Lesson/Week 3. About Diseases and Health

- ✓More key terms
- ✓The geographies of major infectious agents; Where? Why?
- ✓The role of three infectious diseases past and present
- ✓Emerging infectious diseases

Definition of additional terms

Acute: Of abrupt onset, in reference to a disease. Acute often also connotes an illness that is of short duration, rapidly progressive, and in need of urgent care.

Antibody: **A substance produced in the blood to counter toxins and invading organisms.**

Antigen: A substance that stimulates the immune system to manufacture antibodies (immunoglobulins). The function of antibodies is to fight off intruder cells, such as bacteria or viruses, in the body.

Cutaneous **Relating to the skin.**

Chronic: A disease that persists for a long time. A chronic disease is one lasting 3 months or more, by the definition of the U.S. National Center for Health Statistics.

Epidemic: **A rapid spread of a disease affecting a large number of people in a particular locality** at the same time.

Etiology: The study of the cause of a disease

Terms continued…..

Incidence: Fraction of a population that contracts a disease during a specific time

Incubation period: The period between a pathogenic organism entering the body and the beginning of its effects on the body

Infection: An attack by a pathogenic organism.

Infectivity: The ability of a disease to spread.

Inflammation: The reaction of living tissue to an attack by a pathogenic organism, characterized by heat, a swelling, and pain.

Latency: The period of inactivity between the time a stimulus is provided and the time a response occurs

Pandemic A disease epidemic which affects population over a wide geographical area. When applied to plague, the term may refer to a particular cyclic series of widespread epidemics.

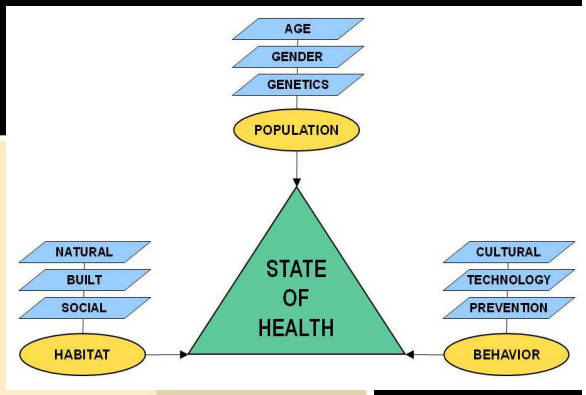
Pathology: The study of disease
Pathogenesis: The development of disease
Primary infection: Acute infection that causes the initial illness
Prevalence: Fraction of a population having a specific disease at a given time
Secondary infection: Opportunistic infection after a primary (predisposing) infection
Subclinical disease: No noticeable signs or symptoms (inapparent infection)
Zoonosis: Also called *zoonotic disease* refers to diseases that can be passed from animals, whether wild or domesticated, to humans. CDC reports that 11 of the last 12 emerging infections in the world with serious health consequences have probably arisen from animal sources.

The geographies of major infectious agents; Where, why?

