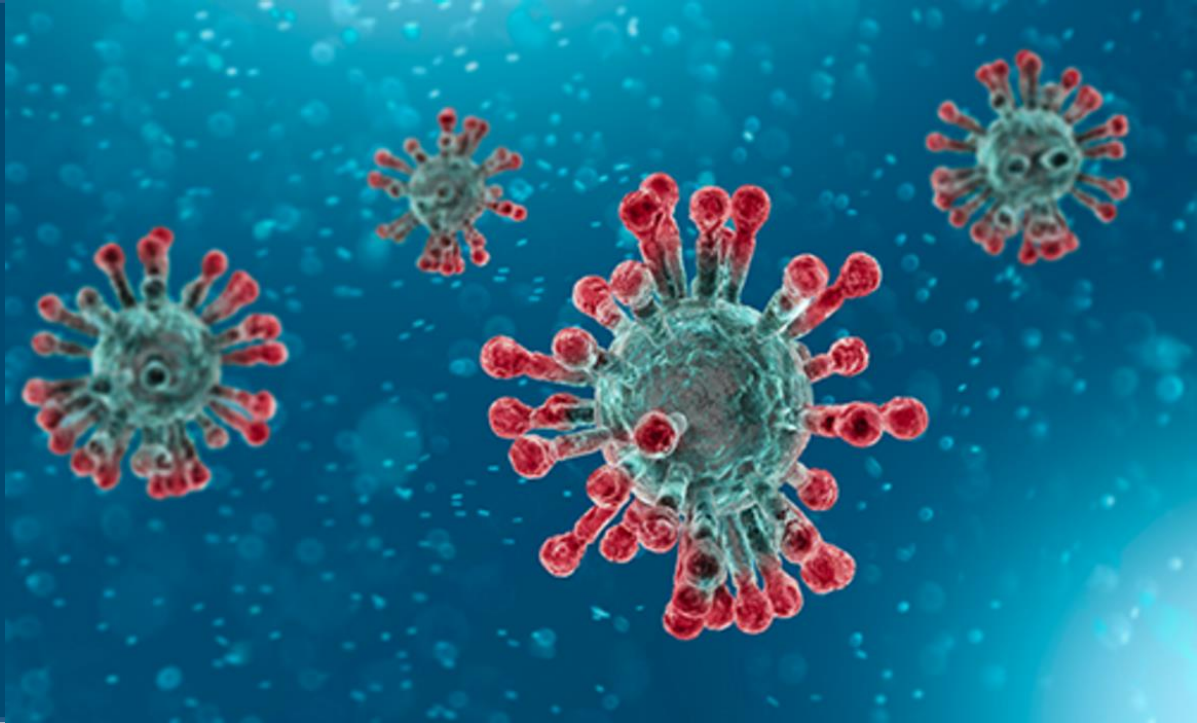
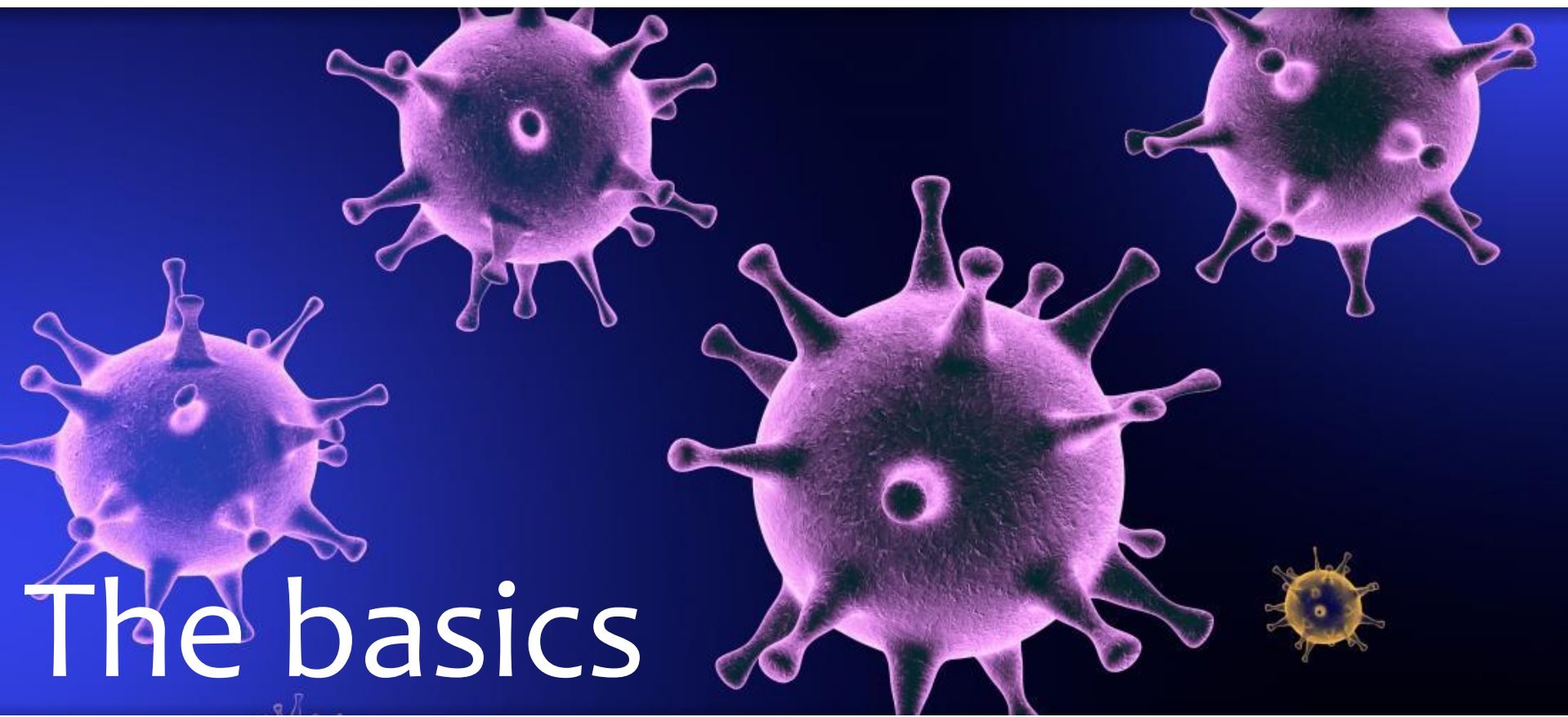


