

CHAPTER 5

# Outliving the Future: Longevity Medicine

## Living Longer, Better

If you could live an extra fifty years in near-perfect health, would you want to? Of course, you say. How much would you pay to live an extra twenty-five years with the vitality of a twenty-five-year-old? \$25,000? What about \$100,000? Are you willing to buy a health-enhancement insurance policy that gives you the right to medically enhance yourself at a certain date? You're intrigued, right? Well, industry is listening, hungry to tap into a market of billions of consumers eager to enhance their health and extend their lives. This is the beginning of Longevity Medicine, and it will change everything.

We will soon be offered vast new choices in health and medicine that we can hardly imagine today. Longevity Medicine will affect who gets the job, who gets the girl, and who gets to live—and for how long. The individual's right to enhancement will become a hotly contested social and ethical issue in the future.

The largest global marketplace in the near future will be shaped by Longevity Medicine, offering a variety of anti-aging and health-enhancement products. Everyone who wants to live longer—and can afford it—will be able to stay healthy. In some nations, the state will pay; in others, consumers will pay.

The ability to extend healthy life will have earthshaking

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## THE TOP TEN LONGEVITY TRENDS

- 1.** Within ten years, humans routinely living beyond one hundred will be an accepted reality.
- 2.** Longevity Medicine will postpone aging and promote health, enabling people to be more active, more productive, and enjoy longer lives.
- 3.** Health-enhancement rights, fueled by the wealth of aging baby boomers and the fusion of nano, bio, IT and neuro innovations, will become fierce social issue.
- 4.** Mapping personal DNA profiles, and linking that knowledge to prevent illness, will radically change medicine, making it boldly predictive.
- 5.** Health enhancement via biotech, stem cells, and genomic drugs will enhance human intelligence.
- 6.** Supercomputers, artificial intelligence, and advanced medical information technology will usher in a new era that will empower doctors to extend the quality of life.
- 7.** Personalized DNA diets will greatly enable longevity as people learn which foods enhance their health and prevent illness.
- 8.** Life-extension treatments, from genetic vaccines and designer DNA "surgery" to smart drugs and neuro-medical devices, will augment health, improving intelligence, and maximizing beauty.
- 9.** Cognitive brain-science breakthroughs will protect the aging mind, refreshing vital memories, improving physical agility, and promoting human performance enhancement.
- 10.** The evolutionary transformation of human beings, via emerging breakthroughs in Longevity Medicine, will provide vast new choices of an astounding and alarming nature for individuals and society.

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societal, political, financial, environmental, and individual consequences. Destinies and futures will be enhanced and broken. Careers and relationships will be shaped and chosen. Longevity Medicine is not just about the future of health care; it is about a personal and social transformation in culture that will define how individuals will live, work, and interact. Laws may be passed to grant enhancement rights to citizens.

Not all of the choices enabled by Longevity Medicine will seem fair, morally right, or even desirous by all people. There are dangerous decisions ahead that will raise fundamental questions about the nature of humanity and human evolution. Every domain of civilization will be affected, none more than that of the individual.

## The End of Primitive Medicine

There is nothing wrong with medicine today, except that it doesn't have the knowledge and tools to do the job. Medicine as we know it is woefully unprepared to deal with its primary charge of eliminating disease. We bombard cancer, attempting to kill it with radiation. Antibiotics mount the assault on infections. We surgically carve out diseased tissue as a routine practice. An amazing array of drugs have more side effects than the illnesses or problems they were designed to address.

Medicine is only performing at its current level of discovery. The truth is that what we call modern medicine is quite primitive and can only accomplish so much until we invent new tools. This is not a slam on medicine but an observation about where medicine is today, how it will change, and why it must change. Doctors are waiting for the next generation of innovation tools that will enable them to do more to heal, restore, and prevent disease.

Most disease begins at the atomic level, where subtle interactions between DNA, genes, the environment, and other parts of the body and mind interact. We don't yet have the tools in modern medicine to see and understand this atomic level of the human body. By the time disease happens, we are way downstream in the organs and tissues. This is a frustrating fact. By the time you feel a lump in your breast, experience pain, or notice something is wrong, disease has already moved into the organs or tissue. What if we could look into human atoms and DNA to identify the potential triggers that form disease? What if we could turn off those disease-causing triggers? The result, increased

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health, would save billions of dollars and enhance the quality of human existence. U.S. health care costs \$2 trillion. This is larger than the GDP of China. Today's U.S. health care costs too much.

There is a new medicine emerging born of the fusion of biotechnology, information technology, nanotechnology and cognitive science. Together, these fields—the convergent technologies I review in this book—will provide the tools needed to “see” and heal at the atomic level. That's what's next.

This may sound like a tall order, but we are making tremendous progress in that direction. Remember, we only learned to decode the human genome over the past few years. In a sense, medicine is about to emerge from the equivalent of the Middle Ages into the glory of the Renaissance.

In the Extreme Future, speculation about disease and treatment will give way to a more precise, predictive, and health-enhancing type of medicine: Longevity Medicine. Medicine that has, at its core, an ability to peer into the individual genomic map of a specific individual, from birth to death. Doctors will have an unparalleled diagnostic tool: a person's own DNA. The next stage will include engineered disease prevention, health promotion, and life extension.

It is entirely possible that most children alive today will live to see the dawn of the twenty-second century. Medicine's mandate is to heal, improve people's health, and yes, extend life. Medicine is primed today for tomorrow's longevity and enhancement. It is inevitable. Modern medicine is only 150 years old. If you look at the time line of medicine, we are only a few inches away from doctors offering patients wooden paddles to bite down on as the only palliative for pain.

## THE DANCE OF THE TELOMERES: AN AGE CLOCK

Might there be a mechanism in the human genome that controls aging? A type of genetic clock that determines how long you live until your body breaks down and you die? Telomeres—specialized nucleoprotein complexes found on the ends of chromosomes—are such a mechanism. If we could better understand them, we might be able to manipulate our aging clock.

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## Fountains of Youth

If you take the average life span throughout human history, it would be about eighteen. Socrates was brilliant and dead before thirty-five. Hannibal led armies at twenty-two. Due to immense progress in public health, medicines, and the war on infectious diseases, humans are living longer. Today we are living longer than any humans have lived on the planet, but this life extension is just the beginning. There is no real end in sight.

The dream of longer life is powerfully seductive. From the legendary quest of Gilgamesh, to Ponce de Leon's search for the Fountain of Youth, to our modern-day bio-chemists tinkering with the human genome and stem cells, the pursuit of immortality is ancient and enduring. The desire for longer life is embedded in the social DNA of humanity and expressed in countless myths and legends. The pantheons of gods and goddesses were immortal beings, and that was the point: Immortality was an attribute of the gods, yearned for yet unattainable by humans. Humans never stopped trying, though, and now medicine is starting to deliver what the storytellers could only dream about.

