Chapter Seven

Infectious Disease and Globalization

"Disease generally begins that equality which death completes."
Samuel Johnson (1709-1784), *The Rambler*, London, September 1, 1750

"Despair often breeds disease."
Sophocles (497-406 B.C.), *Fragments,* 1. 585 *(Tyro Shorn)*

"When there is disharmony in the world, death follows."
Navajo Medicine Man in reference to an outbreak of Hanta virus infections in Arizona 1993.[1]

<u>Learning to Question, Questioning to Learn</u>

- What kinds of factors affect the transmission, manifestation, and treatment of disease?
- To what extent is disease a socially produced condition caused by human beings through our dynamic interactions with each other, the ecosystems we live and work in, and our local and global economic activity?
- In what ways might disease affect and be affected by an increasingly centralized and industrialized global food industry?
- What are some of the major challenges in the global fight against infectious disease?

<u>Introduction</u>

Avian Influenza, SARS (Severe Acute Respiratory Syndrome). HIV/AIDS (Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome). TB (Tuberculosis). Polio. Malaria. West Nile Fever. Influenza. These and other infectious diseases are frequently headline news, reminding us that microscopic organisms can have a devastating impact on the quality of life of individuals and communities around the world. This chapter will consider the contexts, histories, and causes of infectious diseases—human illnesses caused by viruses, bacteria, parasites, fungi, and other microscopic organisms. It will also examine how disease functions in our global, interconnected world, and the ways in which diseases are caused and affected by social relations between people and societies. The chapter begins with a focus on the history of infectious disease. This section is followed by a discussion of the relationship between infectious disease and globalization that considers how local and global interactions with the environment relate to the ways that diseases emerge, reemerge, and affect people. This section also looks at the impact of the food industry, urbanization, air travel, and migration on the nature of infection. The chapter then focuses on AIDS as an example of how disease is inextricably linked to patterns of poverty and inequality. The final section examines current challenges in the global fight against infectious disease.

Microbes and Infectious Diseases: A Brief Overview

From the earliest times, humans have affected and been affected by *microbes*—microscopic organisms, including viruses, bacteria, parasites and fungi, that inhabit every imaginable niche in every ecosystem on the planet, including human communities and human bodies. For the most part, we have managed to live in a state of relative equilibrium with microbes, adapting to their needs and accommodating their adaptations to us. In some cases, we have even developed *symbiotic* relationships. Bacteria in our digestive systems, for example, help us break down foods. In other cases, however, microbes threaten humans, functioning as *pathogens*, or disease causing agents that enter the host and begin to reproduce, weakening or killing the host in the process. Although this is how we often think of microbes—as potential killers—the most “successful” microbes, in terms of the larger struggle to survive and reproduce, are those that do not kill their hosts. Widespread death tends to occur primarily when a microbe infects a population that has had no prior exposure to it. In these cases, the microbe often kills all except those who are naturally the most resistant to it. Over time, the most susceptible hosts perish while the survivors develop an enduring immunity. Eventually, the deadliest strains of the microbe die off, resulting in a relative balance or tolerance between people and microbes. Although it may at first seem paradoxical, this process reveals that the more exposure a community has to disease, the less destructive are its *epidemics*.[2] Conversely, biologically naïve populations with little exposure to disease, and thus no immunity, are more likely to be devastated by disease outbreaks.

History of Infectious Disease

Recent analyses of human DNA show the rich history of our biological interactions with a myriad of pathogens. The human genome includes genetic markers for a range of diseases that our ancient ancestors survived, some of which we still suffer from, including forms of tuberculosis. It also shows that we have genetic material that may make us more or less susceptible to some infectious diseases.[3] One example that scientists speculate may date back to our earliest origins in Africa is the gene trait for sickle-cell red blood cells, which can protect people from the malaria parasite.[4]

The earliest hunting and gathering societies—the foragers—probably lived with fairly constant levels of *endemic diseases.* Most of these societies were isolated enclaves, separate from other societies, which contributed to a state of equilibrium between people and microorganisms. Although diseases existed in these enclaves, hunting-gathering populations were too sparse and mobile to support acute diseases such as smallpox, measles, chickenpox, and other diseases that produce long-lasting immunities. Those kinds of diseases would have burnt themselves out by killing or *immunizing* all available hosts. So although living conditions may not have been ideal in these earliest of foraging societies, they also were not in a state of crisis brought about by disease epidemics. [5]

Disease and Domestication

The emergence of agriculture and *domestication* had profound effects on human communities. First, they significantly increased food supplies, making them more consistent and predictable. Second, they allowed people to settle in one place and invest time and effort in building a community. Third, they provided for a larger and rapidly increasing population. However, the very strides humans made in terms of land settlement, food production, science and industry, and trade and travel also allowed for conditions to emerge that could potentially foster catastrophe.[6] A new reliance on a limited number of domesticated food sources, for example, increased the potential for famine. Domestication also dramatically altered human relationships with animals and the environment, bringing the population into closer contact with pathogens to which they had not previously been exposed.

As people settled down to undertake farming and populations grew, humans intensified their interactions with potentially pathogenic microbes and parasites. Farming took people into new ecosystems—forests, river flood plains, and grasslands—where they encountered a range of disease-carrying organisms. Additionally, as farmers cleared the land for agriculture, they sometimes inadvertently exacerbated the impact of the disease vectors they encountered by creating breeding grounds for them to flourish. For example, irrigation systems created pools and canals of water, providing a welcome environment for mosquitoes—vectors of malaria, yellow fever and filariasis (an infection of filarial worms, which can cause elephantiasis)—to rapidly reproduce. Even today, various farming techniques, such as the environmentally damaging slash and burn agriculture in the Amazon forest, create disease and vector breeding grounds in abundance.

Success with farming also brought disease literally into the home. When storing surplus food in the structures where they lived, humans unwittingly invited in rodents and the potentially pathogenic parasites that these animals host. This more intimate living arrangement significantly increased the risk that infectious diseases affecting animals would evolve to become *zoonotic*, or transmissible to humans. So too did the domestication of *social animals*. Cattle, pigs, poultry, cats, dogs, sheep, goats, and horses were among the earliest social animals that humans brought into the domestic sphere, thus increasing the possibility that animal diseases would adapt and become ours as well. Many highly contagious *crowd diseases,* which tend to develop in situations of overcrowding and poor sanitation, likely made the jump from domesticated animals, including smallpox from cows; measles from sheep, cattle, and goats; influenza from poultry; and tuberculosis from cattle. Crowd diseases, which are among the oldest established infections humans have endured, emerged in the Old World centers of Mesopotamian civilization (the region now occupied by modern Iraq, eastern Syria, and southeastern Turkey) and India where settled agricultural and pastoral societies developed. Later, with the advent of long-distance commerce along the shipping and camel caravan routes of the ancient *Silk Road*, they exploded into the Roman world and China. These infections, which would also later take a ferocious toll on people in Africa and the Americas, have now become endemic globally.

One of the primary factors fostering the increase in crowd diseases was the emergence of urban centers. Cities set the stage for major epidemics, becoming, in the words of British biochemist John Cairns, the "graveyards of mankind."[7] Beginning around 4000 *BCE* in places such as Mesopotamia and Egypt, people started to create concentrated urban centers. These cities were sustained by a constant influx of people, trade items, food surpluses, and animal products, which constantly replenished possible sources of infection. Moreover, specific developments in these urban centers provided ideal environments for disease to flourish. For example, people created public places where they could congregate, coming into close contact with each other socially and sexually; they butchered meat and prepared and sold food in common places; they defecated and urinated into the water sources they used for drinking and bathing; they generated vast amounts of garbage, which provided food sources and breeding grounds for parasites and disease carriers such as rats; and they created small pools and dark, sheltered havens where mosquitoes could hide and breed.

