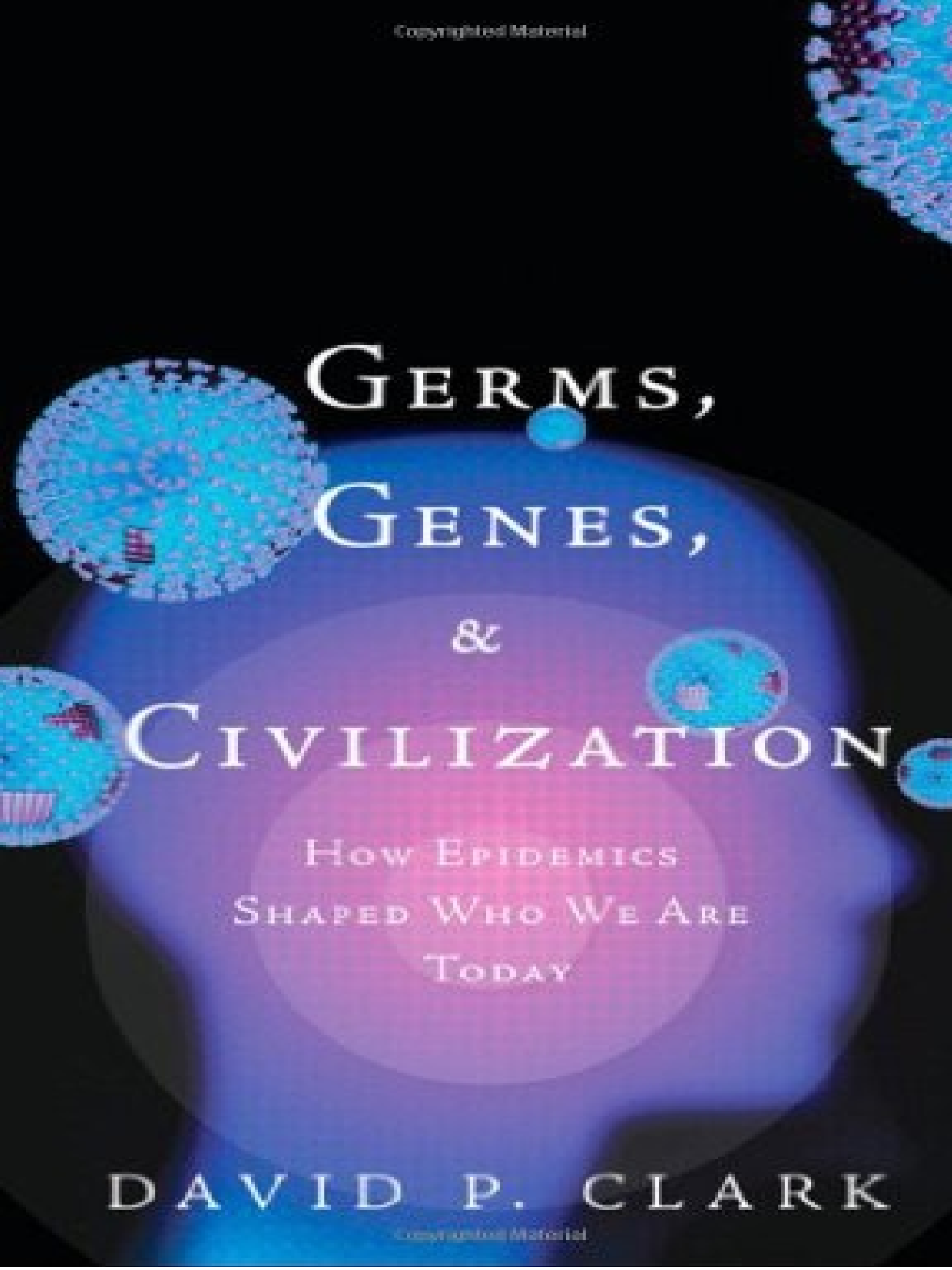
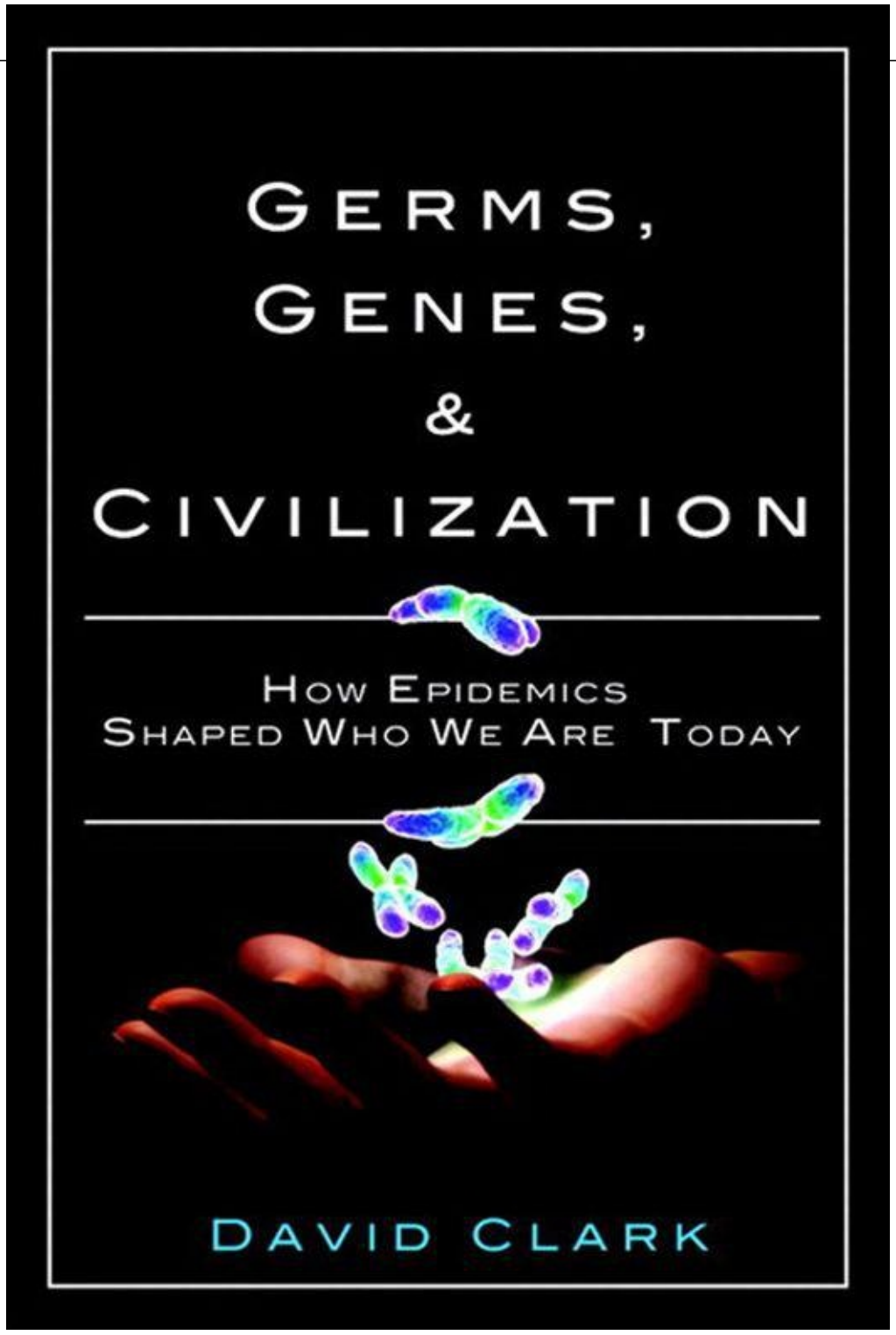