Epidemics and Pandemics



Historical Highlights
From The Great Plague to Novel Coronaviruses



The basics

Definitions

A microscopic image of a virus particle. It features a blue, translucent outer shell with a textured surface. Inside the shell is a dense, yellow-orange core. Several long, thin, reddish-brown filaments extend from the core, giving it a spiky appearance. The background is dark and out of focus.

Merriam-Webster

Epidemic

An outbreak of disease that spreads quickly and affects many individuals in a community at the same time

Pandemic

An outbreak of a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population

Definitions

A microscopic image showing a complex, tangled structure of biological material. The central part is a dense, orange-yellow mass with a textured, almost crystalline appearance. From this mass, several long, thin, reddish-brown filaments or fibers extend outwards, some curving and others straight. The background is dark blue with some lighter, hazy blue shapes, suggesting a cellular or tissue environment.

Epidemiology

Medical science that deals with the incidence, distribution, and control of disease in a population

Etiology

The cause of a disease

Endemic

Regularly found in a certain area

Epidemics and Pandemics Past and Present



PLAGUE – Multiple pandemics caused by bacterium *Yersinia pestis*. Gave rise to quarantine.

CHOLERA – 7 pandemics caused by bacterium *Vibrio cholera*. Gave rise to epidemiology.

SMALLPOX – Many pandemics. Decimated indigenous populations in the New World when brought by explorers. Caused by a virus. Gave rise to vaccination. Has been eradicated from Earth.

LEPROSY – Pandemic in 11th Century Europe caused by the bacterium *Mycobacterium leprae*.

INFLUENZA – Four modern pandemics with epidemics every year caused by influenza viruses.

POLIO – Many 20th century outbreaks and epidemics caused by poliovirus. Stopped by mass vaccination.

Epidemics and Pandemics Past and Present



HIV/AIDS – Pandemic discovered in early 1980s caused by human immunodeficiency virus (HIV).

EBOLA – Multiple epidemics since 1970's caused by ebola virus. Disease limited to Africa.

WEST NILE – Mild disease caused by West Nile virus transmitted by mosquitos occasionally resulting in encephalitis.