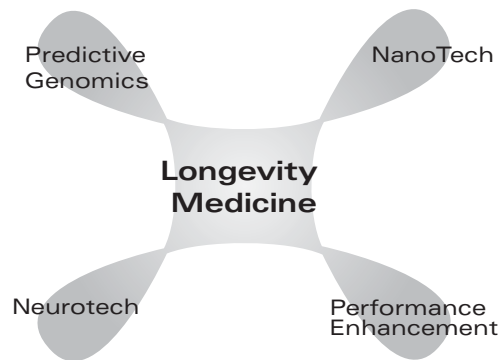
In the decade to come, medicine will be revolutionized. The convergence of pharma, biotech, and nanotech industries will form the biggest global marketplace with one underlying theme: life extension for sale. Botox today will lead to gene-replacement therapy tomorrow. Face-lifts today, nano-engineering stem cells for babylike, wrinkle-free skin tomorrow. Prosthetic titanium hips today, growing new organs tomorrow. Even memories will be for sale, with superagility and enhanced intelligence thrown in for good measure.

The seeds of this trend are firmly in place today. Longevity scientists that I have met are unlocking the secrets of age embedded in our genes, and as organ-replacement and stem-cell research frontiers are being crossed, I forecast that the era of longer living, beyond one hundred years of age, will become common within ten years and be considered a birthright by 2025, due to Longevity Medicine. The individual's rights to be enhanced—genetically, physically, cognitively—will become a complicated social issue in democratic societies. Success may be determined by enhancement features like beauty, intelligence, or skill.

These breakthroughs will transform markets, lifestyles, and culture.

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Are you ready to be enhanced? If not, you may not be able to compete in the future. This is forbidden fruit that is too seductive not to be tasted. The research has already started. Billions are already invested. Breakthroughs are coming in the Extreme Future.



## Medicine 2020

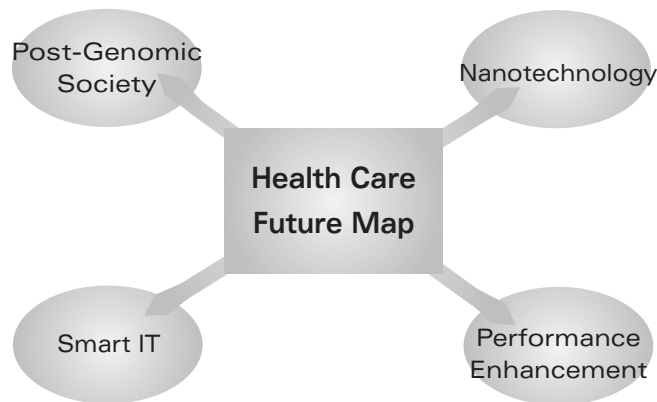
I got my first hint about the future of medicine and health care when I was still a boy, back in 1963. My grandfather, George, handed me a plastic tube made out of white, fine, almost weightless material. Similar tubes had been implanted in his legs by the legendary cardiovascular surgeon, Dr. Michael DeBakey. They were DACRON arteries, one of DeBakey's many innovations, and they were necessary for my grandfather because of the damage he had done to his body from smoking for fifty years. It made an impression; I don't smoke, and I keep a close watch on the latest life-altering medical innovations.

The achievements of DeBakey and other medical pioneers of the past half-century were truly life-altering, but they will pale in comparison with what is to come. What will medicine and health care look like in twenty-five years? The following is a list of key characteristics that will revolutionize this practice, making it unrecognizable to the medicine we know today. Medicine in 2020 will be

- **Predictive**—forecasting future health status, predicting disease.
- **Preventive**—stopping or avoiding illness, dysfunction.

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- **Restorative**—bringing back functionality such as sight, or restoring memory, health, or mobility.
- **Regenerative**—restoring bones, muscles, organs, and cells.
- **Life-Extending**—lengthening life while maintaining health and productivity.
- **Performance-Enhancing**—developing an individual’s full mental and physical potential for realizing maximum, healthy performance.
- **Replacing**—providing viable substitutes for a person’s body or mind in order to restore healthy functionality.
- **Augmenting**—enhancing special-purpose mental or physical functions, some may be superhuman.



## Be a Tiger

In a culture where we are accustomed to paying to enhance ourselves through science, where we straighten our teeth with braces, fix our eyesight with contacts and glasses, and augment our beauty and features with plastic surgery, would we want to enhance ourselves further by living longer and becoming smarter, stronger, and faster? The answer is that we will, and the baby boomers will lead society down the slippery slope toward human health enhancement. We are already on our way.

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Ads show Tiger Woods proudly claim that his eyesight is better than 20/20, due to this company's enhanced eye surgery technique.

The stem-cell and therapeutic-cloning debates are just the beginning of the breakthroughs that are coming. With Alzheimer's striking one in three men over the age of seventy, with cancer and cardiovascular disease cutting people's lives short, why would we not want to enhance ourselves? First we will heal, then we will enhance. Get ready.

## FUTURE LONGEVITY MEDICINE INNOVATIONS TO WATCH FOR

- Personalized DNA tests, which will tell stories about individuals' unique genomic profiles and also reveal future disease risks.
- Nanotechnology, the manipulation of matter at the atomic level, introducing a new generation of very small medical devices, materials, and procedures for prevention and health enhancement.
- Stem cells that can be used for healing disease, growing organs, and rebuilding human beings.
- Genomic foods that consider the unique DNA of an individual and what is best for that person to eat for optimal health.
- Medical devices that have intelligent functions to turn on or off genes related to desired or unwanted behaviors, diseases, or functions.
- Human-enhancement engineering, which will provide surgery to augment intelligence, memory, appearance, or performance.
- Health-enhancement therapies, from gene vaccines and human performance to neuroceutical augmentation.
- Breakthroughs in robotics that will create mobile systems to augment human movement.
- Cognitive replacements for dysfunctional brains.
- Access to vast supercomputers to map the next generation of biotech drugs to unlock complex diseases such as cancer, AIDS, and SARS.

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Longevity Medicine will make Botox treatments seem primitive. Rather than face blindness, deafness, or a bedridden lifestyle, who wouldn't choose sight, hearing, or the active freedom of mobility? A multibillion-dollar market will emerge.

Before we move forward, though, it is essential to recognize that personal choice, freedom of expression, and individual rights should be considered important features in this emerging future forecast. We should tread carefully toward this future, a future in which ethical concerns, values, and laws may be cast too quickly aside. We must be aware of the choices, but also be careful to do no harm—as Hippocrates, the father of medicine, instructed us. Governments may seek to control individual's rights to enhance themselves, to better their future. We should carefully guard against any use of medicine to restrict personal liberty.

## Life Extension

I charted the future of Longevity Medicine, where the promise of life extension has slowly become an undercurrent of national health policy. The stem-cell referendum passed in California for \$7 billion was one piece of evidence; other, larger investments from biotech to nanotech are charting the future of life extension.

Just as the seventy-six million baby boomers, those born between 1946 and 1964, have redefined every aspect of culture, from media to technology to sports, so too will the boomers redefine health care, making it about life extension and human enhancement so they can extend their power, influence, and themselves into the future by living longer and healthier. This is a critical motivation for the most affluent demographic group on the planet. What appears at first to be a narcissistic desire for survival will actually set into motion a (mostly) constructive future.

If you consider this life extension trend in context with the need for society to keep the highly skilled boomers employed in the future workforce longer, you begin to see the larger social issues at play. Longevity medicine will lead not just to longer lives, but to longer, more productive workers. In a future at risk of depopulation due to lower birth rates, longevity medicine, I forecast, will become a much-needed social entitlement.

