Do You Want to Live Forever?
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Wandering through the quadrangles and medieval bastions of learning at the University of Cambridge one overcast Sunday afternoon a few months ago, I found myself ruminating on how this venerable place had been a crucible for the scientific revolution that changed humankinds perceptions of itself and of the world. The notion of Cambridge as a source of grand transformative concepts was very much on my mind that day, because I had traveled to England to meet a contemporary Cantabrigian who aspires to a historical role similar to those enjoyed by Francis Bacon, Isaac Newton, and William Harvey. Aubrey David Nicholas Jasper de Grey is convinced that he has formulated the theoretical means by which human beings might live thousands of yearsindefinitely, in fact.

Perhaps theoretical is too small a word. De Grey has mapped out his proposed course in such detail that he believes it may be possible for his objective to be achieved within as short a period as 25 years, in time for many readers of Technology Review to avail themselves of its formulationsand, not incidentally, in time for his 41-year-old self as well. Like Bacon, de Grey has never stationed himself at a laboratory bench to attempt a -single hands-on experiment, at least not in human biology. He is without qualifications for that, and makes no pretensions to being anything other than what he is, a computer scientist who has taught himself natural science. Aubrey de Grey is a man of ideas, and he has set himself toward the goal of transforming the basis of what it means to be human.

For reasons that his memory cannot now retrieve, de Grey has been convinced since childhood that aging is, in his words, something we need to fix. Having become interested in biology after marrying a geneticist in 1991, he began poring over texts, and autodidacted until he had mastered the subject. The more he learned, the more he became convinced that the postponement of death was a problem that could very well have real solutions and that he might be just the person to find them. As he reviewed the possible reasons why so little progress had been made in spite of the remarkable molecular and cellular discoveries of recent decades, he came to the conclusion that the problem might be far less difficult to solve than some thought; it seemed to him related to a factor too often brushed under the table when the motivations of scientists are discussed, namely the small likelihood of achieving promising results within the -period required for academic advancementcareerism, in a word. As he puts it, High-risk fields are not the most conducive to getting promoted quickly.

De Grey began reading the relevant literature in late 1995 and after only a few months had learned so much that he was able to explain previously unidentified -influences affecting mutations in mitochondria, the intracellular structures that release energy from certain chemical processes necessary to cell function. Having contacted an expert in this area of research who told him that he had indeed made a

new discovery, he published his first biological research paper in 1997, in the peer-reviewed journal BioEssays (A Proposed Refinement of the Mitochondrial Free Radical Theory of Aging, de Grey, ADNJ, BioEssays 19(2)161166, 1997). By July 2000, further assiduous application had brought him to what some have called his eureka moment, the insight he speaks of as his realization that aging could be -described as a reasonably small set of accumulating and eventually pathogenic molecular and cellular changes in our bodies, each of which is potentially amenable to repair. This concept became the theme of all the theoretical investigation he would do from that moment on; it became the leitmotif of his life. He determined to approach longevity as what can only be called a problem in engineering. If it is possible to know all the components of the variety of processes that cause animal tissues to age, he reasoned, it might also be possible to design remedies for each of them.

All along the way, de Grey would be continually surprised at the relative ease with which the necessary knowledge could be masteredor at least, the ease with which he himself could master it. Here I must issue a caveat, a variant of those seen in television commercials featuring daredevilish stunts: Do not attempt this on your own. It is extremely hazardous and requires special abilities. For if you can take a single impression away from spending even a modicum of time with Aubrey de Grey, it is that he is the possessor of special abilities.

As he surveyed the literature, de Grey reached the conclusion that there are seven distinct ingredients in the aging process, and that emerging understanding of molecular biology shows promise of one day providing appropriate technologies by which each of them might be manipulatedperturbed, in the jargon of biologists. He bases his certainty that there are only seven such factors on the fact that no new factor has been discovered in some twenty years, despite the flourishing state of research in the field known as biogeron-tology, the science of aging; his certainty that he is the man to lead the crusade for endless life is based on his conception that the qualification needed to accomplish it is the mindset he brings to the problem: the goal-driven orientation of an engineer rather than the curiosity-driven orientation of the basic scientists who have made and will continue to make the laboratory discoveries that he intends to employ. He sees himself as the applied scientist who will bring the benisons of molecular bi-ology to practical use. In the analogous terminology often used by historians of medicine, he is the clinician who will bring the laboratory to the bedside.