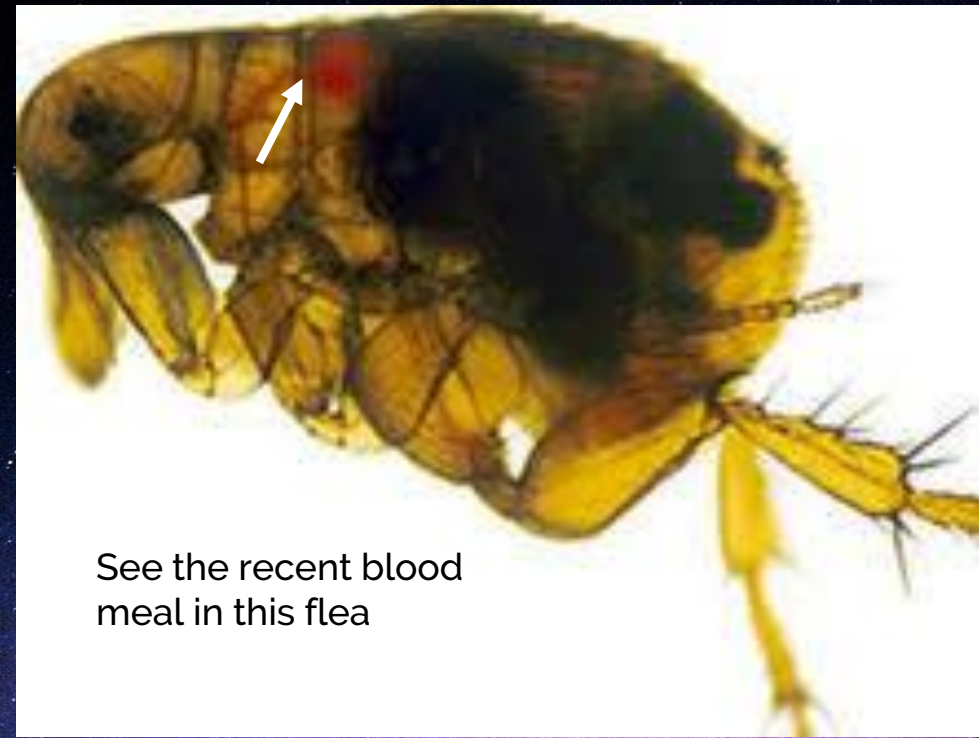
ZIKA VIRUS DISEASE – Mild disease caused by Zika virus transmitted by mosquitos and resulting in birth defects if acquired by pregnant females.

SARS/MERS/CoVID 19 Virus – Recent epidemics and pandemics caused by bat coronaviruses.

Infections such as malaria and tuberculosis caused large outbreaks but were followed by smaller numbers of new outbreaks that became endemic, i.e., never completely disappearing.

the largest pandemic in history





See the recent blood meal in this flea

Plague

Plague is caused by the bacterium *Yersinia pestis*. It is transmitted from diseased rodents (rats were the reservoir) to humans by the bite of infected fleas, and from infected human to human by lice, fleas and respiratory droplets. Those handling and disposing of the dead acquired plague by direct contact with infected tissues.

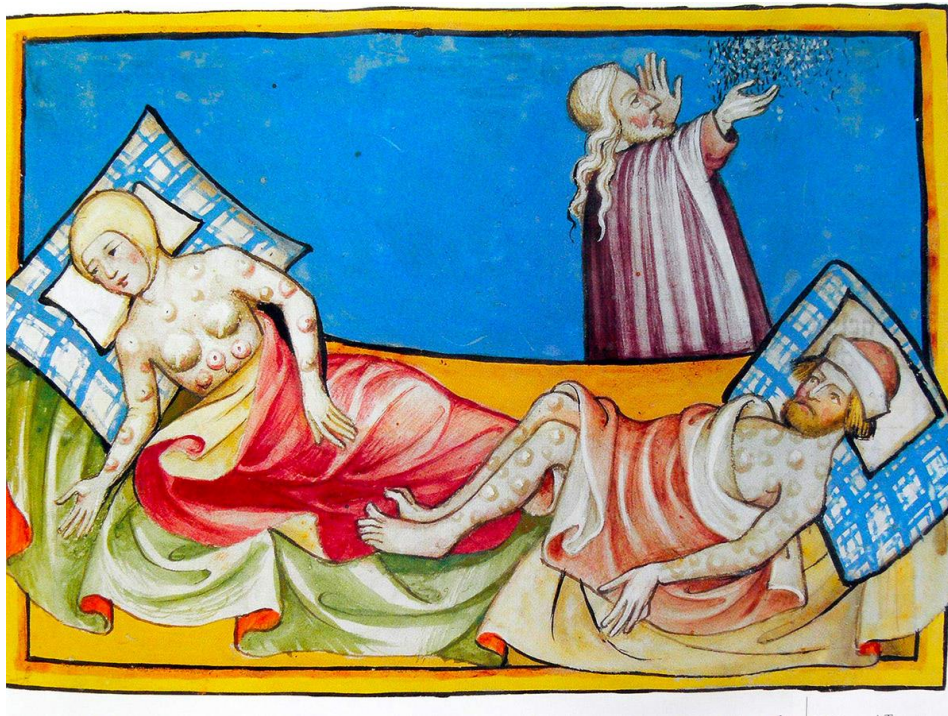
Plague has existed for thousands of years, first described in China in 224 BCE. It has caused many pandemics.