I have looked out into the near future of anti-aging and human -

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performance enhancement with leading scientists, physicists, physicians, engineers, and policy analysts. I realized that the convergence of population changes—the aging baby boomers combined with innovations in life science—will completely transform medicine in the near future.

This represents the most far-reaching forecast on the planet about the future of humanity, not just the future of health care. This is certainly an Extreme Future, but one that is plausible, even desirable to many. The conditions are in place today for a radical change in the way we think about health. The longevity lifestyle marketplace, and its impact on society, will define the Extreme Future.

As we move forward, I will explore the three trends in human performance enhancement—Therapeutic, Augmentation, and Designed Evolution.

## Therapeutic Enhancement Trend: Fixing What's Broken

Therapeutic refers to the enhancement of human performance to restore normal human capabilities to the disabled or dysfunctional. Conditions resulting from disease, birth defects, or accidents would fall into this category. This domain has already emerged and will be accelerated by the coming nano-bio-IT-neurotech convergence. Examples of therapeutic enhancements include

- Restoring Sight
- Restoring Hearing
- Prosthetics for Limbs
- Genetic Vaccines
- Depression Management
- Personalized Medicine
- Organ Cloning
- Memory Restoration
- Mobility Restoration

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## Augmentation Trend: Expanding Possibilities

Augmentation refers to the development of human performance to enhanced levels. Anyone who is a candidate for therapeutic human performance enhancement will want augmentation as well. Augmentation will begin to appear in the next five to eight years. The augmentation of cognitive, physical, and other capabilities could have a broad degree of customization based on career, age, and interests. Examples, and their potential target consumers/patients, include

- Enhanced memory; total recall (everyone).
- Infrared night vision (security workers).
- Wide-spectrum hearing (musicians).
- Long-range vision (soldiers).
- Specialized tool augmentation and cybernetics (doctors, engineers, and artists).
- Embedded wireless communications (knowledge workers).
- High-velocity robotic limbs (athletes).
- On-demand strength augmentation (construction workers).
- Cognitive multitasking (project managers).
- Personal genomic-optimized analysis (medical techs).
- Multimedia cognitive high-capacity storage (poets, inventors).
- Real-time visual and voice-data mining, search, and discovery (media, game designers).

## Designed Evolution Trend: Radical Change

Designed Evolution refers to human enhancements involving the human genome that we might choose to make prior to conception, in vitro, or after birth. This could include in vitro enhancement of memory,

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intelligence, speed, agility, and certain behavioral and physical attributes. The largest area of Designed Evolution will be the in vitro identification of undesired genes that might be precursors for dysfunction or

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disease, such as cancer or alcoholism. They could be altered, or even eliminated. Of course, choosing more attractive physical attributes, such as beauty, or enhancing the "intelligence gene," might be desirable as well. Although this domain of human enhancement is eight to fifteen years away, decisions and choices will be made in the near future that will set the stage for its acceptance or rejection. Tough choices will drive social debate surrounding the issues.

Different cultures will choose different paths, some in direct conflict with their citizens and other cultures. Ideology, politics, and religion will collide with science as experiments driven by the brazen and bold, unfettered by social responsibilities and ethics, will create radical geopolitical risks. Examples include

- Longevity enhancement.
- Optimized immuno-defense.
- Coevolutionary man/machine cyborgs.
- Organ engineering.
- Stem-cell, total-body, and mind rejuvenation.
- Anti-atrophy muscles that resist degeneration.
- Bones that replenish through self-assembly.
- Super agility and speed.
- Intracellular disease scavengers that search and destroy on demand.
- Elimination of unwanted genes that trigger undesirable behavior.

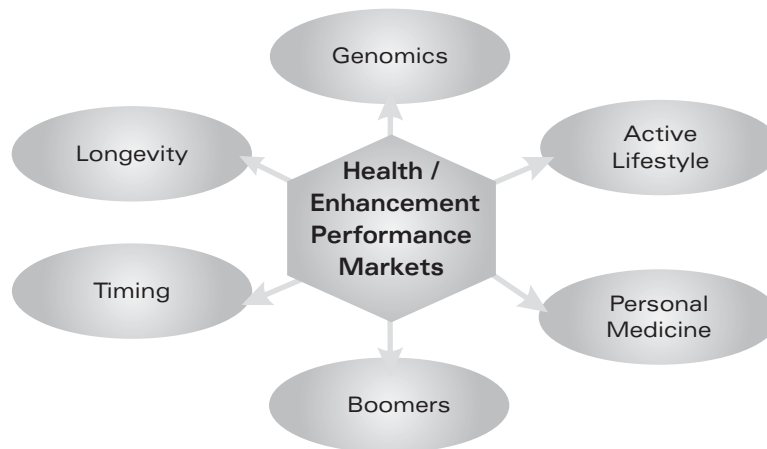
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## Social Implications: Rights and Revolutions

As people live not just longer, but with new replenished capacities and even higher performance, the world we live in will change in dramatic ways. Think about this for a moment. How different would your life be if you believed you had not just sixty or seventy years to live with diminishing capacity in old age, but 125 years, with the vitality of a much younger person along with the wisdom of experience? This is just one way to think about the how Longevity Medicine might affect you.

Perhaps you will be enhanced, or choose enhancements that will make you more robust, more beautiful, more intelligent, more physically agile later in life than you were when you were younger. How different your life will be! How about five careers? Maybe you can live multiple lives with more risk and adventure? Who wouldn't want to live many lifetimes in one? You might have enough time to contribute new solutions to overcome the planet's woes. There are fundamental changes coming in the Extreme Future, and they start with extending our lives. I forecast that enhancement rights will become a political agenda as common as the rights to education, work, or freedom.

Now, not everyone will choose to live longer or be able to afford every health enhancement that the Longevity Medicine marketplace will offer. Some people will never give up their disease-creating lifestyles and will demand to be restored later in life. It's like flossing your teeth. Everyone knows it helps keep teeth in good health later in



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life, but relatively few individuals are willing to make the commitment today. The lazy consumer will fuel future innovations that will restore or replace healthy organs or functions like memory and mobility. Just as Prozac reframes anxiety and Viagra alters sexual relationships, there are new “solutions” coming. The bio-pharma industry will come running to our rescue with products, soon—for a price, of course. Or will employers and governments pay to enhance health and human performance as it serves their interests? Might advertisers pay to enhance consumers to live longer and, of course, buy more? Yes.

## The Ethics of Life Extension

I’m not endorsing this market, any more than I’m advocating other disruptive trends that await in the Extreme Future. My job is to inform, provoke, and stimulate your thinking about what trends are coming fast and how they may influence you and our world. Life extension is one example of a mixed bag of sorts that will challenge traditional values and introduce some new ones into society.

Just as human cloning has been rejected in many countries, there should be debates on what life extension means and what will and will not be made available. There are vital ethical concerns that many will and should debate. We must above all protect the integrity of the humanity from forces that might seek to destabilize it. We must protect individual rights and liberties from governments that may seek to use future medicine to further social repression. We want to tread carefully, with ethical science, global stewardship, and social welfare in mind as we navigate the new domains that life extension may bring. Radical opportunities and risks will emerge.