And so, in order to achieve his goal of transforming our society, de Grey has transformed himself. His day job, as he calls it, is relatively modest; he is the computer support for a genetics research team, and his entire official working space occupies a corner of its small lab. And yet he has achieved international renown and more than a little notoriety in the field of aging, not only for the boldness of his theo-ries, but also because of the forcefulness of his proselytizing on their behalf. His stature has become such that he is a factor to be dealt with in any serious discussion of the topic. De Grey has documented his contributions in the scientific literature, publishing scores of articles in an impressive array of journals, including those of the quality of Trends in Biotechnology and Annals of the New York Academy of Sciences, as well as contributing commentary and letters to other publications like Science and Biogerontology.

De Grey has been indefatigable as a missionary in his own cause, joining the appropriate professional societies and evangelizing in every medium available to him, including sponsoring his own international symposium. Though he and his ideas may be sui generis, he is hardly an isolated monkish figure content to harangue the heavens and desert winds with his lonely philosophy. In addition to everything else, he has a remarkable talent for organization and even for his own unique brand of fellowship. The sheer output of his pen and tongue is staggering, and every line of that bumper crop, whether intended for the most scientifically sophisticated or for the general reader, is delivered in the same linear, lucid, point-by-point style that characterizes all his writings on life prolongation. Like a skilled debater, he replies to arguments before they arise and hammers at his opposition with a forceful rhetoric that has just enough dismissivenessand sometimes even castigationto betray his impatience with stragglers in the march toward extreme longevity.

De Grey is a familiar figure at meetings of scientific societies, where he has earned the respect of many gerontologists and that new variety of theoreticians known as futurists. Not only has his work put him at the forefront of a field that might best be called theoretical biogerontology, but he swims close enough to the mainstream that some of its foremost researchers have agreed to add their names to his papers and letters as coauthors, although they may not agree with the full range of his thinking. Among the most prominent are such highly regarded figures as Bruce Ames of the University of California and the University of Chicagos Leonid Gavrilov and S. Jay Olshansky. Their attitude toward de Grey is perhaps best expressed by Olshansky, who is a senior research scientist in epidemiology and biostatistics: Im a big fan of Aubrey; I love debating him. We need him. He challenges us and makes us expand our way of thinking. I disagree with his conclusions, but in science thats okay. Thats what advances the field. De Grey has by his vigorous efforts brought together a cohort of responsible scientists who see just enough theoretical value in his work to justify not only their engagement but also their cautious encouragement. As Gregory Stock, a futurist of biologic technology currently at UCLA, pointed out to me, de Greys proposals create scientific and public interest in every aspect of the biology of aging. Stock, too, has lent his name to several of de Greys papers.

De Grey enjoys increasing fame as well. He is often called upon when journalists need a quote on antiaging science, and he has been the subject of profiles in publications as varied as Fortune, Popular Science, and Londons Daily Mail. His tireless efforts at thrusting himself

and his theories into the vanguard of a movement in pursuit of a goal of eternal fascination to the human mind have put him among the most prominent proponents of antiaging science in the world. His timing is perfect. As the baby boomersperhaps the most determinedly self-improving (and self-absorbed) generation in historyare now approaching or have reached their early 60s, there is a plenitude of eager seekers after the death-defiant panaceas he promises. De Grey has become more than a man; he is a movement.

I should declare here that I have no desire to live beyond the life span that nature has granted to our species. For reasons that are pragmatic, scientific, demographic, economic, political, social, emotional, and secularly spiritual, I am committed to the notion that both individual fulfillment and the ecological balance of life on this planet are best served by dying when our inherent biology decrees that we do. I am equally committed to making that age as close to our biologically probable maximum of approximately 120 years as modern biomedicine can achieve, and also to efforts at decreasing and compressing the years of morbidity and disabilities now attendant on extreme old age. But I cannot imagine that the consequences of doing a single thing beyond these efforts will be anything but baleful, not only for each of us as an individual, but for every other living creature in our world. Another action I cannot imagine is enrolling myselfas de Grey haswith Alcor, the cryonics company that will, for a price, preserve a customers brain or more until that hoped-for day when it can be brought back to some form of life.