List of biological agents

- ✓Bacteria
- ✓Viruses
- ✓Protozoa
- ✓Fungi
- ✓Helminths
- ✓Prions

The Stages of a Disease



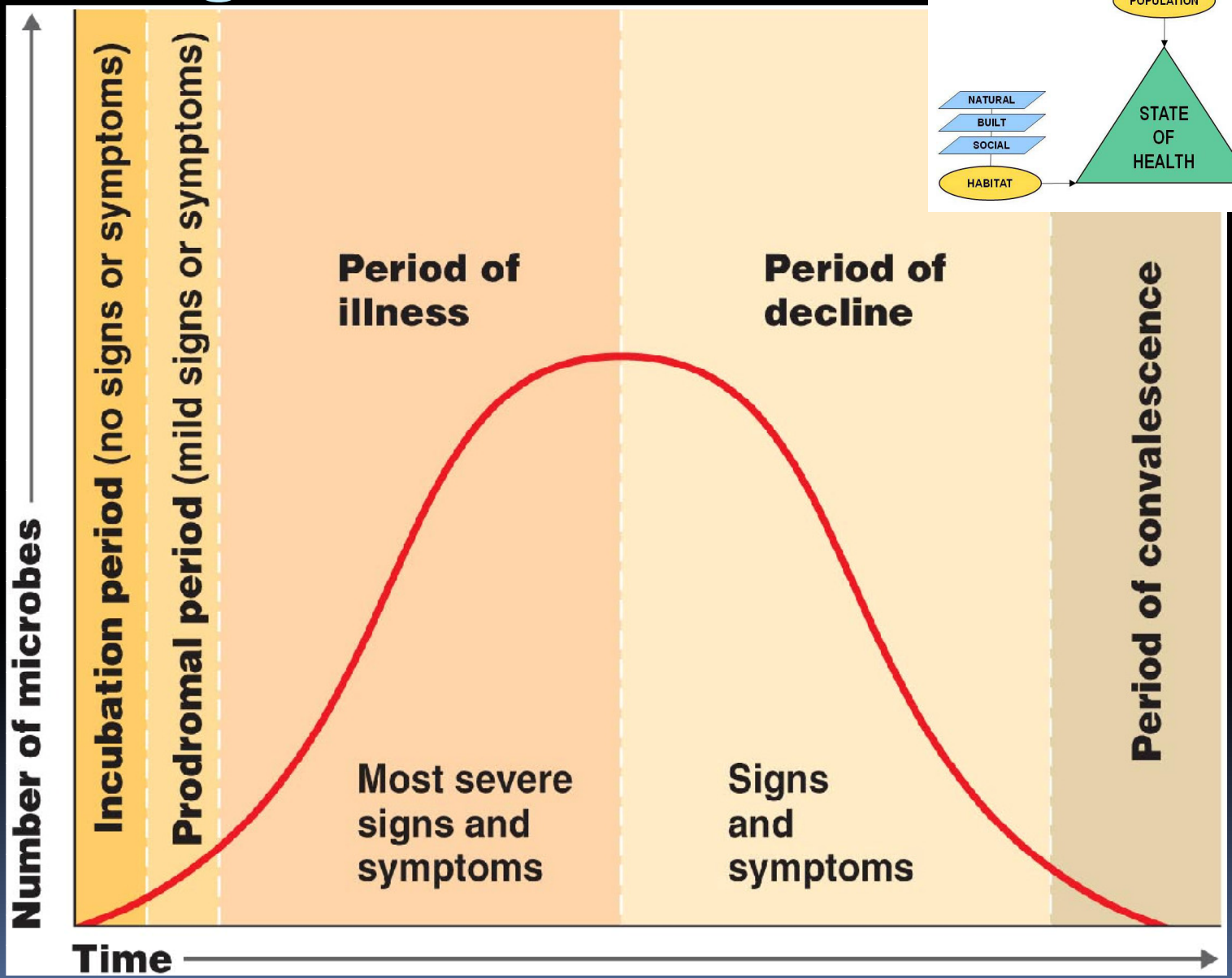


Figure 14.5

Basic facts about disease agents (pathogens):

Microorganisms that are capable of causing disease are called pathogens.

Although microorganisms that cause disease often receive the most attention, it is important to note that most microorganisms do *not* cause disease. In fact, many provide protection against harmful microorganisms.

The terms "infection" and "disease" are not synonymous.

An infection results when a pathogen invades and begins growing within a host.

Disease results only if and when, as a consequence of the invasion and growth of a pathogen, tissue function is impaired.

Our bodies have defense mechanisms to prevent infection and, should those mechanisms fail, to prevent disease after infection occurs.

Basic facts contd…

Some infectious agents are easily transmitted (that is, they are very contagious), but they are not very likely to cause disease (that is, they are not very virulent).

The polio virus is an example: It probably infects most people who contact it, but only about 5 to 10 percent of those infected actually develop clinical disease.

Other infectious agents are very virulent, but not terribly contagious.

The terror surrounding Ebola hemorrhagic fever is based on the virulence of the virus (50 to 90 percent fatality rate among those infected); however, the virus itself is not transmitted easily by casual contact.

The most worrisome infectious agents are those that are both very contagious and very virulent.

Bacteria

- Bacteria are single-celled organisms .
- Bacteria contain DNA but they do not have a nucleus (prokaryotes).
- There are 1,600 known species, but there may be 10 to 100 times more waiting to be discovered.

Major sub-types include (based on shape):

- cocci - round or oval
- bacilli - rod-like
- spirochetes - spiral or corkscrew shaped
- vibrios - curved rods shaped like commas.

Bacteria contd…

Bacteria perform many useful functions in nature, and have been put to use by humans (e.g. sewerage farms, food industry).

- Only a minority of around 200 species cause health problems.

Diseases caused by bacteria include:

- anthrax (*Bacillus anthracis*)
- bubonic plague (*Yersinia pestis*)
- cholera (*Vibrio cholerae*)
- diphtheria (*Corynebacterium diphtheriae*)
- gonorrhoea *(Neisseria gonorrhoeae)*

Bacteria contd…

- leprosy (*Mycobacteria leprae)*
- syphilis (*Treponema pallidum)*
- tetanus (*Clostridium tetani)*
- tuberculosis (*Mycobacteria tuberculosis)*
- typhoid (*Salmonella typhi)*

• Many bacteria can be killed by heat (e.g. boiling, cooking, pasteurization).

o Many bacteria are susceptible to antibiotics.

o However, there is a growing problem of antibiotic resistance due to natural selection.

Viruses

- Viruses are little more than a strand of DNA or RNA enclosed in a protein shell (capsid).
- Viruses vary in size and shape, but they are about 1,000 times smaller than bacteria. Most are too small to be seen by a light microscope.
- Viruses are completely parasitic. It is questionable whether they are a lifeform as they are incapable of an independent existence.
- They reproduce by hijacking a cell's ribosomes, often causing the cell to burst apart.

Diseases caused by viruses include:

- AIDS
- chicken pox
- common cold

- encephalitis
- genital herpes
- hepatitis
- influenza
- measles
- mumps
- poliomyelitis
- rabies
- shingles
- smallpox
- rubella (German measles)
- yellow fever

Viruses contd….