Germs, Genes, & Civilization

How Epidemics Shaped Who We Are Today

David P. Clark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This book is dedicated to my younger brother, Andrew, who has always enjoyed a good argument.

Contents

Preface

Humans typically labor under the illusion that they control their own destiny. This book argues that, i reality, invisible microbes often control human activities. Recent findings have shown that anima that develop without their natural bacterial inhabitants have defective immune systems and po health. Thus, we and other animals depend on the bacteria for our healthy development. On a larg scale, we now recognize that microbes maintain the global ecosystem and are partly responsible f keeping our planet healthy. The amount of “good” bacteria that work to recycle nutrients and degrad waste is greater by far than the amount of “bad” bacteria that threaten human health.

Here I enter the intermediate zone between individual development and planetary ecology, to discu how microbes have decided major historical events and shaped cultural trends. Furthermore, th emergence of resistance to infectious diseases has selected alterations in genes that affect huma behavior.

This book is *not* a history of public health, medicine, or microbiology, although it does mention thes issues. Instead, this book describes how infections have shaped both individual humans and the societies from the very beginning of civilization. Disease has influenced our cultural and religiou beliefs, as well as determined the outcome of wars and major historical events. I have tried to sho how beneficial long-term effects have resulted from epidemics that were terrible tragedies to tho caught up in them.