With this worldview, is it any wonder that I would be intrigued by an Aubrey de Grey? What would it be like to come face to face with such a man? Not to debate hima task for which, as a clinical surgeon, I would in any case be scientifically unqualifiedbut just to sound him out, to see how he behaves in an ordinary situation, to speak of my concerns and his responsesto take his measure. To me, his philosophies are outlandish. To him, mine would seem equally so.

With all of this in mind, I contacted de Grey via e-mail this past fall, and received a response that was both gracious and welcoming. Addressing me by first name, he not only had no hesitation in offering to give up the better part of two days to speak with me, but moreover suggested that we spend them close to the lubricating effects of invigorating fluids, as follows:

> *I hope you like a good English beer, as that is one of the main (open) secrets of my boundless energy as well as a good part of my intellectual creativity (or so I like to think...). A good plan (by which I mean a plan that has been well tested over the years!) is to meet at 11:00 a.m. Monday 18th in the Eagle, the most famous pub in Cambridge for a variety of reasons which I can point out to you. From there we may (weather permitting) be able to go punting on the Cam, an activity with which I fell in love at first sight on arriving here in 1982 and which all visitors seem to find unforgettable. We will be able to talk for as long as you like, and if there is reason to meet again on the Tuesday I can arrange that too.*

The message would prove to be characteristic, including its hint of immodesty. And in a similar vintage was his response when I expressed hesitation about punting, based on friends tales of falling into the Cam on a chilly autumnal day: Evidently, your friends did it without expert guidance. As I learned, de Grey is not a man who allows himself to be less than expert at anything to which he decides to devote those prodigious energies so enthusiastically trumpeted in the e-mail, nor does he allow himself to hide his expertness under a bushel.

Of course, to conceive of oneself as the herald and instrument of the transformation of death and aging requires a supreme self-confidence, and de Grey is the most unabashedly self-confident of men. Soon after we met, this unexampled man told me that One must have a somewhat inflated opinion of oneself if success is to crown such great endeavors. I have that! he added emphatically. By the time he and I had said our good-byes after a total of 10 hours together over a period of two days, I was certain many would accept his self-estimate. Whether one chooses to believe that he is a brilliant and prophetic architect of futuristic biology or merely a misguided and nutty theorist, there can be no doubt about the astonishing magnitude of his intellect.

De Grey calls his program Strategies for Engineered Negligible Senescence, which permits him to say that it makes SENS to embark upon it. Here, in no particular order, follow his seven horsemen of death and the formulations for the breaking of each animal and its rider. (Those seeking more detailed information might wish to consult de Greys website: www.gen.cam.ac.uk/sens/index.html.)

1. Loss and atrophy or degeneration of cells. This element of aging is particularly important in tissues where cells cannot replace themselves as they die, such as the heart and brain. De Grey would treat it primarily by the introduction of growth factors to stimulate cell division or by periodic transfusion of stem cells specifically engineered to replace the types that have been lost.

2. Accumulation of cells that are not wanted. These are (a) fat cells, which tend to proliferate and not only replace muscle but also lead to diabetes by diminishing the bodys ability to respond to the pancreatic hormone insulin, and (b) cells that have become senescent, which accumulate in the cartilage of our joints. Receptors on the surface of such cells are susceptible to immune bodies that de Grey believes scientists will in time learn how to generate, or to other compounds that may make the cells destroy themselves without affecting others

that do not have those distinctive receptors.

3. Mutations in chromosomes. The most damaging consequence of cell mutation is the development of cancer. The immortality of cancer cells is related to the behavior of the telomere, the caplike structure found on the end of every chromosome, which decreases in length each time the cell divides and therefore seems to be involved with the cells mortality. If we could eliminate the gene that makes telomerasethe enzyme that maintains and lengthens telomeresthe cancer cell would die. De Greys solution for this problem is to replace a persons stem cells every 10 or so years with ones engineered not to carry that gene.

4. Mutations in mitochondria. Mitochondria are the micromachines that produce energy for the cells activities. They contain small amounts of DNA, which are particularly susceptible to mutations since they are not housed in the chromosomes of the nucleus. De Grey proposes copying the genes (of which there are 13) from the mitochondrial DNA and then putting those copies into the DNA of the nucleus, where they will be far safer from mutation-causing influences.