Epidemics and Pandemics

As the expansion of human populations and urban centers accelerated, so too did the incidence and virulence of new epidemics. The principal means by which epidemics took hold of populations that had little or no tolerance for new diseases were war and long distance trade. The people of Rome, the Middle East, India, and China all exchanged and suffered from a range of epidemic infectious diseases such as smallpox and measles, largely through trade connections. Then, between 1200 and 1500, it is likely that both the Mongol hordes and long distance trade and travel across the *steppe* between China and Europe brought about devastating epidemics of *plague*, with major outbreaks occurring periodically from the mid-1300s until the mid-1600s. Bubonic plague, or the Black Death, was caused by the bacillus Yersinia pestis, a rodent disease transmitted to humans by fleas. As rats from the steppe (where plague is *enzootic* in various populations of rodents) joined humans in the more hospitable and food-rich farming and urban areas of China and Europe, they brought with them this devastating and terrifying disease. *Mortality* from the plague most commonly ranged from 30 to 50 percent in both Europe and the Middle East.[8] The massive demographic impact of the plague—with up to a third of the population of parts of Europe killed—helped limit the further spread of the disease, as too few people were left who could harbor and aid in its transmission. In some cases, such as in London in 1665, it took the combined effect of massive mortality and a raging fire to stifle the rampaging plague. Over time, there were increasing numbers of epidemics and infections, but the rates of mortality declined, suggesting that overall, people in Europe were slowly developing their immunities.[9]

As European imperialists expanded their trade routes and territories into Africa from the early sixteenth century through the twentieth century, they encountered a completely new range of virulent infectious diseases. These included mosquito-borne diseases, such as malaria (one of the world's leading killers,) dengue, and yellow fever, and parasitic diseases caused by various worms. While many Africans had developed immunities to these pathogens, Europeans died in alarming numbers. So high were the rates of mortality that terrified Europeans referred to Africa as the "white man's grave." In exchange, whites brought the equally devastating diseases of syphilis, tuberculosis, and smallpox. In the period of early contact and conquest, many indigenous peoples, such as the San of southern Africa, died in legions from smallpox, while other communicable infections, such as tuberculosis, spread and killed more slowly.

From the late 1500s on, the dramatically increased mobility of people and the infections they carried intensified the spread and severity of epidemics around the world. As Europeans ventured into the Caribbean and the Americas, they brought with them infections with which the local populations had no prior experience, and therefore no immunity. Although forms of tuberculosis, typhus, pneumonia, and various bacteria-based illnesses did afflict Native Americans prior to the arrival of Europeans, the new imports of crowd diseases, including influenza, smallpox, and measles, had a devastating and terrifying effect on them. Similarly, malaria and yellow fever were probably brought to the Americas by European travelers through the accidental importation of the mosquitoes that carry them.[10] These diseases overwhelmed the local peoples, some to the point of extinction. The population of Hispaniola upon Columbus' arrival in 1492, for example, was approximately eight million people. Twenty years latter, the island natives had vanished, a casualty of both disease and violence.[11] Contact with Europeans was so devastating to the health and prosperity of native peoples that Europeans were sometimes explicitly paired with disease in native lore. The Kiowa Indians of North America, for example, tell a story about the arrival of a stranger dressed like a missionary in a black suit and tall hat. When asked who he is by Saynday, the tribe's mythic hero, the stranger responds:

> I'm smallpox…I come from far away, across the Eastern Ocean. I am one with the white men—they are my people as the Kiowas are yours. Sometimes I travel ahead of them, and sometimes I lurk behind. But I am always their companion and you will find me in their camps and in their houses…I bring death. My breath causes children to whither like young plants in the Spring snow. I bring destruction. No matter how beautiful a woman is, once she has looked at me, she becomes as ugly as death. And to men I bring not death alone but the destruction of their children and the blighting of their wives. The strongest warriors go down before me. No people who have looked at me will ever be the same.[12]

The Europeans did bring devastating diseases to native populations, but it is also important to remember that the epidemics that followed Western contact emerged in the context of broader social, political, economic, and environmental upheavals. The conquest and forcible implantation of the European political economy on the Americas had far-reaching and severely disruptive effects. Some local populations near the coast were struck by disease prior to the wars of conquest, while others further inland may have become infected after conquest. In both cases, the rates of mortality and people's responses to epidemics were affected by war and colonialization. Mounting deaths, social dislocation, loss of food stores, and the collapse of governments all increased the likelihood of infections spreading and prevented indigenous peoples from caring for the sick. As with later epidemics, especially in the developing world, social and economic vulnerability greatly exacerbated the impact of epidemics. Over time, however, survivors and their descendents developed resistance to the new diseases. Some indigenous peoples eventually were able to live through childhood infections with progressively fewer ill effects. In other communities, however, the importation of enslaved Africans contributed to the decimation of the remaining native populations. Confronted not only by European diseases but also those from Africa, some native populations did not emerge from this intensified pathogenic assault.[13]

Similar patterns of large-scale deaths of indigenous peoples from infectious disease occurred in other regions of the world where indigenous populations had no previous experience with Old World disease pools. Around the Pacific Ocean, European travelers and colonizers brought tuberculosis and venereal diseases to the Aborigines of Australia, the Maoris of New Zealand, and the Hawaiians. Many of these peoples saw their populations drop by 60 to 90 percent as a result of the new epidemics. The population of the Hawaiian islands upon Captain James Cook's arrival in 1778, for example, was likely around 800,000, a figure which was reduced to a mere 40,000 a century latter due to the introduction of diseases such as syphilis, influenza, and tuberculosis.[14]As with indigenous people elsewhere, those who survived developed immunities, but their drastically reduced numbers and their marginalization by mainstream societies put them at greater risk for additional health problems.[15]

Other cultural practices and material developments have played major roles in the incidence of epidemics as well. The industrial revolution led to increases in both the availability of food and the size of the population, and better nutrition helped people develop antibodies to fight infection. Despite these advances, the industrial revolution also provided for two important disease catalysts. First, new inventions provided for more rapid and far-reaching transportation in the form of steamships and trains. Second, increased demands for agricultural commodities and potential new markets fueled new connections around the globe through imperial conquest. Europeans ventured into new ecological zones in their tropical colonies with greater frequency and so were exposed to additional new pathogens. They also transported these pathogens back to the metropolitan centers with greater ease.

As with later advances in transportation, shorter travel time with steamships and trains meant it was more likely that host humans and their pathogens would survive to transmit the disease to the urban centers of Europe. As more people crowded into cities around the world, congestion, urban squalor, poverty, and inadequate sanitation and public health measures all contributed to epidemics of smallpox and cholera. Although the preponderance of infectious diseases typically afflicted the poor, some epidemics threatened entire societies. Such was the case with a major cholera epidemic that emerged in the British colony of India in the early 1800s and then spread back to Britain. Cholera produces potentially lethal secretory diarrhea and is spread via water supplies contaminated with human waste. It causes severe dehydration and leads to death in approximately 50 percent of those infected (mortality rates are more than 75 percent for infants and the elderly). In 1824, it took hold in the bustling market cities of India and then spread, traveling along the lines of commerce through the Middle East and Europe to the major cities of Britain by 1834. The threat posed by that cholera epidemic around the world was so severe that it prompted the first major coordinated efforts at public health, including the provision of sanitation systems and cleaner drinking water in a number of cities in Europe and elsewhere.[16]

While industrialization and colonialism intensified the interactions between people and pathogens, warfare also created new paths along which infection could travel. During the

Napoleonic Wars (1799-1815), more men died of diseases, especially typhus, than from battle. In the *Crimean War* (1853-56) as well as in the *South African War* (1899-1902), more soldiers and civilians died of diseases such as dysentery than from the fighting.[17] Noncombatants, moreover, faced markedly increased risks of infection as their societies were disrupted, their food supplies were destroyed, and their ability to care for each other was undermined.