- Antibiotics have no effect on viruses.
- Most drugs that destroy viruses also destroy the host cell.
- The best protection against viruses is provided by vaccines (i.e. weakened strains of the virus that trigger the immune system).

Many viruses mutate continuously rendering vaccines ineffective.

Protozoa

- Protozoa are single-celled eukaryote microorganisms with characteristic organelles (unlike bacteria that are prokaryote)
- Diseases caused by protozoa include:
  - **Malaria (*Plasmodium*)**
  - **Nagana (African Sleeping Sickness) (*Trypanosoma*)**
  - **Chaga's Diseases (*Trypanosoma*)**

Fungus

Fungi are eukaryotic and multicellular, although some, such as yeasts, are unicellular.

Together with bacteria, fungi fulfill the indispensable role of decomposers in the environment.

Many fungi also infect plants and animals.

Examples of diseases caused by fungi are ringworm and histoplasmosis (a mild to severe lung infection transmitted by bat or bird droppings).

Yeasts of the *Candida* genus are opportunistic pathogens that may cause diseases such as yeast infections and thrush (a throat infection) among people who are immunocompromised or undergoing antibiotic therapy.

Antibiotics reduce the bacterial population normally present in the throat and the human female organ, allowing the yeast to grow unchecked.

Helminths

In contrast to the protozoa, helminths (worms and flukes) are multicellular with complex reproductive systems and life cycles . Adults may be dioecious with separate sexes or hermaphroditic.

Because they are animals, their physiology is similar in some ways to ours. This makes parasitic helminth infections difficult to treat because drugs that kill helminths are frequently very toxic to human cells.

Example 1. Schistosome eggs hatch in freshwater, and the resulting larvae infect snails.

When the snails shed these larvae, the larvae attach to and penetrate human skin.

They feed, grow, and mate in the human bloodstream; the damage to human tissues caused by the accumulating schistosome eggs with their sharp spines results in disease symptoms including diarrhea and abdominal pain. Liver and spleen involvement are common.

Example 2. Hookworms **(soil mediated)** . Adults attach to the walls of the jejunum (middle section of the small intestine) and females lay large numbers of eggs that are passed out with the faeces.
The eggs hatch in the soil and infect man by usually burrowing through the soles of the feet.

Example 3. Vector-borne

Filariases: These are arthropod (insect)-borne infections caused by filarial worms wuchereia bancrofti

Onchocerciasis ("river blindness") is caused by Onchocerca volvulus, a tissue dwelling nematode, the microfilariae of which are predominantly found in the eye and skin.

Prions

Prion is an infectious agent composed of protein in a misfolded form.

During the past two decades, evidence has linked some degenerative disorders of the central nervous system to infectious particles that consist only of protein.

These "proteinaceous infectious particles" have been named prions (pree-ons).

The known prion diseases include Creutzfeldt-Jakob disease (in humans), scrapie (in sheep), and bovine spongiform encephalopathy ("mad cow disease" in cattle).

All known prion diseases affect the structure of the brain or other neural tissue and all are currently untreatable and universally fatal.

Rickettsia

Three Groups

- 1. Spotted fever biogroup (15 rickettsioses)
- Example Rocky Mountain spotted fever (RMSF), caused by *Rickettsia rickettsii* ; vector tick

- 2.Typhus group: The causative organisms (*Rickettsia prowazekii* and *Rickettsia typhi*) are similar to those of the spotted fever group but are antigenically distinct.
- Example: Louse-borne (epidemic) typhus; vector louse

- **3. Scrub typhus biogroup**

Example Rickettsia tsutsugamushi; vector: mite

Geography of infectious agents.

The geography of an agent is determined by the geographical distribution of its vectors, reservoirs, intermediate hosts, and hosts.

Example: 1. Scrub typhus (contracted from mite bites).

Scrub typhus is endemic to a part of the world known as the "tsutsugamushi triangle", which extends from northern Japan and far-eastern Russia in the north, to northern Australia in the south, and to Pakistan and Afghanistan in the west.

Example 2: Hantavirus

"In 1993, a previously unknown disease, hantavirus pulmonary syndrome (HPS), was identified among residents of the southwestern United States .

HPS was subsequently recognized throughout the contiguous United States and the Americas (case fatality rate: 37%)

Hantavirus is carried by rodents, especially deer mice.

The virus is in their urine and feces, but it does not make the carrier animal sick.

Humans are thought to become infected when they are exposed to contaminated dust from mice nests or droppings.

p://www.cdc.gov/mmwr/preview/mmwrhtml/rr5109a1.htm

Three Infectious Diseases: Role in Human History

- ❑ Smallpox
- ❑ Influenza
- ❑ Plague

Which one should we worry about the most (or be afraid of)?

Smallpox (430 BC? - 1979)

http://www.oddee.com/item_90608.aspx

Smallpox killed more than 300 million people worldwide in the 20th century alone, and most of the native inhabitants of the Americas.

Known by the Latin names Variola or Variola vera), smallpox is a contagious disease unique to humans.

It is caused by either of two virus variants named Variola major and Variola minor.

The deadlier form, V. major, has a mortality rate of 30–35%.