5. The accumulation of junk within the cell. The junk in question is a collection of complex material that results from the cells breakdown of large molecules. Intracellular structures called lysosomes are the primary microchambers for such breakdown; the junk tends to collect in them, causing problems in the function of certain types of cells. Atherosclerosis, hardening of the arteries, is the biggest manifestation of these complications. To solve this difficulty, de Grey proposes to provide the lysosomes with genes to produce the extra enzymes required to digest the unwelcome material. The source of these genes will be certain soil bacteria, an innovation based on the observation that ground that contains buried animal flesh does not show accumulation of degraded junk.

6. The accumulation of junk outside the cell. The fluid in which all cells are bathedcalled extracellular fluidmay come to contain aggregates of protein material that it is incapable of breaking down. The result is the formation of a substance called amyloid, which is the material found in the brains of people with Alz-heimers disease. To counter this, de Grey proposes vaccination with an as-yet undeveloped substance that might stimulate the immune system to produce cells to engulf and eat the offending material.

7. Cross-links in proteins outside the cell. The extracellular fluid contains many flexible protein molecules that exist unchanged for long periods of time, whose function is to give certain tissues such qualities as elasticity, transparence, or high tensile strength. Over a lifetime, occasional chemical reactions gradually affect these molecules in ways that change their physical and/or chemical qualities. Among these changes is the development of chemical bonds called cross-links between molecules that had previously moved independently of one another. The result is a loss of elasticity or a thickening of the involved tissue. If the tissue is the wall of an artery, for example, the loss of distensibility may lead to high blood pressure. De Greys solution to this problem is to attempt to identify chemicals or enzymes capable of breaking cross-links without injuring anything else.

It must be obvious that, even condensed and simplified as they are here, these seven factors are enormously complex biological problems with even more complex proposed solutions. At least some of those solutions may prove inadequate, and others may be impossible to implement. Moreover, de Greys descriptions are sprinkled with such vague phrases as growth factors and stimulate the immune system, which might prove to be little more than slogans, as when he invokes yet-to-be-discovered chemicals or enzymes capable of breaking cross-links without injuring anything else. In addition, it must be emphasized that researchers have not come close to solving a single one of the seven problems. In the case of several, there have been promising results. Indeed, research on extracellular cross-links has already yielded several drug candidates: a company called Alteon, in Parsippany, NY, has begun clinical trials of molecules that it says can reverse the effects of some conditions associated with age. In the cases of some of the other problems de Grey identifies, howeversuch as the prevention of telomere lengthening or the transfer of mitochondrial DNA to the nucleusit is fair to say that molecular biologists can only speculate about the day, if ever, when these attempts will come to fruition.

But de Grey is unfazed by this incompleteness. It is his thesis that time is being lost, and nothing is accomplished by pessimism about possibilities. For de Grey, pie in the sky, as one biogeron-tologist I consulted called his formulations, is a tasty delicacy whose promise already nourishes his soul.

But others can challenge de Greys science. My purpose was something else entirely. I found myself wondering what sort of man would devote the labors of an incandescently brilliant mind and a seemingly indefatigable constitution to such a project. Not only does the science seem more than a little speculative, but even more speculative is the assumption on which the entire undertaking is basednamely, that it is a good thing for the men and women now populating the earth to have the means to live indefinitely.

I arrived at the Eagle a few minutes early on the appointed day, which gave me time to record some of the words on the memorial plaque near the -entryway, which read An inn has existed at this site since 1667, called Eagle and Child....During their research in the early 1950s, Watson and Crick used the Eagle as a place to relax and discuss their theories whilst refreshing themselves with ale.

