). All these processes are carried out sufficiently slowly so that the patient's temperature does not rise significantly above -130°C: the tissues beyond his blood vessels remain virtually unchanged from the time of his suspension.

New, more sophisticated devices, are introduced. Capillary walls are partially disassembled, and the devices begin to enter the inter-cellular spaces of the brain. These devices also remove ice, but much more carefully than the earlier ones. As ice crystals are disassembled at the molecular level, information concerning their position and orientation is transmitted back to supervising nanocomputers waiting in nearby blood vessels. When biological structures such as cell membranes or dendrite debris are encountered, they are carefully examined and tagged with special identifying molecules, and anchored to nearby cells if necessary. Their original position is also relayed back to the supervising computers and to the revival unit.

A week has now passed. Virtually all the ice has been removed from the patient's brain, and cryogenic fluid now freely circulates throughout the extracellular environment. The patient's temperature is now raised until the contents of his cells become a thick liquid (at about -100°C). Devices for the first time begin to enter cell interiors. Their purpose is to lock up metabolic machinery to prevent premature, uncoupled activity. Enzymes are physically bonded to cell structures, and their active sites are blocked by specially fabricated molecules until repairs are completed.

Once cell interiors have been adequately stabilized, the tetrafluoromethane is replaced with another solvent, and the patient's temperature is raised above the freezing point of water. Trillions of repair devices are now deployed. In sizes ranging from that of large molecules to small cells, the devices take up strategic positions both inside and outside cells. Among these devices are nanocomputers which will now supervise repairs from *inside* cells.

With the repair system now in essentially complete control of the patient's brain, the most sophisticated operations begin. Small devices examine molecules and report their structures to larger controlling devices. Molecular damage due to oxygen and nutrient starvation (ischemia), freezing, and even aging is repaired by nanocomputer-directed repair enzymes. Independent DNA copies are obtained from many different cells, and DNA in these cells is restored to the damage-free sequence of youth inferred by nanocomputer comparison. As repairs proceed, virtually no cellular defects escape the detection and correction of the repair system.

While repairs proceed inside cells, disrupted external structures are restored on the basis information obtained during the ice removal process. Torn membranes are mended, disrupted cell connections restored, and gross fractures are repaired by microscopic surgeons which operate at a level a million times finer and more sophisticated than surgeons today. Where cells have been lost due to aging or other injury, new ones are fabricated and proper connections made. Gradually, over the course of several months, the patient's brain is restored to a healthy state.

As repairs near completion, larger devices are removed, capillary membranes are repaired, and the network of nanocomputers and communications fibers is disassembled. A blood supply grown from the patient's own cells by the revival unit now begins to circulate, and the temperature is stabilized at 37°C (98.6°F). Cell metabolism is restarted by selective unblocking of enzymes inhibited during the repair process, although consciousness is still suppressed by circulating chemicals which inhibit critical steps in nerve cell metabolism. The patient -- an exposed pearly white brain floating within the womb of the revival unit -- is now ready for the final phase of the revival process.

On the surface of his brain a single cell begins to divide. Unlike the cancer which threatened the patient's life, the division of this cell is orderly and planned to restore life. A layer of dividing cells covers the restored but unconscious brain. The cells begin to differentiate, and slowly, like a newly conceived child, a body begins to take shape within the revival unit.

