

A world without ageing

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In *Ageless*, I describe ageing as the greatest humanitarian challenge of our time. That might sound strange but, once you begin to look at ageing as a biologist, the conclusion seems inevitable. Because the ageing process gives rise to terrible diseases like cancer, heart disease and dementia, it is responsible for over two thirds of deaths globally. Those deaths are usually preceded by decades of decline, increasing frailty, loss of memory, hearing, strength and sight—and, of course, the suffering from these diseases too. As a result, ageing is the single largest cause of human suffering, and something I argue we should be ploughing resources into treating—and even curing.

In the book, I set out the science that shows that this isn't some wild, sci-fi pipe dream: we now have dozens of ways to slow and perhaps even reverse the ageing process in the lab; some of these are just proof-of-concept experiments, others are already in human trials. The first anti-ageing drugs could be with us within the decade, and a cavalcade of other therapies will be following close behind.

These therapies will delay age-related changes in our biology and extend our 'healthspan'—the amount of time lived in good health—by deferring the diseases and disabilities that the ageing process causes. They are pretty likely to extend lifespan too—after all, it's these diseases that kill us—but the most important aim of real anti-ageing medicine is to keep us healthier for longer.

A complete 'cure' for ageing would be a biomedical miracle. A family of treatments that could prevent all of these age-related diseases and dysfunctions would alleviate untold quantities of suffering for billions of people around the world. But such a seismic shift in human health wouldn't occur in a vacuum: this medicine would have serious social, political and economic side effects. In this bonus chapter, I'd like to address some of these in more detail than I had space for in *Ageless*, and explain why I firmly believe that curing ageing would have benefits that far outweigh any negative side effects that longer, healthier and happier lives may create.

However, this position isn't immediately intuitive. A 2013 poll of Americans found that 51% thought that medical advances allowing the average person to live to 120 would be bad for society, versus 41% who thought it would be a good thing. This skepticism about longer lives also applies to how long people themselves want to live: the same poll found that the average American wants to live to 90 (about ten years longer than

current US life expectancy), while just 4% wanted to live beyond 120. Everyone wants to have a good long life, of course, but few want to survive to 150, which they probably see as either sci-fi weirdness, involving five decades of total decrepitude, or both. There's also the fact that, put on the spot in a survey, people don't want to seem crazy; this is one interpretation of another finding, that only 38% of people say they want life extension for themselves, while 68% think that 'most people' would want it. Is this an admission that it's desirable, but *I'm* not one of those vain individuals who wants to live longer? (If so, I'd like to remind respondents that there's nothing vain about not wanting to get dementia or heart disease.)

It would be fascinating to know how people might respond to these questions if given a short primer on the science of ageing before answering. As you'll know if you've read *Ageless*, every time we extend lifespan, we also extend healthspan. Whether we are studying the effects of dietary restriction in rats, 'senolytic' drugs that kill senescent cells in mice, or we are examining the genes of 150-day-old worms or 100-year-old people to learn the secrets of longevity hidden in their DNA, we typically find that their extra years of life are in good health. There's some evidence suggesting that knowing this fact could make a significant difference in people's opinions: another study asked how long respondents would want to live if guaranteed physical and mental health—80% said 120 or longer, and almost half hoped for an indefinite lifespan under such circumstances.

However, even if people are persuaded to find an indefinite lifespan desirable personally, my experience talking to people about ageing suggests that many would still think it puts us at risk of disaster globally. The first question most people ask when I tell them I've written a book about ageing isn't about biology, or what they can do to optimise their health—it's 'wouldn't that cause a population disaster?' There are often several more questions about the ethics of living longer before I get asked about the science. This is completely understandable—curing ageing would transform our societies, our planet and what it means to be human. There's a lot to discuss, and I want to convince you that curing ageing would have benefits that far outstrip its costs.

There are a few general arguments that apply to many of the ethical conundrums thrown up by curing ageing. The first is to ask ourselves why, in a particular case, should ageing biology be different to other kinds of medical research? Whether it's Alzheimer's research or finding new ways to combat malaria, most biomedical science aims to make people healthier, usually with the side effect of longer lives. The goals of biogerontology are no different—and yet no-one asks cancer researchers at dinner parties whether their new way to treat childhood leukaemia might lead to overpopulation. 'Curing ageing' sounds weird at first, but we're already living longer, healthier lives thanks to improving lifestyles and advances in medicine—anti-ageing treatments would just be an extension of progress already underway.¹

¹You might wonder whether the converse is true, and we should actually be considering the effect of childhood cancer research on population, and other wider, ethical questions. The strict answer is that we probably should—but I think the conclusions would be the same as I'll lay out for ageing biology, and such research is very worthwhile.