Smallpox killed an estimated 60 million Europeans, including five reigning European monarchs, in the 18th century alone.

Up to 30% of those infected, including 80% of the children under 5 years of age, died from the disease, and one third of the survivors became blind.

As for the Americas, after the first contacts with Europeans and Africans, some believe that the death of 90 to 95 percent of the native population of the New World was caused by Old World diseases.

It is suspected that smallpox was the chief culprit and responsible for killing nearly all of the native inhabitants of the Americas.

Smallpox was responsible for an estimated 300–500 million deaths in the 20th century.

As recently as 1967, the World Health Organization (WHO) estimated that 15 million people contracted the disease and that two million died in that year.

After successful vaccination campaigns throughout the 19th and 20th centuries, the WHO certified the eradication of smallpox in 1979.

To this day, smallpox is the only human infectious disease to have been completely eradicated from nature.

Spanish Flu (1918 - 1919): http://www.oddee.com/item_90608.aspx

Killed 50 to 100 million people worldwide in less than 2 years.

“ The pandemic came and went like a flash. Between the speed of the outbreak and military censorship of the news during World War I, hardly anyone in the United States knew that a quarter of the nation's population -- and a billion people worldwide -- had been infected with the deadly disease. More than half a million died in the U.S. alone; worldwide, more than 50 million. “

Plague

Two types of plague -**Bubonic plague** (Greek *boubon, groin. Latin plaga, a blow, a* stroke.) - and **Pneumonic plague**

Caused by *Yersinia pestis – a bacteria. Named after Alexandre Emile-Jean Yersin, the* first investigator positively to identify the organism, during the Hong Hong outbreak of 1894

Bubonic plague is essentially a disease of rodents, in particular *Rattus rattus, the black* rat.

The bacillus is transmitted into the human domain chiefly by the black rat's principal flea *Xenopsylla cheopis.*

Bubonic plague is therefore a contagious disease, requiring a vector.

In general, without a flea bubonic plague cannot spread.

In Pneumonic plague the victims having the bacillus in their lungs will cough out infected droplets, which can be inhaled by anyone in close proximity.

Pneumonic plague is thus a truly infectious disease, transmissible with no direct contact necessary.

The Black Death, or The Black Plague, was one of the most deadly pandemics in human history.
It began in South-western or Central Asia and spread to Europe by the late 1340s.
The total number of deaths worldwide from the pandemic is estimated at 75 million people; there were an estimated 20 million deaths in Europe alone.
The Black Death is estimated to have killed between a third and two-thirds of Europe's population.

The fourteenth-century eruption of the Black Death had a drastic effect on Europe's population, irrevocably changing Europe's social structure.

The total number of deaths worldwide from the pandemic is estimated at 75 million people; there were an estimated 20 million deaths in Europe alone. The Black Death is estimated to have killed between a third and two-thirds of Europe's population.

The same disease is thought to have returned to Europe every generation with varying virulence and mortalities until the 1700s.

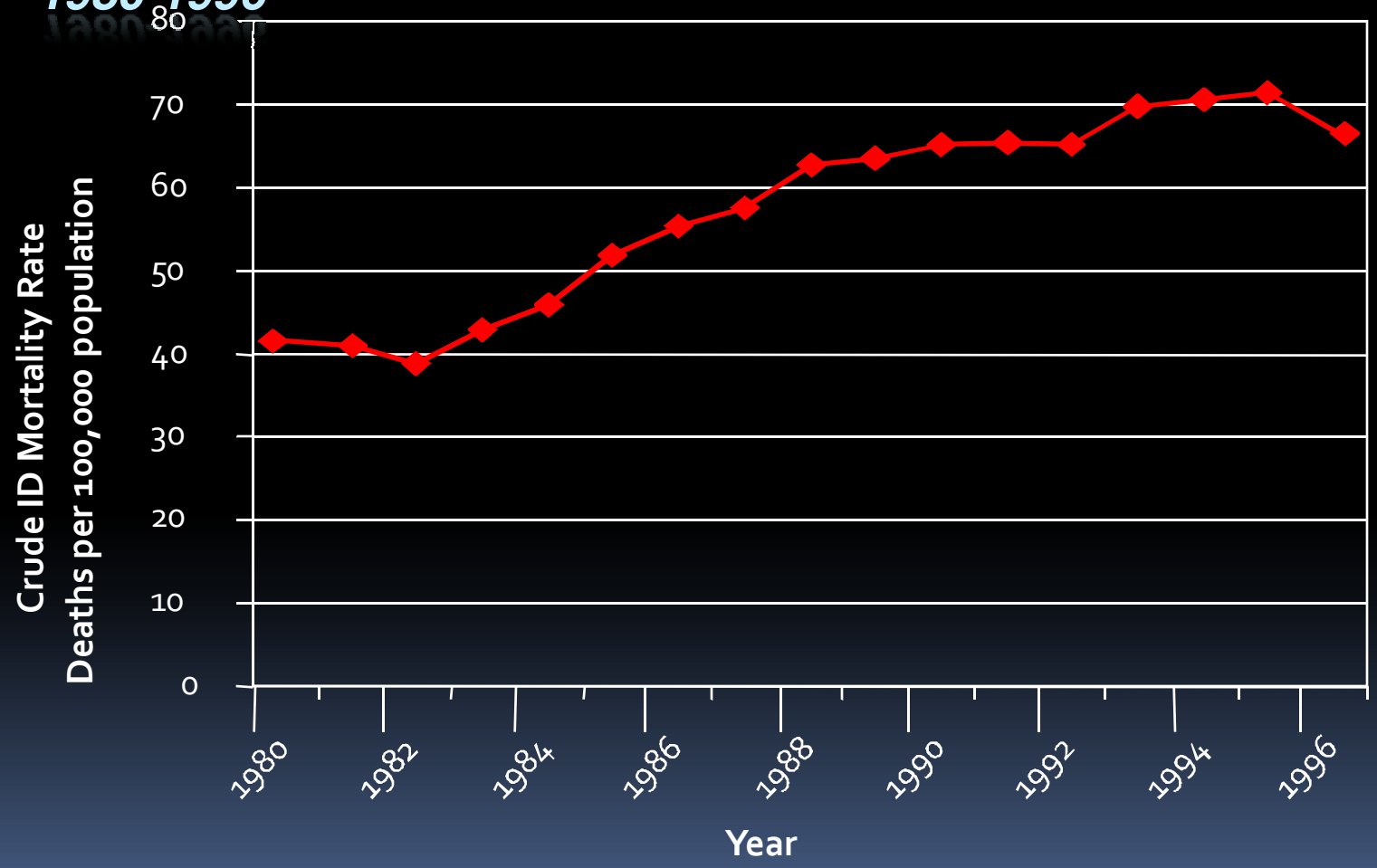
During this period, more than 100 plague epidemics swept across Europe.