The end of the First World War in 1918 saw the emergence of a strain of influenza (flu), unprecedented in its virulence, that infected soldiers and civilians alike. The new global nature of warfare and the strains it placed on societies contributed to the creation of a worldwide *pandemic* of the so called "Spanish flu," as infected soldiers returned to their homes in the far-reaches of the planet. Within months, millions of people who had no previous exposure to the flu succumbed to the particularly deadly strain. It was originally estimated that the pandemic claimed more than twenty million lives, but historians and demographers arrived at these figures in the 1920s before they had taken into account the records of Latin America, Africa, and Asia.[18] Recent estimates suggest that as many as fifty million people may have died of this deadly flu—about two percent of the global population.[19] Over 550,000 people died in the United States alone—ten times the number of American deaths that occurred during battle in World War I. In places where the flu had rarely or never reached prior to the pandemic, the death tolls were even higher. In Western Samoa during the last two months of 1918, for example, 7,542 out of a population of 38,302 died of the flu. Worldwide, most of the deaths occurred within a 6-month period and almost every human population on earth was affected, which has led some to argue that the 1918-19 pandemic was the greatest demographic shock humanity has ever experienced.[20]

The rapid spread and deadly toll of the "Spanish Flu" clearly illustrated that the world was becoming increasingly interconnected, and as a result, new epidemics could quickly explode into global pandemics. Thankfully, however, subsequent pandemics have thus far been less severe. The “Asian flu,” for example, spread to the United States in June 1957, killing about 70,000 Americans.[21] Although the “Asian flu” and other subsequent flu epidemics have not been as virulent as the so-called “Spanish” variety, the medical profession has vigilantly watched for a resurgence of that extraordinarily lethal virus as well as struggled to eliminate its milder forms.

Combating Disease

In the urban spaces of ancient civilizations, *quarantine* and the prompt disposal of the dead were the most widely used tactics to contain the spread of disease. However, because of the limits of knowledge about the origins and transmission of diseases, the success of these efforts was limited. More importantly, until recently, medical care was in short supply, available primarily to the wealthy. There were, of course, a variety of efficacious herbal remedies available to many people. Diviners and shaman also cared for patients using spiritual treatments. Nevertheless, prior to the mid-nineteenth century, there were few major public health measures to combat epidemics of infectious disease.

The devastating impact of disease on armies first prompted organized efforts to contain infection. Initially, better food rations, clean clothing, fumigation for lice and fleas, and, most importantly, provision of clean water supplies and other sanitary measures helped reduce *morbidity* and *mortality* rates among soldiers. Later, the practice of *vaccination*, which had long been used in parts of Asia, started to be used in the West. English physician Edward Jenner developed the practice of vaccination with the cowpox virus in 1798, testing the claim of British dairy farmers that people who were infected with cowpox, a mild disease in humans, became immune to smallpox, a far more serious illness. Jenner collected pus from a cowpox infected woman and injected it into a boy. Later he injected the boy with smallpox, and the boy did not get sick. Jenner called the procedure vaccination, after the Latin word for cow—vacca.[22]

Despite the success of Jenner's experiment, people were suspicious of being infected with a disease just to prevent further infection. As a result, the technique did not become widely accepted until the 1840s. This delay is illustrative of the types of difficulties that medical professionals face when trying to introduce treatments. Similarly, in London in 1849, another physician, John Snow, showed how a cholera epidemic could be stopped simply by cutting off access to the infected water supply. It would take time, however, before the wider society in Britain and Europe adopted safe water standards. Even today, millions of people still suffer from cholera and other diarrheal diseases because of a simple lack of clean water.

Robert Koch's landmark discoveries of the bacilli for tuberculosis, cholera, and anthrax in the late 1800s contributed to the development and acceptance of a more unified *germ theory* of contagion. Following these important medical discoveries, new public health and sanitation measures for combating contagious bacterial infections were rigorously applied in cities around the world. Improved urban housing, sanitation, and especially clean water dramatically curbed the spread of disease, as did the provision of basic healthcare to more people. Although these public health measures were effective and many millions were spared because of them, they were not able to eradicate infectious diseases altogether. One of the reasons for this is that pathogens continue to evolve, making it impossible for humans to wipe out disease once and for all. Moreover, social, economic, and political conditions continue to affect people's experience of disease, including diseases for which there may be cures. For example, although the incidence of tuberculosis (the most deadly disease of the nineteenth century) showed a remarkable decline in U.S. cities by the end of the 1800s, tuberculosis raged on among the black population of South

Africa despite the availability of newly discovered antibiotics. A cure existed, but the racist Apartheid regime relegated black South Africans to segregated urban townships where they were without access to proper treatment.[23]

By the turn of the twentieth century, many in the medical establishment realized that dealing with diseases would require coordinated global efforts. The International Office of Public Hygiene, established in Paris in 1909, helped pave the way for later international medical organizations such as the United Nations' World Health Organization (WHO), the more recent Centers for Disease Control in the U.S. (CDC), and a range of committed medical NGOs such as Doctors without Borders. These organizations continue to monitor and combat disease, saving lives around the world. The twentieth century also saw the development of vaccines for a host of deadly infections, including smallpox, typhoid, diphtheria, polio, and cholera. Walter Reed, the U.S. Army Medical Corps, and a legion of British doctors studying tropical diseases in colonial Africa and Asia, made significant strides in combating malaria and yellow fever through mosquito control.

New drugs and chemicals were also developed in the twentieth century to attack pathogens in the environment and in the body. From the 1940s, antibiotics were used widely, perhaps even indiscriminately, to eradicate bacterial infections in people, and DDT (dichlorodiphenyl trichloroethane) was sprayed over vast stretches of the earth to eradicate mosquitoes. Both penicillin and DDT worked very effectively, for a time. In both cases, however, there were unforeseen consequences of their use. Misuses of antibiotics resulted in infecting organisms developing antibiotic resistance (See Table 7.1). DDT was so toxic that it killed just about everything in its path. Because it did not break down, it remained in the water and the environment, ultimately making its way into the bodies of people and animals. The 1962 publication of *Silent Spring* by American biologist Rachel Carson, which alleged that DDT caused cancer and harmed bird reproduction by thinning egg shells, resulted in a large public outcry against DDT. By the 1970s, many countries, including the US, had banned its use. Controversy emerged, however, around the effects of this decision, since DDT is an effective way of killing disease vectors, such as mosquitoes. By 2006, the anti-DDT climate had begun to shift, as evidenced by WHO's advocacy for the careful, targeted use of DDT in malaria control programs.[24]

Insert Table 7.1, Examples of Drug-Resistant Infectious Agents and Percentage of Infections that are Drug Resistant by Country or Region, here.

<table>
<tr><th colspan="2">Researching to Learn:
Investigating World Health and Disease Issues</th></tr>
<tr><td><u>Organizations</u>
American Society for Microbiology (ASM).
The ASM is the world's largest scientific society of individuals interested in the microbiological sciences. The Society's mission is to advance microbiological sciences through the pursuit of scientific knowledge and dissemination of the results of fundamental and applied research. Microbiology related reports and publications are searchable on ASM's website.
http://www.asm.org/.

Center for Biosecurity.
The Center for Biosecurity is an independent, nonprofit organization of the University of Pittsburgh Medical Center. The Center works to affect policy and practice in ways that lessen the illness, death, and civil disruption that would follow large-scale epidemics, whether they occur naturally or result from the use of a biological weapon.</td><td><u>Online Research Portals</u>
Centers for Disease Control and Prevention.
The CDC publishes the Emerging Infectious Diseases Journal, Preventing Chronic Disease Journal, Morbidity and Mortality Weekly Reports, and hundreds of reports and reference resources.
http://www.cdc.gov/.