It's also worth comparing ageing biology to medical advances from other periods in history. If it was the 19th century and I'd written a book about treating infectious diseases, would critics have argued that cholera and tuberculosis were 'just a natural part of being alive', or worried that people would get bored with life expectancies longer than 40 years? From our healthier, happier vantage point in the 21st century, any such objections seem absurd. It seems likely that people in a post-ageing society of the 24th century would think the same of the arguments against treating ageing that are made today.

The second general approach to ethical concerns is to try reversing the question: if we lived in a society where there was no ageing, and one of these issues raised its head, would you invent ageing to solve it? Take the concern that a booming population would put stress on our ecosystem. Would we create ageing, and condemn billions of people to decades of frailty and decline, to reduce our impact on the planet? Similarly, would causing 100,000 deaths a day (the current global toll of the ageing process) be a proportionate response to end the potential tyranny of an immortal dictator or to alleviate unequal access to anti-ageing treatments? I think, examined this way around, the answer in each case is clearly not—and that means that the reverse, arguing to maintain ageing to perhaps alleviate these issues, is equally clearly the wrong approach.

Thirdly, ask if the particular problem of living longer will need to be dealt with anyway. I discuss the politically fraught debate around raising pension ages in Chapter 1 of *Ageless*—and conclude that it will need to happen even if we were to freeze medical technology at contemporary levels. We are already living too long for pensions to be economically sustainable at current retirement ages. In the UK, these date back to the 1920s, when life expectancy was 23 years lower than it is today. A cure for ageing might alter or intensify some challenges of living longer, like this one, but, in many cases, we are already on the cusp of crisis.

Finally, it's worth bearing in mind that any changes in lifespan will happen very slowly. Even if we cured ageing next week, we wouldn't have many 200-year-olds walking around for at least another century, simply because it will take our current oldest people 100 years to get there. Even in the most extreme scenario of a cure being developed and rolled out globally in an instant, we'll still have plenty of time to adapt to any new normal. In a more plausible, gradual scenario, the challenges of increasing life expectancy will move slowly enough that we'll have plenty of time to get ahead of them.

I think those approaches help reframe the issue, but you'd be forgiven if you aren't yet entirely convinced. For the rest of this chapter, I'll examine specific challenges in depth, and lay out why I believe they're often not as daunting as they first appear. In most cases, we'll consider the effects of the most extreme case—a complete cure for ageing. If a complete cure doesn't cause insurmountable problems, then the more likely outcome of gradually adding more healthy years (or decades) to our current

lifespans shouldn't either.²

Let's start with the most common concern, and I think the most serious: population growth. This is often referred to as 'overpopulation', and my first problem with this is the word itself. Overpopulation suggests that our concern is too many people, when actually the issue is the amount of resources we use. Already at current population levels we're putting huge pressure on the climate, land, water and ecosystems and, yes, more people will put more pressure.

My first response is that addressing this is something we desperately need to do anyway. We are already outside the 'carrying capacity' of the Earth, and we need to scale back our impact on it to avoid disaster. Not only that, but use of our resources is shared incredibly unequally: the richest 10% of people are responsible for around half of global carbon dioxide emissions (and the rich world bears significantly more responsibility than this, if you take into account the historical emissions on which our current wealth was built). The same is true of land use, resource extraction, pollution and so on: rich countries and rich people have by far the most resource-intensive lifestyles, and place the largest burden on our planet as a result.

This sets us a challenge: if we want to offer the whole world a 'Western' quality of life, we're going to have to work out how to do so with a far lower per capita footprint on the planet, and fast. Continuing improvements in crop yields and clean energy technology will help, but it would be naïve to imagine that this won't require some significant social and economic changes too. These measures would be required even if the population *shrinks*—the rich world alone has a big enough environmental footprint to trash the planet.

Would curing ageing make this substantially harder? We can do some simple calculations with population forecasts to find out. The UN's 'medium variant' prediction estimates that global population will be 9.8 billion in 2050. Let's imagine a complete cure of ageing, by 2025. (This is, of course, ludicrous—not only is the timescale absurd scientifically, but we're assuming instantaneous rollout of whatever treatments are developed to the entire population.) In this 'worst' case, the population in 2050 would be 11.3 billion—16% larger than had we not defeated ageing.