Thus properly steeped in history and atmosphere, I entered the pub just in time to see de Grey through the window, parking his ancient bicycle across the narrow street. Narrow, in fact, precisely describes the man himself, who stands six feet tall, weighs 147 pounds. His spareness is accentuated by a mountain-man chestnut beard extending down to mid-thorax that seems never to have seen a comb or brush. He was dressed like an unkempt graduate student, uncaring of tailoring considerations of any sort, wearing a hip-length black mackinaw-type coat that was borderline shabby. Adorning his head was a knitted woolen hat of a half-dozen striped transverse colors, which he told me had been crafted by his wife 14 years ago. As if to prove its age, the frazzled headgear (which was knitted with straplike extensions that tied under the chin) was not without a few holes. When he removed it, I saw that de Greys long straight hair was held in a ponytail by a circular band of bright red wool. But in spite of the visual gestalt, de Grey cannot disguise the fact that he is a boyishly handsome man. As for his voice, being the product of a private school followed by Harrow and then Cambridge, it hardly needs to be described. To an American, he is of rare fauna, and his distinctiveness was catch-your-eye apparent even among his Cambridge colleagues.

Having seen a photo of de Grey on his website, I was prepared for his beard, spareness, and even his laissez-faire attitude toward externals. But I was not prepared for the intensity of those keen blue-gray eyes, nor for the pallor of the face in which they are so gleamingly set. His expression was one of concentrated zeal, even evangelism, and it never let up during our subsequent six hours of nonstop conversation across the narrow pub table that separated us. In the photo, his eyes are so gently warm that I had commented on them in one of my e-mails. But I would see none of that warmth during the 10 hours we spent together, though it reappeared in the 15 minutes during which we chatted with Adelaide de Grey in a courtyard between laboratory buildings after our Monday session at the Eagle.

Adelaide de Grey (ne Carpenter) is a highly accomplished American geneticist and an expert electron microscopist who, at 60, is 19 years older than her husband. They met early in 1990, midway through her Cambridge sabbatical from a faculty position at the University of California, San Diego, and were married in April 1991. Neither of them has ever wanted to have children. There are already lots of people who are very good at that, explained Aubrey when the subject came up. Its either that or do a lot of stuff you wouldnt do if you had children, because you wouldnt have the time. Raised as the only child of an artistic and somewhat eccentric single mother, already at the age of eight or nine he had determined to do something with his life that would make a difference, something that he and perhaps no one else was equipped to accomplish. Why fritter away resources in directions that others might pursue just as well or better? With that in mind no less now than when he was a child, de Grey has trimmed from his days and thoughts any activity he deems superfluous or distracting from the goals he sets for himself. He and Adelaide are two highly focusedsome would say drivenpeople of such apparent similarity of motivation and goals that their work is the overwhelming catalytic force of their lives.

And yet, each member of this uncommon pair is touchingly tender with the other. Even my brief 15 minutes with them was sufficient to observe the softness that comes into de Greys otherwise determined visage when Adelaide is near, and her similar response. I suspect that his website photo was taken while he was either looking at or thinking of her.
Adelaide, although at five foot two much shorter than her husband, looks his perfect sartorial partner: she dresses in a similar way and is apparently just as uncaring about her appearance or grooming. One can easily imagine them on one of their dates, as described by Aubrey. Walking from the small flat where they have lived since they married almost 14 years ago, entering the local laundromat, talking science as the machines beat up on their well-worn clothes. They are hardly bons vivants, nor would they want to be; they quite obviously like things just the way they are. They appear to care not at all for the usual getting and spending, nor even for some of the normative emotional rewards of living in our worldall at a time when the name of Aubrey de Grey has become associated with changing that world in unimaginable ways.

But six uninterrupted hours of compelling talk (most of it pouring out of him in floods of volubility let loose by intermittent questions or comments) and the consumption of numerous pints of Abbots ale still awaited us before I would meet Adelaide and be taken to the laboratory where de Grey performs the duties of his day job. Very soon after we began speaking, an hour before noon on that first day, I asked him why his proposals raise the hackles of so many gerontologists. And right there, at the very outset of our discussions, he replied with the dismissive impatience that would reappear whenever I brought up one or another of the many objections that either a specialist or layperson might have regarding the notion of extending life for millennia. Pretty much invariably, he curtly told me, their objections are based on simple ignorance. Among the bands of that spectrum that de Grey will not confine to a bushel is his feeling that his is one of the few minds capable of comprehending the biology of his formulations, the scientific and societal logic upon which they are based, and the vastness of their potential benefits to our species.