PubMed.
Provides access to over 12 million references from 4600 biomedical journals. Many of these references link to abstracts and in some cases, the full text of articles.
http://www.pubmed.gov.

MedlinePlus.
MedlinePlus will direct you to information to help answer health questions. MedlinePlus brings together authoritative information from the National Library of Medicine (NLM), the National Institutes of Health (NIH), and other government agencies and health-related organizations. Preformulated MEDLINE searches</td></tr>
</table>

http://www.upmc-biosecurity.org/.

Centers for Disease Control and Prevention (CDC).
The CDC is one of the 13 major operating components of the Department of Health and Human Services (HHS), which is the principal agency in the United States government for protecting the health and safety of Americans and for providing essential human services. The CDC website provides users with access to news, research publications, and statistics.
http://www.cdc.gov/.

Infectious Diseases Society of America (IDSA).
IDSA represents physicians, scientists and other health care professionals who specialize in infectious diseases. IDSA's purpose is to improve the health of individuals, communities, and society by promoting excellence in patient care, education, research, public health, and prevention relating to infectious diseases. The IDSA website contains a variety of searchable resources and publications for researchers interested in health and disease related topics.
http://www.idsociety.org/.

National Foundation for Infectious Diseases (NFID).
NFID is dedicated to educating the public and healthcare professionals about the causes, treatment, and prevention of infectious diseases.
http://www.nfid.org.

The National Institute of Allergy and Infectious Diseases (NIAID).
NIAID conducts and supports basic and applied research to better understand, treat, and ultimately prevent infectious, immunologic, and allergic diseases. For are included in MedlinePlus and give easy access to medical journal articles. MedlinePlus also has extensive information about drugs, an illustrated medical encyclopedia, interactive patient tutorials, and latest health news.
http://medlineplus.gov/.

National Institute of Allergy and Infectious Diseases (NIAID) Online Research.
Click "Research by Topic" to find information about various global health issues and emerging and reemerging diseases.
http://www3.niaid.nih.gov/research/.

National Library of Medicine (NLM) Gateway.
Allows you to search across multiple resources and databases, including Medline, the NLM catalog, full text biomedical books, and others.
http://gateway.nlm.nih.gov/gw/Cmd.

<u>Statistical Sources</u>
National Center for Health Statistics.
This site provides statistics in a variety of categories, including Health Data for All Ages; Health Care in America: Trends in Utilization; Classification of Diseases and Functioning and Disability; Birth, Injury, and Death Statistics, surveys, reports, etc.
http://www.cdc.gov/nchs/.

WHO Global Burden of Disease Statistics.
The WHO GBD project draws on a wide range of data sources to develop internally consistent estimates of incidence, health state prevalence, severity and duration, and mortality for over 130 major causes, for WHO Member States, and for sub-regions of the world, for the years 2000 and beyond. Find Death and Disability Adjusted Life Years (DALY) estimates, projections of mortality and burden of disease estimates, and health and life expectancy data.
http://www.who.int/healthinfo/bod/en/index.html.

more than 50 years, NIAID research has led to new therapies, vaccines, diagnostic tests, and other technologies that have improved the health of millions of people in the United States and around the world. http://www3.niaid.nih.gov/. *National Institutes of Health (NIH).* The NIH, a part of the U.S. Department of Health and Human Services, is the primary Federal agency for conducting and supporting medical research. Helping to lead the way toward important medical discoveries that improve people's health and save lives, NIH scientists investigate ways to prevent disease as well as the causes, treatments, and cures for common and rare diseases. http://www.nih.gov.	

Infectious Disease and Globalization: The Current Picture

In the years following World War II, advances in controlling and sometimes eradicating infectious diseases led many to optimistically predict that by the advent of the twenty-first century, infectious diseases would no longer pose a major threat to human health. This has not been the case, however, as at least twenty well-known infectious diseases have reemerged since the 1970s, including tuberculosis, malaria, and cholera. Additionally, thirty previously unknown and currently incurable diseases have emerged, including HIV, Ebola, hepatitis C, and the Nipah virus (See Table 7.2). Currently, diseases that account for the most deaths worldwide include acute lower respiratory tract infections, HIV/AIDS, diarrheal diseases, tuberculosis, and malaria.[25] Every year, about 8.8 million people develop TB and 1.7 million die of it. Unless efforts to control the disease become more successful, tuberculosis will claim more than 35 million lives between the years 2000 and 2020. Malaria takes approximately 3000 lives a day, for a total of more than one million a year. In sub-Saharan Africa, AIDS is deadlier than war; while war killed 308,000 people in Africa in 1998, AIDS killed more than two million. Today AIDS claims approximately three million lives a year (See Table 7.3). It is estimated that in the absence of a cure, by 2020, AIDS will have caused more deaths than any other disease in history.[26]

Insert Table 7.2, Emergent Diseases Identified Since 1973, and 7.3, HIV/AIDS, Tuberculosis and Malaria—The Basic Facts, 2000, here.

Although the world has not experienced another flu pandemic like the deadly one that followed World War I, its milder forms remain pervasive and deadly. According to the CDC, every year in the United States, on average:

- 5 percent to 20 percent of the population gets the flu;
- more than 200,000 people are hospitalized from flu complications, and;
- about 36,000 people die from flu.[27]

Historical patterns indicate that influenza pandemics with death tolls that dwarf these average yearly figures can be expected to occur approximately three to four times each century. Although the World Health Organization warns that the occurrence of influenza pandemics is unpredictable, experts agree that another influenza pandemic is inevitable and possibly close at hand. Dr Samlee Plianbangchang, Regional Director for the World Health Organization's South-East Asia Region says, "The threat of a pandemic is very real. It is no longer a question of 'if' it will occur. It is now only a question of 'when?' When this happens, human casualties could be in the order of millions, and severe economic losses would result."[28]

Currently, experts are watching the development of the Avian flu in an effort to prepare for a possible pandemic, and hopefully by doing so, to minimize its casualties. However, the flu virus has frustrated all efforts to create a vaccine that will successfully combat it for more than a few years at a time because the virus itself is constantly changing. The process through which viruses change slightly from year to year is known as *antigenic drift*, while sudden and more substantial changes are called *antigenic shifts*. When a virus undergoes the more dramatic antigenic shift, people are suddenly exposed to a strain to which they have no built up immunological defenses. As a result, epidemics and pandemics are more likely to occur.[29] In regard to the current avian flu threat, the virus has already changed significantly. It now meets two of the three prerequisites that are necessary to incite an influenza pandemic. According to the World Health organization, these prerequisites are:

1) the emergence of a new virus to which all are susceptible.
2) the new virus is able to replicate and cause disease in humans.
3) the new virus can be transmitted efficiently from human-to-human.

Only the latter prerequisite remains to be met, and it is likely only a matter of time before the virus evolves to allow for efficient and sustained human-to-human transmission. The World Health Organization reports that the virus continues to spread to poultry and wild birds in new areas, further broadening opportunities for human cases to occur. Every time a human catches the flu from an infected bird, the virus is given another opportunity to improve its transmissibility in humans, thereby increasing the possibility that a pandemic will occur.[30]

Despite advances in science and technology, infectious diseases clearly remain and will continue to be a major global health threat. In fact, in the first decade of the twenty-first century, the continual evolution of diseases and the acceleration of the HIV/AIDS pandemic in developing countries have heightened rather than lessened the global impact of infectious diseases. The strength of this impact has also been exacerbated by the widening gap between rich and poorer countries in the availability and quality of health care. The emergence and reemergence of infectious diseases, then, must be understood as a complex process that is influenced by many factors. Positioning microbes as the only cause of disease is inadequate and incomplete, as it ignores the fact that human activities are the most potent factors driving the emergence of disease (See Table 7.4). Microbial adaptation and change are certainly important factors that shape disease patterns, influencing emergence, but so too are social, economic, political, climatic, technological, and environmental ones.[31]

Insert Table 7.4, Basic Concepts in Disease Emergence, here.