Is that a lot? I don't think so—I'd happily work 16% harder to solve environmental problems if it meant no more suffering from old age. And, of course, we're likely to have to work rather less hard than that. A study considering a more realistic scenario, that ageing could be cured by 2040, found that the population would be just over ten billion in 2050, and 14.8 billion in 2100. That's high, but it's not ridiculous—and, because there will be more of us, the economy will be larger, and because we'll be healthier, health and social care costs would be lower, freeing up money that used to be spent trying to save people to save the planet.

²What this means isn't no death at all—there will still be buses to be hit by, infectious diseases, and even things like cancer and heart attacks, just at much lower rates than today. (Even biologically immortal creatures ultimately die.)

If you're still worried about the risk of too many people, there is a far less cruel method to curb human numbers than letting people die of old age—reducing birth rates. This is something which is already happening naturally, thanks to what's known as the demographic transition: a global shift from high birth and death rates to both being low. As death rates fall, especially child mortality, women tend to have fewer children. Chapter 1 of *Ageless* discusses the rapid reductions in death rates around the world, leading to dramatic increases in life expectancy.

The world fertility rate has plummeted in recent decades, from 5.0 in 1950 to 2.4 children per woman today—only slightly above replacement levels. As countries get richer, women tend to both reduce the number of children they have, and have them later: in the UK, a woman is now more likely to give birth aged over 40 than under 20. Currently, about half of the global population lives in countries with fertility rates below replacement levels. If not for migration, their populations would be in long-term decline. For example, the average fertility across the EU is 1.5—and every single EU member state comes in below 2.0. Better education and job prospects for women, reductions in child mortality and increased wealth all reduce birth rates—a far more palatable way to slow global population growth than letting old people suffer and die.

Ultimately, treating ageing should also extend the time when women can have children—potentially indefinitely. In this scenario, it seems likely that the existing trend of women deferring pregnancy would continue. Having a child is disruptive to a woman's career, or whatever her plans are in her 20s and 30s, and the burden of child rearing continues to fall disproportionately on women despite improvements in shared parental leave and pay. If there's no rush biologically, why not wait another few years? At a minimum, this should delay population growth, buying us time to solve environmental issues. Whether it would mean fewer children overall (perhaps because fewer people ever get around to having them without the time pressure) or more (simply because lives are much longer) is much harder to say. What's certain is that alleviating reproductive ageing would give women flexibility that is currently denied to them biologically. I'd go so far as to argue that treating ageing should be characterised as a feminist issue.

Because birth rates have such a large effect on future population, uncertainties about the future trajectory of fertility causes population estimates to be highly uncertain: the UN's high and low variants suggest that the population in 2100 could vary by four or five billion either way, just by slightly varying birth rate. Another prominent population model from the Institute for Health Metrics and Evaluation suggests that the global population will peak somewhere around mid-century and drop back to roughly current levels by 2100 under many scenarios.³ Indeed, many serious demographers

³It's actually quite fascinating how uninterested these highly respected population models are in the future trajectory of life expectancy. While modelling various scenarios for birth rates, both assume that life expectancy increases will slow down substantially—an assumption that has been repeatedly proved wrong in the past, and which could be entirely upended by successes in medicines for ageing.

are worrying about *under*population. Thus, if you're feeling really optimistic, an excellent scenario might be that rapid improvements in wealth, education and equality in low-income countries lead to a collapse in birth rates, and significant medical advances against ageing save us from an underpopulation crisis by keeping people alive and healthy for longer. In a less optimistic scenario, having fewer children remains a better option than letting people age to death just to make space for new people.

Finally, a larger population isn't necessarily a bad thing. Having more people on Earth would have intrinsic benefits that are often overlooked. More people mean more potential for happiness and human flourishing. A larger population means more great artists, musicians and scientists, and more people to appreciate their works. The acceleration of human progress simply by more of us working towards our common goals means that our civilisation could advance further and faster, and more people would be alive to benefit. (The study of questions like these is known as 'population ethics.')

Even with the environmental challenges, which we're going to have to solve anyway, more people could well be a good thing overall depending on your ethical outlook.

Probably the second most common concern about treatments for ageing is inequality of access. Could anti-ageing pills, and especially more advanced and expensive treatments like gene or stem cell therapies, only be available to the rich? Depending on the cost, this could mean just those of us in high-income countries increase our lifespan, leaving poorer nations in the dust—or creating a dystopian cabal of immortal billionaires.

The first thing to note is that these two most popular objections to ageing research are mutually exclusive—if only a handful of super-wealthy people get to enjoy these therapies, then curing ageing cannot also precipitate a population crisis.⁴

Nonetheless, even if wild inequality would defuse the population bomb, there are good ethical reasons to hope that anti-ageing medicine is available more widely. How likely is this to happen?

