FROM THE BESTSELLING AUTHOR OF *SAPIENS*

Yuval Noah Harari

Homo Deus

A Brief History of Tomorrow

Contents

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ABOUT THE BOOK

Yuval Noah Harari, author of the bestselling *Sapiens: A Brief History of Humankind*, envisions a not-too-distant world in which we face a new set of challenges. In *Homo Deus*, he examines our future with his trademark blend of science, history, philosophy and every discipline in between.

Homo Deus explores the projects, dreams and nightmares that will shape the twenty-first century – from overcoming death to creating artificial life. It asks the fundamental questions: Where do we go from here? And how will we protect this fragile world from our own destructive powers? This is the next stage of evolution. This is *Homo Deus*.

War is obsolete
You are more likely to commit suicide than be killed in conflict

Famine is disappearing
You are at more risk of obesity than starvation

Death is just a technical problem
Equality is out – but immortality is in

What does our future hold?

ABOUT THE AUTHOR

Dr Yuval Noah Harari has a PhD in History from the University of Oxford and now lectures at the Hebrew University of Jerusalem, specialising in World History. His books *Sapiens*, *Homo Deus* and *21 Lessons for the 21st Century* have become an international phenomenon.

ALSO BY YUVAL NOAH HARARI

Sapiens: A Brief History of Humankind
21 Lessons for the 21st Century

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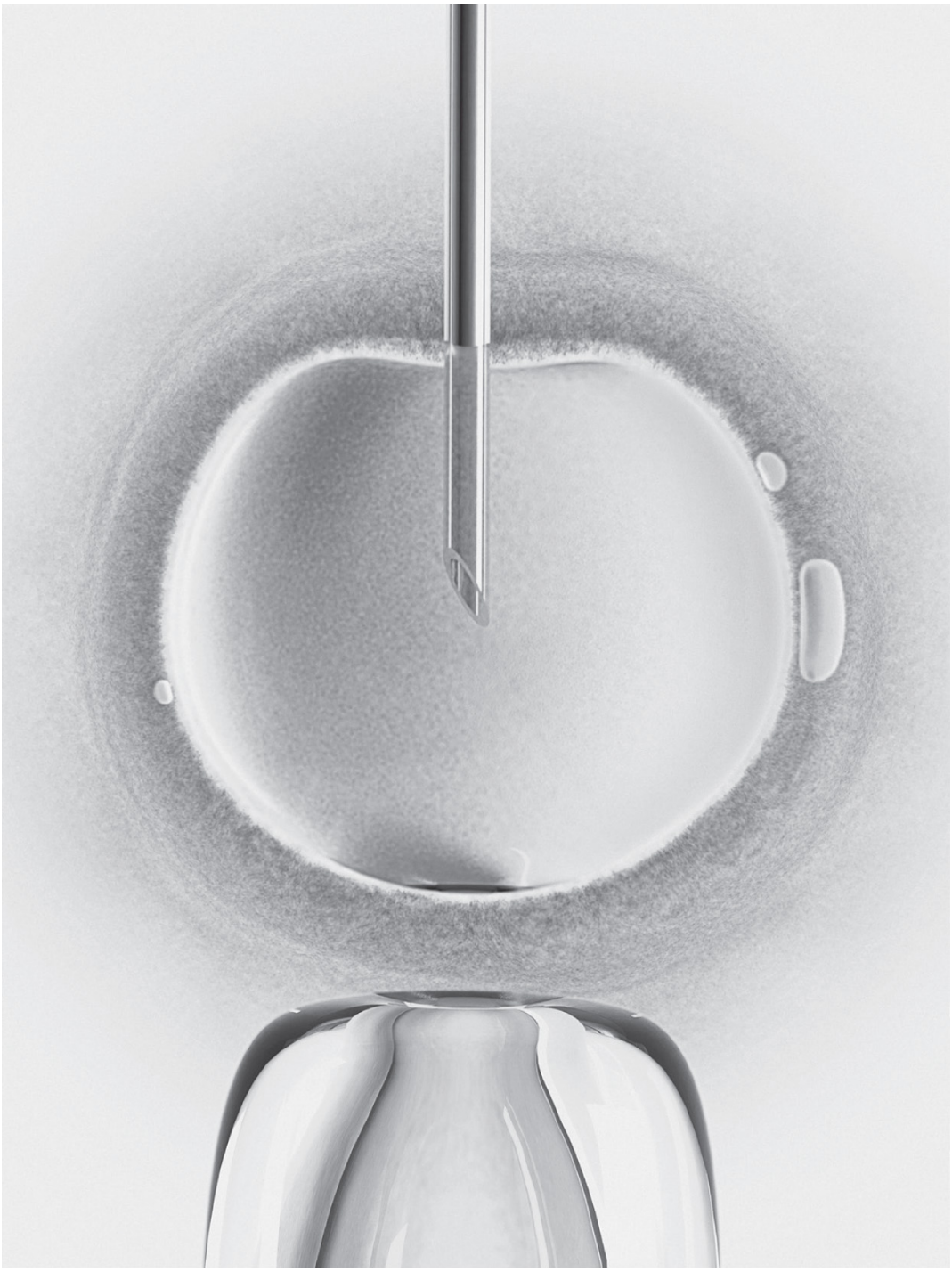
To my teacher, S. N. Goenka (1924–2013), who
lovingly taught me important things.