On its return in 1603, the plague killed 38,000 Londoners.

http://www.oddee.com/item_90608.aspx

Emerging Infectious Diseases

INFECTIOUS DISEASE MORTALITY IN THE UNITED STATES, 1980-1996



Source: JAMA 1996;275:189-193 and unpublished CDC data

CDC

10 Leading Causes of U.S. Deaths: 1900 and 1997

The 10 leading causes of death as a percentage of all deaths in the United States, 1900 and 1990

Pneumonia
Tuberculosis
Diarrhea & Enteritis
Heart Disease
Stroke
Liver Disease
Injuries
Cancer
Senility
Diptheria

http://ocw.jhsph.edu/courses/EpiInfectiousDisease/PDFs/EID_lec1_Nelson.pdf

1997

Heart Disease
Cancer
Stroke
Chronic Lung Disease
Unintentional Injury
Pneumonia & Influenza
Diabetes
HIV Infection
Suicide
Chronic Liver Disease

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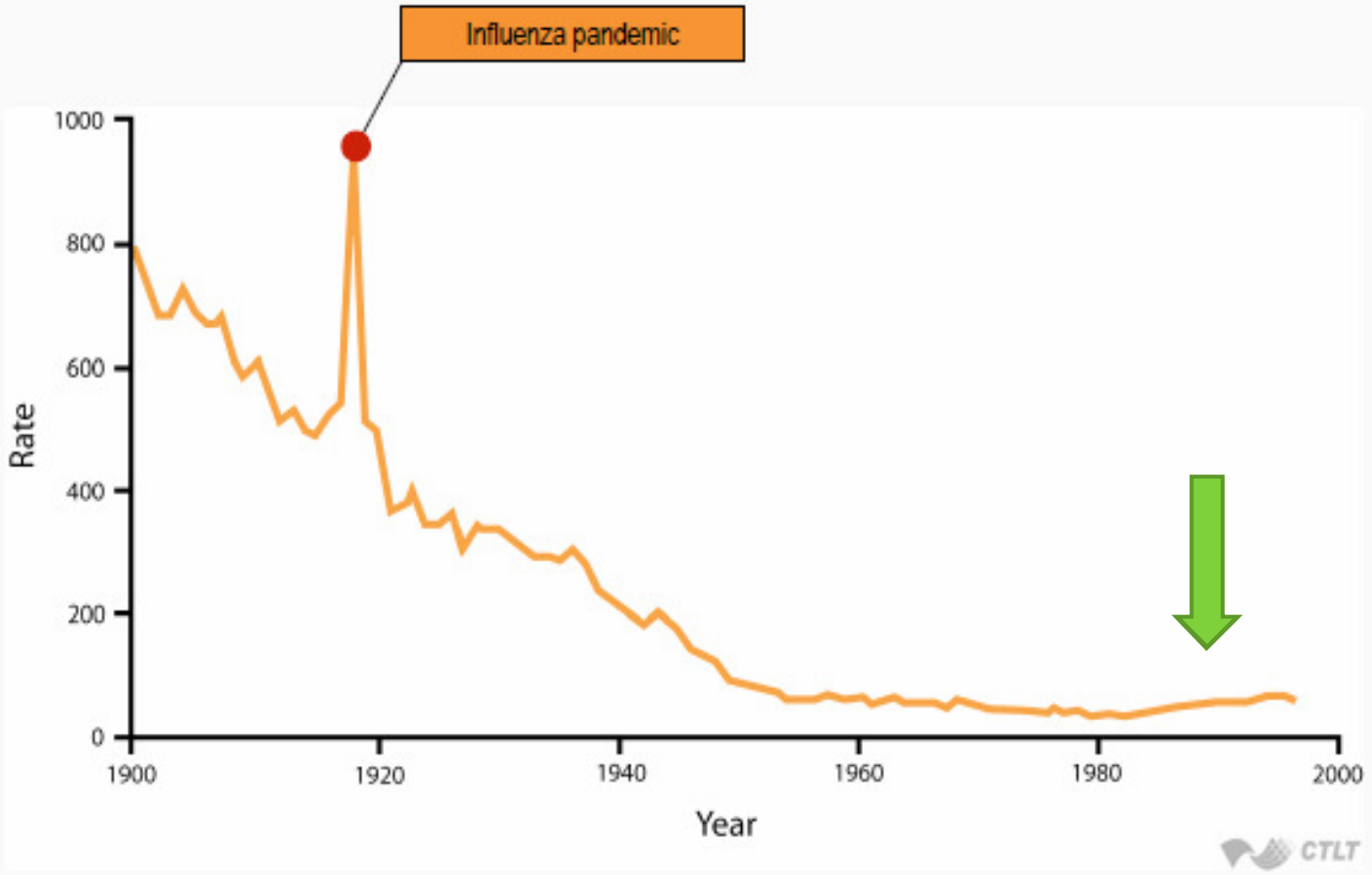
Crude Death Rate* for Infectious Diseases: U.S., 1906–'96