First off, it's quite normal for all kinds of goods to be used by rich people in rich countries before being accessible globally. This is already true of medicines from basic vaccines and antibiotics to cutting-edge cancer drugs: while the former are now available in most parts of the world,⁵ expensive new treatments for cancer are unlikely to be found in clinics in the developing world any time soon. There is good reason to campaign for wider access to advanced treatments and to pursue research into neglected health problems which are particularly found in poorer countries—but bashing biogerontology doesn't advance either agenda.

⁴Holding multiple contradictory, pessimistic beliefs simultaneously is something to guard against in general when considering the future—one of my favourite examples is pessimism that one's generation will never retire coupled with the belief that robots will take all of the jobs.

⁵The global vaccination rate for diphtheria, tetanus and pertussis was 85% in 2019, and diseases from hepatitis B to measles boasted rates over 70%. Unfortunately, coronavirus will have impacted on these figures—rich countries are hoarding covid vaccines, and the pandemic has hit other vaccine programmes too—but the picture is still substantially rosier than many of us imagine.

Thankfully, this process of wider distribution of medicines is helped along both by rising global wealth and most drugs getting cheaper over time. Drug prices are partly governed by the system of patents, which gives companies exclusive rights to produce a particular drug or product for a period before allowing others to manufacture and sell it. Patents last twenty years, with a few caveats, meaning that pharmaceutical companies have a limited time to recoup their research costs; this is one reason why new drugs and treatments are often so expensive initially. Once they go off-patent and 'generic' versions can be produced, prices usually fall significantly.

It's also worth considering how expensive these treatments could actually be. Drugs which can be mass-produced as tablets are often very cheap to manufacture—metformin and off-patent statins, for example, cost cents per dose. The bigger worry is more complex therapies, which can cost far more than this. For example, a cancer treatment known as CAR-T cell immunotherapy has recently been making headlines for seeming to entirely eradicate blood cancers in some patients—and for costing almost \$500,000 per course. If treatments this expensive were needed on, say, an annual basis, it would be fair to surmise that only the mega-rich could afford them.

However, costs at this level are unlikely to continue. Firstly, the actual manufacturing cost of the therapy—which involves extracting a patient's immune cells, genetically modifying them, and reinfusing them back into the patient again—is probably 'only' a five-figure sum, rather than six. The full price incorporates recouping research and development costs by the drug company, profit, and a premium thanks to the largely private US healthcare system—the NHS in the UK has also started offering this treatment, paying an undisclosed sum per course which is less than the US sticker price.

The five-figure cost of CAR-T cell therapy comes because the procedure is still entirely manual, almost artisanal: highly-trained technicians, one literally watching over the other's shoulder to double-check how many drops of chemicals they are adding to cells in a flask. (These stringent standards are applied because there's a very high bar for safety and consistency for products destined to be used in people.) The therapy is brand new, taking its first baby steps outside the research lab environment where it was developed—if it turns out that the applicability of this kind of cell therapy is broader than the few cancers it's been tried on so far, it is inconceivable that manufacturing costs will remain this high. This process is crying out for automation, which will make the therapy both far cheaper, and probably more consistent too.

CAR-T therapy and its ilk sit at the pinnacles of both expense and complexity—nothing discussed in *Ageless* is more involved than taking out cells, modifying them, and putting them back again afterwards. If these therapies cost tens of thousands while at the bleeding edge, I'm optimistic: it suggests that even the priciest treatments should cost thousands rather than millions. Therapies against ageing are also likely to be assisted by tremendous economies of scale. Because the market is literally everyone, rather than sufferers of a specific kind of cancer, there is both a greater impetus to optimise mass production, and a much larger population over which to recoup up-front costs. Naturally there is potential for some therapy not yet even on

the drawing board to be more expensive than we can conceive today—but calling off ageing research thanks to a hypothetical risk of ludicrously pricey treatments seems premature.

The other factor (which we've already mentioned) is that treating ageing will mean there's quite a bit more money to go around. The current cost of dementia, which includes health and social care, plus indirect costs of the sufferers being forced to give up work, or friends and relatives reducing their working hours to help take care of them, is estimated to be over \$1 trillion worldwide, rising to \$2 trillion by 2030. And dementia is just one of dozens of age-related conditions. Alleviating even a fraction of the economic burden of these diseases would free up tens or hundreds of billions of dollars a year to cover the cost of the anti-ageing treatments that helped eliminate them. This also provides the incentive for governments to ensure these treatments are available to more than just the mega-wealthy—savings on healthcare costs and the benefits to the wider economy of keeping people healthy, active, working and spending will pay back the cost of their treatments.