YUVAL NOAH HARARI

Homo Deus

A Brief History of Tomorrow

VINTAGE



1. *In vitro* fertilisation: mastering creation.

1

The New Human Agenda

At the dawn of the third millennium, humanity wakes up, stretching its limbs and rubbing its eyes. Remnants of some awful nightmare are still drifting across its mind. ‘There was something with barbed wire, and huge mushroom clouds. Oh well, it was just a bad dream.’ Going to the bathroom, humanity washes its face, examines its wrinkles in the mirror, makes a cup of coffee and opens the diary. ‘Let’s see what’s on the agenda today.’

For thousands of years the answer to this question remained unchanged. The same three problems preoccupied the people of twentieth-century China, of medieval India and of ancient Egypt. Famine, plague and war were always at the top of the list. For generation after generation humans have prayed to every god, angel and saint, and have invented countless tools, institutions and social systems – but they continued to die in their millions from starvation, epidemics and violence. Many thinkers and prophets concluded that famine, plague and war must be an integral part of God’s cosmic plan or of our imperfect nature, and nothing short of the end of time would free us from them.

Yet at the dawn of the third millennium, humanity wakes up to an amazing realisation. Most people rarely think about it, but in the last few decades we have managed to rein in famine, plague and war. Of course, these problems have not been completely solved, but they have been transformed from incomprehensible and uncontrollable forces of nature into manageable challenges. We don’t need to pray to any god or saint to rescue us from them. We know quite well what needs to be done in order to prevent famine, plague and war – and we usually succeed in doing it.

True, there are still notable failures; but when faced with such failures we no longer shrug our shoulders and say, ‘Well, that’s the way things work in our imperfect world’ or ‘God’s will be done’. Rather, when famine, plague or war break out of our control, we feel that somebody must have screwed

up, we set up a commission of inquiry, and promise ourselves that next time we'll do better. And it actually works. Such calamities indeed happen less and less often. For the first time in history, more people die today from eating too much than from eating too little; more people die from old age than from infectious diseases; and more people commit suicide than are killed by soldiers, terrorists and criminals combined. In the early twenty-first century, the average human is far more likely to die from bingeing at McDonald's than from drought, Ebola or an al-Qaeda attack.

Hence even though presidents, CEOs and generals still have their daily schedules full of economic crises and military conflicts, on the cosmic scale of history humankind can lift its eyes up and start looking towards new horizons. If we are indeed bringing famine, plague and war under control, what will replace them at the top of the human agenda? Like firefighters in a world without fire, so humankind in the twenty-first century needs to ask itself an unprecedented question: what are we going to do with ourselves? In a healthy, prosperous and harmonious world, what will demand our attention and ingenuity? This question becomes doubly urgent given the immense new powers that biotechnology and information technology are providing us with. What will we do with all that power?

Before answering this question, we need to say a few more words about famine, plague and war. The claim that we are bringing them under control may strike many as outrageous, extremely naïve, or perhaps callous. What about the billions of people scraping a living on less than $2 a day? What about the ongoing AIDS crisis in Africa, or the wars raging in Syria and Iraq? To address these concerns, let us take a closer look at the world of the early twenty-first century, before exploring the human agenda for the coming decades.