There are trends emerging in the current debate about stem-cell usage and therapeutic cloning that are instructive. Outside the United States, stem-cell research is proceeding unfettered. But for the first time in U.S. history, a fundamentally new technology with clear value for human health and medicine has been bushwhacked by politics. In light of the globalization of science, the proliferation of Power Tools such as nano-bio-IT-neuro, no technology can be restricted for very long if there are clear and certain benefits for enhancing human health and if a market exists for its products. Stem cells are an indication of consumer demand for human enhancement that will play an important role in the emergence of a new global market that no government will be able to fully control.

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The easy passage of California's \$7 billion stem-cell bond was a direct response to the federal government placing restrictions on stem-cell funding. Prepare for more of this type of reaction from consumers/voters who want to live longer, healthier lives in the twenty-first century.

By the same token, therapeutic cloning for organ replacement will become a reality in the United States, even if you're forced to acquire your organ offshore. Certainly, you will not allow your wife, son, or father to die because you cannot get the organ you need in the U.S. when it is available in Europe or Asia. More than 60,000 Americans will die this year from not having the organ they need. That will not happen in the Extreme Future.

## SEVEN REASONS LONGEVITY MEDICINE WILL TRANSFORM HUMANITY

- 1. Personal Liberty.** Predictive forecasts will provide individuals with customized health plans so they can choose health enhancement and a longer life.
- 2. Desire.** People have always wanted to live longer, taking control over their destiny, cheating death if they can.
- 3. Money.** A large concentration of baby-boomer wealth will be invested in what most boomers want: to live longer, healthier, and more active lives.
- 4. Productivity.** As birth rates drop, nations and employers will come to support longevity of their citizens and workers to preserve a productive population.
- 5. Social Investment.** Health-care costs for healthy people are lower than they are for the sick, reducing the burden on government and individuals.
- 6. Genomics.** The science of the human genome will make it possible to understand the genetic origin of disease and to take action to extend life.
- 7. Healing Tech.** A host of new restoration therapies, using stem cells, genetic vaccines, nanotechnology, and advanced medical devices will be deployed to extend life.

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As Longevity Medicine and human enhancement become reality, there will be an emergence of new ethical codes and models, not to mention a new sense of entitlement to the wonders that await. Consider, for instance, what might be contained in a “Global Human Rights to Enhancement Creed”:

- We strive to enhance our quality of life.
- We believe in the rights of the individual to freely choose enhancement.
- We believe in the democracy of science.
- We desire to enhance our physical performance.
- We desire to enhance our intelligence.
- We desire to extend our healthy life to the maximum years possible.
- We seek to develop our full human potential.
- We desire to positively contribute to society.
- We desire to eliminate disease.
- We choose to coevolve with innovation.

## Inventors of Tomorrow

The inventors of tomorrow will redefine human existence. With access to vast new Power Tools they can, for the first time, ask questions that would have seemed absurd a few years ago. Their tool chest is growing by the minute, including

- **Stem cells.** Universal cells that can be turned into organs and muscles and cure disease.
- **In-silico DNA computer models.** Programs that design potential drugs, devices, or solutions.
- **Supercomputers.** Powerful devices that map hidden proteins and DNA interactions at almost-human brain speed.
- **AFM (Atomic Force Microscopy).** Microscopes that can peer

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into the nanoscale to better understand DNA and the human body.

- **Nanowires.** Nano materials that can be programmed to self-assemble.
- **Internet 2.** The next Net for research and health-care collaboration.

## You Are What You Eat: Nutra Genomics

Are there foods that could promote your health, even protect you from disease? Perhaps. A new innovative science of nutra genomics is being researched with much early-stage potential. The matching of our personal DNA with diet will play an important role in enhancing health and longevity. Even now, studies have shown that certain men in Greece, who were unable to lose weight after all types of diets, enjoyed immediate results after doctors came to understand their DNA profiles.

Can it be as simple as the replacement of certain food groups and the elimination of others to achieve a desired health outcome? The Greek study showed that the men, when introduced to more potatoes and onions, lost weight. Not because this is a new diet rage, but because the diet was customized based on their DNA profiles. It is possible that we could understand diet differently, as food is medicine and medicine is changing to extend life. This may alter worldwide food production and marketing overnight, as people want to know how their biochemical individuality may require them to partake in some foods, and avoid others, to be healthy.

Though early research on red wine, for example, shows promise for extending life, we don't actually understand this yet. In the near future, genomic matching to determine our diet might point the way to living

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a longer life. Certainly this relationship is not new, but a new understanding of specific foods, genomic foods that fit our biochemical individuality, could open up a new era in health. This development will play an important role in the future of Longevity Medicine.

## Stem-Cell Boogie

In a fundamental way, stem cells are the master builder cells that can fix you when you are broken. At least that is the potential. More so than many of the innovations reported in this book, stem cells may hold the most promise to heal. Stem cells will protect life, accelerate healing, and extend life for individuals like your wife, mother, or yourself. Stem-cell research is progressing, but so far has more potential than a real tool kit. This will change very soon.

Stem cells have been used to date to grow new bone and tissue, and to heal certain types of cancer. If you are interested in life extension, then you should be interested in stem cells. I estimate a market of about two billion consumers. We will look back from 2020 and wonder why we did not invest in this fantastic new science sooner, I forecast.

## The Race for the Future

There is a stem-cell race going on—mostly offshore in places like China, Singapore, and Europe—that indicates the commitment of nations, corporations, and universities that are investing billions to beat the Americans. What is the race? It is the race to introduce the first organs, tissues, and bones made from stem cells for a hungry global market—a \$5 trillion opportunity.

There are numerous multibillion-dollar efforts being spent on inventing the future of Longevity Medicine. Taiwan has invested in more than a hundred companies doing work in nano-bio-IT. Singapore's \$5 billion is only the beginning in stem-cell research. Even Canada, seeing America drop the ball by restricting government-funded stem-cell research, is moving fast to outcompete the Yanks.

Stem cells represent a fascinating look at billions being invested for the first time—mostly offshore, but not in the U.S. There is a new innovation economy brewing. Up until the California stem-cell referendum passed, the U.S. had its first-ever brain drain. That's where

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talented, even genius-level scientists were leaving the U.S. for locations in Canada, Europe, and Asia to conduct stem-cell research. This was the first time the U.S. had ever suffered from being anti-innovation in its refusal to fund a fundamental new scientific endeavor. The U.S. cannot be competitive in the future without reinvesting in basic science innovations like stem cells today.

## U.S. Falling Behind

With most Ph.D.'s getting educated here in the sciences and then moving offshore to work, the stem-cell fiasco, if repeated in other areas of innovation, will cripple the competitive advantage of the U.S. Americans cannot afford for this to happen. Not now, not ever. This is not the way to protect national security or a strong economy. When it comes to the market for health-enhancement products and services, there is little doubt that it will cater to a global consumer. The products based on stem cells are close but not 100 percent here. As billions of dollars more are invested worldwide, products will get closer to market.

Need that new kidney by Christmas? How about those memory cells? Don't replace the hip, grow a new one. Stem cell-enabled products will heal faster, prevent longer, and extend the health and life of millions once innovations move out of the labs. Nothing drives innovation more than the market economy of billions of consumers. Even if you have to fly to Rio or Hong Kong for that stem-cell treatment, it may be worth it to those who want to live free of pain, or walk again, or see their cancer retreat.

