Preface

"This is the terror: to have emerged from nothing, to have a name, consciousness of self, deep inner feelings, an excruciating inner yearning for life and self-expression—and with all of this to die." (Becker, 1973, p. 87)

Knowledge of death is a key aspect of human nature. Knowing that we will die shapes how we live our lives and how we deal with others. As I will show with a little demography, it is aging (senescence) more than anything else that makes death inevitable—the climb in mortality rates with age due to senescence leads to death, sooner rather than later, for all of us. The later stages of most human lives are a period of physiological decline, which sometimes can be physically and mentally debilitating.

Three-score-and-ten, or perhaps four-score years, if we are lucky--is that all the time we have? From the time of Ponce de Leon's search for the fountain of youth to today's use of Botox treatments, humans have been desperately trying to avoid aging. Up to now, the treatments have not been effective in slowing aging, and most "solutions" just hide surface aspects of it, at best. However, recent advances in the biology of aging, coupled with knowledge of molecular and cellular biology, are presenting us with a near-term possibility of at least doubling human life expectancy, to 150 years.

A Thought Experiment

Suppose that you just discovered a treatment that appears to slow aging significantly in humans. What would you do? Your first notion might be to patent it, hoping to garner fame and fortune. For many it would seem a no-brainer. The delaying of aging should contribute to the delay of a variety of age-related disorders, reducing or delaying human suffering.

However, you might also consider that there already are too many humans on earth, crowding out other species. Anything substantially delaying aging in humans, especially if it were relatively affordable, would only contribute further to the mounting ecological problems resulting from overpopulation. And any treatment that is expensive would be out-of-reach for many, raising moral and other issues concerning the growing spread between "haves" and "have-nots" in the world.

Would you end up considering the possibility that this is not the best time for such a development, given our recent population explosion? You might recall the unintended consequences that can arise from some of the technologies that flow from science, and wonder if we wouldn't be better off delaying the spread of such knowledge. Given more time, humankind might be better able to adjust to the ebb of aging than it is now, and avoid a precipitous global ecological decline due to human overpopulation.

Or perhaps you wouldn't be quite so selfless. You might consider administering the remedy to yourself and sharing it only with close family and friends. Realistically though, the discovery would be unlikely to remain a secret for long. Each who knew would be tempted to spread it to a few others whom they would want to have "saved" from aging. It wouldn't be long before the secret was out.

Perhaps the key would be just to use it on you. The inevitable downside of this, though, is losing all your friends and family over the years. Would it be worth it to outlive everyone that you love for the sake of the added years, and would some of those

years involve significant disability? Even if you chose this scenario, sooner or later suspicions would be raised about your unnatural longevity. Or, quite likely, given what we now know about aging and the direction of current research efforts, someone without your concerns would make the same, or a similar, discovery, and spread the word. It's only a matter of time, and that is a major message of this book. I hope my writing now will contribute to a greater number of individuals being more knowledgeable about the biology of aging, and hence more prepared for the decisions that will have to be made by individuals and by society in the near future. In addition, a fundamental knowledge of why and how we age can contribute to a better understanding of age-related diseases and the things that happen to each of us as we grow older, and that alone is worth the price of admission.

About the Book

In this book I describe research results that point to our being within a generation or two of a revolution in longevity. I review the history of human aging to set the stage, describe the underlying causes of aging, and then outline the evidence indicating that we are close to a partial solution to the problem of aging. I indicate the general form that a partial solution to aging might take, although there are several options currently being considered. Such an increase in life expectancy will involve drastic restructurings of human life and society, and I examine some of those substantial consequences.

However, most of the book actually concerns why and how we age. That understanding is necessary for gaining the realization that we are close to a partial solution, but also will allow readers to gain an understanding of our current knowledge of aging. Aging, or senescence, is the decline in functioning of an organism with time that leads to an increased probability of its death. We are used to seeing the consequences of human senescence in wrinkled skin and stooped posture, and such surface features merely hint at the numerous changes that are occurring within us. Given that aging is a complex and multifaceted process, how is it we can be close to a partial solution? I will suggest that there are a smaller number of underlying causes of aging at the molecular level, and a reduction in the rate of senescence in humans will likely first come from enhanced activity of the genes that protect against such aging damage. Those genes specify proteins that protect our bodies through repair, molecular turnover or replacement, protection, and other forms of maintenance. Increasing the expression of such genes means increasing the protein products which slow the rate of build-up of age-related damage in our bodies. Experiments with a variety of animals indicate that these repair and maintenance genes are linked in terms of the control of their expression, and this will make the design of an intervention much easier--a single intervention will impact on a variety of aging processes. As the levels of the protective gene products increase, the rate of aging, and the rate of rise of mortality rates, will be reduced. That is it in a nutshell, but there is much to learn to fully appreciate the evidence that supports this view of aging and how to control it. Of course, a book of this sort cannot be written without personal bias creeping in. I will try to indicate when I am taking a view that may not be shared by most other gerontologists. Even the claim that the rate of aging can be reduced is disputed by a minority of gerontologists, but they seem to be shrinking in number as our knowledge grows.