There's also a reasonable case to be made that tackling ageing medically could help the world's poorest. Global life expectancy is over 70 years, which means that most people in most countries will grow old enough to experience the diseases and dysfunctions of old age. Over half of dementia sufferers live in low- or middle-income countries—a figure that is projected to increase to two thirds by 2050, totalling 90 million people. And again, these are the figures for just one age-related disease.

These poorer countries' healthcare systems simply lack the money and the infrastructure to deal with their ageing populations. We've been victims of our own success at improving global health: poorer countries around the world have had the good fortune to improve lifespans by rapidly rolling out cheap, successful interventions for 'easy' health issues, like infectious disease. Along with vaccines and antibiotics, one of the greatest triumphs in global health is basically salty, sugary water to rehydrate children with diarrhoea: this costs almost nothing, and is thought to have saved around 70 million lives. However, innovations like this mean that life expectancy gains have outpaced economic growth: these countries are now dealing with a booming cohort of older people, but without the cash to cope with the burden of expensive chronic diseases.

In high-income countries, life expectancy averages 81 years, and spending on healthcare averages over \$5000 per person per year. Globally, most people live in middle-income countries, which have an average life expectancy of 72—but an average GDP per capita of...\$5000 per year. Healthcare at the level familiar in rich nations is, therefore, obviously untenable. This is an oversimplification (for example, labour costs are lower in poorer countries, which means doctors and nurses are cheaper), but it gives a sense of the scale of the problem: it will take decades of economic growth to solve it the old-fashioned way. Even more so than the rich world, poorer nations could benefit from treatments for ageing to avert a looming crisis in their healthcare systems—and

it will be the moral duty of the rich world to ensure universal access.⁶

Finally, it's also possible to use treatments for ageing to address within-country inequalities. Headline life expectancies of 80-plus years in the rich world mask huge variations between regions within those countries, driven in large part by socioeconomic factors. While the interaction between poverty and health is incredibly complex, the end result from a biological perspective is that the less wealthy essentially age faster than the better-off. Higher rates of smoking, alcohol consumption, obesity, inactivity and so on, driven by a constellation of social factors, cause the same biological changes as accelerated ageing. This means that ensuring wide access to treatments for ageing would be a valuable adjunct to other policies aimed at reducing inequality.

Having examined the objections to treating ageing that deal with data—population growth and unequal access—it's time to turn to those that are more political and philosophical in nature. Would treating or curing ageing change what it means to be human, or change societies and governments in ways that numerical predictions fail to capture?

One common worry is perpetual totalitarianism—in a world without ageing, wouldn't dictators live forever? Of course, the answer is that, technically, yes, they could. However, the data suggest that this wouldn't be as much of a problem as it sounds. If you look at causes of death for dictators, they are one of a handful of groups for whom ageing doesn't top the list. Far more common is being killed by a peer who fancies the top job, or dying in a military coup. In fact, one calculation suggested that completely curing ageing would only add 3.6 years to a dictator's life expectancy. Aspiring autocrats in a post-ageing world would be well advised to seek a safer line of work.

The immortal dictator is one of the ethical objections that sounds most ridiculous when considered in reverse: in an ageless world, would you invent ageing to solve this problem? Even the nastiest rulers rarely exact as much suffering on their people as the ageing process. And it's not entirely obvious that death from ageing would topple a totalitarian regime, even if it gets rid of the individual leader. Removing totalitarian governments is genuinely difficult, and ageing is ill-suited to the task.

Worrying about immortal dictators is also a classic example of concentrating on the negative consequences over the positive: why do we focus on despots, rather than on great leaders or artists who could inspire more people for longer, perhaps with even greater works thanks to their additional accumulated experience? What about scientists uncovering new truths about the universe that only become accessible after 100 years mastering their craft? Since there are far more creative people than tyrannical leaders, an ageless society would very likely be far better on balance—and we'd all be around much longer to enjoy it.

Perhaps a greater worry than immortal tyrants is a tyranny of undying ideas. Is it the case, as physicist Max Planck once quipped, that science makes progress funeral by

⁶Thankfully, ageing is a slower-moving problem than vaccines in a pandemic, giving us more time to ramp up both production and advocacy to reduce the risk of rich nations hoarding the drugs.

funeral?⁷ Do new ideas (and perhaps not just in science) ultimately triumph not by convincing the old guard, but by allowing them to die off and be replaced by a new guard unfettered by old ways of thinking?