Philosophically, we are just emerging from a period of transition between the perfectionist and selfis views of nature. The classic example, in the area of disease, is the idea that, over the ages, infectiou agents will adapt to their hosts. Eventually, all diseases will become no worse than a bad cold. This an attempt to retain a utopian future while allowing evolution to occur. Recently, we have come t realize that although some diseases become milder, others might evolve with greater virulence. W now see nature more as an arms race between life forms deploying assorted genetic strategies.

A second aspect of this more modern viewpoint, is to realize that the scale on which we view events important. Improving a species through evolution inevitably involves the death of many less f individuals. Applying this Darwinian idea to human populations lets us see that whereas ma fatalities from a plague are tragedies at the personal level, they can have positive effects when see from a long-term perspective.

These positive effects vary from genetic changes that make us more resistant to the disea responsible for the epidemic (and often to related infections), to effects on human society that are ha to pin down and quantify. Epidemics have undoubtedly affected the outcome of many wars an conflicts. Whether these interventions were a good thing obviously depends on which side yo support. Less ambiguous is the contribution of epidemics to the development of a free, technological based society in the West. More ambiguous are the possible effects on religious belief and huma behavior.

Modern progress in DNA technology and human genetics is generating a vast amount of dat
Analyzing and checking this will take time. The next few years should reveal many connectio
between infection, disease resistance, and alterations in genes that affect not only our physic
characteristics, but also brain function or development and thus impact human behavior. We live i
exciting times!

David Clark
Carbondale, Illinois

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About the Author

David Clark was born June 1952 in Croydon, a London suburb. After winning a scholarship t
Christ's College, Cambridge, he received his Bachelor of Arts degree in 1973. In 1977, he earned h
Ph.D. from Bristol University for work on antibiotic resistance. David then left England f
postdoctoral research at Yale and then the University of Illinois. He joined the faculty of Souther
Illinois University in 1981 and is now a professor in the Microbiology Department. In 1991, he visite
Sheffield University, England, as a Royal Society Guest Research Fellow. The U.S. Department o
Energy funded David's research into the genetics and regulation of bacterial fermentation from 198
till 2007. David has published more than 70 articles in scientific journals and graduated more than 2
masters and Ph.D. students. He is unmarried and lives with two cats: Little George, who is orange, an
Ralph, who is mostly black and eats cardboard. David is the author of *Molecular Biology Made Simp*
and Fun, now in its third edition, as well as three more serious textbooks.

1. Introduction: our debt to disease

Early in the fifth century A.D., the Huns, led by Attila, emerged from the Asian steppes and swe
across Europe. They faced no serious resistance. What was left of the greatest civilization the wor
had seen, the Roman Empire, was a tottering wreck. One more good shove and the remains of Roma
civilization would have taken a final nose-dive. But strangely, on the verge of storming Rome itsel
Attila withdrew. Why?

For many centuries the official answer was that God had intervened in some mysterious way to prote
his chosen city, Rome, seat of the papacy. In more recent times, such supernatural explanations hav
fallen out of favor and the question has arisen anew. Some have suggested that Attila was overawed b
the sanctity of Rome. But why would a pagan warlord like Attila stand in awe of a Christian cente
Attila was by no means an ignorant barbarian: For example, he invited Roman and Greek enginee
into Hun territory to install bathing facilities. However, his respect for Roman civilization was clear
of a pragmatic rather than a religious nature. Another theory is that Attila was worried about leavin
unattended his newly acquired homeland, in what is now Hungary. But then why did he venture o
almost as far as Rome and hang around indecisively for so long before returning? All thes
explanations founder on the same point. It seems clear that Attila did indeed set out with eve
intention of taking Rome, but his expedition came to a premature halt.

Mounting modern evidence suggests that Attila was stopped by a virulent epidemic of dysentery, c
some similar disease. Most of his men were too ill to stay on their horses, and a significant numb
died. In short, bacteria saved Rome. The ancient world had no knowledge of bacteria. Instead, mo
ancient cultures believed that epidemics were one of the main ways the gods expressed the
displeasure. In the Bible, pestilence is often a punishment for wickedness, both for disobedience b
the Israelites themselves and for intrusions by outsiders. For example, an epidemic saved the holy ci
of Jerusalem from the Assyrian invaders, providing a precedent for the failure of Attila to take Rom
So, in a curious way, the earlier explanation of God preserving Rome has reemerged in a mode
scientific guise.

But before we rush to enroll the bacteria as honorary Roman citizens, we must consider another aspe
of the issue. A major reason Rome itself was in such disarray when Attila approached was that it, too
had fallen victim to pestilence. Several catastrophic epidemics had swept through Rome in the perio
before the Huns surged into Europe. So whose side were the microbes really on?