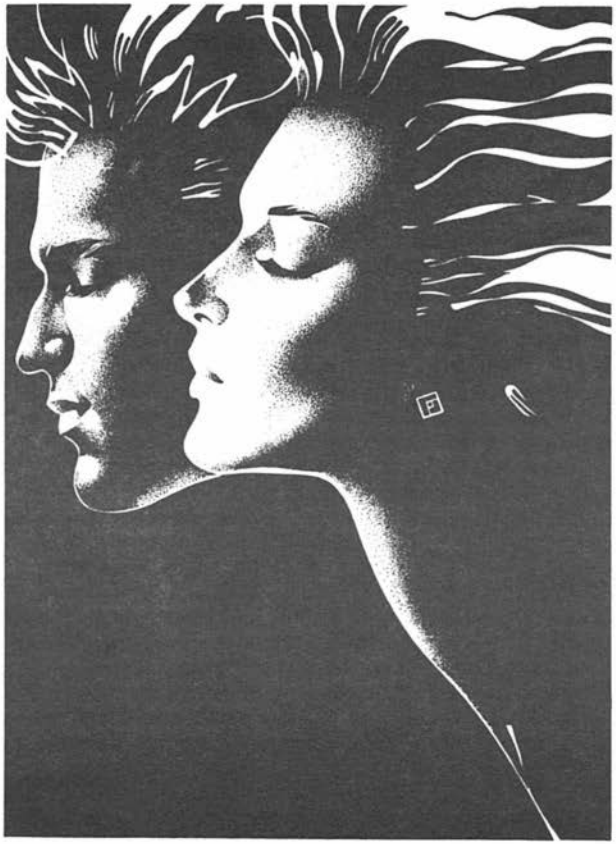
Awakening

Just a little over a year from the start of the revival procedure, the patient awakens in his hospital bed. He returns to consciousness slowly, suffused in a warmth and sense of security which seems strangely at variance with his remembered prognosis. His

last memory is of going to sleep a few days before his suspension over a century ago. He slowly opens his eyes and is greeted by a face that seems strangely familiar but which he cannot quite place.

A familiar voice calls out his name. Instantly there is recognition. It is his wife. But she is not as she was. She is young and beautiful again. More beautiful even than he remembered. An instant before he was trapped in a dying body. Now, he is alive and well and looking into the eyes of someone he loves. He glances down at has his hands and at the contours of the sheet covering his body. He too is young again. He has made the trip successfully.

In an instant, in the blink of an eye he has found his way into the future. An open-ended future of unlimited lifespan and unbounded possibilities.



A REVIEW:
THE DREAD DISEASE:
CANCER AND MODERN AMERICAN CULTURE,
by James T. Patterson

by Thomas Donaldson

Only a few weeks ago I had arrived home from work to find my phone ringing. It was a woman, talking with the reedy voice of the old, calling from the American Cancer Society and asking for money. I decided to give my true opinions. I explained to her about how important aging research was, how most cancers occurred in the old, and that aging was therefore a much more critical problem. She asked me if I was a doctor, to which I answered (not wholly true, but I'm not an MD) that I was not. She asked me for money again, and I told her bluntly that cancer research had already gotten far more money than it deserved and I did not intend to perpetuate that situation.

It's not as if cancer is negligible or deserves no funding at all. But I have felt for years that priorities in American medical research are very seriously out of whack. Cancer isn't even the leading cause of death. Moreover, from the history I am reviewing here, scientists have seriously researched cancer not just for 20 years, but for almost 100, with almost no effect on the survival of cancer patients. Yet the American Cancer Society still comes out with cheerful ads about the great strides we are making against cancer, and magazines one week trumpet the latest treatments (and then a month later put in their back pages the failure of those same treatments).

Ladies and gentlemen, these are the people who say that reviving the frozen is beyond possibility.

Naturally, I haven't just had these feelings about cancer research, but I've also really wanted to know what had gone wrong. Why do we have so many researchers and contributors running pell-mell after a "cure for cancer"? How did this happen?

Patterson's book gives a historical account of how it happened. His book is not deep; behind every reason there lies a deeper reason, and Patterson doesn't get into those issues. He just tells the story, beginning with the late 19th Century, of how this disease took so large a hold on the American imagination. And it is the *American* imagination: not that Frenchmen don't get cancer, but as a subject for research cancer hasn't the clout in other countries that it does in the United States.