A quiet collection of patients are sharing information and contacts

### DISEASES STEM CELLS COULD BENEFIT BY 2010

- Heart disease, to restore hearts.
- Nerve disease, to grow new nerves.
- Cancer, to restore healthy cell growth.
- Immunity diseases, to provide protections against disease.

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about offshore stem-cell treatment centers in China, Brazil, and Thailand. Some of the treatments for increasing mobility and restoring nerve cells are dramatic in their outcomes. Reports we have followed indicate the fast growth of foreign stem-cell centers, where U.S. patients who have not gained access in the U.S. are being treated.

In one closely watched court case, a man sued BlueCross BlueShield and won. His award was treatment by stem cells for his leukemia. He is alive and well today.

## Health History on a Chip

Even before some of the most dramatic advances of Longevity Medicine, consumers/patients will soon enjoy numerous innovations that will enhance their health. For instance, critical lifesaving information delivered when we need it and where we need it, will soon be common with small, robust storage devices—the next generation of the “health chip.” Each of us will soon carry a personal health record “smart card” that contains the relevant data about our health history on a tiny chip. These cards will include our entire health record, including the drugs we’ve taken, operations we’ve had, medicines we’re allergic to, and diseases or conditions we’ve suffered. The next stage of health chips may be embedded in our skin. Upgrades via the wireless web will keep our personal health history current.

### WHAT STEM-CELL TREATMENTS MAY OFFER BY 2030

- New organs, including hearts and lungs.
- New bone growth for legs, arms, and backs.
- New sensory functions and optic nerves to restore eyesight.
- New cancer treatments.
- New nerves to heal muscles and to restore movement.
- New cells to offset the aging brain.

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Such advances in medical information, facilitated by the convergence of health care, computers, and networks, will have a comprehensive impact on consumer health. They may prevent the more than 100,000 mistakes leading to deaths that the U.S. health-care system makes each year. This is a serious step in the right direction, one in which all of your personal health info would be available on demand, anywhere you go.

Looking a bit farther down the road, our genomic profiles will eventually be catalogued on our digital file. This information, critically important to our health, may be even more essential over time as new drugs and interventions born from unlocking the human genome will steadily become available after 2015. These smart cards, hooked into the Net, can quickly alert us to new research on a mutant genetic trait we've inherited, or to a new "smart drug" that can help cure memory lapses we've recorded.

Our health card (eventually even a chip embedded in our bodies), acts as a tiny computer, another gateway to the Net, searching out information for our specific needs, and alerting the hospital or specialist when we need their services. It watches our health statistics and knows what we need, and when. Our health chip might one day save our life.

In the new era of Longevity Medicine, information access—both personal and updates on the latest discoveries—will be essential to living longer and healthier. Longevity Medicine will continually be upgraded, refined, personalized, and improved with time. Consider how we will be able to deliver individual health-care solutions anywhere, at any time of day, when all physicians, hospitals, HMOs, and clinics are connected to the same online network. We'll call it the "Global Health-Net." Savvy companies will anticipate that and get ahead of the competition by matching specific patient needs with information resources available via the Net.

Much of the job of extending life and enhancing health will be about getting the right information to the right people in the right time frame to create a result.

## Future Longevity Devices

The makers of medical devices are also gearing up for the future markets of the twenty-first century, with products to help people cope with disease and dysfunction. New surgically implanted devices, similar to

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the way a pacemaker works to keep the heart beating normally, are being developed to remedy the symptoms of epilepsy, Parkinson's, tremors, chronic pain, incontinence, and sleep apnea. Memory enhancement is next.

But medical devices that are implants may be where the action is in the future. Devices, injected microprocessors, bio-implants made from organic materials, and even DNA implants will be a thriving industry. Neuro implants will be used to enhance memory for Alzheimer's patients, replace limbs, retrofit nerves, and replace organs such as kidneys or eyes. Implants will also be used to enhance human performance. Neuro devices to enhance life will be quickly adopted, even faster than pharmaceuticals.

## Robo-Surgery, Anyone?

High-speed network communications will allow physicians around the world to do more than consult routinely with each other. Surgeons

### FUTURE LONGEVITY MED-DEVICE APPLICATIONS

- Brain devices for enhancing memory and intelligence—including new languages and skills.
- Devices to enhance, regulate, and augment heart functions.
- Titanium and ceramic devices for legs and arms to strengthen them or make them adaptable.
- Stem-cell devices that rebuild and restore organs on demand.
- Bio-devices for replacing eyes, ears, or noses, or enhancing sight, sound, smell, or taste.
- Devices that “watch” for cancer.
- Injectable DNA genetic devices that will automatically scout and neutralize disease-producing agents.
- Nano devices—100,000 times smaller than the head of a match—that will deliver drugs on procedures on demand from inside patients.

could use robotic techniques to operate on patients remotely. One possible scenario has the surgeon remotely guiding a robotic arm in real time, with the device filtering out any of the surgeon's minor hand tremors.

The benefit of such surgery is twofold: The best surgeons will perform the operations they do best with the assistance of remote robots, and unique and "perfect" operations could be viewed by medical students in different locations as part of their training.

Robotic and robotically assisted surgeries can, in fact, be highly effective, because they can be programmed. Imagine a surgeon at Massachusetts General Hospital's telemedicine center using a virtual-reality environment to "walk through" a complicated organ transplant procedure that will take place the following day in Los Angeles. The surgeon can program his robotic assistant in Los Angeles to carry out the step-by-step operation while he watches in real time on his video monitor.

His colleagues at the University of Southern California are also monitoring the program and are ready to step in physically, if need be, should a problem arise. Bringing in doctors from Harvard and Tokyo University via teleconferencing could add new insight, as needed, for a delicate experimental procedure. Voxel Digital Holography routinely uses data collected by Computed Tomography (CT) and Magnetic Resonance (MR) scanners to produce true three-dimensional images. The life-size, transparent holograms, called Voxgrams, literally extend out in space. Voxgrams enable a physician to interact in, around, and through an image as though it were a real specimen of anatomy, making the programming of an operation a feasible goal.

By using such tools, we will also move toward less invasive surgery. Laser Industries, Ltd., and Biosense, Inc., for example, are jointly developing a system for using a catheter-based navigation system to guide laser beams to heart muscles for the relief of angina and coronary artery disease. The system ([www.sharplan.com](http://www.sharplan.com)) allows for the delivery of energy to selected sites on the inner side of the heart wall and may do away with the need for 300,000 coronary artery bypasses each year.

Patients will benefit handsomely when telemedicine solutions

*FUTURE ALERT: 2025*

**Nano-Robo Devices Search  
Bloodstream for Cancer Cells**

involving robots, virtual reality, and computer-generated doctors reach the mainstream.

## Cyberdocs

In the United States, medicine over the Net will be pervasive by 2015, and virtual “face-to-face” doctor-patient relationships will exist without the barrier of time and space. Sometimes, however, the doctor may be a computer, or cyberdoc.

Just as we have accepted other human-machine influences, from voice mail to computers, we will come to not just accept, but also to demand and trust, cyberdocs. It is likely that consumers may get more help from an interactive, intelligent computer than a stressed-out human physician. This makes sense especially if there is a life-threatening illness and there is no room for human error.