Nowadays, floods, earthquakes, and volcanic eruptions are regarded as “acts of God,” at least b
insurance companies. The implication is that neither the victims nor anyone else is responsible. Th
is not entirely true. People who persistently rebuild their homes on a flood plain or along a fault lin
are at least partly to blame. Similarly, epidemics do not just happen to anyone at anytime anywhe
without good reason. Neither the epidemics that struck Rome nor the disaster that overcame Attila
Huns were just random outbreaks of disease. What’s more, their origins were interrelated.

Before Attila, Rome had several narrow escapes from other hordes of barbarians. Several times looked as if the end was near and that the Romans would be overwhelmed. Yet somehow the Roman scraped by. Part of the credit must go to the Romans, who were an unusually determined people, n prone to giving up easily. Yet much of the credit also belongs to the unseen and unsung legions o microbes. It is relatively easy for us today to understand why an overcrowded, unhygienic ancient ci suffered from persistent outbreaks of pestilence. Why disease so often intervened to protect the san city from successive waves of barbarians is more difficult to understand.

Imagine an ancient society that is moving along the path to urbanization. Large numbers of people a crowding into a growing city, such as Babylon, Athens, or Rome, which is much larger tha neighboring communities. Infections normally spread more efficiently through crowded cities tha through sparsely populated villages and rural areas. Sooner or later, some pestilence or plague wi strike the emerging city. Its population will be decimated, and for a while it will be vulnerable. But it recovers, its population will consist largely of those who are resistant to the plague of the day. I other words, denser populations are the first to build up resistance to the current infectious diseases their region of the world. Next time a major conflict arises, the movements of armies or of refuge will spread infection around the war zone. People from rural communities or smaller towns will hav built up less resistance than the population of the city-state, so pestilence will fight on the side of th biggest city.

Once a major population center gains a significant lead over its competitors, the pestilence factor wi make it extremely difficult to overthrow. This indeed is what happened to ancient Rome. A series o epidemics whose identities remain unknown devastated the Romans early in their history. Late barbarians who ventured too close to Rome routinely succumbed to massive epidemics that had on mild effects on the Romans. As long as the Huns retained their nomadic lifestyle, they would hav been little affected by epidemics. Even if an occasional marauder caught some infection from mo settled and crowded regions, it was difficult for pestilence to spread among small, scattered groups nomads. Once the Huns aggregated into a horde, under centralized leadership, the situation change radically. On the one hand, they had little previous exposure to pestilence, so they lacked resistanc On the other hand they now formed a large, dense population, ripe for the spread of invadi microorganisms. In a way, Attila's tragedy was the result of this vulnerable intermediate situatio between nomadism and urbanization.

The general principle that *pestilence favors societies that have become resistant because of pri infection* has had a vast effect on human history. It has not only directed the growth and survival of th empires of the Old World, but it also was the major factor in European invaders' takeover of th American continent.

Epidemics select genetic alterations

Another result of ancient epidemics that experts have only recently come to understand is th accumulation of alterations in the human genome. Through the millennia, a never-ending stream hostile microbes has attacked and decimated human populations. Each time a human population devastated by infectious disease, genetic selection takes place. People carrying genetic alterations th

confer resistance, even if only partially, have a greater chance of survival. Consequently, the descendents will make up a greater proportion of the surviving population.

The result of constant epidemics is that, over the ages, distinct acquired genetic changes now prote us against many individual infections. We still carry these modifications in our DNA sequences, an recent investigations are revealing a steady stream of such genetic alterations, many surprising recent. Thus, in many ways, we are what disease has made us.

Yet another convoluted twist of fate appears here. Several well-known hereditary defects turn out t be side effects of resistance to disease. For example, sickle cell anemia is the result of heredita resistance to malaria, and cystic fibrosis is associated with resistance to intestinal diseases that cau diarrhea and dehydration. A single copy of the cystic fibrosis mutation reduces water loss, thu protecting against a range of diseases whose most dangerous effect is dehydration. Two copies of th cystic fibrosis mutation slow water movements in the lung too much. So one copy of the mutatio protects against disease, and two copies of the same mutation cause a hereditary defect.

The case of cystic fibrosis is especially revealing. The cystic fibrosis mutation is unusually commo in those of northwest European ancestry. Calculations based on mutation rates and population genetic suggest that these mutations arose shortly after the collapse of the Roman Empire. This collapse led a massive loss of general hygiene, especially in the water supply. Doubtless waterborne intestin diseases spread like wildfire, and eventually, mutations providing resistance accumulated.