Disease and the Environment

The human population continues to grow at an astounding, exponential rate, doubling in the last half century to more than six billion people. This dramatic expansion is placing increasing pressure on the natural environment and the resources we depend upon to survive. From air and water pollution to the explosive forces of urbanization, we have both invaded ecosystems where previously unknown and potentially pathogenic microbes live, and we have created the conditions for infectious diseases to thrive and spread. Although there are many complex and interrelated environmental factors affecting the potential spread of pathogens, including temperature, rainfall, and extreme weather events, human activity is often a key element. For example, air pollution has contributed to global warming, increasing temperatures in various regions where malaria and yellow fever carrying mosquitoes breed. Even this slight increase in average temperatures has significantly increased the geographic range and length of the breeding cycle for mosquitoes in some parts of Africa. In Rwanda, for example, mosquito numbers and incidences of malaria have increased between 300 and 500 percent during the 1980s, in large part because of an overall increase in average temperature.[32] Similarly, higher ocean water temperatures have led to an increase in various toxic algae growths, which can affect seafood and cause food illnesses.

Direct expansions into and alterations of the natural environment have also increased the potential for pathogen carrying parasites and viruses to thrive. For example, human engineering to dam rivers and to extend irrigation canals for agriculture has provided ideal new breeding sites for mosquitoes, leading to a dramatic increase in “human made” malaria. Similarly, new road construction and dam building in tropical Africa and Asia have altered patterns of water flow and provided for an increase in the number of snails that harbor the parasite that causes *schistosomiasis* or bilharzia. In Argentina, the expansion of farming into grassland areas triggered the outbreak of a virus that causes *hemorrhagic fever*. As farmers introduced new plants, such as alfalfa and maize, the resident mouse population soared in response to the new food source and the reduction of natural predators. The exploding mouse population left huge amounts of droppings containing the virus, and farmers and workers in the agricultural fields were infected in large numbers. A similar pattern developed in Arizona when suburban expansion in the “Four Corners” region of the United States’ Southwest (an area shared by Arizona, New Mexico, Colorado, and Utah) put people at risk of infection by a form of hantavirus. In May 1993, an unexplained pulmonary illness affected a number of previously healthy young adults. About half of them soon died. Researchers discovered that they had been infected by a form hantavirus, and later they were able to isolate the principle carrier of the disease—deer mice. The sudden cluster of cases emerged because heavy rainfall in the area led to dramatic increases in plant and animal populations; in fact, there were 10 times more mice in the region in May of 1993 than there had been in May of 1992, thereby increasing the chances that mice carrying the hantavirus would come into contact with humans.[33]

Perhaps the best-known case of changing land use patterns affecting the incidence of infectious disease here in the U.S. is that of Lyme disease. In Lyme, Connecticut, the expansion of suburban homes into forested zones contributed to the destruction of natural predators, such as wolves and bears. This led to a dramatic increase in the number of deer and mice (the usual hosts for Lyme disease infected ticks), which in turn led to an increase in ticks. As more and more suburbanites entered the wooded areas, their risk of being bitten by Lyme disease carrying ticks increased.[34]

The destruction of sensitive ecosystems like rainforests also jeopardizes the possibility of making new drug discoveries. Many drugs now used to prevent and cure infections are derived from discoveries made in nature, especially in rainforests, and often by indigenous people who have long used naturally occurring herbal medicines. An estimated one in four purchases from pharmacies in developed countries contains an active ingredient derived from a tropical forest species.[35] By destroying these fragile ecosystems through logging and land clearance, we risk losing the potential to develop a wide range of infectious disease-fighting agents.

Disease and the Food Industry

The food industry also affects the evolution and spread of infectious diseases. The world's food supplies have become increasingly industrialized and centralized in an effort to make farming and food processing more efficient, but doing so has also led to new health threats. Conditions on factory farms are sometimes over-crowded, unsanitary, and thus unsafe for animals and the food products derived from them. For example, the beef supplies for Europe and North America have been threatened by Bovine Spongiform Encephalopathy (BSE or "Mad Cow Disease"). This infection is spread through the use of bad feeding practices—using ground-up cattle parts from infected animals (including the brain and spine) in the feed for other cattle. BSE has been linked to the human form of the disease, Creutzfeldt-Jakob disease, which has killed more than 100 people in Europe.[36] Factory farming has also led to increased use of antibiotics, which contributes to greater microbial resistance to these drugs. Additionally, manure has repeatedly contaminated meat and plant products, causing debilitating and sometimes deadly E. coli infections. In the Fall of 2006, for example, a strain of E. coli known as 0157:H7 sickened 199 people in 26 states who had eaten contaminated Spinach. This particularly lethal strain, unknown before 1982, is believed to have evolved into its current form as the result of industrial agricultural feeding practices. Instead of allowing the cattle to graze in the fields on grass, factory farms house cows in feedlots where they are fed grain. Unfortunately, grain-fed cows provide E. coli 0157:H7 the ideal habitat in which to flourish. In contrast, the bacteria cannot survive long in cattle living on grass.[37]

The reach of the E coli spinach outbreak, affecting 26 states, also highlights another problem with the current farming and processing system: a centralized food system means that more people will be affected if the food supply is contaminated. The meat, milk, and salad that feed millions in the United States are processed by only a handful of companies, which makes them extremely vulnerable to both intentional and unintentional contamination. Rather than affecting only the local population where the food was grown or processed, food contamination today can have a national and sometimes international impact. According to the Centers for Disease Control and Prevention, our nation’s food supply yearly sickens 76 million, kills 5000, and puts more than 300,000 people in the hospital.[38] An intentional contamination of our food supply by terrorists could have even far more widespread and devastating consequences.

Global Connections: Urbanization, Air Travel, and Migration

In 2005, 3.17 billion people out of the total world population of 6.45 billion lived in urban centers. By the year 2007, half the world's population was living in cities, a historical first. Trend watchers predict that these figures will continue to rise, forecasting that by the year 2030, nearly 5 billion out of 8.1 billion people will live in urban centers. These figures indicate that the populations of cities will grow at almost twice the rate of the total global population. Most of this growth will be concentrated in the developing regions of Asia and Africa. While the developed world's cities in Europe, North America, and Latin America are currently growing at an average rate of .75 percent a year, annual urban growth rates are at 4.58 percent in Sub-Saharan Africa and 3.82 percent in South-Eastern Asia.[39]

Population growth in the twenty-first century has been and will continue to be accompanied by the increasing size and influence of *megacities* and *metacities*. Megacities are high-density urban centers with populations of at least 10 million (See Table 7.5). Though they are currently home to less than 10 percent of the world's urban population, megacities will likely be the primary locus of future urban growth in developing nations. Trend watchers predict that by the year 2020, there will be 12 megacities in Asia alone, and that all but four of the world's megacities will be in the developing world. Today, Lagos, Nigeria is the fastest growing megacity in the world, expanding at more than five percent a year. Like megacities, metacities are urban areas with huge populations, but metacities consist of several cities, towns, and suburbs that have expanded so that they coalesce into a single sprawling urban conglomeration of more than 20 million people. Today, Tokyo is the largest metacity in the world, with a population of more than 35 million, a figure that surpasses the population of Canada. Experts predict that by 2020, Mumbai, Delhi, Mexico City, Sao Paulo, New York, Dhaka, Jakarta, and Lagos will all have grown into metacities.[40]

Insert Table 7.5, Basic Concepts in Disease Emergence, here.