*Per 100,000 population per year

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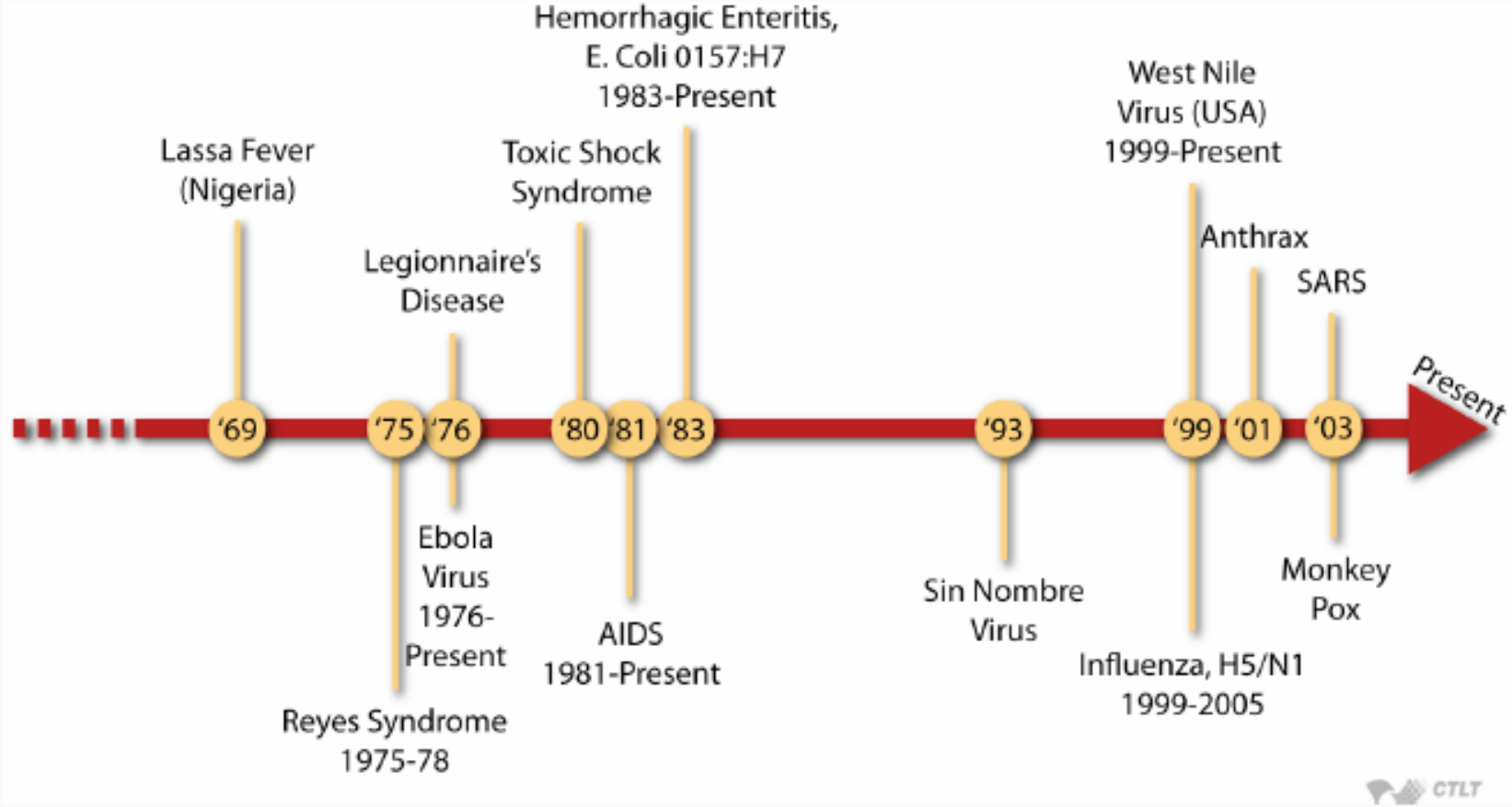
Some Recent Epidemics of Emerging Infectious Diseases