Every cloud has a silver lining: our debt to disease

The way epidemics have intervened in history shows that disease is not just a uniformly negativ matter. The outcome of an epidemic may be quite complex, especially over the long term. Whether w regard any particular outcome as “good” or “bad” depends partly whose side we are on and partly o the relative weight we give to short-term versus long-term effects. In this book, I point out th positive effects of epidemics. This is not because disease is beneficial overall, but because these le obvious beneficial side effects often are overlooked. If a virulent plague rages through society, th obvious response is to stop it by whatever means possible, not to sit around fantasizing about its effe on future centuries.

Not surprisingly, we normally think of infectious disease as our enemy. When a successful program o vaccination wipes out a blight such as smallpox, we feel no remorse that a unique life form ha suffered extinction. When we learn that throughout the course of human history infectious disease ha been responsible for more deaths than war, famine, or any other cause, this only confirms ou viewpoint. Indeed, the victories we have achieved over infectious disease are among modern man greatest triumphs. Today industrialized nations have largely brought infectious disease under contro Unlike our predecessors of only a century or two ago, nowadays we mostly die from heart disease an cancer. Our longer lives give us time to reflect on the other side of this issue, and I argue tha paradoxically, we also owe a great debt to infectious disease.

This approach is not merely idle intellectual self-indulgence. Infections that still threaten us eith

tend to cause disease in a subtler manner, or else they remain dangerous for other complicate reasons. The classic modern-day example is AIDS. This disease does not actually kill directl Instead, it damages the immune system, allowing other diseases, impotent by themselves, to gain foothold. Perhaps it is time for humanity to also take a more indirect and subversive attitude.

Over the long term, a positive side to disease emerges. Granted, if large black swellings are appearin in your armpits and you're about to die of bubonic plague, you'll find it difficult to maintain a unbiased perspective. Nonetheless, although the Black Death epidemics that ravaged Europe in th Middle Ages were devastating at the time, they had beneficial effects on a more global and futurist scale. They shook up the repressive feudal system and, in the long term, made a major contribution the evolution of Western democracy.

On the negative side of the balance sheet, we have the millions who died painful deaths in the plagu epidemics. On the positive side, we must not forget those other millions who would have died misery and poverty if industrial democracy had been delayed significantly. In our horrified emotion reaction to epidemics, we normally forget this latter aspect. We do not know for sure how man children would have died in infancy each century if the feudal system had continued. However, if w compare the infant mortality of 30%–50% that prevailed before industrial democracy with the le than 1% infant mortality of today, we can clearly see that millions of innocent lives have indeed bee saved.

On a more individual level, Charles Darwin probably caught Chagas's disease while on his famou voyage on the *Beagle* around South America and the Galapagos Islands. His resulting poor health kep Darwin at home for much of the rest of his life. Instead of wandering off on more expeditions observe nature and collect specimens, he stayed put and pondered the origins of living things. Th may well have played a major role in Darwin's compilation of the most influential book of the la few centuries, *The Origin of Species*.

As already remarked, whether such indirect effects are "good" or "bad" depends on your perspectiv Should we consider the happiness of the individual, the benefit to a particular group, or the overa betterment of mankind? For that matter, how do we define the "betterment" of mankind? Whatev your outlook, the effects of infectious disease have been undeniably important in changing the cour of history. Perhaps it is not too fanciful to think of "good" and "bad" diseases. Some diseases, lik bubonic plague, may have had some beneficial long-term side effects on human society as a whol Others, like sleeping sickness, have no positive aspect. Whatever our moral perspective, the effects an epidemic on the overall fortune of a tribe, nation, or even a whole continent may be quite differe than the immediate effects on the victims.

Crowding and culling

Pestilence has molded both our cultures and our genes over the long term. But before tackling the long-term effects, let's look at what actually happened to human civilizations when diseases struc Over time, humans increased in numbers and gathered together in villages, towns, and then citie Populations grew larger and denser as civilization progressed. Sooner or later, when people a

crowded together, infectious disease takes the opportunity to spread itself around, too.

Let's focus on severe infections with high mortality rates (such as smallpox, Ebolavirus, or bubon plague). Each time pestilence passes through society, a sizable fraction is wiped out. The survivo give birth to the next generation, and numbers gradually increase again. Once the population is den enough, another epidemic strikes and the cycle repeats. Over many generations, genetic resistan develops, so virulent pestilences wane into childhood diseases and may eventually fade awa completely. Meanwhile, novel infections emerge and spread, taking the place of yesterday's retire plagues.