His book told me many things that I didn't know. After all, I was only born in the 1940's and even by that time cancer mania had had a very long (and quite unsuccessful) history. Death rates from cancer started to rise late in the 19th Century. I was interested and surprized to learn that even as early as this, some people spoke out saying that the disease obviously stemmed from aging.

In the 19th Century people were terrified of cancer. It meant a death sentence, but even more than that it was a degrading disease. Doctors knew, for instance, that women seemed to get cancer more often than men, and that their cancers were cancers of the breast and uterus. In the early 20th Century, doctors lecturing on the causes of cancer constantly encountered bored audiences, who wanted to hear what they *knew* to be true, which was that cancer came from syphilis. When Ulysses S. Grant died from cancer in 1885, the open news coverage of his cancer (a cancer of the throat) was quite unusual. Most patients tried to keep the fact that they had the disease secret.

But times change. The main line of Patterson's history tells of how the medical profession and the American establishment took hold of cancer as *the* problem. In the 19th Century, many people distrusted doctors and felt that neglect was the safer course. In fact, for that time it certainly was. But the germ theory of disease, and the scientific successes attained with it, caused a tremendous rise in the prestige of doctors. The doctors responded to this opportunity. Even though they knew no more about cancer than before, they vigorously put down all opposition ("quacks", "nostrums"). Laws were passed making it much harder to sell patent medicines and monopolizing the practice of medicine to the doctors. Many inferior medical schools were put out of business by legal fiat (this was not a libertarian thing to do, guys). Consequently medicine became very much an upper class preserve: doctors came from predominantly from the upper classes.

The American Cancer Society began as the American Society for the Control of Cancer, founded in 1913. In its early years it was overshadowed by the National Tuberculosis Association. It grew very slowly. But from the beginning, it started to put out the ads we know so well. The ads all suggest that we see a doctor immediately for sores that do not heal, for lumps, irregular bleeding or discharge, or persistent indigestion. The established treatment (I will not say cure) was immediate surgery. The main work of the American Society for the Control of Cancer was education, to try to keep people from hiding their cancer: and of course, to "educate" the lower classes not to attend to quacks.

But just after the war, a big change occurred. No, folks, nobody made any advances in actual treatments. Up until then, the Society had been dominated by doctors. Then Mary Lasker, the wife of Albert Lasker, the advertising tycoon, and her friends virtually took over the American Society for the Control of Cancer. Businessmen sat on the board and much more money poured into it. Mary Lasker got Congress to fund the National Cancer Institute, for research on cancer. At the same time, she changed the name of the Society to the American Cancer Society and gave it a large advertising budget. It is ironic that Albert Lasker made a lot of money advertising tobacco before the war.

The National Cancer Institute since that time, and even now, puts out reams of "research". The American Cancer Society, directly or indirectly, is responsible for all the cheery articles in the press about advances in cancer research. A list of thousands of papers and hundreds of seminars are put forward as the "results" from the spending. It was very interesting, though, to read in Patterson's history of how treatment of most cancers remains what it was in 1910, and remains about as successful.

But opposition to the cancer establishment has persisted in several quarters. An inchoate popular opposition exists in all the people who still pay attention to the "quacks", laetrile, and other treatments. But scientific opposition to the money poured into research is visible too. One scientist is quoted: "I have some advice for young researchers in biology. Stay out of cancer research because it's full of money and just about out of science." Another scientist, quoted by Daniel Greenberg, said that National Cancer Institute research "continues to yield a great many details relevant only to the sub-sub-specialist. It also yields erroneously premature announcements popularized in the dailies as 'great discoveries'. ...an awesome heap of rocks has been gathered and is still growing... " but nothing had come of the heap of rocks.

Support for cancer research remains almost as strong now as before. The NCI is still full of money and actual treatments remain largely unsuccessful. The excesses of surgery in the 1950's (the hemicorporectomy, in which the lower body is cut off at the waist, was a triumph of the 1950's) are no longer performed. Current excesses are in drugs against cancer, many of which are toxic and painful, with a high probability that the drug will cure the patient but kill him due to other toxic effects.