A few examples:

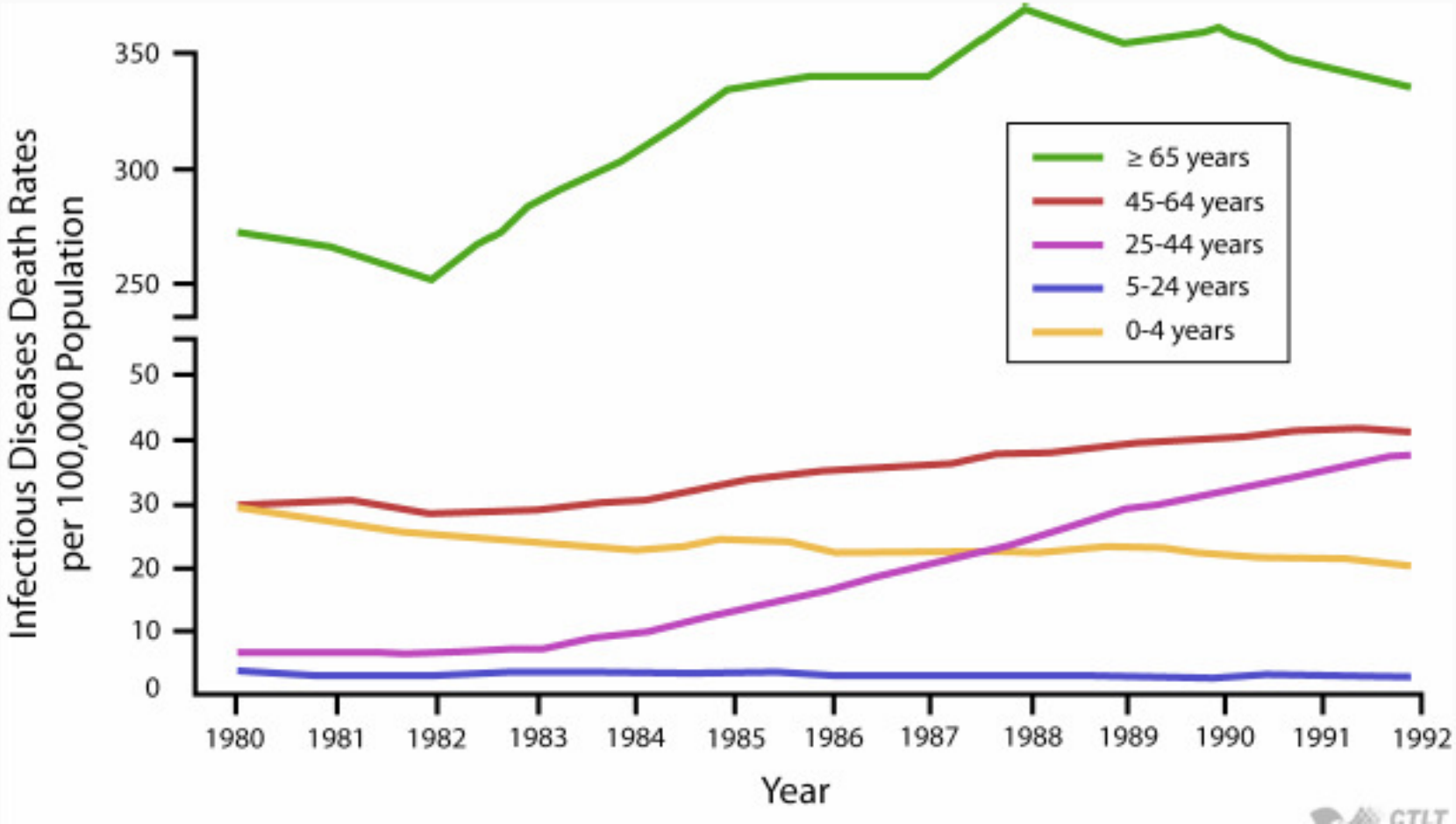
1973	Rotavirus	Enteritis/Diarrhea
1976	Cryptosporidium	Enteritis/Diarrhea
1977	Ebola virus	VHF
1977	Legionella	Legionnaire's dz
1977	Campylobacter	Enteritis/Diarrhea
1980	HTLV-1	Lymphoma
1981	Toxin prod. S.aureus	Toxic Shock Synd.
1982	E.coli 0157:H7	HUS
1982	HTLV-II	Leukemia
1982	Borrelia burgdorferi	Lyme disease