Although cities are often assumed to be centers of wealth and culture that stand in sharp contrast to the difficult conditions characterizing rural life, increasingly poverty is shifting from rural areas to urban regions. Many people who migrate to cities in search of a better life instead find themselves among the nearly one billion residents of the world's slums—squalid and overcrowded urban areas populated by the poor. Approximately one out of every six people on the planet lives in an urban slum.[41] More than 90 percent of the world's slums are located in cities in the developing world. The slums of Mumbai alone are home to more than five million people.[42] Sub-Saharan Africa has the highest slum and urban growth rates, at 4.53 percent and 4.58 percent per year respectively, and in many of its cities, 70 percent of the population live in slums. Slums in Sub-Saharan Africa are also the most deprived, with many residents lacking access to water, sanitation, and/or durable housing. Although countries such as Egypt, Thailand, and Tunisia have both reduced slum growth and improved exiting slums, the slum problem is increasing so rapidly in other countries that forecasters predict that the global slum population will grow at the rate of 27 million per year between 2000 and 2020.[43]

Rapid urbanization in the form of slum growth creates sprawling venues where poverty and disease are pervasive and difficult to escape. According to UN-Habitat, the one billion people who live in slums around the world are more likely to suffer from hunger and disease and to die earlier than their urban counterparts who do not live in slums.[44] Poor living conditions, including contaminated water supplies and the absence of sewage systems, make slum residents vulnerable to a variety of diseases. In slums like those in Mumbai, 73 percent of the households only have access to public toilets, many of which are health hazards due to overuse and poor maintenance.[45] In Mbare, a neighborhood in Zimbabwe's Harare, up to 1,300 people share one communal toilet consisting of six squatting holes. Because of these types of unsanitary conditions, as many as 1.6 million people living in slums die annually. [46] The young are particularly vulnerable. In Sub-Saharan African cities, for example, children living in slums are more likely to die of water-borne and respiratory illnesses than their rural counterparts.[47] Children under the age of five living in slums in Rio de Janeiro are three times more likely to die than those living in non-slum areas of the city, while the mortality rate for children under five in Cape Town is five times higher than the rate in high-income areas.[48] Pneumonia, diarrhea, malaria, measles, and HIV/AIDS, the five illnesses that cause more than half of childhood deaths, are all pervasive in slums. HIV/AIDS in particular is far more prevalent in slums than in rural areas. In Sub-Saharan African countries such as Kenya, Tanzania, and Zambia, the number of city dwellers infected with HIV is nearly double that of rural populations. Women and girls living in slums are a particularly vulnerable population, as poverty forces them to engage in risky sexual behavior.[49]

Disease spreads swiftly in slums, which poses a danger both to the larger city of which the slum is a part as well as to the rest of the world. As a result of the prevalence of air travel, diseases can now rapidly and seemingly randomly crisscross the globe. In 2005, Airports Council International (ACI) facilities handled 4.2 billion passengers, with Atlanta International Airport alone handling 85,907,423 travelers (see table 7.6). [50] The ease and prevalence of international air travel means that people who live in cities are more closely linked to the developing regions of any other major city around the globe than ever before. As Dr. Gro Harlem Brundtland, Director-General of WHO, has said, “In a globalized world, we all swim in a single microbial sea.”[51]

Insert Table 7.6, : Passenger Traffic 2005, here.

People and the infections they carry tend to travel along the fault lines not only of poverty but also of displacement. In 2005, there were more than 190 million international migrants, comprising approximately three percent of the global population. Some of these migrants left home in search of work, while approximately 13,500,000 others were forced to flee their homes as refugees.[52] Because migrants are often poor and without access to health care, they are more likely to carry infections than many other segments of the population. Moreover, many are forced to live in refugee camps, places which are notorious reservoirs of infection.

In Focus: AIDS and Globalization

The crisis of the current AIDS pandemic reflects the patterns of inequality and globalization that influence the spread of infectious diseases. AIDS, which develops from HIV (Human Immunodeficiency Virus), causes a debilitating and fatal suppression of the body's immune system, leaving the sufferer highly susceptible to a broad range of lethal illnesses, especially infectious diseases such as tuberculosis. It is transmitted through sexual contact, and unless treated by an expensive and complicated regime of anti-retroviral drugs, it kills within a few short years. AIDS probably emerged from the central African rain forest, crossing from primates to humans sometime after World War II. Thereafter, it smoldered, slowly, until the intensification of trade, travel, and poverty ignited an explosive pandemic in the 1980s. As Paul Farmer has argued, AIDS followed the contours of the international socioeconomic order, and it traveled along the fault lines of poverty and inequality.[53]

In its early stages, the AIDS pandemic was stigmatized as a localized infection primarily afflicting gay men and Haitians. These were inaccurate views, however, often born of ignorance and fear. There are currently more than 39 million people infected with AIDS, the vast majority of whom are heterosexual. Although AIDS is a preventable disease, more than 30 million people have likely died of it. Of the 2.9 million people who died of AIDS in 2006, 2.1 million (or 72 percent) were from Africa.[54] The pandemic is particularly devastating for developing societies. It wipes out households, renders millions of children orphans, and reduces life expectancy from 20-30 years in some countries. Africa and Southeast Asia are currently the worst affected.

Increasingly, AIDS is also a disease of young women. In Africa, 59 percent of people infected are women, and young women between 15 and 25 years are three to five times more likely to become infected than their male counterparts.[55] This statistic is due in large part to gender inequity, illustrating that AIDS, like many diseases, also strikes along the lines of inequality. Women are particularly susceptible because of their compromised social and economic status in many societies. For example, women are sometimes placed in financially and socially compromised positions where they cannot make independent decisions about their lifestyle, sexual practices, and work. Avoiding unprotected sex is critical, since it poses the greatest risk of infection, but it can be difficult for women to do so if they are expected or forced to have unprotected sex with, for example, promiscuous husbands upon whom they depend financially. Additionally, women withstand the worst of the stigma associated with AIDS, and many are accused of spreading the disease, even though the reality is that men tend to have more sexual partners than women, thereby increasing their risk of exposure and of infecting others.[56]

Although patterns of sexual behavior are an important and obvious component in the spread of AIDS, societal disruptions often set the context for the transmission of HIV/AIDS. In southern Africa, for example, civil wars have torn apart many communities, inciting men to leave their homes as soldiers or refugees, and subsequently to take new sexual partners. In other cases, particularly in conflict zones, rape is prevalent. The regional economy also has a profound impact on the spread of AIDS. Southern Africa has long been a place where people have been forced into migrant labor. From the early days of mining in South Africa to the recent explosion of trucking commerce throughout the region, African men and women have been driven out from their homes in search of work, often having to leave partners and family behind. This has disposed them to take up new partners or engage in the sex trade. Not surprisingly, the rates of HIV infection for sex workers, soldiers housed in same-sex barracks, and long distance truckers and other migrants are very high. Similar patterns hold true for AIDS on the global dimension. The international search for work by migrant laborers, and the displacement of refugees by conflict has also increased the spread of AIDS and other infections. Although this disease has the potential to affect anyone, it is spreading most intensively among people in compromised situations who are least able to cope with it.