Sociologists and economists have tried to establish whether deaths really do catalyse scientific progress, with mixed results. In the context of huge paradigm shifts of the sort Planck (as one of the key figures in paradigm-busting quantum mechanics) was presumably referring to, evidence of adherence to the old ways is weak. This is perhaps because, if the new paradigm is more explanatory and provides better results, there is a strong incentive to switch to it, however reticent or nostalgic you may be at first. On the level of more everyday scientific discoveries and turf wars, a clever large-scale analysis of papers and citations of eminent researchers who died prematurely found that their loss left a vacuum that was often filled by outsiders who brought new ideas into the field—but at a cost to the late scientists' collaborators, meaning that overall scientific output was unchanged. It's unclear whether this is a good or a bad thing; whether progress is better served by new ideas or deeper exploration of old ones is complex and probably context-specific.

If indeed this is a problem, in science or more broadly, the most obvious solution is term limits. Just as politicians in democracies are often restricted to serve a particular number of fixed-length terms, so too could other influential jobs come with a time-limited tenure. How long this should be is of course open to debate—but, given that this effect is visible today, the optimal length may be shorter than contemporary academic careers! This is another occasion where considering a cure for ageing illuminates an issue that we perhaps ought to be taking more seriously already.

Progress-by-funeral theory can be broadened to encompass changes in social attitudes and is euphemistically known as 'cohort replacement': change because previous generations with particular views die, leaving behind younger generations with different attitudes. Attempts to discern this effect suggest that it's a bit more complicated than that. Attitudes to homosexuality have improved because of both cohort replacement and increased acceptance within older cohorts. Conversely, the increasing overall acceptance of sex before marriage has been slightly diluted by older people hardening their views against it.

One piece of research looking at support for government spending to combat climate change found that it decreases with age, regardless of whether you were born in the 1920s or the 1970s, and there is little evidence that cohort replacement is driving change in desire for environmental action. Other studies, asking slightly different questions, find conflicting results. Surveys that look for a cohort effect also find large influences from socioeconomic status and education level; as common as generalising about 'Boomers' or 'Millennials' seems to be, our social and political views and behaviours aren't just a product of our birthdate.

⁷This particular pithy formulation is actually down to economist Paul Samuelson—a Nobel-memorial-prizewinning economist rephrasing a Nobel-prizewinning physicist, meaning this quote has quite the pedigree.

Ultimately, a reliance on death to catalyse social change and scientific progress is lazy, takes a dim view of humanity, and probably isn't enough: even if generational differences in views on climate change *were* significant, we can't wait a generation or two before we cut emissions—we have to start now to avoid catastrophe. Whether you care about the climate; equal rights for people of different races, genders and sexualities; research into medicine to tackle ageing; or all of the above, we'd better hope it's possible to win people over with strong arguments, rather than waiting around for younger hearts and minds to take their place.

There is another aspect of this debate to consider. Even if more detailed research somehow established that older people are set in their ways, that would not be a problem in our scenario, since any treatments addressing the biology of ageing will almost inevitably restore our minds to their youthful agility. Ageing of the brain is driven by the same processes as the rest of the body and, as we've seen, lab experiments with ageing treatments on mice often demonstrate an improvement in cognition alongside other changes. Indeed, it doesn't seem too much of a stretch to imagine that a biologically youthful, agile mind combined with a few extra decades of experience could provide the best of both worlds, leading to a better society rather than a worse one.

There are also reasons to believe that curing ageing would make society better in less direct ways, like helping all of us value life itself more than we do at present. If we lived 200 years, what are currently leading causes of death in youth would become the leading causes of death overall. Helping people at risk of suicide and preventing road accidents would take on a new importance: if dying in a car crash at 30 would rob someone of 170 years of life, that would provide a strong incentive to improve vehicle safety, or to encourage people into safer forms of transport. War and murder, too, would become even less tolerable than today as their cost in years of healthy life exploded. This new actuarial calculus could mean the world becomes an ever-safer and more pleasant place to live.

It's also possible that longer life expectancies might lead to less short-term thinking, as we'll all be around to see more of the consequences of long-term problems. This is actually one idea of which I'm sceptical (just to prove I'm not entirely starry-eyed about the prospects of a world without ageing). Individual humans often make decisions that aren't in their own long-term best interests (including many which will impact our health in old age); we are already incentivised to care about such issues by their impact on our children and grandchildren; and long-run wisdom is also handicapped by short-termism inherent in the structures of institutions, from companies designed to please shareholders, to governments with elections spaced every few years. There are lots of reasons to believe that there would be substantial inertia in the time horizon of human decisionmaking. All that said, any impact from curing ageing is likely to be at worst neutral, and could be slightly positive—it would be strange indeed if longer lives made short-termism worse.