Humans may no longer monopolize medicine after we develop robotic surgeons that are more precise than their human creators, and

cyberdocs that perform routine diagnostics with predictable precision. This will lead to cheaper care available to vastly more people in need. In fact, insurance companies may come to require that robodocs and cyberdocs be used because

their precision and reliability are higher than that of humans. The use of robotics or cyberdocs will be a shock to many at first, but so was voice mail and shopping on the Net.

### *HEADLINES FROM THE FUTURE: 2020*

**New Poll Shows  
People Prefer Cyberdocs**

## Longevity Empowerment

In the decades ahead, we will demand that our cyberdocs, robodocs, and real docs support a mass-consumer emphasis on preventive medicine—a program of taking care of ourselves through lifestyle management to prevent illness and preserve life. It will spawn the creation of hundreds of new companies in the twenty-first century.

Fitness will continue to grow as a subsegment of the emerging health-enhancement marketplace. One new service that health clubs of the future might offer is “Virtual Health Adventures,” which add ex-

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citement to exercise. Through a blending of virtual reality, holography, and interactive multimedia, we could be transported to exotic places or adventurous liaisons. One offering could be a realistic dinosaur hunt where we would burn calories and get our heart rate up to a healthy pace in a dramatic escape from a tromping tyrannosaur. A real-time calorie-burning chart could show our progress.

Health insurers will offer virtual cash and prizes for people to slim down, stop smoking, or reduce stress. There will be a variety of incentives for us to stay healthy. If dinosaur hunts are too dusty, we could sign up for a virtual white-water raft trip down the treacherous Bolo, or a climb to the top of Mt. Everest. For something tamer and in the confines of our own homes, there's always software that can bring us tennis lessons in our bedroom with Wimbledon champion Andre Agassi, or a weight-lifting workout with Arnold Schwarzenegger. The possibilities are endless. We'll have to pay to play, but the results will be worth it.

Net companies could match these adventure firms—or other types of service providers—with “bundled” packages for customers who are likely to buy and use these products to take more responsibility for their health. Predictive programs containing advanced artificial-intelligence agents will be a key part of prevention programs. For example, with permission, they will analyze a patient's DNA and accurately compute the probability of a cardiac condition.

## Smart Drugs

If you're still asking for more evidence to convince you that Americans are enhancement-friendly, you don't need to look far.

More than one half of all Americans today are on some type of medication, according to a 2005 study. The Phillips Health Index, which my firm, the Institute for Global Futures, worked on with Phillips, gave us a deep insight into the health behaviors of Americans. Over a third of those on medication are altering their moods or taking drugs for psychological reasons—stress, anxiety, or depression. We are already enhancing ourselves with drugs. We are a medicated society familiar with using drugs to alter our mental state of being, to help us better cope with life. This data suggests we should take a hard look at what kind of society we are creating.

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Over the next ten years, “smart drugs” will include a new class of neuro-ceuticals, which are mixtures of nutrients, vitamins, and synthesized chemicals. These techno-cocktails will enhance productivity, memory, physical performance, and even entertainment and pleasure. Their growing acceptance may even eliminate street drugs, replacing them with legal pharmaceuticals. This, too, has disturbing consequences. Smart drugs today represent an emerging billion-dollar market, mostly in Europe, and increasingly in Asia and the U.S. The potential of the industry is unlimited, as biotech discovers and creates potent new energy and brain boosters. Once these hybrid drugs are accepted, much as coffee is accepted as a stimulant today, they will shape the way we work, live, and play. Many of the emerging drugs that will be used to fight diseases of aging will also be used to enhance neuro abilities, from smarter minds to sharper memory. Some of us will depend on these drugs to compete in the future workforce.

Part of this trend will inevitably include ways to package pleasure. Anti-anxiety and antidepressant drugs are just the beginning. The idea of packaged pleasure in a pill will challenge the assumptions we have about leisure, work, and entertainment. Pharma magic in the twenty-first century will necessitate a brand-new look at the influence of drugs on society. Will we need smart drugs to cope, manage, or even understand the future we are creating? Perhaps we have already answered this question.

## Medicating Performance

A notable percentage of people using Prozac—an estimated fifteen to twenty-five percent—do so to enhance their performance. They use it as a smart drug. Wouldn’t we all like to eliminate anxiety, work smarter, be more productive, and be more successful? The pharmaceutical companies hear us loud and clear. Better performance through biochemistry will be a multibillion-dollar industry in the stressful, competitive, and chaotic world of tomorrow.

The highly educated and intelligent CEO of a billion-dollar company admitted to me that his choice of recreational drug was Cialis. This sexual enhancement drug works for thirty-six hours and guarantees performance. The CEO is married and his use of Cialis is a personal choice, not a medical response to erectile dysfunction. His decision is a canary in the coal mine of legitimate pleasure pills be-

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coming part of the enhancement culture of America. Professors and researchers I know use drugs prescribed for ADD to create more focus and alertness so they can keep up with their students.

Chemically improving ourselves will become the rage as twenty-first-century smart drugs help to realize new human potential. Slow performance will become abnormal and *déclassé*. Future technobrews will do the job more predictably with DNA precision. A recent discovery offers an excellent scenario for illustrating how to market such smart drugs. Supposedly, a component of green tea called ECGC may stop cancer by interfering with the way the disease invades cells and breaks down healthy tissue. An entrepreneur could buy a supply of green tea, isolate the ECGC, and then combine it with other known anticancer substances. The new tablet could be made chewable and marketed as “Cancer Fighter,” via the Internet, where it would be targeted to disease-specific groups and potentially avoid regulatory oversight.

Who wouldn't want to take this anticancer cocktail to ward off disease? The \$10 billion-a-year vitamin market, fueled by more than one hundred million Americans alone, is a strong indication of the power of this movement. I forecast more than a billion smart-drug devotees ingesting more than \$2 trillion of instant health and performance products by 2015.

## FOUR “SMART DRUGS” THAT MIGHT BE IN PHARMACIES BY 2020

1. **Refresh**—A drug to refresh your brain from fatigue with a biotech brew that stimulates and enhances alertness.
2. **Speed-Up**—A drug that enhances thinking, productivity and creativity.
3. **Xtasy**—A short-term pleasure drug that enhances touch, emotion, and awareness while slowing down the perception of time.
4. **Recall**—A drug that gives you total recall and photographic memory perception, allowing you to learn a language in an hour.

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## Future Longevity Medicine Trends

The following trends will transform the health-care system of the future. They represent the next generation of breakthroughs that will offer bold new choices for people interested in life extension and health enhancement.

- **Holographic projection.** The use of life-size, transparent holographic images of a patient's DNA or body projected into a room or onto a virtual space online for physicians to interact with, and to collaborate with other physicians to diagnose or intervene.
- **Assisted reality.** Supplementing the real world by adding virtual objects so that goggle-wearing surgeons, for example, can "see through" a human body as they perform surgery or genetic enhancement.
- **Robotic surgeons.** Performing operations in which their movements are controlled by a specialist at a remote site or preprogrammed for a specific task and monitored by a physician.
- **Wetware devices.** Neuro-enhancements allow direct brain access to extend intelligence, skills, and memory. Embedded intelligence becomes as natural as breast implants.
- **Stem-cell synthetic tissue and organ growth.** The growing of tissues and organs for human transplantation.
- **Neurogeneration.** The repair and growth of spinal cords, nerves, and brain cells.
- **Therapeutic-cloning banks.** Repositories of an individual's cells that can be grown into organs on demand to replace diseased body parts and prolong life.
- **Longevity tourism.** Vacations where people can medically enhance their appearance, health, performance, fitness, or mental well-being.
- **Designer gene banks.** Where consumers can choose genetic health enhancements.