The Biological Poverty Line

Let's start with famine, which for thousands of years has been humanity's worst enemy. Until recently most humans lived on the very edge of the biological poverty line, below which people succumb to malnutrition and hunger. A small mistake or a bit of bad luck could easily be a death sentence for an entire family or village. If heavy rains destroyed your wheat crop, or robbers carried off your goat herd, you and your loved ones may well have

starved to death. Misfortune or stupidity on the collective level resulted in mass famines. When severe drought hit ancient Egypt or medieval India, it was not uncommon that 5 or 10 per cent of the population perished. Provisions became scarce; transport was too slow and expensive to import sufficient food; and governments were far too weak to save the day.

Open any history book and you are likely to come across horrific accounts of famished populations, driven mad by hunger. In April 1694 a French official in the town of Beauvais described the impact of famine and of soaring food prices, saying that his entire district was now filled with 'an infinite number of poor souls, weak from hunger and wretchedness and dying from want, because, having no work or occupation, they lack the money to buy bread. Seeking to prolong their lives a little and somewhat to appease their hunger, these poor folk eat such unclean things as cats and the flesh of horses flayed and cast onto dung heaps. [Others consume] the blood that flows when cows and oxen are slaughtered, and the offal that cooks throw into the streets. Other poor wretches eat nettles and weeds, or roots and herbs which they boil in water.'[1]

Similar scenes took place all over France. Bad weather had ruined the harvests throughout the kingdom in the previous two years, so that by the spring of 1694 the granaries were completely empty. The rich charged exorbitant prices for whatever food they managed to hoard, and the poor died in droves. About 2.8 million French – 15 per cent of the population – starved to death between 1692 and 1694, while the Sun King, Louis XIV, was dallying with his mistresses in Versailles. The following year, 1695, famine struck Estonia, killing a fifth of the population. In 1696 it was the turn of Finland, where a quarter to a third of people died. Scotland suffered from severe famine between 1695 and 1698, some districts losing up to 20 per cent of their inhabitants.[2]

Most readers probably know how it feels when you miss lunch, when you fast on some religious holiday, or when you live for a few days on vegetable shakes as part of a new wonder diet. But how does it feel when you haven't eaten for days on end and you have no clue where to get the next morsel of food? Most people today have never experienced this excruciating torment. Our ancestors, alas, knew it only too well. When they cried to God, 'Deliver us from famine!', this is what they had in mind.

During the last hundred years, technological, economic and political developments have created an increasingly robust safety net separating

humankind from the biological poverty line. Mass famines still strike some areas from time to time, but they are exceptional, and they are almost always caused by human politics rather than by natural catastrophes. There are no longer natural famines in the world; there are only political famines. If people in Syria, Sudan or Somalia starve to death, it is because some politician wants them to.

In most parts of the planet, even if a person has lost his job and all of his possessions, he is unlikely to die from hunger. Private insurance schemes, government agencies and international NGOs may not rescue him from poverty, but they will provide him with enough daily calories to survive. On the collective level, the global trade network turns droughts and floods into business opportunities, and makes it possible to overcome food shortages quickly and cheaply. Even when wars, earthquakes or tsunamis devastate entire countries, international efforts usually succeed in preventing famine. Though hundreds of millions still go hungry almost every day, in most countries very few people actually starve to death.

Poverty certainly causes many other health problems, and malnutrition shortens life expectancy even in the richest countries on earth. In France, for example, 6 million people (about 10 per cent of the population) suffer from nutritional insecurity. They wake up in the morning not knowing whether they will have anything to eat for lunch; they often go to sleep hungry; and the nutrition they do obtain is unbalanced and unhealthy – lots of starch, sugar and salt, and not enough protein and vitamins.[3] Yet nutritional insecurity isn't famine, and France of the early twenty-first century isn't France of 1694. Even in the worst slums around Beauvais or Paris, people don't die because they have not eaten for weeks on end.