I wanted de Grey to justify his conviction that living for thousands of years is a good thing. Certainly, if one can accept such a viewpoint, everything else follows from it: the push to research beyond the elucidation of the aging process; the gigantic investment of talent and money to accomplish and apply such research; the transformation of a culture based on the expectation of a finite and relatively short lifetime to one without horizons; the odd fact that every adult human being would be physiologically the same age (because rejuvenation would be the inevitable result of de Greys proposals); the effects on family relationshipsit goes on and on.

De Greys response to such a challenge comes in the perfectly formed and articulated sentences that he uses in all his writings. He has the gift of expressing himself both verbally and in print with such clarity and completeness that a listener finds himself entranced by the flow of seemingly logical statements following one after the other. In speech as in his directed life, de Grey never rambles. Everything he says is pertinent to his argument, and so well constructed that one becomes fascinated with the edifice being formed before ones eyes. So true is this that I could not but fix my full attention on him as he spoke. Though many possible distractions arose during the hours in which we confronted each other across that pub table, as people came and went, ate and drank, talked and laughed, and smoked and coughed, I never once found myself looking anywhere but directly at him, except when going to fetch fooda full lunch for me and only potato chips for himor another pint. It was only when reflecting upon the assumptions on which his argument is based that a listener discovers that he must insert the word seemingly before logical in the second sentence of the present paragraph. Here follows an aliquot of de Greys reasoning:

> *The reason we have an imperative, we have a duty, to develop these thera-pies as soon as possible is to give future generations the choice. People are entitled, have a human right, to live as long as they can; people have a duty to give people the opportunity to live as long as they want to. I think its just a straightforward extension of the duty-of-care concept. People are entitled to expect to be treated as they would treat themselves.*
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> *It follows directly and irrevocably as an extension of the golden rule. If we hesitate and vacillate in developing life-extension therapy, there will be some cohort to whom we will deny the option to live much longer than we do. We have a duty not to deny people that option.*

When I raised the question of ethical or moral objections to the extreme extension of life, the reply was similarly seemingly logical and to the point:

> *If there were such objections, they would certainly count in this argument. What does count is that the right to live as long as you choose is the worlds most fundamental right. And this is not something Im ordaining. This seems to be something that all moral codes, religious or secu-lar, seem to agree on: that the right to life is the most important right.*

And then, to what would seem the obvious objection that such moral codes assume our current life span and not one lasting thousands of years:

> *Its an incremental thing. Its not a question of how long life should be, but whether the end of life should be hastened by action or inaction.*

And there it isthe ultimate leap of ingenious argumentation that would do a sophist proud: by our inaction in not pursuing the possible opportunity of extending life for thousands of years, we are hastening death.

No word of the foregoing quotes has been edited or changed in any way. De Grey speaks in formed paragraphs and pages. Many readers of Technology Review are all too familiar with how garbled we often sound when quoted directly. Not so de Grey, who speaks with the same precision with which he writes. Admittedly, some may consider his responses to have the sound of a carefully prepared sermon or sales pitch because he has answered similar questions many times before, but all thought of such considerations disappears when one spends a bit of time with him and realizes that he pours forth every statement in much the same way, whether responding to some problem he has faced a dozen times before or giving a tour of the genetics lab where he works. His every thought comes out perfectly shaped, to the amazement of the bemused observer.

De Grey does not fool himself about the vastness of the efforts that will be required to make the advances in science and technology necessary to attain his objective. But equally, he does not seem fazed by my suggestion that his optimism might simply be based on the fact that, having never worked as a bench researcher in biology, he may not appreciate or even understand the nature of complex biological systems, nor fully take into account the possible consequences of tinkering with what he sees as individual components in a machine. Unlike engineers, the adoption of whose method-ology de Grey considers his main conceptual contribution to solving the problems of aging, biologists do not approach physiological events as distinct entities that have no effect on any others. Each of de Greys interventions will very likely result in unpredictable and incalculable responses in the biochemistry and physics of the cells he is treating, not to mention their extracellular milieu and the tissues and organs of which they are a part. In biology, everything is interdependent; everything is affected by everything else. Though we study phenomena in isolation to avoid complicating factors, those factors come into play with a vengeance when in vitro becomes in vivo. The fearsome concerns are many: a little lengthening of the telomere here, a bit of genetic material from a soil bacterium there, a fistful of stem cellsthe next thing you know, it all explodes in your face.