A crucial point for understanding the long-term effects of an epidemic is that death is distribute neither equally nor at random. Infectious disease strikes harder at some segments of the populatio than others. Let's start with factors that are wholly or mostly biological in nature.

First, older people and young children are especially susceptible. This is because the human immu system is not fully developed in the very young and is beginning to fade away in the very ol Conversely, some individuals may be immune to certain infections. Nowadays, such immunity mostly due to artificial vaccination. Before this was available, immunity was normally acquired th hard way by catching the disease and surviving.

Second is the phenomenon of genetic resistance to disease. In contrast to immunity, which is acquire during an individual's lifetime, genetically based resistance is inherited from one's ancestor Individual people differ greatly in their inherent susceptibility to different diseases. When population suffers from a dangerous disease, those with genetically based resistance survive mo often than others. Consequently, inherited resistance gradually builds up over several generations. Fo example, the earliest reliable accounts of smallpox in Asia and Europe suggest that it was fatal 75% more of the time. Yet over the next thousand years, the mortality rate fell to around 10%–30%. The when smallpox was carried to the New World, the mortality rate among the American Indians wa 75% or more. Thus, a virulent disease is vastly more devastating in a population that has never bee previously exposed and has had no opportunity to build up resistance.

Many other factors affect our susceptibility to disease. These range from mainly biological to large social in nature. For example, those who are poorly fed or live in bad housing and are cold, wet, an dirty are much more at risk than well-fed people who are dry, warm, and clean. Obviously, the close people are crowded together, the easier it is for infectious disease to spread. These factors all lie o the interface where social conditions merge with biological effects.

Many of these factors can be lumped together, at least crudely. To put it bluntly, poor people are bot more likely to become infected and also more likely to die if they are infected. Unfair as it may b this is inevitably true in all real-life human societies. Today this is most clearly seen in the contra between the industrial nations and the Third World. However, throughout recorded history prosperit and status have had their advantages. Even in societies of apes and baboons, higher-status anima tend to be better fed, a factor that helps them fight off many infections.

But how do you get to be rich or poor, high or low? To be sure, one way is to inherit money or soci position (as distinct from genes) from your parents. But this ignores how your ancestors got rich

start with. Do competent, industrious, attractive, healthy, and brave people tend to rise through th ranks of society? Or is it the ruthless, greedy, cowardly, and corrupt who claw their way to the top Whichever of these alternatives you espouse, for better or for worse, during a virulent epidemic, few people at the top will die than those at the bottom.

The message of this book

Humans typically labor under the illusion that they control their own destiny. However, I argue in th book that infectious disease has had a massive unrecognized effect on human history and cultur Moreover, constant epidemics with high death tolls have occurred throughout history and hav selected major genetic alterations in the survivors. Modern DNA analysis, including the recent Huma Genome Project, has revealed that alterations have occurred in certain individual genes. But man more changes remain to be discovered.

Some of these genetic alterations have mainly physical effects, but others may affect brain an behavior. For example, it is possible, though not fully proven, that genetic alterations that predispos humans to schizophrenia also protect against viral infections. As yet, the genes presumed responsib have not been identified.

Before dealing with these issues, we need to understand that many of our infectious diseases hav emerged only very recently, after humans developed agriculture and settled into towns and cities (a discussed in Chapter 2, "Where Did Our Diseases Come From?"). We also need to realize that disease's mode of transmission can alter its virulence over a relatively short period of historical tim (as discussed in Chapter 3, "Transmission, Overcrowding, and Virulence").

2. Where did our diseases come from?

Africa: homeland of mankind and malaria

Africa is the ancestral homeland of mankind. Our species originated there perhaps 100,000 years ag
From Africa, humans spread through the Middle East and around the world. Not surprisingly, most
our original diseases evolved alongside (or inside) their human hosts in Africa, so the human ra
grew up in constant contact with parasites such as trypanosomes, which cause sleeping sickness, a
Plasmodium, which causes malaria.

Many diseases adapted to tropical conditions were left behind by those who migrated to cold
regions. In particular, many parasites that need a warm climate failed to adapt to the temperate zone
Conditions inside the human body remain fairly constant. Consequently, the susceptibility of a disea
agent to climate depends on how much time it spends outside the body between infections. Bacter
and viruses that are passed directly from person to person are affected little. Parasitic worms who
larvae develop in rivers or lakes before reinfecting human hosts are highly susceptible. Diseases th
rely on insects to spread them are greatly affected by climate because their insect vectors often cann
survive colder winters. Thus, mankind left behind malaria, sleeping sickness, yellow fever, and ma
other insect-borne diseases when we emerged from the tropics.