A most compelling reason to think that we are getting close to solving senescence comes from advances in our knowledge of why we age. Basic evolutionary studies have given us insights into the biology of aging. We now have a good idea of why senescence emerged among multi-cellular organisms during evolution, and our current knowledge of the evolutionary trade-offs that resulted in aging bodies is most useful in planning an attack on the problem. Perspectives that come from comparing the life histories of different organisms also contribute to an understanding of why age-related disorders build later in life in most organisms protected from illness, infection, and predation.

Further encouraging news comes from the fact that there are some living entities that seem to avoid aging, or only age very slowly. Some of these living things are cells that are found within each one of us--our germ-line cells, the ones that produce our sperm and eggs, do not seem to show signs of aging. Generation after generation, the germ cell lines that produce the ova and sperm for each succeeding generation do not universally show signs of decline. If they did exhibit senescence the way that the rest of our body cells do, our offspring would not be as vigorous, and, over a period of generations, such a decline would result in the eventual extinction of our species. Instead, at least some of our germ cells, and a limited number of other living things, do not show significant signs of aging. Thus, nature already has developed ways to delay, slow, or avoid aging, and we will find clues to reducing senescence by examining some of these negligibly aging cells and organisms.

We will derive insight, as well, from organisms that live life at a much higher pace than we do, without showing the premature deterioration that would be expected. Most organisms with high rates of metabolism—burning their candles at both ends, so to speak—show rapid aging and deterioration, but that is not observed in some species of birds and bats, even though they expend considerable energy in flight. What allows them to live much longer than other creatures of similar size, despite high rates of energy usage? The answer will help us toward understanding what controls aging in living organisms and also suggests that humans are capable of doubling their current average life expectancies of 75 to 80 years.

There will be challenges to gaining a partial solution to the problem of aging, as well described by Miller (2004), and that is one reason why I suggest that it still is 2-4 decades away: I suggest that human testing will begin sometime between the years 2020 and 2050. I will indicate the likely general mechanism that will bring us a reduction in aging rate the soonest. A couple of other possible ways that aging might be delayed also will be briefly outlined, with reasons given for why they might take longer or not be as complete a solution.

While suggesting that we are close to a solution, I will take to task the snake-oil-like “treatments” for aging that are advertised today, and caution against believing those who currently are exploiting consumers with false hopes of perpetual youth.

A slowing of the rate of senescence means an increase in human longevity, and I will explore how the lengthening of human life will bring profound changes to our lives and society. There are positive and negative consequences that will come with a reduction in senescence. Both utopian and dystopian views of ageless living may be exaggerations, but a significant reduction in the rate of aging is not that far away, and that reduction will have severe consequences for an over-populated world. As mentioned above, we already are facing problems--from the horrors of poverty and starvation to

environmental degradation and depletion of resources caused by human overpopulation and greed. Many of these problems would decisively grow in severity if aging were to be reduced or eliminated for any substantial number of people, as simple calculations will show. We can already begin to explore the consequences.

As well as these societal issues, there also are generational changes and moral concerns for individuals that will arise, especially if the distribution of a "cure" were to be limited by the availability or expense of treatment. Whether for better or worse, we need to plan for what is coming because desperation and desire on the part of some will drive the development of true, anti-aging treatments in the coming several decades. Many baby-boomers will be pressing hard for a solution to come as quickly as possible.

For those who might remain interested in reducing their own personal rate of aging despite the potentially high societal costs, I will suggest what should be done now to prepare. It is not likely that the first methods of delay will overcome the problem of existing levels of aging damage—it is more likely that only future rates of aging will be slowed, at least by the first generation of treatments. So, the less one has aged, and the fewer the age-related diseases at the time of the breakthrough, the better for those who desire to be the guinea pigs for the first-draft solutions. And draft it probably will be, with all of the risks that are entailed. It will not be possible to know beforehand all of the risks involved for the first generation of users, but I will try to indicate why the first attempts at a solution will likely leave us with some age-related disorders while delaying others.

Even with these potential problems, it is a good guess that there will be no shortage of volunteers throwing money and hope in the direction of those who have found a partial solution to the problem, especially given the willingness of individuals to try, and pay for, the many worthless treatments for aging and aging symptoms on the market today.

In the last 25 years, the biology of aging has moved from a backwater area to a hot subject for research. The gerontologists who study aging have many reasons for selecting their subject from among the numerous puzzles available to scientists today. For some, a basic curiosity and desire to understand life and nature has been a motivating force. For others it is a desire to help humankind. An understanding of the causes of aging should contribute to delaying a whole host of age-related disorders--from cancer and heart problems to joint disorders and the diminished muscle mass that weakens the aged. Other gerontologists are interested in profiting from possible solutions to the problem of senescence, and some of them have already formed companies in anticipation (Solomon, 2006).

Not all gerontologists are interested in extending human longevity, but, whether intended or not, life span extension will be the likely outcome of research in the biology of aging within a generation or two. Support for that claim comes, in part, from what we now understand about why and how we age, and that will be a topic that will fill the heart of this book. Towards the end of the book, I will examine the implications of a breakthrough in the delay of aging for society. Beginning to think about the consequences of delayed aging for individuals and society will help prepare us to deal with them when the time soon comes. But first, I'd like to warm up by considering what has happened to life expectancy in the recent past and where we appear to be headed without the kind of breakthrough I am suggesting is getting close. That analysis will

allow us to distinguish two major ways to reduce mortality. Only one of the two actually acts on the underlying causes of aging. Also, it will be enlightening to consider what life would be like without any aging.