Some Milestones in the Progress of Modern Sanitation and Medical Science against Disease

If you want to know more about the topics mentioned below, most have good content on Wikipedia; a few other sources are cited in footnotes.

Sanitation, medicine and disease before modern times

- Most cities since the earliest times (c. 3,000 B.C) were cesspits of disease which thrived on the wastes and contaminated waters of dense urban populations.[1] (Edo-period Japan (c. 1600-1860) was an example of an unusually sanitary society before these times).
- Historically, doctors did more harm than good until perhaps the 19th century, e.g. by prescribing 'cures' such as bloodletting or mercury poisoning.
- Folk medicine, whose knowledge was usually retained and passed on orally (i.e. not written down) and often by women, was more effective, but early biological science 'lost' a lot of this knowledge.
- Disease was not understood at all until the late 19th-century; illness was usually attributed to 'bad air'; rotting food etc. was attributed to the spontaneous emergence of life
- Leeuwenhoek discovers microorganisms in 1675[2], but the spontaneous-emergence theory held sway for another 200 years
- (Shift from wood/thatch to brick/stone/slate in major cities underway by 1700; this increases the distance between humans and rats/fleas; Black Death not seen in England again after 1665 (much of London rebuilt after fire of 1666); of course no-one at the time had any idea of this connection.)

The dawn of modern sanitation and medical science

- Vaccination 'discovered' by Edward Jenner in late 18th Century (an effective inoculation technique had much older origins and was introduced to England in 1721 from the Ottoman Empire); part of Jenner's significance his use *systematic observation and testing*, and the publication of his results
- Naval authorities make discoveries such as the role of citrus fruits to prevent scurvy, and the use of de-lousing and quarantining individuals, in the late-18th and early-19th centuries. Many breakthroughs in the science of disease control will stem from the military because, ironically, they have a vested interest in keeping (their own) men alive.
- Florence Nightingale, statistical analysis, nursing movement and importance of sanitation increase from the 1850s, particularly in hospitals and military, but disease still not understood; nevertheless armies increasingly enforce improved sanitation because they observe it to be effective
- Public health management arguably began with 1854 investigation of a local cholera outbreak in London by John Snow; attempts made after this to improve the cleanliness of the city's water supply
- Pasteur proved that micro-organisms originate from other micro-organisms and not from spontaneous generation c. 1860, and proposed the Germ Theory of Disease
- Koch's Postulates, published in 1890, although today obsolete, are probably the best landmark of the arrival of the Germ Theory of Disease, but even after this date it's acceptance was gradual

Major successes, and some limitations

- U.S. Army successfully managed Malaria and Yellow Fever during their 'intervention' in Cuba in 1900, under the management of Army doctor William Gorgas; this was the first time mosquitos were identified as a disease vector, an idea seen as preposterous by the *Washington Post* newspaper

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[1] William H. McNeill, *Plagues and Peoples* (1976)

[2] Robert Hooke was famous for coining the term 'cell' in 1665, when looking at the structure of cork, but his lenses were not powerful enough to observe living cells. Nevertheless his findings make fascinating reading today and reveal some of the thrill of discovering the microscopic world for the first time. You can explore his entire book *Micrographia* (1665) online: http://ebooks.adelaide.edu.au/h/hooke/robert/micrographia/observ19.html

- Disease had played a leading role in the deaths of c. 50,000 Egyptian labourers building the Suez Canal (completed 1869) and thwarted the first attempt at building the Panama Canal, by the same engineer, de Lesseps in the 1880s; however U.S. Engineering firms succeeded in 1904-14, with the same doctor from the successes in Cuba, Gorgas, playing a leading role. Techniques included elmination of mosquito larval breeding cites (covering water barrels and cisterns, draining puddles and ponds, etc.), keeping them away from humans (mosquito nets), and quarantining infected individuals.[3]
- For the first time in history, fewer men in armies fell to disease than to their enemies; arguably, military success in managing disease made the mechanized slaughter of the Great War possible, by allowing enormous numbers of men to congregate in close proximity without succumbing to outbreaks of disease (de-lousing stations on the western front, but typhus was rife on eastern front, and epidemic erupted in Russia during the Civil War (1918-22))
- International conventions on quarantine measures increasingly comprehensive and successful in late 19th-century
- Public health authorities phenomenally successful in tracking and containing 1911 world outbreak of Black Death, through improved observation, analysis, rapid long-distance communication (telegraph), quarantine etc.[4]
- Less successful at containing 'Spanish Influenza' c. 1918-20 (50 million dead; what is the signifcance of those dates?)
- More national and international agencies established and given more funding, especially after World War II (1948), to study and combat disease. Movement of people and animals increasingly well-controlled (e.g. Foot & Mouth restricted areas in UK in 2001; Australia used to (and still does?) search every piece of luggage coming into the country).

<u>The antibiotic revolution, fully modern science & a new arms race</u>

- Evidence-based medical research becomes more and more scientifically rigorous; 1930s-70s great period for medical science in general; since then the frequency of breakthrough drug discoveries (whether antibiotic or other drugs) has declined and their costs increased.[5]
- First antibiotic (penicillin) discovered by Florey & Chain during World War II (following Fleming's earlier work, note also the requirement of chemical engineers such as Margaret Hutchinson Rousseau to scale up production), then many more until the 1980s when the rate of discovery slowed; antibiotics change everything; penicillin alone has saved c. 82 million lives (or limbs?)
- Science goes from defensive to offensive: WHO founded 1948 launched global vaccination campaigns,
    - Climaxed with the eradication of Smallpox in 1979;
    - Rinderpest eradicated in 2011;
    - Malaria vanishingly rare outside tropics and powerful vaccines exist
    - Polio is close to eradication today
    - Tuberculosis was an ancient scourge now rare in the developed world
    - Typhus, borne by lice and once a scourge of armies is also vanishingly rare in the developed world
    - Yellow Fever, which ruled the tropics, particularly the Caribbean, from c. 1650-1900, is now contained by environmental controls and vaccinations
- BUT This creates ecological niche for antibiotic-resistant bacteria, and evolution duly delivers… MRSA just one example with very high resistance (i.e. resistant to most antibiotics); there are many others, and many old diseases developing increasingly drug-resistant strains
- Several old diseases are still active in the developing world:
    - Malaria kills c. 660,000 per year
    - Schistosomiasis/Bilharzia debilitates c. 200 million and kills 12,00 - 200,000 per year
    - Tuberculosis kills 1.5 million per year, mostly AIDS victims, and strains increasingly resistant to antibiotics are emerging
    - Typhus still kills 200,000 per year
    - Yellow Fever 30,000
    - Etc.

[3] J.R. McNeill, *Mosquito Empires* (2008)
[4] William H. McNeill, *Plagues and Peoples* (1976)
[5] Ben Goldacre, *Bad Science* (2001)

- Complete Human genome read by 2000; thereafter genetic (and protein) screening techniques become cheaper and faster; these are useful for understanding both sides of the disease battle: the genetic aspect of hosts' susceptibility, and the pathogens' DNA.
- Increased computing power and more sophisticated chemical engineering raise the prospect of eventually being able to rapidly design and mass-produce vaccinations and antibiotics[6]
- Meanwhile, new diseases (HIV, Ebola), or new strains of old disesaes (Avian Flu) emerge increasingly from the 1980s onwards, leading to millions of deaths (HIV) or just (so far) scares (Avian Flu, SARS)

[6] http://cid.oxfordjournals.org/content/32/5/675.long#sec-5