These diseases are still a major problem in tropical regions. According to the World Healt
Organization (WHO), some 500 million clinically observed cases of malaria cause a little over
million deaths each year, the majority in Africa. Of these deaths, about half are of children young
than five years old. Recently, AIDS overtook malaria and tuberculosis to become the leading cause
death among the infectious diseases, with around three million deaths. (Diarrheal disease a
respiratory infections still head the mortality tables, but these are each due to several differe
infectious agents.) Tuberculosis kills around 1.5 million victims per year, slightly more than malari
However, these deaths result from about 10 million cases, far fewer than the 500 million cases
malaria. Relatively few malaria victims die outright. Instead, they suffer life-long debilitation, whi
not only lowers their productivity, but also makes them vulnerable to other infections.

How important was malaria?

Malaria is sometimes quoted as having killed more people than all the wars and all the plagues
recorded human history. But although infectious disease as a whole has undoubtedly killed far mo
people than warfare, little compelling evidence indicates that malaria has outperformed all oth
infectious diseases. Although malaria has taken a steady death toll in Africa and other tropical zone
it was absent on the American continent until European colonization. Furthermore, although malar

nibbled at the heels of Europe until recently by infesting marshlands, the dense urban populations temperate Europe and Asia were fairly unaffected. Moreover, until the recent population explosio the population density of Africa and other tropical regions where malaria is endemic was relative sparse.

Even in Africa, the evolutionary homeland of both man and his earliest diseases, was malaria reall the number one killer before the last few centuries? Today *Plasmodium falciparum* causes most leth attacks of malaria, whereas the other three species of malaria cause relatively milder disease and a rarely lethal. Although *P. falciparum* is presently spreading from Africa around the tropical world, th sickle cell mutation that provides resistance is found only in Africans indigenous to regions harborin *P. falciparum* malaria. The fact that the sickle cell trait is so harmful by itself suggests that it is recent, emergency, evolutionary adaptation. Over longer periods, we would expect the build-up resistance with less deleterious side effects, as is the case for many other diseases, including th milder variants of malaria. This suggests that the malignant, falciparum form of malaria is relatively recent origin and that, even in Africa, malaria was present in its milder forms for much early human history.

Moreover, in precolonial Africa, many other diseases that have since been largely eradicated due Western technology were still active. Relative to malaria, yellow fever may be trivial today, but in th early colonial period, sailors to tropical parts feared it at least as much. Again, among many We African tribes, smallpox, which has now been completely eradicated, was historically feared the mos Although malaria has survived the onslaught of modern technology better, this does not necessari mean it was the major killer before other diseases were brought under control.

Our fellow travelers

Malaria is the best known example of a disease that has accompanied our species from its earlie beginnings and remains a major health problem. However, it is by no means the only disease to hav accompanied us since our origin. Tuberculosis, herpes, and typhoid are other well-known example This raises the issue of how an infectious disease avoids getting left behind when its human victim consist only of small, scattered bands.

Consider first a “recent” disease such as measles. This humans-only disease is highly contagious an is spread from human to human without relying on any insects or other carriers. After recover humans gain immunity from measles. Consequently, measles faces the problem of constantly findin fresh victims. When measles has finished infecting all members of a small isolated tribe, it ha nowhere to go. Thus, diseases such as measles cannot persist unless civilization provides a dense packed crowd of victims. Clearly, measles is not one of our original diseases; we consider its origin later.

One way for a disease to avoid the predicament of measles is to be shared among multiple animal Malaria and sleeping sickness are examples of this approach. Another approach is to remain dorma inside a host until fresh victims are available. Herpes, caused by a virus, and typhoid and tuberculosi caused by bacteria, have all taken this route. Viruses of the herpes family may lie quiescent in nerv

cells for years until provoked by stress to emerge. They may then spread to new victims. Typhoid ca
hide in the gall bladder of human hosts who show no symptoms but are a constant source of infectio
to others. Tuberculosis, caused by *Mycobacterium tuberculosis*, hibernates in the lungs.

Human remains showing signs characteristic of tuberculosis (TB) have been found dating as early a
the Neolithic period, when settled agricultural communities first appeared (9,000 B.C. onward). X
rays of Peruvian mummies dating to before the European conquest show signs of tuberculosi
implying that the American Indians brought TB with them when they crossed the Bering Straits som
10,000–15,000 years ago. Extraction of DNA characteristic of *Mycobacterium tuberculosis* from son
of these mummies has confirmed that it really was tuberculosis. The signs of TB in the skull of a hal
million-year-old *Homo erectus* from Turkey are vastly more ancient.