CANCER'S SEVEN WARNING SIGNALS

1. Change in bowel or bladder habits
2. A sore that does not heal
3. Unusual bleeding or discharge
4. Thickening or lump in breast or elsewhere
5. Indigestion or difficulty in swallowing
6. Obvious change in wart or mole
7. Nagging cough or hoarseness

If you have a warning signal, see your doctor

What are we to make of this history? And what are the deeper reasons for it? First, gerontology did lose out in the 19th Century to the more limited idea of "curing" particular diseases. I believe this was because the germ theory had only recently had such success and few people had any idea what could be done about aging. But after gerontology lost out, the surgical approach won not because of proven effectiveness (it had none. Even in classical times, women's cancerous breasts were removed. And Hippocrates counselled against surgery, saying that patients operated on died quickly, while those not operated on sometimes survived for years). I believe that it won because it consolidated surgeons into power, consolidated them as an upper class, and gave them an opportunity to attack other versions of medicine opposed to them.

There have certainly been other terrifying and degrading diseases. Why then was cancer awarded the accolade? That's a question which Patterson never answers well. Certainly even as far back as the mid-19th Century people have had a deep phobia about cancer which they did not have about, say, heart disease. This phobia has persisted despite all common sense. George Crile, a physician and writer about cancer in the 1950's, tells the story of a family anxiously bringing him in to diagnose their grandmother, who had ceased to speak. He examined her and told them there was nothing he could do. She had had a stroke and did not have long to live. "Was it cancer?" the family asked. No, if it was cancer he might have done something. "Thank God," the family all said. "Grandma doesn't have cancer!" One reason for the unreasoning fear about cancer may actually be a survival of the feeling that it carries a moral taint. For years cancer has been a kind of 20th Century leprosy.

Reading Patterson's book, I am struck by how little anything has changed. Work on cancer has had some positive effects: these include actual success with leukemias, the understanding of how dangerous smoking is, and some (demographically minor) improvements in survival rates from cancer. But treatments fundamentally remain much as they were at the turn of the century. Cancer kills about as many people as it did before.

Why does cancer research have such a dismal scientific record? The most visible reason is simply that very little "cancer research" was actually well planned. A great deal of it has consisted of applying the latest scientific wonders from some other field (nuclear technology in the 50's, and now genetic technology with monoclonal antibodies) to cancer, without any real evidence that the new technology has anything to do with the problem. Until recently very little work on cancer has approached the fundamental causes of the disease. Without such knowledge, we can spend unlimited amounts of money and achieve nothing.

I believe strongly that there is a deeper reason. The entire enterprise is

wrongheaded from the start. It is an attempt to achieve logically contradictory goals. To try to cure cancer without curing aging is asking for a square circle. Certainly, the contradiction in these goals isn't quite so obvious, but it is there. The aim of cancer research is not just to prevent people from dying of cancer. We can do that now, by shooting all the cancer patients (See? Cancer death rates are down. Why do you look so unhappy?). We want to restore them to health, but their age alone means they will never return to health. And of course, just because the contradiction isn't so clear, many people will offer their services and promise success in curing cancer without curing aging.

Patterson discusses, without going into the subject deeply, the American fascination with "technology". I don't know what "technology" in the abstract means. In cancer research, it seemed to mean a fascination for big shiny machines. More than in other countries, Americans do have a belief that scientific research can solve problems. But science is a manifold thing. Just like patriotism, which produces sleazy politicians wrapping themselves in the flag, widespread belief in science produces all kinds of frauds and hypocrites, who ask for money to play undisturbed because what they do is "science".