1993	Sin Nombre virus	Hanta Pulm. Synd.
1995	Hepatitis G	Hepatitis
1996	vCJD prion	Variant CJD
1997	Avian influenza (H5N1)	Influenza
1999	Nipah virus	Encephalitis
1999	West Nile virus	Encephalitis
2003	Monkeypox	Pox
2003	SARS-CoV	SARS

http://ocw.jhsph.edu/courses/EpiInfectiousDisease/PDFs/EID_lec1_Nelson.pdf

Trends in Deaths Caused by Infectious Diseases, by Age

- United States,1980–1992, by age group



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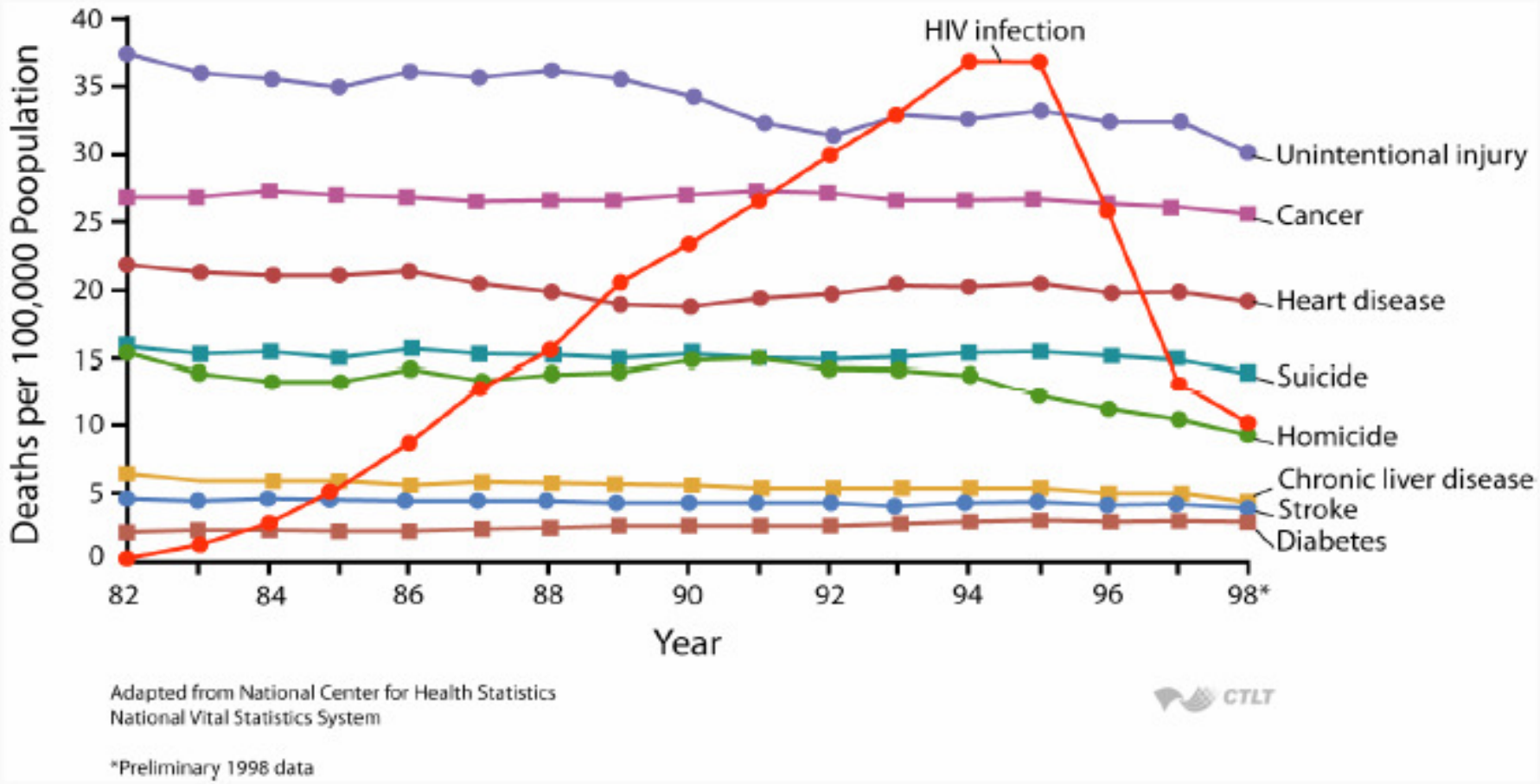
Trends in Death Rates from Leading Causes, Ages 25–44

- Trends in annual rates of death from leading causes of death among persons 25–44 years old, United States, 1982–1998



Factors Leading to Emergence of Infectious Diseases

- AIDS
- Population growth
- Speed and ease of travel
- Dam building
- Global climate change
- Increased antibiotic use for humans and animals
- Encroachment of human populations on forest habitats
  - Industrial commercial agriculture
  - War and social disruption
  - Relocation of animals
  - Growth of daycare
  - Aging of the population
  - Human-animal contact

http://ocw.jhsph.edu/courses/EpiInfectiousDisease/PDFs/EID_lec1_Nelson.pdf