The Three Forms of Plague

bubonic plague is the appearance of buboes (black necrotic lymph nodes and overlying skin) especially in the groin, neck, and armpits; mortality rate varied between 30-75% with death occurring on average within 8 days of exposure. Lymph nodes near the flea bite became infected first.

pneumonic plague is caused by respiratory droplets that directly infect the lungs before the rest of the body, with a mortality rate of 90-95%.

septicemic plague is a form of "blood poisoning" where bacteria invade the bloodstream from buboes or lungs. Mortality rate in the pre-antibiotic era was 100%.



14th Century Plague a.k.a. The Black Death

The most significant outbreak of plague was the **Black Death Pandemic** in 14th Century Europe. Black death referred to blackened skin wounds found on those infected. Recall that the discovery of bacteria as causes of infection was still hundreds of years in the future.

Plague followed **medieval trade routes** from China, through Central Asia and Turkey

Plague arrived in **Italy** in 1347, **England** in 1348, **Oslo, Norway** in 1349

Between 1346-1353

- 33% of China died
- 7,000 died each day in Cairo
- 75% of Florence died in a year
- 50% of Europe died in 3 years
- In a world of 400 million approx. 100 million died in 7 years

How Did Plague Pandemics Come to an End?

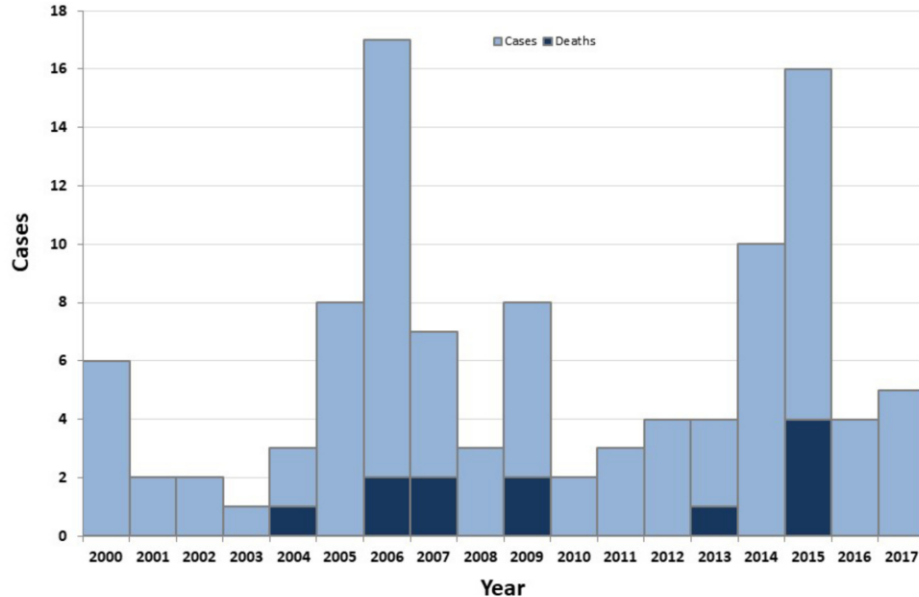


Colonies of *Yersinia pestis* growing on blood agar
HealthNY.gov

People died, or were infected but survived and became immune, or escaped cities to avoid exposure. Over subsequent generations spanning centuries, the plague returned, but when it did officials were able to mitigate its spread by keeping arriving sailors and visitors in isolation until it was clear they were not carrying the disease. In addition, creating social distancing and improved sanitation eliminated or minimized the spread of the disease on land. Sailors and visitors were held on their ships for **40 days (quaranta giorni** in Italian—the origin of the term “quarantine”). The practice is still used today.