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- **Wireless real-time patient-information systems.**
- **Decision-support smart agents.** An interface between agents, doctors, researchers, clinicians, and patients.
- **Online distributed intelligence.** All current updated medical information, procedures, and drugs to support both patients and doctors.

## Scenarios from the Future of Medicine

### THE LONGEVITY LIFESTYLE: YEAR 2018

Frank is a thirty-five-year-old designer living in New York City who is concerned about his weight. He needs to lose twenty-five pounds, exercise, and get healthier. He knows his genomic history is not a healthy one. His father died of a heart attack at forty-five, and his mother is overweight and diabetic. Frank's DNA health-profile scan shows that his health-hazard appraisal gives him five years before he is at risk for a heart attack. Frank has decided to take action now.

Using his wireless videophone, he calls his Internet agent, Nanette, a Digitized Engineered Personality (DEP), who is bright, alert, and a bit pushy—characteristics chosen by Frank. He has committed to himself and his family not to die from denial about his medical history. He wants to deal with it.

He asks Nanette to assemble a customized weight-reduction package that takes into account his rigorous business schedule. He also asks her to scan the Net for available data related to his personal health records and to check for any bonus premiums of cybercash credits offered by his employer, HMO, government, or insurance company. Nanette is configured for Max Intelligence Level 517. She also serves with a passion. She gains upgrade credits that she can use for wanted improvements to her neural net brain. She is self-aware enough to desire.

Within three minutes, Nanette compiles a complete report, which she downloads to Frank's wireless wearable cell phone as an interactive holograph with music, graphics, and charts. It is also delivered in text to his smart-card fax.

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Among her findings is a cybercash credit program offered by McDonald's-Wal-Mart Health Solutions. She registers him and will help him stay on track with a customized health-enhancement program of diet, exercise, and med-device monitors. As a true DEP, Nanette is able to self-evolve, learn, and adapt based on the moods, behaviors, and actions of her creator. For example, she knows Frank's limitations—such as being in denial about the reasons for his weight—and is able to integrate his responses to her in order to come up with solutions for achieving her prime directive, helping Frank trim down: "Twenty minutes on the treadmill will lose you twenty pounds, which gets you twenty years of extended life."

Toward this end, Nanette will navigate through all parts of Frank's life, and will, for example, actually lock the refrigerator after 5:00 P.M. if necessary. "I'm sorry, Frank, snacking is not approved on your diet."

Food not on Frank's diet is no longer approved for purchase at the supermarket checkout. Unapproved items will not clear the cash register. Ditto with cigarettes, which Frank has vowed to quit as part of his new lifestyle. Nanette sends him this message each day: Veggies okay. Easy on meat and dairy. Low- and no-fat is the ticket. Exercise is key. In addition, Nanette offers encouraging reinforcement by hunting down discounts at Frank's favorite Italian clothing stores. She also builds a network of support with Frank's friends and relatives by letting them know his progress and how they can help him achieve the end goal. Nanette advises Marcia, Frank's mother, not to drop off any more of those chocolate-chip cookies. She arranges regular tennis, running, and exercise partners and coaches to fit in with Frank's schedule.

Frank made it clear that Nanette should be relentless in helping him fight the battle of the bulge. Frank's contract for these health changes cannot be canceled for six months, and he has to live with the consequences of Nanette's zealotry.

The kicker comes when Nanette, unsatisfied with Frank's initial progress—his weight is still high, as is his cholesterol—puts together a holographic "This is Your Life" health magazine that depicts his family history of weight-related health problems and early deaths. A lifeline for Frank shows that unless he sticks to the program, he's due to keel over at age forty-five. Even the funeral is depicted in this multimedia show. Shocked by such in-your-face data, Frank joins the gym recommended by Nanette and quits avoiding the prescribed medications. He stops sneaking snacks and swears off nicotine.

Before the six months are up, Frank has reached his goal,

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dropped his weight, and has to spend a bundle on slimmer, more fashionable clothes. He's also got another problem—a sudden flock of admirers.

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## LONGEVITY NET-MED TRAINING 101: YEAR 2019

The famous heart surgeon Dr. Robin Karinchy in her operating room at Stanford University Medical Center, is guiding an intricate triple-bypass operation thousands of miles away in a Singapore hospital. She is training a new generation of doctors in Longevity Medicine—experts in every procedure to prolong life. Medical students from fifty medical schools around the world are watching the procedure via videoconference over the Net as part of their resident training.

“Now with this technique, which I am still perfecting, I have found a way to make more refined incisions by using a fiber-optic-tipped scalpel that is a stem cell-enabled nano-bio device,” Dr. Karinchy describes. “Now I can gently insert the nano-probes so they will form a gateway around the heart, monitoring the heart’s performance and augmenting it if needed with a nano-bio stem-cell device.”

“Does that mean that this process is more precise?” asks one of her students, Sanji Patel, who is beamed in from India.

“Hi, Sanji, good to have you here today. Greater precision is one part of this new procedure, but speed is also a result of the smart-targeting of the nano-bio probes, so we can extend the patient’s capacity to live longer. The insertion of the stem cells directly into the heart will enhance the therapeutic impact as well.”

More than thirty different languages and cultures are represented with simultaneous real-time translation of the exchange between Dr. Karinchy and her team. After an intense one-hour operation, Dr. Karinchy answers questions from the local and remote locations. Her answers and the questions are captured and shared over superfast networks and e-mailed to all present.

“Remember that this course is worth six credits if you download the homework and e-mail it back before April 3. Visual simulations are required, so please don’t submit your work without them. Dr. Karinchy offline.”

Some of the residents later download the operation over the Net and simulate the teacher’s actions to learn her technique. Other students interact with other teachers and students over a groupware

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Net link where they can make notes and diagrams while they play back the operation in slow motion.

The patient's vital signs, displayed as information streaming across their wearable net screens, allows them to monitor the operation's progress. All of this information and the procedure can be redesigned, simulated differently, or stored for playing out different scenarios. The visualization of the surgical procedures enables the students to learn a new type of medicine—Longevity Medicine.

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## ON-DEMAND LONGEVITY MEDICINE: YEAR 2015

Larry has had a long day. He feels tired despite having taken an anti-fatigue pill called "Aware" to get through the last Internet videoconference on the company's newest product. A happy hour beer-fest at the ZLounge is tempting, but just after leaving the building; a sharp chest pain stops him cold. The pain finally subsides, and he quickly speaks to his cell phone, activating his Personal Health Record by uttering the word, "Emergency."

Immediately, Larry is routed via the Internet to his health plan's Clinical Emergency Center for a diagnosis. This involves answering a series of yes-or-no questions about the symptoms and vital signs asked by a MedTech on-duty computer. Larry places a finger on the screen where his biosignature converts his BioScan signals and sends them instantly to the Emerg-Med Team via a virtual Net center many time zones away.