It was once thought that tuberculosis might have moved into the human population from cattle, whic
suffer from a closely related form of the disease. However, recent DNA analysis suggests the revers
—that we humans transmitted tuberculosis to cows after domestication.

Many human diseases originated in animals

Despite the new DNA evidence that exonerates the cow from spreading tuberculosis, most of ou
present infections probably did originate from other animals. It seems likely that prehistoric hunte
gatherers were relatively free of infectious diseases, compared with historical and present-day ma
The unusual susceptibility of American Indians to most diseases brought across the Atlantic from th
Old World argues that the indigenous people of the American continent had never been exposed t
these diseases. This implies that these diseases emerged after the ancestral American Indians split o
from their Asian relatives approximately 15,000 years ago. Because the migrating tribes evidently d
not import them into America, it seems that smallpox, measles, and so forth must have been huma
diseases for less than 15,000 years—perhaps less, even, than that.

Before rushing forward, a word of caution is in order. We are fairly sure that malaria is an ancien
disease. However, malaria was not present among American Indians before contact with the Ol
World was reestablished. The reason is that malaria is carried by mosquitoes, which failed to surviv
when humans migrated from the tropics into the colder regions of Asia. The Asian ancestors of th
American Indians had therefore left malaria behind before they entered the American continent. Whe
invoking New World susceptibility for the age of a disease, we must keep this factor in mind. Othe
tropical diseases that cannot persist in colder climates may also be ancient despite not being carried
the Americas.

Note also that, apart from the domestic dog, the American Indians lacked the domestic anima
characteristic of the Old World. When the Bering Strait was crossed, cattle, sheep, horses, and pig
had not yet been domesticated by the tribes who made the crossing. Many human diseases have con
from these animals. Because the first humans to colonize the Americas did not take these anima
along, they could not have caught their diseases after migrating.

As humans expanded around the globe and populations grew ever denser, our species became a livin

paradise for infectious disease. No other large animal in the known history of our planet has provide such crowds of individuals, packed closely together, just waiting for some pestilence to move in an multiply. Over the ages, infectious diseases have migrated from their original hosts whenever the made contact with the human species. Animals that have the closest relationships with humans hav been the source of most diseases. This includes not just the deliberately domesticated animals, b also the rats and mice that have taken up residence in and around human settlements. Even toda most human towns and cities are home to more rodents than humans.

Dense herds of domestic animals and fields of closely planted crops have provided simil opportunities for colonization by diseases from related wild animals and plants. Some of these, turn, have moved on to humans. Today, as the remaining jungles and rain forests are being explore and exploited, they have yielded more novel diseases. Lassa fever, Hantavirus, and Ebolavirus have a made the jump to man, the ubiquitous host. Although mankind has done a good job of exterminatin other larger animals, we have kept many of their diseases.

Recent diseases from animals

When Hippocrates compiled his treatise in the fifth century B.C., the ancient Greeks did not know smallpox, measles, bubonic plague (an Asian disease), syphilis (an American import), yellow fev (from Africa), or leprosy. They were aware of herpes, typhoid and/or typhus, tetanus, ameb dysentery, rheumatic fever, chlamydia (both venereal and trachoma), and gonorrhea (or somethin very similar).

Zhouhou Beijifang, written by Ge Hong in fourth-century-A.D. China, lists malaria, erysipela typhoid, dysentery, and cholera. In contrast to the ancient Greeks, leprosy and smallpox were no known, implying that these appeared roughly 2,000 years ago. These records, together with a varie of other ancient accounts, suggest that many diseases we are familiar with today were absent in ear historical times and have appeared only within the last thousand years or so.

Viral diseases, which colonized humans only after civilization provided sufficiently crowded victim include mumps, measles, German measles, smallpox, polio, influenza, and even the common cold. A least our hunter-gatherer forefathers didn't have to worry about scaring away the game with viole sneezing! These viral diseases all have close relatives in various animals. After making the jump humans, they adapted over the centuries to their new hosts and, in many cases, lost the ability to infe their original hosts. For several of these diseases, evidence suggests that they were originally mo virulent and have become milder over the years.

For all these diseases, victims who recover become immune. Consequently, these viruses must a keep moving through a constant supply of new hosts. Flu and colds do return year after year an reinfect the same people, but each successive epidemic comes from a newly evolved strain of viru Although you may be reinfected with such new strains, you remain permanently immune to variants flu or cold viruses from previous years.

Smallpox is a good candidate for a very recent addition to humanity's panorama of parasites. It wa