The same transformation has occurred in numerous other countries, most notably China. For millennia, famine stalked every Chinese regime from the Yellow Emperor to the Red communists. A few decades ago China was a byword for food shortages. Tens of millions of Chinese starved to death during the disastrous Great Leap Forward, and experts routinely predicted that the problem would only get worse. In 1974 the first World Food Conference was convened in Rome, and delegates were treated to apocalyptic scenarios. They were told that there was no way for China to feed its billion people, and that the world's most populous country was heading towards catastrophe. In fact, it was heading towards the greatest economic miracle in history. Since 1974 hundreds of millions of Chinese

have been lifted out of poverty, and though hundreds of millions more still suffer greatly from privation and malnutrition, for the first time in its recorded history China is now free from famine.

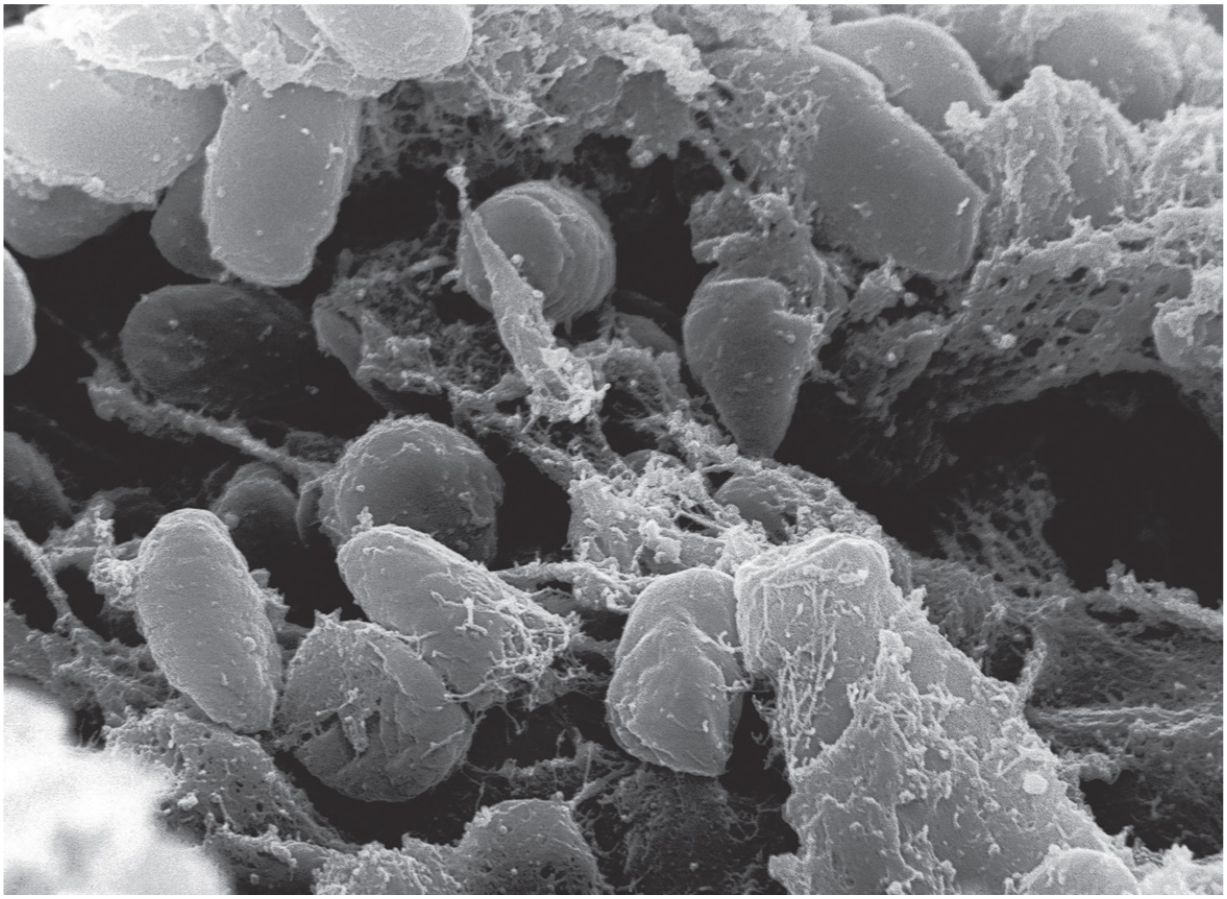
Indeed, in most countries today overeating has become a far worse problem than famine. In the eighteenth century Marie Antoinette allegedly advised the starving masses that if they ran out of bread, they should just eat cake instead. Today, the poor are following this advice to the letter. Whereas the rich residents of Beverly Hills eat lettuce salad and steamed tofu with quinoa, in the slums and ghettos the poor gorge on Twinkie cakes, Cheetos, hamburgers and pizza. In 2014 more than 2.1 billion people were overweight, compared to 850 million who suffered from malnutrition. Half of humankind is expected to be overweight by 2030.[4] In 2010 famine and malnutrition combined killed about 1 million people, whereas obesity killed 3 million.[5]