But cancer research has for 100 years captured the high ground. There has been an opposition, which has never succeeded. The main reason the opposition did not succeed, above all else, may be that it was too disorganized, with no intellectual center. The opposition to support for cancer research for a long time has consisted of two classes: the uneducated from the South and Midwest, fundamentalist, conservative, ready to use folk remedies and distrustful of doctors, and the liberals, who have urged preventive medicine and railed against American society. These two classes could never unite. Furthermore, neither class has ever had a coherent answer to the real problem of human suffering involved in cancer (or any other disease).

Often cryonicists will say that they aren't in conflict with any present versions of medicine. Economically, we are very much in conflict. Implicitly we are saying that all the money which goes into futile medical battles doomed to failure should go into cryonic suspension. If cryonic suspension becomes widespread, that is the choice which people will have to make. But cryonics is also the very first serious (even if not widely heard) challenge to prevailing medical orthodoxy. It is not as if medical orthodoxy has a record of success against the problem. But all previous opposition failed because it lacked any coherent theory about *what to do*. We have some proposals under that heading, which we feel deserve serious attention.

THE HEALTH OF NATIONS
by Leonard Sagan

A review by Thomas Donaldson

This is a very interesting book, likely to truly irritate some cryonicists. It's interesting, of course, not because it will irritate some of us, but because of what Leonard Sagan has to say. His thesis is quite original, though flawed. The originality is what makes it worth reading: just as Francis Bacon said long ago, it is often far better to be wrong than to be confused. If you are wrong you are far along the road to being right. If you are confused you are nowhere.

Sagan is not a relative of the *other* Sagan who has also irritated us, though with far less originality. Leonard Sagan is a doctor and epidemiologist. He has a theory about the major factor which affects general levels of health, i.e., demographic health measures. To summarize, he believes that the *real* story of what happened in the 19th Century, when deathrates dropped so precipitously, was that people came to have much more self-respect, self-esteem, and sense of control over their fate than ever before, that this self-respect greatly improved their immune system, and so disease rates fell and longevity increased.

For many years historians have recognized a major fact about medicine, severely embarassing at least to simple ideas of what medicine has done for us. This is that the major fall in deathrates in both Europe and America happened *before* antibiotics, and even started before the germ theory of disease. True, we do understand more about disease than before. But demographically, that understanding hasn't meant anything.

This problem leaves us with the problem of explaining what really happened. Sagan's ideas aren't the first. One simple explanation, for instance, is just that people began to eat better. Another is that the extensive efforts in public health, beginning in the 19th Century, caused the fall in mortality. Sagan's book is particularly interesting in its debunking of both of these explanations. For instance, death rates in Australia in the early part of the 19th Century were the same as those in England, despite the availability of much more and better food in Australia. Furthermore, wartime Denmark had very low death rates, despite severe food problems. Again, the efforts at public health, just like antibiotics, came *after* the fall in death rate had already begun. Furthermore, even extensive public health efforts have failed in some cases to lower death rates. A US PHS project, done with the Cornell Medical School, tried to lower sickness and mortality at the Many Farms Navajo reservation in the 1950's. It didn't work. Despite lots of care, infant mortality remained about the same. The infants usually died of infectious diseases.

Sagan discusses in detail a lot of embarassing epidemiology. It is embarassing because it belies many claims about medical care. For instance, among developed countries, the more doctors dealing with children, the *higher* the infant mortality rate. Sagan quotes several large studies of intervention for lung cancer or heart disease which looked, for a while, very good. Cancers were caught earlier. High blood pressure was treated. Everybody got excited. But at the end of the study, when it was all summed up, the mortality rate remained the same.

Fundamentally, Sagan's explanation of what happened has to do with changes in how children were raised, the cohesiveness of the family, and whether or not people grew up confident and secure of their control over their fate. He doesn't

just draw a historical conclusion, though. He believes that this tells us important lessons about our own health: basically that our mental health, self-esteem, and sense of control mean much more than following any special diet or exercise regime.