The Global Fight against Infectious Disease: Current Challenges

The AIDS crisis highlights some of the challenges involved in fighting infectious disease on a global scale. A patient’s overall health status and level of nutrition, both of which are likely to be substandard for the poor in developing countries, are important for withstanding the effects AIDS and AIDS related secondary infections. Since AIDS makes people vulnerable to almost any type of infection, it also requires a broad range of treatments. But the poor cannot normally afford the high price of drug treatments for either AIDS or for the secondary infections associated with it. In South Africa, for example, which has one of the world’s highest rates of HIV/AIDS, with more than 30 percent of the population likely infected, expensive drug treatments, some costing $10,000 or more a year, have been out of reach for most South Africans. In an unfortunate twist, the president of South Africa, Thabo Mbeki, further discouraged the use of AIDS drugs by invoking fears that the West was using Africans as “guinea pigs” for drug regimens. The result has been a terrible delay on the part of both Western pharmaceutical companies and the South African government in making life-sustaining drugs available.

There are also a variety of other problems that prevent drugs from reaching the people and communities who need them. Although pharmaceutical companies are constantly developing new drugs, this process takes a long time and is very costly. As a result, companies guard their patents, arguing that the cost of developing the drugs requires that they recover their investment through high drug prices and bans on generic products. But because of these high prices and bans, the majority of the world's poor have no access to pharmaceuticals that could help them. For example, only after significant pressure from NGOs in South Africa and the West did drug companies relax their patents on AIDS drug treatments, allowing South African firms to produce and sell generic versions at a fraction of the cost.[57] There is also little financial incentive for pharmaceutical companies to develop drug treatments for the many diseases that predominantly affect the world's poor. Of 1,393 new drugs developed between 1975 and 1999, a mere 13 (less than one percent) were for treating tropical diseases that afflict the poorest countries.[58] Not only does this raise questions about the ethics of health care in the global community, it also allows infectious diseases to persist in vulnerable populations, which might in turn allow them to burst forth at a latter date onto the world stage.

Global public health efforts have also been set back by violent conflicts. Armed conflict makes people more vulnerable to infectious diseases because it often leads to the breakdown of civil society, undermining a country's ability to provide sound health care or to mount public health initiatives. Such was the case in Nigeria, where local Islamic authorities in the north of the country foiled efforts to institute a polio vaccination program. Globally, polio was close to being eradicated, remaining in only six African countries. However, Nigerian Islamic leaders claimed that the vaccinations were intended to poison people and that they were part of an effort by

Christians and the West to attack them. Underlying this posturing was a long-standing conflict between northern Nigeria and the rest of the country. Nevertheless, the full implementation of the vaccination program in Nigeria was delayed, which led to the emergence of new cases of polio in 17 African states.[59]

Another challenge in the global fight against infectious disease is that most developing countries do not have the funds to support broad public health initiatives. Unequal access to health care yields unequal health status. As such, people in countries without adequate health care are less healthy and less likely to survive infections than those who can afford it. In a vicious cycle, disease both creates and is a product of poverty. Overall, the clear pattern is that many millions of poor people in developed and developing countries alike suffer disproportionately from infectious disease, and as such, they pose a risk to the entire global community.

Conclusion

The history of infectious disease reveals that disease emergence is the product of complex contexts and processes and therefore cannot simply be understood as the result of microbial infections. Rather, human activities are among the most powerful factors driving disease emergence. Any thorough analysis then of how disease functions in a global context must examine the social, economic, political, climatic, technologic, and environmental factors that shape disease patterns and influence the emergence and reemergence of diseases. Recent medical and technological advances have been instrumental in the fight against disease, but the risks and dangers have also increased, as contemporary urbanization, air travel, and migration trends, among others, make us more connected than ever before both to each other and to the diseases we carry. Although it is unlikely that we will ever completely win the fight against infectious disease, we probably can significantly reduce both the incidence of disease and its debilitating impacts. Even the most advanced medical and technological innovations will not make this goal a reality, however, if we fail to address the underlying problems of poverty and inequality that are at the core of this global problem.

Table 7.1: Examples of Drug-Resistant Infectious Agents and Percentage of Infections that are Drug Resistant by Country or Region[60]

Pathogen	Drug	Country/Region	Percentage of Drug-Resistant Infections
Streptococcus pneumoniae	Penicillin	United States Asia, Chile, Spain, Hungary	10 to 35 20 58
Staphylococcus aureus	Methicillin Multidrug	United States Japan	32 60
Mycobacterium tuberculosis	Any drug Any drug Any drug	United States New York City Eastern Europe	13 16 20
Plasmodium falciparum (malaria)	Chloroquine Mephloquine	Kenya Ghana Zimbabwe Burkina Faso Thailand	65 45 59 17 45
Shigella dysenteride	Multidrug	Burundi, Rwanda	100

Table 7.2: Emergent Diseases Identified Since 1973[61]

Year	Microbe	Disease
1973	Rotavirus Virus	Infantile diarrhea
1977	Ebola virus	Acute hemorrhagic fever
1977	Legionella pneumophila Bacterium	Legionnaires' disease
1980	Human T-lymphotrophic virus I (HTLV 1)	T-cell lymphoma/leukemia
1981	Toxin-producing Staphylococcus aureus Bacterium	Toxic shock syndrome
1982	Escherichia coli Bacterium	Hemorrhagic colitis
1982	Borrelia burgdorferi Bacterium	Lyme disease
1983	Human ImmunodeficiencyVirus (HIV) Virus	Acquired Immuno-Deficiency Syndrome(AIDS)
1983	Helicobacter pylori Bacterium	Peptic ulcer disease
1989	Hepatitis C Virus	Parentally transmitted non-A, non-B liver infection
1993	Hantavirus Virus	Adult respiratory distress syndrome

1994	Cryptosporidium Protozoa	Enteric disease
1996	nvCJD Prion	Creutzfeldt-Jakob disease
1997	HVN1 Virus	Influenza
1999	Nipah Virus	Severe encephalitis
2003	SARS-associated coronavirus (SARS-CoV).	Severe viral respiratory illness

Table 7.3: HIV/AIDS, Tuberculosis and Malaria—The Basic Facts, 2000[62]

Disease	Deaths per year	New cases per year	Percentage in developing countries
HIVAIDS	3 million	5.3 million	92%
Tuberculosis	1.9 million	8.8 million	84%
Malaria	More than one million	300 million	Nearly 100%

Table 7.4: Basic Concepts in Disease Emergence [63]

Emergence of infectious diseases is complex.
Infectious diseases are dynamic.
Most new infections are not caused by genuinely new pathogens.
Agents involved in new and reemergent infections cross taxonomic lines to include viruses, bacteria, fungi, protozoa, and helminths.
The concept of the microbe as *the* cause of disease is inadequate and incomplete.
Human activities are the most potent factors driving disease emergence.
Social, economic, political, climatic, technologic, and environmental factors shape disease patterns and influence emergence.
Understanding and responding to disease emergence require a global perspective, conceptually and geographically
The current global situation favors disease emergence.