Invisible Armadas

After famine, humanity's second great enemy was plagues and infectious diseases. Bustling cities linked by a ceaseless stream of merchants, officials and pilgrims were both the bedrock of human civilisation and an ideal breeding ground for pathogens. People consequently lived their lives in ancient Athens or medieval Florence knowing that they might fall ill and die next week, or that an epidemic might suddenly erupt and destroy their entire family in one swoop.

2. Medieval people personified the Black Death as a horrific demonic force beyond human control or comprehension.

The most famous such outbreak, the so-called Black Death, began in the 1330s, somewhere in east or central Asia, when the flea-dwelling bacterium *Yersinia pestis* started infecting humans bitten by the fleas. From there, riding on an army of rats and fleas, the plague quickly spread all over Asia, Europe and North Africa, taking less than twenty years to reach the shores of the Atlantic Ocean. Between 75 million and 200 million people died – more than a quarter of the population of Eurasia. In England, four out of ten people died, and the population dropped from a pre-plague high of 3.7 million people to a post-plague low of 2.2 million. The city of Florence lost 50,000 of its 100,000 inhabitants.[6]



3. The real culprit was the minuscule *Yersinia pestis* bacterium.

The authorities were completely helpless in the face of the calamity. Except for organising mass prayers and processions, they had no idea how to stop the spread of the epidemic – let alone cure it. Until the modern era, humans blamed diseases on bad air, malicious demons and angry gods, and did not suspect the existence of bacteria and viruses. People readily believed in angels and fairies, but they could not imagine that a tiny flea or a single drop of water might contain an entire armada of deadly predators.

The Black Death was not a singular event, nor even the worst plague in history. More disastrous epidemics struck America, Australia and the Pacific Islands following the arrival of the first Europeans. Unbeknown to the explorers and settlers, they brought with them new infectious diseases against which the natives had no immunity. Up to 90 per cent of the local populations died as a result.[7]

On 5 March 1520 a small Spanish flotilla left the island of Cuba on its way to Mexico. The ships carried 900 Spanish soldiers along with horses,

firearms and a few African slaves. One of the slaves, Francisco de Eguía, carried on his person a far deadlier cargo. Francisco didn't know it, but somewhere among his trillions of cells a biological time bomb was ticking: the smallpox virus. After Francisco landed in Mexico the virus began to multiply exponentially within his body, eventually bursting out all over his skin in a terrible rash. The feverish Francisco was taken to bed in the house of a Native American family in the town of Cempoallan. He infected the family members, who infected the neighbours. Within ten days Cempoallan became a graveyard. Refugees spread the disease from Cempoallan to the nearby towns. As town after town succumbed to the plague, new waves of terrified refugees carried the disease throughout Mexico and beyond.

The Mayas in the Yucatán Peninsula believed that three evil gods – Ekpetz, Uzannkak and Sojakak – were flying from village to village at night, infecting people with the disease. The Aztecs blamed it on the gods Tezcatlipoca and Xipetotec, or perhaps on the black magic of the white people. Priests and doctors were consulted. They advised prayers, cold baths, rubbing the body with bitumen and smearing squashed black beetles on the sores. Nothing helped. Tens of thousands of corpses lay rotting in the streets, without anyone daring to approach and bury them. Entire families perished within a few days, and the authorities ordered that the houses were to be collapsed on top of the bodies. In some settlements half the population died.