He replied to all this as to so much else, whether it be the threat of overpopulation, the effect on relationships within families and whole societies, or the need to find employment for vibrantly healthy people who are a thousand years old: we will deal with these problems as they come up. We will make the necessary adjustments, whether in the realm of potential cellular havoc or of the tortuosities of economic necessity. He believes that each problem can be retouched and remedied as it becomes recognized.

De Grey has some interesting notions of human nature. He insists that, on the one hand, it is basic to humankind to want to live forever regardless of consequences, while on the other it is not basic to want to have children. When I protested that the two most formative instincts of all living things are to survive and to pass on their DNA, he quickly made good use of the one and denied the existence of the other. Bolstering his argument with the observation that many peoplelike Adelaide and himselfchoose not to have children, he replied, not without a hint of petulance and some small bit of excited waving of his hands,

> *Your precept is that we all have the fundamental impulse to reproduce. The incidence of voluntary childlessness is exploding. Therefore the imperative to reproduce is not actually so deep seated as psychologists would have us believe. It may simply be that it was the thing to dothe more traditional thing. My point of view is that a large part of it may simply be indoctrination....Im not in favor of giving young girls dolls to play with, because it may perpetuate the urge to motherhood.*

De Grey has commented in several fora on his conviction that, given the choice, the great majority of people would choose life extension over having children and the usual norms of family life. This being so, he says, far fewer children would be born. He did not hesitate to say the same to me:

> *We will realize there is an overpopulation problem, and if we have the sense well decide to fix it [by not reproducing] sooner rather than later, because the sooner we fix it the more choice well have about how we live and where we live and how much space we will have and all that. Therefore, the question is, what will we do? Will we decide to live a long time and have fewer children, or will we decide to reject these rejuvenation therapies in order that we can have children? It seems pretty damn clear to me that well take the former option, but the point is that I dont know and I dont need to know.*

Of course, de Greys reason for not needing to know is that same familiar imperative he keeps returning to, the impera-tive that everyone is entitled to choice regardless of the possible consequences. What we need to know, he argues, can be found out after the fact and dealt with when it appears. Without giving humankind the choice, however, we deprive it of its most basic liberty. It should not be surprising that a man as insistently individualisticand as uncommon a sortas he would emphasize freedom of personal choice far more than the potentially toxic harvest that might result from cultivating that dangerous seed in isolation. As with every other of his formulations, this onethe concept of untrammeled freedom of choice for the individualis taken out of the context of its biological and societal surroundings. Like everything else, it is treated in vitro rather than in vivo.

In campaigns that occur across the length of several continents, de Greys purpose is only secondarily to overcome resistance to his theories. His primary aim is to publicize himself and his formulations as widely as possible, not for the sake of personal glory but as a potential means of raising the considerable funding that will be necessary to carry out the research that needs to be done if his plans are to stand any chance of so much as partial success. He has laid out a schedule projecting the timeline on which he would like to see certain milestones reached.

The first of these milestones would be to rejuvenate mice. De Grey would extend the life span of a two-year-old mouse that might ordinarily live one more year by three years. He believes funding of around $100 million a year will make this feasible 10 years from now; almost certainly not as soon as seven years; but very likely...less than 20 years. Such an accomplishment, de Grey believes, will kick-start a war on aging and be the trigger for enormous social upheaval. In an article for the Annals of the New York Academy of Sciences [de Grey et al., 959: 452462, 2002], which lists seven coauthors after his own name, de Grey writes, We contend that the impact on public opinion and (inevitably) public policy of unam-bigu-ous aging-reversal in mice would be so great that whatever work remained necessary at that time to achieve adequate somatic gene therapy would be hugely accelerated. Not only that, he asserts, but the public enthusiasm following upon such a feat will cause many people to begin making life choices based on the proba-bility that they, too, will reach a proportional number of years. Moreover, when death from a disease like influenza, for example, is considered premature at the age of 200, the urgent need to solve the problems of infectious disease will massively increase government and drug company funding in that area.

In addition to accelerating demand for research, the tripling of a middle-aged mouses remaining life span would bring in entirely new sources of funding. Because governments and drug companies tend to favor research that promises useful results in a relatively short time, de Grey is not counting on them as a source. He is relying on an infusion of private money to supply the funds (significantly more than the cost of reversing aging in mice) that it will take to successfully fight his war against aging in humans. De Grey believes that once aging has been reversed in mice, billionaires will come forward, intent on living as long as possible.