On an individual level, people are often concerned about the psychological impacts of vastly extended lives: boredom, how we'd cope with all the memories, and so on.

These worries enter the realm of pure speculation—the absence of any 200-year-olds to ask means that we simply can't know whether you'd be crushed under the weight of two centuries' worth of wisdom. However, the answer is surely obvious if we reverse the question: in an ageless society, if things were getting a bit tedious for you around the 180-year mark, would you really impose ageing to death on yourself and all your fellows to alleviate it?

Besides, why might someone expect they'd get bored? There are already far more interesting and joyful experiences available on Earth—places to visit, books to read, music to listen to, people to meet—than it is possible to conceive of, let alone actually do in a current lifespan. There are nearly 200 countries in the world—even visiting two a year, you'd be lucky to squeeze them all in. And that assumes that humanity and technology will stand still: what incredible multisensory experiences might brain-computer interfaces enable in the year 2300? How much fun will there be to be had exploring the moons of Jupiter? Unless you somehow get bored with the very essence of being alive itself, it's hard to imagine running out of stuff to do, even if you lived for centuries.

As for memories, it seems unlikely that our brains can actually store hundreds of years' worth of experience at more than a summary level. Given how hazy my memories are of my first day of school, or university, or even work, it's pretty clear to me that my brain is fairly sparing when cutting its highlights reel. I'm more fascinated than terrified to find out what eclectic combination of trivia and major life events I might still remember if I lived to 150, or even 1000—but it seems pretty likely that our brains' ruthless editing would leave enough forgotten to keep us sane.

This kind of speculation also neglects how, by and large, we live our lives day to day. It's not like we never make plans about the future—from booking a holiday months in advance, to dreaming of moving to the country when the kids leave home—but, by and large, we live in the present. Most people don't have a forty-year plan and, if you do, it's worth keeping it provisional so you can adapt to changing circumstances. What if you fall in or out of love, get a job offer you can't refuse, or learn something that changes your whole perspective on life? I suspect that even an indefinite lifespan would be less different to our current one than we think—after all, even though most of us can already look forward to 80-plus years, we rarely consider their full arc all at once.⁸

Living longer will have to change our life course in some ways. There's no way anyone would stick with the same career for 150 years, for example; it's quite likely that the job you started after university wouldn't *exist* a century later. However, again, this is probably something we'll need to address even if we don't make significant headway against ageing, with lifespans expected to top 100 years for children born in rich countries since the year 2000: someone living 80 years might expect a 40-year career, bookended by 20 years of training, and 20 of retirement; someone living to 100 with

⁸This is the same basic reason that I'm sceptical that longer lives would lead to improvements in long-term planning at a societal level, as mentioned above.

a similar life plan would work for 60 years, and in a world where jobs and technology are moving far more rapidly than in the past. (I discuss the idea of periodic retraining and career changes in Chapter 1 of *Ageless*—and it also fits neatly with the idea of term limits discussed previously.) There are also obvious issues with the existing model of pensions and saving for retirement: retiring at 65 or even 80 might be economically untenable if people routinely retire for as long again. If we could live for 150 or 200 years, it's hard not to imagine a cyclical process interleaving work, retraining and periods of temporary retirement. Or maybe the robots will take all our jobs, leaving us to enjoy virtual reality and the moons of Jupiter?

And what about death itself? Curing ageing would extend our healthy lives—and mean that there was much less dying happening around us. How would a reduction in death alter what it means to be human?

Some people argue that death gives life meaning—a final end is what allows the beginning and middle before it to have context and purpose. Bluntly, I think this is nonsense. People may want to leave a legacy—a body of work, a happy family, a successful company or a life well-lived—but you don't need to die to do those things. It's not even obvious that death is an intrinsic motivator to succeed at them. When you last went for a promotion, asked someone out on a date, or did a good deed, did you do so because you knew that death was bearing down on you several decades hence? If anything, death could be construed as a demotivator—an incentive to cash out, stop striving, and spend a few years enjoying what you've earned before mortality overtakes you. Ageing doubles down on this, giving you the knowledge that one day you might be alive, but no longer capable of playing with your grandkids, travelling, or taking up a new hobby. The solution we've come up with for this is, of course, retirement. But deferring frailty and the end of life would free us to do more of what we want, at our own pace. If you want to save up and spend a few years 'retired' before going back to work in your 80s, why not? The idea that death gives life meaning sounds poetic, but it doesn't stand up to scrutiny.