In September 1520 the plague had reached the Valley of Mexico, and in October it entered the gates of the Aztec capital, Tenochtitlan – a magnificent metropolis of 250,000 people. Within two months at least a third of the population perished, including the Aztec emperor Cuitláhuac. Whereas in March 1520, when the Spanish fleet arrived, Mexico was home to 22 million people, by December only 14 million were still alive. Smallpox was only the first blow. While the new Spanish masters were busy enriching themselves and exploiting the natives, deadly waves of flu, measles and other infectious diseases struck Mexico one after the other, until in 1580 its population was down to less than 2 million.[8]

Two centuries later, on 18 January 1778, the British explorer Captain James Cook reached Hawaii. The Hawaiian islands were densely populated by half a million people, who lived in complete isolation from both Europe and America, and consequently had never been exposed to European and American diseases. Captain Cook and his men introduced the first flu,

tuberculosis and syphilis pathogens to Hawaii. Subsequent European visitors added typhoid and smallpox. By 1853, only 70,000 survivors remained in Hawaii.[9]

Epidemics continued to kill tens of millions of people well into the twentieth century. In January 1918 soldiers in the trenches of northern France began dying in their thousands from a particularly virulent strain of flu, nicknamed ‘the Spanish Flu’. The front line was the end point of the most efficient global supply network the world had hitherto seen. Men and munitions were pouring in from Britain, the USA, India and Australia. Oil was sent from the Middle East, grain and beef from Argentina, rubber from Malaya and copper from Congo. In exchange, they all got Spanish Flu. Within a few months, about half a billion people – a third of the global population – came down with the virus. In India it killed 5 per cent of the population (15 million people). On the island of Tahiti, 14 per cent died. On Samoa, 20 per cent. In the copper mines of the Congo one out of five labourers perished. Altogether the pandemic killed between 50 million and 100 million people in less than a year. The First World War killed 40 million from 1914 to 1918.[10]

Alongside such epidemical tsunamis that struck humankind every few decades, people also faced smaller but more regular waves of infectious diseases, which killed millions every year. Children who lacked immunity were particularly susceptible to them, hence they are often called ‘childhood diseases’. Until the early twentieth century, about a third of children died before reaching adulthood from a combination of malnutrition and disease.

During the last century humankind became ever more vulnerable to epidemics, due to a combination of growing populations and better transport. A modern metropolis such as Tokyo or Kinshasa offers pathogens far richer hunting grounds than medieval Florence or 1520 Tenochtitlan, and the global transport network is today even more efficient than in 1918. A Spanish virus can make its way to Congo or Tahiti in less than twenty-four hours. We should therefore have expected to live in an epidemiological hell, with one deadly plague after another.

However, both the incidence and impact of epidemics have gone down dramatically in the last few decades. In particular, global child mortality is at an all-time low: less than 5 per cent of children die before reaching

adulthood. In the developed world the rate is less than 1 per cent.[11] This miracle is due to the unprecedented achievements of twentieth-century medicine, which has provided us with vaccinations, antibiotics, improved hygiene and a much better medical infrastructure.

For example, a global campaign of smallpox vaccination was so successful that in 1979 the World Health Organization declared that humanity had won, and that smallpox had been completely eradicated. It was the first epidemic humans had ever managed to wipe off the face of the earth. In 1967 smallpox had still infected 15 million people and killed 2 million of them, but in 2014 not a single person was either infected or killed by smallpox. The victory has been so complete that today the WHO has stopped vaccinating humans against smallpox.[12]

Every few years we are alarmed by the outbreak of some potential new plague, such as SARS in 2002/3, bird flu in 2005, swine flu in 2009/10 and Ebola in 2014. Yet thanks to efficient counter-measures these incidents have so far resulted in a comparatively small number of victims. SARS, for example, initially raised fears of a new Black Death, but eventually ended with the death of less than 1,000 people worldwide.[13] The Ebola outbreak in West Africa seemed at first to spiral out of control, and on 26 September 2014 the WHO described it as 'the most severe public health emergency seen in modern times'.[14] Nevertheless, by early 2015 the epidemic had been reined in, and in January 2016 the WHO declared it over. It infected 30,000 people (killing 11,000 of them), caused massive economic damage throughout West Africa, and sent shockwaves of anxiety across the world; but it did not spread beyond West Africa, and its death toll was nowhere near the scale of the Spanish Flu or the Mexican smallpox epidemic.