The GE cyberdoc decides that Larry's condition may be acute cardiac ischemia and dispatches a Clinic-Mobile to his exact location. En route to the nearest emergency-care unit, a battery of tests, including another BioScan, are performed and transmitted via a wireless device to a lab for interpretation.

By the time the local emergency team reaches Larry, the doctor on duty has the results, along with a second opinion by a cardiac specialist on duty in Bangalore, India. Larry's Personal Health Card has also provided his medical history and genetic predisposition to the on-duty doctor.

The doctor has authorized several categories of treatment for the condition—a partially clogged artery. The receptionist takes Larry to a voicenet monitor, where he can see and talk to both physicians who have studied his condition. On the split screen, the duty doctor shows Larry holographic 3-D color images of the vessel blockage via a microscopic camera inserted into his bloodstream.

The doctor recommends injecting an army of nanoscrubbers

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to clean out the arteries. Larry is asked to rest while the physician takes a virtual tour of his bloodstream to code in the correct markers for making the noninvasive procedure a success. Once deployed and completed with their mission, the nanoscrubbers dissolve harmlessly.

The actual operation takes only eight minutes, and Larry is discharged shortly afterward. Before leaving, he's given a customized holographic health disk with an analysis of what dietary or lifestyle changes are needed for him to avoid another such episode. All info is uploaded to his virtual agent and his home doctors.

An always-on, wireless, Internet accessible wristband will unobtrusively monitor Larry's condition for the next couple of days, but he feels fine as he strolls out of the neighborhood care unit. In fact, he still has time to make happy hour. He just has to watch what he orders. His updated personal health record may warn him from ordering beverages that are not on his diet. Larry may hear this message: "Light Nutri-beer suggested—and only two servings."

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## THE NEW ELIXIR—STEM CELLS: YEAR 2018

The black market for stem cells emerged in the latter part of 2009, when the health value of stem cells became more fully understood and exploitable. The issue was no longer *if* stem cells could heal cancer, reverse heart disease, or grow new bone or organs. The only issues were where could you get them, and at what price? Access became the challenge, and in the supply-and-demand market for medical longevity, stem cells were king.

Overnight, there was a surge, first in the stem-cell black market and next in the legitimate medical tourism industry. You got what you paid for, but then the Chinese got into the market with very inexpensive stem-cell products. China woke up after the trade wars of 2010 when the trade imbalance with the U.S. and Europe became a political concern.

Stem cells put the sizzle back in the marketplace for new customers, new products, and new markets. Off-the-grid locations in Thailand and Rio, which had been havens for cheap plastic surgery, were now upgrading to stem-cell treatments marketed to a hungry world of aging baby-boomer affluents looking to live an extra fifteen years. Just as growth hormones have spawned the longevity medical boom, stem cells have become the next youth elixir.

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## GET YOUR DNA ON EBAY: YEAR 2025

When Sylvie discovered that she had a rare DNA strain that could be synthesized and used by others, she was suspicious. She didn't understand it. How could this DNA strand be used to prevent breast cancer? But that's what the GeneTechs told her after her test was done.

"You mean I have special DNA?"

"Very special. In fact, rare," Phil the GeneTech told her. "And we might be interested in buying some, you know, for research."

The first time Sylvie put her DNA for sale on eBay's bioMart she got three offers in the first five minutes that were 100 percent over her asking price. She was astounded. At \$25,000 a DNA slice, she thought it was a high price to begin with.

The Longevity Medical Market is open for business.

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## THE DEADLIEST DISEASES BY 2020

Most diseases operate like the living beings they attack. Diseases function like living entities with purpose, adaptive skills, and the capacity to fight for survival. In many ways, diseases affecting humans share many of the aspects of their victims. For example, the virus is a marvel of nature, a bio-engine that is self-reliant and persistent. By 2020, we will have learned to eliminate many diseases, but others, still dangerous killers, will defy a cure. This will frustrate medicine, making health care challenging in the future.

Given what we know about existing diseases, it is not hard to imagine what the future might have in store:

- 1. RetroAIDS Virus.** The new retro strain is deadly, fast-adaptive, and resistant to drugs. RetroAIDS keeps mutating its DNA, even after 1,000 generations, and is always adapting to new survival threats.
- 2. ALZ.** This is a complicated killer, similar to Alzheimer's but a hundred times worse. Not one disease but a combination of interwoven diseases that come together to attack the nerve cells. ALZ is lethal, inoperable, and fast-acting.
- 3. Zimba the Flesh-Eater.** This type of flesh-eating strain will qualify as the fiercest and most deadly disease in 2020. This new strain causes painful death in two hours.
- 4. Zengue Fever.** New forms of dengue fever that mutated with the plague after a biowar attack in London are mutating and spreading

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faster than science can keep up due to poor sanitation conditions in Africa.

**5. NuBola.** A distant relative of Ebola but ten times more deadly.

**6. Avian-X.** A mutated, more powerful form of the avian bird flu.

## Beyond Health

Yes, this all sounds strange, alien, and weird. I admit it. My job as a futurist is to inform you that new and radical choices are coming. Do I think that all human enhancements are positive, ethical, or productive? No, but I do call for an open debate on and recognition that Longevity Medicine, free choice, and democracy are on a collision course in the Extreme Future. As a policy advisor to three White House administrations for more than thirty years, I can forecast that the very concept of health care is being changed now.

The era of Longevity Medicine is upon us. It will offer the ultimate fantasy product to billions of consumers—more time to live. More time to love, to spend, to create, to care, to play. You want it now. We all do. We all want more time to exist in a state of enhanced health.

Emerging innovations, from stem cells to biotech, entice us every day with promises of the next new thing. Clearly, as DNA discoveries merge with medicine, everything from diets to disease will be radically revamped. More than 300 new drugs are in the pipeline waiting for FDA approval over the next two years. Billions in research is targeting the longevity consumer—you. You want to live longer and business wants to charge you for the privilege.

Medicine is in the midst of a revolution in mission and purpose. In the past it was about disease management and healing. In the future it will be about prevention and enhancement. This is the future. It is inevitable and logical given the rate of innovations exploding today. The possibilities for medicine to deliver on health enhancement and prevention are good during our extended lifetimes. As innovations persist, and as the boomers demand to reshape aging, a new era of Longevity Medicine driven by global market demand will emerge. The revolution in longevity is coming faster than you think.

Keep in mind that the drivers of Longevity Medicine may be other trends as well. Lower fertility rates leading to a smaller population—

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fewer workers to keep pace with productivity—would be offset, perhaps, by people living longer and healthier. The simple desire of companies to make money by capitalizing on life extension will drive this market. Along with personal choice to live longer will come governments, even corporations, that will invest heavily in Longevity Medicine with self-preservation in mind. Healthy people, longer-living people, lead to productive, sustainable nations.

Vast new questions remain unasked, let alone answered. Who gets to be enhanced? What are the limits to age? Who will pay? Who will benefit? How will an individual's free choice shape this future? What are the rights of individuals to choose enhancement in democratic societies? How will global competition between nations, corporations, and individuals be shaped by longevity medicine innovations? These questions and more will be key fixtures as Longevity Medicine breakthroughs outpace the questions in the Extreme Future.

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