Given the problem he attempts to explain: that is, the known failure of medical care, public health, or nutritional improvements to explain the massive fall in death rates which happened in the last century, there must be some truth to what he says. In particular, personal self-esteem is very important. It's all very well, say, to explain a fall in sickness and death by saying that people washed more often and paid more attention to personal hygiene. That may even be true, but we also have to explain why they *did* wash more often and paid more attention to hygiene. Even on its own terms, a purely technological explanation doesn't go far enough.

However his idea of causation is faulty. The fall in death rates, increase in longevity, decrease in the average number of children a couple has, ... all of these changes, have to be seen as resulting from a feedback between all the different factors improving health. These include nutrition and better hygiene, but they also include an increase in the sense of personal worth. To try to explain the demographic change as an effect of more personal dignity, alone, is like saying eggs are the sole cause of chickens. What deserves emphasis in Sagan's book, though, isn't just his explanation for the fall in death rates. We can see his book as an argument for attempts to look at these personal factors much more closely in future. Why did the Navajo children of Many Farms reservation not benefit from the concerted medical attention? Because their parents did not have enough of a sense of control over their fate to attend to hygiene at home.

There is another objection, much deeper, that only a cryonicist would think of. To seriously discuss health without once discussing *aging* is impossible. That is exactly what Leonard Sagan tries to do (aging, I believe, must be *invisible* to him). And that is the crux of why his book should be interesting to us. We do not *currently* have any medical advances available to solve the problem of immortality. But that's not important. What *is* important is that it is a problem to us.

In many underdeveloped countries even today, death of infants isn't a *problem.* Infants usually die. Why should anybody think differently about it or be upset? Why bother to treat children well if most of them will die anyway? (Of course, those who survive will suffer permanent scars from their upbringing! Which means that *everyone* will suffer permanent scars, so universal that they are invisible). All of the concern which Leonard Sagan shows for infant mortality would be, to parents from the underdeveloped countries he describes, supernumerary and silly. Even developing a sense of self esteem and personal control would seem outrageous to these parents. Allah provides, we should not question Allah.

The fact is, our wanting immortality is seen by many people as the sign of a pathologically exaggerated self esteem. Do their attitudes, and those of parents of children in Zaire, still seem so far apart? Sagan does not discuss aging because to him there is no *problem.* He writes an entire book, 233 pages, about health and never discusses aging. This is a remarkable, fascinating feat, which tells us a lot about ourselves and also about him.

Meeting Schedules

Alcor business meetings are usually held on the first Sunday of the month. Guests are welcome. Unless otherwise noted, meetings start at 1 PM. For meeting directions, or if you get lost, call Alcor at (714) 736-1703 and page the technician on call.

ALCOR

The AUGUST meeting will be held at the home of:

(SUN, 7 AUG 1988) Bill Seidel and Candy Nash
10627 Youngworth
Culver City, CA

The SEPTEMBER meeting will be held at the home of:

(SUN, 11 SEP 1988) Paul Genteman
(SECOND SUNDAY) 535 S. Alexandria, #325
(PLEASE BRING CHAIRS) Los Angeles, CA

The OCTOBER meeting will be held at the home of:

(SUN, 9 OCT 1988) Allen Lopp
13354 Veracruz St.
Cerritos, CA

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The New York Cryonics Discussion Group of Alcor has recently formed.

The group meets on the the third Saturday of each month at 5:30 PM. The meeting place has been established at the *Omnia Cafe* (Greek), 32-20 Broadway, Astoria, New York (phone #: (718) 274-6650). This is near 31st Street and Broadway, off the elevated train line. There is a train stop from Manhattan on the B and N trains. It is also very close to the Grand Central Parkway and Brooklyn Queens Expressway.

If you live in the New York, Philadelphia, New Jersey, or Boston areas and would like to participate in the rebirth of New York cryonics please contact one or more of the following people:

Gerard Arthus	(516) 273-3201
Al Roca	(201) 352-5268
Curtis Henderson	(516) 589-4256

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