Does Plague Still Exist Today?

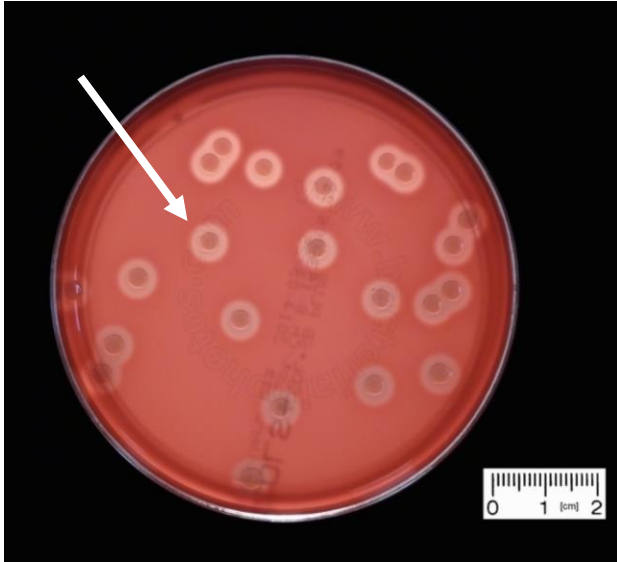
Human Plague Cases and Deaths - United States, 2000-2017



According to The World Health Organization, there are still 1,000 to 3,000 cases of plague every year. In 2017, the largest modern outbreak occurred in Madagascar, infecting thousands and killing 170 people. 2/3rds of the cases were the pneumonic form resulting from human to human transmission. The reservoir was and continues to be the black rat.

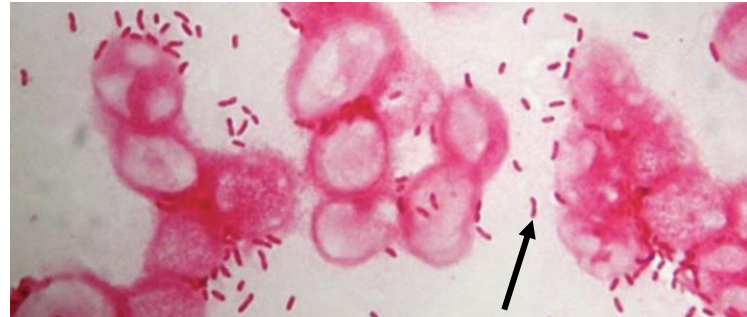
In the United States during recent decades, an average of 7 cases of plague occur each year. The U.S. reservoir is rodent prairie dogs with transmission to humans by flea bites. Plague, when treated early with antibiotics, can be cured.

Cholera Pandemic in England 1864



Colonies of *Vibrio cholerae* each containing 100s of millions of bacterial cells growing on blood agar
CDC.gov