Is it likely that the photograph of a long-lived mouse on the front page of every newspaper in the world would be greeted with the unalloyed enthusiasm of a unanimous public? I doubt it. More probably, acclaim would be balanced by horror. Ethicists, economists, sociologists, members of the clergy, and many worried scientists could be counted on to join huge numbers of thoughtful citizens in a

counterreaction. But of course, if we are to accept de Greys first principle, that the desire to live forever trumps every other factor in human decision-making, then self-interestor what some might call narcissismwill win out in the end.

De Grey projects that 15 years after we have rejuvenated mice we might begin to reverse aging in humans. Early, limited success in extending the human life span will be followed by successive, more dramatic breakthroughs, so that humans now living could reach what de Grey calls life extension escape velocity. De Grey concedes that it might be 100 years before we begin to significantly extend human life. What he does not concede is that it is more likely not to happen at all. He cannot seem to imagine that the odds are heavily against him. And he cannot imagine that not only the odds but society itself may be against him. He will provide any listener or reader with a string of reasons that are really rationalizations to explain why most mainstream gerontologists remain so conspicuously absent from the ranks of those cheering him on. He has safeguarded himself against the informed criticism that should give him cause to -rethink some of his proposals. He has accomplished this self-protection by con-structing a personal worldview in which he is inviolate. He refuses to budge a millimeter; he will not give ground to the possibility that any of the barriers to his success may prove insuperable.

All this makes de Grey sound unlikable. But a major factor behind his success at attracting a following has less to do with his science than with himself. As I discovered during our two sessions at the Eagle, it is impossible not to like de Grey. Despite his unhesitant verbal trashing of those who disagree with him, there is a certain untouched sweetness in the man, which, combined with his lack of care for outward appearance and the sincerity of his commitment to the goals that animate his life, are so disarming that the entire picture is one of the disingenuousness of genius, rather than of the self-promotion of the remote, false messiah. His likability was pointed out even by his detractors. It is a quality not to be expected in such an obviously odd and driven duck.

But the most likable of eccentrics are sometimes the most dangerous. Many decades ago in my navet and ignorance, I thought that the ultimate destruction of our planet would be by the neutral power of celestial catastrophe: collision with a gigantic meteor, the burning out of the sunthat sort of thing. In time, I came to believe that the end of days would be ushered in by the malevolence of a mad dictator who would unleash an arsenal of explosive or biological weaponry: nuclear bombs, engineered microrganismsthat sort of thing. But my notion of that sort of thing has been changing. If we are to be destroyed, I am now convinced that it will not be a neutral or malevolent force that will do us in, but one that is benevolent in the extreme, one whose only motivation is to improve us and better our civilization. If we are ever immolated, it will be by the efforts of well-meaning scientists who are convinced that they have our best interests at heart. We already know who they are. They are the DNA tweakers who would enhance us by allowing parents to choose the genetic makeup of their descendants unto every succeeding generation ad infinitum, heedless of the possibility that breeding out variety may alter factors necessary for the survival of our species and the health of its relationship to every form of life on earth; they are the biogerontologists who study caloric restriction in mice and promise us the extension by 20 percent of a peculiarly nourished existence; they are those other biogerontologists who emerge from their laboratories of molecular science every evening optimistic that they have come just a bit closer to their goal of having us live much longer, downplaying the unanticipated havoc at both the cellular and societal level that might be wrought by their proposed manipulations. And finally, it is the unique and strangely alluring figure of Aubrey de Grey, who, orating, writing, and striding tirelessly through our midst with his less than fully convinced sympathizers, proclaims like the disheveled herald of a new-begotten future that our most inalienable right is to have the choice of living as long as we wish. With the passion of a single-minded zealot crusading against time, he has issued the ultimate challenge, I believe, to our entire concept of the meaning of humanness.

Paradoxically, his clarion call to action is the message neither of a madman nor a bad man, but of a brilliant, beneficent man of goodwill, who wants only for civilization to fulfill the highest hopes he has for its future. It is a good thing that his grand design will almost certainly not succeed. Were it otherwise, he would surely destroy us in attempting to preserve us.

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