In fact, I'd go further than that. Death is terrible. Every death is a tragedy. I would be unreservedly happy if there was less of it. I don't want to die, and nor do I want any of my family, friends, or indeed anyone else to have to do so any sooner than is absolutely necessary. I'm shocked by how controversial an opinion this sometimes seems to be. When someone dies, their personality, relationships, knowledge and wisdom all die with them. It is a tragic loss for the family, friends and community they leave behind. We do need to acknowledge and accept the phenomenon of death, but it's not necessary to twist logic and emotion and pretend it's a good thing. People rarely seem to make this argument in the context of war, car accidents, cancer treatment, or even any individual death ('I'm so glad she died—it really gave her life meaning'); but lots of people seem to defend death when discussing ageing.

Of course there are good reasons to be resigned to dying, as we saw in the surveys of desired life expectancy which I quoted at the start of this chapter. Whether struggling on in ill health, hugely dependent or in constant pain, given the current realities of age-

ing, it's hard to blame anyone for eventually wanting life to come to an end. Dementia could be even worse, memories disappearing, forgetting those closest to you and losing the very essence of what makes you, you. And, if you are one of the 'lucky' few to survive into your 90s or beyond, your reward is watching your friends and loved ones suffer and die, eventually leaving you to struggle on, deeply isolated, to face ageing and death alone.

However, if we cured ageing, none of these would apply; you would be less frail, have less chance of illness and dementia, and so too would friends and family. If you were still young in body, sound in mind, and socially engaged, why would you want to die? It's possible that you still would at some point, but it seems arbitrary to argue that this desire would arrive on schedule at the upper end of current human life expectancy. And, even if you did one day want your life to come to an end, ageing surely wouldn't be the way you'd choose to do it.

There is a lot to discuss when it comes to the ethics of curing ageing but my biggest surprise in doing so has been how often the idea of curing ageing makes us defensive of the status quo. My goal in this chapter has been to help point to changes that are undeniably good. The most obvious is eradicating the single largest contemporary source of human suffering, but plenty of the 'side effects' could be positive, too: a larger population more able to flourish; help for countries both rich and poor to avert a demographic crisis; helping us value life more; and freeing up resources to reduce other causes of human suffering.

It's also worth pointing out that clinging to the status quo is futile. We often tend to assume that life in the future will look pretty much the same as it looks now, just with slightly faster computers and bigger TVs. When we do attempt to envision future technology, we are catastrophically bad at it: for all the predictions of flying cars, silver jumpsuits and moonbases, virtually no-one anticipated the smartphone, at once more mundane and more transformative. Who knows what innovations will make our world unrecognisable over the next century? Or what social, economic and geopolitical transformations we might go through in the intervening time? Imagine trying to explain how we got to the present day to a time traveller from the 1920s. I suspect if you were put in suspended animation until 2122, youthful-looking 150-year-olds wandering around would be one of the less alien changes. And, if you do live through the ageing revolution, I suspect you'll acclimatise so seamlessly to the improving status quo that it might be almost imperceptible.

Curing ageing would change and vastly improve what it means to be human. But, once it's cured, preventative anti-ageing medicine will seem as familiar as cars, computers and air travel do now, and it will be just as hard to imagine a world before it. The annual check-up with our gerontologist will be as normal as a visit to the dentist; we'll wash down healthspan-enhancing pills and supplements with a gulp of morning coffee; a once-a-decade hospital stay for a stem cell infusion will seem serious but routine, more like giving birth than open-heart surgery.

Technological progress has always caused social change, but societies grow and adapt,

A world without ageing

embracing the positive changes and trying, in our flawed, circuitous and human way to use regulations, taxes and social norms to minimise any problems that arise. This isn't without challenge but I'm sure not many of us would prefer to live as peasants in the 16th century, or hunter-gatherers in 25,000 BCE, than in the present day. It's even harder to believe that many living in an ageless society in the year 2200 will pine for the good old days when people could slowly deteriorate to death at the ripe young age of 80.

Life in a post-ageing world will be very different to life now and, given the rapid progress in the science that could make this possible, we'd do well to devote more energy planning for it. But the most important difference in a world without ageing will also be the simplest: an incalculable decrease in human suffering due to frailty and disease. This should be our next great biomedical mission.

If you haven't already read it, *Ageless: The new science of getting older without getting old* explains the science that makes success in this mission possible. You can find out more at ageless.link. If you have read it, thank you for sticking with me all the way to the end of this bonus chapter!