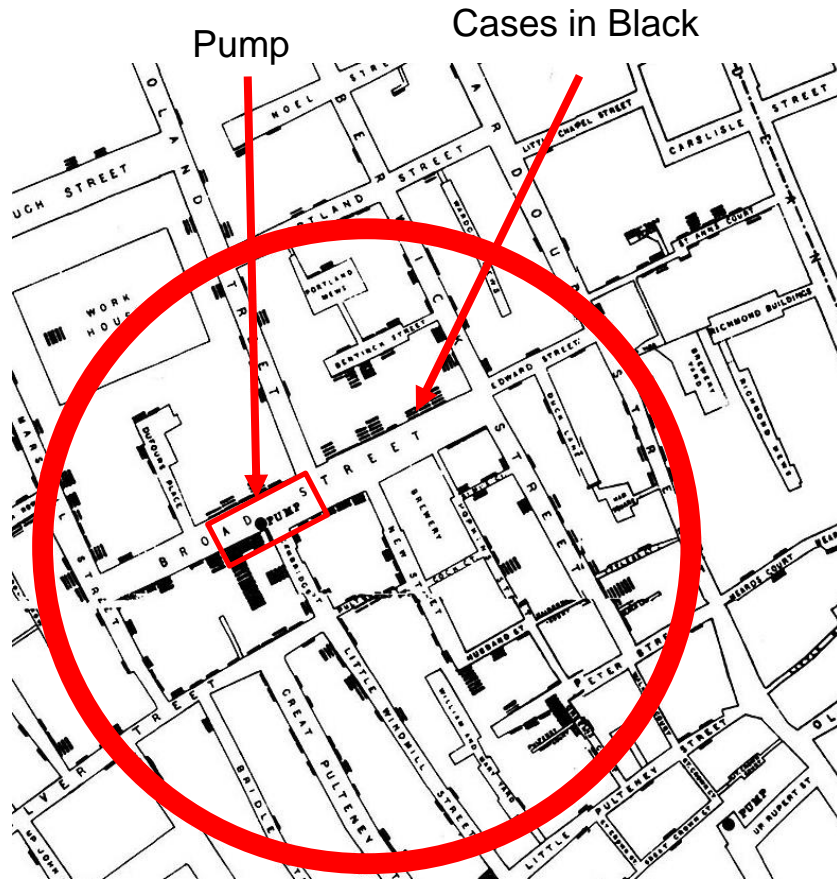
- Cholera is a bacterial infection of the intestine that causes diarrhea and fatal dehydration
- There have been 7 cholera pandemics over the last 200 years
- Between 1831 and 1854, tens of thousands of people in England died during the 3rd cholera pandemic



Stain of *Vibrio cholerae* showing individual bacterial cells. (1000X) Microbe-Canvas.com

Cholera and the Birth of Epidemiology

- In **September 1854**, an outbreak of cholera occurred in the **Soho section of London**
- In three days, 127 people died
- 75% of the residents fled within a week, yet in 10 days a total of 500 people died
- 616 people died by the end of the outbreak
- By carefully mapping cases, **Dr. John Snow** deduced the source of the outbreak as contaminated water from a water pump
- His findings forced authorities to **disable the well pump by removing its handle**
- The outbreak was stopped within weeks and **modern epidemiology** was born
- Decades later, *Vibrio cholerae* was identified as the cause of cholera.



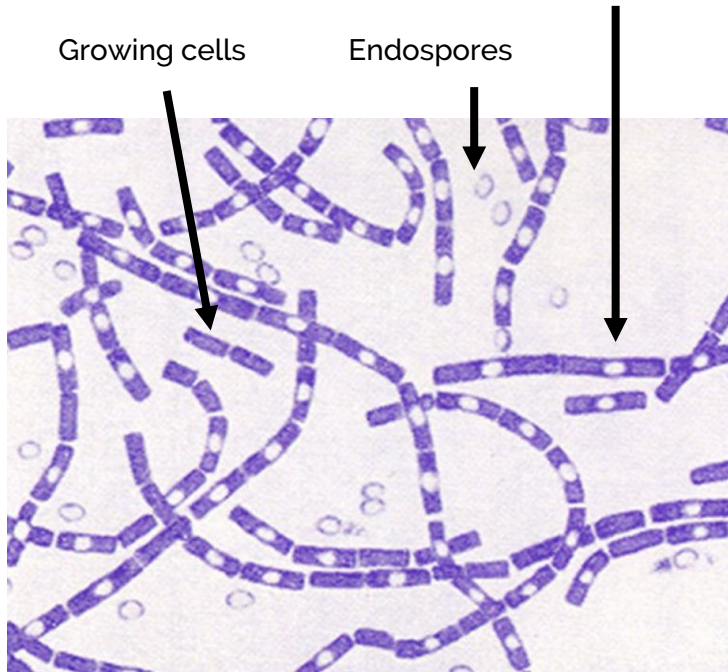
Original map by Doctor John Snow showing cholera cases in Soho



Epidemics

For centuries, the word **plague** has indicated any overwhelming social calamity that spreads quickly causing panic and high mortality. For centuries, contagion overwhelmed countries and continents before modern science learned how to identify and treat bacteria and viruses.