Table 7.5: World Megacities 1975, 2000 and (projected) 2015: Population in Millions[64]

1975	2000	2015
Tokyo (19.8)	Tokyo (26.4)	Tokyo (26.4)
New York (15.9)	Mexico City (18.1)	Mumbai (26.1)
Shanghai (11.4)	Mumbai (18.1)	Lagos (23.2)
Mexico City (11.2)	São Paulo (17.8)	Dhaka (21.1)
São Paulo (10)	Shanghai (17)	São Paulo (20.4)
	New York (16.6)	Karachi (19.2)
	Lagos (13.4)	Mexico City (19.2)
	Los Angeles (13.1)	New York (17.4)
	Kolkata (12.9)	Jakarta (17.3)
	Buenos Aires (12.6)	Kolkata (17.3)
	Dhaka (12.3)	Delhi (16.8)
	Karachi (11.8)	Metro Manila (14.8)
	Delhi (11.7)	Shanghai (14.6)
	Jakarta (11)	Los Angeles (14.1)
	Osaka (11)	Buenos Aires (14.1)
	Metro Manila (10.9)	Cairo (13.8)
	Beijing (10.8)	Istanbul (12.5)
	Rio de Janeiro (10.6)	Beijing (12.3)
	Cairo (10.6)	Rio de Janeiro (11.9)
		Osaka (11.0)
		Tianjin (10.7)
		Hyderabad (10.5)
		Bangkok (10.1)

Table 7.6: Passenger Traffic 2005[65]

Passenger Traffic 2005			
Rank	**City (Airport)**	**Total Passengers**	**% Change**
1	Atlanta, GA (ATL)	85 907 423	2.8
2	Chicago, IL (ORD)	76 510 003	1.3
3	London (LHR)	67 915 403	0.8
4	Tokyo (HND)	63 282 219	1.6
5	Los Angeles, CA (LAX)	61 489 398	1.3
6	Dallas/Ft Worth Airport, TX (DFW)	59 176 265	(0.4)
7	Paris (CDG)	53 798 308	5.0
8	Frankfurt (FRA)	52 219 412	2.2
9	Amsterdam (AMS)	44 163 098	3.8
10	Las Vegas, NV (LAS)	43 989 982	6.0
11	Denver, Colorado (DEN)	43 387 513	2.6
12	Madrid (MAD)	41 940 059	8.4
13	New York, NY (JFK)	41 885 104	8.9
14	Phoenix, Arizona (PHX)	41 213 754	4.3
15	Beijing (PEK)	41 004 008	17.5
16	Hong Kong, China (HKG)	40 269 847	9.7
17	Houston, TX (IAH)	39 684 640	8.7
18	Bangkok (BKK)	38 985 043	2.7
19	Minneapolis/St Paul, MN (MSP)	37 604 373	2.4
20	Detroit, Michigan (DTW)	36 389 294	3.2
21	Orlando, FL (MCO)	34 128 048	8.4
22	Newark, NJ (EWR)	33 999 990	3.3
23	San Francisco, CA (SFO)	32 802 363	2.0
24	London (LGW)	32 784 330	4.2
25	Singapore (SIN)	32 430 856	6.8
26	Philadelphia, PA (PHL)	31 495 385	10.5
27	Tokyo (NRT)	31 451 274	1.3
28	Miami, FL (MIA)	31 008 453	2.8
29	Toronto (YYZ)	29 914 750	4.5
30	Seattle, WA (SEA)	29 289 026	1.7
Airports participating in the ACI annual traffic statistics collection.			
Total Passengers: total passengers enplaned and deplaned, passengers in transit counted once.			

Glossary

antigenic drift	The process through which viruses change slightly from year to year.
antigenic shift	Sudden and substantial change, seen only with influenza A viruses, resulting from the recombination of the genomes of two viral strains.
BCE	The notation BCE means Before the Common Era. BCE is an alternative notation for BC (Before Christ), and CE is an alternative for AD (*anno Domini*, Latin for "In the year of Our Lord.") The Common Era (CE) is the period of measured time beginning with the year 1 on the Gregorian calendar. The CE/BCE system of notation is chronologically equivalent to dates in the AD/BC system, but it is preferred by many due to the absence of religious references.
Crimean War	War fought from October 1853 to February 1856 mainly on the Crimean Peninsula between the Russians and the British, French, and Ottoman Turkish, with support, from January 1855, by the army of Sardinia-Piedmont.
crowd diseases	Diseases, such as typhus, tuberculosis and smallpox, that tend to develop in situations of overcrowding and poor sanitation
disease	A state in which a function or part of the body is no longer in a healthy condition.
domestication	The controlled selection and protected development of naturally occurring plant and animal species. Through the domestication process, wild biological animals become accustomed to living in the company of and/or laboring for human beings. As a result of human control for multiple generations, the behavior, life cycle, and/or physiology of domesticated animals are altered from their wild state.
endemic disease	Diseases that persist in a specific place for a given population year round at fairly constant rates.
enzootic disease	Disease affecting or peculiar to animals of a specific geographic area.
epidemic	A disease outbreak affecting many individuals in a community or a population simultaneously.
germ theory	The theory that certain diseases are caused by the invasion of the body by microorganisms. The French chemist and microbiologist Louis Pasteur, the English surgeon Joseph Lister, and the German physician Robert Koch are given much of the credit for the development and acceptance of the theory.
steppe	The belt of grassland extending over 5,000 miles, from Hungary in the west through Ukraine and Central Asia to Manchuria in the east.
hemorrhagic fever	Any of a group of viral infections, such as Ebola and yellow fever, that occur primarily in tropical climates, are usually transmitted to humans by insects or rodents, and are characterized by high fever, small purple spots, internal bleeding, low blood pressure, and shock.
immunize/immunization	The process/procedure of rendering a subject immune or resistant to a specific disease. Although the term is sometimes used interchangeably with *vaccination* and *inoculation*, the act of inoculation may not always

	successfully render a subject immune.
infection	A state in which disease-causing microbes have invaded or multiplied in body tissues.
vaccination	The introduction of a mild or “killed” form of a bacterium or virus, or pieces of the pathogen, into a person’s body in order to train the immune system to resist infection by the agent.
megacity	High-density urban centers with populations of 10 million or more.
metacity	An agglomeration of several cities, towns, and suburbs that have expanded so that they coalesce into a single, sprawling urban mass of more than 20 million people.
morbidity	The incidence or prevalence rate of a disease. *Note: morbidity rates refer to the number of people who have a disease whereas mortality rates refer to the number of people who have died from it.*
mortality	The relative frequency of deaths in a defined population during a specified interval of time.
Napoleonic Wars	A series of global conflicts fought during Napoleon Bonaparte's rule over France from 1799-1815.
pandemic	A disease outbreak affecting many people in many different regions around the world.
pathogen	A disease causing organism, such as a bacteria, virus, parasite, or fungus.
plague	Infectious fever caused by the bacillus Yersinia pestis, a bacterium transmitted from rodents to humans by the bite of infected fleas. Plague was responsible for some of the most devastating epidemics in history, including the Black Death in the 14th century, which killed as much as one-third of Europe's population.
protozoa	Single-celled organisms. The word means “little animal,” a name they were given because many species behave like tiny animals, hunting and gathering other microbes as food.
quarantine	Isolation imposed in order to prevent the spread of a disease.
schistosomiasis	A group of chronic disorders caused by small, parasitic flatworms (family Schistosomatidae) and characterized by inflammation of the intestines, bladder, liver, and other organs. Next to malaria, it is probably the world’s most serious parasitic infection, affecting at least 200 million people yearly in Africa, Asia, South America, and the Caribbean.
Silk Road	Ancient trade route linking Rome and China. The 4,000-mile caravan tract started at Sian, followed the Great Wall of China to the northwest, bypassed the Takla Makan Desert, climbed the Pamirs, crossed Afghanistan, and went on to the Levant, where merchandise was then shipped across the Mediterranean Sea.
social animals	Animals that live in close physical contact with other animals in large groups.
South African War	Also called the Boer War, or the Anglo-Boer War (Oct. 11, 1899–May 31, 1902). The war was fought between Great Britain and the two Boer (Afrikaner) republics—the South African Republic (Transvaal) and the

	Orange Free State.
symbiotic	Refers to a relationship where two dissimilar organisms rely upon each other for mutual gain.
vector	An organism, often an insect that transmits an infectious agent to a host. For example, mosquitoes are the vectors for the malaria parasite. Mosquitoes transmit malaria to humans, who act as the carriers or hosts.
virus	A strand of DNA or RNA in a protein coat that must get inside a living cell in order to grow and reproduce. Viruses cause a variety of human illnesses, including chickenpox and AIDS.
zoonotic/zoonosis	An animal disease that can be transmitted to humans.

Notes

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