Even the tragedy of AIDS, seemingly the greatest medical failure of the last few decades, can be seen as a sign of progress. Since its first major outbreak in the early 1980s, more than 30 million people have died of AIDS, and tens of millions more have suffered debilitating physical and psychological damage. It was hard to understand and treat the new epidemic, because AIDS is a uniquely devious disease. Whereas a human infected with the smallpox virus dies within a few days, an HIV-positive patient may seem perfectly healthy for weeks and months, yet go on infecting others unknowingly. In addition, the HIV virus itself does not kill. Rather, it destroys the immune system, thereby exposing the patient to

numerous other diseases. It is these secondary diseases that actually kill AIDS victims. Consequently, when AIDS began to spread, it was especially difficult to understand what was happening. When two patients were admitted to a New York hospital in 1981, one ostensibly dying from pneumonia and the other from cancer, it was not at all evident that both were in fact victims of the HIV virus, which may have infected them months or even years previously.[15]

However, despite these difficulties, after the medical community became aware of the mysterious new plague, it took scientists just two years to identify it, understand how the virus spreads and suggest effective ways to slow down the epidemic. Within another ten years new medicines turned AIDS from a death sentence into a chronic condition (at least for those wealthy enough to afford the treatment).[16] Just think what would have happened if AIDS had erupted in 1581 rather than 1981. In all likelihood, nobody back then would have figured out what caused the epidemic, how it moved from person to person, or how it could be halted (let alone cured). Under such conditions, AIDS might have killed a much larger proportion of the human race, equalling and perhaps even surpassing the Black Death.

Despite the horrendous toll AIDS has taken, and despite the millions killed each year by long-established infectious diseases such as malaria, epidemics are a far smaller threat to human health today than in previous millennia. The vast majority of people die from non-infectious illnesses such as cancer and heart disease, or simply from old age.[17] (Incidentally cancer and heart disease are of course not new illnesses – they go back to antiquity. In previous eras, however, relatively few people lived long enough to die from them.)

Many fear that this is only a temporary victory, and that some unknown cousin of the Black Death is waiting just around the corner. No one can guarantee that plagues won't make a comeback, but there are good reasons to think that in the arms race between doctors and germs, doctors run faster. New infectious diseases appear mainly as a result of chance mutations in pathogen genomes. These mutations allow the pathogens to jump from animals to humans, to overcome the human immune system, or to resist medicines such as antibiotics. Today such mutations probably occur and disseminate faster than in the past, due to human impact on the

environment.[18] Yet in the race against medicine, pathogens ultimately depend on the blind hand of fortune.

Doctors, in contrast, count on more than mere luck. Though science owes a huge debt to serendipity, doctors don't just throw different chemicals into test tubes, hoping to chance upon some new medicine. With each passing year doctors accumulate more and better knowledge, which they use in order to design more effective medicines and treatments. Consequently, though in 2050 we will undoubtedly face much more resilient germs, medicine in 2050 will likely be able to deal with them more efficiently than today.[19]

In 2015 doctors announced the discovery of a completely new type of antibiotic – teixobactin – to which bacteria have no resistance as yet. Some scholars believe teixobactin may prove to be a game-changer in the fight against highly resistant germs.[20] Scientists are also developing revolutionary new treatments that work in radically different ways to any previous medicine. For example, some research labs are already home to nano-robots, that may one day navigate through our bloodstream, identify illnesses and kill pathogens and cancerous cells.[21] Microorganisms may have 4 billion years of cumulative experience fighting organic enemies, but they have exactly zero experience fighting bionic predators, and would therefore find it doubly difficult to evolve effective defences.

So while we cannot be certain that some new Ebola outbreak or an unknown flu strain won't sweep across the globe and kill millions, we will not regard it as an inevitable natural calamity. Rather, we will see it as an inexcusable human failure and demand the heads of those responsible. When in late summer 2014 it seemed for a few terrifying weeks that Ebola was gaining the upper hand over the global health authorities, investigative committees were hastily set up. An initial report published on 18 October 2014 criticised the World Health Organization for its unsatisfactory reaction to the outbreak, blaming the epidemic on corruption and inefficiency in the WHO's African branch. Further criticism was levelled at the international community as a whole for not responding quickly and forcefully enough. Such criticism assumes that humankind has the knowledge and tools to prevent plagues, and if an epidemic nevertheless gets out of control, it is due to human incompetence rather than divine anger. Similarly, the fact that AIDS continued to infect and kill millions in Sub-Saharan Africa years after