Growing cells forming endospores



Stain of *Bacillus anthracis* showing growing cells, growing cells forming endospores and resistant, non-growing endospores (1000X)

Anthrax

Bacterial infection caused by ***Bacillus anthracis***

- ***B. anthracis*** produces endospores that can persist in the environment for years
- Anthrax is a disease of animals that is transmitted to humans (zoonosis). Infected cattle and sheep transmitted infection to humans through meat and wool
- Because human to human transmission is rare, small outbreaks and region epidemics did not progress to pandemics
- Disease includes black skin lesions at the site of inoculation, pneumonia if spores are inhaled, or intestinal infection if ingested. Mortality when untreated is 25-80%

Was this mislabeled a Bubonic Plague?

- **Symptoms and lack of human to human transmission were used to differentiate anthrax from plague centuries ago**
- Currently there are annually approximately 1000 cases worldwide with 1-2 cases in the U.S



The first electron micrograph ever taken of ebolavirus in 1976. Magnification 160,000X. F.A. Murphy, CDC.

Note the curved irregular shape.

Ebola

- Viral infection caused by the **ebolavirus** named after a river in what was Zaire, Africa (now the Democratic Republic of Congo)
- Ebolaviruses are found in **bats and primates**
- They are transmitted to humans by contact with infected animals (zoonosis) and then by human to human contact through exposure to **infected body fluids**. Airborne transmission has not been proven to occur
- First discovered in 1976, outbreaks and regional epidemics continue to occur in West **Africa**
- Disease, referred to as **Ebola Hemorrhagic Fever**, includes vomiting, diarrhea, rash and extensive internal and external bleeding. Mortality if untreated is 25-90%
- Some scientists think **The Black Death Pandemic** was caused by the ebolavirus, but ***Yersinia pestis*** DNA found in the bodies of 14 century casualties of the Black Plague argue against this theory
- Ebola is not endemic in the U.S. Cases could occur only by importation of an infected animal or human

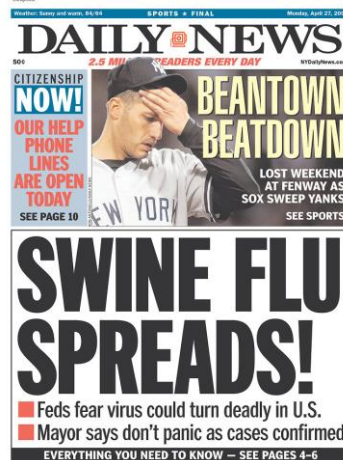
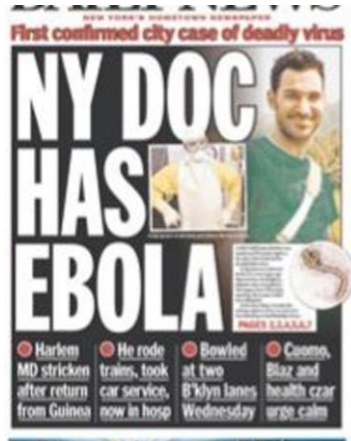
Modern Pandemics

- Examples of pandemics in the last 70 years:
Polio, swine flu, HIV/AIDs, Ebola, Zika, SARS and MERS

- 2020:

CoVID 19 pandemic (Coronavirus Infectious Disease 2019)

Caused by SARS CoV 2 virus (Severe Acute Respiratory Syndrome Coronavirus 2)



Politics & Government

Hundreds Of Lake Foresters Likely Have Coronavirus, Mayor Warns

"Frankly, I expected better from Lake Foresters," Mayor George Pandaleon said, urging residents to take the stay-at-home order seriously.

By Jonah Meadows, Patch Staff

Mar 26, 2020 7:46 pm CT | Updated Mar 27, 2020 2:18 pm CT



Stages of a Modern Epidemic

- **Recognize the potential for epidemic spread**
 - Identify unique patient illness
 - Identify risk of spread
 - **Investigate the outbreak**
 - Detect the pathogen (cause)
 - Identify contact rate and mode of transmission
 - **Manage the risk of spreading**
 - Contain
 - Mitigate
 - Eradicate
 - **Educate the public**
 - authoritative institutions
 - medical scientists
-

The Future

- Pandemics will continue to arise, as they always have: 7 discrete pandemics since 1950
- New pathogens will continue to emerge and most will mutate from animal diseases to infect people
- The most concerning pandemics arise from emerging pathogens that have not been previously encountered, like HIV/AIDS, Ebola, West Nile, Zika, Novel (new to human) Coronaviruses, because humans have no natural immunity
- Education, vigilance and support of the public health infrastructure are critical to effective management and mitigation to keep the death rates down.